UNIVERSITI PUTRA MALAYSIA

THE ASSOCIATION BETWEEN CALCIUM CARBIDE EXPOSURE WITH NEUROBEHAVIORAL PERFORMANCE AMONG FRUIT FARMERS AND WHOLESALERS IN PERAK

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BY

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ABSTRACT

THE ASSOCIATION BETWEEN CALCIUM CARBIDE EXPOSURE WITH NEUROBEHAVIORAL PERFORMANCE AMONG FRUIT FARMERS AND WHOLESALERS IN PERAK

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Introduction: Calcium carbide (CaC_2) was mainly used in the fruit ripening process. When it reacts with the moisture from the surrounding, it released phosphine gas (PH_3) and give impact on neurological systems. In Malaysia, there were no legal and requirement related with the used of CaC_2 as an artificially fruit ripening towards the occupational exposure. Statistic from Health Protection Agency shows there were 26 deaths due to the phosphine poisoning with the estimated concentrations at 1.2 mg/ m^3 (0.9 ppm). **Objective:** This study was conducted to examine the association between concentration of CaC_2 exposure with neurobehavioral performance among farmers and wholesalers in Perak. **Methodology:** A cross-sectional study was conducted among 86 farmers and wholesalers in Perak with the response rate of 87%. Neurobehavioral Core Test Battery (NCTB) and a set of subjective symptoms questionnaire from WHO Operational Guide of NCTB was used to determine the neurobehavioral performances while the personal exposure was measured by using ToxiRae Pro. For the level of psychosocial work factors, it was determined by using the questionnaire from Job Content Questionnaire (JCQ). **Result:** Majority of the respondents were male (64.0%), with the range of age from 26 – 35 years old (27.9%), married (65.1%), Malay (59.3%) also citizen (64.0%) with the highest educational level of secondary school (45.3%) and total income of less than RM1500 (54.7%).There were significant difference on the total score symptoms between exposed and non-exposed group (p=0.00). There were significant correlation between average value of phosphine gas with Santa Ana Dominant Test (r = -0.21) and Time Reaction Test (r = -0.23). **Conclusion:** Finding shows there were association between concentrations of CaC_2 exposure with neurobehavioral performances. Government agencies should prepare one standard operating procedure (SOP) for the safe handling of CaC_2 and the maximum amount of CaC_2 can be used for single fruit ripening process.

Keywords: Calcium carbide (CaC_2), Phosphine Gas (PH_3), Neurobehavioral Performances, Artificial Fruit Ripening, Fruit Farmers and Wholesalers.

ABSTRAK

KAJIAN BERKENAAN HUBUNG KAIT DI ANTARA PENDEDAHAN KALSIUM KARBIDA PADA SISTEM SARAF DAN TINGKAH LAKU DALAM KALANGAN PETANI DAN PEMBORONG BUAH-BUAHAN, DI PERAK.

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Pengenalan: Kalsium karbida telah (CaC_2) telah digunakan dalam proses pemeraman buah. Gas fosfin akan terhasil apabi.a terdapat tindak balas di antara CaC_2 dan kelembapan dari persekitaran. Di Malaysia, tiada undang-undang yang berkaitan dengan pendedahan CaC_2 sebagai bahan tambahan tiruan yang digunakan bagi mempercepatkan proses pemeraman kepada petani dan pemborong buah-buahan. Statistik daripada Agensi Perlindungan Kesihatan menunjukkan terdapat 26 kematian akibat keracunan gas fosfin dengan kepekatan dianggarkan pada 1.2 mg / m^3 (0.9 ppm). **Objektif:** Kajian ini dijalankan untuk mengkaji perkaitan antara kepekatan pendedahan CaC_2 dengan prestasi pada sistem saraf dan tingkahlaku dalam kalangan petani dan pemborong buah-buahan di Perak. **Metodologi:** Kajian keratan rentas telah dijalankan dalam kalangan 86 orang petani dan pemborong buah-buahan di Perak dengan kadar tindak balas sebanyak 87%. Neurobehavioral Core Test Battery (NCTB) dan satu set gejala subjektif soal selidik daripada WHO Panduan Operasi NCTB telah digunakan untuk menentukan prestasi pada sistem saraf, manakala pendedahan diri diukur dengan menggunakan ToxiRae Pro. Untuk tahap faktor kerja psikososial, ia telah ditentukan dengan menggunakan soal selidik daripada "Job Content Questionnaire" (JCQ). **Keputusan:** Majoriti responden adalah lelaki (64.0%), dengan julat umur 26-35 tahun (27.9%), berkahwin (65.1%), Melayu (59.3%) juga warganegara (64.0%) dengan tahap pendidikan tertinggi sekolah menengah (45.3%) dan jumlah pendapatan kurang daripada RM1500 (54.7%). Terdapat perbezaan yang signifikan terhadap jumlah gejala skor antara kumpulan terdedah dan tidak terdedah ($p = 0.000$). Terdapat hubungan yang signifikan antara nilai purata gas fosfin dengan Santa Ana Dominan Test ($r = -0.214$) dan Masa Ujian Reaksi ($r = -0.231$). **Kesimpulan:** Kajian menunjukkan terdapat kaitan antara kepekatan pendedahan CaC_2 dengan prestasi pada sistem saraf dan tingkahlaku. Agensi-agensi kerajaan perlu menyediakan satu prosedur operasi standard (SOP) untuk pengendalian CaC_2 dengan selamat dan jumlah maksimum kalsium karbida yang boleh digunakan untuk proses pemeraman buah pada jangka masa tertentu.

Kata kunci: Kalsium Karbida (CaC_2), Gas fosfin (PH_3), Prestasi Sistem Saraf dan Tingkahlaku, Bahan Tambahan Tiruan, Petani dan Pemborong Buah-buahan.

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LIST OF ABBREVIATIONS

ACGIH	American Conference of Governmental Industrial Hygienists
CaC_2	Calcium Carbide
GDP	Gross Domestic Product
JCQ	Job Content Questionnaire
mg/m^3	Milligram per meter cube
Min	Minimum
Max	Maximum
NCTB	Neurobehavioral Core Test Battery
NIOSH	National Institute for Occupational Safety and Health
OSHA	Occupational Safety and Health Administration
PEL	Permissible Exposure Limit
PH_3	Phosphine gas
PPE	Personal Protective Equipment
ppm	Parts per million
SOP	Standard Operating Procedure
STEL	Short Term Exposure Limit
TWA	Time Weighted Average
U.S	United States
WHO	World Health Organization
%	Percent

CHAPTER 1

INTRODUCTION

1.1 Research Background

Agriculture remains an important sector of Malaysia's economy, contributing 12% to the national Gross Domestic Product (GDP) and providing job opportunities for 16% of the population. The British established large-scope of plantations and introduced new commercial crops (rubber in 1876, palm oil in 1917, and cocoa in the 1950s). The major crops in Malaysia were palm oil and rubber, followed by paddy, cocoa production, timber, peppers, fruits and vegetables. These crops had dominated the agricultural exports. In addition, Malaysian farmers already produced a number of fruits and vegetables for the domestic market including durian, mango and pineapple (Nations Encyclopedia, 2017).

There were two major policies for the agricultural development in Malaysia. The two major policies were Third National Agricultural Policy (1998-2010) and Ninth Malaysia Development Plan (2006-2010). Agricultural sectors were the third causes of development in Malaysia after manufacturing and services sector; however, during

1970s the Malaysian economy was mainly contributor by the agriculture sector. The main factor contributing to the increasing of development in agriculture was due to the peninsular Malaysia that usually did not experienced hurricanes or droughts, and the tropical climate that make it suitable for the cultivation of fruits.
(Istikoma et al., 2015).

According to Gan et al., (1981), Mango *(Mangifera indica)* belongs to the dicotyledonous family of Anacardiaceae. Mango was one of the most popular fruits because it had good nutritional value, delicious taste and attractive color and smell. According to Mohamad (1994), mango was a seasonal fruits because the fruit season starting from April until June for every year. Mango need an area which had a distinct dry period and the most suitable area were at the north region of Malaysia. Current mango clones available in Malaysia are MA128 (Harumanis), MA162 (Golek), MAI65 (MAHA 65), Nam Dok Mai, Masmuda and Chokanan.

Banana, papaya and mango were the type of climacteric fruits. These fruits were harvested hard and green. These fruits will be ripened near the consumption areas to prevent any damage. According to U.S Department of Agriculture, bananas are among the most widely consumed by the human being. India produced the highest bananas worldwide which are 23% of the total banana production. (Jessie, 2014) Papaya (*Carica papaya*) was a tropical fruit that were high in nutritional value. Total annual world productions of papaya were six tones. India was the highest production of papaya with the output of three tones and followed by Brazil, Mexico, Nigeria, Indonesia, China, Peru, Thailand and Philippines. In Malaysia, the main fruits exported were pineapple (32.8%), durian (22.2%), starfruit and papaya (9.6%) and banana (5.4%) (Mohamad, 1994). Mohammad (1994) also stated that, fruits cultivated in Malaysia were divided into two main categories which were non-seasonal fruits like banana and papaya also seasonal fruit like mango. The non-seasonal fruits were not produce continuously along the years; however, it had several peak periods. Unlike seasonal fruits, it occurred in mid-year around the Peninsular Malaysia (Mohamad, 1994).

According to Ur-Rahman et al., (2008) there were several ways of mango fruit ripening by using the calcium carbide (CaC_2). In India, it was the major producing country that produced mango and used the CaC_2 as a fruit ripening agent. The mango was placed with the calcium carbide and moistened with the water before wrapped tightly by using newspaper. The fruits ripened within eight days only. Nagaraj et al., (1984) stated that, two gram of CaC_2 used for every one kilogram of mango and only 96 hours used for the fruit ripening. In Malaysia, the mangoes picked are slightly unripe, then, it was placed into the basket that had been lined with banana leaves and CaC_2. Then, the mangoes are covered with more leaves and the scattered CaC_2 (Ur-Rahman et al., 2008).

According to Liang-Hai (2015), acetylene gas that was produced by the calcium carbide can give impact on the neurological system and caused prolonged hypoxia. In addition, it may also cause mental confusion, memory loss and seizure. The CaC_2 poisoning neurobehavioral and neurological symptoms like increased in deep tendon reflexes, confusion, agitation and lethargy (Huseyin et al., 2006). Thus, the general objective of conducting this study was to examine the association between concentration of CaC_2 exposure with neurobehavioral performance among mango farmers and wholesalers in Perak.

1.2 Problem Statement

In Malaysia, there were no legal and requirement that related with the use of CaC_2 as an artificially fruit ripening towards the occupational exposure. The developing country like India and Bangladesh had their own legislation to control artificial fruit ripening. However, for developing countries, the number of farmers and wholesalers that used the CaC_2 increasing even though there was strict enforcement at their country. For the countries that did not have their own legislation for enforcement, these countries rely on the international standards on food safety. (Islam et al., 2016).

The harmful exposures of phosphines connected with the process of heat and air pollution. The air pollution came from the CaC_2, quicklime, anthracite dust, carbon monoxide, and acetylene. CaC_2 will affect the skin and mucous membranes because of the reaction of calcium hydroxide with moisture or sweat. The moistened impurities of calcium phosphate and calcium arsenate were released phosphine gas (Kjuus et al.,1986).

In humans, acetylene was not acutely toxic below its lower explosive limit of 2.5% and inhalation of 10% acetylene for 1 hour. It does not cause acute toxicity. The inhalation of 33% or 35% can cause unconsciousness within 7 and 5 min respectively. The acute health effect can cause eyes and skin irritation. It is also can cause irritation on mouth, nose and throat and causing coughing and wheezing. The irritation on the lungs may cause shortness of breath and higher exposure lead to pulmonary edema. For the chronic health effect, cause bronchitis to develop with cough, phlegm, and or shortness of breath (Uttam and Kshitij, 2005).

The acetylene gas initiates by the CaC_2 may affect the neurological system by inducing prolonged hypoxia. Recent findings related to carbide poisoning had reported headache, dizziness, mood disturbances, sleepiness, mental confusion, memory loss, cerebral edema and seizure (Siddiqui and Dhua, 2010).

Next, there were 26 deaths resulting from phosphine poisoning reported with the concentrations of phosphine were estimated at 1.2 mg m^{-3} (0.9 ppm) (Health Protection Agency, 2007). For 1982 – 1992, there were records showed 210 cases associated with exposure to phosphine gas and solid formulations of aluminum and zinc phosphide. (DL, 2005)

Farm workers reported to have decreasing in neurobehavioral tests due to the exposed of the chemicals. For the previous working experience with the presence of chemical will having more symptoms and had impaired neurobehavioral performance.

(Freya et al, 2003). There were study on overall mortality and the incidence of cancer among male employees at a plant producing CaC_2 in Norway. Based on the result, there were 234 of death and 92 cases of cancers which were contributing to 326 cases out of 790 employees (Kjuus et al., 1985)

1.3 Study Justification

In Malaysia, the CaC_2 had been used as a fruit ripening especially as the artificially mango ripening. However, the usage of CaC_2 as a food ripening had been banned in India as well as in the Bangladesh. There was no previous study in Malaysia that related with the phosphine gas exposure with neurobehavioral performance. By conducting this study, it can provide new data and can be used as a baseline data for the future research.

This study may increase the knowledge regarding the impact of CaC_2 not just for the farmers; it is including the consumers as well. This is because, most of the farmers and consumers were not aware with the hazard that might appear during the ripening process. This project was expected to provide information, reference and guidance for the management and government agencies to develop any strategy to minimize the use of CaC_2 as a fruit ripening. By minimizing the used of CaC_2, it can reduce the risk of neurobehavioral symptoms and diseases due to the high exposure of phosphine gas. In addition, it is also can be used in increasing awareness on effect of hazardous chemicals to human health and taking safety precaution to minimize the risk.

By conducting this study, it helps the farmers and wholesalers that exposed to CaC_2 for every day, to improve their quality of life and improving the way of handling CaC_2. They can started to do the safe work practice by using PPE while handling the calcium carbide and did not perform the work task in a closed area due to the higher exposure compared to the open space area.

This study is important because, it does not only give impact on the farmers, but it is also giving impact towards the consumers. The consumers also will have symptoms like dizziness, vomiting, nausea and diarrhea if they not wash the fruits properly before eating. It is the acute symptoms by the consumer once its exposed with the CaC_2 (Mohamad, 1994).

By conducting this study, the total exposure of CaC_2 can be calculated by using the personal air sampling. The level of neurobehavioral performance can be determined and the level of socio-demographic and individual characteristics, working characteristics and psychosocial work factors of respondents can be evaluated. The findings of this study can be use by the enforcement body or government to provide any guideline to enforce the suitable rules and regulation and prepared with the standard operating procedure (SOP) on the quantity of CaC_2 supposed to be use for ripening process, the safe exposure level of phosphine and specific safety precautions for all farmers and wholesalers in Malaysia. It is important to develop new and better technique of application, which prevents direct contact of the CaC_2 with the fruits. New compound, which were environmentally safe and not harmful for human health, must be discovered and tested.

1.4 Conceptual Framework

This study is about the affect of CaC_2 exposures towards the neurobehavioral performance among mango farmers in Perak. During the fruit ripening process, the CaC_2 was exposed to the surrounding and the routes of entry are through inhalation. The independent variables in this study are psychosocial, working characteristics, phosphine gas ambient concentration and also socio-demographic. For the psychosocial, working characteristics and socio-demographic, it was measured by using questionnaire. In addition, another measurement was taken to measure the amount of CaC_2 exposed to the workers by using personal air sampling pump. There were confounder that may affect the neurobehavioral performance which was smoking status, alcohol consumption, medical history and the presence of other chemicals. The neurobehavioral performance was tested by using Neurobehavioral Core Test Battery (NCTB). There are seven elements was measured in the NCTB which consists of visual perception or memory, attention or response speed, manual dexterity, motor and visual coordination, motor steadiness, perceptual motor speed and lastly, short term memory capacity.

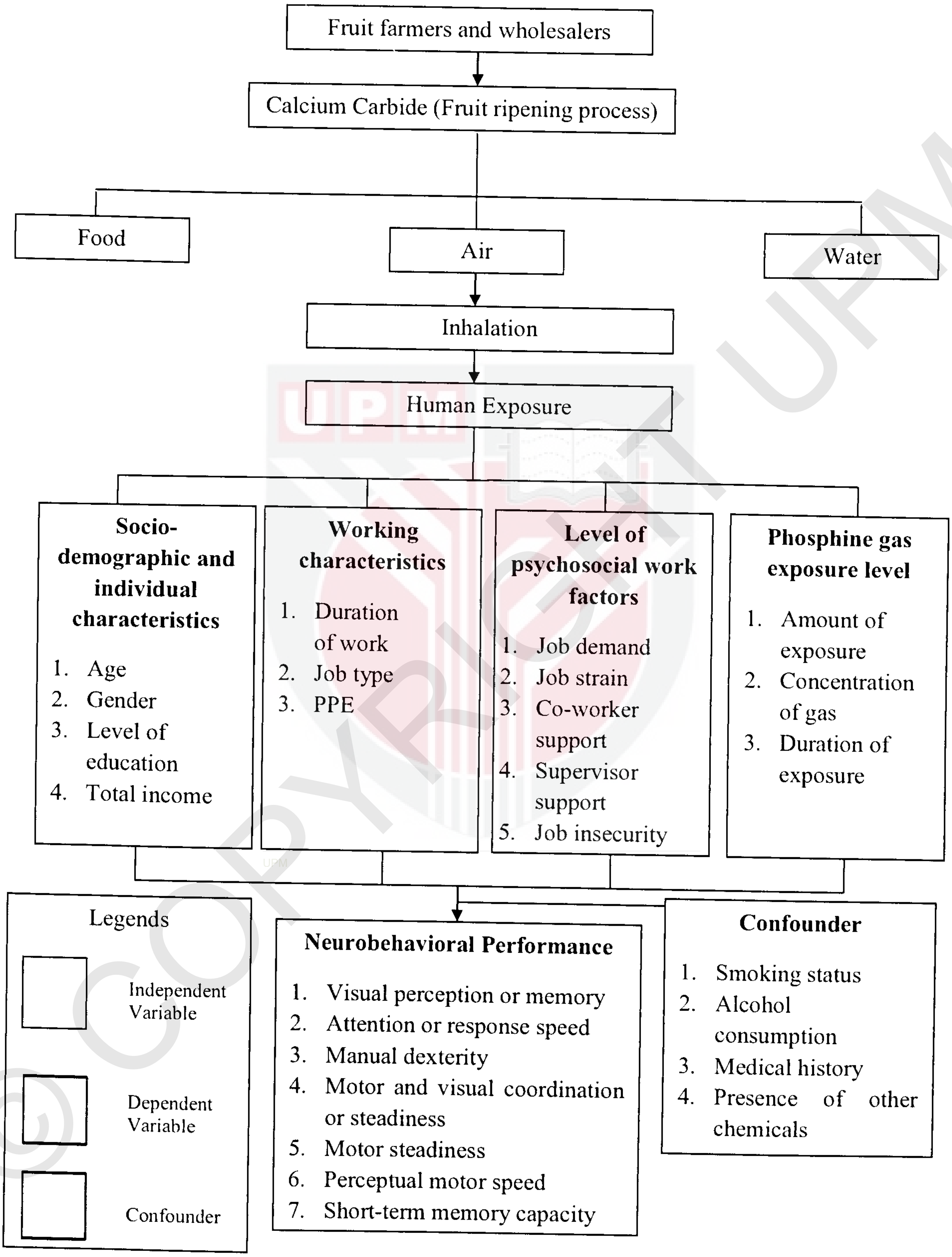

Figure 1.1: Conceptual Frameworks

1.5 Operational Definition

1.5.1 Phosphine gas

A dark gray crystalline compound CaC_2 used especially for the generation of acetylene (Merriam-webster, 2017). The phosphine gas produced from the calcium carbide was measured by using ToxiRAE Pro model PGM-1860.

1.5.2 Socio-demographic

Socio-demographic background of respondents in this study was determined based on the questionnaire.

1.5.3 Working characteristics

Working characteristics of respondents in this study was determined based on the questionnaire.

1.5.4 Psychosocial work factors

Psychosocial work factors of respondents in this study were determined based on the questionnaire of Job Content Questionnaire (JCQ).

1.5.5 Neurobehavioral performance

Neurobehavioral performance was assessed through a set of neurobehavioral core test battery (NCTB) to evaluate the respondent performance. NCTB is a paper-based series of tests including seven subjects which are Benton Visual, Digit Span, Digit Symbol, Santa Ana, Pursuit Aiming, Trail Making and Time Reaction (Broadwater, 2010).

1.6 Conceptual Definition

1.6.1 Calcium Carbide

Fruit ripening substances that is used to artificially accelerate the process of fruits maturation (Islam et. al., 2016).

1.6.2 Phosphine gas

Gas produced from the CaC_2 when it contacts with humid air and reacts with spontaneous decomposition (Siddiqui and Dhua, 2010).

1.6.3 Socio-demographic

A group defined by its sociological and demographic characteristics.

1.6.4 Working characteristics

Features specific to a job, such as knowledge and skill, mental and physical demands and working condition that can be recognized, defined and assessed (Schuurman, 2011).

1.6.5 Psychosocial factors

Interaction among job content, work organization and management and other environmental and organizational condition and the employee's competencies and needs on the other (International Labor Organizaton, 1986).

1.6.6 Neurobehavioral performance

Nervous system function includes the mood (affect), cognitive and psychomotor ability (World Health Organization, 1986).

1.7 Research Questions

I. Is there any difference between the mean difference of total score symptoms between exposed and non-exposed group:

II. Is there any association between the socio-demographic and individual characteristics; working characteristics; level of psychosocial work factors; and phosphine gas exposure levels of respondents with the neurobehavioral performance among farmers and wholesalers

1.8 Study Objective

1.8.1 General Objective

To examine the association between concentration of calcium carbide exposure with neurobehavioral performance among farmers and wholesalers in Perak.

