Pesticide Exposure of Family in Chili Farm Community, Hua-Rua sub-district, Muang district, Ubonratchathani province, Thailand

Miss. Saowanee Norkaew

A Dissertation Submitted in Partial Fulfillment of the Requirements
for the Degree of Doctoral of Philosophy Program in Public Health
College of Public Health Sciences
Chulalongkorn University
Academic Year 2012

การรับสัมผัสสารกำจัดศัตรูพืชของผู้อยู่อาศัยในชุมชนเกษตรกรรมผู้ปลูกพริก ตำบลหัวเรือ อำเภอเมือง จังหวัดอุบลราชธานี ประเทศไทย

นางสาวเสาวนีย์ หน่อแก้ว

วิทยานิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาสาธารณสุขศาสตรดุษฎีบัณฑิต
สาขาวิชาสาธารณสุขศาสตร์
วิทยาลัยวิทยาศาสตร์สาธารณสุข จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2555

Thesis Title	PESTICIDE EXPOSURE OF FAMILY IN CHILI FARM COMMUNITY, HUA-RUA SUB-DISTRICT, MUANG DISTRICT, UBONRATCHATHANI PROVINCE, THAILAND
By	Miss Saowanee Norkaew
Field of Study	Public Health
Thesis Advisor	Assistant Professor Wattasit Siriwong, Ph.D.
Thesis Co-advisor	Professor Mark Gregory Robson, Ph.D., M.P.H.

Accepted by College of Public Health Sciences, Chulalongkorn University in Partial Fullfillment of the Requirements for the Doctoral Degree

…………………………………Dean of the College of Public Health Sciences
(Professor Surasak Taneepanichskul, M.D.)

THESIS COMMITTEE

…………………………………Chairperson
(Professor Surasak Taneepanichskul, M.D.**)**

…………………………………Thesis Advisor
(Assistant Professor Wattasit Siriwong, Ph.D.)

…………………………………Thesis Co-advisor
(Professor Mark Gregory Robson, Ph. D., M.P.H.)

…………………………………Examiner
(Associate Professor Somrat Lertmaharit, M.Sc., M. Med Stat)

…………………………………Examiner
(Associate Professor Sathirakorn Pongpanich, Ph.D.)

…………………………………External Examiner
(Chidhathai Petchuay, Ph. D.)

เสาวนีย์ หน่อแก้ว: การรับสัมผัสสารกำจัดศัตรูพืชของผู้อยู่อาศัยในชุมชนเกษตรกรรมผู้ปลูกพริก ตำบลหัวเรือ อำเภอเมือง จังหวัดอุบลราชธานีประเทศไทย. (PESTICIDE EXPOSURE OF FAMILY IN CHILI FARM COMMUNITY, HUA-RUA SUB-DISTRICT, MUANG DISTRICT, UBONRATCHATHANI PROVINCE, THAILAND) อ.ที่ปรึกษาวิทยานิพนธ์หลัก: ผศ.ดร.วัฒน์สิทธิ์ ศิริวงศ์ อ.ที่ปรึกษาวิทยานิพนธ์ร่วม: ศ.ดร.มาร์ค เกรกอรี รอบสัน, 203 หน้า.

ประชากรผู้อยู่อาศัยในชุมชนเกษตรกรรมมีโอกาสได้รับสัมผัสสารเคมีกำจัดศัตรูพืชจากการเกษตรกรรมผ่านเส้นทางการรับสัมผัสสารหลากหลายเส้นทางและแหล่งที่มา รวมไปถึงการได้รับสัมผัสทางอ้อมจากสารเคมีกำจัดแมลงที่ใช้ในครัวเรือน การศึกษานี้มุ่งเน้นในกลุ่มประชากรผู้อยู่อาศัยในชุมชนเกษตรกรรมใน ต.หัวเรือ อ.เมือง จ.อุบลราชธานี ประเทศไทย โดยการคัดเลือก 54 ครัวเรือนจากครอบครัวเกษตรกร และ 54 ครัวเรือนจากครอบครัวที่ไม่ใช่เกษตรกรในการเข้าร่วมการศึกษา การสัมภาษณ์แบบตัวต่อตัวเกี่ยวกับสารเคมีกำจัดแมลงในครัวเรือนพบว่า 73.1% ของผู้เข้าร่วมการวิจัยใช้สารเคมีกำจัดแมลงในครัวเรือน 70.9% ของผู้เข้าร่วมการวิจัยที่ใช้สารเคมีกำจัดแมลง ใช้สารเคมีกำจัดแมลงชนิดสเปรย์ และชนิดขด (26.6%) ในการควบคุมสัตว์รบกวนภายในครัวเรือน 82.3% ของผู้ใช้สารเคมีกำจัดแมลงในครัวเรือนใช้สารเคมีกำจัดแมลง 1-2 ครั้งต่อสัปดาห์ และ 45.4% ทำความสะอาดครัวเรือน 1-2 ครั้งต่อสัปดาห์ สารเคมีกำจัดแมลงในครัวเรือนทั้งหมดที่พบในการศึกษานี้เป็นสารกลุ่มไพรีทรอยด์ พบสารกลุ่มออร์แกนโนฟอสเฟตตกค้างในตัวอย่างอากาศ 22.2% และตัวอย่างพื้น 21.3% เมื่อทำการเปรียบเทียบความเข้มข้นของสารกลุ่มออร์แกนโนฟอสเฟตที่ตกค้างระหว่างระยะที่ตั้งของที่อยู่อาศัย พบว่าบ้านที่ตั้งอยู่ในระยะที่ 1 มีความเข้มข้นของสารกลุ่มออร์แกนโนฟอสเฟตที่ตกค้างมากกว่า บ้านที่ตั้งในระยะที่ 2 และระยะที่ 3 อย่างมีนัยสำคัญ (ระยะห่างจากสวนพริกน้อยกว่า 50 เมตร, 50-100 เมตร และ101-150 เมตร ตามลำดับ) (Kruskal Wallis test, $p<0.001$) พบสารกลุ่มไพรีทรอยด์ตกค้างมากที่สุดบนพื้น, มือ และเท้า ตามลำดับ อย่างไรก็ตามผลการศึกษายังพบว่า ระดับสารเมตาโบไลต์ของสารกำจัดศัตรูพืชตกค้างกลุ่มออร์แกนโนฟอสเฟตของสมาชิกในครอบครัวเกษตรกรมีความแตกต่างอย่างมีนัยสำคัญกับระดับสารเมตาโบไลต์ของสมาชิกในครอบครัวที่ไม่ใช่เกษตรกร (Mann-Whitney test, $p<0.05$) ยกเว้นในกลุ่มผู้สูงอายุ และพบว่าระดับสารเมตาโบไลต์ของผู้เข้าร่วมงานวิจัย มีความสัมพันธ์กับการรับสัมผัสสารกำจัดศัตรูพืชผ่านทางผิวหนัง และทางการหายใจ (ค่าสัมประสิทธิ์ความสัมพันธ์ตามตำแหน่งของสเปียร์แมน 0.424 และ 0.379 ตามลำดับ *p-value*<0.01) จากการศึกษานี้จึงเสนอให้มีการให้ความรู้และการอบรมเกี่ยวกับการใช้สารเคมีกำจัดแมลงในครัวเรือน และแนวทางในการป้องกันตนเองจากสารเคมีกำจัดศัตรูพืชที่ใช้ในการเกษตรแก่ประชากรที่อาศัยในชุมชนเกษตรกรรม

สาขาวิชา สาธารณสุขศาสตร์	ลายมือชื่อนิสิต
ปีการศึกษา 2555	ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์หลัก
	ลายมือชื่อ อ.ที่ปรึกษาวิทยานิพนธ์ร่วม

##5379212553: MAJOR PUBLIC HEALTH
KEYWORDS : AGRICULTURAL COMMUNITY/ HOUSEHOLD INSECTICIDE/ EXPOSURE/ INDIRECT EXPOSURE

SAOWANEE NORKAEW:PESTICIDE EXPOSURE OF FAMILY IN CHILI FARM COMMUNITY, HUA-RUA SUB-DISTRICT, MUANG DISTRICT, UBONRATCHATHANI PROVINCE, THAILAND. ADVISOR: ASST. PROF. WATTASIT SIRIWONG, Ph.D., CO-ADVISOR: PROF. MARK G. ROBSON, Ph.D., M.P.H., 203 pp.

People living in agricultural communities can be exposed to agricultural pesticides from multiple pathways and sources. These include indirect exposure from household insecticides. The study population focused on people who living in an agricultural community in Hua-Rua sub-district, Muang district, Ubonratchathani province, Thailand recruited 54 occupational households and 54 non-occupational households to participate. Questionnaires on household pesticide use were completed by face to face interviews and observations. The results showed that 73.1% of the participants reported using household pesticides. Most of them (70.9%) used pesticides bottled sprays follow by mosquito coils (26.6%) for pest control in their house. About 82.3% of the household pesticide users reported using pesticide 1-2 times per week and 45.4% of the respondents generally cleaned their house 1-2 times per week. All household pesticide products in this area contain pyrethroids. Organophosphate pesticides (OPs) residues were found in air samples (22.2%) and surface wipes (21.3%). All households were cross compared of OPs concentration between house located levels. It was found that all households of level 1 had significantly higher levels of OPs concentration than level 2 and level 3 (<50m., 50-100m. and 101-150 m., respectively), (Kruskal Wallis test, $p<0.001$). Pyrethroid insecticides residue was mostly found in surface wipe, hands and foot, respectively. The OPs urinary metabolite of member in occupational family was significantly different from the urinary metabolite of non-occupational family (Mann-Whitney test, $p<0.05$) except elderly. The main associated of pesticide exposure pathways and urinary metabolites were found from the dermal and inhalation pathways (Spearman's rank correlation coefficient 0.424 and 0.379 respectively; *p-value* <0.01).This study suggests that the education and training program regarding household insecticides use and guidelines regarding agricultural pesticides prevention should be developed for people in agricultural community.

Field of Study: Public Health Student's Signature ....
Academic Year: 2012 Advisor's Signature ....
Co-advisor's Signature ....

ACKNOWLEDGEMENTS

I would like to express my overwhelming gratitude and deep appreciation to my thesis advisor, Asst. Prof. Dr. Wattasit Siriwong, for his advice, suggestions and encouragement and Prof. Dr. Mark Gregory Robson, my co-advisor, for his kind support and encouragement. I would like to express my sincere thanks to Professor Surasak Taneepanichskul my thesis chairman and with great respect and heartfelt appreciation to Assoc. Prof. Somrat Lertmaharit, for her advice during the steps of my dissertation, and Assoc. Prof. Dr. Sathirakorn Pongpanich for being my thesis examination member and for his comments and suggestions and Dr. Chidhathai Petchuay, my external examiner, for her help and suggestions.

Special thanks are given to all participants in Hua-Rua sub-district who were involved in my study. The work would not be complete without the cooperation and support from Ubon Ratchathani Provincial Health Office, Mr. Thanin Chaiyanukul, Muang Ubon Ratchathani District Health Office and Tambon Hua-Rua Health Promoting Hospital. I gratefully acknowledge Asst. Prof. Dr. Sumana Siripattanakul and Ms.Sirinuttakan Singkibut from Ubon Ratchathani University for providing field equipment, including chemicals. In the laboratory analysis steps, first of all, it's my honor to have Asst. Prof. Dr.Parinya Panuwet, Rollins School of Public Health, Emory University, USA. My work would not be successful without his suggestions and encouragement. Along with Asst. Prof. Dr.Parinya, I am grateful to have Prof. Dr. Dana Barr for giving me a chance to train in her laboratory. Alongside those mentioned above, I would like to acknowledge Dr. Tippawan Prapamontol, Mr.Sompong Laoyang and Dr.Surat Hongsibsong, Chiangmai University, for urinary metabolite analysis training and supporting chemical on this part of the study. Moreover, I gratefully thank Dr. Sarintip Sooksai, for her help and suggestions on sample preparation. I would like to thank all the teachers and laboratory staff, College of public health sciences for their guidance and instrument support. I would like to acknowledge Dr. Kriangkrai Lerdthusnee for the inspiration of this study. Also, I would like to acknowledge Mr.Somkiet Thoumsang, Ministry of Public Health for his kind help and suggestions on the process of sample analysis and Ms.Witchuda Witchayanareaphon, Central Institute of forensic science for her encouragement and laboratory instrument support. Moreover, I gratefully thank Dr. Marija Borjan, Rutgers University for her help and suggestions on writing part. I also do thank grant support from CU.GRADUATE SCHOOL THESIS GRANT, Thai Fogarty ITREOH Center D43 TW007849-01 NIH Fogarty International Center and the higher education research promotion and national research university project of Thailand, office of the higher education commission (AS581A).

Finally, I would like to thank Ms.Nutta Taneepanichskul, she is not only my close friend but she is one of my family and all my close friends for their love and their great friendship. I would like to give deepest thanks to my best family; my parents, my brothers and my little cousin, N'Pa for their encouragement, their support and their love. There are meaningful that always give me a power even when I was about to failed. Thanks indeed, my graduation could not have been finished without all of them.

CONTENTS

Pages

LIST OF TABLES

Pages

LIST OF FIGURES

Pages

LIST OF ABBREVIATIONS

DAP	= Dialkylphosphate
DEP	= Diethylphosphate
DETP	= Diethylthiophosphate
DEDTP	= Diethyldithiophosphate
DGR	= Department of Groundwater Resources
DMP	= Dimethylphosphate
DMTP	= Dimethylthiophosphate
DMDTP	= Dimehyldithiophosphate
μECD	= Micro electron capture detector
FPD	= Flame photometric detector
GC	= Gas chromatography
LOD	= Limit of detection
NHL	= Non- Hodgkin's Lymphoma
NIOSH	= National institute for occupational safety and health
TNSO	= The National Statistical Office
OPs	= Organophosphate pesticides
PPE	= Personal protective equipment
PYs	= Pyrethroid insecticides
US EPA	= United state environment protection agency
WHO	= World health organization

CHAPTER I

INTRODUCTION

1.1 Background of the study

Thailand is known as an agricultural country. In Thailand's agricultural communities, a number of pesticide products have been highly used in agricultural farming and has raised concerns about potential adverse effects on human health and the environment. According to the National Statistical Office of Thailand (2003a), 54.4% of agriculture areas reported using pesticides, of which 45.9% used chemicals. The majority of agricultural areas using pesticides are located in the Central and Northeastern Region (76.5% and 44.9% respectively) of Thailand, which includes Nakhon Ratchasima (6.39 million rais) and Ubonratchathani (4.40 million rais) province (1rai = 1,600 square meters) (TNSO, 2003b).

