UNIVERSITI PUTRA MALAYSIA

THE NEUROBEHAVIOURAL ASSESSMENT AMONG PESTICIDE HANDLERS IN OIL PALM PLANTATION IN JOHOR

BY
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ABSTRAK

PENILAIAN TINGKAH LAKU NEURO DI KALANGAN PENGENDALI RACUN MAKHLUK PEROSAK DI LADANG KELAPA SAWIT, JOHOR

NORHANA BINTI ABD HAMIS

Pengenalan: Racun makhluk perosak digunakan dalam jumlah yang berbeza pada tanaman dalam sektor pertanian. Kajian cross-sectional ini telah dijalankan di ladang kelapa sawit (FELDA), Johor. **Objektif:** Objektif utama adalah untuk menentukan samada terdapat perkaitan antara tahap pendedahan racun perosak dan prestasi tingkah laku neuro di kalangan pengendali racun perosak yang bekerja di ladang FELDA di Johor. **Kaedah:** Kajian ini telah dijalankan dalam tempoh racun perosak digunakan untuk pokok kelapa sawit. Pensampelan bertujuan telah digunakan untuk memilih responden berdasarkan kriteria yang dikehendaki seperti seperti pekerja lelaki, serta boleh membaca dan menulis. Terdapat 51 pengendali racun perosak lelaki (kumpulan terdedah) terdedah kepada Paraquat dan 51 penuai lelaki (kumpulan yang tidak terdedah) telah dipilih untuk mengambil bahagian dalam kajian ini. Soal selidik telah digunakan dalam menentukan demografi, ciri-ciri kerja, sejarah pendedahan dan status kesihatan. Semua responden dikehendaki menyelesikan 7 ujian bateri teras neurotingkahlaku (NCTB) (abstraksi lisan, perhatian, ingatan, dan kelajuan visualmotor). Penilaian secara pemerhatian terhadap kumpulan terdedah telah dilakukan untuk menentukan penilaian pendedahan (ER) berdasarkan kaedah penilaian risiko kesihatan kimia (CHRA). **Keputusan:** Hasilnya menunjukkan skor prestasi tingkahlaku Neuro bagi kumpulan yang terdedah dan tidak terdedah kepada racun perosak di ladang kelapa sawit, Johor tidak mempunyai perbezaan yang signifikan antara kedua-dua kumpulan ($p > 0.05$). Faktor-faktor pekerjaan seperti penilaian pendedahan (ER) dan tahun pekerjaan mempunyai hubungan yang signifikan ($p < 0.05$) dengan ujian NCTB. Penilaian pendedahan dan merokok didapati menjadi faktor yang mempengaruhi jumlah skor NCTB berdasarkan analisis regresi berganda. **Kesimpulan:** Bukti daripada kajian ini mencadangkan bahawa faktor pengendali racun perosak telah dikaitkan dengan gangguan neurologi akibat pendedahan kepada racun perosak

Kata Kunci: Neurobehavioral core test battery (NCTB), Paraquat, pengendali racun, pendedahan penilaian (ER)

ABSTRACT

THE NEUROBEHAVIORAL ASSESSMENT AMONG PESTICIDE HANDLERS IN OIL PALM PLANTATION IN JOHOR

NORHANA BINTI ABD HAMIS

Introduction: Pesticides are used in varying amounts on crops in the agriculture sectors. This cross sectional study was conducted in oil palm (FELDA) plantation, Johor. **Objective:** The main objective is to determine the association between pesticide exposure level and the neurobehavioral performance among pesticide handlers working in FELDA plantation in Johor. **Methods:** This study was conducted during the period of pesticides applied to the palm oil tree. Purposive sampling was used to select the respondents based on the inclusion criteria such as male workers, and must be literate. There were 51 male pesticide handlers (exposed group) exposed to Paraquat and 51 male harvesters (non-exposed group) were selected to participate in this study. Questionnaire was administered in determining demographic, working characteristics, exposure history and health status. All respondents completed the 7 tests of neurobehavioral core test battery (NCTB) (verbal abstraction, attention, memory, and visualmotor speed). Field observation of exposed group was performed to determine the exposure rating (ER) based on chemical health risk assessment (CHRA) method. **Results:** The result showed the neurobehavioral performance score for exposed group and non-exposed group of oil palm plantation in Johor has no significant different ($p > 0.05$). Working factors such as exposure rating (ER) and years of employment has significant relationship ($p < 0.05$) with NCTB test. Exposure rating and smoking were found to be the factors that influence the total NCTB score based on multiple regression analysis. **Conclusions:** Evidence from this study suggests that working factors of pesticide handlers were associated with neurological impairment due to pesticide exposure.

Keywords: Neurobehavioral core test battery (NCTB), Paraquat, Pesticide handlers, Exposure rating

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LIST OF ACRONYMS AND ABBREVIATIONS

AChE	Acetycholinesterase
ACGIH	American Conference of Governmental Industrial Hygienists
CNS	Central Nervous System
DOA	Department of Agriculture
EPA	Environmental Protection Agency
ER	Exposure Rating
FELDA	Federal Land Development Authority
MPOB	Malaysian Palm Oil Board
NCTB	Neurobehavioral Core Test Battery
OSHA	Occupational Safety and Health Act
USEPA	United States Environmental Protection Agency
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

1.1 Agricultural Importance in Malaysia

Agriculture remains an important sector of Malaysia's economy, contributing 12 percent to the national gross domestic product (GDP) and providing employment for 16 percent of the population. During pre-independence era, the British had established large-scale plantations and introduced new commercial crops such as rubber (1876), palm oil (1917), and cocoa (1950).

Since the last 2 decades, various steps have been undertaken by Malaysian Rubber Board, Malaysian Palm Oil Board (MPOB), Federal Land Development Authority (FELDA), Farmers Organizations and Department of Agriculture (DOA), Forestry Department and Department of Veterinary Services to maximise the use of rubber, oil palm, cocoa and coconut lands by introducing mixed farming on existing land in an effort to increase land productivity and income of farmers (Ministry of Agriculture, 2000).

Among the public sector agencies, FELDA has played significant roles in the development of oil palm in Malaysia. In fact, it is the largest player in the industry in Malaysia, accounting for 17.7% of the total planted area and about 20.6% of the palm oil produced in Malaysia in 2001. In addition, FELDA is also Malaysia largest plantation operator, supporting well over 880,000 hectares of plantation land bank and managing over 530,000 hectares of it. The FELDA Group of Companies has a presence in US, Canada, Australia, Pakistan, China, Sri Lanka, Thailand, South Africa and France (FELDA Holdings, 2011).

In recent years, there has been increasing concern regarding the widespread use of pesticides in agricultural communities and potential impacts on public health. Pesticides are used in varying amounts on crops in the agriculture sectors (including use in the oil palm plantation) to maintain yield and quality. A pesticide is any substance or mixture of substances intended for preventing, destroying, repelling, or mitigating any pest (Environmental Protection Agency, 2006). Insecticides which can be neurotoxic to humans represent the greatest proportion of pesticides used in developing countries because of their relatively cheaper cost. Besides, herbicides also commonly known as weedkillers, have been used in oil palm plantation in order to kill unwanted plants. The major occupational populations at risk are workers in agriculture.

In the 1990s, in the United States, some 2.5-5.0 million agricultural workers were exposed to organophosphate insecticides (Das *et al*. 2001). Organophosphate is one of the prominent insecticide families that commonly are used in agriculture sector to kill the pest and insects. Scientific field investigations have focused on delineating the extent of exposure and potential health effects in agricultural and non-agricultural communities.

Some organophosphate insecticide can produce delayed and persistent in the spinal cord and peripheral nervous system (PNS). The resulting muscle weakness may progress to paralysis. The central nervous system (CNS) is part of the nervous system that consists of the brain and spinal cord. It is one of the two major divisions of the nervous system. The other is the peripheral nervous system (PNS) which is outside the brain and spinal cord. Peripheral nervous system (PNS) connects the central nervous system (CNS) to sensory organs (such as the eye and ear), other organs of the body, muscles, blood vessels and glands (Figure 1.1)

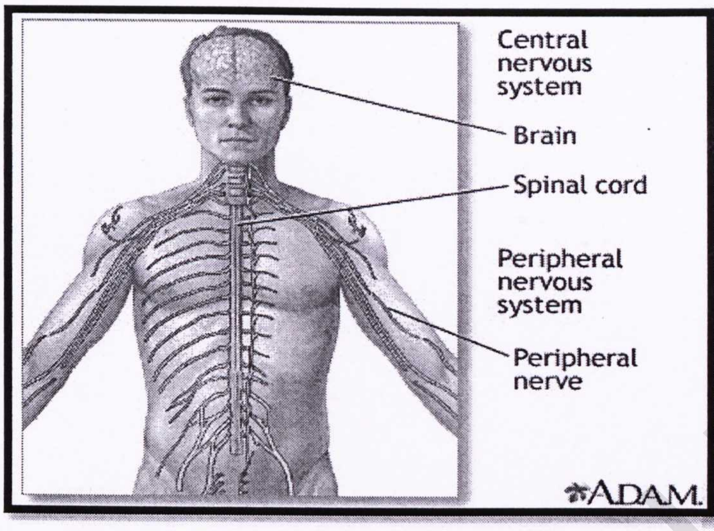


Figure 1.1: Structure of Central Nervous System and Peripheral Nervous System (ADAM, 2009)

Furthermore, herbicides are widely used in agriculture and in landscape turf management. In the U.S., they account for about 70% of all agricultural pesticide use (Kellogg *et al.,* 2000). Herbicides have widely variable toxicity. In addition to acute toxicity from high exposures there is concern of possible carcinogenicity as well as other long-term problems such as contributing to Parkinson's disease.

There is a test that is frequently used to examine the neurobehavioural effects of acute pesticide exposure in adult working populations; which is neurobehavioural (NB) test batteries. Individuals with histories of toxic exposures to organophosphates have shown a consistent pattern of deficits on measures of motor speed and coordination, sustained attention, and information processing speed (Wesseling *et al.* 2002).

1.2 Problem statement

It had been estimated that agricultural industry relied heavily in using pesticide product and accounts for approximately 80% by volume is currently used by the agricultural industry (Donalson, 2002).

A priority for agriculture is to measure pesticide residue levels encountered by those most directly affected by reason of their occupation: the pesticide handlers engaged in agriculture and pesticide exposure. Agricultural worker and pesticide sprayer are expose to pesticide directly when mixing and spraying these pesticides, especially so in developing countries such as Asia (Rampal, 2009).

Furthermore, pesticides are used in an extraordinarily wide range of setting. By controlling agriculture pests, it has contributed to dramatic increase in crop yields and in the quantity and variety of the crops (National Research Council, 1993). Serious epidemics of pesticide poisoning have occurred in the developing world. Besides being beneficial for increasing crop yield as well as in vector programmers, it has resulted in the manifestation of several health-related problems. From the previous study by Hancock *et al.,* (2008), the risk of Parkinson's disease has been shown to increase with occupational exposure to herbicides and pesticides.

For the herbicides, it may cause a range of health effects ranging from skin rashes to death. The herbicide Paraquat is suspected to be one of the environmental factors associated with Parkinson's disease (Oliveira *et al.*, 2006). The route of exposure of herbicides can arise from intentional or unintentional direct consumption, improper application resulting in the herbicide coming into direct contact with people or wildlife, inhalation of aerial sprays, or food consumption prior to the labeled pre-harvest interval.

General health effect that caused by pesticide poisoning (insecticides and herbicides) are nausea, vomiting, diarrhoea, abdominal cramps, headache, excessive sweating and tremors. In serious cases, respiratory failure and death can occur. Examples of chronic effects include birth defects, toxicity to a fetus, blood disorders, nerve disorder, endocrine disruption and reproduction effects (Diane *et al.*, 2006).

In addition, the Environment Protection Agency revised Worker Protection Standard (WPS) in August 1992 for Agricultural Pesticides. The WPS offers protections from occupation exposure to agricultural pesticides to approximately 2.5 million of agricultural workers and pesticide handler (people who mix, load, or apply pesticides) that work at over 600,000 agricultural establishments. This standard also requires for training, notification of pesticide application and use of personal protective equipment (EPA, 2009).

1.3 Study justification

This study was done with the objective of assessing the neurobehavioural performances among workers exposed to pesticides in oil palm plantation workers. Oil palm plantation had been chosen due to production and demand in agricultural sector of the world. Palm oil being one of the world's leading agricultural commodities is widely used as a food ingredient and cooking oil compare than other agricultural product such as rubber, cocoa and vegetables.

Agriculture has been one of the primary economic avenues in Malaysia contributing to about 42 billion to the gross domestic product (GDP). In terms of agriculture, the use of pesticides usage is rampant and without proper control. In Malaysia, little attention has been given in determining the effect of neurobehavioural performance due to pesticide exposure among pesticide handlers in oil palm plantation. This study seeks to provide basic information in order to have a better understanding and awareness due to pesticides exposure and its health effect.

Herbicides such as Paraquat is one of the most widely used to control broad-leaved weeds and grasses. It does not harm mature tree barks and is widely used for weed control in fruit orchards and plantation crops, including coffee, cocoa, coconut, oil palms, rubber, bananas, olives and tea, ornamental trees and shrubs and in forestry. Paraquat is highly toxic to animals and has serious and irreversible delayed effects if absorbed. Absorbed Paraquat is distributed via the bloodstream to practically all areas of the body. The lungs selectively accumulate Paraquat, and therefore contain higher concentrations of it than in other tissues.

The research location was the oil palm plantation at Johor; which is one of FELDA's branches. The reason for selecting FELDA for this study is because it is among one the world's largest palm oil producers, accounting for almost 8% of world palm oil production in 2009 (FELDA Holdings, 2011). Another aspect of selection was the majority of people that work in this area and within the FELDA or oil palm plantation lack the knowledge and awareness in terms on how to prevent the health effect due to pesticide exposure. Most of workers have no concern of taking preventive and precaution steps in reducing the exposure of pesticide due to lack of awareness. To make thing worse, the use of personal protective equipment (PPE) such as respirator is not deemed mandatory.

In addition, this study assesses the neurobehavioural performance and health risk assessment among pesticide workers. Indirectly, it would create awareness and bring knowledge to palm oil plantation workers on the importance of proper prevention steps of pesticides use and things related the safety component in the working area.

Finally, this study will be able to improve and enhance further understanding on previous research finding related with pesticide handlers which can contribute additional reference for the future research.

1.4 Conceptual Framework

Figure 1.2 shows the conceptual framework or the overall study problem. This can be used to assist and guide the researcher in implementing the studies on pesticides. The aim of the study is to determine the exposure of pesticide to the neurobehavioural performance among pesticide handlers at oil palm plantation in Johor.

From the figure, there are three pathways for the pesticide to be exposed to human. These pathways are through inhalation, ingestion and through direct skin contact. Once the pesticide handlers being exposed to pesticides, the pesticide residue will travel into one's circulatory system and effect to organ such as blood, lung, heart, kidney and central nervous system (CNS).

The neurobehavioural core test battery (NCTB) method will be used in order to determine the severity of the pesticide exposure on the CNS. The score from the neurobehavioural performance test will be compared to the score of WHO NCTB for normal non-exposed population (WHO, 1986).

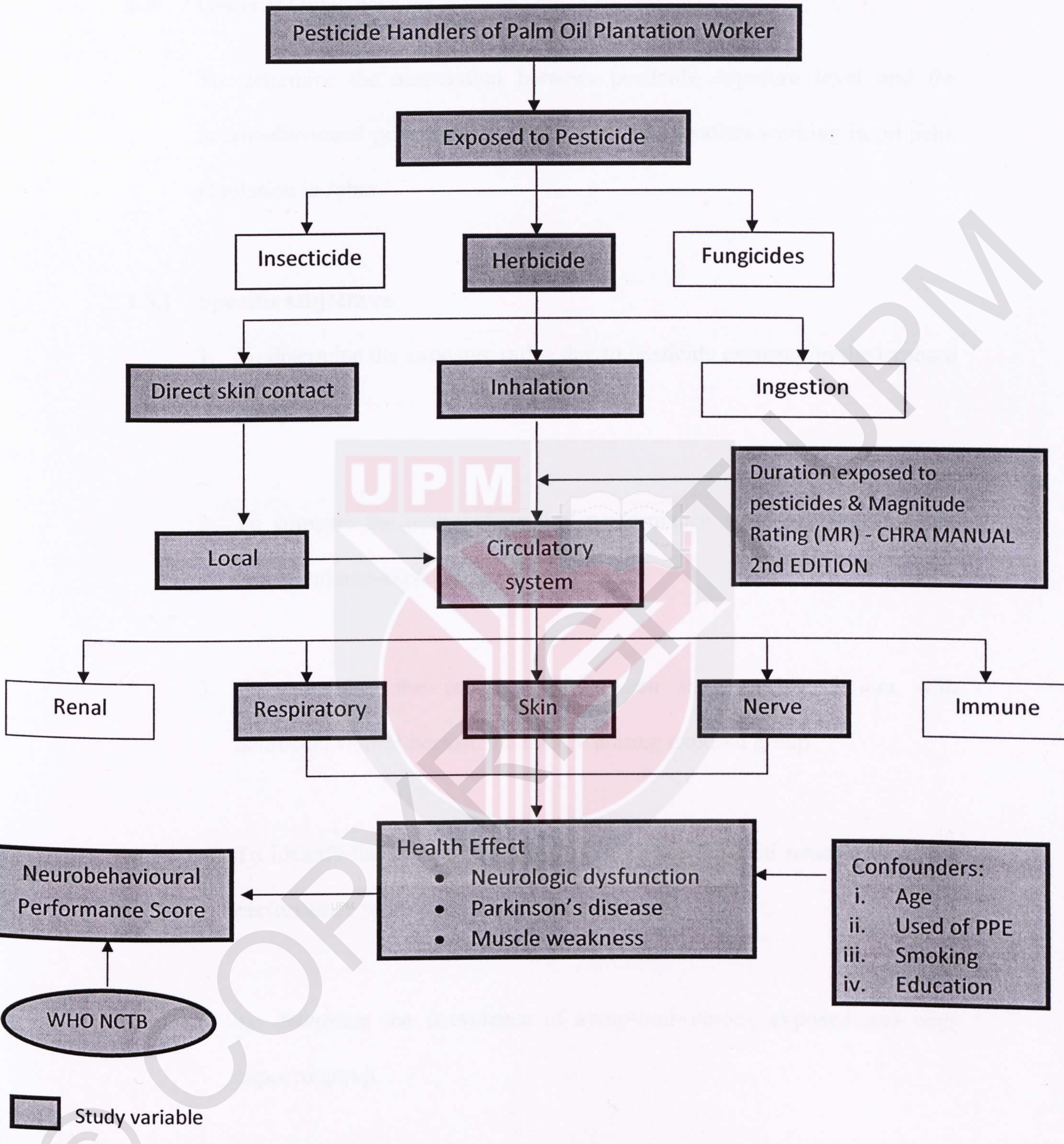


Figure 1.2: Conceptual Framework of Pesticide Exposure among Pesticide handlers

1.5 General Objective

To determine the association between pesticide exposure level and the neurobehavioural performance among pesticide handlers working in oil palm plantation in Johor

1.5.1 Specific Objectives

1. To determine the exposure rating due to pesticide exposure in the exposed group.

2. To compare the neurobehavioural performance score between exposed group and non-exposed group.

3. To determine the relationship between the working factors with neurobehavioural performance score among exposed group

4. To identify the selected factors that influence the total neurobehavioural performance score among the exposed group.

5. To determine the prevalence of symptoms among exposed and non-exposed group.

1.6 Hypothesis

1. The neurobehavioural performance score for exposed group is significantly lower compared to score for non-exposed group.