1.8.2 Specific Objectives

I. To identify the socio-demographic and individual characteristics; working characteristics; level of psychosocial work factors; and phosphine gas exposure levels of respondents To determine the level of neurobehavioral performance among respondents.

II. To determine the mean difference of total score symptoms between exposed and non-exposed group.

III. To determine the association between the socio-demographic and individual characteristics; working characteristics; level of psychosocial work factors; and phosphine gas exposure levels of respondents with the neurobehavioral performance among respondents

1.9 Study Hypothesis

I. There was significant difference of total score symptoms between exposed and non-exposed group.

II. There is significant association between the level of psychosocial work factors; working characteristics; phosphine gas exposure levels; and socio-demographic characteristics of respondents with the neurobehavioral performance

1.10 Study Variable

1.10.1 Independent Variables

The independent variables are categorized into four groups which are the socio-demographic and individual characteristics of respondents, working characteristics, phosphine gas exposure level and the level of psychosocial work factors.

1.10.2 Dependent Variables

The dependent variable in this study is the neurobehavioral performance. The neurobehavioral performance is further divided into visual perception or memory, attention or response speed, manual dexterity, motor and visual coordination, motor steadiness, perceptual motor speed and short-term memory capacity.

CHAPTER 2

LITERATURE REVIEW

2.1 Calcium Carbide

According to Mohammad (2012), CaC_2 was produced acetylene gas which used for the ripening process of fruits when the calcium carbide contact with the moisture at the atmosphere. Muhammad (2012), further explains that, acetylene, ethylene and propylene caused fruit ripening either fruits in normal and chilled condition. The CaC_2 processes the unripe fruits for softening, flavor and color changes. The used being discourage because it caused health hazards (Muhammad, 2012).

When CaC_2 exposed to the human at toxic levels, it caused cancer, cardiovascular disease, kidney and liver dysfunction, hormonal imbalance, reproductive disorders, birth defects, premature births, decreasing in immune system, musculoskeletal disease, affect the development of nervous and sensory system, mental health problems, and learning disabilities. (WHO, 2009).

Ministry of Agriculture, Customs, Mobile court, Ministry of health, Ministry of Science at Bangladesh already implement the act of Pesticide law 2007, Pure food rules and act 1967 and 2005, Quarantine rules 1968, and Mobil court act 2009. (Islam et al., 2016). These laws and acts prohibit the usage of any chemicals that used to ripen fruits and penalize any person who is mixing, selling or using illegally ripened fruits. Islam et al., (2016), also state in India and Nepal, there were Prevention of Food Adulteration Rules 1955 and Nepal Food Regulation 2027 which is used to prohibit the use of carbide gas for fruit ripening.

The taste of the fruits were sweet or sour and ripening is the process of making the fruits become sweeter, less green and soft. CaC_2 is widely used as artificially fruit ripening at all over the world. (A. J., 2013). Table 2.1 below shows the calcium carbide used in countries on various fruits to increase the time taken for fruit ripening process. In Malaysia, the CaC_2 was used for the ripening of mango. Australia, Egypt, India, Philippines, South Africa, Sudan and Taiwan were some of the countries that widely used the CaC_2 (Rehaman et al., 2008).

Table 2.1: Calcium carbide used in countries on various fruits.

Banana	Australia, Egypt, India, Philippines, South Africa, Sudan, Taiwan, U.S.A, Yemen
Mango	Brazil, Costa Rica, India, Malaysia, Philippines, Senegal, South Africa
Citrus	Australia, Philippines, South Africa
Tomatoes	Australia, Morocco, Philippines, U.S.A
Plums	South Africa
Peaches	South Africa

Table 2.2 below shows the artificial ripeness and fruits. A.J. (2013), in the study stated that calcium carbide, ethephon, ethylene, oxytocin, aminoethoxyvinylglycine, putrescine, n-Valeric acid and photoporphyrinogen were the list of artificial ripeness. For the calcium carbide, it is used to ripen banana, mango, citrus, tomato, plum and peaches.

Table 2.2: Artificial ripeness and fruits

No	Chemicals	Fruits
1	Calcium carbide	Banana, Mango, Citrus, Tomato, Plums, Peaches.
2	Ethephon	Apples, Currants, Blackberries, Blueberries, Cranberries, Morello cherries, Citrus, Figs, Tomatoes, Sugar Beet, Coffee, Capsicum, Wheat, Tobacco, Cotton, Pineapple, Rice
3	Ethylene	Apples, Avocados, Bananas, Melons, Peaches, Pears, Tomatoes, Broccoli, Cabbage, Cauliflower, Leafy Greens, Lettuce
4	Oxytocin	Melon, Cucumbers, Lactitating mammals
5	Aminoethoxyvinylglycine	Apple (Delay ripening)
6	Putrescine	Japanese plum
7	n-Valeric acid	Sugarcane
8	Photoporphyrinogen	Sugarcane

2.2 Neurobehavioral Performance

2.2.1 Socio-demographic and Neurobehavioral Performance

Diane et al, (2006), in their study found that the non-agriculture workers performed better in NCTB compared to agriculture workers due to the long term of low level exposure on the function of nervous system in agricultural workers. In this study, they examined the impact of age, years of education, gender and years of working in agriculture field on each neurobehavioral measure. For the age, the neurobehavioral performance decreased when the age of the participants increased. Next, there was a significant association between years of education with the performance where increasing years of education, increasing the performance level. In addition, as years of working in agriculture increased, the neurobehavioral performances were decreased. Lastly, female have worse performance compared to male. Similar gender effects were reported in an earlier study conducted in 1999 (Rothlein et al., 2006). Rohlman et. al., (2007) they found that female respondents were performs worse than the male respondents. While gender differences have been noted on specific neurobehavioral tests, these results and earlier findings suggest that there may be a differential impact from agricultural work as well. Other studies also found lower performance on neurobehavioral tests associated with increased years working in agriculture (Kamel et al., 2003;Rolda´n-Tapia et al., 2005).

2.2.2 Working Characteristics and Neurobehavioral Performance

Zhang et al. (2015), was conducted a study on pesticide poisoning and neurobehavioral function among farm workers in Jiangsu. A total of 121 farm workers who self-reported recent pesticide poisonings within the previous 12 months (case group) and 80 farm workers who reported no pesticide poisoning in the previous 12 months (control group) were recruited from three areas of Jiangsu Province, China. Zhang et al. (2015), found that, there were increasing of working duration in agricultural work, the likelihood of decreasing in neurobehavioral performance will also increasing. There was also association between years of involving in agricultural work with the lower performance in neurobehavioral performances.

Freya et al, (2003), were focusing a research on the neurobehavioral performance with the work experience among 288 Florida farm workers and control group that had been worked for at least one month. There was no association between neurobehavioral test and work in the farm before the age of 14. Next, the increasing of years in working at the farm and participants with at least 6 years of education, have a lower neurobehavioral performance. In addition, there was a significant association between duration of working with the neurobehavioral performance, where longer duration of farm work was associated with worse performance. Lastly, the neurobehavioral performance decreased when there was chronic exposure of poisoning even in the absence of a history of the poisoning.

2.2.3 Phosphine Gas Exposure Level and Neurobehavioral Performance

Phosphine gas was colorless and odorless gas that had been produced by the calcium carbide. Oral exposure can caused nausea, vomiting, shock, hypotension and death. National Institute for Occupational Safety and Health of USA (NIOSH), American Conference of Governmental Industrial Hygienists (ACGIH) and Occupational Safety and Health Administration of Malaysia (OSHA) had established the similar limits for occupational exposure to the phosphine. NIOSH has a 10-hour time-weighted average (TWA) of 0.3 ppm while ACGIH and OSHA had established an 8-hour TWA of 0.3

ppm. In addition, there were also 15-minute short-term exposure limit (STEL) of 1.0 ppm established by the ACGIH and NIOSH (Bill et al, 2004).

Kyle et al., (2000) stated that there were safety problem with the phosphine gas due to the inherent instability. Phosphine gas can be measured by using with colorimetric tubes or direct-reading monitoring instruments. Symptoms of overexposure in occupational exposures are largely non-specific including effect on central nervous system that may affect the neurobehavioral performance. The symptoms of central nervous system were headache, dizziness, and staggering gait.

According to Health Protection Agency (2007), on the Phosphine Toxicological Overview, it stated that there were limited data available indicate that phosphine can cause reproductive or developmental effects, because no record related with teratogenic effects. However, a study on mice reported an increase in the number of fetal resorptions following exposure to low concentrations of phosphine. Children that exposed to phosphine will had the same symptoms of toxicity as adults. Phosphine was rapidly absorbed and distributed throughout the body and it affects on the respiratory, circulatory and nervous system, liver, kidney and gastrointestinal tract (Health Protection Agency, 2007).

Table 2.3 shows the time taken for symptoms or death to occur following inhalation of phosphine in humans. Humans were shown the severity effects started from 7 ppm.

Table 2.3: Time taken for symptoms or death to occur following inhalation of phosphine in humans.

Dose		Severity of Effects
ppm	mg/m^3	
7	10	No serious effects after 30 – 60 minutes
100 – 190	140 - 260	Serious effects after 30 – 60 minutes
290 – 430	400 - 600	Dangerous to life after 30 – 60 minutes
400 – 600	560 - 840	Death after 30 – 60 minutes
2000	2800	Death after 30 – 60 minutes

Source: Health Protection Agency, 2007

The table 2.4 below shows the laws and regulations related with the prohibition of the usage of phosphine gas (carbide gas) during the fruit ripening process. Only two countries got the related laws and regulation which were India and Nepal (Mehnaz et al., 2015).

Table 2.4: Laws and regulations practiced in Asian subcontinent to prohibit artificial fruit ripening and food adulteration.

Country	Laws and Regulations	Aims and Actions
India	Prevention of Food Adulteration Rules 1955	To prohibit the use of carbide gas for fruit ripening.
	Food Safety and Standards act, 2006	
Nepal	The Nepal Food Regulation-2027	To prohibit the use of carbide gas for fruit ripening

2.2.4 Psychosocial Work Factors and Neurobehavioral Performance

According to Siedler et al., (2004), there was significant association between the workloads with dementia diagnosis. Dementia was a chronic mental processed caused brain disease and lead to memory disorders, personality changes, and impaired reasoning. Restriction to the cases without cardiovascular disease led to a significant association between the social climates at work to the dementia cases reported.

Every occupation had its own specific risk factors associated with job-related stress and a job demand was one of the risks. Job demands refer to those physical, psychological, social and organizational aspects of the job that require sustained physical and psychological (cognitive and emotional) effort or skills and are therefore associated with certain physiological and/or psychological costs (Evangalia and Arnold, 2011).

Catharina et al., (2017) in their study found that, on 1960s, there were reports published on the psychiatric effects of organophosphate exposures, including depression, aggression and other behavioral disorders. Organophosphates were cholinesterase inhibitors. The enzyme acetyl cholinesterase controls nerve impulses at the cholinergic synapses throughout the nervous system. One of the questionnaires, the Brief Symptom Inventory (BSI) consists of subscales of different dimensions of psychological distress, including depression, anxiety and hostility, with higher scores indicative of impairment. The domain of depression contains a specific question on suicidal ideation. The results of this study were consistent with a substantial number of other published reports on the neuropsychological effects of organophosphate overexposure, including depressive symptoms and a higher prevalence of suicidal thoughts, and are supportive of our a priori hypothesis.

CHAPTER 3

METHODOLOGY

3.1 Study Design

The study design was a cross-sectional study. The data collection was conducted in a specific point of time which was from January 2017 until February 2017.

3.2 Study Location and Population

This study was conducted in various areas in Perak including Kuala Kangsar, Manjung, Bidor and Tanjung Tualang. These areas were chosen due to the large area of farm which is 80 hectare and also the high amount of fruit production for each year. It was conducted among the 97 respondents that involving farmers and wholesalers that used the CaC_2 as the fruit ripening agent for the exposed group. For the non-exposed group, the respondents were from the management team at MARDI Parit, MARDI Kuala Kangsar and also farmers that never handled CaC_2 at Taman Pertanian Universiti (TPU). The figure 3.1 below show the map of Peninsular Malaysia and the shaded area represent the Perak state.

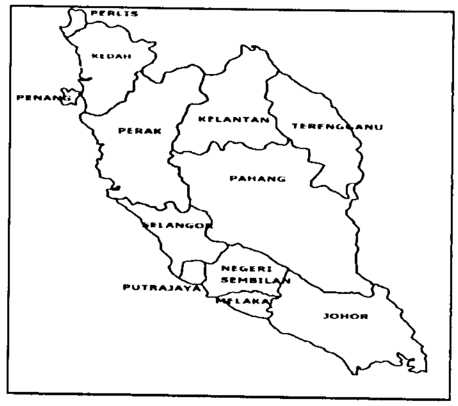

Figure 3.1: Map of Peninsular Malaysia

3.3. Sampling Technique

3.3.1 Sampling Frame

The name list of the respondents obtained from the Perak State Department of Agriculture. Originally there were 120 respondents according to the name list; however 34 of the respondents drop out from the study due to the off season of mango and did not handled the calcium carbide anymore.

3.3.2 Sampling Method

The sampling methods used in this study were purposive sampling method for the study location and respondents. For the exposed group, the respondents was chosen due to the CaC_2 handling while the non-exposed group, the respondents were from those who never handled the CaC_2.

3.3.3 Sampling Unit

The farmers and wholesalers who involve in the agriculture area that handled the CaC_2 were selected as the sampling unit. The inclusion and exclusion criteria for this study were:

Inclusive Criteria:

I. The agriculture farmer and also wholesalers who age 18 – 75 years old

II. Farmers and wholesalers who can understand either Malay or English language

III. Farmers and wholesalers that had the working duration for at least three months and above in handling calcium carbide.

Exclusive Criteria:

I. Farmers or wholesalers who have epilepsy and stroke that had been diagnosed by health practitioner (medical doctor).

3.3.4 Sampling Size

The confidence interval was 95% and desired precision is 0.05. Lameshow, Klar & Lawanga (1990) method was used to calculate sample size. Based on the Operational Guide of Neurobehavioral Core Test Battery, there were blurred vision, frequent headache and excessive sweating as part of the subjective symptoms questions that can be used as the prevalence to calculate the sample size (WHO, 1986).

According to Lynette et al., (1995) and Lorann and Cheryl (2001), the prevalence of neurobehavioral performance symptoms was substitute into the equation below:

$$n = \frac{\{z_{1-\frac{\alpha}{2}}\sqrt{2P(1-P)} + Z_{1-\beta}\sqrt{P_1(1-P_1) + P_2(1-P_2)}\}^2}{(P_1 - P_2)^2}$$

Where,

$P = (P_1 + P_2)/2$

P_1 = estimated proportion (larger)

P_2 = estimated proportion (smaller)

Frequent Headache

$$= \frac{\{1.96\sqrt{(2)0.4(1-0.4)} + 0.842\sqrt{0.58\,(1-0.58) + 0.22(1-0.22)}\}^2}{(0.58 - 0.22)^2}$$

Frequent Headache = 28

The sample, n, obtained then added to 10% of its value. The equation as below:

= 10/100 X 28

= 3

Total number of respondents for one group is calculated as follows:

28 + 3 = 31

Excessive Sweating

$$= \frac{\{1.96\sqrt{(2)0.132(1-0.132)} + 0.842\sqrt{0.203(1-0.203) + 0.061(1-0.061)}\}^2}{(0.203 - 0.061)^2}$$

$Excessive\ Sweating = 88$

The sample, n, obtained then added to 10% of its value. The equation as below:

= 10/100 X 88

= 9

Total number of respondents for one group was calculated as follows:

88 + 9 = 97

The study samples chosen among the farmers and wholesalers were excessive sweating symptom with total number of respondents at 194 due to the exposed and non-exposed group.

3.4 Instrumentation

3.4.1 Questionnaire

A set of standardized questionnaire was used for this study. The standardized questionnaire was obtained from the Job Content Questionnaire (JCQ) for the psychosocial factors. There were 27 questions in JCQ, including 5 questions on job demands, 9 questions on job decision latitude, 8 questions on co-worker support and supervisor support also 3 questions on job insecurity. Job strain is defined as above the average on demands, below average on decision latitude. A score more than was indicate as a job strain. For the JCQ, the respondent was given the answer either it is 1 = strongly disagree, 2 = disagree, 3 = agree or 4 = strongly agree. JCQ was designed to measure scales assessing job demands, job decision latitude, co worker support, and supervisor support also job insecurity. The Malay version of JCQ questionnaire used had been tested among secondary school teacher in Kota Bharu, Kelantan and the results indicated that Cronbach's alpha coefficients revealed decision latitude (0.75), psychological job demand (0.50) and social support (0.84) (Azlihanis et al., 2006).

The questionnaire from the WHO Operational Guide of NCTB was used for the neurobehavioral performance. The questionnaire was developed at the Institute of Occupational Health (Helsinki). This questionnaire was used to determine the most discomforts or troubles in behavior, feelings and sensations that experienced by the respondents. The answer given for this questionnaire was either “yes” or “no”. There were three different section in the neurobehavioral performance part which were the exposure to chemical, health status and subjective symptoms questionnaire.

The estimated time taken to answer the questionnaire is 20 minutes. The total questions should be answer by the respondents were 105 questions. This questionnaire was available in Bahasa Melayu and English version. The professional and reliable person was review the questionnaire to maintain the quality of translation. The farmers and wholesalers were interviewed one by one by the researcher and the respondents were just need to give the answers. The questionnaire was conducted in Malay language. There were four parts in the questionnaire which were Part A for socio-demographic and individual characteristics of respondent’s information which consists of age, marital status, ethnic group, level of education, total income, smoking and alcoholic status. In addition, the questions for the individual characteristics were involving the type of diseases, total sleep, memory and sleep status, changes on personality or behavior also recently taking any medicine or not. Part B was the working characteristics information consists of the job type, working and frequency duration, daily exposure, the use of PPE also the PPE and safety training. Next, Part C for the level of psychosocial work factor information such as job demand, job strain, co-worker support, and supervisor support also job insecurity. Lastly, Part D for the neurobehavioral performance that consists of exposure to chemical, health status and subjective symptoms questionnaire.

3.4.2 Neurobehavioral Core Test Battery (NCTB) Tests

According to Anger (2003) from the World Health Organization, the neurobehavioral performance can be assessed by using the Neurobehavioral Core Test Battery or also known as NCTB. The exposure to neurotoxicants and neuropsychological assessment was being the earliest indication for the neurobehavioral changes (Moser and Tilson, 1990). There are seven tests that must be performed by the respondents. For this study, there was no competent person needed to conduct all the seven tests. Next, the researcher who conducted these tests already attends a training which is conducted by the Industrial Hygienists. The tests were conducted based on Operational Guide of Neurobehavioral Core Test Battery. The standard score for each test then calculated. The score was divided into two groups which was "More than 50" for the standard score more than 50 and "Less than 50" for the standard score less than 50.

3.4.2.1 Pursuit Aiming Test

The purpose of this test was to measure the ability to make quick and accurate movements with hand. The respondents were requested to place one dot inside each circle following the pattern given on the Pursuit Aiming Test sheet.

3.4.2.2 Simple Reaction Time Test

The purpose of this test was to measure how fast a person reacts and requires sustained attention from the subject. The respondent's task was to give fast motor response to repetitive visual stimuli in randomly varied intervals.

3.4.2.3 Digit Symbol Test

This test was used for the perceptual motor speed which also requires learning of association. The Digit Symbol test worksheet contain a list of numbers that were associated with certain symbol in a list of random digits from 1 through 9 with blank squares below each dig it.

3.4.2.4 Santa Ana Manual Dexterity Test

It was test of manual dexterity which required rapid eye-hand coordinated movements. The equipments consist of 48 square holes and equal number of fitted pegs having a cylindrical upper part and square base. The respondents were asked to turn each peg 180° as fast as possible in 30 seconds. There will be two trials for each hand. Starting with the dominant hand and followed by the non-dominant hand. Every correct peg that been inserted correctly will be given with one point.

3.4.2.5 Benton Visual Retention Test

It was used to test of short term visual memory which utilize the same geometric patterns and measure the ability to organize geometrical pattern in space. The respondents were asked to memorize the geometrical patterns. The respondents were given with 10 seconds to memorize the shape shown in the card. Next, the interviewee shows four pattern of card because one of the patterns was the same like the previous card. Another 10 seconds given to give the correct answer. Every correct answer will be given with one point.

3.4.2.6 Digit Span Test

The purpose of this test was to identify the immediate or short term auditory memory which requires focused attention. It consists of two different parts, Digits Forward and Digit Backward, each comprising seven pairs of progressively longer sequences of random numbers. The interviewee was read the numbers and the respondents required to repeat the numbers in forward manner. However, for digit backward, the respondents should repeat the numbers in reverse order. The test will be stopping once the respondents unable to give the correct sequence. Every correct answer will be given with one point.

3.4.2.7 Trail Making Test

The test was for visual conceptual and vasomotor tracking which involve motor speed and attention functions. This test was divided into two parts namely Part A and Part B. Both parts consist of 25 circles distributed over a sheet of paper. The participants were asked to draw a line connecting the numbers in ascending order Part A while in Part B they were requested to connect the circles by alternating numbers and alphabets.

3.4.3 Phosphine Gas Sampling

There was involvement of personal air monitoring during this assessment. The monitoring was conducted to determine the level of phosphine exposure that exposed towards the workers during the process of handling the calcium carbide. The ToxiRAE Pro was the instrument used to measure the phophine gas exposure level. The ToxiRAE Pro was used the software of ProRAE Studio II V1.11.0 with the 2016 RAE Systems by Honeywell. Next, the serial numbers for the ToxiRAE Pro were G0243041 and G024304162 for the model of PGM-1860.

The sampling period was done for 15 minutes as it had been compared according to Short Term Exposure Limit (STEL). According to Bill (The guidelines used for worker exposure standards of phosphine are 0.3 ppm as an 8-hour TWA (Occupational Safety and Health Organization, 1999) and 1 ppm as a 15 minutes STEL (National Institute of Occupational Safety and Health, 1997).

