PARKINSONISM AND RELATED FACTORS AMONG FARMERS LIVING IN CHILLI FARM AREA IN HUA RUA SUB-DISTRICT MUANG DISTRICT UBONRATCHATHANI THAILAND

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กลุ่มอาการพาร์กินสัน และปัจจัยที่เกี่ยวข้องในเกษตรกร ที่อาศัยในพื้นที่ปลูกพริก ตำบลหัวเรือ อำเภอเมือง อุบลราชธานี ประเทศไทย

นางสาวสุนิตย์ กุกเรยา

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สุนิตย์ กุกเรยา : กลุ่มอาการพาร์กินสัน และปัจจัยที่เกี่ยวข้องในเกษตรกร ที่อาศัยในพื้นที่ปลูกพริก ตำบลหัวเรือ อำเภอเมือง อุบลราชธานี ประเทศไทย. (PARKINSONISM AND RELATED FACTORS AMONG FARMERS LIVING IN CHILLI FARM AREA IN HUA RUA SUB-DISTRICT MUANG DISTRICT UBONRATCHATHANI THAILAND) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ผศ. ดร. วัฒน์สิทธิ์ ศิริวงศ์, 88 หน้า.

การศึกษาก่อนหน้านี้มีรายงานว่าการได้รับสัมผัสสารกำจัดศัตรูพืชในปริมาณสูงและหลายประเภท อาจก่อให้เกิดกลุ่มอาการพาร์กินสัน ในการหาความสัมพันธ์ของกลุ่มอาการพาร์กินสัน ในเกษตรกรนั้น มีปัจจัยเสี่ยง เช่น ลักษณะส่วนบุคคลและการสัมผัสสารกำจัดศัตรูพืช และการป้องกันตัวจากการสัมผัสสารกำจัดศัตรูพืช ซึ่งจำเป็นต้องได้รับการศึกษาต่อไป ผู้เข้าร่วมประกอบด้วยเกษตรกรจำนวน 271 ราย เป็นผู้ที่มีอายุเฉลี่ย 50 ปีขึ้นไป ทั้งในผู้ที่เป็นเกษตรกรอดีตและปัจจุบัน จะถูกเลือกเข้ามาในการศึกษาครั้งนี้ปัจจัยเสี่ยงที่เกี่ยวข้องจะถูกนำมาวิเคราะห์โดยใช้สถิติไคสแควร์เพื่อทดสอบความเกี่ยวข้องกับความเสี่ยงของกลุ่มอาการพาร์กินสัน อายุ การผสมของสารกำจัดศัตรูพืช และการใช้สารเคมีกำจัดวัชพืชและกลุ่มออร์กาโนคลอรีนซึ่งเป็นปัจจัยเสี่ยงที่รุนแรงที่สุดสำหรับกลุ่มพาร์กินสัน ($p<0.01$) ปัจจัยเสี่ยงอื่น ๆ รวมถึง ประวัติการเจ็บป่วย ระยะเวลาที่อาศัยอยู่ในพื้นที่ จำนวนไร่ ประสบการณ์และกิจกรรม ในการทำเกษตรกรรม และการเตรียมสารกำจัดศัตรูพืชในที่พักอาศัย การใช้ยารักษาโรคความดันโลหิตสูง และโรคเบาหวาน รวมทั้งความถูกต้องในการใช้อุปกรณ์ป้องกันส่วนบุคคล ผลที่พบสามารถลดปัจจัยเสี่ยงสำหรับกลุ่มอาการพาร์กินสัน ($p<0.05$) นี่เป็นการแสดงให้เห็นว่า กลไกพื้นฐานที่เฉพาะเจาะจงสำหรับกลุ่มอาการพาร์กินสัน เป็นอาการที่เกิดจากการสูญเสียสารโดปามีน การรับสัมผัสสารกำจัดศัตรูพืชในระยะยาว โดยเฉพาะอย่างยิ่งสารกำจัดศัตรูพืชกลุ่มออร์กาโนคลอรีน และสารเคมีกำจัดวัชพืชทุกกลุ่ม สามารถทำให้เกิดอาการกลุ่มอาการพาร์กินสัน ในหมู่เกษตรกรได้ การศึกษาในอนาคตจำเป็นสำหรับการที่จะเข้าใจถึงกลไกของโรคพาร์กินสัน เพื่อหาความสัมพันธ์ในสาเหตุที่เฉพาะเจาะจงกับปัจจัยหรือสารกำจัดศัตรูพืชที่เฉพาะเจาะจง เช่น กลุ่มออร์กาโนคลอรีน พาราควอต หรือ ไกลโฟเซต

สาขาวิชา สาธารณสุขศาสตร์ ลายมือชื่อนิสิต ....

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Previous studies had reported that pesticide exposure and various types of pesticides used may cause the symptoms of Parkinsonism. To explore the association of Parkinsonism in farmers, the risks factors such the demographics and pesticide exposure and pesticide prevention must be studied. 271 participants that consisted of elderly farmers with average of 50 and above, both current and former, were selected for this study. The risk factors involved were analyzed using chi square to determine the association with the risk of Parkinsonism. Age, pesticide combination and use of organochlorine and herbicides were the strongest risk factors Parkinsonism ($p<0.01$). Other risk factors included medical history, years living in the area, farm size, farming experience and activities with pesticides and pesticide preparation at home. Use of medication to treat hypertension and diabetes as well as the correct use of personal protective equipment was found to reduce the risk of Parkinsonism ($p<0.05$). This suggests that there are underlying mechanisms specific for Parkinson's Disease (PD) as caused by the dopamine loss. The long term exposure to pesticides particularly organochlorine and all groups of herbicides had begun to cause the symptoms of Parkinsonism among the farmers. Future studies will be required for understanding the mechanisms of PD in order to establish the causal relationship specific to a factor or specific pesticide such as those of organochlorine, paraquat or glyphosate.

Field of Study: Public Health — Student's Signature ....

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CHAPTER I

INTRODUCTION

1.1 Background and significance of the problem

Thailand is an agricultural country with high usage and import of pesticides. It ranks 3rd among Asian countries in terms of pesticide import as well as usage (Damrongsat, 2011). Some of these pesticides include herbicides, insecticides, growth stimulators, etc. Pesticide could be useful in terms of crop protection but the residue from the exposure could cause harmful side effects to the human body. There are increasing uses of pesticide for cultivating crops each year as people want to stimulate more crops with good quality and appearance to meet the demand and generate more income (Panuwet et al., 2012) as demonstrated in Figure 1.

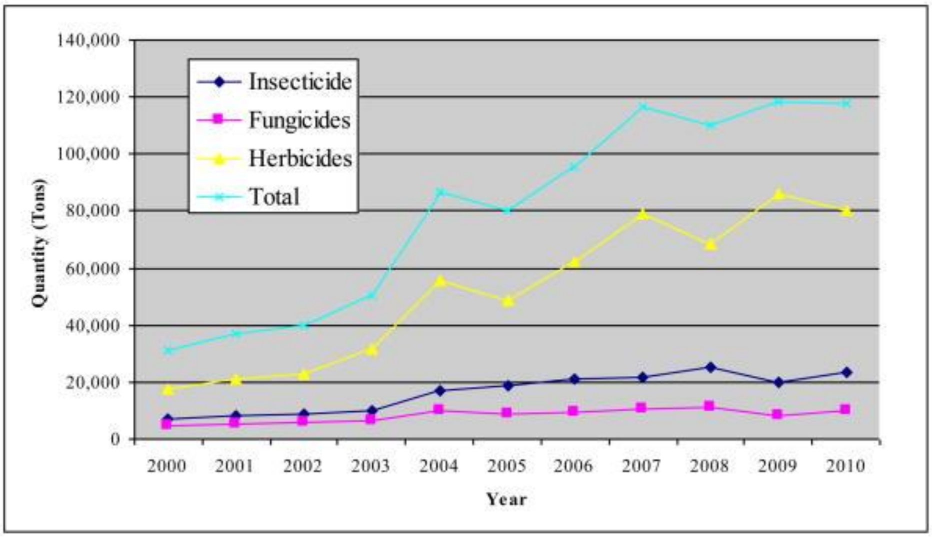


Figure 1 Pesticide use in Thailand (Panuwet et al., 2012)

Pesticides usage was increased by four fold from years 2000-2010 with more than 100,000 tons of active ingredients exported to Thailand. Herbicides (glyphosate, paraquat, dichloride, 2, 4-D, ametryn and atrazine) make up the most pesticide imports, followed by insecticides (chlorpyrifos, fenocarb, cartap, hydrochloride, cypermethin, and methomyl), fungicides (mancozeb, sulfur, carbendazim, promineb, and captan) and plant regulators (Panuwet et al., 2012).

Pesticides work differently according to types of pests and targets. The most common insecticide used by the farmers is organophosphate as it is cheap and effective ((Taneepanichskul et al., 2011); (Jirachaiyabhas et al., 2004)). The other types used are carbamates and organochlorine group (Taneepanichskul, 2012). Even though there are benefits in yielding crops, pesticide exposure could result in symptoms such as headache, nausea, vomiting, blurred vision and tremors, etc. (US EPA, 2012). Pesticide poisoning is now considered an important issue among all the occupational exposures (Norkaew et al., 2010).

One of the major agricultural products consumed by people in Thailand is chilli. It can be assumed that almost every household in Thailand consumes chilli. One of the locations with major chilli plantation is located in Ubonratchathani province at Nai Muang district. Chilli is one vegetable that uses vast amounts of pesticides. This high load would require proper and correct use of PPE or personal protective equipment and the precise knowledge regarding pesticide use (concentration recommendation and proper loading, mixing, and application) of which farmers lack. Of the total area of 16,112 km^2, 10,577.66 km^2 is used for farming (rice, chilli, rubber tree, etc.) which means that farmers are highly exposed to pesticide and are exposed to pesticide all year round (Norkaew et al., 2010).

The frequent use of pesticide and the high exposure have put the farmers in great risk of developing Parkinson’s disease. Parkinson’s disease is one of the neurodegenerative diseases that are occurring among elderly and ranks second of the aging disease. As of March 2011, estimated prevalence of PD in Thailand is 60,565 cases (40,049 cases identified by PD registry and estimated underreporting of 20,516 cases). High prevalence is found in residents of the central plain valley of Thailand, an area with a large amount of pesticide use (Bhidayasiri et al., 2011).

The objective of this study is to identify the risk factors of Parkinsonism among the elderly farmers residing near chilli farm area and to explore the association between socio-demographic characteristics, pesticide exposure and the risk of Parkinsonism.

1.2 Research Question

- Is there an association between the socio-demographic characteristics and Parkinsonism among elderly farmers of Ubonratchathani province, Thailand?
- Is there an association between the pesticide exposure and Parkinsonism among elderly farmers of Ubonratchathani province, Thailand?
- Is there an association between the pesticide prevention and Parkinsonism among elderly farmers of Ubonratchathani province, Thailand?

1.3 Research Objective

1. To explore the association between the socio-demographic characteristics of farmers and Parkinsonism in elderly farmers in Ubonratchathani, Thailand.
2. To explore the association between the pesticide exposure and Parkinsonism in elderly farmers of Ubonratchathani province, Thailand.

3. To explore the association between the pesticide prevention and Parkinsonism in elderly farmers of Ubonratchathani province, Thailand.