The amount of imported pesticides rose from 29,189 million tons in 1993 to 65,074 million tons in 2002. Pesticides most frequently imported for agricultural use includes glyphosate, carbofuran, methamidophos, 2,4-D sodium, atrazine, methyl parathion, alachlor, and chlorpyrifos (Department of Agriculture Thailand, 2003).

Pesticides belong to a wide group of chemicals which are of a growing public health concern. Pesticide exposure has been associated with leukemia, non-Hodgkin's lymphoma (NHL) and other cancers (Meinert et al., 2000; Richter and Chlamtac, 2002), respiratory symptoms (Salameh et al., 2003) and hormonal and reproductive abnormalities (Bell et al., 2001). More specifically, exposure to organophosphate insecticides (e.g. chlorpyrifos) have been associated with delayed neuropathy, chromosome aberrations, central nervous system alterations and NHL (Maroni and Fait, 1993); and glyphosate has been associated with adverse neurobehavioral development (Garry et al., 2002).

Pesticide compounds that are used outdoors or occupationally have also been found to contaminate indoor environments. Outdoor contaminants can be tracked indoors by shoes, clothes and air drift (Lewis et al., 2001). Bouvier et al. (2006), found people were exposed inside their homes to various insecticides, such as organochlorines, organophosphates and pyrethroids and also to wood preservatives and some herbicides and fungicides .

The National Institute for Occupational Health and Safety (NIOSH) conducted a study to evaluate the potential contamination of the home by substances brought home from the workplace. The study raised concern when it showed that contamination of worker's homes was a global problem (Curwin et al., 2002). Research has shown that childhood cancer has been associated with children whose parents' occupations involve pesticide application (Daniels et al., 1997; Zahm and Ward, 1998; Flower et al., 2004) and household pesticide use has been associated with childhood leukemia (Ma et al., 2002).

Children and spouses of farmers are potentially indirectly exposed to pesticides tracked into farm homes on the clothing and shoes of farmer workers (Curwin et al., 2002). Children living with parents who work with agricultural pesticides, or who live in close proximity to pesticide-treated farmland, have higher exposures than do other children living in the same community (Fenske et al., 2002; Lu et al., 2000). Children living in agricultural areas may also be exposed to higher levels of pesticides than other children as a result of pesticide drift, playing in nearby fields, or through breast milk from their mothers who work on the farm or who have been indirectly exposed through their spouse (Eskenazi et al., 1999).

Pesticide urine concentrations among the children of farmers and farm workers have been shown to be elevated when compared with children of non-farm families (Loewenherz et al, 1997; Lu et al., 2000) and pesticide levels in house dust have been correlated with urinary pesticide levels in children and adults living in the home. Differences in children's physiology, behavior patterns and hygiene may result in significantly greater exposures of children to environmental contaminants than adults (Bearer, 1995). Small children spend much of their time on the floor or ground and are very likely to come into contact with pesticide residues uncovered floors when playing inside and yard dirt when playing outside (Renwick, 1998). Children may also be more susceptible than adults to the toxic effects of pesticides, due to the sensitivity of developing organ systems.

Pesticide exposure can occur directly and indirectly through several pathways. Dermal exposure can occur when directly handling pesticides through mixing and application. Inhalation and indirect ingestion can occur as well (Curwin et al., 2002). In farm homes, families may be exposed to pesticides even though they may not participate in farming activities involving pesticide use. Residential environments in proximity to farm operations where pesticides are used may be contaminated through a variety of routes including through the air, tracking contaminated soil into the home on shoes, and through deposition on the clothing of applicators. Indirect inhalation and dermal exposure of families to pesticides may occur through redistribution of pesticides via indoor air to surfaces. Families can also be exposed to pesticides through food or drinking water and in homes that have been sprayed with pesticides

The potential for pesticide exposure of susceptible groups, such as children and the elderly, living in agricultural communities is a serious concern. Individuals living in these communities can be exposed to pesticides through several pathways. For example, inhalation exposure via pesticide application; re-suspension of contaminated dust; dermal exposure via contact with contaminated surface or soil outside the home and indirect ingestion via hand to mouth after contact with contaminated surface (Figure 1.1).

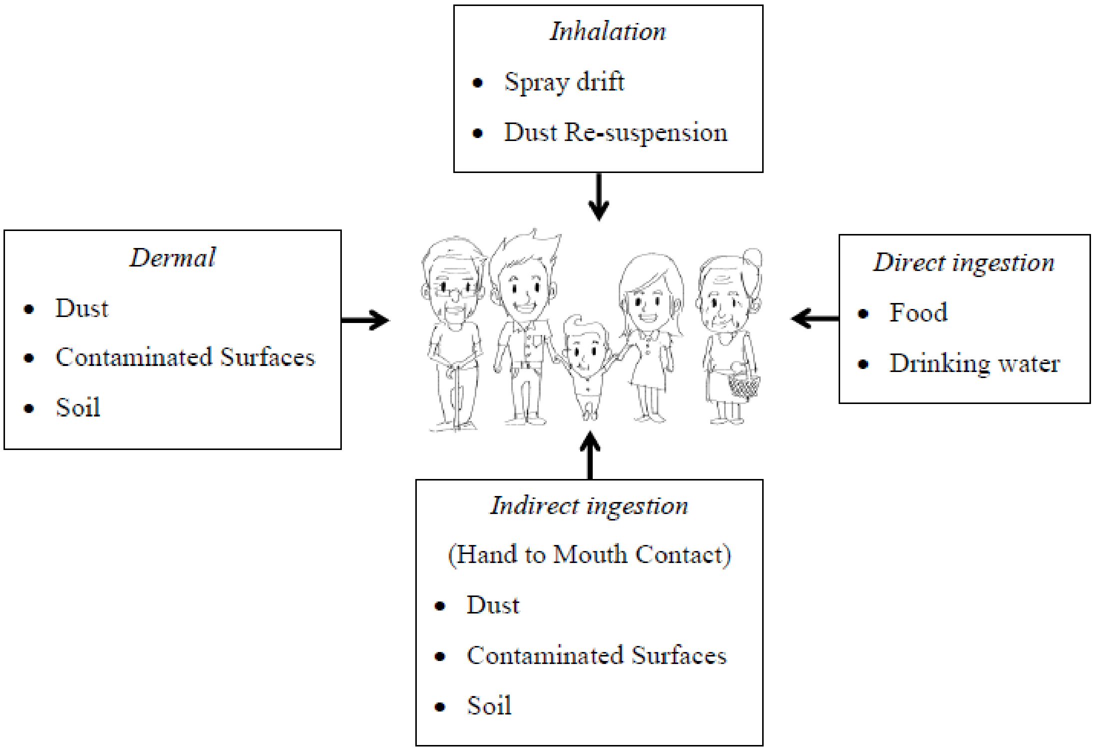


Figure 1.1 sources of exposure for agricultural communities

1.2 Research Questions

1. Is the environmental media (e.g. air, dust, drinking water) related to the urinary pesticide levels in people living in agricultural communities?
2. Do people living in agricultural communities have high pesticide exposure?
3. What is the concentration of urinary pesticides metabolites in people living in agricultural communities?

1.3 Research Objectives

1. To evaluate the risk pesticide exposures in people living in agricultural community.
2. To determine the relationship between environmental media (e.g. air, dust, drinking water) and the urinary pesticide levels in people living in agricultural community.
3. To identify environmental factors that contributes to pesticide exposure.

1.4 Research Hypothesis

1. The environmental media (e.g. air, dust, drinking water) is related to the urinary pesticide levels in people living in agricultural community.
2. People living in agricultural community have higher pesticide exposure than other people.
3. People living near agricultural farm have urinary pesticides metabolite concentration higher than people living far from agricultural farm.

1.5 Conceptual Framework

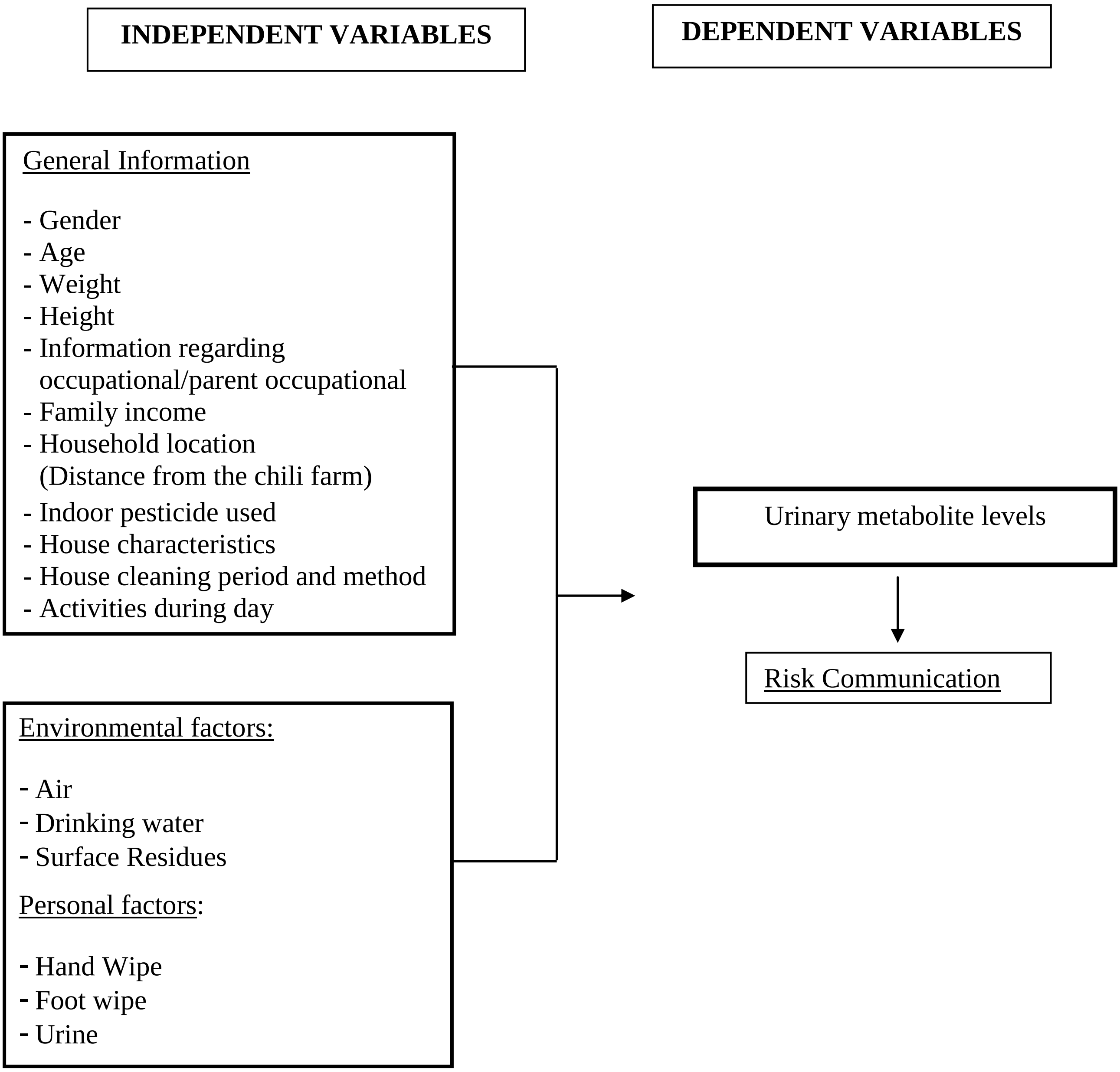


Figure 1.2 Conceptual Frameworks

1.6 Operational Definition

Non-occupational family (non-farm family) group

In this study, non-occupational families are people living in agricultural communities in the Hua-Rua sub-district, Muang district, Ubonratchathani province, Thailand on land that is not used for farming. Including, nobody in the household working in agriculture or commercial pesticide application and have at least one child or working age or elderly in their family.

Occupational family (Farm family) group

In this study, occupational families are people living in agricultural communities in the Hua-Rua sub-district, Muang district, Ubonratchathani province, Thailand and work on land that is used for chili farming. Occupational families may include one household member that works in agriculture or commercial pesticide application; has at least one child; or person of working age; or elderly in their family.

Common pesticides used

This study concentrates on pesticide application on chili farms and household pesticides used in agricultural communities (organophosphate pesticides).

Pesticide

The US EPA defines pesticides as “substances that prevent, destroy, repel, or mitigate a pest”. In addition, “a product’s relative toxicity to humans or other non-target organisms does not make it a pesticide and the Agency has concluded that the use of the pesticide product will not cause unreasonable adverse effects to humans or the environment when applied according to the label directions and restrictions” (US EPA, 2010).

Insecticide

Insecticide is only one type of pesticides, according to the Environmental Protection Agency (EPA), the federal agency that regulates pesticides. Pesticides also include products that kill or control weeds (herbicide), rodents (rodenticide), mold (fungicide), bacteria, and an insecticide is a killer of insects.

Household insecticide used

Household insecticides were used to treat problem insects such as mosquitoes, ants, and cockroaches such as pyrethroid insecticides.

Air Samples

In this study, air samples represent pesticide concentration which people inhale a contaminate air during farm activity. The measuring pesticide concentrations via inhalation were followed by NIOSH 5600 method (Organophosphorus pesticides, Issue 1, dated 15 August 1994).

Drinking water

Drinking water in this study is a representative of pesticide contamination via house's member ingestion route. Samples were collected from the bottle or cooler of drinking water which participants used in their house.

Wipe samples

Wipe samples collecting for analyzing the concentration of pesticide residue on hand and foot of each participant. Including hard surface of the common area in each house was collected.

Urinary Metabolite Level

The pesticide metabolites were analyzed from the urine sample for each participant. These study Organophosphate pesticides were measured due to their mostly used in this study area. The six common dialkylphosphate (DAP) metabolites of OP insecticides were measured including dimethylphosphate (DMP), diethylphosphate(DEP), dimethylthiophosphate (DMTP), dimethyldithiophosphate (DMDTP), diethylthiophosphate (DETP), and diethyldithiophosphate (DEDTP) and the specific metabolites of organophosphate pesticides.