A personal sampler which was ToxiRAE Pro was attached at the part which was close to the breathing zone of a worker. The breathing zone area was 30 cm radius from the respondent's mouth and nose. The phosphine gas was released during the ripening process of the fruits. The farmers and wholesalers was did the ripening process by using CaC_2 that released the phosphine gas with the daily exposure of at least one hour every day. The phosphine gas released after 96 hours of fruit ripening process.

Figure 3.2 shows the method of personal phosphine gas sampling. Firstly, the ToxiRAE Pro was calibrated for every six months. Next, the date, time and the respondent's ID was set for every respondent. The The ToxiRAE Pro was placed at the breathing zone area of the respondents. The data logging start when the worker starts handling the calcium carbide for the ripening process. After 15 minutes of measurement, the data logging was stop and the result shown for the peak, minimum and average value of the phosphine. Lastly, all the data logging was transferred into the computer

ToxiRAE Pro was calibrated to get an accurate result.

↓

Then, the ToxiRAE Pro was turned on and warm up.

↓

The date, time and the respondent's ID was set for every respondent.

↓

The ToxiRAE Pro was placed at the breathing zone area.

↓

After 15 minutes of measurement, the data logging was stop.

↓

The minimum, average and peak value of phosphine gas was shown after the data logging stopped.

↓

Lastly, the ToxiRAE Pro was turned off and the data was transferred into the computer.

Figure 3.2: Method of personal phosphine gas sampling

3.5 Quality Assurance and Quality Control

The quality controls for this research were, firstly, the pre-test interview, post-test interview and also the tests was done with the same interviewee. Next, the used of the standardized questionnaire for the psychosocial work factors and neurobehavioral performances. The pre-test questionnaire was done to ensure the reliability of the questionnaire. It was done for 10% of the sample size which is for 10 respondents. The written consent form was obtained from the respondents before the test been conducted. Next, during the neurobehavioral core test battery, a comfort place without being disturbed with the noise was provided. The tests and interview was conducted by using the same examiner and was trained in interviewing and behavioral test techniques. The post test was immediately done after finish the tests.

For the phosphine gas measurement, firstly, we had to do the testing on the alarms, manually. Under normal non-alarm conditions, the buzzer, vibration alarm, and LEDs can be tested at any time by pressing and holding [Y/+]. If all the alarms are turned on, but one or more of them (buzzer, LED lights, or vibration alarm) does not respond to this test, the instrument cannot be used. Next, the user need to perform the routine calibration for every six months, before conducting this study, the ToxiRAE Pro was being calibrated. The "buzz" sound produced when the reading of phosphine already exceed the STEL or TWA. Lastly, the zero calibration was done was the zero point of the sensor calibration curve for clean air. Expose the ToxiRAE Pro to a clean air source with 20.9% oxygen and without any organic, toxic, or combustible gas impurities. This "Zero Air" can come from a cylinder or clean ambient air.

3.6 Data Analysis

The data was being analyzed using Statistical Package for the Social Sciences Version 22.0 (SPSS 22.0). The variables in this study were being analyzed by using descriptive, univariate and bivariate analysis.

3.6.1 Descriptive Analysis

Descriptive analysis were performed to obtain the frequency, mean, median and standard deviation for the socio-demographic and individual characteristics, working characteristics, psychosocial work factors and phosphine gas exposure levels.

3.6.2 Univariate Analysis

Independent t-test was performed to compare mean difference for variables of socio-demographic and individual characteristics, psychosocial work factors and total score symptoms among exposed and non exposed group.

3.6.3 Bivariate Analysis

Spearman's Rho Correlation and Chi-square test were carried out to measure the association between the level of psychosocial work factors; working characteristics;

phosphine gas exposure levels; and socio-demographic characteristics of respondents with the neurobehavioral performance among respondents

3.7 Ethical Consideration

This study was submitted to the Ethics Committee for Researches Involving Human Subject of University Putra Malaysia and had been approved by the committee with the JKEUPM Reference Number of FPSK (EXP16-OSH) U033. Written informed consent was obtained from the participants and their answer will be kept as private and confidential. Next, all information obtained was only used as research study.

CHAPTER 4

RESULTS

4.1 Background Information

The respondents were farmers and wholesalers in Perak who ever handling CaC_2 during the fruit ripening process. A total of 86 respondents were selected to participate in this study as the exposed group. There were another 76 respondents selected as the control group. It was conducted among the respondents that involving farmers and wholesalers that used the CaC_2 as the fruit ripening agent for the exposed group. For the non-exposed group, the respondents were from the management team at MARDI Parit, MARDI Kuala Kangsar and also farmers that never handled CaC_2 at Taman Pertanian Universiti (TPU).

4.2 Response Rate

A total of 194 respondents for exposed and non-exposed groups were selected for this study, however, only 86 respondents for exposed group involving the farmers and wholesalers was participated and giving the response rate of 89%. On the other hand, 76 respondents for non-exposed group involving farmers and management that never exposed to CaC_2 and giving the response rate of 80%.

4.3 Socio-Demographic Information and Individual Characteristics

Table 4.1 shows the summary of socio-demographic information and individual characteristics of respondents. The variables assessed were age, gender, marital status, ethnicity, education level, total income, smoking status and duration, alcohol intake and alcohol intake duration, health status, type of disease, total sleep, memory status, coordination of hands, problems among family members, personality or behavior changes, medicine intake and condition of sleep.

Majority of the exposed group respondents were male (64.0%), with the range of age from 26 – 35 years old (27.9%), married (65.1%), Malay (59.3%) also citizen (64.0%) with the highest educational level of secondary school (45.3%) and total income of less than RM1500 (54.7%). Majority of the respondents were non smoker (65.1%), never took alcoholic beverages (91.9%) and did not suffered from any disease (86.0%). Most of the respondents need 6 – 7 hours of sleep to feel rested (68.6%), sleep well last night (82.6%), did not have memory worse (55.8%), did not have less coordination in hands (79.1%), family members did not had any problems (93.0%), did not had personality or behavior changes (95.3%) and did not took any medicine (75.6%).

For the non-exposed group, majority of the respondents were male (65.8%), with the range of age from 26 – 35 years old (47.4%), married (68.4%), Malay (100%) also citizen (100%) with the highest educational level of secondary school (60.5%) and total income of less than RM1500 (38.2%). Majority of the respondents were non smoker (63.2%), never took alcoholic beverages (100%) and did not suffered from any disease

(90.8%). Most of the respondents need 6 – 7 hours of sleep to feel rested (68.4%), sleep well last night (82.9%), did have memory worse (56.6%), did not have less coordination in hands (90.8%), family members did not had any problems (97.4%), did not had personality or behavior changes (100%) and did not took any medicine (82.9%).

Table 4.1: Socio-demographic and individual characteristics among exposed and non-exposed group.

Variable	Exposed			Non-exposed		
	Frequency (%)	Mean[a](SD) Median[b]	Min - Max	Frequency (%)	Mean[a](SD) Median[b]	Min - Max
Gender		1 [b]			1 [b]	
Male	55 (64.0)			50 (65.8)		
Female	31 (36.0)			26 (34.2)		
Age		40.21[a] (14.07)	18 - 69		36.25 [a] (1.15)	20 - 60
18 - 25	13 (15.1)			10 (13.2)		
26 – 35	24 (27.9)			36 (47.4)		
36 – 45	20 (23.3)			12 (15.8)		
46 – 55	9 (10.5)			12 (15.8)		
≥ 56	20 (23.3)			6 (7.9)		
Marital Status		2 [b]			2 [b]	
Single	29 (33.7)			23 (30.3)		
Married	56 (65.1)			52 (68.4)		
Divorced	1 (1.2)			1 (1.3)		
Ethnic		1 [b]			1 [b]	
Malay	51 (59.3)			76 (100)		
Indian	1 (1.2)			-		
Chinese	3 (3.5)			-		
Indonesian	20 (23.3)			-		
Others	11 (12.8)			-		
Citizenship		1 [b]			1 [b]	
Citizen	55 (64.0)			76 (100)		
Non - Citizen	31 (36.0)			-		
Education Level		3 [b]			3 [b]	
Not Attending School	17 (19.8)			-		
Primary School	13 (15.1)			3 (3.9)		
Secondary School	39 (45.3)			46 (60.5)		
Higher Education	17 (19.8)			27 (35.5)		

Variable	Exposed			Non-exposed		
	Frequency (%)	Mean[a](SD) Median[b]	Min - Max	Frequency (%)	Mean[a](SD) Median[b]	Min - Max
Total Income		3034.48[a] (4954.48)	600 – 30000		2247.17[a] (1346.80)	500 - 6000
≤ RM 1500	47 (54.7)			29 (38.2)		
RM 1501 – RM 2500	16 (18.6)			24 (31.6)		
RM 2501 – RM 3500	6 (7.0)			10 (13.2)		
RM 3501 – RM 4500	5 (5.8)			6 (7.9)		
RM 4501 – RM 5500	6 (7.0)			5 (6.6)		
≥ RM 5501	6 (7.0)			2 (2.6)		
Smoking Status		2[b]			2[b]	
Yes	30 (34.9)			28 (36.8)		
No	56 (65.1)			48 (63.2)		
Smoking Duration (Years)		5.43[a] (8.97)	0– 40		4.67[a] (8.79)	0 - 45
Not Smoking	56 (65.1)			48 (63.2)		
1 – 10	15 (17.4)			13 (17.1)		
11 – 20	10 (11.6)			12 (15.8)		
≥ 21	5 (5.8)			3 (3.9)		
Alcohol Intake		2[b]			2[b]	
Yes	7 (8.1)			-		
No	79 (91.9)			76 (100)		
Alcohol Intake Duration		0.027[a] (1.26)	0 - 10		0.00[a] (0.00)	-
Not Drinking Alcohol	79 (91.9)			76 (100)		
≤ 5 years	6 (7.0)			-		
≥ 6 years	1 (1.2)			-		

Variable	Exposed			Non-exposed		
	Frequency (%)	Mean[a](SD) Median[b]	Min - Max	Frequency (%)	Mean[a](SD) Median[b]	Min - Max
Type of disease		-	-		-	-
No disease	75 (87.2)			69 (90.8)		
Asthma	1 (1.2)			-		
Asthma and sinusitis	-			1 (1.3)		
Chronic gastritis	1 (1.2)			1 (1.3)		
Diabetes and high blood pressure	1 (1.2)			2 (2.6)		
Sinusitis	1 (1.2)			-		
Tonsil	-			1 (1.3)		
Hemeorrhoids	1 (1.2)			-		
Diabetes	2 (2.3)			1 (1.3)		
Hepatitis B	1 (1.2)			-		
High Blood Pressure	3 (3.5)			1 (1.3)		
Total sleep to feel rested (hours)		6.76[a] (1.06)	4 - 11		6.51[a] (0.95)	5 - 8
≤ 5	7 (8.1)			9 (11.8)		
6 – 7	59 (68.6)			52 (68.4)		
≥ 8	20 (23.3)			15 (19.7)		
Sleep well last night		1[b]			1[b]	
Yes	71 (82.6)			63 (82.9)		
No	15 (17.4)			13 (17.1)		
Memory worse lately		2[b]			1[b]	
Yes	38 (44.2)			43 (56.6)		
No	48 (55.8)			33 (43.4)		

Variable	Exposed			Non-exposed		
	Frequency (%)	Mean[a](SD) Median[b]	Min - Max	Frequency (%)	Mean[a](SD) Median[b]	Min - Max
Family members had emotions and problems		2 [b]			2 [b]	
Yes	6 (7.0)			2 (2.6)		
No	80 (93.0)			74 (97.4)		
Personality or behavior changes		2 [b]			2 [b]	
Yes	4 (4.7)			-		
No	82 (95.3)			76 (100)		
Recently taking any medicine		2 [b]			2 [b]	
Yes	21 (24.4)			13 (17.1)		
No	65 (75.6)			63 (82.9)		

N = 162

4.4 Comparison of Socio-Demographic and Individual Characteristics among Exposed and Non-Exposed Group.

Table 4.2 shows that there was a significant difference of age and alcohol intake duration between exposed and non – exposed groups. The p-value < 0.05, therefore the null hypotheses was rejected and the result was significant. The exposed group had higher mean on age and alcohol intake duration compared to the non-exposed group.

Table 4.2: Comparison on socio-demographic and individual characteristics among exposed and non-exposed group.

Variables	Mean (SD)		Mean difference (95%CI)	t-statistics (df)	*p*-value*
	Exposed	Non - Exposed			
Age	2.99 (1.39)	2.58 (1.15)	3.95 (0.08 – 7.81)	2.02 (156.92)	0.05*
Total Income	2.13 (1.61)	2.21 (1.35)	-0.08 (-0.55 – 0.38)	-0.35 (160)	0.73
Smoking Duration	1.58 (0.91)	1.61 (0.90)	-0.02 (-0.31 – 0.26)	-0.17 (160)	0.87
Alcohol Intake Duration	1.09 (1.26)	1.00 (0.00)	0.09 (0.02 – 0.16)	2.61 (85)	0.01*
Total sleep to feel rested	2.15 (0.54)	2.08 (0.56)	0.07 (-0.1 – 0.24)	0.83 (160)	0.41

N = 162
**p*-value significant at 0.05 level
Independent t-test

4.5 Working Characteristics

Table 4.3 shows the summary of working characteristics of respondents. The variables assessed were type of fruits, job type, working duration, working frequency, daily exposure, used of Personal Protective Equipment (PPE), the type of PPE used, frequency of using PPE, frequency of changing PPE, PPE training and safety training.

Most of the fruits used for ripening were papaya and banana (33.7%). Majority of the respondents for exposed group were farmers (68.6%), working duration of less than five years (40.7%), work frequency in between 5 – 6 days (47.7%) and daily exposure of 2 hours every day (48.8%). Most of the respondents did not use PPE (69.8%). All of the respondents did not use face shield (100%). Most of the respondents did not use coverall (98.8%), hand protection (89.5%) and safety shoes (94.2%). There were respondents that did not attend any PPE training (89.5%) and safety training (91.9%).

For the non exposed group, majority of the respondents were management staff (53.9%) and did not handled any fruit ripening process. Most of them had the working duration of less than five years (39.5%) and work frequency of 1 – 4 days (97.4%). There were no daily exposure (100%) and used of PPE (100%). All of the respondent did not use face shield (100%), coverall (100%), hand protection (100%), safety shoes (100%), not attending any PPE training (100%) and safety training (100%).

Table 4.3: Working characteristics among exposed and non-exposed group.

Variable	Exposed			Non-exposed		
	Frequency (%)	Mean^a(SD) Median^b	Range	Frequency (%)	Mean^a(SD) Median^b	Range
Type of Fruits		2.00^b			-	-
Mango	28 (32.6)			-		
Papaya	29 (33.7)			-		
Banana	29 (33.7)			-		
Job Type		1.00^b			3.00^b	-
Farmer	59 (68.6)			35 (46.1)		
Wholesaler	27 (31.4)			-		
Management	-			41 (53.9)		
Working Duration (years)		8.08^a (7.80)	1 – 4		10.07^a (9.51)	1 – 40
≤ 5	35 (40.7)			30 (39.5)		
6 – 10	33 (38.4)			23 (30.3)		
11 – 20	13 (15.1)			14 (18.4)		
≥ 21	5 (5.8)			9 (11.8)		
Work Frequency (Days)		6.17^a (1.10)	1 - 7		5.05^a (0.322)	5– 7
1 – 4	6 (7.0)			0. (97.4)		
5 – 6	41 (47.7)			2 (2.6)		
7	39 (45.3)			-		

Variable	Exposed			Non-exposed		
	Frequency (%)	Mean[a](SD) Median[b]	Range	Frequency (%)	Mean[a](SD) Median[b]	Range
Daily Exposure (Hours)		1.82[a] (1.04)	0 – 7		-	-
Not Exposed	-			76 (100)		
1	31 (36.0)			-		
2	42 (48.8)			-		
3	9 (10.5)			-		
≥ 4	4 (4.7)			-		
Use of Personal Protective Equipment (PPE)		2[b]			-	-
Yes	26 (30.2)			-		
No	60 (69.8)			76 (100)		
Type of PPE						
Respiratory Protection		2[b]			2[b]	
Yes	22 (25.6)			-		
No	64 (74.4)			76 (100)		
Face Shield		2[b]			2[b]	
Yes	-			-		
No	86 (100)			76 (100)		
Coverall		2[b]			2[b]	
Yes	1 (1.2)			-		
No	85 (98.8)			76 (100)		
Hand Protection (chemical)		2[b]			2[b]	
Yes	9 (10.5)			-		
No	77 (89.5)			76 (100)		

Variable	Exposed			Non-exposed		
	Frequency (%)	Mean[a](SD) Median[b]	Range	Frequency (%)	Mean[a](SD) Median[b]	Range
Safety Shoes		2[b]			2[b]	
Yes	5 (5.8)			-		
No	81 (94.2)			76 (100)		
Frequency of Using PPE		-	-		-	-
Never used	64 (74.4)			76 (100)		
Every time handling chemicals	20 (23.3)			-		
2 – 4 times per week	1 (1.2)			-		
Once a week	1 (1.2)			-		
Frequency of Changing PPE		-	-		-	-
Never Used	64 (74.4)			76 (100)		
Everyday	3 (3.5)			-		
Once a week	6 (7.0)			-		
Twice a month	2 (2.3)			-		
Once a month	9 (10.5)			-		
Others	2 (2.3)			-		
Training of PPE		2[b]			2[b]	
Yes	9 (10.5)			-		
No	77 (89.5)			76 (100)		
Safety Training		2[b]			2[b]	
Yes	7 (8.1)			-		
No	79 (91.9)			76 (100)		

N = 162

4.6 Psychosocial Work Factors

Table 4.4 shows the summary of psychosocial work factors. The variables assessed were job strain, job demands, job decision latitude, co-worker support, and supervisor support also job insecurity.

Table 4.4: Psychosocial work factors among exposed and non-exposed group.

Variable	Exposed			Non – Exposed		
	Mean (SD)	Min – Max	Range	Mean (SD)	Min – Max	Range
Job Demands	32.15 (7.68)	25.00 – 40.00	70.00	29.42 (4.08)	21.00 – 40.00	19.00
Job Decision Latitude	64.20 (7.38)	48.00 – 94.00	46.00	63.08 (6.02)	48.00 – 78.00	30.00
Co Worker Support	11.44 (1.16)	8.00 – 15.00	7.00	11.71 (1.12)	10.00 – 15.00	5.00
Supervisor Support	12.85 (1.97)	8.00 – 16.00	8.00	13.84 (5.28)	9.00 – 56.00	47.00
Job Insecurity	5.17 (1.87)	3.00 – 10.00	7.00	3.89 (0.90)	3.00 – 8.00	5.00

N = 162

	Exposed		Non-exposed	
	Frequency (%)	Median	Frequency (%)	Mean (SD)
Job strain		2		1
Yes	52 (60.5)		26 (34.2)	
No	34 (39.5)		50 (65.8)	

N = 162

4.7 Comparison of Psychosocial Work Factors among Exposed and Non-exposed Group.

Table 4.5 shows that there was a significant difference of job demands and job insecurity between exposed and non – exposed groups. The p-value < 0.05, therefore the null hypotheses are rejected and the result is significant. The exposed group had higher mean on job demands and job insecurity than non exposed group.

Table 4.5: Comparison on psychosocial work factors among exposed and non-exposed group.

Variable	Mean (SD)		Mean difference (95%CI)	t-statistics (df)	*p*-value*
	Exposed	Non – Exposed			
Job Demands	32.85 (3.63)	29.42 (4.08)	3.43 (2.23 – 4.62)	5.66 (160)	0.000*
Job Decision Latitude	64.21 (7.34)	63.08 (6.02)	1.13 (-0.97 – 3.23)	1.06 (160)	0.289
Co Worker Support	11.44 (1.16)	11.71 (1.12)	-0.27 (-0.62 – 0.087)	-1.49 (160)	0.137
Supervisor Support	12.85 (1.97)	13.84 (5.28)	-0.99 (-2.20 - 0.22)	-1.62 (160)	0.107
Job Insecurity	5.17 (1.87)	3.89 (0.90)	1.28 (0.83 – 1.73)	5.64 (125.71)	0.000*

N = 162
*p-value significant at 0.05 level
Independent t-test

4.8 Phosphine Gas Exposure Level

Table 4.6 shows the summary of phosphine gas exposure level. The variables assessed were peak, minimum and average exposure of the phosphine gas.

Table 4.6: Phosphine gas exposure level

Variable (ppm)	Mean (SD)	Min - Max	Range
Peak Exposure	0.11 (0.18)	0.00 – 0.90	0.90
Minimum Exposure	0.01 (0.02)	0.00 – 0.10	0.10
Average Exposure	0.03 (0.06)	0.00 – 0.30	0.30

N = 86

4.9 Phosphine Gas Exposure Level according to Different Location

Table 4.7 shows the summary of phosphine gas according to different location. There were four different locations for the measurement of phosphine. The location assessed were Manjung, Bidor, Kuala Kangsar and Tanjung Tualang.