1.4 Research Hypothesis

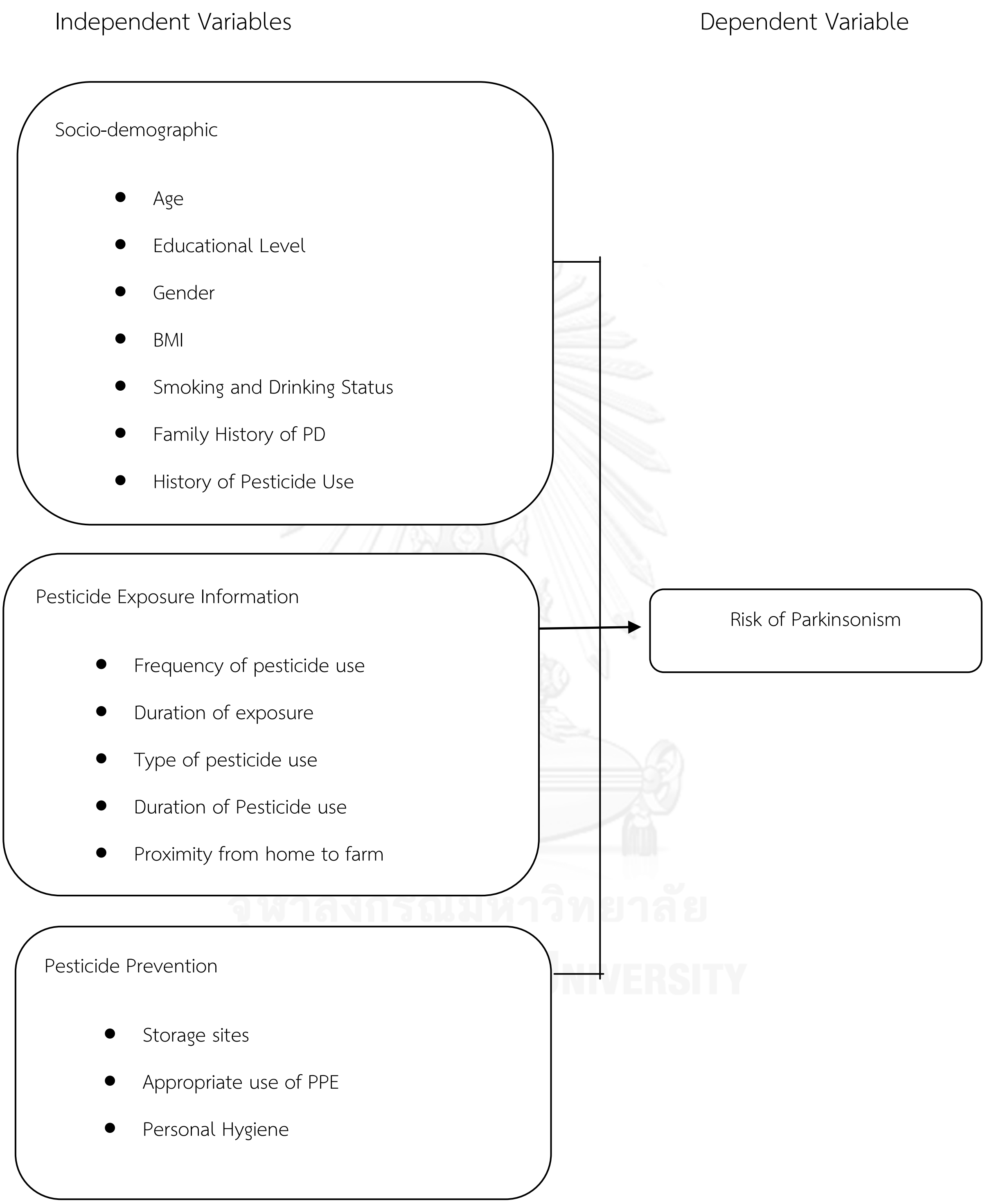
- There is an association between the socio-demographic characteristics and Parkinsonism in elderly farmers of Ubonratchathani province, Thailand.
- There is an association between the pesticide exposure and Parkinsonism in elderly farmers of Ubonratchathani province, Thailand.
- There is an association between the pesticide prevention and Parkinsonism in elderly farmers of Ubonratchathani province, Thailand.

1.5 Study Area

Figure 2 Hua Rua subdistrict, Muang district, Ubonratchathani province

(Norkaew et al. 2010).

1.6 Conceptual Framework



1.7 **Operational Definition**

Pesticide

- Pesticide usage could result in many symptoms affecting various systems of the body especially the central nervous system. Long term exposure could eventually lead to neurodegenerative disorders. Insecticides and Herbicides make up the most consumption in Thailand and are known to be the major groups causing Parkinson's disease.

Parkinson's disease (PD)

- In person with PD, there is gradual degeneration of nerve cells in the portion of the midbrain that controls body movements. Body movements are regulated by a portion of the brain called the basal ganglia, whose cells require a proper balance of two substances called dopamine and acetylcholine, both involved in the transmission of nerve impulses. In Parkinson's, cells that produce dopamine begin to degenerate, throwing off the balance of these two neurotransmitters. Some causes are aging, genetics, and environment factors which include use of chemicals and pesticides. Symptoms include rigid movements, trembling of the hands, poor body balance, and abnormal facial expressions (European Parkinson's Disease Association, 2014).

Parkinsonism

- Refers to any condition that involves the types of movement changes seen in Parkinson's disease. Although Parkinson's disease is the main underlying cause, the other causes include use of certain medicines and other disorders called secondary Parkinsonism. These disorders include AIDs, encephalitis, meningitis, stroke, multiple system atrophy, and progressive supranuclear palsy (U.S. National Library of Medicine, 2014).

Personal Protective Equipment (PPE)

- Use of PPE could influence the amount of pesticide exposure that farmers are exposed to. These equipment include goggle, gloves, respirators, full sleeves, long legged clothes, masks and rubber boots.

Hygiene

- Refers to set of practices taken by the people to protect themselves when performing activities. It includes drinking or eating in farm, preparing pesticides at home, storing pesticides at home, consumption source and water treatment before drinking.

Elderly Farmers

- Farmers who are 50 years or above because the mean onset of Parkinson's Disease is at 50 years (Dick, 2006).

Family History of PD

- Refer have any first degree relative in the family who had been diagnosed of PD. Those with positive family history of PD have higher risk of developing Parkinson's disease.

Duration of exposure

- Refer to the number hours that are used for pesticide application per week.

Frequency of exposure

- Refer to the time (in months) that the pesticide is used per crop cultivation.

Types of Pesticide

- Many types of pesticides are usually combined to cause effects of PD. However, the most prominent active ingredients belong to the insecticides and the herbicides group. Some ingredients include carbamates, organophosphates, organochlorine, paraquat, etc.

History of Pesticide use

- Refer to the year of first pesticide use and include all types of pesticide.

Storage sites

- Refer to the location where pesticide is stored. If the pesticide is stored at residential area, the exposure increases.

Duration of Pesticide use

- Refer the length during which that specific type of pesticide was used for growing crop.

CHAPTER II
LITERATURE REVIEW

Pesticides are generally classified by the target they intend to kill, reduce, repel or mitigate (US EPA, 2012). Table 1 below gives the main classes and the examples of pesticides. When pesticides are applied in farms, the applicator is usually exposed via three routes of exposure: ingestion, inhalation and dermal (skin) contact. The exposure could cause effects on many various parts and organs of the body. One method is acting via interrupting the function of neurotransmitter such as cholinesterase.

Table 1 Classes of pesticides and some examples.

Action	General Class (Examples)
Insecticide	*Organophosphate* (parathion, malathion, diazinon, chlorpyrifos, ethaphos) *Carbamate* (aldicarb, carbaryl) *Organochlorine* (DDT, endosulfan, lindane, heptachlor, chlordane, dieldrin) *Plant-derived* (pyrethrins, pyrethroids, nicotine, rotenone) *Phenolic* (dinitrophenol) *Inorganic* (arsenic trioxide, copper sulfate, cyanide) *Lactone* (abamectin)
Herbicide	*Dipyridyl* (paraquat, diquat, cyperquat) *Chlorophenoxy* (2,4D, 2,4,5-T) *Benzonitrile* (ioxynil, bromoxynil) *Glyphosate*
Fungicide	*Organophosphate*

Action	General Class (Examples)
	Carbamates *Miscellaneous* (captan, captofol, sulphur)
Rodenticide	*Anticoagulant* (dicoumarin, brodifacoum) *Sodium fluoroacetate* *Strychnine*
Fumigant	*Cyanides, methyl bromide, carbon disulfide, phosphine*

(Le Couteur et al., 1999)

Table 2 Pesticides Classified by Target

Type	Target	Type	Target
Acaricides	Substances that kill mites and ticks	Herbicides	Substances that kill weeds and other plants
Algicides	Substances that control algae in water	Insecticides	Substances that kill insects and other arthropods
Antifouling Agents	Substances that kill or repel organisms that attach to underwater surfaces	Insect Growth Regulators	Substances that disrupt molting and other processes in insects
Antimicrobials	Substances that kill microorganisms	Microbial Pesticides	Microorganisms that kill or outcompete insects and other microbes
Attractants	Substances that attract pests	Molluscicides	Substances that kill snails and slugs

Type	Target	Type	Target
Biopesticides	Pesticides that are derived from natural materials, such as animals, plants, bacteria, or minerals	Nematicides	Substances that kill nematodes (microscopic, wormlike organisms that usually live in the soil)
Biocides	Substances that kill microorganisms	Ovicides	Substances that kill the eggs of insects and mites
Defoliants	Substances that cause leaves and foliage to drop from plants	Pheromones	Biochemicals that disrupt the mating behaviors of insects
Dessicants	Substances that promote drying of tissues	Plant growth regulators	Substances (other than fertilizers) that alter the growth and reproduction of plants
Disinfectants and sanitiziers	Substances that kill or inactivate disease-causing microbes	Repellents	Substances that repel pests (such as mosquitoes and birds)
Fumigants	Substances that produce gas or vapor to kill pests	Rodenticides	Substances that control mice and other rodents
Fungicides	Substances that kill fungi		

(Frumkin, 2012)

Herbicides and insecticides make up most of the pesticides commonly used by people. There are two kinds of herbicides: selective and non selective. Nonselective will kill any weeds or plants they come into contact with while non selective kill only the specific weeds or plants. Herbicides could be classified into two types: contact herbicides and systemic herbicides. Contact herbicides would kill any plant they contact with. The toxicity is acute and plants are usually burned within few hours after application. Contact herbicides target the membranes and inhibits the photosynthesis. Examples of this include paraquat, sodium chlorate and fuel oils. Systemic herbicides, on the other hand, inhibit enzymes that are responsible for regulating growth and cell division as well as blocking the path of photosynthesis. Examples of this include carbamates, atrazine, 2,4,5-T and 2,4-D, agent orange (combination of 2,4,5-T and 2,4-D). They usually cause symptoms of birth defects (Friss, 2012).

Insecticides could be classified into four main chemical families: Organophosphate, Carbamate, Organochlorine and Pyrethroid. Organophosphate functions by targeting the phosphorylation and inactivates the activities of cholinesterase causing nervous system toxicity. It is the most common type of insecticide used by farmers. The toxicity varies depending on the frequency and dosage and the effects could be reduced by the use of PPE. It is non-persistent and is easy to degrade. Common organophosphates are chlorpyrifos, diazinon, malathion, and azinphos methyl. Carbamates also function through the inhibition of cholinesterase although the toxicity is chronic unlike organophosphate which is acute. It is more expensive than organophosphate, hence, less common. Examples of carbamates are aldicarb, carbaryl and methomyl. Organochlorine is one type of insecticide that has already been banned from usage. Illegal use still exist and the effects of usage in the past remains. It is the persistent organic pollutants (POPs) that attaches to adipose tissue and causes damages to various organs of the body. It is a toxic chemical that could accumulate and transfer through food chains and most importantly, it is biomagnified by the organisms. These banned organochlorines include DDT, aldrin, dieldrin, chlordane, etc. Lastly, there is the pyrethroid which is used least of this group due to rapid degradation. It is a synthetic insecticide developed from naturally occurring pyrethrin which could be extracted from chrysanthemum flowers. Like organochlorines, it disrupts the function of the nervous system but it is better in that it quickly degrades and causes less effects when consumed (Friss, 2012).