2. There is significant relationship between working factors with neurobehavioural performance score among pesticide handlers in oil palm plantation.

3. Exposure rating factors will influence the total neurobehavioural performance score among exposed group.

1.7 Conceptual Definition

1.7.1 Pesticide

Pesticide is a substance, mixture of substances intended for preventing, destroying, repelling or mitigating any pesticide (Environment Protection Agency, 2006). The primary categories are insecticides, herbicides and fungicides. Many other categories, such as wood preservatives, termiticides, rodenticides, algaecides, repellents and miticides, are also in use. An excellent resource book describing the various pesticide classes is available (Ware, 1994).

1.7.2 Pesticide Handler

Anyone who is employed for any type of compensation by an agricultural establishment or a commercial pesticide handling establishment that uses pesticides in the production of agricultural plants on a farm, forest, nursery, or greenhouse, and is doing any of the following tasks: mixing, loading, transferring, or applying pesticides, handling opened containers of pesticides and acting as a flagger (USEPA, 1998).

1.7.3 Central Nervous systems

The central nervous system (CNS) is a structure that controls the action and function of the body. It comprises of the brain and spinal cord, their nerve and ganglia and the fiber forming the autonomic system (Roper, 1987).

1.7.4 Neurobehavioural Core Test Battery

A reduction of verbal attention, visual memory, and motor affectivity was demonstrated through neurobehavioural testing with the WHO protocol core test battery (WHO, 1986).

1.8 Operational Definition

1.8.1 Pesticide

Pesticides, including herbicides, are commonly used in oil palm plantations, despite their adverse impacts on human beings and the environment. The four main group of pesticide used are organochlorine, organophosphate, carbamate and pyrethroid insecticide.

1.8.2 Pesticide Handler

Pesticide handlers are the person who are handling with the pesticides and working at the oil palm plantation.

1.8.3 Central Nervous systems

The central nervous system (CNS) is one of the two major divisions of the nervous system. The other is the peripheral nervous system (PNS) which is outside the brain and spinal cord. CNS will controls and coordinates all physical activities of the human organism.

1.8.4 Neurobehavioural Core Test Battery

It is consists of seven tests that meet three criteria which used to measure potential health effect to nervous system. Besides, this test provides specific method and objective measure of nervous system function and related to basic neurobehavioural function of definition disease state.

CHAPTER 2

LITERATURE REVIEW

2.1 Pesticide's Properties

Pesticides a is chemical that is mainly used in agriculture to prevent, destroy, repell or mitigate pesticides such as insect, bacteria, fungi, rodent and others (Yucra, 2006). Comparing to other various environmental toxins, pesticides are toxic chemicals that are intentionally introduced into the environment to reduce nuisance species (Colosio *et al.*, 2003). The primary uses of pesticides are for the control of insect populations in homes and in agricultural settings. However; there is consistent research to suggest an association between even low levels of pesticide exposure to neurobehavioural deficits (Rothlein *et al.*, 2006).

Pesticides application has increased rapidly due to the intensification of farming in order to obtain higher yields worldwide. Currently there are about 759 chemicals and biological pesticides used in the agriculture and health sectors. Of this, 33 pesticides have been classified by World Health Organization (WHO, 1998) as extremely hazardous to human health (CLASS IA), 48 pesticides as highly hazardous (CLASS IB), 118 pesticides as moderately hazardous (CLASS II) and 239 pesticides as slightly hazardous (CLASS III) and 149 pesticides have been considered as unlikely to cause hazard in normal use (class IV) (Xavier *et al.*, 2004). Most pesticides are designed to be toxic to their target pest/weeds and because any substance can be harmful if used improperly; therefore pesticide use is strictly controlled by the Malaysia government under Act 149 Pesticide Act 1974. In this act, it clearly describes the control of manufacture, sale and storage of pesticides by licensing, control of presence of pesticides in food and enforcement related to pesticides. For the USA, The Department of Pesticide Regulation (DPR) is function to protect human health and the environment by regulating pesticide sales and use and by fostering reduced-risk pest management (California Dept Pesticide Regulation).

Additionally, findings by Calvert *et al.* (2008) suggested that acute pesticide poisoning in the agricultural industry continues to be an important problem. The four main groups (organochlorine, organophosphate, carbamate, and pyrethroid insecticides) are of particular concern because of their toxicity and persistence in the environment. Organophosphate class is well known toxicants affecting the nervous system through the inhibition of acetyl-cholinesterase in a range of nerve, neuromuscular and glandular tissues where the enzyme plays a key role in cell's communications.

Crops including palm oil and rubber require intensive use of pesticides, particularly herbicides. The most frequent used was Paraquat, it has been used as the weedkillers or kills unwanted plants (Paraquat Information Centre 2010a). Herbicides have widely variable toxicity. Examples of health problems associated with herbicides exposure are Parkinson's disease, central nervous system depression and immune dysfunction for chronic effect (Karalliedde, *et al*., 2003).

2.2 Insecticide's properties

Organophosphates (OP) usually refer to a group of insecticides or nerve agents acting on the enzyme acetylcholinesterase (AChE). The term is used often to describe virtually any organic phosphorus (V)-containing compound, especially when dealing with neurotoxic compounds. Effects caused by AChE inhibition may be a result of action on neurons in the central nervous system and/or the peripheral nervous system. Forty organophosphate pesticides are registered in the U.S., with at least 73 million pounds used in agricultural and residential settings.

OP compounds are extensively used as pesticides and in industrial chemicals. The Environmental Protection Agency (EPA) lists organophosphates as very highly acutely toxic to bees, wildlife, and humans. Commonly used organophosphate includes parathion, malathion, methyl parathion, phosmet, fenitrothion, and azinphos methyl. Malathion is widely used in agriculture, residential landscaping, public recreation areas, and in public health pest control programs such as mosquito eradication (EPA, 2008)

Organophosphates are well documented as a cause of acute poisoning in humans in a variety of situations including suicidal ingestion, occupational exposure and unintentional exposure through inhalation, skin absorption and ingestion. Acute poisonings by organophosphates and carbamates account for the majority of systemic pesticide poisoning cases seen in the United States (Blondell, 1997).

Recent studies suggest a possible link to adverse effects in the neurobehavioural development of fetuses and children, even at very low levels of exposure. They are primarily neurotoxic and produce well-defined muscarinic, nicotinic, and cholinergic neurosymptoms involving both central and peripheral nervous systems (Kamal F, 2005). Report shows that farm workers, greenhouse workers, and pesticide factory workers exposed to OPs shows more neurologic symptoms than unexposed workers.

2.3 Herbicide's Properties

Herbicides are chemicals with the capacity to kill selectively or non-selectively plants, representing more than the half of all pesticides employed and Paraquat is a widely used herbicide. The main chemical classes of herbicides include bipiridilium compounds (diquat, Paraquat), triazine derivatives containing three heterocyclic nitrogen atoms in the ring structure (atrazine, prometryn), chlorophenoxy acid derivatives (2,4-D, 2,4,5-T), substituted chloro-acetanilides (alachlor, propachlor), derivatives of 2,6-dinitroaniline (benfluralin, trifluralin), substituted phenylcarbamates (carbetamide, chlorbufam), urea derivatives (chlorbromuron, chlorotoluron) (Tibor *et al.,* 2004).

Herbicides protect crops from getting the competition from weeds and enhance the nutritional quality of foods. Herbicide show a wide range of beneficial effects, improving plant health, maintaining agro-ecosystems, food supply, and economical advantages (Tibor *et al.,* 2004).

The acute toxic effects of exposure to chlorophenoxy herbicides include gastroenteritis, skeletal muscle myotonia, myoglobinuria, cardiac dysrhythmias, and central nervous system depression. Chronic effects have included chloracne, increased incidence of certain cancers, and immune dysfunction. Ingestion of large amounts of Paraquat (usually suicide) may cause death from cardiovascular collapse within a few days or from irreversible pulmonary fibrosis within weeks (Bronstein *et al.,* 1992).

2.3.1 Paraquat's Properties

I. Common name

- Paraquat, Paraquat dichloride

II. Molecular formula and structure

- Paraquat: $C_{12}H_{14}N_2$
- Paraquat dichloride: $C_{12}H_{14}N_2C_{12}$
- It is a quaternary nitrogen compound.

Paraquat is a substance that is highly poisonous to humans and fast-acting, non-selective contact herbicide that is absorbed by the foliage. It destroys plant tissue by disrupting photosynthesis and rupturing cell membranes, which allows water to escape leading to rapid desiccation of foliage (Olivera *et al.,* 2006).

Moreover, Paraquat is highly acutely toxic and enters the body mainly by swallowing or through damaged skin, but may also be inhaled. Thousands of deaths have occurred from ingestion (often suicide) or dermal exposure (mainly occupational) to Paraquat. It may damage the lungs, heart, kidneys, adrenal glands, central nervous system, liver, muscles and spleen, causing multi-organ failure, as well as damaging the skin and eyes (Watts, 2011).

In addition, Paraquat is use for eliminating grasses and weeds to minimise ploughing and help prevent soil erosion. It was first introduced in Malaysian rubber plantations in 1961 (Isenring, 2006). It is now approved for use in about 100 countries (Paraquat Information Centre 2010a). According to Gochez, 2009, the sales of Paraquat between 1995 and 2001 were from oil palm plantations (3.9%), banana plantations (3.1%) and 2.5% to tea estates. Paraquat is a bipyridylium herbicide and classified in WHO class II (Moderately Hazardous) for acute toxicity (WHO 2005).

In Malaysia, Paraquat was banned in 2002, with all use to be phased out by 2005. The reasons for this ban because it is acutely toxic with irreversible effects and with no known antidote; high annual statistics of human poisoning; long experience and the associated poisoning shows risk of handling and using Paraquat under local conditions is unacceptably high; there are plenty of cost-effective less hazardous alternative herbicides (UNEP 2006). However in 2006 the ban was reversed and restricted use are allowed in oil palm plantations (UNEP 2006), ostensibly allowing a comprehensive study of its uses.

In November 2007, the Malaysian government announced that the ban was postponed until further notice. In 2009 the pesticide board announced they were waiting for a study on integrated weed management and alternatives on Paraquat, commissioned by the roundtable on sustainable palm oil (RSPO) before they make the decision on Paraquat. Paraquat is still on the market in Malaysia, theoretically restricted for use on oil palms less than 2 years old (Tenaganita 2009). Although the use of Paraquat was banned, study found that it is still the most popular herbicide in Sarawak, but although still commonly used it had been overtaken by glyphosate (Watts, 2011).

2.3.2 Paraquat's Route of Exposure

Paraquat is efficiently absorbed by inhalation, ingestion and skin penetration due to the physical properties which is in gases and liquid phase. Although ingesting pesticides is generally the most dangerous form of exposure, inhalation and absorption through the skin are probably the major causes of occupational poisoning cases among farmers in developing nations as they are often unaware of these particular risks (Hesperian Foundation, 2005). Figure 2.1 shows the route of exposure of Paraquat.

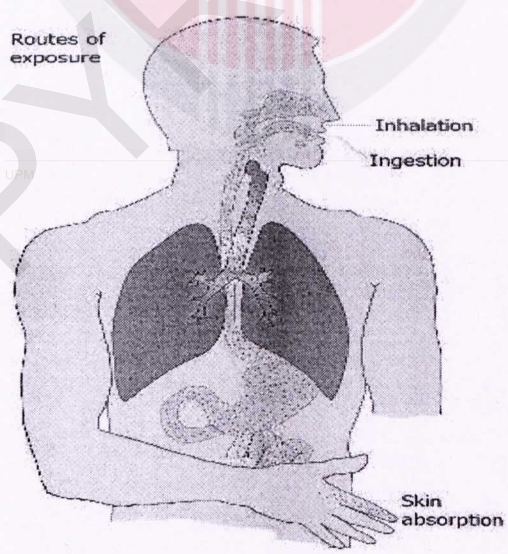


Figure 2.1: Routes of Paraquat exposure (Stewardship community, 2011)

2.3.2.1 Inhalation

Route of exposure through inhalation is not the main route of exposure as Paraquat is non-volatile and sprayed droplets are reputedly too large to enter small airways. But, Paraquat can be rapidly absorbed by inhalation then affects the lungs and the intestine after ingestion. Absorption after oral intake is about 10% (EC, 2003). Handling concentrated wet table powders can pose a hazard if inhaled during mixing.

2.3.2.2 Direct Contact/ Dermal

The main route of exposure in agriculture is through the skin. Skin is the primary route of exposure to pesticides, particularly while spraying, but also while handling pesticides in other ways. Exposure occurs primarily through splashing during preparation of the spray and its transport, deposition of spray mist, adjusting spray equipment, and walking through sprayed vegetation. Hence the most exposed areas are hands, wrists, legs, back, and genitals (Wesseling *et al.,* 2001).

Absorption through intact skin is generally low, 0.5% according to EC (2003), but is substantially increased if the skin is damaged, and has lead to death in humans (Kemi, 2006). Absorption will continue as long as the pesticide remains in contact with the skin. The rate at which dermal absorption occurs is different for each part of the body. The relative absorption rates are determined by comparing each respective absorption rate with the forearm absorption rate. Excluding acute pesticide intoxications, the most common adverse effect of pesticides is said to be contact dermatitis (Spiewak R., 2001).

Paraquat is known to be a highly irritant pesticide, and only one study from Gutierrez *et. al.,* (1997) reported skin rash or burn in 53% of applicators using backpack sprayers under conditions lacking in use of personal protective gear. Wearing of protective clothing and equipment can reduce exposure, but it is frequently not worn in developing countries for a variety of reasons including its expense, lack of availability, and unsuitability for hot humid climates.

2.3.2.3 Ingestion

Exposure to pesticides exposure occurs through ingestion of food and water. Pesticides can be ingested by accident, through carelessness, or intentionally. Pesticides are commonly found in water consumed by both rural and urban populations.

Allowable pesticide levels for water are calculated on the basis of adult exposure and toxicity but again the pediatric population is exposed to a considerably greater total amount of residues that are potentially toxic because they are consuming on average 4 times the amount of water per kg of body weight (National Research Council, 1993).

Residues of pesticides that are severely restricted because of their serious effects on human health were also found in significant quantities in the water sources. Residues enter the water supply through leaching from soil into ground water after home, lawn, roadway and agricultural spraying (National Research Council, 1993).

2.4 Effect of Pesticides

2.4.1 Nervous system

The nervous system is one of the most susceptible and portion of the body. The insecticide attack the nervous system as the primary target organ and poisoning the nervous system is the quickest way to upset the regular body mechanism. Since the earliest recorded history of workplace hazards, the nervous system has been a sensitive target organ for chemical exposures (Anger, 2003).

The central nervous system (CNS) includes the brain and spinal cord, and CNS dysfunction can be subdivided into two general categories, neurobehavioural and motor/sensory. Neurobehavioural difficulties involve two primary categories: cognitive decline, including memory problems and dementia; and neuropsychiatric disorders, including neurasthenia (a collection of symptoms including difficulty concentrating, headache, insomnia, and fatigue), depression, posttraumatic stress disorder (PTSD), and suicide. The CNS serves as the integration system and composed of millions of nerve cell which are connected with one another by junction which called synapses (Nurul, 2005).

The peripheral nervous system includes all nerves not in the brain or spinal cord and connects all parts of the body to the central nervous system. The peripheral (sensory) nervous system receives stimuli, the central nervous system interprets them, and then the peripheral (motor) nervous system initiates responses.

Paraquat alters the levels and activity of various enzymes in liver and kidney (Dere and Polat 2000); and in serum, including acetycholinesterase (AChE) (El-Demerdash *et al.,* 2001). Acetycholinesterase hydrolyzes the neurotransmitter acetylcholine, and thereby plays a critical role in regulating nerve transmissions in the central and peripheral nervous systems. Paraquat also kills neurons in the brain both mature and immature cerebellar granule neurons (Stelmashook *et al.,* 2007) and damages the hippocampus region of the brain, reducing learning and memory (Chen *et al.,* 2010a).