Table 4.7: Phosphine gas exposure level according to different location

Location (ppm)	Mean (SD)	Min - Max	Range
Manjung			
Peak Exposure	0.21 (0.23)	0.00 – 0.70	0.70
Minimum Exposure	0.01 (0.03)	0.00 – 0.10	0.10
Average Exposure	0.07 (0.06)	0.00 – 0.20	0.20
Bidor			
Peak Exposure	0.16 (0.11)	0.00 – 0.30	0.30
Minimum Exposure	0.02 (0.04)	0.00 – 0.10	0.10
Average Exposure	0.07 (0.07)	0.00 – 0.20	0.20
Kuala Kangsar			
Peak Exposure	0.22 (0.25)	0.00 – 0.90	0.90
Minimum Exposure	0.01 (0.02)	0.00 – 0.10	0.10
Average Exposure	0.06 (0.09)	0.00 – 0.30	0.30

Location (ppm)	Mean (SD)	Min - Max	Range
Tanjung Tualang			
Peak Exposure	0.197 (0.179)	0.00 – 0.80	0.80
Minimum Exposure	0.013 (0.035)	0.00 – 0.10	0.10
Average Exposure	0.067 (0.076)	0.00 – 0.20	0.20

N=86

4.10 Neurobehavioral Performance

Table 4.8 and Table 4.9 show the summary of neurobehavioral performance. There were two sections for this part which are the exposure to chemical substances and neurobehavioral symptoms. For the exposure to chemical substances among the exposed group, most of the respondent's house was far from any chemical plants or hazardous chemical wastes (98.8%). Majority of the respondents were not exposed to other chemical (96.5%), do not exposed to chemical, noise or vibration in previous job (65.1%), they were used chemical during working hour (100%) and do not used PPE while handling CaC_2 (59.3%). For the neurobehavioral symptoms, majority of the respondents often feel tired (87.2%), feel tired when wake up in the morning (59.3%), feel sleepy during the day (62.8%), do not often fall asleep while watching television (79.1%), do not experiencing insomnia (68.6%), do not often wake up at night (81.4%), rarely had nightmares (95.3%), rarely forget things (54.7%), do not often feel that thought were incorrect (82.6%) and rarely felt lost in own thoughts (81.4%). Next, majority of the respondents did not have difficulty in concentrate (57%), rarely felt depressed (77.9%), still interested in events (91.9%), do not felt afraid when there was no real danger (95.3%), did not felt withdrawn from environment (95.3%), stood did not easily changed (95.3%), did not felt irritated (95.3%) and restless (90.7%). Majority of the respondents often felt headache (53.5%), did not experienced vertigo (51.8%), normal heart beat (75.6%), do not had excessive sweating (72.1%), rarely experienced poor appetite (77.9%), diarrhea (89.5%), constipation (90.7%) and stomach ache (76.7%). For the next symptoms, most of the respondents did not felt numbness in fingers (61.6%), upper limbs (62.8%) and lower limbs (66.3%). There were also rarely felt weak in upper limbs (65.1%), lower limbs (67.4%), hands did not often tremble (83.7%), did not drop objects unintentionally (83.7%), did not had difficulty to walk in dark (93.0%), did not had changed of smell (97.7%), taste (97.7%), not felt numbness on face (97.7%) and did not experienced strange sensation in the muscle face (97.7%). For the exposure to chemical substances among the non exposed group, most of the respondent's house was far from any chemical plants or hazardous chemical wastes (98.7%). Majority of the respondents were not exposed to other chemical (89.5%), do not exposed to chemical, noise or vibration in previous job (94.7%), they did not used chemical during working hour (90.8%) and do not used PPE while handling CaC_2 (100%). For the neurobehavioral symptoms, majority of the respondents often felt tired (59.2%), did not felt tired when wake up in the morning (85.5%) or sleepy during the day (63.2%), or easily fall asleep while watching television (88.2%), did not experiencing insomnia (69.7%), did not often wake up at night (77.6%), rarely had nightmares (94.7%), rarely forget things (76.3%), did not often feel that thought were incorrect (88.2%) and rarely felt lost in own thoughts (88.2%). Next, majority of the respondents did not have difficulty in concentrate (82.9%), rarely felt depressed (88.2%), still interested in events (100%), do not felt afraid when there was no real danger (100%), did not felt withdrawn from environment (100%), stood did not easily changed (98.7%), did not felt irritated (97.4%) and restless (93.4%). Majority of the respondents did not often felt headache (67.1%), did not experienced vertigo (90.8%), normal heart beat (89.5%), did not had excessive sweating (82.9%), rarely experienced poor appetite (85.5%), diarrhea (85.5%), constipation (92.1%) and stomach ache (69.7%). For the next symptoms, most of the respondents did not felt numbness in fingers (65.8%), upper limbs (73.7%) and lower limbs (67.1%). There were also rarely felt weak in upper limbs (75%), lower limbs (80.3%), hands did not often tremble (92.1%), did not drop objects unintentionally (98.7%), did not had difficulty to walk in dark (100%), did not had changed of smell (94.7%), taste (98.7%), not felt numbness on face (100%) and did not experienced strange sensation in the muscle face (98.7%).

Table 4.8: Exposure to chemical substance among exposed and non – exposed groups.

Variable	Exposed	Non-exposed
	Frequency (%)	Frequency (%)
House location close to chemical plants or hazardous chemical waste sites.		
Yes	1 (1.2)	1 (1.3)
No	85 (98.8)	75 (98.7)
Exposure to chemical other than CaC_2		
Yes	3 (3.5)	8 (10.5)
No	83 (96.5)	68 (89.5)
Exposure to chemicals, noise, or vibration in a previous job		
Yes	30 (34.9)	4 (5.3)
No	56 (65.1)	72 (94.7)
Use of chemicals during working hour		
Yes	86 (100)	6 (9.2)
No	-	69 (90.8)
The used of personal protective equipment (PPE) while handling CaC_2.		
Yes	35 (40.7)	-
No	51 (59.3)	76 (100)
Other chemicals exposed		
No chemical	83 (96.5)	69 (90.8)
Herbicides	1 (1.2)	-
Pesticides	-	4 (5.3)
Pesticides and herbicides	1 (1.2)	-
Pesticides, fungicides and herbicides	1 (1.2)	-
Chlorine	-	1 (1.3)
Pesticides and fertilizers	-	2 (2.6)

N=162

Table 4.9: Neurobehavioral symptoms among exposed and non – exposed groups.

Variable	Exposed	Non-exposed
	Frequency (%)	Frequency (%)
Often feel tired after work		
Yes	75 (87.2)	31 (40.8)
No	11 (12.8)	45 (59.2)
Feel tired when you are wake up in the morning		
Yes	51 (59.3)	11 (14.5)
No	35 (40.7)	65 (85.5)
Feel sleepy during the day		
Yes	54 (62.8)	28 (36.8)
No	31 (36.0)	48 (63.2)
Often fall asleep while watching television		
Yes	18 (20.9)	9 (11.8)
No	68 (79.1)	67 (88.2)
Often experiencing insomnia		
Yes	27 (31.4)	23 (30.3)
No	59 (68.6)	53 (69.7)
Often wake up at night		
Yes	16 (18.6)	17 (22.4)
No	70 (81.4)	59 (77.6)
Often have nightmares		
Yes	4 (4.7)	4 (5.3)
No	82 (95.3)	72 (94.7)
Often forget things		
Yes	39 (45.3)	18 (23.7)
No	47 (54.7)	58 (76.

Variable	Exposed	Non-exposed
	Frequency (%)	Frequency (%)
Often feel lost in your own thoughts		
Yes	16 (18.6)	9 (11.8)
No	70 (81.4)	67 (88.2)
Have any difficulty in concentrate		
Yes	37 (43.0)	13 (17.1)
No	49 (57.0)	63 (82.9)
Often feel depressed without knowing why		
Yes	19 (22.1)	9 (11.8)
No	67 (77.9)	67 (88.2)
Often feel not interested in events around you		
Yes	7 (8.1)	1 (1.3)
No	79 (91.9)	75 (98.7)
Often afraid when there is no real danger		
Yes	4 (4.7)	-
No	82 (95.3)	76 (100)
Feel withdrawn from your environment		
Yes	4 (4.7)	-
No	82 (95.3)	76 (100)
Your stood change easily		
Yes	4 (4.7)	1 (1.3)
No	82 (95.3)	75 (98.7)
Often feel irritated		
Yes	4 (4.7)	2 (2.6)
No	82 (95.3)	74 (97.4)

Variable	Exposed	Non-exposed
	Frequency (%)	Frequency (%)
Often feel restless		
Yes	8 (9.3)	5 (6.6)
No	78 (90.7)	71 (93.4)
Often feel headache		
Yes	46 (53.5)	25 (32.9)
No	40 (46.5)	51 (67.1)
Often experience vertigo		
Yes	36 (41.9)	7 (9.2)
No	50 (51.8)	69 (90.8)
Often feel that your heart beats quicker than usual		
Yes	21 (24.4)	8 (10.5)
No	65 (75.6)	68 (89.5)
Often experience excessive sweating		
Yes	24 (27.9)	13 (17.1)
No	62 (72.1)	63 (82.9)
Often experience poor appetite		
Yes	19 (22.1)	11 (14.5)
No	67 (77.9)	65 (85.5)
Often have diarrhea		
Yes	9 (10.5)	11 (14.5)
No	77 (89.5)	65 (85.5)
Often have constipation		
Yes	8 (9.3)	6 (7.9)
No	78 (90.7)	70 (92.1)
Often experience stomach ache		
Yes	20 (23.3)	23 (30.3)
No	66 (76.7)	53 (69.7)

Variable	Exposed	Non-exposed
	Frequency (%)	Frequency (%)
Feel numbness in your fingers		
Yes	33 (38.4)	26 (34.2)
No	53 (61.6)	50 (65.8)
Feel numbness in your upper limbs		
Yes	32 (37.2)	20 (26.3)
No	54 (62.8)	56 (73.7)
Feel numbness in your lower limbs		
Yes	29 (33.7)	25 (32.9)
No	57 (66.3)	51 (67.1)
Often feel your upper limbs are weak		
Yes	30 (34.9)	19 (25.0)
No	56 (65.1)	57 (75.0)
Often feel your lower limbs are weak		
Yes	28 (32.6)	15 (19.7)
No	58 (67.4)	61 (80.3)
Hands often tremble		
Yes	14 (16.3)	6 (7.9)
No	72 (83.7)	70 (92.1)
Drop objects from your hands unintentionally		
Yes	14 (16.3)	1 (1.3)
No	72 (83.7)	75 (98.7)
Often find it difficult to walk in the dark		
Yes	6 (7.0)	-
No	80 (93.0)	76 (100)
Feel that your sense of smell has changed		
Yes	2 (2.3)	4 (5.3)
No	84 (97.7)	72 (94.7)

Variable	Exposed	Non-exposed
	Frequency (%)	Frequency (%)
Feel that your sense of taste has changed		
Yes	2 (2.3)	1 (1.3)
No	84 (97.7)	75 (98.7)
Feel that your part of your face are numb		
Yes	2 (2.3)	-
No	84 (97.7)	76 (100)
Experience strange sensations in the muscle in your face		
Yes	2 (2.3)	1 (1.3)
No	84 (97.7)	75 (98.7)

N = 162

Table 4.10: Scores of NCTB tests among farmers and wholesalers.

Variable	Exposed	
	Frequency (%)	Mean (SD)
Benton Visual Retention Test		1.33 (0.47)
More than 50	58 (67.4)	
Less than 50	28 (32.6)	
Digit Span Test		1.50 (0.50)
More than 50	43 (50.0)	
Less than 50	43 (50.0)	
Digit Symbol Test		1.50 (0.50)
More than 50	43 (50.0)	
Less than 50	43 (50.0)	
Santa Ana Dominant Test		1.54 (0.50)
More than 50	40 (46.5)	
Less than 50	46 (53.5)	
Santa Ana Non Dominant Test		1.47 (0.50)
More than 50	46 (53.5)	
Less than 50	40 (46.5)	
Time Reaction Test		1.47 (0.50)
More than 50	46 (53.5)	
Less than 50	40 (46.5)	
Trail Making Test		1.28 (0.45)
More than 50	62 (72.1)	
Less than 50	24 (27.9)	
Pursuit Aiming Test		1.55 (0.50)
More than 50	39 (45.3)	
Less than 50	47 (54.7)	

N = 86

4.11 Neurobehavioral Performance Score

A set of seven NCTB tests were performed on farmers and wholesalers to obtain the neurodevelopment score as shown in Table 4.10. These tests were done on the exposed group which was the wholesalers and farmers that handled the CaC_2.

4.12 Comparison of Neurobehavioral Symptoms among Exposed and Non – Exposed Groups

Table 4.11 shows that there was a significant difference of total score symptoms between exposed and non – exposed groups. The p-value < 0.05, therefore the null hypotheses are rejected and the result is significant. The non-exposed group had higher scores on neurobehavioral symptoms than exposed group.

Table 4.11: Total score symptoms among exposed and non-exposed group.

Variable	Mean (SD)		Mean difference (95%CI)	t-statistics (df)	*p*-value*
	Exposed	Non - Exposed			
Total Score Symptoms	67.17 (5.87)	70.58 (4.25)	-3.40 (-5.01, -1.80)	-4.18 (160)	0.000*

N = 162
**p*-value significant at 0.05 level
Independent t-test

4.13 Correlation between Socio-Demographic and Individual Characteristics with Neurobehavioral Performance

Table 4.12 shows there were significant correlation between age with Trail Making Test (r = -0.214), total income with Digit Symbol Test (r = - 0.395), Trail Making Test (r = -0.223) and Pursuit Aiming Test (r = -0.332). Nest, there were significant correlation between smoking duration with Benton Visual Retention Test (r = 0.312) and Digit Symbol Test (r = 0.215). Lastly, there were significant correlation between sleep duration with Santa Ana Non Dominant Test (r = -0.245).

Table 4.12: Correlation between socio-demographic and individual characteristics with neurobehavioral performances.

		Benton Visual Retention	Digit Span	Digit Symbol	Santa Ana Dominant	Santa Ana Non Dominant	Time Reaction	Trail Making	Pursuit Aiming
Age	r-value	-0.066	-0.106	-0.026	-0.043	-0.101	0.121	-0.214*	-0.113
	p-value	0.546	0.332	0.814	0.693	0.352	0.266	0.048	0.300
Total Income	r-value	-0.198	-0.106	-0.395**	-0.175	-0.011	0.183	-0.223*	0.332**
	p-value	0.068	0.332	0.000	0.107	0.918	0.092	0.039	0.002
Smoking Duration	r-value	0.312**	0.167	0.215*	0.145	0.002	0.059	-0.036	-0.069
	p-value	0.003	0.123	0.047	0.182	0.984	0.593	0.745	0.527
Alcohol Duration	r-value	0.156	0.127	0.123	0.022	-0.111	0.075	0.189	0.090
	p-value	0.151	0.242	0.257	0.842	0.309	0.491	0.081	0.408
Sleep Duration	r-value	0.041	0.089	-0.008	-0.126	-0.245*	0.063	-0.038	-0.102
	p-value	0.708	0.413	0.943	0.249	0.023	0.567	0.726	0.351

N = 86
Spearman's Rank-Order Correlation
* Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

4.14 Association between Socio-Demographic and Individual Characteristics with Neurobehavioral Performance

Table 4.13 shows the association between the socio-demographic and individual characteristics of respondents with the neurobehavioral performances. There were significant association (p-value < 0.05) between gender with Benton Visual Retention Test and Digit Symbol Test, the ethnicity with the Trail Making Test, Benton Visual Retention Test and also the Digit Symbol Test. For the citizenship, there were significant association (p-value < 0.05) with Benton Visual Retention Test, Digit Symbol Test Trail Making test and Pursuit Aiming Test. There was also significant association between alcohol intakes with Trail Making Test (p-value < 0.05). Lastly; there were also significant association (p-value < 0.05) between education level with Digit Symbol Test and also between the smoking status with Benton Visual Retention Test and Digit Symbol Test.

Table 4.13: Association between socio-demographic and individual characteristic with the neurobehavioral performances.

	Benton Visual Retention				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Gender				8.528	0.003*
Male	31 (56.4)	24 (43.6)	55 (100)		
Female	27 (87.1)	4 (12.9)	31 (100)		
Total	58 (67.4)	28 (32.6)	86 (100)		

	Digit Span				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Gender				1.261	0.261
Male	25 (45.5)	30 (54.5)	55 (100)		
Female	18 (58.1)	13 (41.9)	31 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		

	Digit Symbol				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Gender				8.524	0.004*
Male	21 (38.2)	34 (61.8)	55 (100)		
Female	22 (71.0)	9 (29.0)	31 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		

	Santa Ana Dominant				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Gender				1.351	0.245
Male	23 (41.8)	32 (58.2)	55 (100)		
Female	17 (54.8)	14 (45.2)	31 (100)		
Total	40 (46.5)	46 (53.5)	86 (100)		

	Santa Ana Non Dominant				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Gender				0.036	0.850
Male	29 (52.7)	26 (47.3)	55 (100)		
Female	17 (54.8)	14 (45.2)	31 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		
	Time Reaction				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Gender				1.186	0.276
Male	27 (49.1)	28 (50.9)	55 (100)		
Female	19 (61.3)	12 (38.7)	31 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		
	Trail Making				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Gender				0.684	0.408
Male	38 (69.1)	17 (30.9)	55 (100)		
Female	24 (77.4)	7 (22.6)	31 (100)		
Total	62 (72.1)	24 (27.9)	86 (100)		
	Pursuit Aiming				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Gender				0.181	0.671
Male	24 (43.6)	31 (56.4)	55 (100)		
Female	15 (48.4)	16 (51.6)	31 (100)		
Total	39 (45.3)	47 (54.7)	86 (100)		

N = 86
Chi-square test
*significant at p-value < 0.05

	Benton Visual Retention				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Marital Status				1.974	0.422
Single	22 (75.9)	7 (24.1)	29 (100)		
Married	35 (62.5)	21 (37.5)	56 (100)		
Divorced	1 (100)	-	1 (10)		
Total	58 (67.4)	28 (32.6)	86 (100)		
	Digit Span				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Marital Status				3.236	0.171
Single	11 (37.9)	18 (62.1)	29 (100)		
Married	31 (55.4)	25 (44.6)	56 (100)		
Divorced	1 (100)	-	1 (10)		
Total	43 (50.0)	43 (50.0)	86 (100)		
	Digit Symbol				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Marital Status				3.236	0.171
Single	11 (37.9)	18 (62.1)	29 (100)		
Married	31 (55.4)	25 (44.6)	56 (100)		
Divorced	1 (100)	-	1 (10)		
Total	43 (50.0)	43 (50.0)	86 (100)		
	Santa Ana Dominant				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Marital Status				2.269	0.257
Single	11 (37.9)	18 (62.1)	29 (100)		
Married	29 (51.8)	27 (48.2)	56 (100)		
Divorced	-	1 (100)	1 (10)		
Total	40 (46.5)	46 (53.5)	86 (100)		

	Santa Ana Non Dominant				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Marital Status				3.933	0.087
Single	12 (41.4)	17 (58.6)	29 (100)		
Married	34 (60.7)	22 (39.3)	56 (100)		
Divorced	-	1 (100)	1 (10)		
Total	46 (53.5)	40 (46.5)	86 (100)		
	Time Reaction				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Marital Status				1.388	0.568
Single	17 (58.6)	12 (41.4)	29 (100)		
Married	28 (50.0)	28 (50.0)	56 (100)		
Divorced	1 (100)	-	1 (10)		
Total	46 (53.5)	40 (46.5)	86 (100)		
	Trail Making				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Marital Status				4.107	0.110
Single	17 (58.6)	12 (41.4)	29 (100)		
Married	44 (78.6)	12 (21.4)	56 (100)		
Divorced	1 (100)	-	1 (10)		
Total	62 (72.1)	24 (27.9)	86 (100)		

	Pursuit Aiming				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Marital Status				3.047	0.173
Single	10 (34.5)	19 (65.5)	29 (100)		
Married	29 (51.8)	27 (48.2)	56 (100)		
Divorced	-	1 (100)	1 (10)		
Total	39 (45.3)	47 (54.7)	86 (100)		

N = 86
Fisher's Exact Test
*significant at p-value < 0.05

	Benton Visual Retention				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Ethnicity				16.136	0.005*
Malay	23 (45.1)	28 (54.9)	51 (100)		
Indian	1 (100)	-	1 (100)		
Chinese	2 (66.7)	1 (33.3)	3 (100)		
Indonesian	8 (40.0)	12 (60.0)	20 (100)		
Others	6 (54.5)	5 (45.5)	11 (100)		
Total	40 (46.5)	46 (53.5)	86 (100)		

	Digit Span				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Ethnicity				9.549	0.128
Malay	30 (58.8)	21 (41.2)	51 (100)		
Indian	-	1 (100)	1 (100)		
Chinese	1 (33.3)	2 (66.7)	3 (100)		
Indonesian	8 (40.0)	12 (60.0)	20 (100)		
Others	4 (36.4)	7 (63.6)	11 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		

	Digit Symbol				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Ethnicity				16.397	0.003*
Malay	32 (62.7)	19 (37.3)	51 (100)		
Indian	-	1 (100)	1 (100)		
Chinese	1 (33.3)	2 (66.7)	3 (100)		
Indonesian	4 (20.0)	16 (80.0)	20 (100)		
Others	6 (54.5)	5 (45.5)	11 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		

	Santa Ana Dominant				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Ethnicity				7.622	0.316
Malay	23 (45.1)	28 (54.9)	51 (100)		
Indian	1 (100)	-	1 (100)		
Chinese	2 (66.7)	1 (33.3)	3 (100)		
Indonesian	8 (40.0)	12 (60.0)	20 (100)		
Others	6 (54.5)	5 (45.5)	11 (100)		
Total	40 (46.5)	46 (53.5)	86 (100)		

	Santa Ana Non Dominant				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Ethnicity				4.039	0.940
Malay	25 (49.0)	26 (51.0)	51 (100)		
Indian	1 (100)	-	1 (100)		
Chinese	3 (100)	-	3 (100)		
Indonesian	12 (60.0)	8 (40.0)	20 (100)		
Others	5 (45.5)	6 (54.5)	11 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		

	Time Reaction				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Ethnicity				10.859	0.067
Malay	26 (51.0)	25 (49.0)	51 (100)		
Indian	1 (100)	-	1 (100)		
Chinese	1 (33.3)	2 (66.7)	3 (100)		
Indonesian	12 (60.0)	8 (40.0)	20 (100)		
Others	6 (54.5)	5 (45.5)	11 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		

	Trail Making				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	**χ^2**	**p-value**
Ethnicity				9.870	0.043*
Malay	41 (80.4)	10 (19.6)	51 (100)		
Indian	-	1 (100)	1 (100)		
Chinese	3 (100)	-	3 (100)		
Indonesian	13 (65.0)	7 (35.0)	20 (100)		
Others	5 (45.5)	6 (54.5)	11 (100)		
Total	62 (72.1)	24 (27.9)	86 (100)		