Risk Communication

The goal of risk communication is "to rectify the knowledge gap" between the researcher of scientific information and those receiving the information (Frewer, 2004). Risk communication focused on communicating general risk messages to communities, not on communicating specific exposure or risk data to individuals. The collection of all samples presents a responsibility to return information to the affected participants.

This study includes risk communication into the last step. The results will give the information and provide the knowledge of pesticide exposure to all participants for protect their family and themselves including reducing risk in this community.

CHAPTER II

LITERATURE REVIEWS

Pesticides are often referred to according to the type of pest they control. Another way to think about pesticides is to consider those that are chemical pesticides or are derived from a common source or production method. Other categories include bio-pesticides, antimicrobials, and pest control devices (US EPA, 2006).

Approximately 80% are used in agriculture, 8% are used in homes and gardens and the remainder is used in government, commercial or industrial applications. Herbicides comprise the bulk of conventional pesticides used (42%) while insecticides (10%), fungicides (6%) and other insecticides (43%) make up the remainder (Kiely et al., 2004). However, residential uses of chlorpyrifos and diazinon, two common of OP insecticides were eliminated in 2001 and 2003 (US EPA, 2002).

The current use or contemporary pesticides include OP, carbamates, and pyrethroid insecticides, and triazine, chloroacetanilides and phenoxy herbicides and are considered non persistent. These pesticides have much shorter environmental half-lives. In fact, most of these pesticides are excreted from humans within 24 hr as the parent pesticide, a mercapturic acid detoxification product, oxidative or dealkylation metabolites, and/or glucuronide- or sulfate-bound metabolites (Barr et al., 2007)

Pesticide exposure refers to human contact with pesticides in environmental media. Sources of pesticide exposure include such media as dust, soil, air, water, and food, and routes of pesticide exposure include inhalation, ingestion, and dermal contact. (The course that a pesticide takes from exposure source to exposure route is the exposure pathway (Zartarian *et al.*, 2005.)

2.1 Agricultural in Thailand

The National Statistical Office (NSO) conducted the Fifth Agricultural Census in 2003 in order to collect the data on structure of agriculture obtained from the agricultural holdings throughout the country.

In table 3.1, a total of 5.6 million holdings with crops in the country, 91.9% used fertilizers. Also found that the highest percentage of holding using fertilizers was in the Northeastern Region (97%) follow by Central and Northern region respectively. Among these 95.5% used inorganic fertilizers. The average inorganic fertilizer per rai of the Central Region was the highest which was 58.3 kg./rai (1rai = 1,600 m^2) Agricultural Census, 2003).

Considering the use of pesticides, 54.4% of holding reported of using pesticides, of which 45.9% used chemical. The majority of holdings using pesticides were in the Central and Northern Region (76.5 and 73.3% respectively). However, pesticide users were followed by in the Northeastern Region (44.9%) (Agricultural Census, 2003).

Table 2.1 Percentage distribution of holdings with crops by using fertilizer and pesticide (Agricultural Census, 2003)

Item	Total	Central	Northern	Northeastern	Southern
1. Number of holdings with crops	**5,563,057**	**805,424**	**1,320,544**	**2,585,476**	**851,613**
	(100.0)	(14.5)	(23.7)	(46.5)	(15.3)
By using fertilizer	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Not use fertilizer	8.1	10.5	10.6	3.0	17.7
Use fertilizer	91.9	89.5	89.4	97.0	82.3
Inorganic	57.5	55.0	60.2	56.5	58.8
Organic	2.5	4.6	2.9	1.5	2.7
Inorganic and organic	31.9	29.9	26.3	39.0	20.8
By using pesticide	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Not use pesticide	45.6	23.5	26.7	55.1	67.1
Use pesticide [1/]	54.4	76.5	73.3	44.9	32.9
Chemical	45.9	72.7	69.8	31.7	27.0
Organic	3.4	5.2	3.9	2.9	2.5
Natural-enemies	1.1	1.3	1.1	1.2	0.9
Others	10.8	5.9	5.6	16.4	6.3
2. Area treated inorganic fertilizer (rai)	**101,734,6**	**23,066,34**	**23,843,42**	**43,619,85**	**11,204,96**
	(100.0)	(22.7)	(23.4)	(42.9)	(11.0)
3. Quantity used inorganic fertilizer (1,000 kg.)				**1,414,125**	**554,628**
	(100.0)	(30.9)	(23.9)	(32.5)	(12.7)
Average per rai (kg.)	42.8	58.3	43.7	32.4	49.5

[1/] One holding may report more than one method of using pesticide.

In term of agricultural worker, NSO reported that 58.6% of the total holdings employed agricultural workers. The highest percentage of employed agricultural workers was in the Northeastern region (68.2%) follow by Northern and Central region respectively. Moreover, the highest number of permanent workers was found in the Northeastern region as well (99.1%).

Table 2.2 Percentage distribution of holdings by employment and number of permanent workers by region (Agricultural Census, 2003)

Item	Total	Central	Northern	Northeastern	Southern
1. Total number of holdings	100.0	100.0	100.0	100.0	100.0
Not employ agricultural workers	41.4	44.8	39.1	31.8	70.1
Employ agricultural workers	58.6	55.2	60.9	68.2	29.9
Permanent workers	1.4	2.0	0.5	0.2	6.2
Occasional workers	55.6	50.6	59.3	67.5	19.5
Permanent and occasional workers	1.6	2.6	1.1	0.5	4.2
2. Number of permanent workers	704,959	168,844	137,361	155,127	243,627
	(100.0)	(23.9)	(19.5)	(22.0)	(34.6)
By sex	100.0	100.0	100.0	100.0	100.0
Male	55.8	59.7	54.7	47.7	58.8
Female	44.2	40.3	45.3	52.3	41.2
By source of workers	100.0	100.0	100.0	100.0	100.0
Thai	92.0	90.6	84.8	99.1	92.4
Foreigner	8.0	9.4	15.2	0.9	7.6

The studies and methodologies of pesticides exposure in several pathways vary widely and including environmental (for example, dust and surface wipe), personal (for example, hand wipe) and biological sample (for example, urine). Summary of studies related to this study were reviewed and presented in Table 2.3.

2.2 Organophosphate insecticides (OP)

OP insecticides are comprised of a phosphate (or thio- or dithio-phosphate) moiety and an organic moiety. In most cases, the phosphate moiety is O, O-dialkyl substituted. These pesticides, after being enzymatically converted to their active oxon form, are potent cholinesterase inhibitors by binding to the serine residue in the active site of acetyl cholinesterase, thus preventing its natural function in metabolism of acetylcholine (Barr, 2008).This action is not unique to insects, but can produce the same effects in wildlife and humans.

Six DAP metabolites (dimethylphosphate (DMP), diethylphosphate(DEP), dimethylthiophosphate (DMTP), dimethyldithiophosphate (DMDTP), diethylthiophosphate (DETP), and diethyldithiophosphate (DEDTP)) are the most commonly measured metabolites for assessing human exposure to OP pesticides (Petchuay et al., 2006). Pesticide-specific metabolites of OP insecticides are also frequently measured. The most common metabolite measured is 3,5,6-trichloropyridinol (3,5,6-TCPy), a metabolite of chlorpyrifos (Olsson et al., 2004)

2.3 Pyrethroid insecticides

Pyrethrins are naturally-occurring chemicals that are produced by chrysanthemums which possess pesticidal activity. Natural pyrethrins are comprised of many isomeric forms and are usually classified as the pyrethrin I and II isomer sets with pyrethrum being a representative pyrethrin. Synthetic pyrethroids are man-made chemicals that are produced to mimic the effective action of natural pyrethrins; however, their structures are inherently more stable affording them a longer environmental half-life and their pesticide activity more effective.

Pyrethroids exhibit neurotoxic effects by modulating sodium channel voltages. Some pyrethroids also have a slight repellent effect. In the past several years, the use of synthetic pyrethroids has escalated as the use of the more toxic OP and carbamate insecticides has been curtailed. Many products that are routinely found in retail stores for home use contain pyrethroids, such as permethrin and allethrin, for eliminating household pests such as ants and spiders (Barr, 2008).

The metabolites of permethrin, cypermethrin, deltamethrin, and cyfluthrin are most commonly measured. 3-Phenoxybenzoic acid (3-PBA) is a metabolite that is common to as many as 20 synthetic pyrethroids. It has been measured alone, with other non-pyrethroid pesticides, or as a part of a suite of pyrethroid metabolites (Barr et al., 2007).

Other more specific metabolites of synthetic pyrethroids have also been measured in urine. Cis- and transisomers of 2,2-dichlorovinyl-2,2-dimethylcyclopropane-1-carboxylic acid (cis- and trans-DCCA) are metabolites of permethrin, cypermethrin, and cyfluthrin. Pyrethroid insecticides have been measured in a variety of populations including occupationally exposed (Leng et al., 1996) and general populations.

Because biomonitoring of pyrethroid insecticide exposure is relatively new compared to other exposure assessments, epidemiologic studies are just beginning to focus on pyrethroid exposures and any resulting health outcomes.

2.4 Previous studies

Several other organophosphate exposure studies have been initiated that include children and in agricultural communities (Table 2.3). The most common target pesticides are organophosphate pesticides. Most of studies try to finding the pesticides concentration in several environment samples. The studies reviewed here have provided some new understanding into the extent of organophosphate pesticide exposure in agricultural community. It seems clear that people who live near treated farmland or children with parents working in agriculture can have higher exposure than other people in the same community. In addition, according to all reviewed studies, exposure pathways for these people and children in agricultural community are farmland proximity and family’s member take-home.

Table 2.3 Summary of studies indirect pesticide exposure in several pathways

References	Study population	Sample media	Pesticides	Results
Simcox et al., 1995	59 households of Farm, Farm-worker and non-farm family	Dust and soil	Organophosphates	Farm and farm-worker's homes had significantly higher of dust concentration than non-farm's homes.
Bradman et al., 1997	11 households of farm-worker and non-farm worker family	Dust and hand wipe	33 different pesticides in dust. 9 different pesticides in hand wipe.	Farm-worker's homes had higher dust concentration of chlorpyrifos and diazinon than non-worker's homes.
Loewenherz et al., 1997	88 children, age >6 years old living with pesticide applicators and reference children	Urine	Organophosphates	Children in pesticide applicators site had significantly higher detected frequencies and DMTP levels in urine than reference children.
Azaroff, 1999	108 households of famer and family living in an agricultural community	Urine	Organophosphates	Farmers and their family who applied organophosphate pesticides were best predictors for urinary OPs metabolites.

References	Study population	Sample media	Pesticides	Results
Lu et al., 2000	Children 9 months to 6 years old living in an agricultural community	Dust, hand wipe and urine	Organophosphates	Average pesticide metabolite concentrations were higher in agricultural children and average house dust OPs concentration was significantly higher in agricultural homes.
Curl et al., 2002	218 households of farm-workers and their children living in an agricultural community	Dust and urine	Organophosphates	Azinphos-methyl concentrations in house dust and OPs metabolite levels in children and adult from same household were significantly associated.
Frenske et al., 2002	Children <6 years old of pesticide applicators in farm and non-farm workers	Dust, urine, hand wipe and surface wipe	Chlorpyrifos and Parathion	Farm-worker's home or close proximility to pesticide treated farmland had higher concentrations in dust.

References	Study population	Sample media	Pesticides	Results
Koch et al., 2002	Children 2-5 years old living in agricultural community	Urine	Organophosphates	No differences in organophosphate urinary metabolite levels were seen due to parental occupational or proximity to fields.
Thompson et al., 2003	Farm workers and children 2-5 years old	Dust and urine	Organophosphates	- Dust samples from farm worker's home had pesticide levels above the limit of quantification and also in urine samples. - Organophosphate urinary metabolite levels in adult and children from same home were significantly associated.
McCauley et al., 2003	Agricultural and references family	Dust	Organophosphates	Agricultural family had significantly association with pesticide residues in house dust.

References	Study population	Sample media	Pesticides	Results
Quandt et al., 2004	Farm workers family with at least one child <7 years old.	Hand and surface wipe	21 pesticides: 8 agricultural pesticides and 13 residential pesticides	Agricultural pesticide exposure was associated with housing close to agricultural fields.
Hogenkamp et al., 2004	Farmer and non-farmer households	Dust	7 pesticides used in flower farming	Farmer's households had higher detecting pesticides than non-farmer's home.
Coronado et al., 2004	Farm workers and their child 2-5 years old living in agricultural community	Dust and urine	Organophosphate	Farm workers were more likely to have detectable levels of Azinphos-methyl in their houses.

2.4.1 Related studies

A study on non-occupational exposures to pesticides for residents of two U.S. cities in 1994 (Whitmore et al.,1994). The objectives of this study were to assess total human exposures to 32 pesticides and pesticide degradation products in the non-occupational environment. This study focused primarily on inhalation exposures. Jacksonville, Florida (USA) and Springfield/Chicopee, Massachusetts (USA) were studied during three seasons: Summer 1986 (Jacksonville only), spring 1987, and winter 1988. Probability samples of 49 to 72 persons participated in individual site/seasons. The primary environmental monitoring consisted of 24-hr indoor, personal, and outdoor air samples analyzed by gas chromatography/mass spectrometry and gas chromatography/electron capture detection. Indoor and personal air concentrations tended to be higher in Jacksonville than in Springfield/Chicopee. Concentrations tended to be highest in summer, lower in spring, and lowest in winter. Indoor and personal air concentrations were generally comparable and were usually much higher than outdoor air concentrations. Inhalation exposure exceeded dietary exposure for cyclodiene termiticides and for pesticides used mainly in the home.

Bouvier et al (2006) conducted a study on Pesticide exposure of non-occupationally exposed subjects compared to some occupational exposure: A French pilot study. This study aimed to assess residential pesticide exposure of non-occupationally exposed adults, and to compare it with occupational exposure of subjects working indoors. Data about non-dietary exposure to different chemical classes of pesticides are scarce, especially in France. Twenty unexposed persons, five gardeners, seven florists and nine veterinary workers living in Paris area were recruited. Nineteen residences, two greenhouses, three florist shops and three veterinary departments were then sampled. Thirty-eight insecticides, herbicides and fungicides were measured in indoor air with an air sampler for 24 h, and on hands by wiping them with iso-propanol-wetted swabs. After extraction, samples were analyzed by gas and high-performance liquid chromatography. Seventeen different pesticides were detected at least once in indoor air and twenty-one on the hands. An average of 4.2 ± 1.7 different pesticides was detected per indoor air sample. The organochlorines lindane, α-endosulfan and α-HCH were the most frequently detected compounds, in 97%, 69% and 38% of the samples, respectively. The organophosphates dichlorvos and fenthion, the carbamate propoxur and the herbicides atrazine and alachlor were detected in more than 20% of the air samples.