Pesticides can act as powerful inhibitors of cholinesterase and cause neurotoxicity to the body. Following exposure, the level of cholinesterase activity generally decreases. Signs and symptoms of cholinesterase inhibition from exposure to pesticides such as carbamate or organophosphate include the following (Baldi, Filleul L, & Mohammed-Brahim, 2001):

a. In mild cases (within 4 - 24 hours of contact): there are usually symptoms of tiredness, weakness, dizziness, nausea and blurred vision.
b. In moderate cases (within 4 - 24 hours of contact): there are usually headache, sweating, tearing, drooling, vomiting, tunnel vision, and twitching.
c. In severe cases (after continued daily absorption): there are abdominal cramps, urinating, diarrhea, muscular tremors, staggering gait, pinpoint pupils, hypotension (abnormally low blood pressure), slow heartbeat, breathing difficulty, and possibly death.

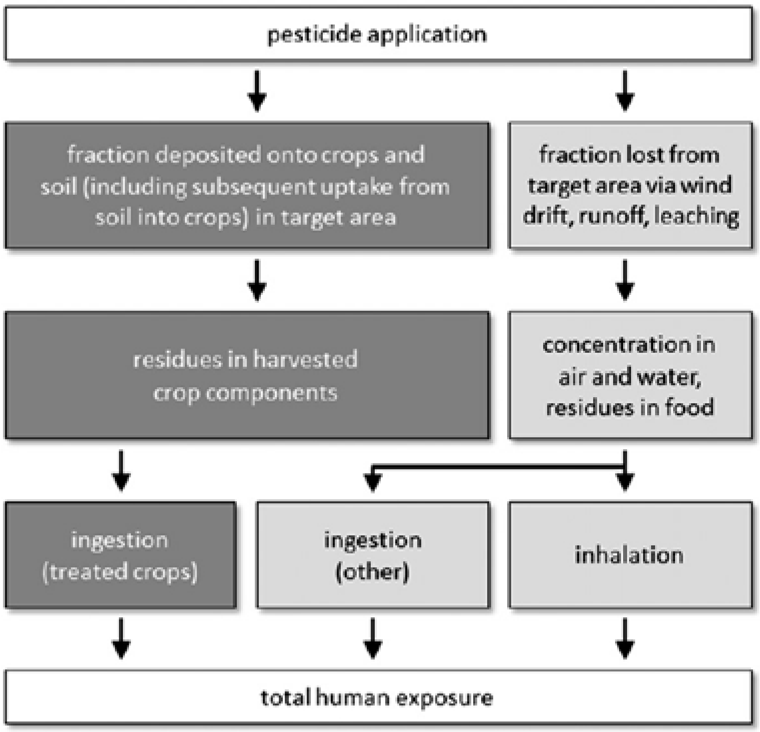


Figure 3 Light gray boxes: exposure pathway via pesticide losses from target area; dark gray boxes: exposure pathway via pesticide residues in treated food crops (Fantke, Friedrich, & Jolliet, 2012).

Insufficient precaution and inappropriate use of PPE could also influence the amount of pesticide exposure. According to the survey on the health effects of pesticides conducted in Chiang Mai province, Northern Thailand, farmers do not take sufficient precaution (Danida, 2005). Analysis of spraying behavior shows that almost all farmers get easily exposed to pesticides. Half of them get wet during spraying. Some farmers work with leaking equipment and do not use gloves during spraying and mixing of the chemicals. Many of them drink or eat food during the spraying operations.

Long term pesticide exposure could lead to bronchoconstriction, muscle twitching, fatigue, dizziness, numbness, convulsions, coma, depression of respiratory and circulatory systems, and neurodegenerative diseases. Some symptoms found in pesticide exposure are found to be similar to those in the early stages of Parkinson's disease. PD is generally characterized by progressive loss of muscle control, which leads to trembling of the limbs and head while at rest, stiffness, slowness, and impaired balance. There are 5 stages of Parkinson's Disease (Parkinson's Disease Organization, 2012).

Stage one: First symptoms of PD are usually mild symptoms. The person have little difficulty in completing day-to-day task. Symptoms include the presence of tremors or shaking of one limb, poor posture and balance, and abnormal facial expressions. Usually these symptoms could be noticed by friends and family.

Stage two: At the stage, the symptoms would be bilateral, where both sides (of the limbs) are shaking. There would have trouble walking or maintaining balance. Their physical ability would be poor and apparent.

Stage three: The symptoms would be quite severe and the patients would be unable to walk or stand straight. Overall the physical movement would be slow.

Stage four: At stage four, the patient would still be able to walk but the walking is limited due to rigidity and bradykinesia (slow movement). They would not be able to perform day-to-day task on their own and a caretaker may be required. The tremors and shakiness that were present at early stages may be lessen or disappear.

Stage five: At this last stage, the patient would not be able to walk or stand and the physical movements are impossible. The patient would not be able to take care of themselves and caretaker is of necessity.

Figure 4 Stages of Parkinson’s disease **(Parkinson's Disease Organization, 2012)**

The four cardinal symptoms of PD are bradykinesia, rigidity, tremor at rest, and loss of postural reflexes. Diagnosis of parkinsonism requires the presence of at least two of the cardinal symptoms of PD (bradykinesia and resting tremor) (Jankovic, 2008). .Age is the strongest risk factor for PD and researches have pointed out that men are more likely than women to have PD (Van Den Eeden et al., 2003).

There have 4.1 and 4.6 million (female and male) cases in 2005 and the prevalence of PD is estimated to double to between 8.7 and 9.3 million by 2030 (Dorsey et al., 2007) due to higher life expectancy and aging population. People who are at risk of getting PD include people aged 50 and above (although cases have been found in people of around 40 years as well), men are affected about 1.5-2 times more often than women, individuals with family history of PD and lastly, individuals with head trauma, illness, and those who are exposed to environmental toxins such as pesticides and herbicides (Albin, 2006).

According to Pezzoli and Cereda (2013), People who work with pesticides and chemical solvents or are exposed to them elsewhere, develop PD at higher rates than people who do not. PD risk is doubled with exposure to the herbicide paraquat, or the fungicide, maneb, and mancozeb and risk increase with longer exposures and higher doses (Pezzoli & Cereda, 2013). Pesticide harms the cell and causes disruption in the function of mitochondrial complex I which eventually leads to apoptosis of the cells and the malfunction of the central nervous system as well as oxidative injury. They also cause protein aggregation and altered dopamine levels by inhibiting or inducing other metabolizing enzymes causing damage to neurotoxins (Dick, 2006). Pesticide, therefore, is regarded as one of the environmental factor that could cause toxicity to mitochondria. Gene play important role as well. Subjects with PD are often reported with having impaired metabolism. Pesticides are usually detoxified by decreasing lipid solubility. CYP (Human Cytochrome P450) is responsible for the initial metabolism of pesticide. It causes activation and inactivation of CYP2D6 (cytochrome P450 enzyme 2D6) which has the task of detoxification of MPTP, OP, and organochlorines (Betarbet et al., 2000). Another enzyme called paraoxonase (PON1) has the task of detoxification of active metabolites of OP, parathion, and other insecticides. The study also made clear association that old age is associated with impairment of genes and drug metabolism of the body. It works by impairing the oxygenation process to hepatocytes. Another association made is that old age is associated with the increased risk of toxicity after exposure to MPTP (1-methyl-4-phenyl-1, 2, 3, 6-tetrahydropyridine) (Le Couteur et al., 1999).

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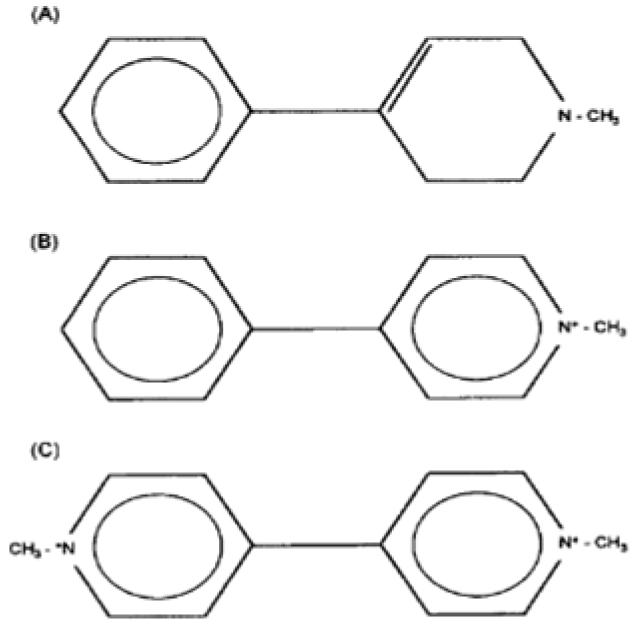

Figure 5 (A) 1-methyl-4-phenyl-1, 2, 3, 6-tetrahydropyridine (MPTP); (B) 1-methyl-4-phenylpyridinium (MPP+), the active metabolite of MPTP, sold as herbicide, cyperquat; and (C) the herbicide, paraquat. (Le Couteur et al., 1999)

MPTP is the precursor of MPP+ (1-methyl-4-phenylpyridinium). It is converted by the enzyme MAO-B. MPP+ is quite toxic and it interferes with oxidative phosphorylation process in the mitochondria resulting in reduction of ATP (energy source of the body) and cell death (due to high lactate production) ((National Center for Biotechnology Information, 2009); (Jirachaiyabhas et al., 2004)). MPP+ also reduces dopamine level by causing toxicity and death to dopamine producing neurons in the substantia nigra. The chloride of MPP+ is used in the compound of herbicide (cyperquat) which means that it has structural similarity to herbicide paraquat which is popularly used among farmers. According to Moretto and Colosio (2011), pesticides that cause serious oxidative damage to the body include paraquat, maneb, pyrethroids, rotenone, and dieldrin. Their study clearly pointed out that no single chemical can produce the characteristics of PD. “PD might be a long term result of sub-toxic multi-hits at different targets within dopaminergic system” (Moretto & Colosio, 2011). The appearance of clinical signs would show as the age increases and neuronal function begin to slow down. To sum up, the severity and the onset is dose and age dependent.

CHAPTER III
RESEARCH METHODOLOGY

3.1 Research Design

This is a cross-sectional study.

3.2 Study population

The study population would be the farmers of Ubonratchathani Province, Nai Muang District. There are total of 16 villages with 2,247 households. The overall population of the people living in this area is 9,096 people. The estimated population of elderly farmers in that district is approximately 2293 people (National Statistic Office Thailand, 2012).

3.3 Inclusion criteria:

- Participant must be farmers (or used to be) and had lived in that district for at least 30 years.
- Participant must be age 50 and above (Moretto & Colosio, 2011)

3.4 Exclusion criteria:

- Participant who have history of cardiac disease, renal or hepatic insufficiency diagnosed by doctor.
- Participant who are using any neurological related medication.
- Participants who had Injuries/Head Trauma that had cause any type of harm to brain or central nervous system.

3.5 Sample size calculation

Sample size is calculated using the estimation population proportion formula.

$$\frac{(Z_{\alpha/2})^2 P (1-P)}{d^2}$$

Where, n = the sample size

$Z_{\alpha/2}$ = Reliability of coefficient base on level of significance (1.96)

P = Estimated population proportion of farmers diagnosed with symptoms of Parkinsonism (0.2) (Harris et al., 2011)

d = Absolute precision required (0.05)

Represent n $= \frac{(1.96)^2\, 0.2\, (1-0.2)}{(0.05)^2}$

$= 246$

In case of missing data ± 10% = 271

3.6 Sampling method

Purposive Sampling was used to select the Muang district (from 25 districts) and Hua Rua sub-district (from 219 sub-districts) of Ubonratchathani province. Next, the elderly farmer within the selected sub district (16 villages in the sub district) would be selected by quota sampling (the number from calculations of the sample size, n=271).