Neurotoxicity tests were not required by the US EPA (1997) because of the chemical nature of Paraquat and the fact that it did not inhibit cholinesterase or damage the structure of the nervous system. Since then, a number of studies have shown that exposure of laboratory animals to Paraquat causes reductions in neurotransmitters in the brain, resulting in signicantly disturbed or reduced motor activity including walking, drinking, rearing, and rotational activity and increased anxiety.

Available epidemiological studies suggest there is an association between the degenerative neurological condition Parkinson's disease and exposure especially to herbicides (Hancock *et al.,* 2008) and also pesticides (Kamel *et al.,* 2007; Bronstein *et al.,* 2009). Strong evidence links pesticide exposure to worsened neurological outcomes (Sanborn *et al.,* 2007). The risk of developing Parkinson's disease is 70% greater in those exposed to even low levels of pesticides. People with Parkinson's were 61% more likely to report direct pesticide application than were healthy relatives. Both insecticides and herbicides significantly increase the risk of Parkinson's disease.

Fewer studies have examined the effect of long-term, low-level exposure to pesticides on nervous system functioning, but neurobehavioural changes have been reported in greenhouse workers, tree fruit workers, and farmworkers in Florida (Kamel *et al*., 2003). These studies have found deficits in measures of sustained attention, information processing, and motor speed and coordination. An examination of a group of cotton pesticides applicators in Egypt presumed to have high exposures and found to have deficits, including visual motor speed, verbal abstraction, attention, and memory (Farahat *et al*., 2003).

2.4.2 Skin

Health effects of pesticides may be acute or delayed in those who are exposed (EPA, 2007). This is because the chemistry of pesticide is highly diverse and pesticides are capable of causing a wide range of health effect. Paraquat is corrosive to the skin and once the skin is damaged it is easily absorbed into the body. In developing countries Paraquat is often applied under hazardous conditions that result in high dermal exposure (EPA, 2007)

Irritant and/or allergic skin effects of pesticides are potential problems, depending on the type of pesticide and individual susceptibility, both constitutional and due to coexisting environmental circumstances. Although dermal absorption is low through intact skin, it is considerably higher through damaged skin including skin that may be initially irritated by the Paraquat. One recent study of Paraquat use in Malaysia showed that manual knapsacks resulted in high levels of dermal exposure (Rafee *et al.,* 2010).

2.5 Prevalence of Pesticides Exposure

Table 2.1 shows the prevalence of pesticides exposure from previous study.

Table 2.1: Prevalence of pesticides exposure from previous study

Author	Prevalence of pesticides exposure
Davanzo et al 2004).	In Italy, Paraquat was most frequently associated with non-fatal poisonings referred to the main poison centre in 2000-2001. There are 46 poisonings out of 872 were due to Paraquat.
Farahat *et al.*, 2003	Fifty two exposed male workers, 50 unexposed male controls who were similar in age, socioeconomic class, and years of education. Result showed that, Serum AChE was significantly lower in the exposed than the control participants; it was not significantly correlated with either neurobehavioural performance or neurological abnormalities.
Chen *et al.*, 2009	Six out of 7 cases were found intravenous Paraquat poisoning. Patients with oral Paraquat ingestion suffer from oral ulcers, hemoptysis and gastrointestinal (GI) symptoms such as nausea, vomiting, diarrhea and GI bleeding
Tenaganita & PANAP 2002	Six female plantation workers in Malaysia that exposed to Paraquat were medically examined. Three workers had itching skin or eczema or (diagnosed as contact dermatitis possibly due to pesticide), 3 reported having occasional pain in the chest, chest tightness and/or difficulty in breathing. Besides, they also experience symptoms such as numbness of hands, headache, abdominal cramp, nausea and vomiting.

2.6 Neurobehavioural Performance

Pesticide damage primarily the nervous system, and neurobehavioural test methods have been a primary method for detecting this damage in cross sectional workplace research (Anger *et al.,* 1997). To evaluate the neurotoxic effect, World Health Organization (WHO) monographed the Neurobehavioural Core Test Battery (NCTB), this is proposed as a unified instrument to be routinely used worldwide for the detection of nervous system impairment due to neurotoxic agents present in the working environment (WHO 1986). In addition, NCTB can also be used as standard marker tests within larger test batteries, to allow cross-comparison between studies and countries.

Neurobehavioural testing is a non-invasive method used to evaluate the functioning of a person's central nervous system. There are many neurobehavioural tests available to identify the neurobehavioural performance (Neurological Testing Procedure Manual, 1993). In the Operational Guide for NCTB WHO 1986, there are seven NCTB tests that assess the different functions: affect attention/response speed, auditory memory, manual dexterity, perceptual-motor speed, visual perception/memory, and motor steadiness (WHO 1986).

Better performance is evaluated by higher scores obtained on tests of Digit Symbol, Digit Span (Lezak MD, 1995), benton visual retention, santa ana (dominant and non dominant hand), and pursuit aiming test ; by contrast, lower latencies or time to complete trailmaking part A and B tests and simple reaction time test indicated better performance.

Individuals with histories of toxic exposure to organophosphate have shown a consistent pattern of deficits on measures of motor speed and coordination, sustained attention, and information process speed (Rothlein, 2006). Population that exposed to organophosphate have shown a consistent pattern of deficits when compare to unexposed population a measures of motor speed and coordination, sustained attention and information processing speed (Rohlman, 2006).

Behavioral measures have been well established as reliable and valid indicators of nervous system function in experimental research, performance assessment, and clinical assessment. The exposed participant showed significant lower performance that control on six neurobehavioural test and the duration of work with pesticides was associated with lower performance and most neurobehavioural tests after adjusting for multiple comparisons (Farahat *et al.*, 2003).

CHAPTER 3

METHODOLOGY

3.1 Study Design

The study design was a cross-sectional comparative study with the objective to determine the association between pesticide exposure level and the neurobehavioural performance among pesticide handlers in oil palm plantation in Johor.

3.2 Study Location

The location for this study was at FELDA Plantation at Kota Tinggi, Johor Darul Takzim. There were two FELDA plantations have been chosen for this study and due to confidentially it will remain anonymous.

3.3 Work Process

The work processes at the location were harvesting, loading and spraying the oil palm trees with herbicides. The trade names of herbicide used were PARAQUAT, ECOMAX® and ALLY®

Figure 3.1: The process of harvesting

Figure 3.2: The process of loading

Figure 3.3: The process of spraying

3.4 Study Population

The study population of this research was male worked as pesticide handlers in FELDA Plantation at Kota Tinggi District, Johor Darul Takzim. While the comparative group for this research was male workers worked as harvesters who were never exposed to pesticides at Kota Tinggi District, Johor Darul Takzim.

3.5 Study Frame

The assessment was done only onto resident or respondent who meet the inclusion criteria only. The sampling frames include the name lists of pesticides handlers working at FELDA plantation which was obtain from the management office.

3.6 Sampling Unit

A respondent was chosen based on the inclusive criteria as below.

The inclusive criteria in the study were:

i. Male worker
ii. Age ranged between 18-56 years old
iii. Literate (able to read and write)

3.7 Sampling Method

The method use in this study was purposive sampling. The respondent that selected was based on the inclusion criteria.

3.8 Sampling Size

The sample size was calculated using formula by **Kirkwood, 1988**:

$$n = \delta\,(100 - \delta)/e^2$$

Where:

n = Sample size

δ = Standard deviation (SD). The SD has been taken from the previous study by Devan, 2000 = 11.67

e = standard error (5%)

In this study, the sample population was extended to 20% from the minimum numbers of respondents. The purpose was to overcome the problems of non-response among the respondent.

For exposed group

$n = \delta\ (100- \delta)/e^2$

$n = 11.67\ (100-11.67)/5^2$

$n = 41.23\%$

Therefore n = 41 respondent

Account for any missing data during data collection, add about 20 percent = 8

$n = 41 + 8$

n = 49

For the **comparative group**, the number of respondents was same as the number of respondents for exposed group. So, the total amount of respondents for this study was **98 respondents.**

3.9 Variables

3.9.1 Dependent variable

Neurobehavioural performance score of respondents.

3.9.2 Independent variables

Pesticide exposure level

3.10 Data Collection

3.10.1 Interview based questionnaire

A self-administrated questionnaire was used on all respondent consenting to the study and required to answer one set of questionnaire comprising of social demographic factors and questions related to working activity, exposure history and health status. The respondents were interview to fill up the questionnaire for 10-15 minutes.

3.10.2 Measurement of neurobehavioural performances

The measurements for the neurobehavioural performance were determined by using neurobehavioural core test battery (NCTB). The NCTB consists of seven different tests which each of the test have different domain function. It takes approximately 45 minutes for each respondent to complete all the 7 tests.

3.10.3 Observation of Magnitude Rating (MR)

To identify the magnitude rating of pesticide exposure for each respondent, the observation were based on works have been done. To identify the magnitude rating, it was refer to two criteria which were observing the degree of chemical release or presence and also the degree of chemical absorbed or contacted. Both of these criteria were observed by the researcher based on the guidelines stated in the Chemical Health Risk Assessment (CHRA) Manual 2nd Edition. Then, the data from both criteria were converted to magnitude rating (MR).

From the magnitude rating result then it was combining with the result of the duration respondent exposed to pesticide per day (asked in the questionnaire). Both results will be referred to the exposure rating (ER) matrix to get the actual result for the pesticide exposure level for each respondent.

3.11 Data collection flow (summary)

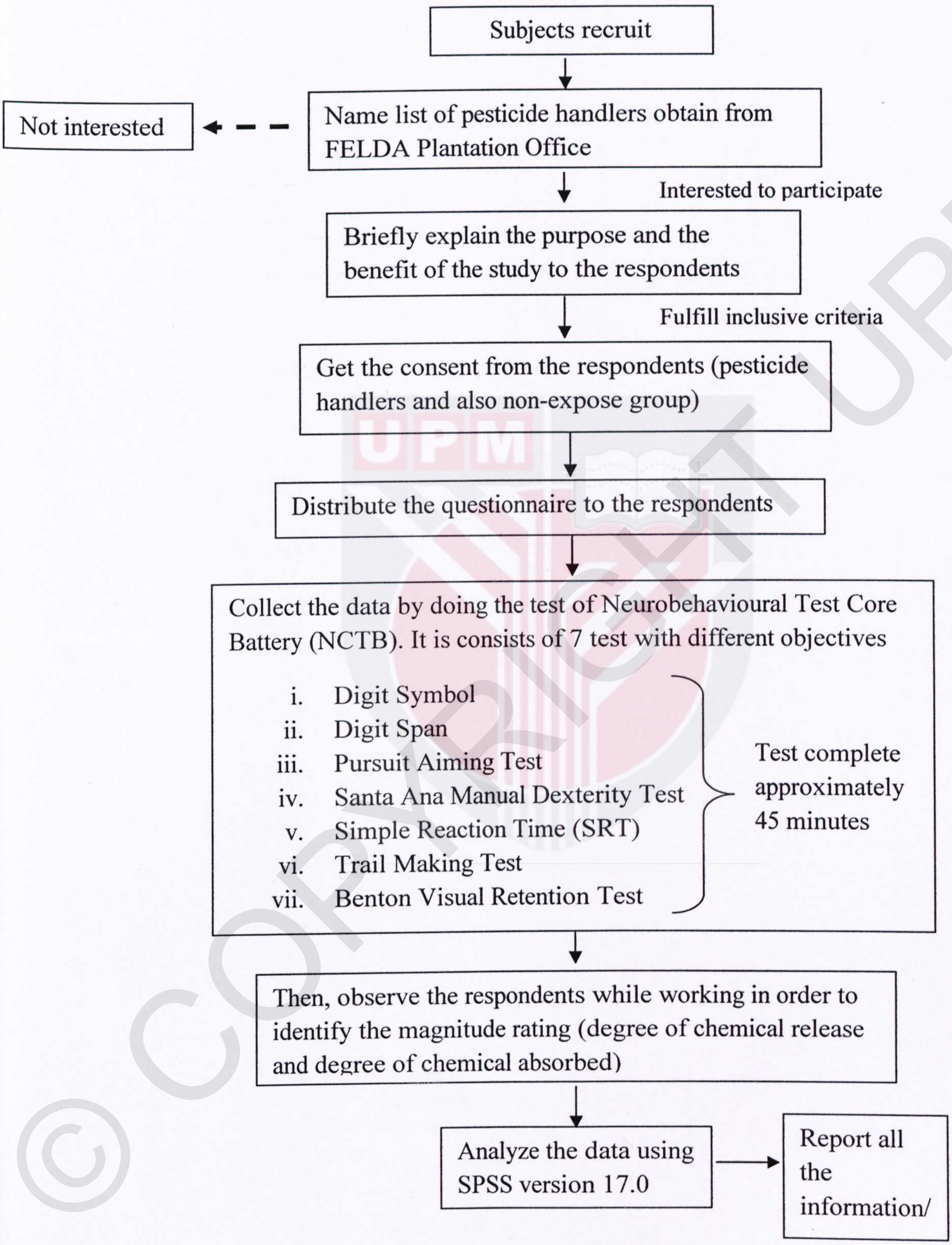


Figure 3.4: Summary of Data Collection

3.12 Study Instrumentation

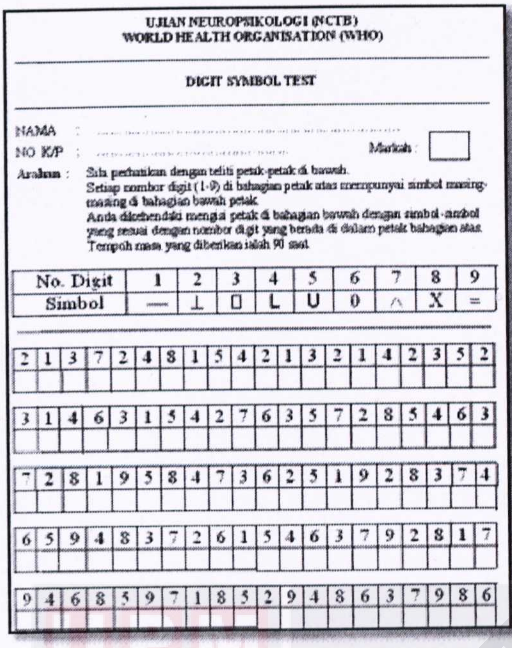
3.12.1 Neurobehavioural Core Test Battery (NCTB) - (Adopted from WHO)

To improve the lack of standardization in neurobehavioural assessment, the World Health Organisation (WHO) Neurobehavioural Core Test Battery (NCTB) has been advocated as a validated, standardised psychological test battery that has been reported as transcultural (WHO 1986).

This neurobehavioural was a simple pencil and paper test and test conducted by trained examiners. All tests have been translated from English to Bahasa Malaysia which is the national language which also has been pretested. But the tests were conducted in either Bahasa Malaysia, Chinese or English according to participants choice.

i. Digit Symbol

The subject was presented with a key at the top of the page with the numbers 1 to 9 displayed with their respective matching symbols. Below are blanks with digits above. The subject must copy the appropriate matching symbols for each digit based on the key at the top of the page.



UJIAN NEUROPSIKOLOGI (NCTB)
WORLD HEALTH ORGANISATION (WHO)

DIGIT SYMBOL TEST

NAMA :

NO K/P : Markah :

Arahan : Sila perhatikan dengan teliti petak-petak di bawah.
Setiap nombor digit (1-9) di bahagian petak atas mempunyai simbol masing-masing di bahagian bawah petak.
Anda dikehendaki mengisi petak di bahagian bawah dengan simbol-simbol yang sesuai dengan nombor digit yang berada di dalam petak bahagian atas.
Tempoh masa yang diberikan ialah 90 saat.

No. Digit	1	2	3	4	5	6	7	8	9
Simbol	—	⊥	□	L	U	0	^	X	=

2	1	3	7	2	4	8	1	5	4	2	1	3	2	1	4	2	3	5	2

3	1	4	6	3	1	5	4	2	7	6	3	5	7	2	8	5	4	6	3

7	2	8	1	9	5	8	4	7	3	6	2	5	1	9	2	8	3	7	4

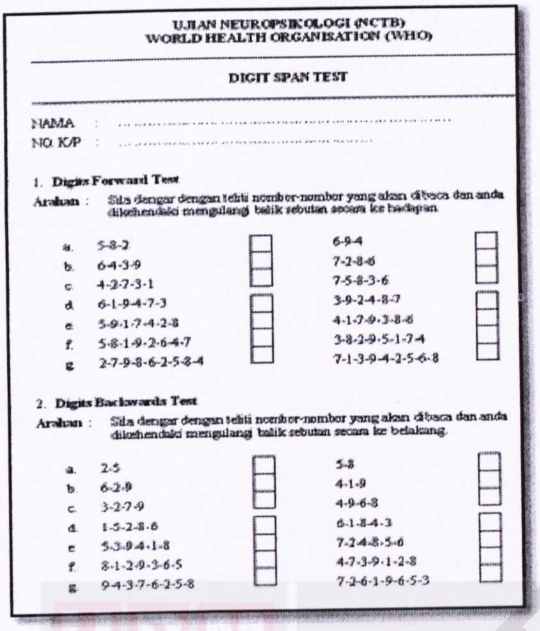
6	5	9	4	8	3	7	2	6	1	5	4	6	3	7	9	2	8	1	7

9	4	6	8	5	9	7	1	8	5	2	9	4	8	6	3	7	9	8	6

Figure 3.5: Digit Symbol form (WHO 1986)

ii. **Digit Span**

Digit span, from Weschler adult intelligence scale measures short term memory and attention. In the digit forward the tester recites a group of 3, 4, 5, 6, progressively up to 8 numbers and the subject were requested to repeat each exactly as he hears them. The digit backwards sequence runs from two to eight digits and the subject was requested to repeat them in exactly reversed order. The score was the total number of correct sequence individually.



UJIAN NEUROPSIKOLOGI (NCTB)
WORLD HEALTH ORGANISATION (WHO)

DIGIT SPAN TEST

NAMA : ....

NO. K/P : ....