	Pursuit Aiming				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	**χ^2**	**p-value**
Ethnicity				4.826	0.306
Malay	27 (52.9)	24 (47.1)	51 (100)		
Indian	-	1 (100)	1 (100)		
Chinese	2 (66.7)	1 (33.3)	3 (100)		
Indonesian	6 (30.0)	14 (70.0)	20 (100)		
Others	4 (36.4)	7 (63.6)	11 (100)		
Total	39 (45.3)	47 (54.7)	86 (100)		

N = 86
Fisher's Exact Test
*significant at p-value < 0.05

	Benton Visual Retention				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Citizenship				5.531	0.019*
Citizen	42 (76.4)	13 (23.6)	55 (100)		
Non Citizen	16 (51.6)	15 (48.4)	31 (100)		
Total	58 (67.4)	28 (32.6)	86 (100)		

	Digit Span				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Citizenship				2.472	0.116
Citizen	31 (56.4)	24 (43.6)	55 (100)		
Non Citizen	12 (38.7)	19 (61.3)	31 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		

	Digit Symbol				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Citizenship				6.103	0.013*
Citizen	33 (60.0)	22 (40.0)	55 (100)		
Non Citizen	10 (32.3)	21 (67.7)	31 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		

	Santa Ana Dominant				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Citizenship				0.036	0.850
Citizen	26 (47.3)	29 (52.7)	55 (100)		
Non Citizen	14 (45.2)	17 (54.8)	31 (100)		
Total	40 (46.5)	46 (53.5)	86 (100)		

	Santa Ana Non Dominant				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Citizenship				0.036	0.850
Citizen	29 (52.7)	26 (47.3)	55 (100)		
Non Citizen	17 (54.8)	14 (45.2)	31 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		

	Time Reaction				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Citizenship				0.408	0.523
Citizen	28 (50.9)	27 (49.1)	55 (100)		
Non Citizen	18 (58.1)	13 (41.9)	31 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		

	Trail Making				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Citizenship				4.741	0.029*
Citizen	44 (80.0)	11 (20.0)	55 (100)		
Non Citizen	18 (58.1)	13 (41.9)	31 (100)		
Total	62 (72.1)	24 (27.9)	86 (100)		

	Pursuit Aiming				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Citizenship				3.352	0.067
Citizen	29 (52.7)	26 (47.3)	55 (100)		
Non Citizen	10 (32.3)	21 (67.7)	31 (100)		
Total	39 (45.3)	47 (54.7)	86 (100)		

N = 86
Chi-square test
*significant at p-value < 0.05

	Benton Visual Retention				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Education Level				5.192	0.158
Not Attending School	9 (52.9)	8 (47.1)	17 (100)		
Primary School	8 (61.5)	5 (38.5)	13 (100)		
Secondary School	26 (66.7)	13 (33.3)	39 (100)		
Higher Education	15 (88.2)	2 (11.8)	17 (100)		
Total	58 (67.4)	28 (32.6)	86 (100)		
	Digit Span				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Education Level				2.103	0.551
Not Attending School	6 (35.3)	11 (64.7)	17 (100)		
Primary School	7 (53.8)	6 (46.2)	13 (100)		
Secondary School	20 (51.3)	19 (48.7)	39 (100)		
Higher Education	10 (58.8)	7 (41.2)	17 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		
	Digit Symbol				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Education Level				8.980	0.030*
Not Attending School	4 (23.5)	13 (76.5)	17 (100)		
Primary School	5 (38.5)	8 (61.5)	13 (100)		
Secondary School	22 (56.4)	17 (43.6)	39 (100)		
Higher Education	12 (70.6)	5 (29.4)	17 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		

	Santa Ana Dominant				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Education Level				0.274	0.965
Not Attending School	7 (41.2)	10 (58.8)	17 (100)		
Primary School	6 (46.2)	7 (53.8)	13 (100)		
Secondary School	19 (48.7)	20 (51.3)	39 (100)		
Higher Education	8 (47.1)	9 (52.9)	17 (100)		
Total	40 (46.5)	46 (53.5)	86 (100)		

	Santa Ana Non Dominant				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Education Level				0.007	1.000
Not Attending School	9 (52.9)	8 (47.1)	17 (100)		
Primary School	7 (53.8)	6 (46.2)	13 (100)		
Secondary School	21 (53.8)	18 (46.2)	39 (100)		
Higher Education	9 (52.9)	8 (47.1)	17 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		

	Time Reaction				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Education Level				0.419	0.936
Not Attending School	9 (52.9)	8 (47.1)	17 (100)		
Primary School	8 (61.5)	5 (38.5)	13 (100)		
Secondary School	20 (51.3)	19 (48.7)	39 (100)		
Higher Education	9 (52.9)	8 (47.1)	17 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		

	Trail Making				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Education Level				5.454	0.141
Not Attending School	9 (52.9)	8 (47.1)	17 (100)		
Primary School	9 (69.2)	4 (30.8)	13 (100)		
Secondary School	29 (74.4)	10 (25.6)	39 (100)		
Higher Education	15 (88.2)	2 (11.8)	17 (100)		
Total	62 (72.1)	24 (27.9)	86 (100)		
	Pursuit Aiming				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Education Level				4.657	0.199
Not Attending School	5 (29.4)	12 (70.6)	17 (100)		
Primary School	4 (30.8)	9 (69.2)	13 (100)		
Secondary School	20 (51.3)	19 (48.7)	39 (100)		
Higher Education	10 (58.8)	7 (41.2)	17 (100)		
Total	39 (45.3)	47 (54.7)	86 (100)		

N = 86
Chi-square test
*significant at p-value < 0.05

	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Benton Visual Retention					
Smoking Status				9.056	0.003*
Yes	14 (46.7)	16 (53.3)	30 (100)		
No	44 (78.6)	12 (21.4)	56 (100)		
Total	58 (67.4)	28 (32.6)	86 (100)		
Digit Span	**More than 50 (%)**	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Smoking Status				3.276	0.070
Yes	11 (36.7)	19 (63.3)	30 (100)		
No	32 (57.1)	24 (42.9)	56 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		
Digit Symbol	**More than 50 (%)**	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Smoking Status				5.119	0.024*
Yes	10 (33.3)	20 (66.7)	30 (100)		
No	33 (58.9)	23 (41.1)	56 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		
Santa Ana Dominant	**More than 50 (%)**	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Smoking Status				3.216	0.073
Yes	10 (33.3)	20 (66.7)	30 (100)		
No	30 (53.6)	26 (46.4)	56 (100)		
Total	40 (46.5)	46 (53.5)	86 (100)		

	Santa Ana Non Dominant				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Smoking Status				0.225	0.635
Yes	15 (50.0)	15 (50.0)	30 (100)		
No	31 (55.4)	25 (44.6)	56 (100)		
Total	46 (53.5	40 (46.5)	86 (100)		
	Time Reaction				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Smoking Status				0.225	0.635
Yes	15 (50.0)	15 (50.0)	30 (100)		
No	31 (55.4)	25 (44.6)	56 (100)		
Total	46 (53.5	40 (46.5)	86 (100)		
	Trail Making				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Smoking Status				0.035	0.851
Yes	22 (73.3)	8 (26.7)	30 (100)		
No	40 (71.4)	16 (28.6)	56 (100)		
Total	62 (72.1)	24 (27.9)	86 (100)		
	Pursuit Aiming				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Smoking Status				0.032	0.857
Yes	14 (46.7)	16 (53.3)	30 (100)		
No	25 (44.6)	31 (55.4)	56 (100)		
Total	39 (45.3)	47 (54.7)	86 (100)		

N = 86
Chi-square test
*significant at p-value < 0.05

	Benton Visual Retention				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	**χ^2**	**p-value**
Alcohol Intake				3.050	0.238
Yes	3 (42.9)	4 (57.1)	7 (100)		
No	55 (69.6)	24 (30.4)	79 (100)		
Total	58 (67.4)	28 (32.6)	86 (100)		
	Digit Span				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	**χ^2**	**p-value**
Alcohol Intake				1.706	0.433
Yes	2 (28.6)	5 (71.4)	7 (100)		
No	41 (51.9)	38 (48.1)	79 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		
	Digit Symbol				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	**χ^2**	**p-value**
Alcohol Intake				1.706	0.433
Yes	2 (28.6)	5 (71.4)	7 (100)		
No	41 (51.9)	38 (48.1)	79 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		
	Santa Ana Dominant				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	**χ^2**	**p-value**
Alcohol Intake				0.927	1.00
Yes	3 (42.9)	4 (57.1)	7 (100)		
No	37 (46.8)	42 (53.2)	79 (100)		
Total	40 (46.5)	46 (53.5)	86 (100)		

	Santa Ana Non Dominant				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Alcohol Intake				1.302	0.681
Yes	5 (71.4)	2 (28.6)	7 (100)		
No	41 (51.9)	38 (48.1)	79 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		
	Time Reaction				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Alcohol Intake				1.227	0.829
Yes	3 (42.9)	4 (57.1)	7 (100)		
No	43 (54.4)	36 (45.6)	79 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		
	Trail Making				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Alcohol Intake				4.705	0.050*
Yes	3 (42.9)	4 (57.1)	7 (100)		
No	59 (74.7)	20 (25.3)	79 (100)		
Total	62 (72.1)	24 (27.9)	86 (100)		
	Pursuit Aiming				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Alcohol Intake				3.020	0.148
Yes	2 (28.6)	5 (71.4)	7 (100)		
No	37 (46.8)	42 (53.2)	79 (100)		
Total	39 (45.3)	47 (54.7)	86 (100)		

N = 86
Fisher's Exact Test
*significant at p-value < 0.05

	Benton Visual Retention				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Suffered from any disease				1.604	0.205
Yes	10 (83.3)	2 (16.7)	12 (100)		
No	48 (64.9)	26 (35.1)	74 (100)		
Total	58 (67.4)	28 (32.6)	86 (100)		
	Digit Span				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Suffered from any disease				3.486	0.062
Yes	9 (75.0)	3(25.0)	12 (100)		
No	34 (45.9)	40 (54.1)	74 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		
	Digit Symbol				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Suffered from any disease				1.550	0.213
Yes	8 (66.7)	4 (33.3)	12 (100)		
No	35 (47.3)	39 (52.7)	74 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		

	Santa Ana Dominant				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Suffered from any disease				0.068	0.794
Yes	6 (50.0)	6 (50.0)	12 (100)		
No	34 (45.9)	40 (54.1)	74 (100)		
Total	40 (46.5)	46 (53.5)	86 (100)		

	Santa Ana Non Dominant				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Suffered from any disease				0.783	0.376
Yes	5 (41.7)	7 (58.3)	12 (100)		
No	41 (55.4)	33 (44.6)	74 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		

	Time Reaction				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Suffered from any disease				0.068	0.794
Yes	6 (50.0)	6 (50.0)	12 (100)		
No	40 (54.1)	34 (45.9)	74 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		

	Trail Making				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Suffered from any disease				5.398	0.020*
Yes	12 (100)	-	12 (100)		
No	50 (67.6)	24 (32.4)	74 (100)		
Total	62 (72.1)	24 (27.9)	86 (100)		

	Pursuit Aiming				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Suffered from any disease				0.949	0.330
Yes	7 (58.3)	5 (41.7)	12 (100)		
No	32 (43.2)	42 (56.8)	74 (100)		
Total	39 (45.3)	47 (54.7)	86 (100)		

N = 86
Chi-square test
*significant at p-value < 0.05

	Benton Visual Retention				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	**χ^2**	**p-value**
Memory worse lately				4.599	0.032
Yes	21 (55.3)	17 (44.7)	38 (100)		
No	37 (77.1)	11 (22.9)	48 (100)		
Total	58 (67.4)	28 (32.6)	86 (100)		

	Digit Span				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	**χ^2**	**p-value**
Memory worse lately				1.697	0.193
Yes	16 (42.1)	22 (57.9)	38 (100)		
No	27 (56.3)	21 (43.8)	48 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		

	Digit Symbol				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	**χ^2**	**p-value**
Memory worse lately				0.189	0.664
Yes	18 (47.4)	20 (52.6)	38 (100)		
No	25 (52.1)	23 (47.9)	48 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		

	Santa Ana Dominant				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	**χ^2**	**p-value**
Memory worse lately				0.531	0.466
Yes	16 (42.1)	22 (57.9)	38 (100)		
No	24 (50.0)	24 (50.0)	48 (100)		
Total	40 (46.5)	46 (53.5)	86 (100)		

	Santa Ana Non Dominant				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Memory worse lately				0.020	0.887
Yes	20 (52.6)	18 (47.4)	38 (100)		
No	26 (52.4)	22 (45.8)	48 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		

	Time Reaction				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Memory worse lately				2.559	0.110
Yes	24 (63.2)	14 (36.8)	38 (100)		
No	22 (45.8)	26 (52.4)	48 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		

	Trail Making				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Memory worse lately				2.702	0.100
Yes	24 (63.2)	14 (36.8)	38 (100)		
No	38 (79.2)	10 (20.8)	48 (100)		
Total	62 (72.1)	24 (27.9)	86 (100)		

	Pursuit Aiming				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Memory worse lately				1.457	0.227
Yes	20 (52.6)	18 (47.4)	38 (100)		
No	19 (39.6)	29 (60.4)	48 (100)		
Total	39 (45.3)	47 (54.7)	86 (100)		

N = 86
Chi-square test
*significant at p-value < 0.05

Benton Visual Retention					
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Less coordination in hands				0.237	0.626
Yes	13 (72.2)	5 (27.8)	18 (100)		
No	45 (66.2)	23 (33.8)	68 (100)		
Total	58 (67.4)	28 (32.6)	86 (100)		
Digit Span					
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Less coordination in hands				0.000	1.000
Yes	9 (50.0)	9 (50.0)	18 (100)		
No	34 (50.0)	34 (50.0)	68 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		
Digit Symbol					
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Less coordination in hands				0.000	1.000
Yes	9 (50.0)	9 (50.0)	18 (100)		
No	34 (50.0)	34 (50.0)	68 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		
Santa Ana Dominant					
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Less coordination in hands				0.111	0.739
Yes	9 (50.0)	9 (50.0)	18 (100)		
No	31 (45.6)	37 (54.4)	68 (100)		
Total	40 (46.5)	46 (53.5)	86 (100)		

	Santa Ana Non Dominant				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Less coordination in hands				0.748	0.387
Yes	8 (44.4)	10 (55.6)	18 (100)		
No	38 (55.9)	30 (44.1)	68 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		
	Time Reaction				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Less coordination in hands				0.039	0.843
Yes	10 (55.6)	8 (44.4)	18 (100)		
No	36 (52.9)	32 (47.1)	68 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		
	Trail Making				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Less coordination in hands				5.523	0.019*
Yes	9 (50.0)	9 (50.0)	18 (100)		
No	53 (77.9)	15 (22.1)	68 (100)		
Total	62 (72.1)	24 (27.9)	86 (100)		

	Pursuit Aiming				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Less coordination in hands				0.957	0.328
Yes	10 (55.6)	8 (44.4)	18 (100)		
No	29 (42.6)	39 (57.4)	68 (100)		
Total	39 (45.3)	47 (54.7)	86 (100)		

N = 86
Chi-square test
*significant at p-value < 0.05

Benton Visual Retention					
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Family members had problems				3.417	0.065
Yes	2 (33.3)	4 (66.7)	6 (100)		
No	56 (70.0)	24 (30.0)	80 (100)		
Total	58 (67.4)	28 (32.6)	86 (100)		

Digit Span					
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Family members had problems				0.717	0.397
Yes	4 (66.7)	2 (33.3)	6 (100)		
No	39 (48.8)	41 (51.3)	80 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		

Digit Symbol					
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Family members had problems				0.717	0.397
Yes	4 (66.7)	2 (33.3)	6 (100)		
No	39 (48.8)	41 (51.3)	80 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		

Santa Ana Dominant					
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Family members had problems				2.309	0.129
Yes	1 (16.7)	5 (83.3)	6 (100)		
No	39 (48.8)	41 (51.3)	80 (100)		
Total	40 (46.5)	46 (53.5)	86 (100)		

	Santa Ana Non Dominant				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Family members had problems				2.309	0.129
Yes	5 (83.3)	1 (16.7)	6 (100)		
No	41 (51.3)	39 (48.8)	80 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		
	Time Reaction				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Family members had problems				0.450	0.502
Yes	4 (66.7)	2 (33.3)	6 (100)		
No	42 (52.5)	38 (47.5)	80 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		
	Trail Making				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Family members had problems				2.497	0.114
Yes	6 (100)	-	6 (100)		
No	56 (70.0)	24 (30.0)	80 (100)		
Total	62 (72.1)	24 (27.9)	86 (100)		

	Pursuit Aiming				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Family members had problems				3.755	0.053
Yes	5 (83.3)	1 (16.7)	6 (100)		
No	34 (42.5)	46 (57.5)	80 (100)		
Total	39 (45.3)	47 (54.7)	86 (100)		

N = 86
Chi-square test
*significant at p-value < 0.05

	Benton Visual Retention				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Behavioral change				3.441	0.09
Yes	1 (25.0)	3 (75.0)	4 (100)		
No	57 (69.5)	25 (30.5)	82 (100)		
Total	58 (67.4)	28 (32.6)	86 (100)		

	Digit Span				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Behavioral change				0.000	1.000
Yes	2 (50.0)	2 (50.0)	4 (100)		
No	41 (50.0)	41 (50.0)	82 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		

	Digit Symbol				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Behavioral change				1.049	0.616
Yes	1 (25.0)	3 (75.0)	4 (100)		
No	42 (51.2)	40 (48.8)	82 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		

	Santa Ana Dominant				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Behavioral change				3.648	0.120
Yes	-	4 (100)	4 (100)		
No	40 (48.8)	42 (51.2)	82 (100)		
Total	40 (46.5)	46 (53.5)	86 (100)		

	Santa Ana Non Dominant				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Behavioral change				0.780	0.620
Yes	3 (75.0)	1 (25.0)	4 (100)		
No	43 (52.4)	39 (47.6)	82 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		

	Time Reaction				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Behavioral change				0.021	1.000
Yes	2 (50.0)	2 (50.0)	4 (100)		
No	44 (53.7)	38 (46.3)	82 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		

	Trail Making				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	**χ^2**	**p-value**
Behavioral change				1.624	0.573
Yes	4 (100)	-	4 (100)		
No	58 (70.7)	24 (29.3)	82 (100)		
Total	62 (72.1)	24 (27.9)	86 (100)		
	Pursuit Aiming				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	**χ^2**	**p-value**
Behavioral change				0.037	1.000
Yes	2 (50.0)	2 (50.0)	4 (100)		
No	37 (45.1)	45 (54.9)	82 (100)		
Total	39 (45.3)	47 (54.7)	86 (100)		

N = 86
Chi-square test
*significant at p-value < 0.05

	Benton Visual Retention				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Taking any medicine				4.972	0.026*
Yes	10 (47.6)	11 (52.4)	21 (100)		
No	48 (73.8)	17 (26.2)	65 (100)		
Total	58 (67.4)	28 (32.6)	86 (100)		
	Digit Span				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Taking any medicine				0.567	0.451
Yes	9 (42.9)	12 (57.1)	21 (100)		
No	34 (52.3)	31 (47.7)	65 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		
	Digit Symbol				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Taking any medicine				0.063	0.802
Yes	11 (52.4)	10 (47.6)	21 (100)		
No	32 (49.2)	33 (50.8)	65 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		
	Santa Ana Dominant				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Taking any medicine				0.791	0.374
Yes	8 (38.1)	13 (61.9)	21 (100)		
No	32 (49.2)	33 (50.8)	65 (100)		
Total	40 (46.5)	46 (53.5)	86 (100)		

Santa Ana Non Dominant

	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Taking any medicine				0.791	0.374
Yes	13 (61.9)	8 (38.1)	21 (100)		
No	33 (50.8)	32 (49.2)	65 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		

Time Reaction

	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Taking any medicine				0.014	0.907
Yes	11 (52.4)	10 (47.6)	21 (100)		
No	35 (53.8)	30 (46.2)	65 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		

Trail Making

	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Taking any medicine				*2.562*	*0.109*
Yes	18 (85.7)	3 (14.3)	21 (100)		
No	44 (67.7)	21 (32.3)	65 (100)		
Total	62 (72.1)	24 (27.9)	86 (100)		

	Pursuit Aiming				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Taking any medicine				0.554	0.457
Yes	11 (52.4)	10 (47.6)	21 (100)		
No	28 (43.1)	37 (56.9)	65 (100)		
Total	39 (45.3)	47 (54.7)	86 (100)		

N = 86
Chi-square test
*significant at p-value < 0.05

	Benton Visual Retention				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	**χ^2**	**p-value**
Sleep well last night				0.458	0.498
Yes	49 (69.0)	22 (31.0)	71 (100)		
No	9 (60.0)	6 (40.0)	15 (100)		
Total	58 (67.4)	28 (32.6)	86 (100)		
	Digit Span				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	**χ^2**	**p-value**
Sleep well last night				0.081	0.776
Yes	36 (50.7)	35 (49.3)	71 (100)		
No	7 (46.7)	8 (53.3)	15 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		
	Digit Symbol				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	**χ^2**	**p-value**
Sleep well last night				0.081	0.776
Yes	35 (49.3)	36 (50.7)	71 (100)		
No	8 (53.3)	7 (46.7)	15 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		
	Santa Ana Dominant				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	**χ^2**	**p-value**
Sleep well last night				1.329	0.249
Yes	31 (43.7)	40 (53.6)	71 (100)		
No	9 (60.0)	6 (40.0)	15 (100)		
Total	40 (46.5)	46 (53.5)	86 (100)		

	Santa Ana Non Dominant				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Sleep well last night				0.340	0.560
Yes	39 (54.9)	32 (45.1)	71 (100)		
No	7 (46.7)	8 (53.3)	15 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		

	Time Reaction				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Sleep well last night				0.310	0.578
Yes	37 (52.1)	34 (47.9)	71 (100)		
No	9 (60.0)	6 (40.0)	15 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		

	Trail Making				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Sleep well last night				9.301	0.002*
Yes	56 (78.9)	15 (21.1)	71 (100)		
No	6 (40.0)	9 (60.0)	15 (100)		
Total	62 (72.1)	24 (27.9)	86 (100)		

	Pursuit Aiming				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Sleep well last night				0.013	0.910
Yes	32 (45.1)	39 (54.9)	71 (100)		
No	7 (46.7)	8 (53.3)	15 (100)		
Total	39 (45.3)	47 (54.7)	86 (100)		

N = 86
Chi-square test
*significant at p-value < 0.05

4.15 Correlation between Working Characteristics with Neurobehavioral Performance

Table 4.14 shows there were significant correlation between type of fruits with Santa Ana Dominant Test ($r = -0.216$), job type with Benton Visual Retention Test ($r = -0.310$) and Santa Ana Dominant Test ($r = -0.223$). Lastly, there were significant correlation between work frequency with Digit Symbol Test ($r = -0.251$) and daily exposure with Pursuit Aiming Test (-0.214).