Indoor air concentrations were often low, but could reach 200–300 ng/m^3 in residences for atrazine and propoxur. Propoxur levels significantly differed between the air of veterinary places and other places and dieldrin levels between residences and workplaces. There was a greater number of pesticides on hands than in air, with an average of 6.3$\pm$3.3 different pesticides detected per sample, the most frequently detected being malathion, lindane and trifluralin, in more than 60% of the subjects. Maximal levels (up to 1000–3000 ng/hands) were observed either in the general population or in workers, depending on the pesticide.

However, no significant difference was observed between workers and general population hand wipe pesticide levels. As expected, gardeners were exposed to pesticides sprayed in greenhouses. Florists and veterinary workers, whose pesticide exposure had not been described until now, were also indirectly exposed to pesticides used for former pest control operations. Overall, general population was exposed to more various pesticides and at levels sometimes higher than in occupational places.

In 2006, a studied on biological monitoring of organophosphate pesticides in preschool children in an agricultural community in Thailand by Petchuay et al. The study aimed to compare the urinary metabolites in the children living in or near the vegetable-farm area with those children living outside the farm area in the same sub-district. The survey was conducted in a sample of 37 farm children and 17 non-farm children. They found that the levels of dialkylphosphate (DAP) metabolites were measured in first-morning-void urine samples. During the dry season (April–May), the farm children excreted significantly higher levels of all DAP metabolites than the reference children did (Mann–Whitney U test, $p < 0.05$; Wilcoxon signed-rank text, $p < 0.05$). During the wet season (September–October), DAP metabolite levels were similar in the two groups. Reference children showed no significant difference related to season. Pesticide spraying during the dry season is a likely cause of the farm children's organophosphate exposures.

Urinary pesticide metabolites in school students from northern Thailand by Panuwet et al (2009). This study aimed to assess exposure to commonly used pesticides in school children in Chiang Mai Province, northern Thailand. They evaluated exposure to pesticides among secondary school students aged 12–13 years old in ChiangMai Province, Thailand. Pesticide-specific urinary metabolites were used as biomarkers of exposure for a variety of pesticides, including organophosphorus insecticides, synthetic pyrethroid insecticides and selected herbicides. We employed a simple solid-phase extraction with analysis using isotope dilution high-performance liquid chromatography tandem mass spectrometry (HPLC-MS/MS). A total of 207 urine samples from Thai students were analyzed for 18 specific pesticide metabolites. We found 14 metabolites in the urine samples tested; seven of them were detected with a frequency≥17%. The most frequently detected metabolites were 2-[(dimethoxyphosphorothioyl) sulfanyl] succinic acid (malathion dicarboxylic acid), para-nitrophenol (PNP), 3,5,6-trichloro-2-pyridinol (TPCY; metabolite of chlorpyrifos), 2,4-dichlorophenoxyacetic acid (2,4-D), cis- and trans-3-(2,2-dichlorovinyl)-2,2-dimethylcyclopropane- 1-carboxylic acids (c-DCCA and t-DCCA; metabolite of permethrin) and 3-phenoxybenzoic acid (3-PBA; metabolite of pyrethroids).

The students were classified into 4 groups according to their parental occupations: farmers (N=60), merchants and traders (N=39), government and company employees (N=52), and laborers (N=56). Children of farmers had significantly higher urinary concentrations of pyrethroid insecticide metabolites than did other children ($p<0.05$). Similarly, children of agricultural families had significantly higher pyrethroid metabolite concentrations. Males had significantly higher values of PNP (Mann–Whitney test, $p=0.009$); however, no other sex-related differences were observed. Because parental occupation and agricultural activities seemed to have little influence on pesticide levels, dietary sources were the likely contributors to the metabolite levels observe.

Naeher et al., (2010) conducted a study on organophosphorus and pyrethroid insecticide urinary metabolite concentrations in young children living in a southeastern United States city. This study aimed to evaluate young children's exposures to current-use pesticides in their everyday environment. Pesticide metabolites are routinely measured in the urine of children in the United States. They performed a study in a city (Jacksonville, Florida) previously determined to have elevated rates of pesticide use. They enrolled a convenience sample of 203 children ranging in age from 4 to 6 years; their caregivers completed a questionnaire and the children provided a urine sample, which was analyzed for a series of organophosphorus and pyrethroid insecticide metabolites. The questionnaire responses substantiated much higher pesticide use for the study participants as compared to other studies. Urinary metabolite concentrations were approximately an order of magnitude higher than concentrations reported for young children in other studies. Few statistically significant differences (at the $p<0.05$ level) were observed, however, several trends are worth noting. In general, mean urinary pesticide metabolite concentrations were higher for males, Caucasians, and those children living in homes with an indoor pesticide application occurring within the past four weeks. Comparing the urinary pesticide metabolite concentrations in this study to those reported in the NHANES and GerES studies showed that the children living in Jacksonville had substantially higher pyrethroid pesticide exposures than the general populations of the United States and Germany.

CHAPTER III

METHODOLOGY

3.1 Study Design

The study is designed as a cross sectional study. Pesticide exposure in an agricultural community in Hua-Rua sub-district, Muang district, Ubonratchathani province, Thailand will be investigated through administration of questionnaires; environmental sample collection; foot and hand wipe samples; and urine analysis. Data collection was conducted April 2012. Chili season is from October through May and pesticide use on chili crops is the highest during April.

3.2 Study Area

The study area is Hua-Rua Sub-District, Muang District, Ubonratchathani Province, Thailand. There were three chili farms selected as the center to select the households and participants because these farms were growing chili during data collection (Figure 3.1).

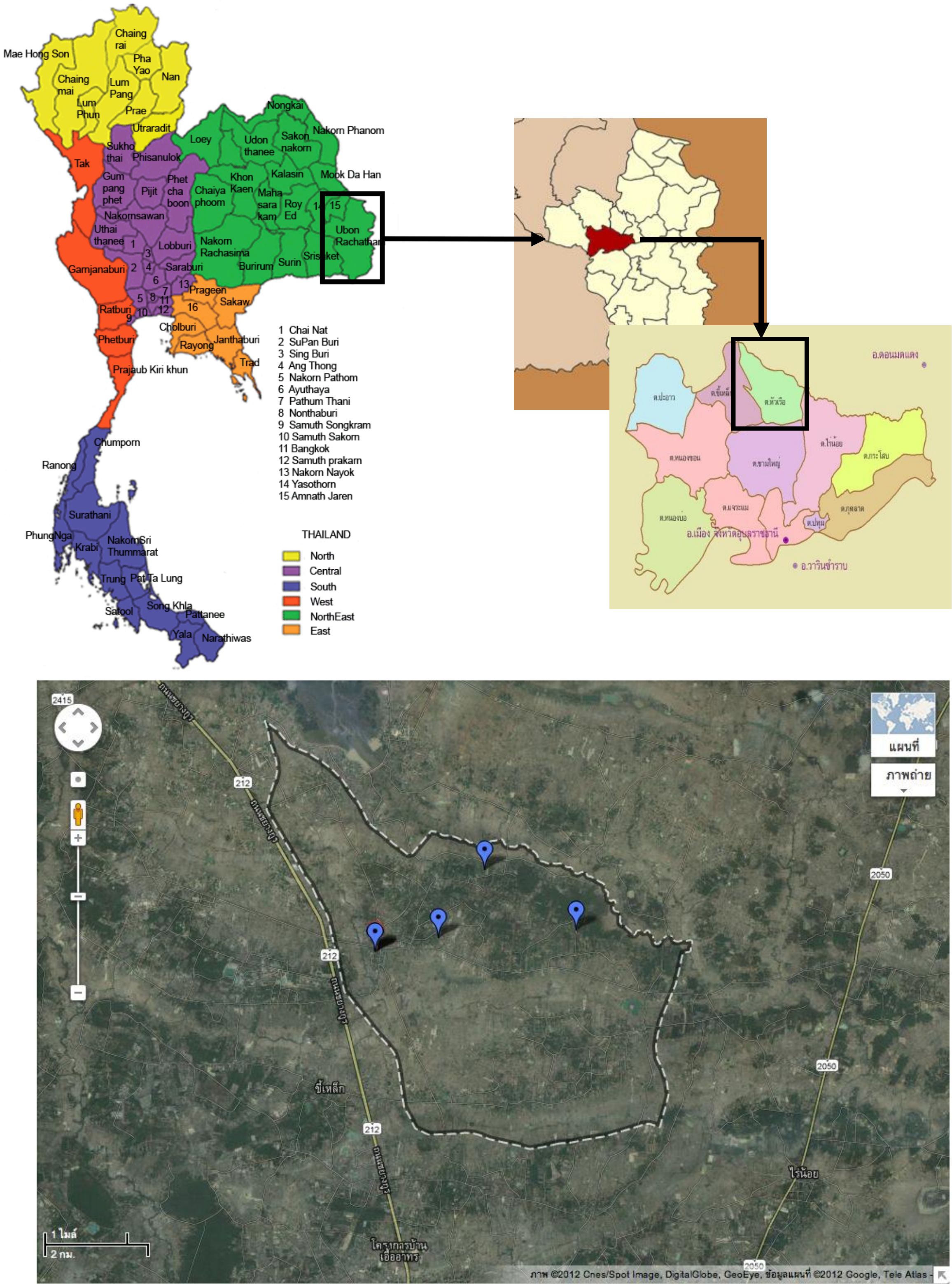


Figure 3.1 The study area is located at Hua-Rua Sub-District, Muang District, Ubonratchathani Province, Thailand.

3.3 Study population

108 participated in this study. All study participants lived in Hua-Rua sub-district, Muang district, Ubonratchathani province, Thailand for more than 1 year.

The participants in this study were separated into three groups:

1. Preschool children (2-5 years of age)
2. Working age (15-59 years of age)
3. Elderly people (greater than 60 years of age)

<u>Non-occupational family (non-farm family) group</u>

Inclusion criteria:

- The housing locations where outside the farm in the agricultural community, Hua-Rua sub-district, Muang district, Ubonratchathani province, Thailand.
- Have at least one child or working age or elderly family member.
- Have to be on land that is not used for farming.
- Nobody in the household is working in agriculture or commercial pesticide application.
- Healthy children 2-5 years of age who have no desirable health diseases.
- Healthy working age people 15-59 years of age who have no desirable health diseases.
- Healthy elderly people greater than 60 years of age who have no desirable health diseases.
- Males and females are included.

Exclusion criteria:

- Live outside the study area.
- One of their family members are a farmer or working in agriculture or commercial pesticide application.
- Unwilling to give urine or environment samples.

Occupational family (Farm family) group

Inclusion criteria:

- Homes are located in the agricultural community, Hua-Rua sub-district, Muang district, Ubonratchathani province, Thailand.
- Have at least one child or working age or elderly family member.
- Have to reside on the land used for chili farming.
- One member of the household is a chili farmer.
- Healthy children 2-5 years of age who have no desirable health diseases.
- Healthy working age people 15-59 years of age who have no desirable health diseases.
- Healthy elderly people greater than 60 years of age who have no desirable health diseases.
- Males and females are included.

Exclusion criteria:

- Live outside the study area.
- Nobody in the household is working in agriculture or commercial pesticide application.
- Unwilling to give urine or environment samples.

All participants were screened by primary health care in this area (Tambon Hua-Rua Health Promoting Hospital) for desirable health diseases which include:

- Pestilence or chronic disease.
- Drug addiction.
- Alcoholism.
- Mental disorder.

3.4 Sample size

Sample size calculation based on the main objective of the study to determine the urinary metabolite concentration. The participants in this study were divided into 2 independent groups. To conduct the number of subject, the size of difference urine metabolite concentrations (d) and SD of difference (σ) were used to calculate the sample size.

According to previous study (Petchuay et al., 2006), the mean and standard deviation of urinary metabolite concentration in agricultural area and non-agricultural area was used to calculate sample size.

The formula to calculate sample size;

$$n = \frac{2(Z_{\alpha/2} + Z_{\beta})^2\sigma^2}{d^2}$$

Where:

n	= Sample size
α	= 0.05
β	= 0.1 (statistical power 90%)
σ	= Standard deviation
d	= Difference in mean of urinary metabolite concentration

STATA (version10.1) is used to calculate sample size for two-sample comparison of means. The result showed below;

Alpha = 0.05 (two-sided)

Beta = 0.1 (statistical power = 90%)

Group	Mean	SD
1	2.14	2.5
2	0.85	1.5

Note:

Group 1 : Children in agricultural area.

Group 2 : Children in non-agricultural area.

From STATA, estimated required sample size was;

Power of 90%, n/group = 54

In this study was test of difference in agricultural family and non-agricultural family similar to the previous study and data of urinary metabolite concentration from the previous study was used to calculate sample size. Sample sizes can be calculated to detect the difference mean between two groups for perform estimation in the sample size determination.

Therefore, the number of house should be 54 samples per group (non-occupational family/farm family).

3.5 Household Selection

Purposive sampling, a nonprobability sampling method, was used to select the households for this study since it is known that chili farmers use high concentrations of pesticides during the month of April. Household selection was based on residence location to the chili farm. Occupational families reside on the farms. Non-occupational families lived within in a 100 m radius from the chili farms and were divided into three levels (Figure 3.2):

Level 1: Reside less than 50 m from chili farm.

Level 2: Reside 50-100 m from chili farm.

Level 3: Reside 101-150 m from chili farm.