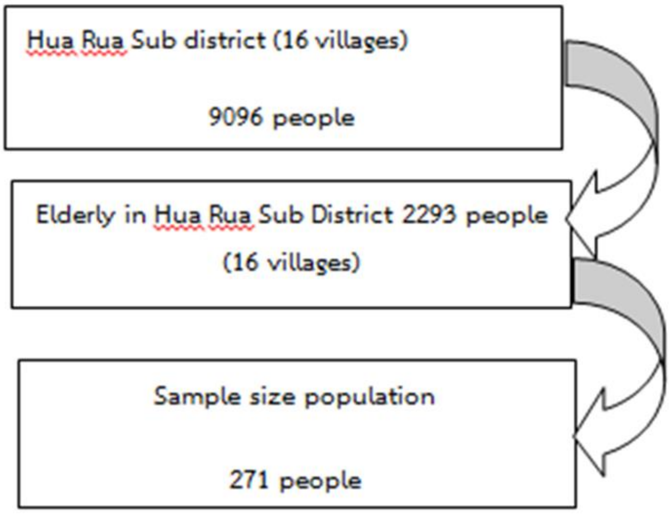

Figure 6 Sample size

3.7 Data Collection/ Research instrument and measurement

The questionnaire regarding exposure status, duration of exposure as well as symptoms was an instrument for collecting data in this study. It was developed from reviewing previous studies and guidelines. Exposure status questionnaire was reviewed and adapted from past exposure and health surveillance research conducted in that area (Taneepanichskul, 2012). This part of the questionnaire was tested for validity by three experts.

Parkinson screening questionnaire used in this study had been tested for content validity by experts in Parkinson recognition (0.86). Reliability of the questionnaire was analyzed by using Cronbach's Alpha Coefficient method and the result was 0.73. At the cutoff point, the questionnaire had a sensitivity of 0.88 and the specificity of 0.95 (Setthawatcharawanich et al., 2011). Translated version was asked from the author who developed the questionnaire. This questionnaire was developed in hospital setting; hence reliability test was done in addition to ensure that this questionnaire is suitable for the community setting. The reliability test of this questionnaire was tested among farmers with similar characteristics and the result was 0.72. The cut point of this questionnaire is at 5.

Prior to conducting the research, there was coordination with the leader of the community and personnel at the subdistrict health promotion hospital and the interview was conducted at the subdistrict health promotion hospital. Flyer was also used so that participants were aware about the research. This research required assistance and all assistants were trained by the researcher. Each participant was interviewed face to face in complete privacy.

3.7.1 The questionnaire consists of 3 parts including:

Part 1: Socio-demographics/Personal Characteristics

This part asked about the general information such as age, gender, education levels, monthly income, duration of work as farmers, number of working days per week, smoking status, alcohol consumption and family history.

Part 2: Parkinsonism Screening

This section asked about the symptoms after the long term exposure. Some symptoms included difficulty in movement, poor body balance, loss of muscle control, trembling or shakiness and the stiffness of the body (Moretto & Colosio, 2011). This part is yes/no and contains 11 questions. If the respondents answered yes for 5 questions or more, it could be concluded that the respondent is in risk of Parkinson or have developed Parkinsonian symptoms (Setthawatcharawanich et al., 2011). In this section, the interviewer must also observe the participants' expressions and movement along with the interview at the subdistrict health promotion hospital.

Part 3: Pesticide Exposure Information and Pesticide Prevention

This part contained questions concerning frequency of use, storage site, hygiene, use of PPE, history of pesticide use and the duration exposure.

3.8 Data analysis

The SPSS software for windows version 16.0 was used for analyzing quantitative data. For descriptive statistics, nominal variables were calculated as frequency and percent; both ratio and interval variables were calculated as mean, standard deviation, maximum and minimum.

For inferential statistic, Chi-square test was used to find association between Parkinsonism and related factors. Crude odd ratio (OR) was also computed to determine the level of risk compared to the referent group.

3.9 Ethical consideration

The study protocol was approved by the Ethical Committee of Chulalongkorn University COA No.030.1/57. All participants signed a consent form prior to participating in the study. In case of any severe cases found, the farmers were advised to visit physicians immediately.

3.10 Expected benefits & Application

By conducting this study, we can assess the risk factors for PD resulting from pesticide exposure among the farm workers. The information will be useful for developing an intervention related to prevention practices and use of PPE as well as for reducing the prevalence of Parkinson's disease. This research may also raise the awareness of PD and PD related symptoms so that early treatment is possible.

CHAPTER IV

RESULTS

4.1 SOCIO-DEMOGRAPHICS

There were total of 271 farmers who participated in the study. There were 106 males (39.1%) and 165 females (60.9%). Age range was from 50-89 with most participants between ages 50-59 (47.2%) and 60-69 (29.5%). Majority of the participants had normal BMI (60.5%) and had primary school level education (84.1%). Most participants (71.2%) did not smoke and approximately (14%) were former smokers. Half of the participants (56.5%) did not drink and approximately 28% of participants drank, most of which were males. Medical history was divided into half with only 10 participants (3.7%) who did not know. 54.6% of the farmers had hypertension and diabetes and approximately 50.2% of them were on medication. These prescribed medications were to treat hypertension and diabetes.

Most participants reported that they did not have a first degree relative with Parkinson's disease (81.9%) while only 7 participants claimed that they had first degree relative with Parkinson's disease.

Table 3 Socio-demographics of farmers in Hua Rua Sub-district, Ubonratchathani Province (n=271)

Characteristics	n	Percentage
Gender		
Male	106	39.1
Female	165	60.9
Age (years)		
50-59	128	47.2
60-69	80	29.5
70-79	51	18.8

Characteristics	n	Percentage
80-89	12	4.4
Mean= 68		
Minimum = 50		
Maximum = 89		
Standard Deviation = 0.89		
BMI		
Underweight (<18.5)	35	12.9
Normal (18.5-24.9)	164	60.5
Overweight (25-29.9)	53	19.6
Obese (>29.9)	19	7.0
Education		
Uneducated	4	1.5
Primary School	228	84.1
Secondary School	36	13.3
Diploma or higher	3	1.1
Smoking		
Non smoker	193	71.2
Former smoker	38	14.0
Current smoker	40	14.8
Drinking		
Non drinker	153	56.5
Former Drinker	41	15.1
Current Drinker	77	28.4
Medical History		
Yes	148	54.6
No	113	41.7
Don't Know	10	3.7
Medication		
Yes	136	50.2

Characteristics	n	Percentage
No	135	49.8
1st Degree relative with Parkinson		
Yes	7	2.6
No	222	81.9
Don't Know	42	15.5

4.2 FARMING CHARACTERISTICS AND PESTICIDE USE

Most of the farmers had lived in Hua Rua subdistrict for more than 50 years. 56.8% (ages 50-69) and 17.7% (ages 70-89) had lived in there for their entire life. 67.5% of the participants (n= 183) are currently doing farming while 32.5% (n = 88) were former farmers who were either too old to work or had decided to retire. Majority (94.5%) of the participants owned 1-20 Rais of farming area (1 Rai is approximately 1,600 sqm^2). These Rais include both their own and rented. Most farmers have had the working experience of 1-20 years (n=101, 37.3%) and 21-40 years (n=111, 41%). 25.8% of the participants claimed that they had never used pesticides while the rest had used for 1-19 years (30.6%), 20-39 years (34.3%) and more than 40 years (9.2%). Duration of work hours per week varied in 5 ranges from 1 hour up to the maximum of 50 hours. 36.9% worked 1-10 hours per week, followed by those who work for 21-30 hours (25.1%). 16.6% were made up by those who worked for 11-20 hours. Range of 30 hour and more was nearly equally distributed (11.4% and 10%). Out of 271 participants, 70 farmers claimed that they had never used pesticide. Majority of the farmers (70.8%) had used pesticides for 1-20 years with only 3.3% who used for more than 20 years. Lastly, most farmers lived nearby farming areas. 211 participants lived within 0-199 meters of farms.

Table 4 Farming characteristics of the participants living in Hua Rua sub-district (n=271)

Characteristics	n	Percentage
Years living in this area		
30-49	69	25.5
50-69	154	56.8
70-89	48	17.7
Status		
Current Farmer	183	67.5
Former Farmer	88	32.5
Farming Area in Rai (1 Rai = 1,600 sqm^2		
1-20	256	94.5
21-40	9	3.3
41-60	4	1.5
61-80	2	0.7
Years of Farming Experience		
1-20	101	37.3
21-40	111	41.0
41-60	57	21.0
61-80	2	0.7
Years of Using Pesticides		
Did not apply	70	25.8
1-19	83	30.6
20-39	93	34.3
More than 40	25	9.2
Duration of work hours per week		
1-10	100	36.9

Characteristics	n	Percentage
11-20	45	16.6
21-30	68	25.1
31-40	31	11.4
41-50	27	10.0
Last use of Pesticide (years)		
Never Used	70	25.8
1-20	192	70.8
21-40	9	3.3
Distance from home to farm (meter)		
0-199	211	77.9
200-499	37	13.7
500-799	21	7.7
800-1,000	2	0.7

201 participants (74.2%) used pesticide by themselves with 70 participants (25.8%) hired other people to do it for them. 20.7% of the participants who used pesticide by themselves reported that they used only one type of pesticide in their farming activities. 32.8% used two pesticide combinations while 20.7% used more than two types of pesticides in their activities. Those who applied pesticide by themselves mostly applied 1-20 times per year. There were 38 participants who used 21-40 times and 31 participants who used more than 40 times.

Table 5 Farmers' activities with Pesticides3 **(n=271)**

Activity with Pesticides	n	Percentage
Pesticides Application		
Hired	70	25.8
Self	201	74.2
No. of Types of Pesticide		
Did not apply	70	25.8
1 type	56	20.7
2 types	89	32.8
More than two types	56	20.7
No. of application times per year		
Did not apply	70	25.8
1-20	132	48.7
21-40	38	14.0
41 or higher	31	11.4

Insecticides and herbicides were the two main types of pesticide used by the farmers. Insecticides used could be categorized into four main groups: organochlorine, organophosphate, carbamate and other groups such as abamectin and pyrethroids. There were three herbicide groups used by the participants: dipyridyl (paraquat), glyphosate, and chlorophenoxy (2-4D).

Table 6 Pesticides used by participants

Type	Class / Main Ingredient
Insecticide	*Organophosphate*: prothiphos, chlorpyrifos, parathion, malathion *Organochlorine*: DDT, chlordane, dieldrin *Carbamate*: Carbofuran, dinotefuran, carbaryl, Propoxur

Type	Class / Main Ingredient
	Others: Pyrethroid (Cypermethrin), Abamectin, Rotenone, copper hydroxide
Herbicide	*Dipyridyl*: Paraquat *Glyphosate* *Chlorophenoxy*: 2-4D

49 participants (18.1%) stated that they used organochlorine, 147 (54.92%) reported using organophosphate, 37 (13.7%) used carbamate and 59 (21.8%) used other groups. 34.7% of the participants used dipyridyl, 11.8% used glyphosate and 6.3% used chlorophenoxy. Duration of usage for both insecticide and herbicide were group into less than 5 years, 5-15 years and more than 15 years.