Table 4.14: Correlation between working characteristics with neurobehavioral performances.

		Benton Visual Retention	Digit Span	Digit Symbol	Santa Ana Dominant	Santa Ana Non Dominant	Time Reaction	Trail Making	Pursuit Aiming
Type of Fruits	r-value	-0.193	-0.100	-0.157	-0.216*	-0.013	0.072	0.150	-0.101
	p-value	0.075	0.358	0.149	0.046	0.906	0.509	0.168	0.356
Job Type	r-value	-0.310**	-0.125	-0.175	-0.223*	-0.078	0.123	-0.142	0.113
	p-value	0.004	0.250	0.106	0.039	0.474	0.261	0.193	0.300
Work Duration	r-value	-0.109	-0.167	-0.023	0.004	-0.020	0.007	-0.014	-0.121
	p-value	0.318	0.124	0.833	0.973	0.853	0.948	0.897	0.266
Work Frequency	r-value	-0.069	-0.058	-0.251*	-0.043	0.005	-0.126	-0.130	0.117
	p-value	0.526	0.597	0.020	0.694	0.966	0.247	0.233	0.283
Daily Exposure	r-value	0.015	0.032	0.032	-0.093	-0.040	-0.110	-0.214*	0.108
	p-value	0.895	0.772	0.768	0.395	0.712	0.313	0.048	0.324

N = 86
Spearman's Rank-Order Correlation
* Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

4.16 Association between Working Characteristics with Neurobehavioral Performance

Table 4.15 shows the association between the working characteristics of respondents with the neurobehavioral performances. There were significant association (p-value < 0.05) between job type with Benton Visual Retention Test and Santa Ana Dominant Test, the used of PPE with the Trail Making Test. For the frequency of using PPE, there were significant association (p-value < 0.05) with Trail Making Test. Lastly, there were also significant association (p-value < 0.05) between PPE training and safety training with Time Reaction Test.

Table 4.15: Association between working characteristic with the neurobehavioral performances.

	Benton Visual Retention				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Used Of (PPE)				1.526	0.217
Yes	20 (76.9)	6 (23.1)	26 (100)		
No	38 (63.3)	22 (36.7)	60 (100)		
Total	58 (100)	28 (100)	86 (100)		

	Digit Span				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Used Of (PPE)				1.985	0.159
Yes	16 (61.5)	10 (38.5)	26 (100)		
No	27 (45)	33 (55)	60 (100)		
Total	43 (50)	43 (50)	86 (100)		

	Digit Symbol				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Used Of (PPE)				1.985	0.159
Yes	16 (61.5)	10 (38.5)	26 (100)		
No	27 (45)	33 (55)	60 (100)		
Total	43 (50)	43 (50)	86 (100)		

	Santa Ana Dominant				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Used Of (PPE)				0.806	0.369
Yes	14 (53.8)	12 (46.2)	26 (100)		
No	26 (43.3)	34 (56.7)	60 (100)		
Total	40 (46.5)	46 (53.5)	86 (100)		
	Santa Ana Non Dominant				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Used Of (PPE)				0.002	0.965
Yes	14 (53.8)	12 (46.2)	26 (100)		
No	32 (53.3)	28 (46.7)	60 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		

Time Reaction					
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Used Of (PPE)				0.182	0.669
Yes	13 (50)	13 (50)	26 (100)		
No	33 (55)	27 (45)	60 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		

Trail Making					
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Used Of (PPE)				4.963	0.026*
Yes	23 (88.5)	3 (11.5)	26 (100)		
No	39 (65)	21 (35)	60 (100)		
Total	62 (72.1)	24 (27.9)	86 (100)		

Pursuit Aiming					
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Used Of (PPE)				0.010	0.921
Yes	12 (46.2)	14 (53.8)	26 (100)		
No	27 (45)	33 (55)	60 (100)		
Total	39 (45.3)	47 (54.7)	86 (100)		

N = 86
Chi-square test
*significant at p-value < 0.05

	Benton Visual Retention				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Frequency Of Using PPE				4.323	0.317
Never used	41 (64.1)	23 (35.9)	64 (100)		
Every time handling chemicals	16 (80)	4 (20)	20 (100)		
2 – 4 times per week	1 (100)	-	1 (100)		
Once a week	-	1 (100)	1 (100)		
Total	58 (67.4)	28 (32.6)	86 (100)		

	Digit Span				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Frequency Of Using PPE				3.050	0.240
Never used	30 (46.9)	34 (53.1)	64 (100)		
Every time handling chemicals	12 (60)	8 (40)	20 (100)		
2 – 4 times per week	1 (100)	-	1 (100)		
Once a week	-	1 (100)	1 (100)		
Total	43 (50)	43 (50)	86 (100)		

	Digit Symbol				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Frequency Of Using PPE				3.050	0.240
Never used	30 (46.9)	34 (53.1)	64 (100)		
Every time handling chemicals	12 (60)	8 (40)	20 (100)		
2 – 4 times per week	1 (100)	-	1 (100)		
Once a week	-	1 (100)	1 (100)		
Total	43 (50)	43 (50)	86 (100)		

	Santa Ana Dominant				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Frequency Of Using PPE				2.795	0.481
Never used	28 (43.8)	36 (56.3)	64 (100)		
Every time handling chemicals	11 (55.0)	9 (45.0)	20 (100)		
2 – 4 times per week	1 (100)	-	1 (100)		
Once a week	-	1 (100)	1 (100)		
Total	40 (46.5)	46 (53.5)	86 (100)		

	Trail Making				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Frequency Of Using PPE				9.518	0.035*
Never used	42 (65.6)	22 (34.4)	64 (100)		
Every time handling chemicals	19 (95.0)	1 (5.0)	20 (100)		
2 – 4 times per week	1 (100)	-	1 (100)		
Once a week	-	1 (100)	1 (100)		
Total	62 (72.1)	24 (27.9)	86 (100)		

	Pursuit Aiming				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Frequency Of Using PPE				2.036	1.000
Never used	29 (45.3)	35 (54.7)	64 (100)		
Every time handling chemicals	9 (45.0)	11 (55.0)	20 (100)		
2 – 4 times per week	1 (100)	-	1 (100)		
Once a week	-	1 (100)	1 (100)		
Total	39 (45.3)	47 (54.7)	86 (100)		

N = 86
Chi-square test
*significant at p-value < 0.05

	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Benton Visual Retention					
PPE Training				0.003	0.958
Yes	6 (66.7)	3 (33.3)	9 (100)		
No	52 (67.5)	25 (32.5)	77 (100)		
Total	58 (67.4)	28 (32.6)	86 (100)		
Digit Span					
PPE Training				0.124	0.725
Yes	4 (44.4)	5 (55.6)	9 (100)		
No	39 (50.6)	38 (49.4)	77 (100)		
Total	43 (50)	43 (50)	86 (100)		
Digit Symbol					
PPE Training				1.117	0.291
Yes	6 (66.7)	3 (33.3)	9 (100)		
No	37 (48.1)	40 (51.9)	77 (100)		
Total	43 (50)	43 (50)	86 (100)		
Santa Ana Dominant					
PPE Training				1.641	0.200
Yes	6 (66.7)	3 (33.3)	9 (100)		
No	34 (44.2)	43 (55.8)	77 (100)		
Total	40 (46.5)	46 (53.5)	86 (100)		

	Santa Ana Non Dominant				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
PPE Training				0.017	0.895
Yes	5 (55.6)	4 (44.4)	9 (100)		
No	41 (53.2)	36 (46.8)	77 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		
	Time Reaction				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
PPE Training				3.950	0.047*
Yes	2 (22.2)	7 (77.8)	9 (100)		
No	44 (57.1)	33 (42.9)	77 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		
	Trail Making				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
PPE Training				0.161	0.688
Yes	7 (77.8)	2 (22.2)	9 (100)		
No	55 (71.4)	22 (28.6)	77 (100)		
Total	62 (72.1)	24 (27.9)	86 (100)		
	Pursuit Aiming				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
PPE Training				1.843	0.175
Yes	6 (66.7)	3 (33.3)	9 (100)		
No	33 (42.9)	44 (57.1)	77 (100)		
Total	39 (45.3)	47 (54.7)	86 (100)		

N = 86
Fisher's Exact Test
*significant at p-value < 0.05

Benton Visual Retention					
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Safety Training				0.055	0.814
Yes	5 (71.4)	2 (28.6)	7 (100)		
No	53 (67.1)	26 (32.9)	79 (100)		
Total	58 (67.4)	28 (32.6)	86 (100)		

Digit Span					
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Safety Training				0.156	0.693
Yes	3 (42.9)	4 (57.1)	7 (100)		
No	40 (50.6)	39 (49.4)	79 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		

Digit Symbol					
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Safety Training				0.156	0.693
Yes	3 (42.9)	4 (57.1)	7 (100)		
No	40 (50.6)	39 (49.4)	79 (100)		
Total	43 (50.0)	43 (50.0)	86 (100)		

Santa Ana Dominant					
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Safety Training				1.902	0.168
Yes	5 (71.4)	2 (28.6)	7 (100)		
No	35 (44.3)	44 (55.7)	79 (100)		
Total	40 (46.5)	46 (53.5)	86 (100)		

	Santa Ana Non Dominant				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Safety Training				0.041	0.840
Yes	4 (57.1)	3 (42.9)	7 (100)		
No	42 (53.2)	37 (46.8)	79 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		

	Time Reaction				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Safety Training				4.707	0.030
Yes	1 (14.3)	6 (85.7)	7 (100)		
No	45 (57.0)	34 (43.0)	79 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		

	Trail Making				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Safety Training				0.002	0.967
Yes	5 (71.4)	2 (28.6)	7 (100)		
No	57 (72.2)	22 (27.8)	79 (100)		
Total	62 (72.1)	24 (27.9)	86 (100)		

	Pursuit Aiming				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	χ^2	**p-value**
Safety Training				0.428	0.513
Yes	4 (57.1)	3 (42.9)	7 (100)		
No	35 (44.3)	44 (55.7)	79 (100)		
Total	39 (45.3)	47 (54.7)	86 (100)		

N = 86
Chi-square test
*significant at p-value < 0.05

4.17 Correlation between Psychosocial Work Factors with Neurobehavioral Performance

Table 4.16 shows there were significant correlation between job strain with Digit Symbol Test (r = 0.272) and Pursuit Aiming Test (r = 0.313). There were also significant correlation between job demands with Pursuit Aiming Test (r = 0.217) also job decision-latitude with Time Reaction Test (r = 0.279) and Pursuit Aiming Test (r = -0.246). Next, for the co-worker support, there were significant correlation with Santa Ana Dominant (r = 0.259) and significant correlation between supervisor support with Benton Visual Retention Test (r = -0.311) and Digit Span Test (r = -0.257). Lastly, there were significant correlation between job insecurity with Benton Visual Retention Test (r = 0.308).

Table 4.16: Correlation between psychosocial work factors with neurobehavioral performances.

		Benton Visual Retention	Digit Span	Digit Symbol	Santa Ana Dominant	Santa Ana Non Dominant	Time Reaction	Trail Making	Pursuit Aiming
Job Demands	r-value	-0.090	0.114	0.162	-0.082	0.081	0.048	-0.003	0.217*
	p-value	0.411	0.296	0.137	0.453	0.456	0.659	0.981	0.044
Job Decision Latitude	r-value	-0.205	-0.132	-0.193	0.011	0.066	0.279**	-0.139	-0.246*
	p-value	0.058	0.226	0.075	0.917	0.544	0.009	0.202	0.022
Co-worker Support	r-value	-0.160	-0.054	-0.184	0.156	0.259*	-0.148	0.116	0.067
	p-value	0.142	0.621	0.089	0.152	0.016	0.175	0.286	0.542
Supervisor Support	r-value	-0.311**	-0.257*	-0.143	-0.029	0.132	-0.004	-0.061	0.113
	p-value	0.004	0.017	0.190	0.792	0.227	0.974	0.578	0.299
Job Insecurity	r-value	0.308**	0.190	0.177	0.033	0.013	-0.018	0.207	0.023
	p-value	0.004	0.080	0.103	0.764	0.909	0.867	0.056	0.833

N = 86
Spearman's Rank-Order Correlation
* Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed).

4.18 Association between Psychosocial Work Factors with Neurobehavioral Performance

Table 4.17 below shows the association between psychosocial work factors with neurobehavioral performances.

There was significant association (p-value < 0.005) between job strain with Digit Symbol Test and Pursuit Aiming Test.

Table 4.17: Association between psychosocial work factors with neurobehavioral performances.

	Benton Visual Retention				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	**χ^2**	**p-value**
Job Strain				0.949	0.330
Yes	33 (63.5)	19 (36.5)	52 (100)		
No	25 (73.5)	9 (26.5)	34 (100)		
Total	58 (67.5)	28 (32.6)	86 (100)		
	Digit Span				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	**χ^2**	**p-value**
Job Strain				3.113	0.078
Yes	22 (42.3)	30 (57.7)	52 (100)		
No	21 (61.8)	13 (38.2)	34 (100)		
Total	43 (50)	43 (50)	86 (100)		
	Digit Symbol				
	More than 50 (%)	**Less than 50 (%)**	**Total (%)**	**χ^2**	**p-value**
Job Strain				4.864	0.027*
Yes	21 (40.4)	31 (59.6)	52 (100)		
No	22 (64.7)	12 (35.3)	34 (100)		
Total	43 (50)	43 (50)	86 (100)		

Santa Ana Dominant					
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Job Strain				0.275	0.600
Yes	23 (44.2)	29 (55.8)	52 (100)		
No	17 (50)	17 (50)	34 (100)		
Total	40 (46.5)	46 (53.5)	86 (100)		

Santa Ana Non Dominant					
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Job Strain				1.548	0.213
Yes	25 (48.1)	27 (51.9)	52 (100)		
No	21 (61.8)	13 (38.2)	34 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		

Time Reaction					
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Job Strain				3.426	0.064
Yes	32 (62.5)	20 (38.5)	52 (100)		
No	14 (41.2)	20 (58.8)	34 (100)		
Total	46 (53.5)	40 (46.5)	86 (100)		

Trail Making					
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Job Strain				0.536	0.464
Yes	36 (69.2)	16 (30.8)	52 (100)		
No	26 (76.5)	8 (23.5)	34 (100)		
Total	62 (72.1)	24 (27.9)	86 (100)		

	Pursuit Aiming				
	More than 50 (%)	Less than 50 (%)	Total (%)	χ^2	p-value
Job Strain				8.501	0.004*
Yes	17 (32.7)	35 (67.3)	52 (100)		
No	22 (64.7)	12 (35.3)	34 (100)		
Total	39 (45.3)	47 (54.7)	86 (100)		

N = 86
Chi-square test
*significant at p-value < 0.05

4.19 Correlation between Phosphine Gas Exposure Levels with Neurobehavioral Performance

Table 4.18 shows there were significant correlation between average values of phosphine gas with Santa Ana Dominant Test ($r = -0.214$) and Time Reaction Test ($r = -0.231$)

Table 4.18: Correlation between phosphine gas exposure levels with neurobehavioral performances.

		Benton Visual Retention	Digit Span	Digit Symbol	Santa Ana Dominant	Santa Ana Non Dominant	Time Reaction	Trail Making	Pursuit Aiming
Peak Value	r-value	-0.158	-0.172	-0.046	-0.149	0.000	-0.199	-0.090	0.114
	p-value	0.146	0.114	0.677	0.171	0.999	0.066	0.412	0.294
Minimum Value	r-value	-0.080	0.012	-0.135	-0.191	-0.138	-0.041	0.165	-0.132
	p-value	0.466	0.910	0.216	0.078	0.205	0.706	0.130	0.224
Average Value	r-value	-0.049	-0.082	-0.086	-0.214**	-0.078	-0.231*	0.095	-0.085
	p-value	0.652	0.455	0.432	0.048	0.475	0.033	0.387	0.437

N = 86
Spearman's Rank-Order Correlation

* Correlation is significant at the 0.05 level (2-tailed).
**Correlation is significant at the 0.01 level (2-tailed)

CHAPTER 5

DISCUSSION

5.1 Background Information of Respondents

In this study, 86 farmers and wholesalers represented the exposed group as they were handling CaC_2 everyday for the fruit ripening purposes. On the other hand, another 76 respondents from the management group and farmers represented the non-exposed group as they were never interacts with CaC_2 during their working time. This study conducted in several areas in Perak which were Manjung, Kuala Kangsar, Bidor and Tanjung Tualang for the exposed group while for the non exposed group, it was conducted in MARDI Parit, MARDI Kuala Kangsar and Taman Pertanian Universiti. Originally there were 97 respondents for exposed group, however, 11 of them drop out from the study due to the lost of contact and did not handled the CaC_2 due to the off season. For the non exposed group, it did not represent the sample size due to the limited time to obtain the approval from several sectors to conduct this study.

5.2 Calcium Carbide Exposure

The CaC_2 was used to increase the time taken for the ripening process. The CaC_2 was produced acetylene gas which used for the ripening process of fruits when the CaC_2

contact with the moisture at the atmosphere (Mohammad, 2012). The measurement of phosphine gas exposure level was taken during the work process. In this study, there was significant association between phosphine gas exposure levels with neurobehavioral performance. In some location, the reading of phosphine was exceeding the STEL for phosphine which was 1 ppm. It was due to fruit ripening preparation when the farmers mix the CaC_2 with a small slice of mango to have a contact with the moisture produced by the mango.

5.3 Neurobehavioral Performance

The questionnaire was used to assess data on the neurobehavioral performance among the exposed group and non-exposed group. The questionnaire was adapted from the subjective symptoms questionnaire World Health Organization Neurobehavioral Core Test Battery, 1986 (Johnson et al., 1987). The subjective symptom questionnaire consists of 37 questions focusing on the numbness (temporary loss of sensations), short term memory loss, anxiety which is unpleasant emotion in anticipation of imagined danger, vertigo (an illusionary sensation that the surrounding or body resolving) and frequent headache (Bidisha et al., 2014).

Based on the results, there was significant difference of total score symptoms between the exposed and non-exposed group, p-value < 0.05. The non-exposed group had higher score compared to exposed group due to the nature of job lead to stress and affecting memory. According to Mohammad (2012), CaC_2 consists of the combination of arsenic and phosphorus. When it dissolved in water, it released the acetylene gas. Thus, the hypothesis stating that there was significant difference for the mean of total score symptoms between exposed and non-exposed group was not rejected.

Bidisha et al., (2014) found that there was a significant difference of anxiety, reduced sense of taste, blurred vision, burning sensations in extremities, tingling and transient loss of memory between the control and exposed group, p-value < 0.0001. The acute effect of exposure can cause headache, fatigue and depression for the chronic effect (Wand and Chen, 1993).

Thus, the hypothesis stating that there will be significant association between the level of psychosocial work factors; working characteristics; phosphine gas exposure levels; and socio-demographic characteristics of respondents with the neurobehavioral performance was not rejected.

5.4 Correlation between Socio-Demographic and Individual Characteristics with Neurobehavioral Performance

Based on the result, the variable of age, educational level was significantly associated with the trail making test and digit symbol test. According to Galvin (2017), as age increases, brain and nervous system had the natural changes. The nerve cell begin to pass message slower than the past. Sarah et. al., (2011) conducted a prospective study among pesticide applicators. After doing the adjustment on the age and educational level, exposed workers performed significantly worse than the unexposed workers for the neurobehavioral core test battery that was used to measure the neurobehavioral performance. The exposed workers do not perform well in Digit Symbol Test and Trail Making Test. Rohlman et. al., (2007) stated that, age and educational level were the major predictor of performance on Trail Making Test as well as Digit Symbol Test. The neurobehavioral test decreased as the age increased while when there were decreasing in educational level, the neurobehavioral were decreasing as well. Both factors were decreasing in several tests due to them unable to understand well the instruction given by the researcher even though they already done the trial sheet before proceed with the actual tests. Next, there were significant associations between the smoking duration and smoking status with the Benton Visual Retention Test also Digit Symbol Test because of the other chemical exposure from the cigarette itself. Smoking gives impact on the central nervous system due to the content of the cigarette which was the nicotine that makes the changes in memory. The alcohol intake had the significant association with Trail Making Test because according to National Institute of Alcohol Abuse, brain damage due to alcohol is indirect while in higher dose, it affect the neurobehavioral performance because it contains ethanol and psychoactive drugs (Marinkovic, 2007). In addition, there was also significant correlation between total income with the Digit Symbol Test, Trail Making Test and Pursuit Aiming Test. Low total income usually had association with the NCTB because they did not aware with the importance of PPE while handling the CaC_2 especially on the wholesalers. Next, low income family usually stays at the area near the agriculture field and they faced the continuous accumulation of chemicals (Morris, 2008). According to S.E. Starks et al., (2012) smoking status, smoking duration and total income were the confounders that associate with the outcome of neurobehavioral performances.