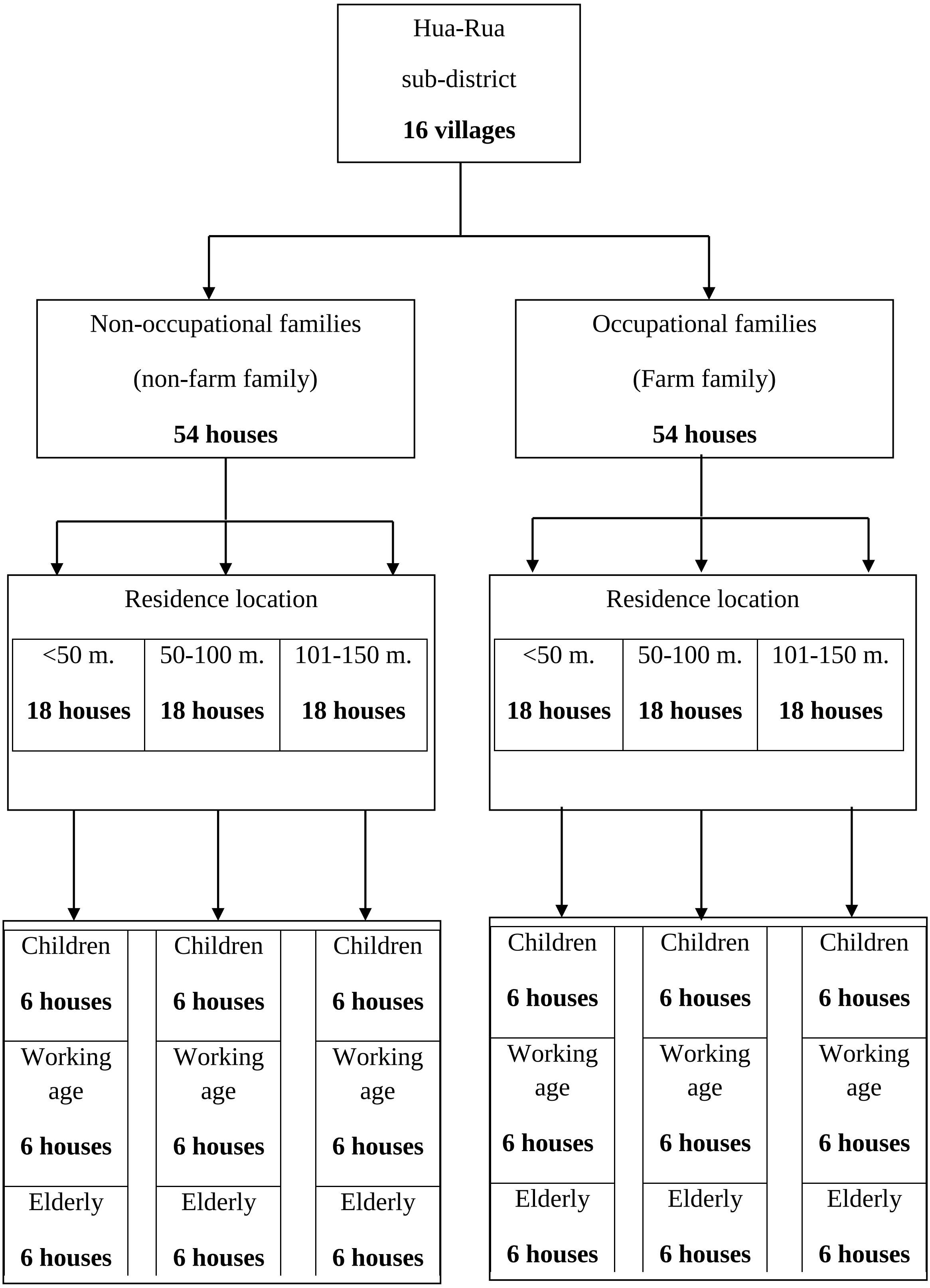


Figure 3.2 Household selection

3.6 Measurement Tools

3.6.1 Questionnaire

The questionnaires were administered in person and consisted of 2 parts:

Part 1: Demographics

Basic demographic information such as gender, age, weight and height, occupation, household income, household location, and house characteristics were collected.

Part 2: Exposure information

Exposure information included questions regarding activities associated with pesticide exposure in the home and at work. For farm family group will add the questions about personal protective equipment use. Parents will be asked to complete the questionnaire for children in their household (Appendix A).

3.6.2 Environmental samples

3.6.2.1 Air sample

NIOSH 5600 air sampling methods were followed for this study (Appendix B). The 24 h air samples were collected from the household common area using OSHA Versatile sampler (OVS-2) sorbent tubes, containing XAD-2 resin with 13 mm quartz. Pumps were set and calibrated according to NIOSH methods.

All samples were transported in ice from the field. Samples were solvent extracted and analyzed by gas chromatography with flame photo detector (GC/FPD) for the applied target pesticide group.

3.6.2.2 Drinking water

Approximately 1 liter of water was collected from each unique drinking water source. Drinking water samples were collected first thing in the morning after overnight stagnation (8-10 h). Drinking water sample collection procedures were adopted from US EPA Sampling Guidance for Unknown Contaminants in Drinking Water (2008).

3.6.2.3 Surface residues

Surface residue samples were collected from the study participant's entire house. The aluminum template (114 $inch^2$) was placed in the household common area. Before wiping within the template, the gauze was soaked with 40% isopropanol (IPA). The wipe composite samples cleaned aluminum foil, were placed in plastic bags and stored in an insulated ice box. The wipe samples were kept at 10^oC until analysis. This floor wiping method is modified from Stout II et al., (2009) method.

3.6.3 Personal samples

3.6.3.1 Hand wipe

Gauze pads were moistened with 40% IPA and used to wipe hands for the presence of pesticide residues. One gauze pad was used to wipe each hand; one side for the palm and the back of the hand and the other side for each finger and area between the fingers. The wipe samples were transferred to zip-lock plastic bags and were transported to the laboratory in an ice box. The wipe samples were kept at 10^oC until analysis.

3.6.3.2 Foot wipe

Gauze pads were moistened with 40% IPA and used to wipe feet for the presence of pesticide residues. One gauze pad was used to wipe each foot; one side for bottom and top of the foot and the other side for each toe and area between the toes. The wipe samples were transferred to zip-lock plastic bags and were transported to the laboratory in an ice box. The wipe samples were kept at 10^oC until analysis. Curwin et al., (2006) methods for wipe samples were followed.

3.6.3.3 Urine

First morning void urine samples were collected from each participant. Parents were provided with one polyethylene urine collection bottle and instructed to collect the urine samples for children in their household. Urine samples were collected in 50 mL polyethylene bottles with screw cap and placed in a zip-lock plastic bag and kept in a refrigerator until the samples were transported in dry ice to the laboratory were the samples were stored at -20^{o}C until analysis. This urine sampling method was obtained from Panuwet et al. (2009).

3.7 Sample Collection

Data collection was done by the researcher along with trained researcher assistants. All research assistances were trained in administering the questionnaires and in environmental sample collection, which were all demonstrated by the researcher.

3.7.1 Sampling period

Administration of questionnaires and environmental sampling were all conducted during April of 2012, when pesticide concentrations are the highest during chili season.

3.7.2 Questionnaire

The questionnaire was administered to each participant on the first household visit. Part 1 collected basic demographic information including gender, age, weight and height, occupation of household members, household income, household location, indoor pesticide use, house characteristics, house cleaning period and method. Part 2 collected exposure information and included questions regarding activities associated with pesticide exposure in the home and at work. For farm family group will add the questions about personal protective equipment use.

3.7.3 Environmental samples

3.7.3.1 Air samples

Air samples were prepared using NIOSH method 5600 (NIOSH, 1994). Appendix C shows the NIOSH 5600 method. Air collection was started on the first visit. The 24 h air samples were collected from the common area and finished on the second visit. All samples were transport from the field in the ice box and transfer to a freezer. The sampler was stability at least 10 days at 25ºC and at least 30 days at 0ºC.

3.7.3.2 Drinking water

Water samples were collect on the second visit. A water sample was collected an approximately 1 liter from each unique drinking water source. Drinking water samples were collected the first liter in the morning after overnight stagnation (8-10 h) was sample. All samples were transport from the field in the ice box to laboratory.

3.7.3.3 Surface residues

Surface residues were collected participant's entire house on the second visit. Samples were select from common area. The aluminum template (114 in^2) was place in area that they stay in most of the time. The wipe was soaked with 40% isopropanol (IPA) before wiping within the template. The wipe samples were composite in cleaned aluminum foil, put in plastic bag and store in insulated ice box and keep in refrigerator at 10 ^oC until analysis.

3.7.3.4 Hand and foot wipe

All samples were collected on the second visit from each participant. Hand and foot were be wiped for the presence of pesticide residues using the gauze pads moistened with 40% isopropanol (IPA). Each hand/foot was used 1 pad; one side for palm and back of the foot, other side was used to wipe each finger and area between the fingers. Wipe samples were transferred to zip-lock plastic bag and store in ice box and transport to laboratory and keep in refrigerator at 10 ^oC until analysis.

3.7.3.5 Urine

All participants were explained the urine collection instructors prior to the urine collection. During the first visit, the participant was given a urine sample container. The participant was asked to collect the urine sample in the morning on the second visit. First morning void urine samples were collected from each participant. Urine samples were collect in 50 mL polyethylene bottle with screw cap and put in zip-lock plastic bag and kept in refrigerator until it was pick up and transport on dry ice to the laboratory and keep in ice box during transportation and store at -20 ^oC in freezer until analysis.

Children: The parent were provided with one polyethylene urine collection bottle and instructed to collect the urine samples.

Table 3.1 Sample collection period

Day 1	**Day2**	
10:00 AM	Early morning	10:00 AM
- Provide urine sample container - Questionnaire	- Urine sample collection	- Drinking water collection - Wipe samples collection (hand, foot and surface)
Air samples: 24 hours →		

3.8 Sample analysis

All environmental samples (air, drinking water and surface wipe samples) and dermal wipe samples (hands and feet wipe samples) were sent to Central laboratory (Thailand) Co., Ltd. in Khon-Kaen district for analysis. Biological samples (urinary metabolite) were analyzed by researchers at the Environment and Health Research Unit (ERU), Research Institute for Health Sciences (RIHES), Chiang Mai University.

Urinary metabolite analysis

Urine samples from each participant were analyzed for pesticide metabolites. This study focused on organophosphate pesticides due to its high usage in this study area. Table 3.1 contains a list of urinary metabolites that are measured for in this study.

Table 3.2 Metabolites and their parent compounds

Pesticides	Metabolite common name	Abbreviation	Parental compounds
Organophosphate insecticides	Dimethylphosphate	DMP	
	Dimethylthiophosphate	DMTP	Dimethyl-substituted
	Dimethyldithiophosphate	DMDTP	Organophosphate insecticides
	Diethylphosphate	DEP	
	Diethylthiophosphate	DETP	Diethyl-substituted
	Diethyldithiophosphate	DEDTP	Organophosphate insecticides

The six common dialkylphosphate (DAP) metabolites of OP insecticides will be measured including dimethylphosphate (DMP), diethylphosphate(DEP), dimethylthiophosphate (DMTP), dimethyldithiophosphate (DMDTP), diethylthiophosphate (DETP), and diethyldithiophosphate (DEDTP). Gas chromatography (GC) was used for urine analysis and was equipped with a flame photometric detector (GC-FPD) (Petchuay et al., 2006). Methods for dialkylphosphate (DAP) metabolite analysis were adopted from Hardt (2000) and Petchuay (2006).

3.8.1 Sample Analysis Procedures

Gauze patch analysis (Sample preparation) (Central laboratory (Thailand) Co.,Ltd.)

Weight Sample 1 g

↓ + DI water 10 ml
+ NaCl 5 g
+ Acetonitrile (HPLC) 10 ml
+ Magnesium Sulfate

Vortex Mixed 2 minutes, Centrifuge 10 minutes at 3000 rpm, 5ºC

↓

Transfer supernatant 5 ml to new test tube

↓

Dry by N_2 evaporator to less than 1 ml

↓

Adjusted volume to 1 ml

↓ + Magnesium Sulfate ½ tea spoon
+ PSA Bowded Silica 1 tea spoon

Vortex Mixed 1 minute, Centrifuge 3 minutes at 3000 rpm, 5ºC

↓

Pass solvent to Syring filter Nylon 0.2 µm

↓

GC-µECD / GC-FPD

Drinking water analysis (Sample preparation) (Central laboratory (Thailand) Co.,Ltd.)

Water sample 500 ml

↓ + NaCl 20 g in Separation funnel

Extraction by CH_2Cl_2; 100: 50: 50 ml (3 times)

↓

Pass solvent through $NaSO_4$ anhydrous into 250 ml round bottom (3 times)

↓

Dry the residue by Rotary Evaporator (Dichloromethane Program; at 40 ºC)

↓

Adjusted volume by ethyl acetate (AR grade) 5 ml

↓

GC-FPD

Air sample analysis (Sample Preparation) (Central laboratory (Thailand) Co.,Ltd.)

Added Toluene: Acetone (9:1, v/v) 20ml to air sampler

↓

Evaporated solvent by evaporator rotary (Acetone Program; 65ºC)

↓

Adjusted volume to 1 ml by Ethyl acetate

↓

GC-FPD

Urinary analysis (Sample preparation) (Hardt., 2000)

NaCl 2 g + Urine 5 ml

+ Internal Standard

(DBP; Conc 1.25 ppm) 50µl

+ HCL (6mol/L) 1 ml

Extraction by Ethyl acetate: Acetone (1:1, v/v) 5ml (2 times)

- Shake 5 mines
- Centrifuge 5 mines at 2000 rpm

Organic Solvent

+ K_2CO_3 20 mg

Evaporated to 0.5 ml

+ Acetonitrile 2 ml

Evaporated to dry

Dry residue

+ K_2CO_3 20 mg

+ Acetonitrile 3 ml

+ PFBBr 50 µl

Derivertization at 50 ºC, 15 hours

+ H_2O 4 ml

+ Hexane 2 x 5 ml

Liquid-Liquid Extraction

- Shake 5 mines
- Centrifuge 5 mines at 2000 rpm

Organic Solvent

- Dry by N_2
- Added Toluene 200 µl

GC-FPD

Gas Chromatography (GC) condition for analysis

GC-FPD

Model:	Agilent Technology, 6890N, Made in USA		
Inlet:	Inject	2 µl	
	Temperature	200 ºC	
	Pressure	26 psi	
	Gas Type	Nitrogen	
Oven:	Initial temperature	80 ºC	
	Rate (ºC/min)	Final temp (ºC)	Time (min)
	12	195	0
	2	210	7
	15	225	10
	35	275	13
	Runtime	50.51 mines	
Column:	Capillary column		
	Model number: Agilent DB-1701 (30m x 0.248 mm x 0.25 µm particle size)		
	Flow: 2.6 ml/min		
Detector:	Flame Photometric Detector (FPD)		
	Temperature: 220 ºC		

GC-µECD

Model:	Agilent Technology, 6890N, Made in USA		
Inlet:	Inject	2 µl	
	Temperature	210 ºC	
	Pressure	14 psi	
	Gas Type	Nitrogen	
Oven:	Initial temperature	80 ºC	
	Rate (ºC/min)	Final temp (ºC)	Time (min)
	20	190	10
	3	215	3
	10	250	5
	20	280	10
	Runtime	47.83 mines	
Column:	Capillary column		
	Model number: Agilent 19091J-413 HP5		
	Flow: 3.1 ml/min		
Detector:	Micro-Electron Capture Detector (µECD)		
	Temperature: 320 ºC		

3.9 Quality Control

AOAC Peer Verified Methods Program (1993) recommends that the laboratory will be assessed the analytical chemical technique to document method validation. The standard laboratory in Center laboratory of Thailand in Khonkaen district was used to control inter and intra observer variation for analyzing residue of pesticide. For biological monitoring (urinary metabolites), all samples were prepared by the researcher to reach the standard quality control at Laboratory.