Table 7 Types of Pesticides (Insecticides and Herbicides) used and duration of each pesticide group usage in percentage **(n=271).**

Types of Pesticides and duration of usage	**Usage**		**Duration of Usage**			
	Not Use	Use	Not Use	<5 years	5-15 years	>15 years
Insecticide						
Organochlorine	81.9%	18.1%	81.9%	2.2%	11.8%	4.1%
Organophosphate	45.8%	54.2%	45.8%	11.1%	33.9%	9.2%
Carbamate	86.3%	13.7%	86.3%	2.6%	9.6%	1.5%
Other	78.2%	21.8%	78.2%	3.3%	14%	4.4%
Herbicide						
Dipyridyl	65.3%	34.7%	65.3%	5.9%	21.8%	7.0%
Glyphosate	88.2%	11.8%	88.2%	3.7%	7.4%	0.7%
Chlorophenoxy	93.7%	6.3%	93.7%	1.1%	5.2%	0%

4.3 PESTICIDE PREVENTION AND HYGIENE

Table 8 described the PPE use reported by the farmers. PPE were some tools that could be used to reduce the exposure to pesticides. Farmers were questioned about the regularity of the necessary equipment they should use to protect themselves. Equipment that most farmers use always include rubber gloves, long sleeves shirt, long legged pants and boots (56.1%, 88.6%, 86.3% and 78.6% consecutively).

Table 8 Different personal protective equipment (PPE) used by farmers of Hua Rua Sub-district in percentage (n=271).

Use of PPE	Never	Sometimes	Always
Fabric or plastic gloves	55%	18.5%	26.6%
Rubber gloves	30.6%	13.3%	56.1%
Face masks	73.1%	8.5%	18.5%
Respirators	56.8%	17.7%	25.5%
Long sleeves shirt	8.1%	3.3%	88.6%
Long legged pants	9.6%	4.1%	86.3%
Goggles	79%	7%	14%
Boots	16.2%	5.2%	78.6%
Aprons	73.1%	9.2%	17.7%

Most farmers (60.5%) had safety concerns. Hence, they never eat or drink in the farming area. 14.4% ate or drank sometimes. Approximately 25.1% always had food or drinks in the farm. Majority of the farmers never prepare pesticides at home neither do they store pesticides at home. Approximately half of the participants (58.3%) drink from tap water. 35.8% drank from underground water. Only 5.9% drank from well water. There were four options that participants used to drink water. 27.7%

boiled their water, 33.6% filtered their water, and 11.4% used the method of precipitation. Lastly, 27.3% used other methods or drank their water right away.

Table 9 Hygiene of the participants in Hua Rua Sub-district (n=271)

Hygiene	n	Percentage
Eating or drinking in the farming area		
Always	68	25.1
Sometimes	39	14.4
Never	164	60.5
Pesticide preparation at home		
Always	20	7.4
Sometimes	6	2.2
Never	245	90.4
Pesticide storage at home		
Always	17	6.3
Sometimes	12	4.4
Never	242	89.3
Source of drinking water		
Tap water	158	58.3
Shallow water	97	35.8
Deep water	16	5.9
Water treatment before drinking		
Boil	75	27.7
Filter	91	33.6
Precipitate	31	11.4
No treatment	74	27.3

4.4 RISK OF PARKINSONISM

Out of 271 participants, 115 participants scored 0 which means they did not have any symptoms of Parkinsonism. 72 participants scored 1-2 meaning they had low risk of Parkinsonism. 46 participants were considered having moderate risk. Lastly, there were 38 participants who reached the cut off points and scored 5 or more out of 11 questions. They were at high risk of developing Parkinsonian symptoms.

Table 10 Risk of Parkinsonism of the farmers in Hua Rua sub-district (n=271).

Parkinson Screening	N	Percentage
No Parkinsonism (score 0)	115	42.4
Low Risk (score 1-2)	72	26.6
Moderate Risk (score 3-4)	46	17.0
High Risk (score 5 or more)	38	14.0

There were total 11 questions that were used for Parkinsonism screening. Table 11 below show the responses of each question from 271 participants. Participants responded yes most to questions 1 (33.2%), 5 (30.3%) and 6 (31.7%). Questions with least yes were questions 8 (7.4%), 10 (5.9%) and 11 (7.7%).

Table 11 Parkinson Screening Question used for screening the Parkinsonism Symptoms (n=271).

Parkinson Screening Questions	No	Yes
1. Slow or stiff movement	181 (66.8%)	90 (33.2%)
2. Walking with a stooped posture	220 (81.2%)	51 (18.8%)
3. Decreased Arm Swings	238 (87.8%)	33 (12.2%)

Parkinson Screening Questions	No	Yes
4. Difficulty when starting to walk or stopping suddenly	236 (87.1%)	35 (12.9%)
5. Difficulty in getting up after sitting down	189 (69.7%)	82 (30.3%)
6. Lose of body balance when turning around	185 (68.3%)	86 (31.7%)
7. Tremor of hands, arms, legs or head	237 (87.5%)	34 (12.5%)
8. Lack of facial expression or tendency to drool when mouth is half-open	251 (92.6%)	20 (7.4%)
9. Voice became softer or monotonous	255 (94.1%)	16 (5.9%)
10. Increased clumsiness or difficulty achieving day to day task that involve fine hand control e.g. doing up your buttons	250 (92.3%)	21 (7.7%)
11. Smaller handwriting (micrographia)	254 (93.7%)	17 (6.3%)

4.5 ASSOCIATION BETWEEN SOCIO DEMOGRAPHICS, FARMING CHARACTERISTICS, PESTICIDE PREVENTION AND PARKINSONISM

Table 12-15 displayed the association between socio demographics, farming characteristics, pesticide prevention, pesticide exposure and risk of Parkinsonism. Age, medical history and medication were found to be statistically significant in table 12. Years living in the area, RAI, farming experience, number of working hours and years of using pesticides were found to be statistically significant in increasing the risk of Parkinsonism (table 13). Use of correct PPE was found to be significant and effective in reducing the risk of Parkinsonism (Table 14). Pesticide preparation at home was also statistically significant. Lastly, in terms of pesticide usage and duration, organochlorine insecticide and all three groups of herbicide was significant in determining the risk of Parkinsonism. No. of types used was also significant as displayed in table 15.

Table 12 Association between Socio Demographics Characteristics and Risk of Parkinsonism.

Characteristics	Risk of Parkinsonism			
	X^2	P-Value	Crude OR	95% CI
Gender				
Male			1	
Female	0.446	0.504	1.277	0.622-2.624
Age				
50-59			1	
60-69	1.912	0.167	1.881	0.760-4.657
70-79	8.357	0.004*	3.631	1.456-9.056
80-89	13.144	<0.01*	8.429	2.259-31.449

Characteristics	Risk of Parkinsonism			
	X^2	P-Value	Crude OR	95% CI
BMI				
Normal			1	
Underweight	1.062	0.303	1.918	0.545-6.748
Overweight	0.001	0.979	0.988	0.417-2.346
Obese	0.301	0.583	0.654	0.142-3.008
Education				
Uneducated			1	
Primary School	0.279	0.597	0.544	0.055-5.5381
Secondary School	1.962	0.161	0.176	0.012-2.561
Diploma or Higher	0.875	0.350	0.750	0.426-1.321
Smoking				
No			1	
Yes	3.168	0.075	0.285	0.066-1.235
Drinking				
No			1	
Yes	0.096	0.757	0.885	0.407-1.922
Medical History				
No			1	
Yes	6.486	0.011*	2.637	1.225-5.674
Medication				
No			1	
Yes	6.581	0.038*	0.473	0.231-0.970
1st degree relative with Parkinsons				
No			1	
Yes	1.172	0.279	0.856	0.815-0.899

*(chi square, $p<0.05$)

Table 13 Association between Farming Characteristics and Risk of Parkinsonism.

Characteristics	Risk of Parkinsonism			
	X^2	P-Value	Crude OR	95%CI
Years Living in this area				
30-49			1	
50-69	1.016	0.313	1.694	0.602-4.766
70-89	11.509	0.001*	5.818	1.945-17.406
Farming Status				
Current			1	
Former	3.032	0.082	1.847	0.919-3.711
Farm Size (RAI)				
1-20			1	
21-40	7.206	0.007*	5.406	1.381-21.161
41-60	0.591	0.442	0.871	0.831-0.913
61-80	2.389	0.122	6.758	0.413-110.661
Farming experience				
1-20			1	
21-40	0.049	0.824	0.901	0.359-2.263
41-60	10.208	0.001*	3.868	1.628-9.186
61-80	3.306	0.069	9.100	0.528-156.954
No. of working hours per week				
1-10			1	
11-20	0.000	0.983	0.986	0.287-3.389
21-30	2.767	0.096	2.167	0.858-5.470
31-40	4.071	0.044*	2.949	0.996-8.730
41-50	3.568	0.059	2.889	0.927-9.004
Years of using pesticides				

Characteristics	Risk of Parkinsonism			
	X^2	P-Value	Crude OR	95%CI
Did not apply			1	
1-19	0.694	0.405	1.521	0.564-4.102
20-39	0.136	0.712	1.207	0.443-3.291
More than 40	6.705	0.010*	4.235	1.345-13.338
Last use of pesticide (years)				
Did not apply			1	
1-20	1.338	0.247	1.667	0.696-3.989
21-40	0.011	0.914	1.125	0.122-10.365
Proximity (home&farm)				
1-199			1	
200-499	0.578	0.447	0.654	0.217-1.968
500-799	1.807	0.179	0.270	0.035-2.079
800-1000	0.370	0.543	0.844	0.796-0.894

* (chi square, p<0.05)

Table 14 Association between Pesticide Prevention and Risk of Parkinsonism.

Pesticide Prevention	Risk of Parkinsonism			
	X^2	P-Value	Crude OR	95%CI
PPE use				
Incorrect			1	
Correct	7.193	0.007*	0.394	0.197-0.791
Eating or drinking at farm				
No			1	
Yes	2.046	0.153	1.648	0.827-3.281
Pesticide Preparation at home				
No				

Pesticide Prevention	Risk of Parkinsonism			
	X^2	P-Value	Crude OR	95%CI
Yes			1	
	3.970	0.046*	2.543	0.989-6.543
Pesticide storage at home				
No			1	
Yes	2.756	0.097	2.166	0.854-5.491
Source of drinking water				
Shallow/Deep water			1	
Tap water	2.174	0.140	0.598	0.300-1.190
Water treatment before drinking				
No			1	
Yes	0.352	0.553	0.785	0.353-1.748

* (chi square, p<0.05)

Table 15 Association between Pesticide exposure and Risk of Parkinsonism.