A study conducted by Rohlman et. al., (2007) they found that gender give significant main impact on Trail Making Test and female respondents were perform worse than the male respondents. This is due to the accumulation of chemicals that affect hormone and less oxygen supply to brain compared to male respondents (Reed, 2002). The gender differences give the significant result on the Digit Symbol Test and Trail Making Test based on the overall neurobehavioral of the farm workers Rothlein et al., (2006). Based on the result of the research, there was significant association between genders with the Benton Visual Retention Test also Digit Symbol Test.

Lastly, according to the result, there was significant correlation between sleep duration with Santa Ana Non Dominant Test because of lack of rest and unable to focus during the test. Sleep deprivation affects alertness, attention and memory of the respondents (Durmer, 2009). There were also significant association between ethnicity and citizenship with the Digit Symbol Test and Trail Making Test also Benton Visual Retention Test. According to Freya et al., (2003) hours of sleep was related with the tests used to measure the neurobehavioral performance and for the ethnicity, it was highly associated with one another.

5.5 Correlation between Working Characteristics with Neurobehavioral Performance

Farmers and wholesalers were the two type of respondents chosen that exposed to CaC_2 at least for 15 minutes every day during the fruit ripening process. According to the result by this research, variables, type of fruits and job type were had significant correlation with Santa Ana Dominant Test. For the job type, it was also had significant correlation with Benton Visual Retention Test. Farmers was associated with the lower performance on most of the neurobehavioral core test battery including motor coordination, motor speed and verbal memory (Sarah et. al., 2011). Different job type was give different result because of the different level of CaC_2 exposure and presence of other chemicals during the work process. If the respondents had involved with farm work, there were associated with lower neurobehavioral performance of Digit Span Test (forward) and Santa Ana Dominant Test (Freya et. al., 2003).

Next, based on the result obtained by this research, there was significant correlation between work frequency and daily exposure with Digit Symbol Test and Pursuit Aiming Test. Most of the farmers and wholesalers were working at least 6 days per week and exposed to CaC_2 for at least 2 hours every day. Kamel et al., 2003 and Roldan-Tapia et al., 2005 stated that the decreasing of neurobehavioral performance was associated with the increasing years of working in agriculture field. The exposed to chemicals for more than 10 years was lowering the performance on perception and visuospatial processing (Roldan-Tapia et al., 2005). There were significant association between years of working in agriculture with the Benton Visual Retention Test (match-to-sample), this is because, the increasing of years in agriculture, there was decreasing in neurobehavioral performance (Rohlman et. al., 2007). The increasing years in farm work was associated with the decreasing of performance in Digit Symbol Test, Trail Making Test and Santa Ana Test (Freya et. al., 2003).

The use of Personal Protective Equipment (PPE) and frequency of using PPE were associated with Trail Making Test while PPE training and safety training were associated with Time Reaction Test. Most of the respondents do not use the PPE while handling the CaC_2. The used of PPE and frequency of changing PPE were important to minimize the total exposure of CaC_2 and also to maintain the efficiency of the PPE. According to Rohlman et. al., (2007), based on the study of neurobehavioral performance of adult and adolescent agriculture worker, they found that the male participants who handled pesticides for the previous month frequently not using or do not used the PPE at all. The neurobehavioral performance decreased specifically on the Digit Span, Benton Visual Retention (Match-to-Sample) and Continuous Performance Test.

5.6 Correlation between Psychosocial Work Factors with Neurobehavioral Performance

Based on the result, there were significant correlations between the job strain, job demands, job decision-latitude, co-worker support, and supervisor support also the job insecurity with the neurobehavioral core test battery. The poor social support was increased the possibility of mental illness. Next, there was association between poor social supports with depression (Fatih et al., 2007). Lastly, there was significant association between challenge of work and psychosocial work factors with dementia. Dementia is a type of brain disease that shows the symptom by the memory disorders (Siedler et al., 2004). The high level of psychosocial work factors released the hormone of cortisol that decrease the number of brain cells and it caused the impairing of memory (A.J., 2013).

5.7 Correlation between Phosphine Gas Exposure Levels with Neurobehavioral Performance

Based on the result, there were significant correlation between average value of phosphine gas with Santa Ana Dominant Test and Time Reaction Test. It was a weak correlation because the phosphine was measured for 15 minutes and it does not fully represent the actual exposure of the phosphine towards the farmers and wholesalers.The findings was compared with the STEL. The CaC_2 released the acetylene, reduced the oxygen supply to brain and affects the nervous system (A.J., 2013). The overexposure of phosphine gas towards the farmers and wholesalers give impact on the nervous system and decreased the neurobehavioral performances. CaC_2 consists of the arsenic and phosphorus, the moistened impurities of calcium arsenate and calcium phosphate released the toxic gases of phosphine (Kjuus et al., 1986). The phosphine gas will give serious effect when the exposure was higher than 100 ppm (Health Protection Agency, 2007).

CHAPTER 6

CONCLUSION

6.1 Conclusion

This the first study on the effect of phosphine gas released by the CaC_2 during the fruit ripening process towards the neurobehavioral performance. From the findings, it shows that farmers and wholesalers were at risk of decreasing the neurobehavioral performance due to the exposure of phosphine gas. Majority of the respondents had the lower performances in Santa Ana Dominant Test which required rapid eye-hand coordinated movements and also the Pursuit Aiming Test which was used to measure the ability to make quick and accurate movements with hand.

The socio-demographic and individual characteristics of gender, ethnicity, citizenship, education level, smoking status and duration, total income also sleep duration had the significant association with the neurobehavioral performance. The working characteristics of the used and frequency on using PPE, safety training, type of works, work frequency and daily exposure had the significant association with the neurobehavioral performance as well. There were also significant correlation for the level of psychosocial work factors and also the phosphine gas exposure level with the neurobehavioral performance among the fruit farmers and wholesalers in Perak.

6.2 Limitation of Study

This study was design as cross-sectional study, thus there were several limitations as the total exposure of phosphine as the factor that influenced the neurobehavioral performances determined at the same specific time. On the other hand, recall bias occurred when the respondents unable to remember the accurate information given and it did not reflect the actual situation. There were also difficulties in getting cooperation from the farmers and wholesalers because during January until February it was the off season for mango. While for the banana and papaya, most of the trees were replanted. These factors were lead to the decreasing number of respondents that handled CaC_2. There was also limited number of instruments, ToxiRAE Pro, and did not enable to perform the eight hours monitoring.

6.3 Recommendation

It is suggested the follow-up evaluation of nervous system either central or peripheral abnormalities of the respondents to be carried out. The respondents that showed the lower neurobehavioral performances should be referred to specialist for appropriate treatment. Besides, there should be one standard operating procedure (SOP) prepared for the safe handling of CaC_2 to minimize the amount of exposure towards the farmers and wholesalers and also one standard for maximum amount of CaC_2 can be used for a single fruit ripening process by the government agencies. Lastly, further study should be conducted focusing on the neurobehavioral core test battery with two different groups which are exposed group and control group to identify the association between phosphine gas exposures with the neurobehavioral performances.

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Appendix A

Questionnaire

Kod :

Jabatan Kesihatan dan Persekitaran Pekerjaan

Fakulti Perubatan dan Sains Kesihatan

Universiti Putra Malaysia

"Kajian Berkenaan Kalsium Karbida dan Kesihatan dalam Kalangan Petani Buah-buahan di Perak."

1. Borang soal selidik ini mengandungi empat (6) bahagian:
   - Bahagian A: Maklumat Sosio-Demografi
   - Bahagian B: Maklumat Pekerjaan
   - Bahagian C: Faktor Psikososial Pekerjaan
   - Bahagian D: Prestasi Neurobehavioral
2. Anda dikehendaki untuk menjawab kesemua soalan yang dikemukakan.
3. Anda boleh menandakan jawapan anda pada ruangan yang disediakan bagi setiap soalan.
4. Semua maklumat akan dirahsiakan dan hanya akan digunakan untuk tujuan kajian.
5. Borang soal selidik perlu dikembalikan setelah selesai menjawab kesemua soalan.

Organisasi : ....

Tarikh : ....

BAHAGIAN A: MAKLUMAT SOSIO-DEMOGRAFI

1. Umur : ………………. Tahun

2. Status Perkahwinan : ☐ Bujang ☐ Berkahwin ☐ Bercerai

3. Bangsa : ☐ Melayu ☐ India ☐ Cina ☐ Lain-lain (………)

4. Tahap Pendidikan : ☐ Tidak Bersekolah ☐ UPSR ☐ PMR/SPM ☐ Diploma/Ijazah/Sijil ☐ Lain-lain

5. Jumlah Pendapatan Sebulan : ……………….

6. Adakah anda merokok? : ☐ Ya ☐ Tidak

7. Sekiranya YA, sudah berapa lama anda merokok? : …………… Tahun

8. Adakah anda mengambil minuman beralkohol? : ☐ Ya ☐ Tidak

9. Sekiranya YA, sudah berapa lama anda mengambil minuman beralkohol? : ………… Tahun

BAHAGIAN B: MAKLUMAT PEKERJAAN

1. Apakah tugas utama anda dalam pekerjaan sekarang?

………………………………………………………………………………………………

2. Sudah berapa lama anda terlibat dengan kerja pemeraman buah-buahan ? ……………. Tahun

3. Berapa hari anda bekerja dalam seminggu? ……………. Hari

4. Berapa lama masa yang anda ambil untuk mengendalikan kalsium karbida (karbaid) bagi setiap hari?

……………. Jam

5. Adakah anda memakai sebarang alat pelindung diri semasa mengendalikan kerja-kerja pengeraman buah?

☐ Ya ☐ Tidak

6. Sekiranya YA, apakah jenis alat pelindung diri yang digunakan semasa mengendalikan bahan-bahan kimia tersebut? (Tandakan semua yang berkaitan)

☐ Alat pelindung pernafasan ☐ Alat pelindung muka

☐ Baju pelindung anggota badan ☐ Sarung tangan kulit

☐ Sarung tangan tahan bahan kimia (contoh: neoprene & nitril)

☐ Lain-lain alat pelindung diri (Kasut keselamatan, apron, seluar kalis bahan kimia)

7. Sekiranya anda memakai alat pelindung diri, berapakah tahap kekerapan anda menggunakannya?

☐ Setiap kali mengendalikan bahan kimia ☐ 2 – 4 kali seminggu

☐ Sekali seminggu ☐ Kurang daripada sekali dalam tempoh sebulan

8. Berapakah tahap kekerapan anda menggantikan alat pelindung diri?

☐ Setiap hari ☐ Sekali setiap minggu ☐ Dua kali sebulan

☐ Sekali setiap bulan ☐ Lain-lain (.......................................)

9. Adakah latihan penggunaan alat pelindung diri diberikan?

☐ Ya ☐ Tidak

10. Adakah latihan tentang keselamatan pekerjaan diberikan? (Contoh: Latihan berkenaan pengendalian bahan kimia dan cara pemakaian alat pelindung diri yang betul)

☐ Ya ☐ Tidak

BAHAGIAN C: FAKTOR PSIKOSOSIAL PEKERJAAN

	Sangat Tidak Setuju	Tidak Setuju	Setuju	Sangat Setuju
Pekerjaan saya memerlukan saya mempelajari perkara baru.				
Pekerjaan saya melibatkan kerja yang berulang-ulang.				
Pekerjaan saya memerlukan kreativiti.				
Pekerjaan saya membenarkan saya membuat keputusan sendiri.				
Pekerjaan saya memerlukan kemahiran yang tinggi.				
Semasa bekerja, kebebasan saya membuat keputusan sendiri adalah amat terbatas.				
Semasa bekerja, saya berupaya melakukan berbagai perkara yang berbeza-beza.				
Saya mempunyai hak untuk menentukan pekerjaan saya.				
Saya berpeluang untuk mengembangkan kebolehan saya.				
Pekerjaan saya memerlukan saya bekerja dengan lebih pantas.				
Pekerjaan saya memerlukan saya bekerja dengan lebih kuat.				
Pekerjaan saya memerlukan saya menggunakan kekuatan fizikal.				
Saya tidak diminta untuk melakukan beban kerja yang berlebihan.				
Saya diberikan masa yang secukupnya dalam memastikan kerja yang diberikan selesai mengikut waktu.				
Saya bebas daripada tekanan-tekanan yang dibuat oleh orang lain.				
Tahap keselamatan pekerjaan yang saya lakukan dalam keadaan baik.				
Rakan sekerja saya adalaj mereka yang pekerja mahir dalam melaksanakan tugas mereka				
Saya bekerja dengan mereka yang suka mengambil kesempatan ke atas saya				

Saya dikelilingi oleh rakan sekerja yang peramah.				
Rakan sekerja saya amat membantu dalam memastikan kerja yang saya lakukan dapat diselesaikan.				
Penyelia di tempat kerja saya amat membantu dalam memastikan kebajikan para pekerja dibawah seliaan beliau.				
Penyelia saya amat mengambil berat terhadap masalah yang dihadapi oleh para pekerja dibawah seliaan beliau.				
Penyelia saya amat membantu saya dalam memastikan kerja yang diberikan selesai mengikut masa yang ditetapkan.				
Penyelia saya berjaya memastikan para pekerja di bawah seliaan beliau saling bekerjasama.				

Berapa stabilkah kerja anda? (Sila pilih satu jawapan sahaja) □ Tetap dan stabil (1) □ Bermusim (4) □ Kerap tergendala (4) □ Bermusim dan kerap tergendala (4) □ Lain-lain
Pekerjaan saya dijamin baik. □ Sangat tidak setuju (1) □ Tidak Setuju (2) □ Setuju (3) □ Sangat Setuju
Dalam tempoh setahun lepas, berapa kerap anda berdepan dengan masalah kehilangan pekerjaan atau kerja-kerja yang sering tergendala? □ Tidak pernah □ Sekali □ Lebih daripada sekali □ Sentiasa □ Sememangnya diberhentikan
Kadangkala seseorang itu hilang pekerjaan tetap mereka. Adakah kemungkinan anda akan kehilangan pekerjaan anda sekarang dalam beberapa tahun lagi? □ Tidak mungkin sama sekali (1) □ Ada sedikit kemungkinan (2) □ Ada kemungkinan (3) □ Kemungkinan besar (4)

BAHAGIAN D: PRESTASI NEUROBEHAVIORAL

Seksyen A: Pendedahan Terhadap Bahan Kimia

Sila tandakan jawapan yang paling tepat bagi setiap soalan di bawah:

		Ya	Tidak
1.	Adakah anda tinggal berhampiran kawasan loji bahan kimia atau kawasan pelupusan bahan kimia?		
2.	Adakah bidang kerja anda melibatkan penggunaan bahan kimia?		
3.	Bagi pekerjaan yang terdahulu, adakah anda terdedah kepada bahan kimia, bunyi bising, atau getaran?		
4.	Adakah anda terdedah kepada bahan kimia seperti gas phosphin yang terhasil daripada kalsium karbida?		
5.	Semasa mengendalikan bahan kimia tersebut, adakah anda dibekalkan dengan sebarang alat pelindung diri?		

Bagi jawapan nombor 4, jika jawapan anda adalah YA, sila nyatakan sekiranya terdapat lain-lain bahan kimia yang terlibat.

....

....

Seksyen B: Status Kesihatan

1.	Adakah anda menghidapi sebarang penyakit? Sekiranya YA, sila nyatakan. ______________________		
2.	Berapakah jumlah masa yang diambil untuk tidur bagi membolehkan anda berasa mendapat rehat yang secukupnya?		
		Ya	Tidak
3.	Adakah anda berasa kurang daya ingatan sejak kebelakangan ini?		
4.	Adakah anda berasa kurang penyelarasan pada tangan sejak beberapa tahun yang lalu?		

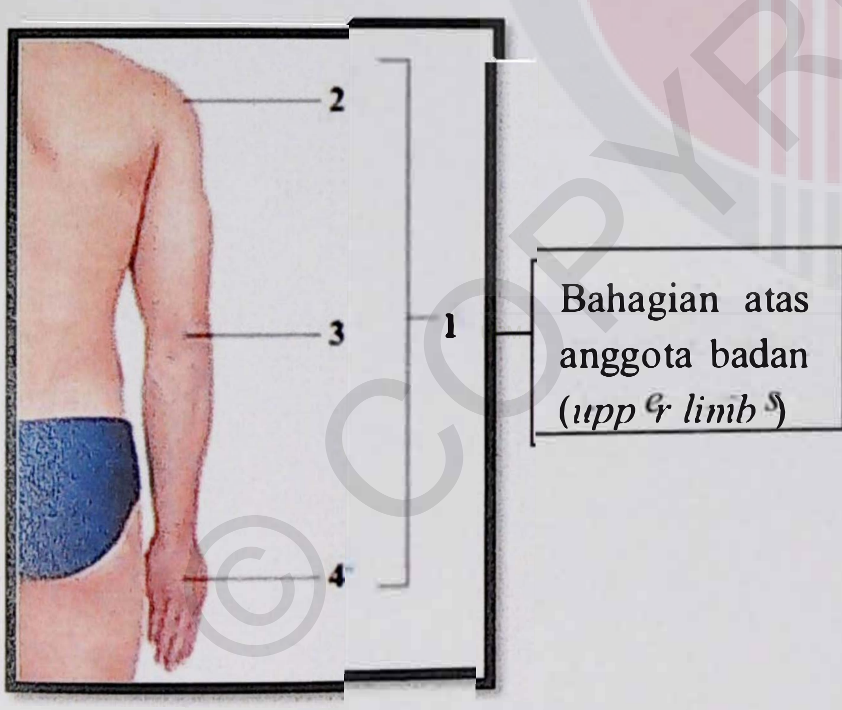
5.	Adakah sesiapa dalam kalangan ahli keluarga anda mengalami sebarang masalah sejak beberapa tahun yang lalu?		
6.	Adakah anda sedar tentang perubahan dalam diri dan personaliti anda sejak kebelakangan ini atau adakah sesiapa memberitahu anda tentang perubahan yang berlaku dalam diri anda sejak beberapa tahun kebelakangan ini?		
7.	Adakah anda sedang mengambil sebarang jenis ubat-ubatan?		
8.	Adakah anda mengambil minuman beralkohol?		
9.	Adakah anda mengambil minuman beralkohol pada hari ini?		
10.	Adakah anda mendapat tidur yang lena semalam?		
11.	Adakah anda merokok?		

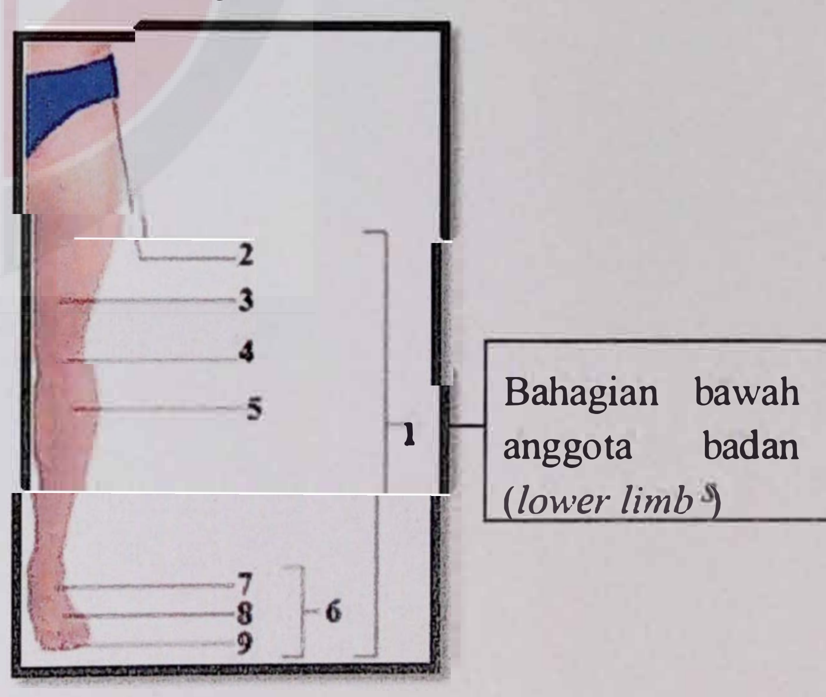
Seksyen C: Simptom Berkaitan Prestasi Neurobehavioral

		Ya	Tidak
1	Adakah anda sering berasa letih selepas bekerja?		
2	Adakah anda sering berasa letih setelah bangun dari tidur pada waktu pagi?		
3	Adakah anda sering berasa mengantuk pada waktu siang?		
4	Dakah anda sering tertidur apabila sedang menonton televisyen?		
5	Adakah anda sering mengalami kesukaran tidur pada waktu malam?		
6	Adakah anda sering terjaga dari tidur pada waktu malam?		
7	adakah anda sering mengalami mimpi ngeri apabila tidur?		
8	Adakah anda sering terlupa perkara-perkara penting?		
9	Adakah anda sering merasakan apa yang anda fikirkan sering kali tidak betul?		
10	Adakah anda sering rasa kehilangan apabila memikirkan sesuatu perkara?		
11	Adakah anda mempunyai masalah dalam menumpukan perhatian?		
12	Adakah anda sering tertekan tanpa mengetahui puncanya?		
13	Adakah anda tidak berminat untuk menyertai sebarang aktiviti yang dijalankan di sekeliling anda?		
14	Adakah anda sering berasa di dalam ketakutan walau tiada situasi bahaya yang sedang berlaku?		

15	Adakah anda berasa terasing dari persekitaran anda?		
16	Adakah pendirian anda mudah berubah?		
17	Adakah anda sering berasa jengkel?		
18	Adakah anda sering berasa gelisah?		
19	Adakah anda sering menghidapi sakit kepala?		
20	Adakah anda pernah mengalami masalah hilang keseimbangan apabila berdiri?		
21	Adakah anda merasakan degupan jantung anda lebih pantas daripada biasa?		
22	Adakah anda kerap merasakan peluh yang berlebihan?		
23	Adakah anda sering menghadapi masalah hilang selera makan?		
24	Adakah anda sering menghadapi masalah cirit-birit?		
25	Adakah anda sering menghadapi masalah sembelit?		
26	Adakah anda sering menghadapi masalah sakit perut?		
27	Adakah anda berasa kebas di bahagian jari anda?		