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	6-9-4
b.	6-4-3-9	7-2-8-6
c.	4-2-7-3-1	7-5-8-3-6
d.	6-1-9-4-7-3	3-9-2-4-8-7
e.	5-9-1-7-4-2-8	4-1-7-9-3-8-6
f.	5-8-1-9-2-6-4-7	3-8-2-9-5-1-7-4
g.	2-7-9-8-6-2-5-8-4	7-1-3-9-4-2-5-6-8

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	5-8
b.	6-2-9	4-1-9
c.	3-2-7-9	4-9-6-8
d.	1-5-2-8-6	6-1-8-4-3
e.	5-3-9-4-1-8	7-2-4-8-5-6
f.	8-1-2-9-3-6-5	4-7-3-9-1-2-8
g.	9-4-3-7-6-2-5-8	7-2-6-1-9-6-5-3

Figure 3.6: Digit Span form (WHO 1986)

iii. Pursuit Aiming Test

Subject was instructed to dot the center of circles using a pencil as quickly and accurately as possible. The circle was 2 mm in diameter were arrayed on a paper sheet in 30 columns by 40 rows. Excluding outliers, the number of dotted circles in two 30 seconds trials was the score.

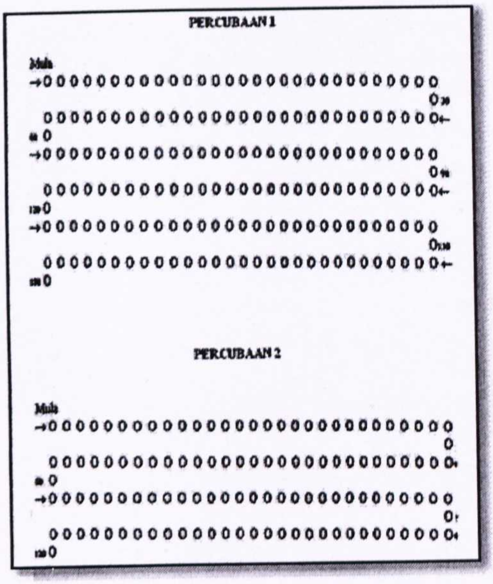


Figure 3.7: Pursuit aiming form (WHO 1986)

iv. Santa Ana Manual Dexterity Test

The subject must rotate pegs through 180˚. The pegs were arranged in 4 rows of 12 pegs on rectangular board. The number of pegs rotated in 30 seconds was the score. The test was repeated for the preferred, non-preferred and both hands.

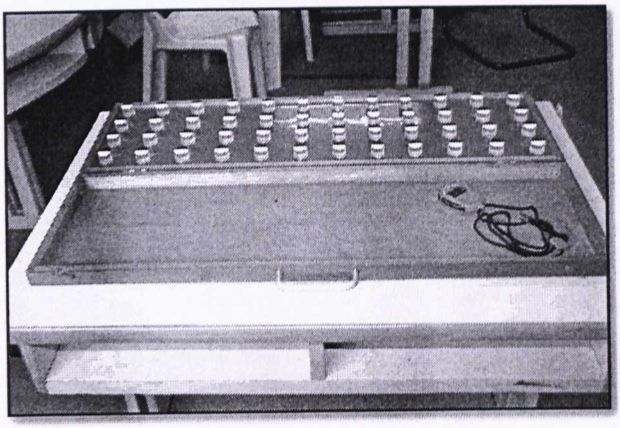


Figure 3.8: Santa Ana Manual Dexterity Test

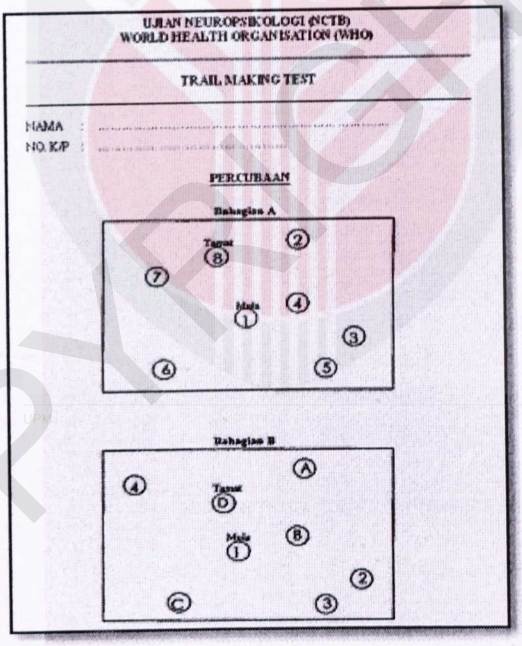
v. Simple Reaction Time (SRT)

This test was to measures simple visual reaction time which means to measure how fast a subject reacts. It requires sustained attention by the subject to responds to a red light stimulus by immediately releasing key (A) and then press key (B) with his/her index finger. Respondents need to react with the stimulus within 1 to 10 seconds by using their dominant hand.

Figure 3.9: Simple Time Reaction

vi. Trail Making Test

This test has two parts, each consisting of 25 circles distributed over a sheet of paper. In Trail A the circles contain numbers 1 to 25. The subject was required to draw a line connecting the circles in numerical sequence as quickly as possible. Trail B differs from Trail A in that the circles contain numbers 1 to 13 and letters A to L. In connecting the circles the subjects was required to alternate between the numbers and letters as he proceeds in ascending sequence. The test was scored as the number of seconds needed to finish each part.


UJIAN NEUROPSIKOLOGI (NCTB)
WORLD HEALTH ORGANISATION (WHO)

TRAIL MAKING TEST

NAMA :
NO. K/P :

PERCUBAAN

Bahagian A

Tamat
Mula

Bahagian B

Tamat
Mula

Figure 3.10: Trail Making form (WHO 1986)

vii. Benton Visual Retention Test

The subject was shown a drawing for 10 seconds composed of geometric figures. After the drawing was removed, the subject was shown four similar looking drawings, only one of which was a true replica of the original. The subject must identify the correct drawing. The number correct in 10 trials was the score.

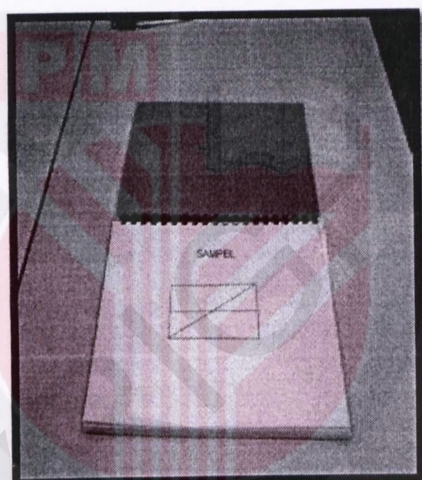


Figure 3.11: The booklet of Benton Visual Retention Test

When administering the test, the instruction was always given in the standard wording, clearly and distinctly. Pre-test activities have been done for the purpose of informing the respondents of the details of this study and to obtain information needed in interpreting the results from the neurobehavioural test. Before the NCTB test is done, informed subject consent was obtained and the purposed of the study was explained to each respondents.

Table 3.1 shows the function domain of NCTB test. There were seven tests with different functions to be tested.

Table 3.1: Neurobehavioural Test and the functional domain tested

No	Test function	Domain
1	Benton visual retention	Visual perception/memory
2	Simple Reaction Time	Attention/ response speed
3	Santa Ana Manual Dexterity	Motor speed, coordination
4	Trail Making	Motor & visual coordination/steadiness, attention
5	Pursuit Aiming	Motor steadiness
6	Digit Symbol	Perceptual motor speed, working memory
7	Digit Span	Auditory memory

The calculation for **Standard Scores (SS)** is as below:

First step:

1. Calculate mean of the test.
2. MEAN = sum of the raw scores / the number of raw score

Second step:

1. Calculate Standard Deviation of the test
2. SD = square root of [the sum of (raw scores – mean)^2 / number of scores]

Example of SS calculation:

Raw score	-	*Mean*	=	*Adjusted score*		*(Adjusted score)^2*
10	-	**16.25**	=	**10 – 16.25 = -6.25**		**$(-6.25)^2 = 39.06$**
15	-	**16.25**	=	**-1.25**		**$(-1.25)^2 = 1.56$**
20	-	**16.25**	=	**3.75**		**$(3.75)^2 = 14.06$**
20	-	**16.25**	=	**3.75**		**$(3.75)^2 = 14.06$**
				Sum	=	**68.74**

Sum (raw score – mean)^2 = 39.06 + 1.56 + 14.06 + 14.06 = 68.74

<u>Third step:</u>

1. Calculate Standard Score (SS)
2. SS = [(raw score – mean) / SD] x 10 + 50

z score (= (raw score – mean) / SD)

3.12.2 Questionnaire

Questionnaire was used to determine the personal information, social demographic, working activity, exposure history, health status, working duration, usage of personal protective equipment (PPE) and knowledge about pesticide. Pre-test has been conducted first before the actual data being collected. 10% of the studies populations were involve doing the pre-test. There were four sections consist in the questionnaire:

i. Section A: Personal Information

ii. Section B: Working Information

iii. Section C: Lifestyle (smoking/drug)

iv. Section D: Pesticide Exposure →

- History exposed to pesticide
- Personal protective equipment
- Health effect

Consist of:

- Duration exposed to pesticide (based on CHRA Manual 2^{ND} Edition)
- Then, **observation** has been done by researcher for Magnitude Rating (MR):
  i. Degree of chemical release or presence
  ii. Degree of chemical absorbed or contacted
- Then, both results may be combined and exposure rating will be assinged

3. 12.3 Duration of exposed to pesticide

A duration rating was used to assess chronic or routine exposures. Duration of exposure also has a significant effect on the exposure. For assessing chronic exposures use the total exposure duration was used rather than the frequency of exposure. The total exposure duration was the product of the number of exposures and the average duration of each exposure (CHRA Manual 2nd Edition, 2000). Table 3.2 show the duration rating that has been asked in the questionnaire.

Table 3.2: Duration Rating

Rating	Total Duration of Exposure*	
	% work hour	**Duration per 8-hr shift or per 40-hr week**
1	> 87.5 %	> 7 hrs/ shift or > 35 hours/ week
2	50-87.5 %	4 to 7 hrs/ shift or 20 to 35 hours/ week
3	25-50 %	2 to 4 hrs/ shift or 10 to 20 hours/ week
4	12.5-25 %	1 to 2 hrs/ shift or 5 to 10 hours/ week
5	< 12.5 %	< 1 hr/ 8 hr shift or < 5 hours/ week

***Note**: Total exposure duration per week (TD)

= (Number of exposure per week) x (Average duration of each exposure)

3.12.4 Magnitude Rating (MR)

To identify the magnitude rating, it should be refer to:

a) Degree of chemical release or presence.

Table 3.3 shows the degree of chemical release or presence in the environment that can be estimated from the chemical's physicochemical properties, the process characteristics, the quantity used, the method of handling, and the atmospheric conditions. This information was obtained from the Chemical Safety Data Sheet, process descriptions, and from observation of environmental conditions.

Table 3.3: Degree of Chemical Release or Presence

DEGREE	OBSERVATION
Low	**Low or little release into the air.** No contamination of air, clothing and work surfaces with chemicals capable of skin absorption or causing irritation or corrosion.
Moderate	**Moderate release such as** a) Solvents with medium drying time in uncovered containers or exposed to work environment; b) Detectable odour of chemicals with odour thresholds exceeding the permissible exposure limits (PEL). Evidence of contamination of air, clothing and work surfaces with chemicals capable of skin absorption or causing irritation or corrosion.
High	**Substantial release such as** a) Solvents with fast drying time in uncovered containers; b) Sprays or dust clouds in poorly ventilated areas; c) Chemicals with high rates of evaporation exposed to work environment; d) Strong odour of chemicals with odour thresholds exceeding the permissible exposure limits (PEL). Gross contamination of air, clothing and work surfaces with chemicals capable of skin absorption or causing irritation or corrosion.

b) Degree of chemical absorbed or contacted

It was to assess the degree of chemicals being inhaled and absorbed through skin. Chemical substances with the ability to be absorbed through the skin include organic solvents and many pesticides. Table 3.4 shows on how to observe the degree of chemical absorbed or contacted.

Table 3.4: Degree of chemical absorbed or contacted

DEGREE	OBSERVATION
Low	• Low breathing rate (light work) • Source far from breathing zone • Contact with chemical other than those described under "Moderate" and "High". • Small area of contact with chemicals capable of skin absorption - limited to palm (intact skin). <2% or 0.04m2 • No indication of any skin conditions. Intact/normal skin • No contamination of skin or eyes
Moderate	• Moderate breathing rate (moderate work). • Source close to breathing zone • Contact with eye or skin irritants, sensitisers or chemicals capable • Skin dryness and detectable skin condition. Dry, red skin of skin penetration, except those described under 'High'. • Moderate area of contact- one or both hands up to the elbows. Skin area >2% or 0.04m2
High	• High breathing rate (heavy work). • Source within breathing zone. • Gross contamination of eye or skin with skin or eye irritants, sensitisers or chemicals capable of skin absorption • Skin soaked or immersed in chemical capable of skin penetration. • Area of contact not only confined to hands but also other parts of body. Skin area>50% or 1m2 • Follicle rich areas. • Skin damaged. • Severe drying, peeling and cracking

c) **Assigning Magnitude Rating (MR)**

Table 3.5 shows the criteria to assign the magnitude rating:

Table 3.5: Magnitude Rating

Degree of release	Degree of absorption	MR
LOW	Low	1
	Moderate	2
	High	3
MODERATE	Low	2
	Moderate	3
	High	4
HIGH	Low	3
	Moderate	4
	High	5

d) **Assigned Exposure Rating**

Based on the frequency or duration rating and the magnitude rating, an exposure rating may be assigned (Table 3.6).

Table 3.6: Exposure Rating

		MAGNITUDE RATING (MR)				
		1	2	3	4	5
FREQUENCY RATING/ DURATION RATING	1	1	2	2	2	3
	2	2	2	3	3	4
	3	2	3	3	4	4
	4	2	3	4	4	5
	5	3	4	4	5	5

Note: Assign ER=5 if confirmed case(s) of occupational disease due to exposure to the chemical hazardous to health have been reported for the particular work unit.

3.13 Quality Control

3.13.1 Reliability Test

The pre-test questionnaire was done in order to ensure that the questionnaire was relevant and valid. The pre-test has was done by taking 10% population that have similar criteria to the target population. This was to ensure and test the understanding towards the question among the respondents. The reliability test was analysed with Alpha (α) Cronbach using SPSS Version 19.0. Alpha-Cronbach is to determine the internal consistency or average correlation between the variation measurements. The result shows that the reliability was α= 0.836 the internal consistency was good based on the Table 3.7 that show the result of reliability test.

Table 3.7: Result of Reliability Test

Alpha Cronbach	Internal consistency
$\alpha \geq 0.9$	Excellent
$0.9 > \alpha \geq 0.8$	Good
$0.8 > \alpha \geq 0.7$	Acceptable
$0.7 > \alpha \geq 0.6$	Quantifiable
$0.6 > \alpha \geq 0.5$	Poor
$0.5 > \alpha$	Unacceptable

3.14 Statistical Analysis

All data gathered for this study were analyzed using the statistical computer software Statistical Package for Social Science (SPSS Windows Version 19.0). The SPSS software was to analyse unviariate descriptive analyses which explain the data such as mean, median and standard deviation. In NCTB test, Microsoft Excel 2007 had been used before analyzing using SPSS to determine the standard score for all seven NCTB tests. Frequency tests (percentage, mean and standard deviation) were used to determine the socio-demographic distribution (age, income, education), and occupational background such as duration of employment and duration working per day. Normality test was used to determine the normality of the data using the *Kolmogorov-Smirnov.*

Independent t-test was used to compare the NCTB scores between exposed group and non-exposed group because the NCTB score was parametric data. The association between working factors with NCTB scores was determined by using Spearman's rho test because it was non- parametric data. Next, for the selected factors such as age, body mass index (BMI), years of employment, duration working per day, personal protective equipment (PPE), smoking and exposure rating were used multiple regressions analysis in order to identify the selected factors which may significantly influenced the total NCTB score. The level of significance was set at $p < 0.05$ for all statistical tests.

3.15 Study Limitation

The study limitations are as follows:

i. Information bias: This can be happen when the respondent required recalling the information or previous history in order to answer the questionnaire.
ii. NCTB test needs at least 45 minutes for each respondent. It needs full commitment to conduct this test.
iii. The study conduct was cross-sectional, thus the cause and effect of relationship are not certain.

3.16 Ethical Consent

The ethical consent was obtained from Faculty of Medicine and Health Science of UPM, Serdang, Selangor Darul Ehsan. The reference number of ethic letter: UPM/FPSK/PADS/T7-MJKEEtikaPer/F01(JKK(U)_Dis(11)14).

CHAPTER 4

RESULTS

4.1 Demographic Data

4.1.1 Sosio-demographic Information

A total of 102 respondents participated in the study. From the total of 102 of respondent, 51 were pesticide handlers (exposed group) and 51 harvesters (non-exposed). The mean ± SD ages were 27 ± 7.09 for exposed group and 27± 5.569 for non-exposed group. All of them were male which were selected from Tenaga Kerja Indonesia (TKI) lists from FELDA management of Johor Bahru Province. Most participants had a BMI in the normal range (20.42 ± 1.841 kg/m^2) for pesticide handlers and 20.78 ± 2.281 kg/m^2 among harvesters. Majority of the pesticide handler were smoked (82.4%) and 90.2 % (harvesters). None of the participants consumed alcohol (Table 4.1).

The analysis below showed that there were no significant difference for all the socio demographic information except for net income between exposed and non-exposed group ($p < 0.05$).