Activities with Pesticide	Risk of Parkinsonism			
	X^2	P-Value	Crude OR	95%CI
Pesticide Application				
Hired			1	
Self-application	1.266	0.260	1.641	0.688-3.916
No. of types of pesticides used				
1 type			1	
2 or more types	8.359	0.004*	6.750	1.554-29.323
No. of application times per year				
Not apply			1	
1-20	1.048	0.306	1.607	0.644-4.010

Activities with Pesticide	Risk of Parkinsonism			
	X^2	P-Value	Crude OR	95%CI
21-40	2.516	0.113	2.4	0.796-7.236
41 or higher	0.003	0.960	0.964	0.232-4.005
Insecticides				
Organochlorine (a)				
Usage				
<15 years			1	
15 years or more	25.594	<0.01*	5.865	2.796-12.298
Duration				
<15 years			1	
15 years or more	9.396	0.002*	5.732	1.656-19.843
Organophosphate (b)				
Usage				
<5 years			1	
5 years or more	2.374	0.123	1.750	0.854-3.587
Duration				
<5 years			1	
5 years or more	0.317	0.573	1.218	0.612-2.423
Carbamate (b)				
Usage				
<5 years			1	
5 years or more	0.171	0.679	1.222	0.472-3.160
Duration				
<5 years			1	
5 years or more	0.710	0.399	0.846	0.718-0.997
Other (b)				
Usage				
<5 years			1	
5 years or more	0.291	0.589	0.786	0.327-1.888

Activities with Pesticide	Risk of Parkinsonism			
	X^2	P-Value	Crude OR	95%CI
Duration				
<5 years			1	
5 years or more	0.049	0.825	0.773	0.078-7.664
Herbicides				
Dipyridyl (b)				
Usage				
<5 years			1	
5 years or more	18.873	<0.01*	4.571	2.210-9.455
Duration				
<5 years			1	
5 years or more	18.886	<0.01*	4.450	2.185-9.064
Glyphosate (b)				
Usage				
<5 years			1	
5 years or more	8.933	0.003*	3.425	1.471-7.975
Duration				
<5 years			1	
5 years or more	14.357	<0.01*	5.252	2.064-13.364
Chlorophenoxy (b)				
Usage				
<5 years			1	
5 years or more	22.788	<0.01*	8.728	3.123-24.397
Duration				
<5 years			1	
5 years or more	22.769	<0.01*	10.089	3.276-31.073

* (chi square, $p<0.05$)

a – analyzed based on duration of use more than 15 years

b – analyzed based on duration of use 5 years or more

CHAPTER V
DISCUSSION

The objective of this study was to investigate the risk factors of Parkinsonism among the farmers who were exposed to pesticides. Parkinsonism is the muscle movement disorders caused by neurological impairment resulting from loss of dopaminergic neurons in Substantia Nigra. Parkinsonian symptoms are usually characterized by difficulty in movement, poor body balance, loss of muscle control, tremors at rest and body stiffness (Moretto & Colosio, 2011). PD is a disorder where the clinical symptoms must be present in order to be diagnosed. Symptoms become apparent when approximately 70% of dopaminergic neurons are lost. Symptoms that are presented differ from person to person. Neurological examination for Parkinson's disease is often very difficult because PD is an aging disorder. Many symptoms are similar with aging (Dick, 2006).

5.1 RISK OF PARKINSONISM AND SOCIO-DEMOGRAPHICS

Fourteen percent of farmers in Hua Rua subdistrict exhibit the symptoms of Parkinsonism. The average age of participants in this study was approximately 68 years old and most participants were female. PD is a disorder that is age related; therefore age was significant factor in determining the risk of PD (Cho et al., 2008). The association of age towards Parkinsonism becomes stronger as the age increases similar to the results from this study. The participants of the study were at the age of 50 and above. Participants aged 60-69 have higher risk of PD (OR=4.481) and risk becomes highest at 80 and above (OR=8.429).

In this study, no specific gender was found to be associated with risk of Parkinsonism though previous studies (Pezzoli & Cereda, 2013) had suggested that man had higher risk of PD. Women's risk was slightly higher due to the fact that most female participants had the average age of 60. At this age, women would be in post-menopausal and the estrogen that delayed the onset was reduced. Men and women were at equal risk of developing PD when women were aged 60 and above (Haaxma et al., 2007). In this study, there were 13 males and 25 females who were at risk of Parkinsonism. Most females who had high risk were aged 60 and above.

There were total 193 nonsmokers of which 162 were females and 31 were males. Research had suggested that smoking could be a protective factor for PD (Cho et al., 2008). In this study, smoking had no significance upon the risks level of Parkinsonism. This was likely due to the fact that 61% of the participants were women and did not smoke. Those who used to smoke had quit smoking for more than 10 years meaning that they had lower protection from PD. Those who had ever smoked had lower risk of PD compared to those who had never smoked. Nicotine could regulate the FSH levels thus influencing the estrogen levels which reduced the risk (Chen et al., 2010). The effectiveness of nicotine would depend on the number of packets, duration of smoking (Dick, 2006). There were no significant association between alcohol and risk of Parkinsonism similar to previous studies done by Noyce et al. (2012) and Van der Mark et al. (2014).

Most participants had a medical history of hypertension and diabetes. This could influence the risk of Parkinsonism in this study because it is difficult to differentiate the symptoms. Symptoms that appeared might drug induced. In this study, both hypertension and Diabetes were found to be associated with the increasing risk of PD ($p<0.01$). According to Hu et al. (2007), diabetes had positive association with the increasing risk of PD. Their studies also observed that diabetes was associated with rigidity and gait which is somewhat similar to the findings of this study (Hu et al., 2007). Participants in the study had difficulties with balance and stiffness of the movement. Mechanisms of the association are unknown but there were some proposals that changes in insulin activities could affect or have an inverse relationship with the dopamine levels (Craft & Stennis Watson, 2004). One of the factors that have roles in both diabetes and PD is cigarette smoking. Cigarettes are known to increase the risk of DM, yet for PD, it has inverse relationship (Hu et al., 2007). Hypertension was also found to have positive association with PD especially in women. Study by Qiu et al. (2011) had suggested that women with high normal blood pressure and hypertension had 60% higher chance of developing PD than men. There is elevated systolic pressure for females above 55 years old. From the cardiovascular perspective, as age increases, systolic pressure also increases. Diastolic pressure, on the other hand, remains constant or decline with age (Qiu et al., 2011). Systolic hypertension in women could also be linked with the estrogen levels when women are at the post-menopausal period (Coylewright, Reckelhoff, & Ouyang, 2008). Hypertension and PD could be linked in that the elevated blood pressure affects the nondopaminergic subcortical structures. It could cause vasculopathy (disorder of blood vessels) in the basal ganglia, thalamus and the brain stem and break the connections between the substangia nigra and the striatum (Qiu et al., 2011). Lastly, dysfunction in the renin-angiotensin system and oxidative stress, risks factors for both hypertension and PD, occurs greatly in post-menopausal women making hypertension a significant factor for PD especially in women ((Rodriguez-Perez et al., 2010); (Yanes et al., 2010)). Medication used by participants was also found to be significant in reducing the risk of Parkinsonism (OR=0.5). However, the crude odd ratio of 0.5 may not accurately represent the true odd because of either selection or measurement bias. Mechanisms of this remains unclear although there had been proposed researches that drugs used to treat diabetes (exenatide) had some effects in treating Parkinson's disease ((Barker, Stacy, & Brundin, 2013); (Harkavyi et al., 2008); (Bertilsson et al., 2008)). Moreover, calcium channel blockers used to treat hypertension also had the mechanisms to reduce the risk of PD although, like DM, more researches are required for further analysis (Nauert, 2008).

5.2 RISK OF PARKINSONISM AND FARMINIG CHARACTERISTICS AND PESTICIDE USE

According to this study, most of the participants had live in Hua Rua sub district for 50 years or more. This reflected the importance of environment in shaping the characteristics and the exposure. Hua Rua subdistrict had long been used an agricultural area. People in this community had long been exposed to pesticide both directly and indirectly. Those who lived there for 70 years or more had OR as high as 5.8 times. Farming status weren't statistically significant because both groups had received exposure or are currently some exposure in their day to day activities. Most farmers had 1-20 Rais which they use for various crops depending on the seasons. More Rais indicate that there was more frequency of exposure to pesticides (OR=5.4). As the farm size exceeded 40 rais, the risk decreased and there was no statistically significant relationship probably due to the fact there would be more workers who reduce the workload and the risk is spread. Most farmers have had at least 10 years of farming experience. The risk increases as the farming experience increases and slowed down as they reached middle 60s. Compared to those who had 1-20 years of farming experience, participants who had worked for 41 years and above had 3.8

times greater risk of developing PD. Number of workers was also found to be statistically significant (p<0.044). Those who worked for 31 hours or more had 2.9 times greater risk compared to those who worked for 1-10 hours. All these factors indicated that the frequency of pesticide use and exposure was strongly associated with the risk of Parkinsonism ((Hurtig, San Sebastian Soto, & Shingre, 2003); (Hancock et al., 2008)). Majority of the participants had used pesticides during their lifetime as farmers. Study done by Simoniello et al. (2008) demonstrated the positive association between those who used pesticide and DNA damages that could harmful effects to the body. These harmful effects could lead to DNA changes and induce underlying mechanism of genetics causing body disorders including the symptoms of Parkinsonism. Similar to this study, the results revealed that spraying group did not have significant association. Years of exposure was also significant in this study (p<0.015) and in study from Simoniello et al. (2008) (p<0.05). Those who used pesticide for more than 40 years had 4.2 times greater odds of developing symptoms of Parkinsonism.

The use of pesticide combination was the strong risk factors for developing PD. Freire and Koifman (2012) did some research on pesticides exposure related to specific pesticides. In their study, they found that insecticides particularly chlorpyrifos and organochlorines and herbicides such as paraquat when used in combination increase the odds of developing PD (Freire & Koifman, 2012) as obtained in this study (OR = 6.7). Another study that confirmed this finding was done by Marianne van der et al. (2011). In addition, the study also suggested that whether the pesticide were self-applied or hired application, both groups were receiving some exposure and have some risk.

Insecticides and herbicides were the main pesticides used among the participants. Even though some organochlorine pesticides such as DDT had been banned for a while, there were still some reports of usage (Panuwet et al., 2012). Organochlorine was known to persist in the environment and have long term effects (Chhillar et al., 2013). No association was found in terms of gender but Dieldrin and DDT was associated with PD since some residues could be found in the brain (Dick, 2006). The mechanism of how organochlorine caused neurotoxicity was through damaging the dopamine system and causing oxidative stress. This would lead to disruption of mitochondria and eventual apoptosis of the cells ((Chhillar et al., 2013);(Hatcher, Pennell, & Miller, 2008)). This supports the results of this study in which organochlorine use increases the risk of developing Parkinsonism by 5.9 times and 5.7 times for usage and duration.

Most farmers prefer to use organophosphate because of the cheaper price and the effectiveness it has upon repelling targeted pests (Taneepanichskul et al., 2011). It inhibits cholinesterase activities and cause neurotoxicity yet the toxicity are acute. Similar to Dick (2006), there was no association found in this study. The association was unclear since many participants switched pesticides (organophosphates, carbamate, and other insecticides). Many insecticides such as abamectin and pyrethroids were new pesticides and were not widely used due to expensive pricing. In order to develop PD, there must be long term exposure and other factors involved. This applies to carbamate and other insecticides groups used in this study. Result was found to similar to the studies of Elbaz et al. (2009).

Among the herbicides, dipyridyl (paraquat) and glyphosate was the most commonly used pesticides followed by chlorophenoxy. Those exposed to paraquat had the OR of 4.6 times. OR for participants to glyphosate was 3.4 times and chlorophenoxy was 8.7 times. Paraquat had strong association among the herbicide group due to its similarity in structure with MPTP (Freire & Koifman, 2012). A Meta-analysis (Caroline et al., 2011) reported the OR of paraquat ranging from 1.8 to 4.4 while very few studies have found the association of Parkinsonism with glyphosate. Proposed mechanism of how glyphosate increased the risk of PD was that it impairs the cytochrome P450 (CYP) pathway. CYP is responsible for creating enzymes that forms or breaks down the molecules within cells, converting androgen into estrogen and creating cortisol and aldosterone. Moreover, it also detoxifies toxic chemicals such as pesticides. Dysfunction of this pathway affects the neurotransmitter signaling resulting in neurological disorders (Samsel & Seneff, 2013).

Tanner, Ross, and Jewell (2009) also found association with 2-4 D where the OR was 2.9. Chlorophenoxy is known to cause dopamine depletion and protein aggregation. Disruptions in the anti-oxidant capability cause oxidative stress and cell apoptosis (Dick, 2006). Combined use of herbicides as well as with insecticides could increase the risk of PD by 3 folds or an 80% increase in risk ((Wang et al., 2011); (Pezzoli & Cereda, 2013)). The association of insecticides and herbicides followed a dose response relationship. The relationship is resilient when there is long term exposure to insecticides and herbicides. Risk of PD multiplies when there is exposure to paraquat compared to those who had not used paraquat. These pesticides intoxicate the body by stimulating the free radical production and inducing lipid peroxidation. This leads to disturbances in the antioxidant capability and ultimately, neurotoxification.