Limit of Detection (LOD) and Limit of Quantitation (LOQ)

The limit of detection (LOD) is the lowest concentration level that can be determined to be statistically different from a blank (99% confidence). The limit of quantitation (LOQ) is the level above which quantitative results may be obtained with a specified degree of confidence.

Method Detection Limit (MDL)

The method detection limit is the minimum concentration of a substance that can be measured and reported with 95% confidence that the analyze concentration is greater than zero.

Assessment of method precision

Relative Standard Deviation (RSD) or coefficient of variation (CV) used to estimate the precision for multiple samples. The precision acceptance criterion depends on the type of analysis. The precision in environmental analysis depends on the sample matrix, the concentration of analyze and the analysis technique. It can vary between 2% and more than 20%.

Assessment of method accuracy

To access the method of accuracy is calculate by percent of recovery from analysis of reference materials, or laboratory control samples (Siriwong, 2006).

3.10 Ethical considerations

This study was approved by The Ethic Review Committee for Research Involving Human Research Subjects, Health Science Group, Chulalongkorn University. With the certified code No. 054/2555 (Date of approval: 4 April 2012), all participants signed a consent form prior to participation in this study. Informed consent for parents and children about the study protocols. Parents were signed in consent form. The code name was used to protect the subject privacy and the data was kept in confidential.

CHAPTER IV

RESULT

This was a cross sectional study conducted in a chili farm community in Hua-Rua sub-district, Muang district, Ubonratchathani province, Thailand.

The study population was focused on individuals living in agricultural communities. The study included 108 households. Fifty-four were occupational households: children 18 houses, working age 18 houses, elder 18 houses and 54 non-occupational households: children 18 houses, working age 18 houses, elder 18 houses were recruited to participate. Participants were selected by purposive sampling technique for selecting each household from chili farm community.

4.1 Questionnaires information

In this part, a face to face questionnaire was completed through 108 households (54 occupational households and 54 non-occupational households). The questionnaire consisted of 2 parts; 1.)General information; general information for each participant such as gender, age, weight and height, information regarding occupational / parent's occupational, family income, household location, indoor pesticide used, house characteristics, house cleaning period and method. 2.) Exposure information the activities associated with pesticide exposure. The questions based on exposure data for used to calculate average daily dose and assess the risk. For average daily dose calculation were gathered 3 routes of pesticide exposure including inhalation, dermal contact and ingestion. For farm family group were add the questions about personal protective equipment use. For children, parents were asked to complete questionnaires. The data collected was completed the information by face to face technique in first home visited during April, 2012.

4.1.1 Household insecticide uses in chili farm community[1]

This part was to determine household insecticides use and frequency of use among people living in chili farm community, total 108 households. Table 4.1 showed the participant age ranged from 19 to 84 years. The average age (±SD) was 53.0(±12.3) years. The majority of the respondents were in the range of 41 to 50 (27.6%) and 61 to 70 years (27.0%), while of 24.1% were in range of 51 to 60 years and of 13.9% were in range of 31 to 40 years, and 5.5% of remaining were older than 70 years.

The majority of the participants were female (52.8%) and 47.2% were male, 80.6% of respondents graduated from primary school and 18.5% of them graduated from secondary school. About half of respondents (52.7%) had an income less than 5,000 baht per month, of 33.4% had an income 5,001-10,000 baht per month, and 13.8% had an income more than 10,000 baht per month. Approximately, 49.1% of the respondents were employees, of 24.1% were farmers, of 13.0% were local business owners such as local food shop or grocery shop, and 11.1% of them were unemployed. Table 4.1 demonstrates the general profile and socio-demographic characteristics of sampling population.

---

[1] *Parts of this contents were published in Norkaew, S., Taneepanichskul, N., Siriwong, W., Siripattanakul, S. and Robson, M. 2012. HOUSEHOLD PESTICIDE USE IN AGRICULTURAL COMMUNITY, NORTHEASTERN, THAILAND. Journal of Medicine and Medical Sciences. 3(10): 631-637.*

Table 4.1 Socio-demographic characteristics of the respondents (n=108)

Characteristics	**Number (n=108)**	**Percentage (%)**
Gender		
Male	51	47.2
Female	57	52.8
Age		
<30	2	1.9
31-40	15	13.9
41-50	30	27.6
51-60	26	24.1
61-70	29	27
71-80	4	3.7
>80	2	1.8
Mean$\pm$ SD = 53.0$\pm$ 12.3 Range = 19 to 84		
Education		
Never	1	0.9
Primary school	87	80.6
Secondary school	20	18.5

Characteristics	Number (n=108)	Percentage (%)
Income (Baht/month)		
< 5,000	57	52.7
5,001-10,000	36	33.4
10,001-15,000	15	13.8
Occupation		
Unemployed	12	11.1
Local business	14	13.0
Employee	53	49.1
Farmer	26	24.1
Others	3	2.8

For household insecticide use (table 4.2), 73.1% of the participants reported using household insecticides. Most of them (70.9%) used pesticides bottled sprays, some of them (26.6%) used mosquito coils, and few of them (2.5%) used insecticides chalk (also known as miraculous chalk) for pest control in their house such as ants and small insect. Mosquitoes were the most pests reported (63.3%), followed by cockroaches (22.8%) and ants (13.9%). About 82.3% of the household insecticide users reported using pesticide 1-2 times per week, 15.2% of them used 3-4 times per week. Most of them (36.7%) used pesticide latest during1-2 weeks ago, 29.1% of the users used the latest during 3-4 weeks ago, 25.3% of them used the latest within a week and few of them (8.9%) used the latest over 4 weeks. Of 66.7% the respondents reported that after each pesticides spraying mostly in the daytime, they stayed for their house activities outside house around their common area during the day, but 28.7% of them stayed in their bed room and 4.6% stayed inside common area.

About the frequency of house's cleaning, it was found that in that 45.4% of the respondents generally cleaned their house 1-2 times per week, 44.4% of them cleaned 3-4 times per week, and 10.2% of them cleaned over 5 times per week. Most of participants (53.7%) reported the cleaning ways that they (36.1%) sweep their house and follow with wet mop. And 6.5% of them combined wet mop with detergent but the remaining (3.7%) used only dry mop.

Table 4.2 Household insecticides and their application (n=108)

Information	**Number (n=108)**	**Percentage (%)**
Household insecticide uses		
Yes	79	73.1
No	29	26.9
Pests in home		
Mosquitoes	50	63.3
Cockroaches	18	22.8
Ants	11	13.9
Type of household insecticides application		
Spray	56	70.9
Coil	21	26.6
Others	2	2.5
Frequency of household pesticide usage (time(s)/week)		
1-2	65	82.3
3-4	12	15.2
>5	2	2.5

Information	Number (n=108)	Percentage (%)
Latest household insecticides use		
<1 week	20	25.3
1–2 weeks	29	36.7
3-4 weeks	23	29.1
>4 weeks	7	8.9
Family area during pesticides application during day		
Bed room	31	28.7
In house common area	5	4.6
Outside common area	72	66.7
Frequency of cleaning house (time(s)/week)		
1-2	49	45.4
3-4	48	44.4
>5	11	10.2
House cleaning method.		
Sweep	58	53.7
Dry mop	4	3.7
Wet mop	39	36.1
Wet mop with detergent	7	6.5

Among the 79 respondents indicated that they used pesticides in their house in which the products were mostly found such as spray, mosquito coil, and insecticide chalk (in Table 4.3). The product and brand names were identified using questionnaire and interviewer observation in the household. All household insecticide products in this area contain pyrethroids, for example in sprays; the active ingredients are esbiothrin, d-tetramethrin, cypermethrin, prallethrin, imiprothrin and permethrin. Mosquito coils were also commonly used and the active ingredients are esbiothrin and d-allethrin. However, insecticide chalk was not much used as sprays and coils in which the active ingredient was deltamethrin.

In figure 4.1 shows type of household insecticide used applications that respondents usually used in study area and categorize by product brands. The spray brand 1 ingredients are esbiothrin, imiprothrin, and permethrin, the spray brand 2 contains cypermethrin, prallethrin, and imiprothrin, and the sprays brand 3 contains d-tetramethrin, cypermethrin, and permethrin. Most respondents reported that about 26.6% of respondents used the spray brand 3 (26.6%), 22.8% of the used the spray brand 2, and the remaining 21.5% used the spray brand 1.

For mosquito coil, there are 3 popular products use in this area. The ingredient of mosquito coil brand 1 is esbiothrin, and same ingredient of brand 2 and brand 3 is d-allethrin. Of 13.9% the respondents used mosquito coil brand 3, 10.2% used mosquito coil brand 1, and few of them (2.5%) used mosquito coil brand 2. For insecticide chalk, the respondents reported used only one product contains deltamethrin, and only 2.5% of them used it as household insecticides.

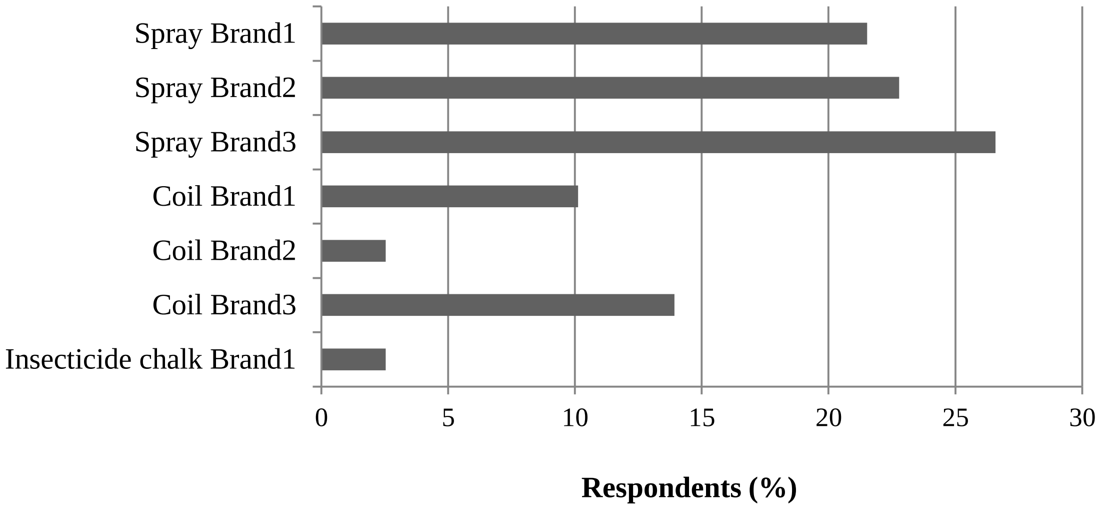


Figure 4.1 Typical type of pesticides used in household

Table 4.3 Active ingredients of household insecticides used in study area

Household insecticide Type	Active ingredients (%, W/W)							
	Esbiothrin	d-Allethrin	d-Tetramethrin	Deltamethrin	Cypermethrin	Prallethrin	Imiprothrin	Permethrin
Spray Brand1	0.11						0.06	0.06
Spray Brand2					0.1	0.03	0.03	
Spray Brand3			0.11		0.16			0.255
Coil Brand1	0.1							
Coil Brand2		0.225						
Coil Brand3		0.2						
Insecticide chalk Brand1				0.11				

In term of comparable of educational level and pest in home, Chi-square test and was applied. Type of household insecticides application and frequency of household insecticide usage of both groups were comparable in term of statistical.

Cross comparisons between educational level and type of household insecticides application and frequency of household insecticide usage were not comparable (Pearson Chi-square test, *p-value*= 0.010and 0.002, respectively). In addition, household insecticide users reported that insecticides as household insects control. Thus, the comparable of pests in home and type of household insecticides application, and frequency of household insecticide usage were applied and found that there were not comparable (Pearson Chi-square test, *p-value* <0.001) as show in table 4.4.

Table 4.4 Association among education, pests in home and household insecticide uses

Variables	***p-value***
Educational level & Type of household insecticides application[1]	0.010
Educational level & Frequency of household insecticide usage[2]	0.002
Pests in home & Type of household insecticides application[1]	<0.001
Pests in home & Frequency of household insecticide usage[2]	<0.001

(1) Type of household insecticides application; (Not use, Spray, Coil/Others)

(2) Frequency of household insecticide usage; (0, 1-2, >2)

4.1.2 Pesticide and personal protective equipment (PPE) use information: Occupational family.

Table 4.5 illustrates the respondents had duration of pesticide application 60 to 90 minutes per time (53.8%). Most of respondents reported that they sprayed pesticide 2 times per day (65.4%) and more than half of them sprayed pesticide 3 to 4 days per week (57.7%). Less than 50% of respondents wore gloves but most of them usually wore mask (57.7%) and boot (76.9%).

Table 4.5 Pesticide and PPE use of farmer in farm family

Characteristics	Number (n=26)	Percentage (%)
Duration of application/ time (minutes)		
<60	6	23.1
60-90	14	53.8
>90	6	23.1
Mean± SD = 75.0± 30.3 Range = 30 to 120		
Frequency of spraying pesticide (time(s)/day)		
1	9	34.6
2	17	65.4
Frequency of spraying pesticide (day(s)/week)		
2-3	15	57.7
4-5	11	42.3

Characteristics	Number (n=26)	Percentage (%)
Personal protective equipment (PPE)use		
Gloves		
Usually	11	42.3
Sometimes	15	57.7
Mask		
Usually	15	57.7
Sometimes	11	42.3
Boots		
Usually	20	76.9
Sometimes	6	23.1

4.2 Residential Pesticide Contamination

A total of 108 households (54 non-occupational families and 54 occupational families) were enrolled in a study investigating residential pesticide contamination. Air, drinking water and surface residues samples were collected from each house.