Table 4.1: Sosio-demographic of respondents (N=102)

Characteristic	Exposed group, n=51 N (%)	Non-exposed group, n=51 N (%)	x^2	p
Age (Years)				
<19	1 (2.0)	2 (3.9)	26.971	0.136
20-25	26 (51.0)	23 (45.1)		
26-30	11 (21.6)	16 (31.4)		
>31	13 (25.5)	10 (19.6)		
BMI (Kg/m^2)				
<18.5	6 (11.8)	4 (7.8)	102.00	0.269
18.5-24.9	44 (86.3)	44 (86.3)		
25-29.9	1 (2.0)	3 (5.9)		
>30	-	-		
Education				
None	3 (5.9)	6 (11.8)	4.197	0.380
Primary	12 (23.5)	13 (25.5)		
Lower secondary	18 (35.3)	21 (41.2)		
Upper secondary	16 (31.4)	11 (21.6)		
University	2 (3.9)	-		
Net income				
RM500-RM999	14 (27.5)	29 (56.9)	9.046	0.003
RM1000-RM2000	37 (72.5)	22 (43.1)		
>RM2000	-	-		
Current smoker				
Yes	42 (82.4)	46 (90.2)	1.325	0.250
No	9 (17.6)	5 (9.8)		
Alcohol consumption				
Yes	-	-	-	-
No	51 (100)	51 (100)		

(N=102)

4.1.2 Work information of respondents

According to Table 4.2, 40 pesticide handlers (78.4%) and 50 harvester (98%) worked during weekends. From the data gained 21 pesticide handlers (41.2%) worked four times in a month during the weekend and 33.3% of them worked three times in a month.

The working duration among pesticide handler was 1. 8 ± 0.76 years with daily average time of 6.5 ± 1.0 hours and for resting duration around 30-60 minutes (74.5%). Among the non-exposed group, working duration is also similar (1.68 ± 0.52) years and the average time of daily working is 6.43 ± 1.05 hours. They have similar resting time compared to pesticide handler (30-60 minutes) 62.7%).

Table 4.2: Physical work characteristics

Characteristics	Exposed group, n=51 N (%)	Non-exposed group, n=51 N (%)	χ^2	p
Previous work				
Yes	23 (45.1)	32 (62.7)	3.196	0.074
No	28 (54.9)	19 (37.3)		
Working on weekend				
Yes	40 (78.4)	50 (98.0)	9.444	0.002
No	11 (21.6)	1 (2.0)		
Frequency working on weekend				
None	11 (21.6)	1 (2.0)	13.749	0.008
1 in a month	2 (3.9)	2 (3.9)		
2 in a month	9 (17.6)	15 (29.4)		
3 in a month	8 (15.7)	17 (33.3)		
4 in a month	21 (41.2)	16 (31.4)		
Duration of working (years)				
<1 years	19 (37.3)	18 (35.3)	4.448	0.217
1-2 years	26 (51.0)	32 (62.7)		
2-3 years	4 (7.8)	1 (2.0)		
>3 years	2 (3.9)	-		
Working duration in a day (hours)				
<1 hour	-	-	6.008	0.050
1-2 hours	-	-		
3-4 hours	3 (5.9)	3 (5.9)		
5-7 hours	40 (78.4)	47 (92.2)		
>7 hours	8 (15.7)	1 (2.0)		
Duration of resting in a day (minutes)				
<30 minutes	9 (17.6)	15 (29.4)	2.014	0.365
30-59 minutes	38 (74.5)	32 (62.7)		
>60 minutes	4 (7.8)	4 (7.8)		

(N=102)

4.1.3 Previous occupation for harvester (Non-exposed group)

From the Table 4.3, 62.7% (32 harvesters) have previous working experience. Besides, 78.2% of the harvester already worked as harvester before but at the different workplace. Based on the previous working experience, none of the harvester has experience in handling the pesticides.

Table 4.3: Types of previous occupation for harvester (N=32)

Variable	N	%
Construction worker	1	3.1
Farmer	1	3.1
Harvester	25	78.2
Loader	5	15.6
Total	**32**	**100**

(N=32)

4.2 Respondents' Socio-lifestyle

The result from descriptive analysis showed that 82% of the pesticide handlers were smoker while 18% of them were non-smoker (Figure 4.1). A personal hygiene practice was evaluated based on their self-reported on the hand washing, taking a shower, and change clothes after working. Ninety two percent of pesticide handlers washed their hand, 90.2 % took a shower, and 88.2% changed their clothes (Figure 4.2).

Figure 4.1: The frequency of pesticide handlers who were smoking.

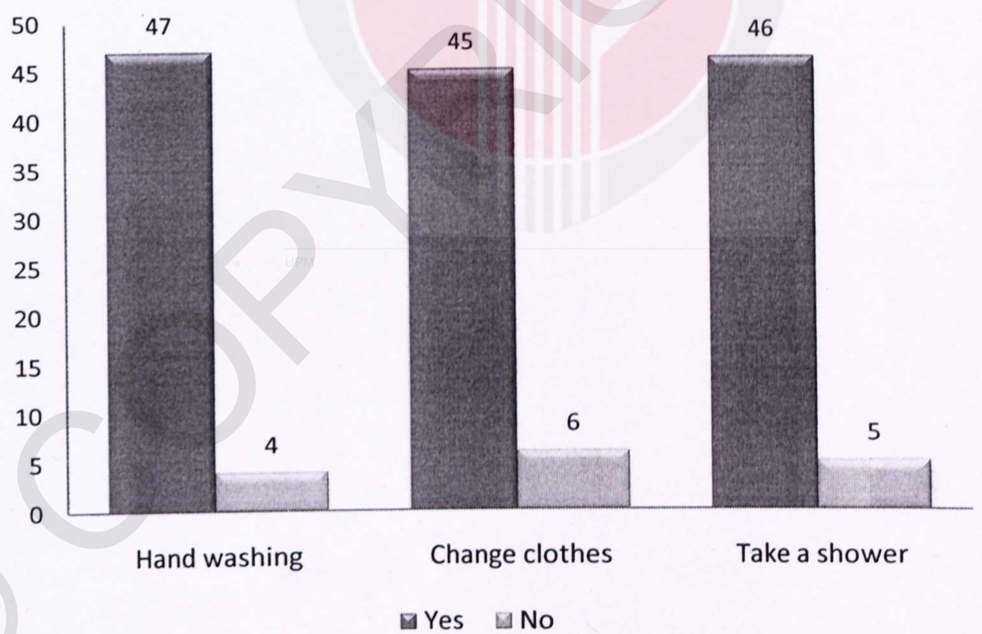


Figure 4.2: Personal hygiene practice of pesticide handlers after working.

4.3 The Use of Personal Protective Equipment (PPE)

Figure 4.3 show the frequency of pesticide handlers using personal protective equipment ppe while working. Seventy eight percent (40 pesticide handlers) used PPE while working. The most frequent PPE used was safety boot (38 pesticide handlers used it) followed by mask (37 pesticide handlers). The least frequent PPE used by pesticide handlers was safety helmet with only 20 respondents (39.2%) used it (Figure 4.4).

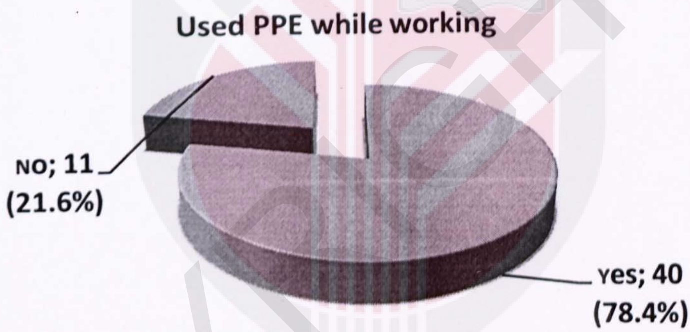


Figure 4.3: Frequency of pesticide handlers used Personal Protective equipment (PPE) while working

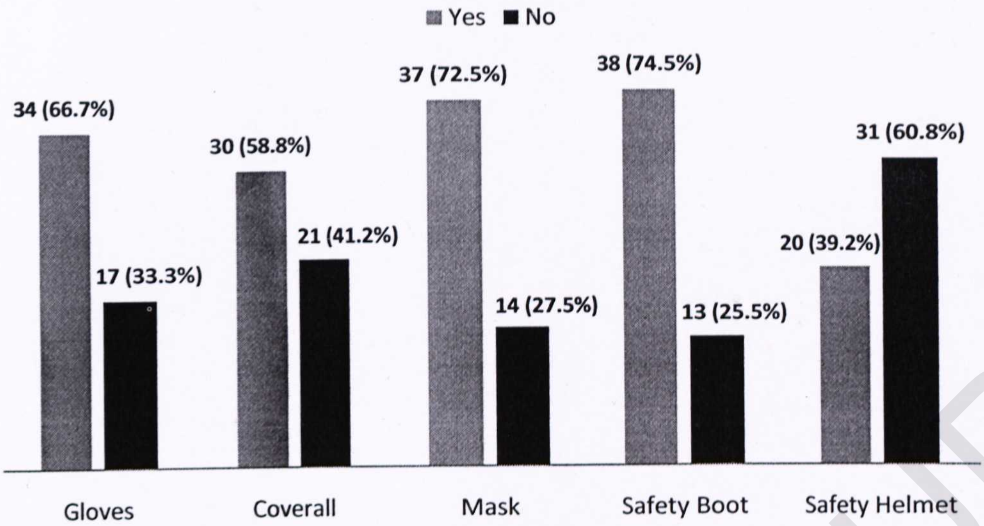


Figure 4.4: The frequency of PPE used by Pesticide Handlers while working

4.4 Exposure rating of exposed group

Exposure rating has been evaluated by observing the pesticide handlers while working by referring to Chemical Health Risk Assessment (CHRA) Manual Second Edition 2000. The result showed that the most frequent exposure rating for the pesticide handlers was ER= 4 with the frequency of 44 respondents (86.3%) (Table 4.4)

Table 4.4: Exposure rating based on CHRA

ER	N	%
1	-	-
2	-	-
3	6	11.8
4	44	86.3
5	1	2.0

(N=51)

4.5 Neurobehavioural performance score

The second objective of the study was to compare the neurobehavioural performance score between exposed group and non-exposed group. The result from independent t-test showed no significant different were observed for the entire test between exposed and control group as shown in Table 4.5.

Table 4.5: Comparison of the neurobehavioural performance score between exposed group and non-exposed group

Neurobehavioural test	Exposed Group, n=51	Non exposed Group, n=51	Statistical Analysis	
	SS ± SD	SS ± SD	t	P
Benton Visual Test	50.39± 10.58	49.02± 9.65	0.486	0.628
Digit Span Test	50.20± 10.86	50.0± 10.58	0.140	0.889
Digit Symbol Test	49.41± 10.08	50.78± 10.74	-0.609	0.544
Santa Ana (Dominant)	50.20± 10.49	50.20± 10.68	0.039	0.969
Santa Ana (Non dominant)	49.80± 10.29	50.78± 10.36	-0.511	0.611
Reaction time (A) test	49.80± 10.10	50.20± 10.10	-0.135	0.893
Movement Time (B) test	50.78± 10.93	50.39± 9.99	0.049	0.961
Trail Making Test	49.80± 9.69	49.61± 10.58	0.149	0.882
Pursuit Aiming Test	50.39± 9.79	49.80± 10.49	0.380	0.705

(N=102)

4.6 Relationship between the working factors with neurobehavioural performance score among exposed group

Table 4.6 shows the third objective in which to determine the relationship between the working factors with neurobehavioural performance score among pesticide handlers. The first factor is the years of employment for pesticide handlers and the second factor was Exposure Rating (ER) (rating based on the CHRA calculation). Spearman's rho test was used to identify the correlation of both variables. Years of employment has significant relationship with Santa Ana

(Dominant), p = 0.044 and r = 0.283. Second working factor which was exposure rating show that Digit symbol test has significant result with p = 0.014 and r = 0.34.

Table 4.6: Relationship between the working factors with neurobehavioural performance score among pesticide handlers (N=51)

Neurobehavioural test	Years of employment		Exposure rating	
	r	p	r	P
Benton Visual Test	0.123	0.390	0.097	0.500
Digit Span Test	0.096	0.505	0.232	0.102
Digit Symbol Test	0.341*	0.014	0.271	0.054
Santa Ana (Dominant)	-0.025	0.862	0.283*	0.044
Santa Ana (Non dominant)	0.010	0.943	0.275	0.051
Reaction time (A) test	0.000	1.000	0.092	0.523
Movement Time (B) test	0.093	0.515	0.066	0.646
Trail Making Test	0.059	0.682	0.131	0.358
Pursuit Aiming Test	-0.075	0.599	0.090	0.532

(N=51)

**. Correlation is significant at 0.01 level (2-tailed)

*. Correlation is significant at 0.05 level (2-tailed)

The third factor for working factors was duration of pesticide handlers exposed to pesticide (Table 4.7). The result from Spearman's rho test showed that there was no significant association between duration exposed to pesticide with neurobehavioural performance score among pesticide handlers ($p > 0.05$).

Table 4.7: Association between working duration with neurobehavioural performance score among pesticide handlers

Neurobehavioural test	**Duration working per day**	
	r	**p**
Benton Visual Test	-0.059	0.678
Digit Span Test	0.123	0.389
Digit Symbol Test	0.070	0.628
Santa Ana (Dominant)	-0.098	0.493
Santa Ana (Non dominant)	0.118	0.411
Reaction time (A) test	0.213	0.133
Movement Time (B) test	-0.036	0.800
Trail Making Test	0.107	0.455
Pursuit Aiming Test	-0.057	0.690

(N=51)

**. Correlation is significant at 0.01 level (2-tailed)

*. Correlation is significant at 0.05 level (2-tailed)

4.7 Selected Factors which influences the total NCTB score

Multiple Regressions analysis was done to identify the selected predictor factors (independent variable) which may significantly influence the total NCTB score. In this test, the dependent variable was total NCTB score while independent variable was age, BMI, years of employment, duration of work daily (hour), PPE, smoking habit and Exposure Rating (ER).

R^2 = 0.288 (29% fit the model)

Total NCTB score = 410.485 – 1.654 (*age*) – 4.638 (*BMI*) – 5.302 (*years of employment*) – 5.397 (*duration of work daily*) + 3.773 (*PPE*) + 32.208 (*smoking habit*) + 47.900 (*Exposure Rating*)

Coefficient of multiple determinations (R^2) is 0.288 which correlate 29% of the selected predictor factors fit the model. From the equation, Exposure rating and PPE had positive relationship with the total NCTB score, whereas age, BMI, years of employment, duration of work daily (hour), and smoking habit had negative relationship with total NCTB score. Nevertheless, at the 5% significant level, it showed that smoking and exposure rating are the variables which significantly influence the total NCTB score among pesticide handlers.

The forth objective was to identify the selected factors that influence the total neurobehavioural performance score among exposed group. Table 4.8 shows the variables that influence the total NCTB score of exposed group. Exposure rating was p = 0.025 and smoking has p = 0.043, which shows both have significant results ($p < 0.05$) and both factors indeed influence the NCTB score. Therefore, the hypothesis was failed to reject.

Table 4.8: Selected variables which influence total NCTB score among exposed group

Variables	Regression Coefficient (β)	t	p
(Constant)	-	3.562	0.001
Age	-1.654	-1.873	0.068
BMI	-4.638	-1.391	0.171
Years of employment	-5.302	-0.584	0.562
Duration working per day	-5.397	-0.758	0.453
PPE	3.773	1.214	0.231
Smoking Habit	32.208	2.090	0.043
Exposure Rating	47.900	2.322	0.025

(N = 51)

Regression Method = Enter

F value = 2.429

r = 0.537

$R^2 = 0.288$

4.8 Prevalence of symptoms for exposed and non-exposed group

The last objective was to determine the prevalence of symptoms for exposed and non-exposed group. Table 4.9 shows the symptoms that occur to the respondents after working. Skin itching show the highest frequency among exposed group whereas skin dryness have same frequency for both groups.

Table 4.9 Prevalence of symptoms that occur after working

Symptoms	Exposed group (pesticide handler), n=51		Non-exposed group (harvester),n=51	
	Yes	No	Yes	No
Skin dryness	14 (27.5%)	37 (72.5%)	14 (27.5%)	37 (72.5%)
Skin itching	33 (64.7%)	18 (35.3%)	10 (19.6%)	41 (80.4%)
Eyes irritation	23 (45.1%)	28 (54.9%)	12 (23.5%)	39 (76.5%)

(N=102)

Table 4.10 show the prevalence of neuro problems among respondents. The symptoms of easily forget (31.4%) shows the highest prevalence for pesticide handlers whereas difficult to focus (25.5%) was higher for harvester.

Table 4.10 Prevalence of neuro problems

Symptoms	**Exposed group, N=51**		**Non-exposed group, N=51**	
	Yes	**No**	**Yes**	**No**
Easily forget (see/heard)	16 (31.4%)	35 (68.6%)	7 (13.7%)	44 (86.3%)
Slow reaction	9 (17.6%)	42 (82.4%)	8 (15.7%)	43 (84.3%)
Difficult to focus	7 (13.7%)	44 (86.3%)	13 (25.5%)	38 (74.5%)
Difficult in understanding & learning	11 (21.6%)	40 (78.4%)	6 (11.8%)	45 (88.2%)
Confusion & misunderstanding	15 (29.4%)	36 (70.6%)	7 (13.7%)	44 (86.3%)

(N=102)

CHAPTER 5

DISCUSSION, CONCLUSION AND RECOMMENDATION

5.1 DISCUSSION

5.1.1 Pre-test and Neurobehavioural Core Test Battery (NCTB)

Neurobehavioural core test battery (NCTB) was one of the content for prevention of neurotoxic illness in working population that was monographed by World Health Organization (WHO). Based on WHO (1986), NCTB was proposed as a unified instrument to be routinely used for the early detection of nervous system impairment due to neurotoxic agents present in the working environment.

Pre-test for the questionnaire was developed by the researcher and was carried out. The total number of respondents for the pre-test was 14 respondents.

From the results, the reliability test shows $\alpha = 0.836$ in which the internal consistency was good. The result was analysed using SPSS Version 19.0.