There are many pathways involved in the interactions between the environmental factors and the genetics factors in developing neurodegenerative diseases from pesticide exposure. The catabolism of pesticides is facilitated by cytochrome P450 enzymes which cause oxidative damage. Differential expression of CYP2D6 also increases the risk of farmers (Fong et al., 2007). Enzymes and xenobiotics also play a certain role in pesticide exposed farmers. Exposure to combination of pesticides results in the inhibition of E1 ligase and DJ1 which is a mitochondrial protein responsible for protecting the body from oxidative stress (Cho et al., 2008).

5.3 RISK OF PARKINSONISM AND PESTICIDE PREVENTION AND HYGIENE

Personal Protective Equipment (PPE) must always be taken into consideration when determining the health risk from exposures (Simoniello et al., 2008). In this study, the use of PPE was associated with the risk of Parkinsonism. Correct use of PPE categorized by the use of 3 or more water proof equipment (Blanco-Muñoz & Lacasaña, 2011) could reduce the risk of Parkinsonism by 0.4 times. However, the crude odd ratio of 0.4 may not accurately represent the true odd because of either selection or measurement bias. Rubber gloves and boots were the water proof equipment used by majority of the participants. Other water proof equipment included goggles and respirators. These water proof equipment could help reduce or lessen the exposure of pesticides through inhalation, dermal or ingestion.

Frequency of pesticide use, pesticide preparation and storage at home, eating or drinking at the farm during pesticide application and inappropriate protective clothing were all the risky behavior that could induce Parkinsonism (Hurtig, San Sebastian Soto, & Shingre, 2003). In this study, preparing pesticides at home could increase the risk of PD by 2.5 times. Well water drinking and underground water was not significant in this study because most participants drank tap water and had some water treatment (Hancock et al., 2008).

5.4 LIMITATION AND RECOMMENDATION

This study was designed to identify risk factors by self-report. The participants were not diagnosed by a physician. Causal relationship of the risk factors of Parkinsonism was not established. Many mechanisms are involved in this neurological disorder. Many symptoms of Parkinsonism are similar to those with aging making the diagnosis difficult since those who report the symptoms are generally at the last stage. This research was based on studying small population therefore, it has low generalizability. Future studies should aim towards sampling in the larger population so that the mechanisms and genetic polymorphisms become clearer from the exposure data that was reported. Moreover, the data was analyzed as uni-variant analysis, not multi-variant, therefore, the overall relationships and association might not be understood. Further studies should use these factors to compute for the multivariate analysis in order to understand more about Parkinsonism. Lastly, there was recall bias in this study. Participants were interviewed about pesticides and the years that they used those pesticides. Most elderly farmers did not remember the duration or age when those pesticides were used. Most farmers also used many varieties of pesticides and used it mixtures. This made it challenging in linking and associating a specific agent with PD.

5.6 CONCLUSION

The use of pesticides and pesticide exposure certainly had impact and increase the risk of Parkinsonism. Whether there were self-application of pesticides or not, participants were receiving some risks even though they were not categorized as having high risk. Some were exposed and influenced less than the others; nevertheless, they still have the potential risk of developing PD in the future. Future studies should focus towards the risk assessment and reducing risk. They should also aim towards building better survey tools to reduce recall bias. This could lead to the better understanding of the association and causation of PD linking to specific pesticides such as organochlorine, paraquat, glyphosate and 2-4 or other influencing factors.

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APPENDICES

APPENDIX A
Questionnaire (English version)

Description

There are 3 parts to this questionnaire; first and second parts consisted of open and closed questions, last part has only closed questions. Details for each part are as following:

Part 1 Socio-demographics

Part 2 Parkinson Screening Questionnaire

Part 3 Pesticide Exposure Information and Pesticide Prevention

-Place an (/) in the ( )

This questionnaire has total of 7 pages and should take no more than 30 minutes to complete.

Part 1: Socio – demographics

1. Gender ( ) Male ( ) Female
2. Age ………………. Years
3. Weight ……………..Kg
4. Height ……………….. Cm
5. Educational Background

   ( ) Uneducated

   ( ) Primary school

   ( ) secondary school

   ( ) Diploma and higher
6. Smoking

   ( ) Never

   ( ) Used to smoke

   When was the last time you smoked? ________________

   ( ) Currently smoking

   How many packs per day? ___________________
7. Drinking Alcohol

   ( ) Never

   ( ) Used to drink

   When was the last time you drank? __________________

   ( ) Currently drinking

   Does your hand shake when you don't drink? (Circle one) yes /no

   When you drink, do the symptoms disappear? (Circle one) yes/no
8. Are you currently on any medication?

   ( ) Yes, please name_______________________________

   ( ) No

9. Had anyone in your family been diagnosed of Parkinson's disease by a doctor?

( ) Yes, please provide the relationship________________________

( ) No

10. Have you been diagnosed of Parkinson's disease by a doctor?

( ) Yes when __________________________________

( ) No

11. Have you ever had pesticide related medical care?

( ) Yes when __________________________

( ) No

Agricultural works and farming descriptions

12. How long have you live in this area _______________years

13. Are you still working as a farmer?

( ) Yes

( ) No When did you quit being a farmer? ______________

14. Area cultivated ______________ Rai

15. Years working in agriculture ______________ Years

16. Years using Pesticides ______________ years ______________ months

17. Number of annual pesticide applications ____________________ times

18. Number of days working in farm per week _____________________days

19. Last use of pesticides __________________________________

Part 2: Parkinson Screening Questionnaire (Setthawatcharawanich et al. 2011)

Items	Yes	No
1. Do you feel you move slowly or stiffly?		
2. Do you walk with a stooped posture?		
3. Have you noticed that you do not swing your arms when you walk as much as you used to?		
4. Do you find it difficult to start walking from a standstill or have difficulty in stopping suddenly when you want to?		
5. After you sit down, do you find it difficult to get up again?		
6. When you turn, do you lose balance or do you need to take quite a few steps to turn right around?		
7. Have you noticed that a tremor of your hands, arms, legs or head?		
8. Do you have a lack of facial expression or tend to drool with your mouth half-open?		
9. Have you noticed that your voice has become softer or more monotonous?		
10. Have you noticed that you become more clumsy or have more difficulty with tasks that involve fine hand control: for example, doing up your buttons?		
11. Have your handwriting changed and become smaller compared to when you were young?		

<u>Part 3: Exposure Information and Prevention</u>

1. Farming Tasks of chilli growing
   - ( ) Mixing
   - ( ) Loading
   - ( ) Applying
2. Do you use the required amount of pesticides as recommended by the label?
   - ( ) Always
   - ( ) Sometimes
   - ( ) Never
3. Duration of application/ time _______Hours
4. Frequency of spraying Pesticide _________________________Months/ year
5. What type of Pesticide do you use? Please specify the duration of use!

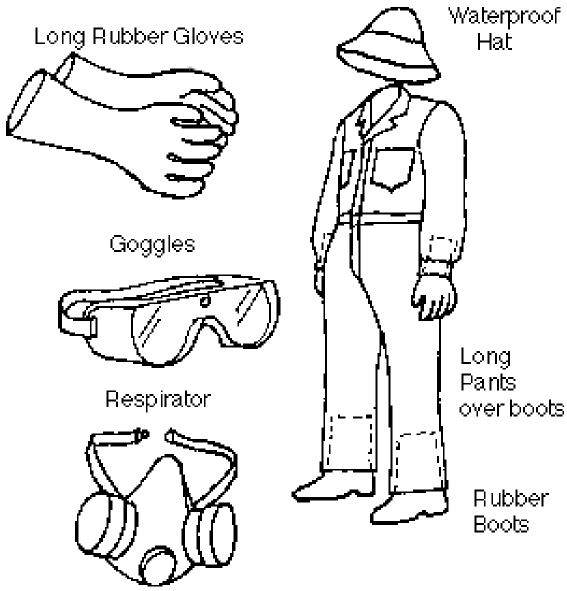
Type	Duration

Type	Duration

6. Do you use combination of pesticides or only one type of pesticide at a time?
   - ( ) One type
   - ( ) two types
   - ( ) more than two types
7. How far is your house from farm? _________________Meters

Use of PPE

	Always	Sometimes	Never
1. Use of fabric or plastic gloves			
2. Use of rubber gloves			
3. Use of respirators			
4. Use of Masks			
5. Use of long sleeves shirt			
6. Use of long legged pants			
7. Use of goggles			
8. Use of Boots			
9. Use of Aprons			



Personal Hygiene

1. Do clean the equipment after use?
   ( ) Always
   ( ) Sometimes
   ( ) Never

2. Do you take meal at workplace?
   ( ) Always
   ( ) Sometimes
   ( ) Never

3. Do you smoke while applying pesticides?
   ( ) Always
   ( ) Sometimes
   ( ) Never

4. Do you prepare or mix pesticides at home?
   ( ) Always
   ( ) Sometimes
   ( ) Never

5. Do you store pesticides at home?
   ( ) Always
   ( ) Sometimes
   ( ) Never

6. What is your source of drinking water?
   ( ) Tap Water
   ( ) Underground water

( ) well water

( ) Other ___________________

7. How do you treat your water before drinking?

( ) Boil

( ) Filter

( ) Precipitation

( ) Other ___________________

APPENDIX B

Questionnaire (Thai version)

<u>กลุ่มอาการพาร์กินสัน และปัจจัยที่เกี่ยวข้องในเกษตรกร ที่อาศัยในพื้นที่ปลูกพริก ตำบลหัวเรือ อำเภอเมือง อุบลราชธานี ประเทศไทย</u>

<u>คำชี้แจง</u>

1. **แบบสอบถามใช้สัมภาษณ์เกษตรกรผู้สูงอายุที่อาศัยในพื้นที่เกษตรกรรม**
2. **แบบสอบถามมีจำนวนทั้งสิ้น 8 หน้า แบ่งออกเป็น 3 ส่วน โดยในส่วนที่ 1 และ 3 จะประกอบไปด้วยคำถามลักษณะเปิดและปิด ในส่วนที่ 2 จะเป็นคำถามปิดอย่างเดียว:**

   ส่วนที่ 1 ข้อมูลทั่วไป

   ส่วนที่ 2 ข้อมูลกลุ่มอาการพาร์กินสัน

   ส่วนที่ 3 ข้อมูลการรับสัมผัสสารกำจัดศัตรูพืชและการป้องกัน

3. ให้ใส่เครื่องหมาย (/) ลงใน ( ) หน้าข้อความ และเติมข้อความในช่องว่าง

ใช้เวลาในการตอบแบบสอบถามทั้งหมดไม่เกิน 30 นาทีต่อชุด

ส่วนที่ 1: ข้อมูลทั่วไป

1. เพศ ( ) ชาย ( ) หญิง
2. อายุ .... ปี .... เดือน
3. น้ำหนัก ....กิโลกรัม
4. ส่วนสูง .... เซ็นติเมตร
5. ระดับการศึกษาสูงสุด
   ( ) ไม่ได้ศึกษา
   ( ) ประถมศึกษา
   ( ) มัธยมศึกษา
   ( ) ปวส. / ปวช.
   ( ) ปริญญาตรีหรือสูงกว่า
6. ท่านสูบบุหรี่หรือไม่
   ( ) ไม่เคย
   ( ) เคย แต่เลิกสูบแล้ว__________ปี
   ( ) สูบ ________มวนต่อวัน
7. ท่านดื่มสุราหรือไม่
   ( ) ไม่เคย
   ( ) เคย แต่เลิกดื่มแล้ว__________ปี
   ( ) ดื่ม มือสั่นหรือไม่หากไม่ได้ดื่มสุรา ( ) สั่น ( ) ไม่สั่น
   เมื่อดื่มสุราอาการมือสั่นจะหายไปหรือไม่ ( ) หาย ( ) ไม่หาย
8. ท่านมีโรคประจำตัวที่ได้รับการวินิจฉัยโดยแพทย์หรือไม่
   ( ) มี โปรดระบุ______________________________
   ( ) ไม่มี
   ( ) ไม่ทราบ
9. ปัจจุบันท่านทานยาอยู่หรือไม่?
   ( ) ทาน โปรดระบุยา____
   ( ) ไม่ทาน

10. ท่านมีญาติหรือคนในครอบครัวที่ได้รับการวินิจฉัยโดยแพทย์ว่าเป็นโรคพาร์กินสันหรือไม่

( ) มี โปรดระบุความสัมพันธ์________________________________

( ) ไม่มี

( ) ไม่ทราบ

11. ท่านเคยได้รับการวินิจฉัยโดยแพทย์ว่าเป็นโรคพาร์กินสันหรือไม่

( ) เคย เมื่อ ________________________________

( ) ไม่เคย

12. ท่านเคยป่วยหรือต้องไปหาหมออย่างเฉียบพลันโดยมีสาเหตุมาจากการใช้สารกำจัดศัตรูพืชหรือไม่

( ) เคย เมื่อ ________________________

( ) ไม่เคย

<u>*ลักษณะการทำงานในพื้นที่เกษตรกรรม*</u>

13. ท่านอาศัยอยู่ในชุมชนนี้________________ ปี

14. ปัจจุบันท่านยังเป็นเกษตรกรปลูกพืชผลอยู่หรือไม่?