Study house selection was depend on the residence location and separate to 3 levels.

Level 1: far from the agricultural farm less than 50 m.

- Non-occupational family 18 houses: children 6 houses, working age 6 houses, elder 6 houses.
- Occupational family 18 houses: children 6 houses, working age 6 houses, elder 6 houses.

Level 2: far from the agricultural farm 50-100 m.

- Non-occupational family 18 houses: children 6 houses, working age 6 houses, elder 6 houses.
- Occupational family 18 houses: children 6 houses, working age 6 houses, elder 6 houses.

Level 3: far from the agricultural farm 101-150 m.

- Non-occupational family 18 houses: children 6 houses, working age 6 houses, elder 6 houses.
- Occupational family 18 houses: children 6 houses, working age 6 houses, elder 6 houses.

4.2.1 Environmental samples[2]

Air, drinking water, wipe (surface residue, hand and foot) samples were analyzed by Central laboratory (Thailand) Co.,Ltd.

All samples were analyzed for organophosphate pesticides and pyrethroid insecticides. Organophosphate pesticides (chlorpyrifos) were detected in 24 air samples (22.2%). All of drinking water samples were not detected all pesticides. Approximately 21.3% of surface wipe samples were detected organophosphate pesticides (chlorpyrifos and pirimiphos-methyl) and more than half of surface wipe samples (56.5%) were detected pyrethroid insecticides (permethrin and cypermethrin). All of hands wipe and foot wipe samples were not detected organophosphate pesticides but 22.2% of hand wipe samples were detected permethrin and cypermethrin and 13.9% of foot wipe samples were detected permethin.

In level 1: chlorpyfifos were detected in air samples, 4.6% of non-occupational households and 10.2% of occupational households and 5.6% of surface wipe samples in non-occupational households and 15.7% of surface wipe samples in occupational households were detected organophosphate pesticides. All surface wipe samples in level 2 and 3 were below the LOD for organophosphate pesticides. Although in air samples of level 2 were detected chlorpyrifos in both of non-occupational (2.8%) and occupational (3.7%) households. Most of air samples in level 3 were below the LOD, only 1 (0.9%) of occupational house was detected chlorpyrifos.

---

[2]Parts of this contents were published in Norkaew, S., Taneepanichskul, N., Siriwong, W.,Siripattanakul,S. and Robson, M. 2012.INDIRECT EXPOSURE OF FARM AND NON-FARM FAMILY IN AGRICULTURAL COMMUNITY, UBONRATCHATHANI PROVINCE, THAILAND. Journal of Health Research.27(2).

A majority of surface wipe samples were detected in level 1, 14.8% of non-occupational houses and (10.2%) of occupational houses. As level 1, surface wipe samples in non-occupational houses were detected more than occupational houses but in level 3 the detection frequency of surface wipe samples were equally in both of non-occupational and occupational households. 8.3% of hand wipe samples were detected in non-occupational houses and 3.7% of occupational houses in level 1. In level 2, only 3.7% of non-occupational and 2.8% of occupational houses were detected pyrethroid insecticides. Houses located in level 3 were rarely detected in hand and foot wipe samples.

4.2.1.1 Air samples

A total of 108 households enrolled, 54 occupational households and 54 non-occupational households. Approximately 77.8% of air samples were below the LOD for organophosphate pesticides and all air samples were below the LOD for pyrethroid insecticides tested. Of the 25 air samples (23.1%), chlorpyrifos was detected in air samples taken from 16 occupational houses and 9 non-occupational houses. Cross comparisons of air samples concentration were completed among household of occupational family and non-occupational family. There were no significantly differences of detection frequencies between occupational and non-occupational households (Chi-square test, p=0.247).

Table 4.6 showed the detected frequency and average concentration of OPs in air samples with concentration range 0.001-0.002 $mg/m^3$and with an average concentration$1.28x10^{-3}$ mg/m^3 in occupational houses and $1.15x10^{-3}$ mg/m^3 in non-occupational houses. The concentrations in occupational family were higher than non-occupational family and houses in level 1 had high concentration than level 2 and level 3.

There were no significant differences between non-occupational and occupational households for average concentration of all OPs (Mann-Whitney test, p>0.05). All households were cross compared between house located levels. It was found that all households of level 1 had significantly higher OPs concentration than level 2 and level 3 (Kruskal Wallis test, *p*<0.001), occupational and non-occupational households of level 1 had significantly higher OPs concentration than level 2 and level 3 (Kruskal Wallis test, *p*<0.001 and *p* =0.018 respectively).

Table 4.6 Detected frequency and average concentration of OPs (chlorpyrifos) in air samples.

Pesticides	House type	Number (% Detection)	Concentration (mg/m^3)						
			Mean	GeoMean	Range	25th	50th	75th	95th
Chlorpyrifos*		24 (22.2%)							
	Non-occupational family (n=56)	9 (16.1%)	$1.15x10^{-3}$	$1.11x10^{-3}$	<LOD – 0.002	<LOD	<LOD	<LOD	0.002
	Occupational family (n=56)	15 (26.8%)	$1.28x10^{-3}$	$1.21x10^{-3}$	<LOD – 0.002	<LOD	<LOD	0.002	0.002

Abbreviation: LOD= limit of detection, *LOD= 0.001 mg/m^3

**Samples reported as below LOD were assigned LOD prior to statistical analysis.

4.2.1.2 Drinking water samples

A total of 54 drinking water samples from occupational houses and 54 drinking water samples from non-occupational houses were not detected organophosphate pesticides and pyrethroid insecticides.

4.2.1.3 Surface-wipe samples

Surface wipe samples were collected from each household, total 108 samples. Approximately 11.1% of surface wipe samples were detected chlorpyrifos from 3 non-occupational and 9 occupational households

Cross comparisons of surface wipe samples of OPs and pyrethroid concentration were completed among household of occupational family and non-occupational family. There were no significantly differences of detection frequencies between occupational and non-occupational households (Chi-square test, p=0.123 and p=0.202).

Table 4.7 showed the detected frequency and average concentration of OPs in surface wipe samples with an average concentration 2.89×10^{-2} mg/cm^2 in non-occupational households and 4.67×10^{-2} mg/cm^{2}in occupational households. Of 10.2% of surface wipe samples were detected pirimiphos-methyl with average concentration 2.44×10^{-2}mg/cm^2 in non-occupational households and 3.18×10^{-2} mg/cm^{2}in occupational households. Chlorpyrifos and pirimiphos-methyl were detected in surface wipe samples in both of non-occupational and occupational households located in level 1. Additional, an average concentration in occupational houses were higher than non-occupational houses.

The majority of these samples were detected pyrethroid insecticides (permethrin and cypermethrin). For permethrin, there were no significantly differences of detection frequencies between occupational and non-occupational households (Chi-square test, p=0.576) and cypermethrin, there were significantly different between occupational and non-occupational households (Chi-square test, p=0.026). About half of surface wipe samples (46.3%) were detected permethrin in

25 non-occupational households and 25 occupational households with average concentration 12.4×10^{-2} mg/cm^2, 10.8×10^{-2} mg/cm^2 respectively. 8.4% of surface wipe samples were detected cypermethrin in non-occupation households with average concentration 3.33×10^{-2} mg/cm^2 and 1.8% in occupational households with average concentration 2.29×10^{-2}mg/cm^2.

There were no significant differences between non-occupational and occupational households for average concentration of chlorpyrifos and pirimiphos-methyl (Mann-Whitney test, p=0.067 and p=0.113 respectively). Also, there were no significant differences between non-occupational and occupational households for average concentration of permethrin (Mann-Whitney test, p=0.742) but for cypermethrin had significantly differences between non-occupational and occupational households (Mann-Whitney test, p=0.027). All households were cross compared of OPs and pyrithroid concentration between house located levels. It was found that all households of level1 had significantly higher levels of OPs concentration than level2 and level3 (Kruskal Wallis test, p<0.001). Also, permethrin and cypermethrin concentration of level1 had significantly higher than level2 and level3 (Kruskal Wallis test, p=0.035 and p=0.045 respectively).

For samples reported as below limit of detection (LOD) were assigned LOD prior to statistical analysis;

LOD of chlorpyrifos = 0.02 mg/cm^2

LOD of pirimiphos-methyl = 0.02 mg/cm^2

LOD of permethrin = 0.02 mg/cm^2

LOD of cypermethrin = 0.02 mg/cm^2

Table 4.7 Detected frequency and average concentration of OPs and PY in surface wipe samples

Insecticides	House type	Number (% Detection)	Concentration (mg/cm^2)						
			Mean	GeoMean	Range	25th	50th	75th	95th
Chlorpyrifos		12 (11.1%)							
	Non-occupational family (n=56)	3 (5.36%)	2.89x10^{-2}	2.26x10^{-2}	<LOD – 0.18	<LOD	<LOD	<LOD	0.18
	Occupational family (n=56)	9 (16.1%)	4.67x10^{-2}	2.88x10^{-2}	<LOD – 0.18	<LOD	<LOD	<LOD	0.18
Pirimiphos-methyl		11 (10.2%)							
	Non-occupational family (n=56)	3 (5.36%)	2.44x10^{-2}	2.19x10^{-2}	<LOD – 0.10	<LOD	<LOD	<LOD	0.10
	Occupational family (n=56)	8 (14.3%)	3.18x10^{-2}	2.54x10^{-2}	<LOD – 0.10	<LOD	<LOD	<LOD	0.10
Permethrin		50 (46.3%)							
	Non-occupational family (n=56)	25 (44.6%)	12.4x10^{-2}	5.84x10^{-2}	<LOD – 0.36	<LOD	<LOD	0.29	0.36
	Occupational family (n=56)	25 (44.6%)	10.8x10^{-2}	5.25x10^{-2}	<LOD – 0.36	<LOD	<LOD	0.22	0.36
Cypermethrin		11 (10.2%)							
	Non-occupational family (n=56)	9 (16.1%)	3.33x10^{-2}	2.62x10^{-2}	<LOD – 0.10	<LOD	<LOD	<LOD	0.10
	Occupational family (n=56)	2 (3.57%)	2.29x10^{-2}	2.12x10^{-2}	<LOD – 0.10	<LOD	<LOD	<LOD	0.04

4.2.2 Personal samples

In this part of results hands wipe and foot wipe samples were reported as personal.

4.2.2.1Study Population Characteristics

In this study was separated participants into 3 groups; children, working age group and elderly. The results of each group were divided by family's occupational; farmer and non-farmer family.

4.2.2.1.1Children Characteristics

Table 4.8 showed the information of children from 18 non-occupational households and 18 occupational households, the majority of the participants were male (55.6%) and 44.4% were female the participant age ranged from 2 to 5 years. The average age (±SD) was 3.4 (±0.8) years. In non-occupational family; the majority of their families occupational were employees (61.1%), of 33.3% were local business owner such as local food shop or grocery shop and in occupational family; all of their families occupational were chili farmers (100.0%). All children in this study, most of their parent graduated from primary school (80.6%) and 19.4% of them graduated from secondary school. Table 4.8 concluded the characteristics of children.

Table 4.8 General information of studied children

Characteristics	Household type: Non-Occupational Family (n=18)	Household type: Occupational family (n=18)	Total (n=36)
Gender			
Male	11 (61.1%)	9 (50.0%)	20 (55.6%)
Female	7 (38.9%)	9 (50.0%)	16 (44.4%)
Age (Years)			
2	2 (11.1%)	5 (27.8%)	7 (19.4%)
3	9 (50.0%)	4 (22.2%)	13 (36.1%)
4	6 (33.3%)	7 (38.9%)	13 (36.1%)
5	1 (5.6%)	2 (11.1%)	3 (8.3%)
Mean± SD	3.4 (±0.8)	3.5(±0.9)	3.4 (±0.8)
Range	2 to 5	2 to 5	2 to 5
Weight (kg)			
Mean± SD	15.1 (±3.5)	15.1 (±3.6)	15.1(±3.5)
Range	12 to 25	10 to 25	10 to 25
Height (cm)			
Mean± SD	85.6 (±9.5)	88.2 (±10.3)	86.9 (±9.9)
Range	70 to 108	60 to 100	60 to 108

Characteristics	Household type: Non-Occupational Family (n=18)	Household type: Occupational family (n=18)	Total (n=36)
Family Occupation			
Local business	6 (33.3%)	-	6 (16.7%)
Employee	11 (61.1%)	-	11(30.6%)
Chili farmer	-	18 (100%)	18 (50.0%)
Others	1 (5.6%)	-	1 (2.8%)
Education: Parent's education			
Primary school	16 (88.8%)	13 (72.2%)	29 (80.6%)
Secondary school	2 (11.1%)	5 (27.8%)	7 (19.4%)

Table 4.9 showed the information of house characteristics of studied children, all of studied children were almost having equally chili farm's area that nearest their houses (3.0 rais of occupational family and 3.3 rais of non-occupational family). The average house's area was 100.3 square meters and most of their houses had 2 floors (61.1%).

Table 4.9 House Characteristics of studied children

Characteristics	Household type		Total (n=36)
	Non-Occupational Family (n=18)	Occupational family (n=18)	
Residence located (From farm area: m)			
<10	1 (5.6%)	3 (16.7)	4 (11.1%)
10-30	1 (5.6%)	2 (11.1%)	3 (8.3%)
31-50	4 (22.2%)	1 (5.6%)	5 (13.9%)
51-70	2 (11.1%)	4 (22.2)	6 (16.7%)
71-90	3 (16.7%)	2 (11.1%)	5 (13.9%)
91-100	1 (5.6%)	-	1 (2.8%)
101-130	4 (22.2%)	2 (11.1%)	6 (16.7%)
131-150	2 (11.1%)	4 (22.2%)	6 (16.7%)
Farm area nearest residence (rai(s)*)			
Mean± SD	3.3 (±1.3)	3.0 (±1.0)	3.2 (±1.2)
Range	2 to 5	2 to 5	2 to 5
House characteristics			
House area (m^2)			
Mean± SD	96.7 (±22.8)	103.9 (±20.6)	100.3 (±21.7)
Range	50 to 150	80 to 150	50 to 150

Characteristics	Household type		Total
	Non-Occupational Family (n=18)	Occupational family (n=18)	(n=36)
House floor(s)			
1	6 (33.3%)	8 (44.5%)	14 (38.9%)
2	12(66.6%)	10 (55.5%)	22 (61.1%)

*1rai = 1,600 square meters

Table 4.10 showed the information of exposure in children including their activities that may get expose from pesticides in community. Because children in this study were preschool children, they were not going to school and may stay at home most of the day. The average time that children stay at home were about 22 hours and most of them and their family were stay outside common area during day (97.2%). Most of non-occupational children reported usually wear shoes when going outside their houses (83.3%) and approximately 72.2% of occupational children not always wear shoes when going out. The majority of studied children wash their foot (80.6%) and hands (55.5%) 1 to 2 times per day and more than half of them sometimes suck fingers into mouth. Most of occupational and non-occupation family reported cleaning houses 3 to 4 times per week (58.3%), 55.6% of them used sweep follow by wet mop (33.3%).In past six months, approximately 86.1% of respondents were sometimes had an illness. More than half of them reported source of drinking water in family was underground water (66.7%) and 47.2% of children had 11 to 15 glasses of water per day and 38.9% of them had 5 to 10 glasses of water per day (1 glass~200 ml).