5.1.2 Demographic data

There were two groups of respondents involved in this study. The totals of respondents that have been chosen were 102 which were divided into first group pesticide handlers (exposed group) consist of 51 respondents and the second group harvester (non-exposed group) also 51 respondents. Both groups were working in the oil palm plantations in Johor and only male workers were chosen and they must be literate. Studies from Sack D et al. (1993) has demonstrated neorophysiological effects of pesticides in men, for example slowed nerve conduction velocities (NCVs), prolonged latencies of brain-evoked potentials, and indicated abnormal pattern on postural sway assessment.

Definition from U.S. Environmental Protection Agency (1998) for pesticides handler was anyone who mixing, loading, transferring, or applying pesticides, and handling opened containers of pesticides. Thus, their job task needs them working directly to pesticide exposure.

For non-exposed group which were the harvester consist of those who were must never been exposed to pesticide or pesticide. By referring to Table 4.3, 32 harvesters had previous working experience. From the interview based questionnaire, the information gained shows that none of the non-exposed group had been exposed to pesticide and work directly with any pesticides. But, some studies such as from Steenland et al. (2000) and van Wendel de Joode et al. (2001) did not exclude individuals with a history of pesticide poisoning. Several studies in which such individuals were excluded found no relationship of chronic exposure to neurobehavioural performance or nerve conduction velocity but other studies of nonpoisoned individuals have found associations (van Wendel de Joode *et al.* 2001).

Age and body mass index (BMI) of the respondents were taken into account because these factors were possible to be confounder in this study. According to the results as summarized in Table 4.1, the age of pesticide handlers range from 18 to 50 years old, with mean ± SD of 27 ± 7.1 years old. The aged for harvesters was range from 19 to 44 years old and mean ± SD of 26 ± 5.6 years old. Majority of the respondents were young people from Lombok and come to Malaysia to seek better jobs in order to help their family in Indonesia. According to Kamel F. et al. (2003), to reduce variability in neurobehavioural performance, they restricted the age range to 28–55 years of age and excluded individuals with diabetes, epilepsy, or stroke. Thus, in this study people who above than 55 years old was excluded to be the respondent.

For the BMI, 44 (86.3%) of pesticide handlers were within normal weight whereas only 1 (2.1%) of them were overweight. The standard BMI was based on the WHO standard. Otherwise, for non-exposed group, 44 (86.3%) respondents were normal and 2 of them were overweight.

In addition, Table 4.1 also shows that most of the exposed and non-exposed group had completed secondary school education (66.7% and 62.8%, respectively). On the other hand, 3.9 % of exposed group had attended the university education whereas none of non-exposed group had attended the university. Although two respondents of exposed group had attended university but none of them complete their study due to the financial problems.

5.1.3 Exposure rating of exposed group

Exposure rating (ER) was evaluated by observing the pesticide handlers in their working environment. As mention earlier, exposure rating was the independent variable in this study and it was assigned based on the frequency or duration rating and the magnitude rating (MR). The result in Table 4.4 shows that the most frequent exposure rating for the pesticide handlers were ER= 4 with the frequency of 44 respondents (86.3%). The result showed that pesticide handlers exposed to high pesticide exposure during working.

Magnitude rating was referring to the two criteria which were observing the degree of chemical release or presence and also the degree of chemical absorbed or contacted. Both of these criteria were observed by the researchers based on the guidelines stated in the Chemical Health Risk Assessment (CHRA) Manual Second Edition 2000. From the MR results, it was mapped with the result of the duration respondent exposed to pesticide per day. Most of pesticide handlers (86.3%) were classified to have ER 4 which can be categorized as high exposure rating because they have moderate degree of chemical release (inhalation exposure) and also moderate degree of chemical absorbed in which the source close to breathing zone and have contact with eye or skin irritant. Besides, 78.4% of them were working for 4 to 7 hours per day (duration rating 4).

5.1.4 Comparison of neurobehavioural performance score between exposed group and non-exposed group

The second objective in this study was to compare the Neurobehavioural performance score between pesticide handlers with non-exposed group. There were 9 of NCTB tests with different domain functions which were Benton Visual Retention Test (for visual perception), Digit Span Test (auditory memory), Digit Symbol Test (working memory, perceptual motor speed), Santa Ana (Dominant) (motor speed, coordination), Santa Ana (Non dominant), Reaction time (A) test (Attention), Movement Time (B) test (Response speed), Trail Making Test (motor and visual coordination) and Pursuit Aiming Test (motor steadiness). The WHO NCTB was used to detect subclinical neurobehavioural changes because the neurobehavioural changes were found to be consistently sensitive to the effect of chemicals such as pesticides.

Table 4.5 shows that in Benton visual test and Pursuit Aiming Test, the score for non-exposed group was lower than exposed group. Standard score (SS) ± SD for Benton visual test was 50.39± 10.576 (exposed) and 49.02± 9.645(non-exposed) whereas for Pursuit Aiming Test, 50.39± 9.790 (exposed) and 49.80± 10.486 (non-exposed). This can be explained due to the lower education for non-exposed group compared to the exposed group.

Besides, the statistical test shows that there was no significant difference for all NCTB tests between exposed group with non-exposed group. Similar findings had been reported by Nurul Ain (2005) and Azli (2010) indicates that no significant differences of neurobehavioural performance score among pesticides handlers with comparative group. It was possible due to the same range of working experience among exposed and non-exposed group. Even though the exposure to pesticides was different but the short work experience of pesticide handlers was not affect the neurobehavioural performance.

Thus, the previous hypothesis in this study regarding the neurobehavioural performance score for exposed group was significantly lower compared to neurobehavioural performance score for non-exposed group was rejected.

5.1.5 Relationship between working factors with the neurobehavioural performance score among pesticide handlers

5.1.5.1 Exposure rating (ER)

The first working factor in this study was exposure rating that had been evaluated based on the field observation. Pesticide handlers in this FELDA plantation used Paraquat pesticide (group of herbicides) while working. The information from Chemical Safety Data Sheet (CSDS) stated that Paraquat is classified as a solid and may cause long term effects in the aquatic environment. World Health Organization (WHO) 2005 classified the Paraquat dichloride in WHO class II for acute hazard based on an oral LD_{50} in rats of 150 mg per kg body weight. ACGIH 2001 stated that Threshold Limit Value (TLV) for Paraquat is 0.5 mg/m^3. Same goes to OSHA Permissible Exposure Limit which was Time weighted average (TWA) 0.5 mg/m^3 for skin. From the field observation for ER evaluation, pesticide handlers may be exposed to pesticides mainly by inhalation and direct skin contact. It is due to its aerosol and evaporation at 20 ^oC is negligible.

Based on the result obtained, Santa Ana Test for dominant hand that functions for motor speed/coordination has a significant relationship with ER ($p = 0.014$ and $r = 0.34$). The most frequent rating for pesticide handlers was ER 4 which consists of 44 respondents (86.3%). Based on Farahat et al. (2003) and Tenaganita & PANAP (2002), the neurological symptoms of numbness were significantly more prevalent among exposed than control workers. Thus, the higher exposure rating of pesticides may slowly contribute to numbness of hand.

Most respondents were classified to have ER= 4 which can be categorized as high exposure rating due to the unsafe handling of pesticides. Hurtig et al. (2003) and Damalas et al. (2006) had identified the elements of unsafe pesticides handling include the lack of attention to safety precautions, environmental hazards, information about first aid and antidotes given by the label, the use of faulty spraying equipment or lack of proper maintenance of spraying equipment, and lack of the use of protective gear and appropriate clothing during handling of pesticides.

5.1.5.2 Years of employment

In addition to ER, the years of employment also contributed to neurobehavioural score. Data obtained shows the years of employment of pesticide handlers was 1.78 ± 0.76 years. Neurobehavioural score of Digit symbol (working memory and perceptual motor speed) shows a weak significant relationship with years of employment among pesticide handlers (Table 4.6). Even though the pesticide handlers had experience working as sprayer for less than 5 years but the clinical manifestation of neurologic disorders may start to appear gradually. This was supported by Kamel F. et al. (2003) that conclude the long-term experience of farm work was associated with measurable deficits in cognitive and psychomotor function due to the pesticides exposure in Florida. In this study, only Digit Symbol test have significant results because the decreased performance was associated with work duration with the largest decreases seen after 10 or more years of work (Kamel F. et al., 2003). Thus, neuro problems cannot be seen clearly at the moment due to short-term work.

5.1.5.3 Duration of work

However, the factor of working duration per day has no significant association for the entire of NCTB tests. Most of pesticide handlers working from 8.00 am to 3.00 pm per day with mean ± SD were 6.45 ± 0.1 hour and 74.5% of them rest for 30-60 minutes while working. Although the pesticide handlers in oil palm plantations, Johor worked at average of 7 hours per day, most of them were working as pesticide handlers for less than 5 years. This indicates that the level of pesticide exposure was not at risk for them to have neurologic impairment

Therefore, second hypothesis that stated there was significant relationship between working factors (exposure rating and years of employment) with neurobehavioural performance score among pesticide handlers was failed to reject.

5.1.6 Selected factors which influences the total NCTB score

There were several factors that may influence the total NCTB score such as age, BMI, years of employment, duration of work daily (hour), PPE, smoking habit and exposure rating (ER). Multiple linear regressions were performed to control for these differences. By referring to Table 4.8 there were only two factors that influence the total NCTB score which were exposure rating (ER) ($p = 0.025$) and smoking habit ($p = 0.043$).

5.1.6.1 Exposure rating (ER)

Exposure rating (ER) was the independent factor in this study and Paraquat was the pesticide used by the pesticide handlers. Rohlman et al., (2007) stated that any experience of mixing or applying pesticides (pesticide handlers) was found to significantly decrease performance on neurobehavioural measures. Thus, it is important to know the level of pesticide exposure among pesticide handlers by evaluate the exposure rating (ER).

Based on WHO (2005), Paraquat is a bipyridylium herbicide and classified in WHO class II (Moderately Hazardous) for acute toxicity. By referring to the CHRA Manual Second Edition 2000, ER was assigned based on the frequency or duration rating and the magnitude rating. The result showed that ER was significant at $p < 0.05$ and thus the duration of working affect the total NCTB score. According to Kamel F. et al. (2003), longer duration exposed to pesticides was associated with worse performance. Most of the pesticide handlers had ER 4 which can be categorize as high exposure rating. A study from Steenland et al. (2000) found that both acute and chronic pesticide exposures were associated with limited neurologic dysfunction, including impaired balance and color vision.

5.1.6.2 Smoking habit of exposed group

Another factor that influences the total NCTB score was smoking. This study showed that 82.4% of pesticide handlers were identified as smoker. Previous study from Ridzuan (2005) stated that alcohol consumption and smoking was major confounders that influence the NCTB score of respondents. There were several findings stated that the effects of smoking on brain are highly dangerous. According to the National Institute on Drug Abuse or NIDA (2012), once a cigarette smoker inhales a puff of smoke from the cigarette, it takes 8 seconds for the nicotine to travel to the brain. Once in the brain, nicotine causes multiple changes in brain chemistry. Nicotine happens to be shaped like the natural brain chemical acetylcholine. Acetylcholine is one of many chemicals called neurotransmitters that carry messages between brain cells. Nicotine locks into acetylcholine receptors, rapidly causing changes in the brain and body. For instance, nicotine increases blood pressure, heart rate, and respiration (breathing).

Additional information gather from Leong (2009), smoking tobacco increases the risk of two serious neurological problems which were seizures and amytrophic lateral sclerosis (ALS). Amytrophic lateral sclerosis is a progressive neurological disease that causes gradual degeneration of the nerves in the brain and spinal cord. People with this disorder gradually lose the ability to control their muscles which leads to jerky movements and eventually paralysis. Moreover, the study found that the pesticide handlers had been smoking for a long time and this does not surprisingly that smoking is one of the factors that affect the neurologic disorders.

5.1.6.3 Other factors

Age was not a factor that influences the total NCTB score in this study but it can affect memory due to pesticide exposure. The mean ± SD age for pesticide handlers in this study was 27 ± 7.1 years. In the younger group, they showed better scores in NCTB test. Santacruz and Swagerty (2001) in their finding stated that aging may affect memory by changing the way the brain stores information and by making it harder to recall stored information. When the age was in 20s, human begin to lose brain cells a few at a time. Besides that, the body also starts to make less of the chemicals human brain cells need to work. The increasing of age will bring more changes that can affect memory.

Other factors such as the use of personal protective equipment (PPE) is also important to emphasize, although it does not affect the total score NCTB. Seventy eight percent of pesticide handlers in this study used PPE while working. According to Franklin et al. (2005), PPE such as glove and respiratory mask have major impact on reducing and mitigating the workers risks to pesticides exposure. Besides, Coble et al. (2005), and Thompson et al. (2003) found that the poor usage of protective equipment increases pesticide residues accumulating in the body. Thus, the proper PPE usage is important as a measure to reduce exposure to pesticides and prevention of neurologic problems.

From the field observation, the glove and mask that had been using by the pesticide handlers were not appropriate with their work task. They used cotton glove and mask which may absorb the pesticides by inhalation and direct skin contact. Thus, it is better for them to use chemical glove and respirator while handling the pesticides.

Additional information gathered from interview based questionnaire shows 27.5% of pesticide handlers do not used PPE while working and 17.6 % from them told that they feel uncomfortable while using the PPE. Study from Cantor et al.

(2002) and MacFarlane et al. (2008) stated that many circumstances contributed to non adherence to proper use of PPE like extreme heat during pesticide application, uncomfortable to use, few resources to afford new PPE, peer-related factors, and increasing age.

5.1.7 Prevalence of symptoms

International Programme on Chemical Safety (IPCS) 2001 and NIOSH 1996 indicated that Paraquat has a skin notation where it can acts as a strong irritant, especially in concentrated formulations. Information obtained indicate that the symptoms after working for pesticide handlers was 64.7% for skin itching, 45.1% for eye irritation and 27.5% for skin dryness. This study reinforced through the study by Penagos (2002), found that contact dermatitis is a significant health problem for banana workers in Panama, who are exposed to Paraquat. Thus, exposure of agricultural workers during spraying presents considerable acute and chronic risks to health, which could ideally be reduced to a certain extent by good practice and use of adequate protective clothing.

There were growing evidence that Paraquat has chronic effects on the brain and may lead to Parkinson's disease, one of the central nervous system disorders that cause impaired speech and motor skills. Based on the prevalence of neurologic problems, 31.4% of pesticide handlers have memory problems and 29.4 % of them had confusion and misunderstanding problems (false expectation). For example, Stelmashook et al. (2007) and Chen et al. (2010) have indicated that Paraquat can kills neurons in the brain both mature and immature cerebellar granule neurons and damages the hippocampus region of the brain. These will reduce learning and memory abilitity among pesticide handlers. Moreover, researcher at the University of Chicago found a link between the use of pesticides and increased level of anxiety, difficulty concentrating, memory problems and personality changes (Rizzo 2012).

5.2 CONCLUSION

As conclusion, the main objective of this study which is to determine the association between pesticide exposure level and the neurobehavioural performance among pesticide handlers in oil palm plantation in Johor has been achieved by evaluating the exposure rating of the sprayers.

Besides, the results show that there was no significant comparison observed for the entire test between exposed and non-exposed group with neurobehavioural performance score of oil palm plantation, Johor. The study also shows that working factors such as years of employment and exposure rating gave significant relationship with neurobehavioural performance score among pesticide handlers. However, duration of work has no significant result with neurobehavioural performance score. Multiple regressions indicate that exposure rating and smoking were among the factor that influence the total NCTB scores.

Most of the pesticide handlers had experienced skin itching and eyes irritation after working. Besides that, they also had neurological symptoms and signs in which easily forget what they see and hear, difficult in understanding and learning and easily to feel confuse and misunderstanding.

5.3 RECOMMENDATIONS

5.3.1 Health and Medical Surveillance

Health surveillance programme must be done among the respondents in order to know their current health status. Programs such as campaign and health screening can be carried out to know the potential risks as results of pesticide exposure to workers. Besides, the pesticide handlers should undergo the medical surveillance as it is the component of the health surveillance programme and must be carried out by an occupational health doctor (OHD). Based on the Use and Standards of Exposed of Chemical Hazardous to Health (USECHH) Regulation 2000, pesticide was classified as chemical listed in Schedule II, so the pesticide handlers must undergo the health surveillance not more than 12 months or at such shorter intervals as determined by OH doctor.

5.3.2 Training and Education

The pesticide handlers must be trained on how to handle the pesticide. The FELDA Management must conduct the training programme at least once in 2 years. Plus, the training programmes should be provided to pesticide handlers with sufficient information and instruction to enable them to know the risk to health created by pesticide exposure and the precaution which should be taken. Furthermore, the management must provide the education to pesticide handlers on how to understand the Chemical Safety Data Sheet (CSDS). By giving this knowledge, they will know on how to prevent accident that caused by pesticide/ chemicals as well as an education approaches to pesticide handlers.

5.3.3 Maintenance of Personal Protective Equipment

Personal protective equipment (PPE) must be used by pesticide handlers while working because other control measures were not practicable. Personal protective equipment is used to control pesticide exposure to health and it protects the user at the points of potential absorption. The employer or management must implement the maintenance of the PPE because it may give a bad impact to health if the PPE not properly maintain even though the workers use it. Besides, the management is also responsible to ensure that the PPE being used by all the workers.