Rujuk gambar di bawah bagi menjawab soalan nombor 28 sehingga 31:





28	Adakah anda berasa kebas di bahagian atas anggota badan anda?		
29	Adakah anda berasa kebas di bahagian bawah anggota badan anda?		
30	Adakah anda sering berasa lemah di bahagian atas anggota badan anda?		
31	Adakah anda sering berasa lemah di bahagian bawah anggota badan anda?		

32	Adakah tangan anda sering menggeletar?		
33	Adakah anda sering menjatuhkan barang yang sedang anda pegang secara tidak sengaja?		
34	Adakah anda sering kali merasakan kesukaran untuk berjalan di dalam keadaan yang gelap?		
35	Adakah anda merasakan bahawa deria bau anda telah berubah?		
36	Adakah anda merasakan bahawa derai rasa anda telah berubah?		
37	Adakah anda merasakan bahawa sebahagian dari wajah anda berasa kebas?		
38	Adakah anda mengalami sebarang rasa aneh pada bahagian otot di muka anda?		

Appendix B

Consent Form

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

BORANG B1: PENERANGAN DAN PERSETUJUAN RESPONDEN

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

1.TAJUK KAJIAN

Kajian berkenaan hubung kait di antara pendedahan kalsium karbida pada sistem saraf dan tingkah laku dalam kalangan petani dan pemborong buah-buahan di Perak.

2. PENGENALAN

Penggunaan kalsium karbida semasa proses pemeraman buah-buahan dipercayai memberi kesan terhadap kesihatan sama ada kesan akut atau kronik. Penggunan kalsium karbida sebagai salah satu kaedah pemeraman telah diharamkan penggunaannya di negara tertentu seperti Bangladesh dan India. Kajian ini akan dijalankan bagi mengukur tahap pendedahan gas fosfin yang terhasil daripada kalsium karbida semasa proses pemeraman buah-buahan dengan menggunakan instrumen gas fosfin PRO ToxiRAE. Seterusnya, responden diminta untuk menjawab kesemua soalan dalam borang soal selidik yang berkaitan dengan maklumat sosio-demografi, ciri-ciri kerja, faktor kerja psikososial, dan prestasi neurobehavioral. Tujuan menjawab soal selidik ini adalah untuk menentukan hubung kait antara tahap faktor kerja psikososial, ciri-ciri kerja dan ciri-ciri sosio-demografi responden dengan prestasi neurobehavioral. Seterusnya, responden perlu melengkapkan kesemua tujuh ujian di neurobehavioral Core Test Battery (NCTB). Tujuan ujian adalah untuk mengukur tahap prestasi neurobehavioral dalam kalangan peserta bagi kajian ini.

3. APAKAH YANG PERLU ANDA LAKUKAN?

Jika anda membuat keputusan untuk mengambil bahagian di dalam soal selidik ini, anda akan diberikan satu set borang soal selidik. Dalam borang soal selidik ini, terdapat tiga bahagian yang mengandungi soalan-soalan yang berkaitan dengan faktor psikososial dalam pekerjaan, ciri-ciri kerja dan ciri-ciri sosio-demografi responden. Masa yang dianggarkan bagi melengkapkan borang soal selidik ini adalah selama 20 minit. Seterusnya, gas phosphin diukur bagi mendapatkan tahap pendedahan gas tersebut kepada petani dan pemborong buah-buahan. Jangka masa yang diperlukan bagi mengukur gas fosfin bagi setiap responden adalah selama 15 minit. Akhir sekali, terdapat tujuh jenis ujian yang perlu diajalankan iaitu *Pursuit Aiming Test, Simple Reaction Time Test, Digit Symbol Test, Santa Ana, Manual Dexterity Test, Benton*

Visual Retention Test, Digit Span Test and Trail Making Test. Tujuan ujian ini dijalankan adalah untuk memantau pergerakan tangan yang cepat, tahap fokus seseorang dalam mengingati arahan yang diberikan dan ingatan visual. Anggaran masa yang diambil bagi menyelesaikan kesemua jenis ujian adalah selama 15 minit.

4. SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?

Jika anda mempunyai sejarah perubatan berkaitan epilepsi dan strok serta bekerja dalam bidang pertanian yang melibatkan penggunaan kalsium karbida kurang dari tiga bulan , anda tidak digalakkan untuk mengambil bahagian dalam kajian ini.

5. APAKAH FAEDAH MENYERTAI KAJIAN INI?

a) KEPADA ANDA SEBAGAI PESERTA?

Anda tidak memperoleh sebarang faedah secara langsung, walaubagaimanapun, jawapan yang anda berikan berkaitan faktor psikososial dalam pekerjaan, ciri-ciri kerja dan ciri-ciri sosio-demografi yang diperoleh melalui borang soal selidik dapat digunakan dalam mengenal pasti kesan ciri-ciri tersebut terhadap tingkah laku manusia terutamanya bagi mereka yang dalam kalangan petani dan pemborong buah-buahan.

b) KEPADA PENYELIDIK?

Maklumat yang diperolehi akan digunakan dalam mengenal pasti masalah sistem saraf dan tingkah laku dalam kalangan petani dan pemborong buah-buahan di Perak.

6. ADAKAH IA BERISIKO?

Tiada risiko yang perlu dihadapi oleh para peserta.

7. ADAKAH MAKLUMAT DAN IDENTITI SAYA KEKAL RAHSIA?

Jawapan yang diberikan oleh responden di dalam soal selidik ini akan kekal sulit dan rahsia. Untuk melindungi maklumat yang diberikan, kami tidak akan mempamerkan sebarang tanda-tanda yang akan memberi kemungkinan anda dapat dikenal pasti oleh orang ramai.

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

Jika anda mempunyai sebarang soalan mengenai kajian ini, anda boleh menghubungi saya, Norhasliza Binti Hairan, Pelajar Sarjana Muda (Kesihatan Persekitaran dan Pekerjaan), Universiti Putra Malaysia di 011-14361753

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

9. PERSETUJUAN

Saya... No Kad Pengenalan. ....
beralamat..
..............................dengan ini bersetuju untuk mengambil bahagian secara sukarela dalam penyelidikan yang tersebut di atas *(kajian klinikal/percubaan ubat-ubatan/rakaman video/kumpulan sasaran/temuduga/ soal selidik).

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

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

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

*potong yang tidak berkenaan

Tandatangan ....
(*Responden*)

Tarikh :..

Tandatangan ....
(*Saksi*)

Nama :..

No. K/P: ....

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

Tarikh ....

Tandatangan ....
(*Penyelidik*)

Appendix C

Ethic Approval Letter

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

Research title	:	**The Association Between Calcium Carbide Exposures with Neurobehavioral Performance Among Male Mango Farmers in Manjung, Perak**
Study Site	:	**Manjung,Perak**
JKEUPM Ref No.	:	**FPSK(EXP16-OSH)U033**
Researcher	:	**Norhasliza Bt Hairan**
Supervisor	:	**Dr. Irniza Bt Rasdi**

Documents received and reviewed with reference to the above study:

1. Ethics Application Form, Version 1 dated 18/10/2016
2. Respondent Information Sheet & Consent (English) Version 2 dated 16/12/2016
3. Respondent Information Sheet & Consent (Malay) Version 1 dated 18/10/2016
4. Proposal (English), Version 2 dated 16/12/2016
5. Questionnaire (English), Version 1 dated 18/10/2016
6. Questionnaire (Malay), Version 1 dated 16/12/2016
7. Curriculum Vitae of:
   a. Dr. Irniza bt Rasdi

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

Decision by JKEUPM:

[X] Approved

[X] **Permission MUST BE OBTAINED from the respective hospitals/ institutions before conducting the research**

[ ] Disapproved

Please note that the approval is valid until 3 January 2018

Researchers should comply with the following:

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

Appendix D

Phosphine Gas Measurement – Toxirae Pro

Front view of the ToxiRAE Pro

The back view of ToxiRAE Pro

Appendix E

Calibration Certificate Of Toxirae Pro

Appendix F

Neurobehavioral Core Test Battery (NCTB) Test Sheets

Centre Number:		
Industrial Code:		
Respondent No.:		
Respondent ID:		
Date:		

NEUROBEHAVIORAL CORE TEST BATTERY (NCTB)

WORLD HEALTH ORGANIZATION

BENTON VISUAL RETENTION TEST

ANSWER:

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

TOTAL CORRECT ANSWER:

NEUROBEHAVIORAL CORE TEST BATTERY (NCTB)
WORLD HEALTH ORGANIZATION

DIGIT SPAN TEST

1. Digits Forward Test:

Instruction: Please listen carefully to the numbers that will be read to you. You are required to repeat the numbers in read in forward manner.

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 Backward Test:

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 – 4 – 2 – 8	☐
g. 9 – 4 – 3 – 7 – 6 – 2 – 5 – 8	☐	7 – 2 – 6 – 1 – 9 – 6 – 5 – 3	☐

Score: ______________

NEUROBEHAVIORAL CORE TEST BATTERY (NCTB)
WORLD HEALTH ORGANIZATION

DIGIT SYMBOL TEST

Instruction: Please observe the boxes below.

Each digit number (1 – 9) on the upper row has a corresponding symbol on the respective boxes below.

You are required to fill in the boxes below with the correct symbols corresponding to the digit numbers on the upper boxes.

You are given 90 seconds.

Digit Number	1	2	3	4	5	6	7	8	9
Symbol	—	⊥	□	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

Score: ______________

NEUROBEHAVIORAL CORE TEST BATTERY (NCTB)
WORLD HEALTH ORGANIZATION

SANTA ANA MANUAL DEXTERITY

RESPONDENT DOMINANT HAND:

☐ LEFT HANDED ☐ RIGHT HANDED

	TRIAL 1	TRIAL 2	TOTAL	AVERAGE
DOMINANT HAND				
NON-DOMINANT HAND				

TIME REACTION / MOVEMENT TEST

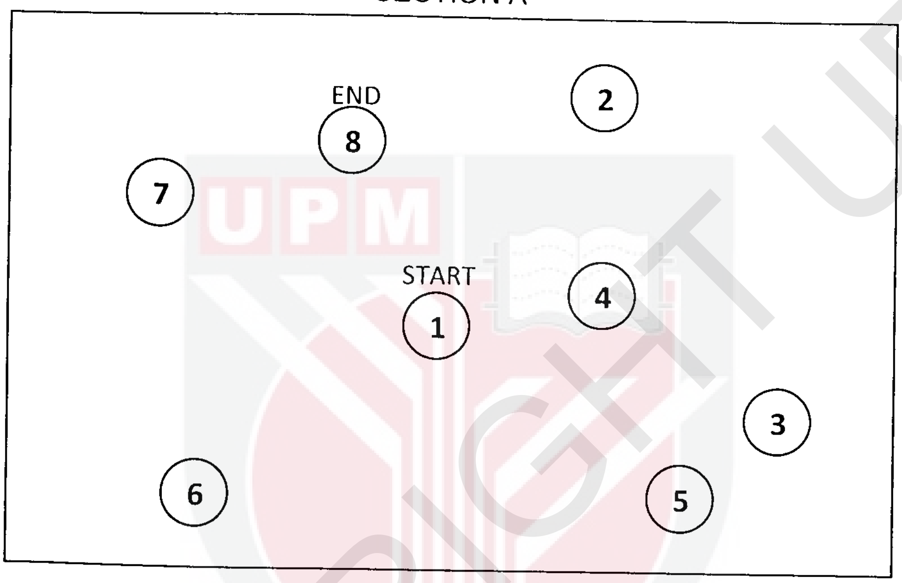
	BACAAN A	BACAAN B	BACAAN B - A
TRIAL 1			
TRIAL 2			
TRIAL 3			
	AVERAGE	AVERAGE	AVERAGE

NEUROBEHAVIORAL CORE TEST BATTERY (NCTB)
WORLD HEALTH ORGANIZATION

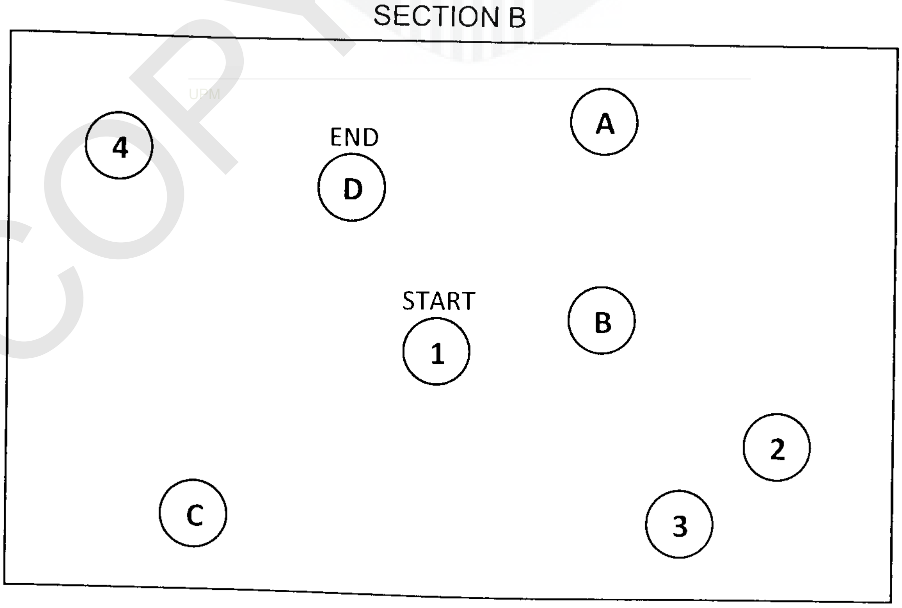
TRAIL MAKING TEST

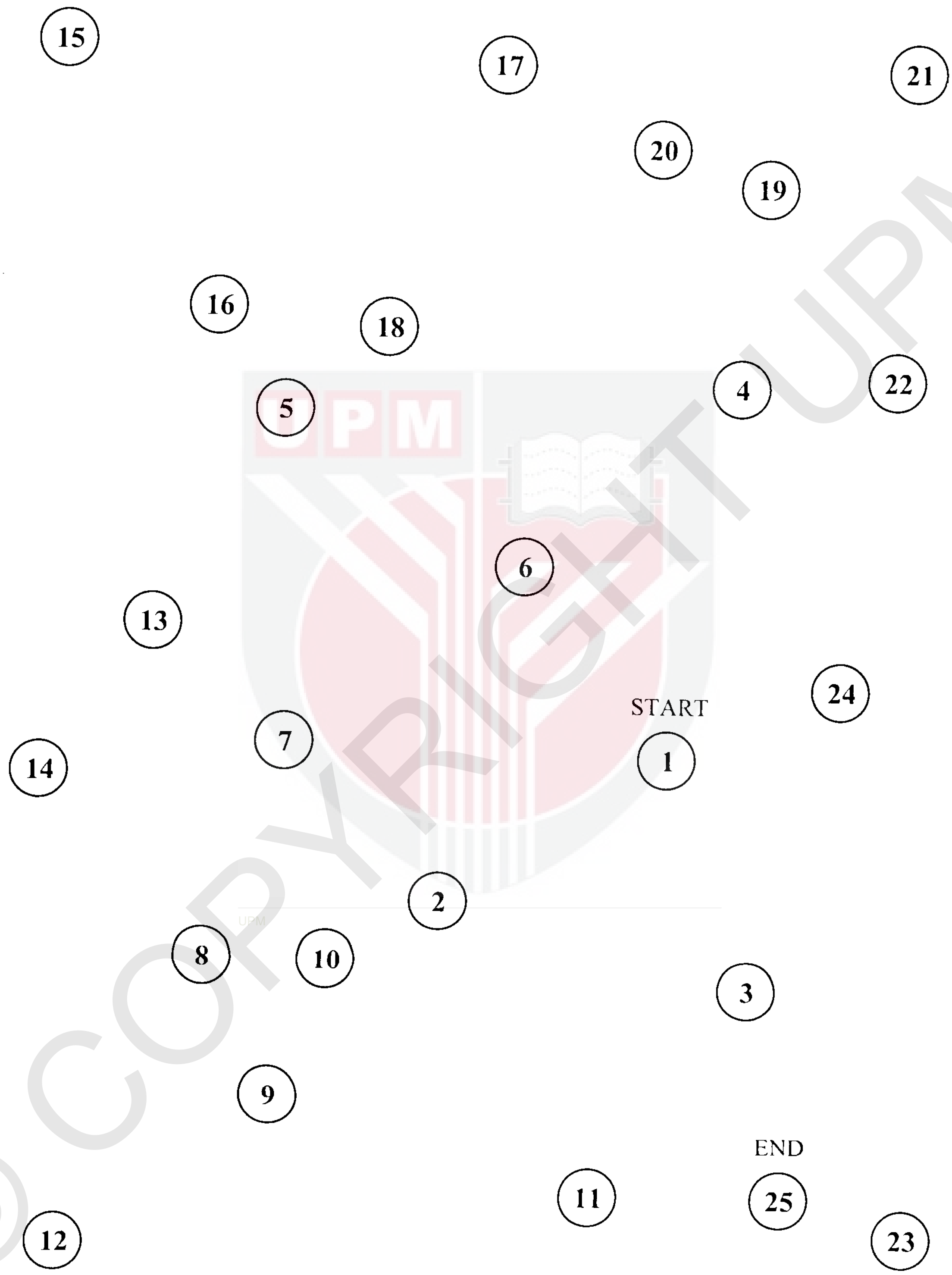
TRIALS

SECTION A

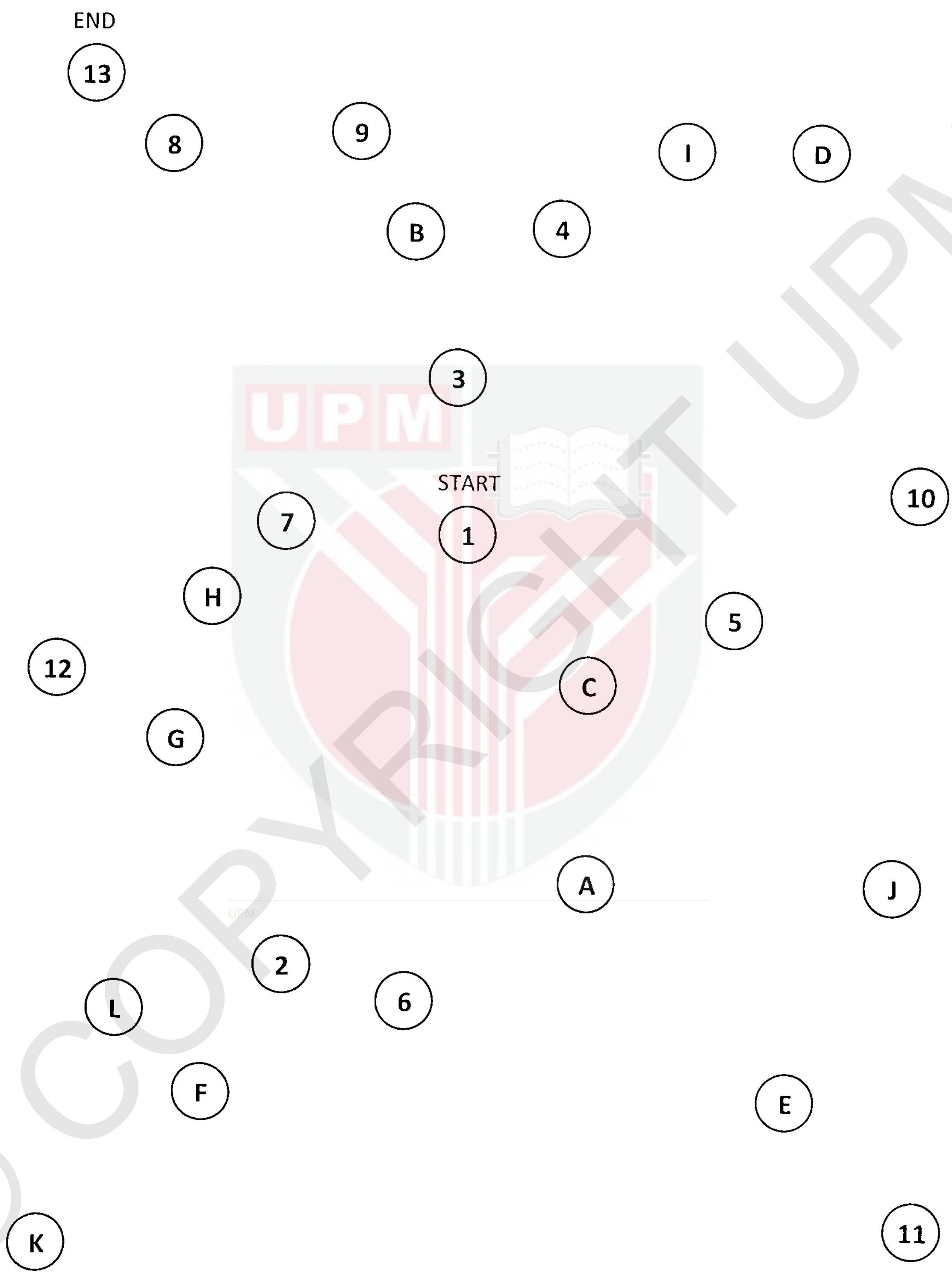


SECTION B





BAHAGIAN A



BAHAGIAN B

NEUROBEHAVIORAL CORE TEST BATTERY (NCTB)
WORLD HEALTH ORGANIZATION

PURSUIT AIMING TEST

Instruction: You are required to place **a dot** or **spot** in each of the symbol "**O**" given below by following the direction of each arrow as shown below.

You are given 60 second.

LATIHAN

→

→ 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 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 0

Numbers of correct dots/spots : Trial 1 [ ] Trial 2 [ ] Total correct [ ]

Numbers of wrong dots/spots : Trial 1 [ ] Trial 2 [ ] Total wrong [ ]

GRAND TOTAL [ ]

TRIAL 1

Starts

→ 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

0 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 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 0

0 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 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 0

0 150

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 0

TRIAL 2

Starts

→ 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

0 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 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 0

0 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 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 0

0 150

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 0