( ) ใช่

( ) ไม่ใช่ ท่านเลิกเป็นปลูกพืชผลเมื่อ ___________________

15. พื้นที่ที่ใช้ในการเพาะปลูก ______________ ไร่

16. ท่านเป็นเกษตรกรเป็นระยะเวลา ______________ ปี

17. ท่านใช้สารกำจัดศัตรูพืชเป็นระยะเวลา ______________ ปี

18. ท่านฉีดพ่นสารกำจัดศัตรูพืช _____________________ ครั้งต่อเดือน

_____________________เดือนต่อปี

19. ท่านทำงานเกษตร _____________________วันต่อสัปดาห์

_____________________ชั่วโมงต่อวัน

20. ครั้งล่าสุดที่ท่านใช้สารกำจัดศัตรูพืช _____________________

<u>ส่วนที่ 2: ข้อมูลกลุ่มอาการพาร์กินสัน</u>

คำถาม	ใช่	ไม่ใช่
1. ท่านงุ่มง่ามมากขึ้น หรือลำบากมากขึ้นในการใช้มือทำงาน เช่น ติดกระดุม, บิดลูกบิดประตู ใช้ไขควง อาการเหล่านี้ไม่ได้เกิดจาก โรคข้ออักเสบรูมาตอยด์, ข้ออักเสบ หรืออัมพฤกษ์		
2. ลายมือของท่านเปลี่ยนไป และมีขนาด<u>เล็กลง</u> เทียบกับตอนหนุ่มๆ สาวๆ		
3. ท่านรู้สึกว่า ท่านเคลื่อนไหวช้า หรือแข็งๆ		
4. ท่านเดินไหล่ห่อ งองุ้ม		
5. ขณะเดิน แขนของท่านไม่แกว่งเหมือนเมื่อก่อน		
6. ท่านเริ่มการเดินด้วยความลำบาก หรือ เมื่อเดินแล้ว ไม่สามารถหยุดเดินได้ทันที		
7. ท่านมีอาการสั่นของมือ, แขน,ขา หรือศีรษะ		
8. ท่านไม่มีการแสดงออกทางสีหน้า (หน้าตาย หรือเหมือนหน้ากาก) หรือมีน้ำลายสอจะไหลเมื่ออ้าปากเล็กน้อย		
9. เสียงของท่านเบาลง และราบเรียบมากขึ้น		
10. ท่านเสียการทรงตัวขณะหมุนตัว		
11. ท่านลุกขึ้นจากเก้าอี้ด้วยความลำบาก		

(Setthawatcharawanich et al. 2011)

ส่วนที่ 3: ข้อมูลการรับสัมผัสสารกำจัดศัตรูพืชและการป้องกันตัว

1. กิจกรรมที่ท่านเกี่ยวข้องกับการเพาะปลูกขณะทำการเกษตร (เลือกได้มากกว่า 1)
   - ( ) ผสมยา
   - ( ) เทยาลงในเป้ฉีดพ่น
   - ( ) ฉีดพ่นยา
   - ( ) อื่นๆ ระบุ ______________________
2. ท่านใช้สารกำจัดศัตรูพืชตามที่ฉลากกำหนดหรือไม่?
   - ( ) ทุกครั้ง
   - ( ) บางครั้ง
   - ( ) ไม่เคย
3. ท่านเคยใช้สารกำจัดศัตรูชนิดไหนมาบ้าง โปรดระบุชนิดหรือยี่ห้อและระยะเวลาที่ท่านได้ใช้สารเหล่านั้น

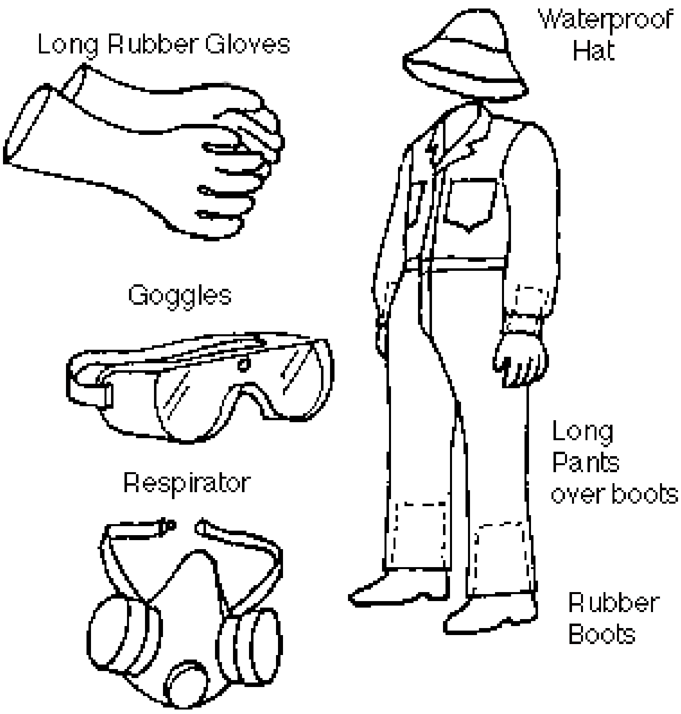
ชนิด/ยี่ห้อ ของยาฆ่าแมลง	ระยะเวลา	
	ใช้เมื่อไหร่	ใช้นานเท่าไหร่

4. ท่านใช้สารกำจัดศัตรูพืชกี่ชนิดในการทำการเกษตร
   - ( ) ชนิดเดียว
   - ( ) สองชนิด
   - ( ) มากกว่าสองชนิดขึ้นไป

5. ที่อยู่อาศัยของท่านตั้งอยู่ห่างจากพื้นที่เกษตรกรรมเป็นระยะทาง ________________ เมตร

<u>*การใช้อุปกรณ์ป้องกันตัวส่วนบุคคล*</u>

	ทุกครั้ง	บางครั้ง	ไม่เคย
1. ท่านใช้ถุงมือผ้า หรือถุงมือพลาสติกทุกครั้งหรือไม่			
2. ท่านใช้ถุงมือยางทุกครั้งหรือไม่			
3. ท่านใช้หน้ากากปิดจมูกทุกครั้งหรือไม่			
4. ท่านใช้ผ้าปิดจมูกทุกครั้งหรือไม่			
5. ทานสวมเสื้อแขนยาวทุกครั้งหรือไม่			
6. ท่านสวมกางเกงขายาวทุกครั้งหรือไม่			
7. ท่านใช่แว่นตาหรือหน้ากากกันลมทุกครั้งหรือไม่			
8. ท่านสวมรองเท้าบูททุกครั้งหรือไม่			
9. ท่านใช้ผ้ากันเปื้อน ทุกครั้งหรือไม่			



6. ท่านนำอาหาร/เครื่องดื่มไปกินที่พื้นที่การเกษตรด้วยหรือไม่?

( ) ทุกครั้ง

( ) บางครั้ง

( ) ไม่เคย

7. ท่านสูบบุหรี่ระหว่างฉีดพ่นหรือไม่?

( ) ทุกครั้ง

( ) บางครั้ง

( ) ไม่เคย

8. ท่านเตรียมสารกำจัดศัตรูพืชที่บ้านหรือไม่

( ) ทุกครั้ง

( ) บางครั้ง

( ) ไม่เคย

9. ท่านเก็บสารกำจัดศัตรูพืชที่บ้านหรือไม่?

( ) ทุกครั้ง

( ) บางครั้ง

( ) ไม่เคย

10. ท่านดื่มน้ำจากแหล่งใดขณะอยู่ในพื้นที่การเกษตร?

( ) น้ำประปา

( ) น้ำใต้ดิน

( ) บ่อน้ำ

( ) อื่นๆ ____________________

11. วิธีการดื่มน้ำของท่านเป็นอย่างไร

( ) ต้มน้ำ

( ) กรองน้ำ

( ) ตกตะกอน

( ) อื่นๆ ____________________

APPENDIX C

PROTOCOL

AF 02-12

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COA No. 069/2014

Certificate of Approval

Study Title No.030.1/57 : **PARKINSONISM AND RELATED FACTORS AMONG ELDERLY FARMERS LIVING IN CHILLI FARM AREA IN HUA RUA SUB-DISTRICT, MUANG DISTRICT, UBONRATCHATHANI THAILAND**

Principal Investigator : MS. SUNIT KUKREJA

Place of Proposed Study/Institution : College of Public Health Sciences, Chulalongkorn University

The Ethics Review Committee for Research Involving Human Research Subjects, Health Science Group, Chulalongkorn University, Thailand, has approved constituted in accordance with the International Conference on Harmonization – Good Clinical Practice (ICH-GCP) and/or Code of Conduct in Animal Use of NRCT version 2000.

Signature: Prida Tasanapradit
(Associate Professor Prida Tasanapradit, M.D.)
Chairman

Signature: Nuntaree Chaichanawongsaroj
(Assistant Professor Dr. Nuntaree Chaichanawongsaroj)
Secretary

Date of Approval : 17 April 2014 Approval Expire date : 16 April 2015

The approval documents including

1) Research proposal
2) Patient/Participant Information Sheet and Informed Consent Form
3) Researcher
4) Questionnaire

Protocol No. 030.1/57
Date of Approval 17 APR 2014
Approval Expire Date 16 APR 2015

The approved investigator must comply with the following conditions:

1. *The research/project activities must end on the approval expired date of the Ethics Review Committee for Research Involving Human Research Subjects, Health Science Group, Chulalongkorn University (ECCU). In case the research/project is unable to complete within that date, the project extension can be applied one month prior to the ECCU approval expired date.*
2. *Strictly conduct the research/project activities as written in the proposal.*
3. *Using only the documents that bearing the ECCU's seal of approval with the subjects/volunteers (including subject information sheet, consent form, invitation letter for project/research participation (if available).*
4. *Report to the ECCU for any serious adverse events within 5 working days*
5. *Report to the ECCU for any change of the research/project activities prior to conduct the activities.*
6. *Final report (AF 03-12) and abstract is required for a one year (or less) research/project and report within 30 days after the completion of the research/project. For thesis, abstract is required and report within 30 days after the completion of the research/project.*
7. *Annual progress report is needed for a two- year (or more) research/project and submit the progress report before the expire date of certificate. After the completion of the research/project processes as No. 6.*

VITA

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