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APPENDIX 1

EVIDENCE OF APPROVAL ETHICAL BY MEDICAL RESEARCH ETHICS COMMITTEE

APPENDIX 2

INFORM CONSENT
AND
RESPONDENT'S INFORMATION SHEET

APPENDIX 3

QUESTIONNAIRE (MALAY VERSION)

PENILAIAN TINGKAHLAKU NEURO DI KALANGAN PENGENDALI RACUN MAKHLUK PEROSAK DI LADANG KELAPA SAWIT, JOHOR

KEGUNAAN PENYELIDIK

RESPONDENT ID: ☐☐☐☐

BAHAGIAN A: BUTIRAN DIRI

				Kegunaan penyelidik
1.1	Nama	: ______________________		
1.2	No. tel.	: ☐☐☐☐☐☐☐☐☐☐☐☐☐		
1.3	Umur	: ☐☐ tahun		A1 ☐
1.4	Warganegara	: 1 ☐ Warganegara	2 ☐ Bukan warganegara	A2 ☐
1.5	Etnik	: 1 ☐ Melayu 3 ☐ India	2 ☐ Cina 4 ☐ Lain-lain ________	A3 ☐
1.6	Status	: 1 ☐ Bujang	2 ☐ Berkahwin	A4 ☐
1.7	Bilangan Tanggungan	: ______________ orang (termasuk ayah, ibu, isteri, anak)		A5 ☐
1.8	Pendidikan	: 1 ☐ Tidak bersekolah 3 ☐ Peringkat menengah (13 – 17 tahun)	2 ☐ Peringkat rendah (7 – 12 tahun) 4 ☐ Peringkat tinggi (≥ 18 tahun)	A6 ☐

KEGUNAAN PENYELIDIK

1.8 Pendapatan pokok : A7

1 ☐ < RM 500
2 ☐ RM 500 – RM 1000
3 ☐ RM 1000 – RM 2000
4 ☐ > RM 2000

1.8 Pendapatan kerja lebih masa : A8

1 ☐ < RM 500
2 ☐ RM 500 – RM 1000
3 ☐ RM 1000 – RM 2000
4 ☐ > RM 2000

KEGUNAAN PENYELIDIK

BAHAGIAN B: MAKLUMAT PEKERJAAN

2.1 Maklumat pekerjaan terdahulu

2.1.1 Pernahkah anda bekerja di tempat lain sebelum ini?

1 ☐ Ya 0 ☐ Tidak B1 ☐

2.1.2 Jika Ya, sila nyatakan jenis pekerjaan dan tempoh :

Jenis pekerjaan	Tempoh bekerja (jam)	Jumlah tahun bekerja
Jumlah		

☐

2.2 Maklumat pekerjaan sekarang

2.2.1 Apakah pekerjaan anda sekarang?

i) ☐ Harvester

ii) ☐ Loader

iii) ☐ Pesticides sprayer

B2 ☐

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

____________________ tahun B3 ☐

2.2.3 Adakah anda bekerja pada hari cuti?

1 ☐ Ya 0 ☐ Tidak B4 ☐

Jika Ya, secara purata, berapa kerap anda bekerja pada hari cuti?

1 ☐ Sekali sebulan 2 ☐ Dua kali sebulan B5 ☐

3 ☐ Tiga kali sebulan 4 ☐ Empat kali sebulan

KEGUNAAN PENYELIDIK

2.2.4 Secara purata, berapa jam anda bekerja dalam sehari?

_______________________ jam

B6 ☐

2.2.5 Adakah kerja anda sekarang mengikut syif?

1 ☐ Ya   0 ☐ Tidak

B7 ☐

2.2.5 Berapa lamakah anda berehat dalam masa sehari anda bekerja?

_______________________ jam

B8 ☐

BAHAGIAN C: MAKLUMAT SOSIAL/GAYA HIDUP

3.1 <u>Sejarah pengambilan nikotin</u>

3.1.1 Adakah anda pernah merokok?

1 ☐ Ya   0 ☐ Tidak

C1 ☐

3.1.2 Jika Ya, adakah anda masih merokok sekarang?

1 ☐ Ya   0 ☐ Tidak

C2 ☐

3.1.4 Jika Tidak, berapa lamakah anda telah berhenti merokok?

_______________________ tahun

C3 ☐

3.2 <u>Sejarah pengambilan alkohol</u>

3.2.1 Adakah anda pernah mengambil minuman beralkohol?

1 ☐ Ya   0 ☐ Tidak

C4 ☐

3.2.2 Adakah anda masih mengambil minuman beralkohol?

1 ☐ Ya   0 ☐ Tidak

C5 ☐

KEGUNAAN PENYELIDIK

BAHAGIAN D: PENDEDAHAN RACUN PEROSAK

4.0 Pendedahan racun perosak

4.1 Adakah pekerjaan anda melibatkan penggunaan racun makhluk perosak?

1 ☐ Ya   0 ☐ Tidak   D1 ☐

4.2 Nyatakan kekerapan anda menggunakan racun makhluk perosak tersebut semasa bekerja dalam masa sehari?

1 ☐ Kurang daripada 1 jam   D2 ☐
2 ☐ 1 hingga 2 jam
3 ☐ 2 hingga 4 jam
4 ☐ 4 hingga 7 jam
5 ☐ Lebih daripada 7 jam

4.3 Adakah anda ada menggunakan racun makhluk perosak selain dalam waktu bekerja?

1 ☐ Ya   0 ☐ Tidak   D3 ☐

4.4 Sejarah Penggunaan Racun Perosak

4.4.2 Adakah anda menggunakan racun perosak dalam pekerjaan terdahulu?

1 ☐ Ya   0 ☐ Tidak   D4 ☐

4.4.3 Jika ya, berapa lamakah tempoh pendedahan penggunaan racun perosak sehari?

1 ☐ Kurang daripada 1 jam   D5 ☐
2 ☐ 1 hingga 2 jam
3 ☐ 2 hingga 4 jam
4 ☐ 4 hingga 7 jam
5 ☐ Lebih daripada 7 jam

KEGUNAAN PENYELIDIK

4.5 Penggunaan Perlindungan Diri

4.5.2 Adakah anda menggunakan sebarang kelengkapan perlindungan diri sepanjang masa anda bekerja?

1 ☐ Ya   0 ☐ Tidak   D6 ☐

4.5.3 Jika tidak, pada pendapat anda apakah yang menghalang anda dari menggunakan alat perlindungan diri?

1 ☐ Malas   3 ☐ Tidak faham   D7 ☐

2 ☐ Tidak selesa   4 ☐ Tidak diajar cara penggunaannya

4.5.4 Sila nyatakan jenis kelengkapan perlindungan diri yang anda gunakan semasa waktu bekerja:

		Ya	Tidak	
4.5.4.1	Sarung tangan	1 ☐	0 ☐	D8 ☐
4.5.4.2	Coverall	1 ☐	0 ☐	D9 ☐
4.5.4.3	Topeng pernafasan *(Mask)*	1 ☐	0 ☐	D10 ☐
4.5.4.4	Kasut Keselamatan *(Safety Boot)*	1 ☐	0 ☐	D11 ☐
4.5.4.5	Topi Keselamatan *(Safety Helmet)*	1 ☐	0 ☐	D12 ☐

4.6 Maklumat Kesihatan Diri

4.6.1 Adakah anda pernah mengalami tanda atau gejala masalah seperti di bawah?

		Ya	Tidak	
4.6.1.2	Muntah-muntah	1 ☐	0 ☐	D13 ☐
4.6.1.3	Cirit-birit	1 ☐	0 ☐	D14 ☐
4.6.1.4	Kabur penglihatan	1 ☐	0 ☐	D15 ☐
4.6.1.5	Menggigil	1 ☐	0 ☐	D16 ☐
4.6.1.6	Kesukaran bernafas	1 ☐	0 ☐	D17 ☐
4.6.1.7	Kekeliruan mental	1 ☐	0 ☐	D18 ☐

KEGUNAAN PENYELIDIK

4.6.2 Adakah anda mengalami gejala seperti di bawah selepas melakukan kerja meracun?

		Ya	Tidak	
4.6.2.1	Kulit kering	1 ☐	0 ☐	D19 ☐
4.6.2.2	Gatal-gatal kulit	1 ☐	0 ☐	D20 ☐
4.6.2.3	Kulit mengelupas	1 ☐	0 ☐	D21 ☐
4.6.2.4	Pedih mata	1 ☐	0 ☐	D22 ☐

4.6.3 Adakah kebelakangan ini anda pernah mengalami masalah seperti di bawah?

		Ya	Tidak	
4.6.3.1	Mudah lupa apa yang dilihat/ didengari	1 ☐	0 ☐	D23 ☐
4.6.3.2	Lambat bertindak apabila sesuatu hal berlaku	1 ☐	0 ☐	D24 ☐
4.6.3.4	Mudah hilang tumpuan dalam sesuatu hal	1 ☐	0 ☐	D25 ☐
4.6.3.5	Sukar memahami/mempelajari sesuatu hal	1 ☐	0 ☐	D26 ☐
4.6.3.6	Sering keliru atau salah tanggapan mengenai sesuatu hal	1 ☐	0 ☐	D27 ☐

4.7 Maklumat Kebersihan Diri

4.7.1 Adakah anda melakukan perkara seperti di bawah selepas melakukan kerja meracun?

		Ya	Tidak	
4.7.1.1	Membasuh tangan	1 ☐	0 ☐	D28 ☐
4.7.1.2	Mandi	1 ☐	0 ☐	D29 ☐
4.7.1.3	Menukar pakaian	1 ☐	0 ☐	D30 ☐

KEGUNAAN PENYELIDIK

4.8 Cara kerja melalui pemerhatian (Penyelidik)

4.8.1 Tahap pelepasan bahan kimia dan kehadirannya (Lampiran 1) D31 ☐

1 ☐ Rendah

2 ☐ Sederhana

3 ☐ Tinggi

4.8.2 Tahap kimia diserap dan sentuhan "contact" (Lampiran 2) D32 ☐

1 ☐ Rendah

2 ☐ Sederhana

3 ☐ Tinggi

4.8.3 Menetapkan penilaian magnitude (MR) D33 ☐

Tahap pelepasan	Tahap penyerapan	MR
Rendah	Rendah	1
	Sederhana	2
	Tinggi	3
Sederhana	Rendah	2
	Sederhana	3
	Tinggi	4
Tinggi	Rendah	3
	Sederhana	4
	Tinggi	5

4.8.4 Menetapkan penilaian pendedahan D34 ☐

		Penilaian magnitude (MR)				
		1	2	3	4	5
Tempoh pendedahan (Rujuk soalan 7.5.3)	1	1	2	2	2	3
	2	2	2	3	3	4
	3	2	3	3	4	4
	4	2	3	4	4	5
	5	3	4	4	5	5

KEGUNAAN PENYELIDIK

Lampiran 1 (Tahap pelepasan bahan kimia dan kehadirannya)

Tahap	Pemerhatian	√
Rendah	Pelepasan yang rendah atau sedikit ke udara	
	Tiada pencemaran udara	
	Pakaian dan permukaan kerja dimana bahan kimia yang boleh menyerap ke dalam kulit (baju lengan panjang, seluar panjang)	
	Menyebabkan iritasi atau hakisan kepada kulit	
Sederhana	Pelepasan sederhana seperti: Pelarut dengan sederhana kering semasa di dalam bekas bertutup atau terdedah kepada persekitaran kerja (semasa penyedian)	
	Bau yang boleh dikesan	
	Pencemaran udara berlaku	
	Pakaian dan permukaan kerja dengan bahan kimia yang boleh menyerap ke dalam kulit (baju lengan pendek, seluar pendek)	
	Menyebabkan iritasi atau hakisan kepada kulit (lebih parah berbanding di tahap rendah)	
Tinggi	Pelepasan yang tinggi seperti: Pelarut dengan cepat kering dalam bekas bertutup (semasa penyediaan)	
	Semburan di kawasan yang kurang pengudaraan	
	Kimia dengan kadar sejatan yang tinggi yang terdedah kepada persekitaran kerja	
	Bau bahan kimia yang kuat	
	Meliputi kesemua aspek seperti i. Pencemaran udara, ii. Pakaian dan kerja-kerja dengan bahan kimia yang boleh penyerapan kulit iii. Menyebabkan iritasi atau hakisan pada kulit	

Lampiran 2 (Tahap kimia diserap dan sentuhan "contact")

Tahap	Pemerhatian	√
Rendah	Kadar pernafasan yang rendah (Duduk, pergerakan sederhana lengan, kaki dan tubuh badan)	
	Sumber jauh dari zon pernafasan	
	Bersentuhan dengan bahan kimia selain daripada "Sederhana" dan "Tinggi".	
	Permukaaan kecil terdedah kepada bahan kimia seperti tapak tangan (menyerap ke dalam kulit) <2% atau 0.04m^2	
	Kulit normal. Tiada kesan pada kulit atau mata	
Sederhana	Pernafasan kadar sederhana (duduk, banyak pergerakan pada lengan dan kaki, berjalan, aktiviti mengangkat & menolak secara sederhana)	
	Punca hampir dari zon pernafasan	
	Sentuhan kepada mata dan kulit	
	Kekeringan kulit, kulit merah (radang). Kecuali yang dinyatakan di bawah 'Tinggi'	
	Permukaan sederhana terdedah/bersentuhan dengan salah satu atau kedua-dua belah tangan sehingga ke siku. Kawasan kulit> 2% atau 0.04m^2	
Tinggi	Kadar pernafasan tinggi (Aktiviti menolak, angkat, menarik yang berat secara berkala, kerja berat berterusan)	
	Sumber dalam zon pernafasan.	
	Pencemaran kasar pada mata dan kulit atau bahan kimia yang mampu menyerap ke dalam kulit	
	Bahan kimia menembusi kulit apabila bersentuhan. Kawasan terdedah tidak terhad kepada tangan tetapi juga bahagian lain badan. Kawasan kulit> 50% atau 1m^2	
	Kulit yang rosak (Pengeringan yang teruk, dan mengelupas kulit berlaku)	

APPENDIX 4

NCTB FORM BY WHO

UJIAN NEUROPSIKOLOGI (NCTB)
WORLD HEALTH ORGANISATION (WHO)

PERSUIT AIMING TEST

NAMA : ……………………………………………………………………………

NO. K/P : ……………………………………………………

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

<u>LATIHAN</u>

```
                                                     ↓
→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 O O O O O O O O O
```

Titik/bintik yang betul	:	Percubaan 1	☐	2	☐	Jumlah betul	☐
Titik/bintik yang salah	:	Percubaan 1	☐	2	☐	Jumlah salah	☐
						JUMLAH BESAR	☐

PERCUBAAN 1

Mula

→0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

O 30

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0←

60 O

→0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

O 90

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0←

120 O

→0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

O 150

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0←

180 O

PERCUBAAN 2

Mula

→0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

O

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

60 O

→0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

O

0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0 0

120 O

UJIAN NEUROPSIKOLOGI (NCTB)
WORLD HEALTH ORGANISATION (WHO)

SANTA ANA MANUAL DEXTERITY TEST

NAMA : ……………………………………………………………………

NO. K/P : ………………………………………………

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

	PERCUBAAN 1	PERCUBAAN 2	JUMLAH	PURATA
TANGAN DOMINAN				
TANGAN BUKAN DOMINAN				

UJIAN NEUROPSIKOLOGI (NCTB)
WORLD HEALTH ORGANISATION (WHO)

DIGIT SPAN TEST

NAMA : ....

NO. K/P : ....

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	6-9-4
b.	6-4-3-9	7-2-8-6
c.	4-2-7-3-1	7-5-8-3-6
d.	6-1-9-4-7-3	3-9-2-4-8-7
e.	5-9-1-7-4-2-8	4-1-7-9-3-8-6
f.	5-8-1-9-2-6-4-7	3-8-2-9-5-1-7-4
g.	2-7-9-8-6-2-5-8-4	7-1-3-9-4-2-5-6-8

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	5-8
b.	6-2-9	4-1-9
c.	3-2-7-9	4-9-6-8
d.	1-5-2-8-6	6-1-8-4-3
e.	5-3-9-4-1-8	7-2-4-8-5-6
f.	8-1-2-9-3-6-5	4-7-3-9-1-2-8
g.	9-4-3-7-6-2-5-8	7-2-6-1-9-6-5-3

UJIAN NEUROPSIKOLOGI (NCTB)
WORLD HEALTH ORGANIZATION (WHO)

SIMPLE TIME REACTION (STR)

	Reaction (RT)	Movement (RT)
Trial 1		
Trial 2		
Trial 3		
AVERAGE		

UJIAN NEUROPSIKOLOGI (NCTB)
WORLD HEALTH ORGANISATION (WHO)

DIGIT SYMBOL TEST

NAMA : ……………………………………………………………

NO. K/P : ……………………………………………

Markah : ☐

Arahan : Sila perhatikan dengan teliti petak-petak di bawah.
Setiap nombor digit (1-9) di bahagian petak atas mempunyai simbol masing-masing di bahagian bawah petak.
Anda dikehendaki mengisi petak di bahagian bawah dengan simbol-simbol yang sesuai dengan nombor digit yang berada di dalam petak bahagian atas.
Tempoh masa yang diberikan ialah 90 saat.

No. Digit	1	2	3	4	5	6	7	8	9
Simbol	—	⊥	□	L	U	0	∧	X	=

2	1	3	7	2	4	8	1	5	4	2	1	3	2	1	4	2	3	5	2

3	1	4	6	3	1	5	4	2	7	6	3	5	7	2	8	5	4	6	3

7	2	8	1	9	5	8	4	7	3	6	2	5	1	9	2	8	3	7	4

6	5	9	4	8	3	7	2	6	1	5	4	6	3	7	9	2	8	1	7

9	4	6	8	5	9	7	1	8	5	2	9	4	8	6	3	7	9	8	6

UJIAN NEUROPSIKOLOGI (NCTB)
WORLD HEALTH ORGANISATION (WHO)

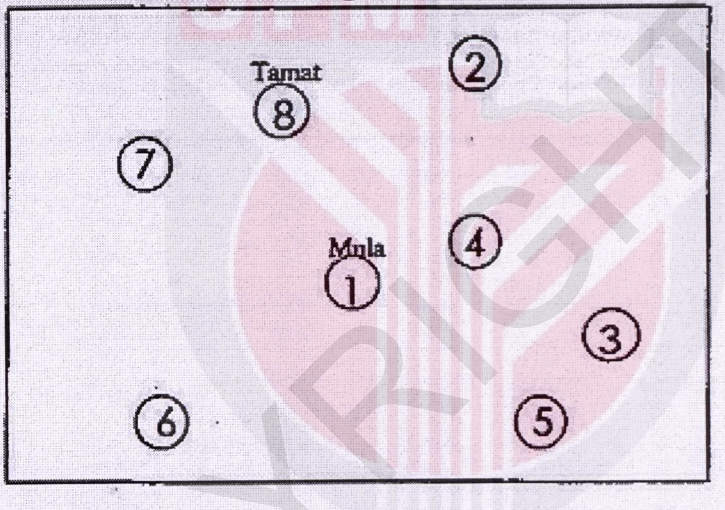
TRAIL MAKING TEST

NAMA : ……………………………………………………………………

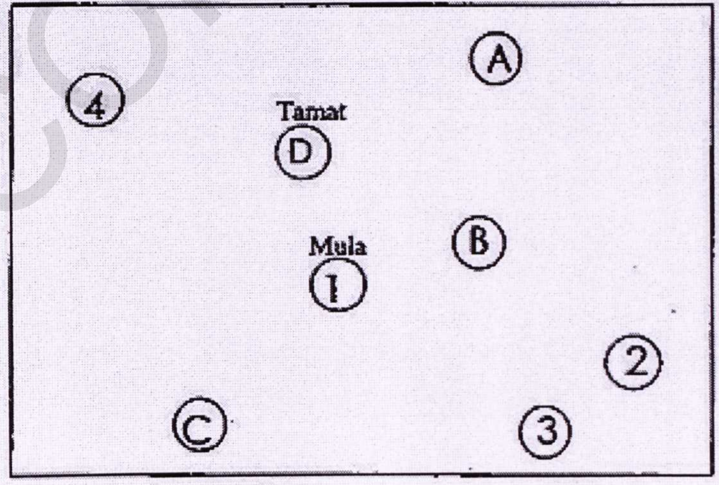
NO. K/P : ………………………………………………

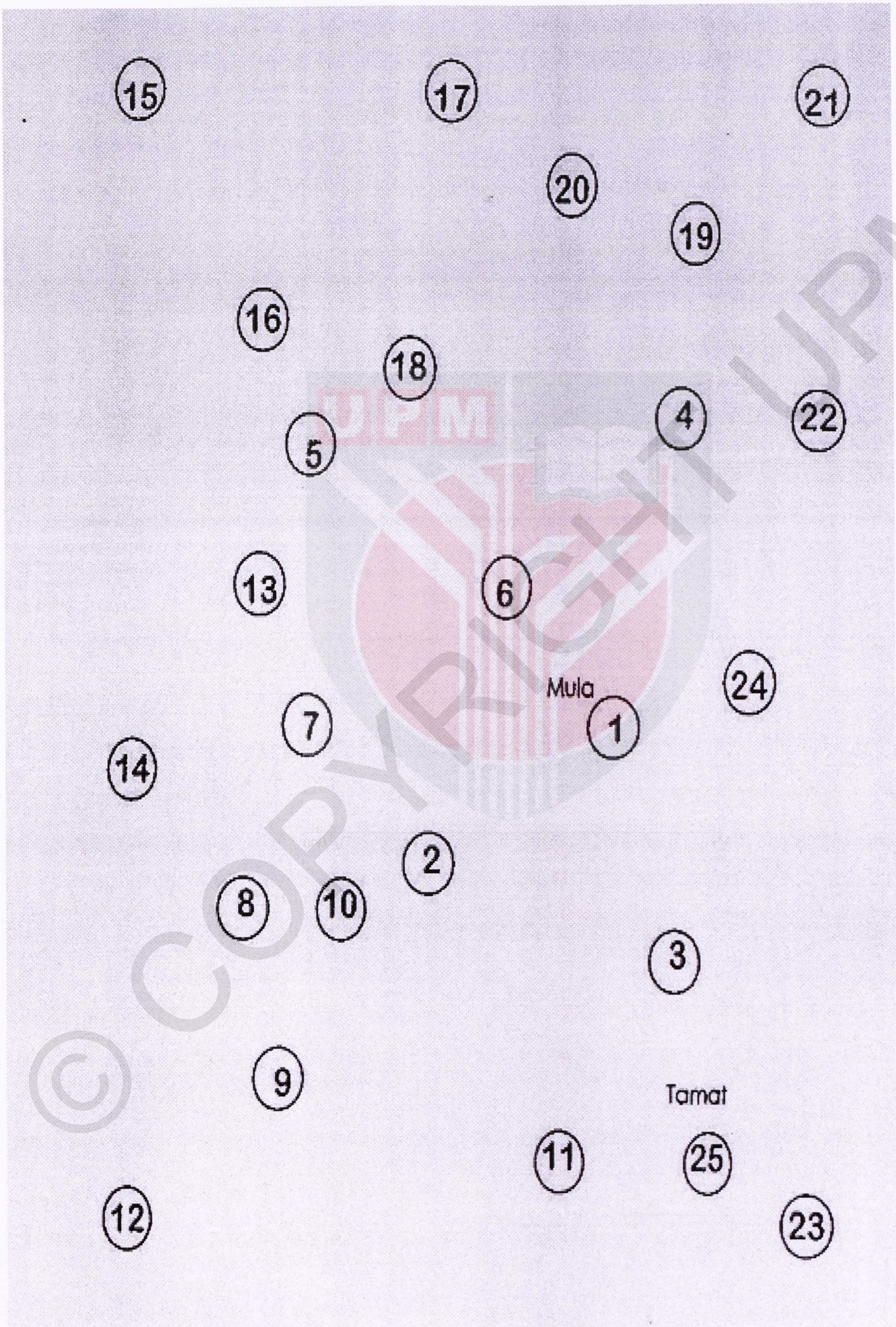
PERCUBAAN

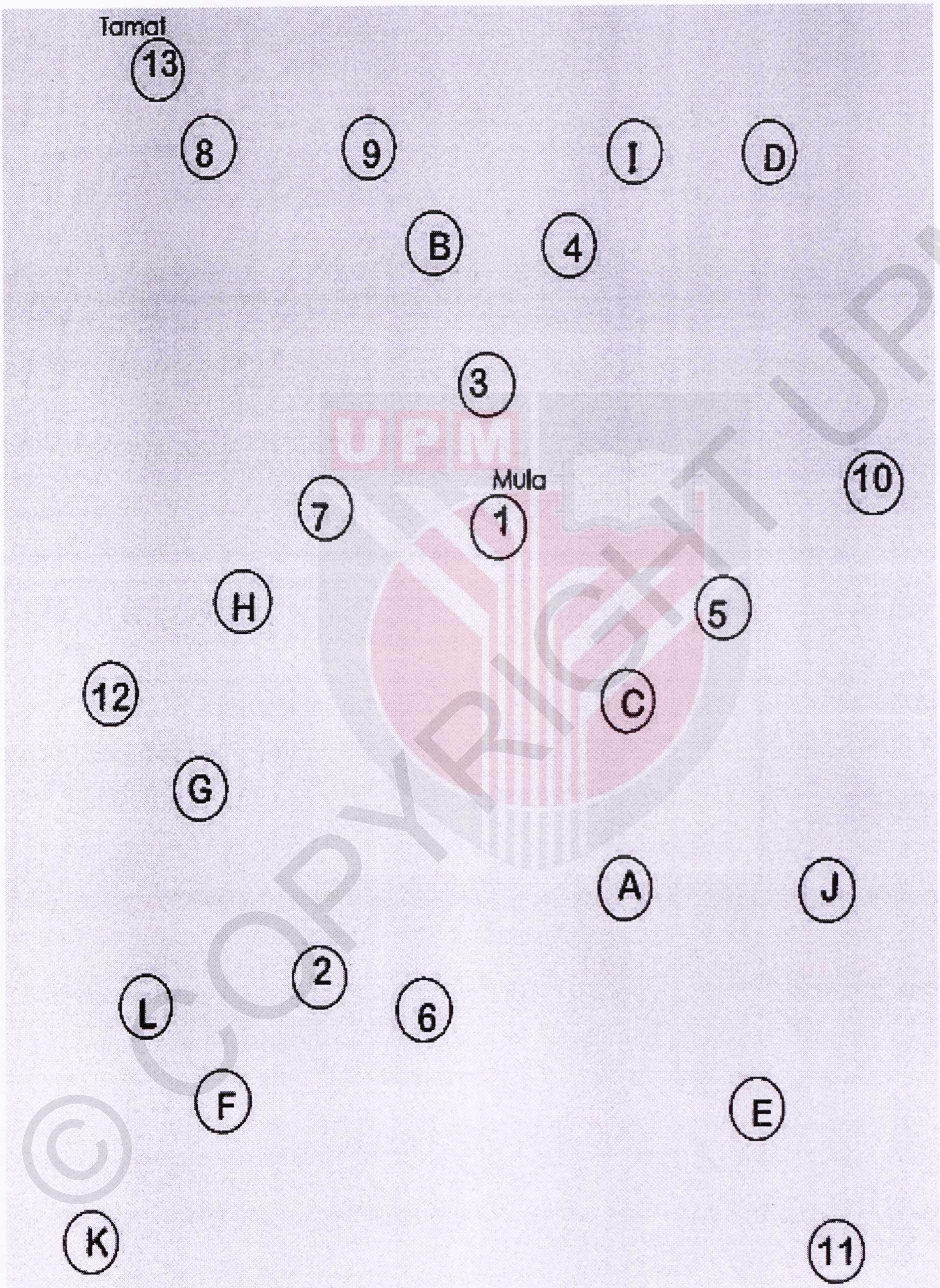
Bahagian A



Bahagian B




15
17
21
20
19
16
18
4
22
5
13
6
Mula
1
24
7
14
2
8
10
3
9
Tamat
11
25
12
23


Tamat
13
8
9
I
D
B
4
3
Mula
1
7
10
H
5
12
C
G
A
J
2
L
6
F
E
K
11

UJIAN NEUROPSIKOLOGI (NCTB)
WORLD HEALTH ORGANISATION (WHO)

BENTON VISUAL RETENTION TEST

NAMA : ………………………………………………………………

NO. K/P : …………………………………………………

<u>JAWAPAN</u>

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

APPENDIX 5

PHOTOGRAPH OF RESEARCH STUDY

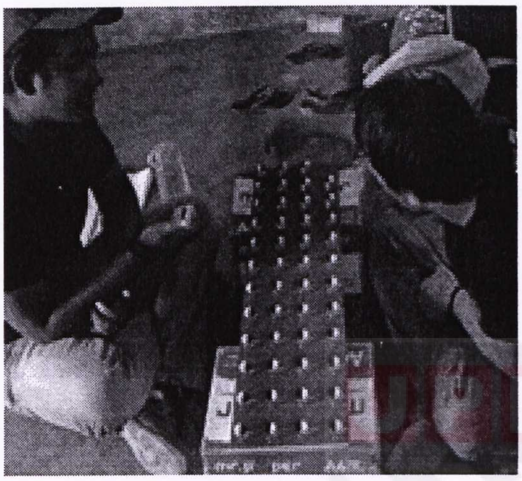


Figure 1 : Respondent was tested for Santa Ana Test

Figure 2 : Respondent was tested for Pursuit aiming Test

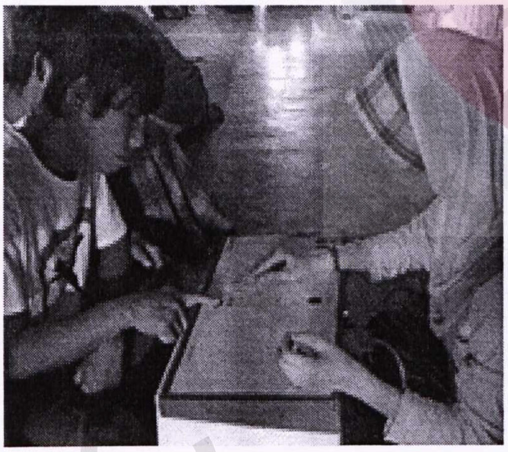


Figure 3 : Respondent was tested for Simple reaction time Test

Figure 4 : Respondent was tested for Benton Visual Retention Test

FAKULTI PERUBATAN DAN SAINS KESIHATAN
FACULTY OF MEDICINE AND HEALTH SCIENCES
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG,
SELANGOR, MALAYSIA

BORANG PERSETUJUAN RESPONDEN

TAJUK KAJIAN : PENILAIAN TINGKAH LAKU NEURO DI KALANGAN PENGENDALI RACUN MAKHLUK PEROSAK DI LADANG KELAPA SAWIT, JOHOR

PENYELIDIK : NORHANA BINTI ABD HAMIS

Saya...No.K/P.....................................

bersetuju/ tidak bersetuju * untuk menyertai kajian bertajuk seperti di atas.

Saya telah membaca dan memahami isi kandungan kajian berdasarkan apa yang telah dinyatakan di dalam 'PENERANGAN KEPADA PESERTA' yang telah dilampirkan bersama surat kebenaran ini dan penerangan tambahan daripada penyelidik.

Saya juga faham bahawa segala maklumat yang diberikan dan segala keputusan yang saya perolehi adalah sulit dan hanya akan digunakan untuk tujuan penyelidikan dan rujukan penyelidik. Saya juga faham bahawa maklumat ini boleh digunakan untuk penerbitan tetapi setiap individu tidak akan dinyatakan identitinya.

Saya faham bahawa saya mempunyai hak untuk menarik diri dan juga mempunyai hak untuk menarik semula keizinan pada bila-bila masa sekiranya perlu apabila merasa tidak selesa pada mana-mana ujian atau aktiviti yang dijalankan oleh penyelidik semasa kajian dijalankan dan tiada sebarang tindakan boleh dikenakan ke atas saya atas tindakan tersebut.

Tandatangan .... (Responden)

Tandatangan.. *(Saksi)*

Tarikh :..

Nama...

No. K/P :..

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

Tarikh ....

Tandatangan .... (Penyelidik)

FAKULTI PERUBATAN DAN SAINS KESIHATAN
FACULTY OF MEDICINE AND HEALTH SCIENCES
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG, SELANGOR, MALAYSIA

PENERANGAN KEPADA PESERTA

TAJUK KAJIAN:

Kajian Risiko Kesihatan Disebabkan oleh Pendedahan Racun Perosak terhadap Neurotingkahlaku di Kalangan Pengendali Racun Perosak di Ladang kelapa sawit.

Terima kasih kerana membantu kami di dalam kajian ini.

1. Apakah kajian ini?

Kajian ini adalah berkaitan dengan risiko kesihatan terhadap neurotingkahlaku di kalangan responden. Pendedahan kepada racun perosak secara berlebihan boleh menyebabkan kesan kesihatan seperti kecacatan neurologi iaitu tanda-tanda klinikal dan gejala-gejala yang disebabkan oleh kecederaan atau kecacatan sistem saraf. Kesan lain adalah pening, masalah pernafasan, gangguan ingatan dan kemurungan.

2. Apakah tujuan kajian ini?

Kajian ini dijalankan bertujuan untuk mengkaji risiko kesihatan disebabkan oleh pendedahan racun perosak terhadap neurotingkahlaku di kalangan pengendali racun perosak di ladang kelapa sawit. Kajian ini menentukan sama ada pengendali racun serangga mempunyai masalah seperti gangguan ingatan, persepsi visual, gangguan ingatan dan kecacatan neurologi disebabkan oleh pendedahan racun serangga perosak secara berlebihan.

3. Berapa ramai responden yang terpilih?

Responden akan dipilih dari kalangan penduduk lelaki Felda di Johor Darul Takzim yang bekerja sebagai pengendali racun serangga perosak di ladang kelapa sawit. Seramai 51 orang responden akan dipilih untuk terlibat di dalam penyelidikan ini. Untuk responden yang tidak terdedah kepada racun serangga, 51 responden dipilih dari dari kalangan penuai lelaki Felda di Johor Darul Takzim yang tidak bekerja sebagai pengendali racun serangga perosak di ladang kelapa sawit mahupun terdedah kepada sebarang racun serangga perosak.

4. Apakah jenis ujian yang akan dijalankan?

Semua responden akan diberikan borang soal selidik untuk diisi sendiri oleh responden. Untuk mengaji neurotingkahlaku pengendali racun serangga perosak, semua responden akan menjalani tujuh ujian Neurobehavioral Core Test Battery (NCTB). Setiap ujian mempunyai fungsi kajian yang berbeza seperti ujian simbol digit untuk menguji daya ingatan dan kepantasan responden.

5. Adakah bayaran dikenakan?

Pengkaji akan menanggung segala pembiayaan ujian yang akan dijalankan dan tiada sebarang bayaran dikenakan terhadap setiap responden.

6. Adakah maklumat dijamin sulit?

Semua maklumat yang diberikan oleh responden di dalam borang kaji selidik adalah dijamin sulit. Tiada huraian individu akan dibuat pada mana-mana bahagian di dalam kajian atau penerbitan.

7. Adakah hak anda?

Kajian ini melibatkan anda secara sukarela. Oleh itu, peserta mempunyai hak untuk menarik diri dari penyertaan dalam kajian ini pada bila-bila masa sekiranya peserta merasa tidak selesa untuk memberikan maklumat kepada pengkaji.

8. Apakah yang harus anda lakukan?

Anda dikehendaki menandatangani borang penyertaan responden yang menyatakan minat anda untuk menyertai kajian ini. Ianya boleh dilakukan setelah anda membaca dan memahami isi kandungan penerangan ini. Borang penyertaan responden haruslah dikembalikan kepada penyelidik sebelum ujian dijalankan. Sekiranya anda mempunyai sebarang kemusykilan, penyelidik akan membantu untuk memberi maklumat yang selanjutnya.

Terima kasih atas kerjasama dan bantuan anda.

NORHANA BINTI ABD HAMIS

Penyelidik

B. Sc. Kesihatan Persekitaran dan Pekerjaan

Unit Kesihatan Persekitaran dan Pekerjaan

Jabatan Kesihatan komuniti

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