Table 4.10 Exposure Information of studied children

Characteristics	Household type: Non-Occupational Family (n=18)	Household type: Occupational family (n=18)	Total (n=36)
Stay at home (Hour(s)/day)			
Mean± SD	22.3 (±2.2)	21.9 (±2.9)	22.1 (±2.5)
Range	18 to 24	15 to 24	15 to 24
Most house's area usage (per day)			
In house common area	-	1 (5.6%)	1 (2.8%)
Outside common area	18 (100%)	17 (94.4%)	35 (97.2%)
Wear shoes when going outside home			
Never	-	5 (27.8%)	5 (13.9%)
Sometimes	3 (16.7%)	13 (72.2%)	16 (44.4%)
Usually	15 (83.3%)	-	15 (41.7%)
Frequency of foot wash (time(s)/day)			
1-2	14 (77.8%)	15 (83.3%)	29 (80.6%)
3-4	4 (22.2%)	3 (16.7%)	7 (19.4%)

Characteristics	Household type: Non-Occupational Family (n=18)	Household type: Occupational family (n=18)	Total (n=36)
Children's fingers suck into mouth			
Never	2 (11.1%)	3 (16.7%)	5 (13.9%)
Sometimes	11 (61.1%)	11 (61.1%)	22 (61.1%)
Often	5 (27.8%)	4 (22.2%)	9 (25.0%)
Frequency of hands wash (time(s)/day)			
1-2	10 (55.5%)	10 (55.5%)	20 (55.5%)
3-4	8 (44.5%)	8 (44.5%)	16 (44.5%)
Frequency of cleaning house (time(s)/week)			
1-2	-	10 (55.5%)	10 (27.8%)
3-4	13 (72.2%)	8 (44.5%)	21 (58.3%)
>5	5 (27.8%)	-	5 (13.9%)
House cleaning method			
Sweep	11 (61.1%)	9 (50.0%)	20 (55.6%)
Dry mop	2 (11.1%)	-	2 (5.6%)
Wet mop	4 (22.2%)	8 (44.5%)	12 (33.3%)
Wet mop with detergent	1 (5.6%)	1 (5.6%)	2 (5.6%)

Characteristics	Household type		Total
	Non-Occupational Family (n=18)	Occupational family (n=18)	(n=36)
Frequently of illness in the past six months			
Never	3 (16.7%)	2 (11.1%)	5 (13.9%)
Sometimes	15 (83.3%)	16 (88.8%)	31 (86.1%)
Source of drinking water			
Tab water	6 (33.3%)	2 (11.1%)	8 (22.2%)
Underground water	11 (61.1%)	13 (72.2%)	24 (66.7%)
Other	1 (5.6%)	3 (16.7%)	4 (11.1%)
Number of glasses per day			
<5	1 (5.6%)	-	1 (2.8%)
5-10	6 (33.3%)	8 (44.5%)	14 (38.9%)
11-15	9 (50.0%)	8 (44.5%)	17 (47.2%)
>15	2 (11.1%)	2 (11.1%)	4 (11.1%)

4.2.2.1.2 Working age Characteristics

Table 4.11 showed the information of working age group from 18 non-occupational households and 18 occupational households, the majority of the participants were female (63.9%) and 36.1% were male the participant age ranged from 19 to 57 years. The average age (±SD) was 45.8 (±8.6) years. In non-occupational family; the majority of respondents were employees (66.6%), of 16.7% were local business owner and in occupational family, more than half of respondents were employees (55.5%), follow with chili farmers (27.8%) and local business (16.7%).

Most of respondents in occupational family had income less than 5,000 baht per month (66.6%), 27.8% of them had income 5,001-10,000 baht per month, 44.5% of respondents in non-occupational family had family income less than 5,000 baht per month and 5,001-10,000 baht per month. Most of participants graduated from primary school (69.4%) and 30.6% of them graduated from secondary school.

Table 4.11 Characteristics of studied working age group

Characteristics	Household type: Non-Occupational Family (n=18)	Household type: Occupational family (n=18)	Total (n=36)
Gender			
Male	6 (33.3%)	7 (38.9%)	13 (36.1%)
Female	12 (66.6%)	11 (61.1%)	23 (63.9%)
Age (Years)			
15-30	1 (5.6%)	-	1 (2.8%)
31-40	5 (27.8%)	3 (16.7%)	8 (22.2%)
41-50	7 (38.9%)	9 (50.0%)	16 (44.4%)
51-59	5 (27.8%)	6 (33.3%)	11 (30.6%)
Mean± SD	44.3 (±10.3)	47.2 (±6.3)	45.8 (±8.6)
Range	19 to 57	35 to 55	19 to 57
Weight (kg)			
Mean± SD	55.3 (±12.3)	56.6 (±8.7)	56.0 (±10.5)
Range	34 to 85	43 to 75	34 to 85
Height (cm)			
Mean± SD	153.2 (±5.2)	156.8 (±7.1)	155.0 (±6.4)
Range	145 to 165	145 to 167	145 to 167

Characteristics	Household type: Non-Occupational Family (n=18)	Household type: Occupational family (n=18)	Total (n=36)
Family Occupation			
Unemployed	1(5.6%)	-	1 (2.8%)
Local business	3 (16.7%)	3 (16.7%)	6 (16.7%)
Employee	12 (66.6%)	10 (55.5%)	22 (61.1%)
Chili farmer	-	5 (27.8%)	5 (13.9%)
Others	2 (11.1%)	-	2 (5.6%)
Education			
Primary school	12 (66.6%)	13 (72.2%)	25 (69.4%)
Secondary school	6 (33.3%)	5 (27.8%)	11 (30.6%)

Table 4.12 showed the information of house characteristics of studied working age group, all of participants were almost having equally chili farm's area that nearest their houses (3.1rais of occupational family and 3.2rais of non-occupational family). The average house's area was 96.5 square meters and most of their houses had 2 floors (63.9%).

Table 4.12 House Characteristics of studied working age group

Characteristics	Household type		Total (n=36)
	Non-Occupational Family (n=18)	Occupational family (n=18)	
Residence located (From farm area: m)			
<10	4 (22.2%)	4 (22.2%)	8 (22.2%)
10-30	1 (5.6%)	1 (5.6%)	2 (5.6%)
31-50	1 (5.6%)	1 (5.6%)	2 (5.6%)
51-70	4 (22.2%)	1 (5.6%)	5 (13.9%)
71-90	2 (11.1%)	1 (5.6%)	3 (8.3%)
91-100	-	4 (5.6%)	4 (11.1%)
101-130	2 (11.2%)	2 (11.1%)	4 (11.1%)
131-150	4 (22.2%)	4 (22.2%)	8 (22.2%)
Farm area nearest residence (rai(s)*)			
Mean± SD	3.2 (±1.3)	3.1 (±1.3)	3.1 (±1.3)
Range	2 to 5	2 to 5	2 to 5
House characteristics			
House area (m^2)			
Mean± SD	101.3 (±30.0)	91.7 (±13.4)	96.5 (±23.4)
Range	80 to 200	80 to 120	80 to 200

Characteristics	Household type		Total (n=36)
	Non-Occupational Family (n=18)	**Occupational family (n=18)**	
House floor(s)			
1	5 (27.8%)	8 (44.5%)	13 (36.1%)
2	13 (72.2%)	10 (55.5%)	23 (63.9%)

*1 rai=1,600 square meters

Table 4.13 showed the information of exposure in working age group, the average time that they stay at home were about 14 hours because they are going to work all day and after work the house's area that they spend their time were in bed room (52.8%) and outside common area (36.1%). Most of respondents reported usually wear shoes when going outside their houses (77.8%). The majority of participants washes their foot (75.0%) 1 to 2 times per day and washes their hands (94.4%) 3 to 4 times per day. Most of respondents reported cleaning houses 3 to 4 times per week (47.2%), 47.2% of them used sweep follow by wet mop (44.4%). In past six months, approximately 61.1% of respondents were sometimes had an illness. The main sources of drinking water in their family were tab water (44.4%) and underground water (30.6%). Most of respondents had more than 15 glasses of water per day (52.8%) and 30.6% of them had 11 to 15 glasses of water per day.

Table 4.13 Exposure Information of studied working age group

Characteristics	Household type		Total (n=36)
	Non-Occupational Family (n=18)	Occupational family (n=18)	
Stay at home (Hour(s))			
Mean± SD	14.8(±3.9)	14.1 (±3.9)	14.4 (±3.9)
Range	10 to 24	10 to 24	10 to 24
Most house's area usage (per day)			
Bed room	9 (50.0%)	10 (55.5%)	19 (52.8%)
In house common area	2 (11.1%)	2 (11.1%)	4 (11.1%)
Outside common area	7 (38.9%)	6 (33.3%)	13 (36.1%)
Wear shoes when going outside home			
Sometimes	4 (22.2%)	4 (22.2%)	8 (22.2%)
Usually	14 (77.8%)	14 (77.8%)	28 (77.8%)
Frequency of foot wash (time(s)/day)			
1-2	13 (72.2%)	14 (77.8%)	27 (75.0%)
3-4	5 (27.8%)	4 (22.2%)	9 (25.0%)
Frequency of hand wash (time(s)/day)			
3-4	17 (94.4%)	17 (94.4%)	34 (94.4%)
>5	1 (5.6%)	1 (5.6%)	2 (5.6%)

Characteristics	Household type		Total
	Non-Occupational Family (n=18)	**Occupational family (n=18)**	**(n=36)**
Frequency of cleaning house (time(s)/week)			
1-2	7 (38.9%)	8 (44.5%)	15 (41.7%)
3-4	9 (50.0%)	8 (44.5%)	17 (47.2%)
>5	2 (11.1%)	2 (11.1%)	4 (11.1%)
House cleaning method.			
Sweep	9 (50.0%)	8 (44.5%)	17 (47.2%)
Wet mop	7 (38.9%)	9 (50.0%)	16 (44.4%)
Wet mop with detergent	2 (11.1%)	1 (5.6%)	3 (8.3%)
Frequently of illness in the past six months			
Never	6 (33.3%)	8 (44.5%)	14 (38.9%)
Sometimes	12 (66.6%)	10 (55.5%)	22 (61.1%)
Source of drinking water			
Tab water	8 (44.5%)	8 (44.5%)	16 (44.4%)
Underground water	5 (27.8%)	6 (33.3%)	11 (30.6%)
Other	5 (27.8%)	4 (22.2%)	9 (25.0%)

Characteristics	Household type: Non-Occupational Family (n=18)	Household type: Occupational family (n=18)	Total (n=36)
Number of glasses per day			
5-10	3 (16.7%)	3 (16.7%)	6 (16.7%)
11-15	4 (22.2%)	7 (38.9%)	11 (30.6%)
>15	11 (61.1%)	8 (44.5%)	19 (52.8%)

4.2.2.1.3 Elderly Characteristics

Table 4.14 showed the information of elderly group from 18 non-occupational households and 18 occupational households, all participants were having equally gender (18 male and 18 female) the participant age ranged from 60 to 84 years. The average age (±SD) was 66.3 (±5.9) years. In non-occupational family; the majority of respondents were unemployed (50.0%), of 38.9% were employees and in occupational family, most of respondents were employees (72.2%), follow with chili farmers (16.7%).

Most of participants had income less than 5,000 baht per month (72.2%), 27.8% of them had income 5,001-10,000 baht per month and 91.7% of respondents graduated from primary school.

Table 4.14 Characteristics of studied elderly group

Characteristics	**Household type**		**Total**
	Non-Occupational Family (n=18)	**Occupational family (n=18)**	**(n=36)**
Gender			
Male	9 (50.0%)	9 (50.0%)	18 (50.0%)
Female	9 (50.0%)	9 (50.0%)	18 (50.0%)
Age (Years)			
61-70	14 (77.7%)	16 (88.8%)	30 (83.3%)
71-80	3 (16.7%)	1 (5.6%)	4 (11.1%)
>80	1 (5.6%)	1 (5.6%)	2 (5.6%)
Mean± SD	67.3 (±6.2)	65.3 (±5.6)	66.3 (±5.9)
Range	60 to 83	61 to 84	60 to 84
Weight (kg)			
Mean± SD	55.7 (±11.5)	57.9 (±8.7)	56.8 (±10.1)
Range	44 to 90	40 to 72	44 to 90
Height (cm)			
Mean± SD	154.8 (±6.0)	157.2(±6.4)	156.0 (±6.3)
Range	145 to 165	150 to 170	145 to 170

Characteristics	Household type		Total (n=36)
	Non-Occupational Family (n=18)	Occupational family (n=18)	
Occupation			
Unemployed	9 (50.0%)	2 (11.1%)	11 (30.6%)
Local business	2 (11.1%)	-	2 (5.6%)
Employee	7 (38.9%)	13 (72.2%)	20 (55.6%)
Chili farmer	-	3 (16.7%)	3 (8.3%)
Education			
Never	1 (5.6%)	-	1 (2.8%)
Primary school	16 (88.8%)	17 (94.4%)	33 (91.7%)
Secondary school	1 (5.6%)	1 (5.6%)	2 (5.6%)

Table 4.15 showed the information of house characteristics of studied elderly group, all of participants were almost having equally chili farm's area that nearest their houses (3.5 rais of occupational family and 3.7 rais of non-occupational family). The average house's area was 92.8 square meters and 50.0% of their houses had 2 floors.

Table 4.15 House Characteristics of studied elderly group

Characteristics	Household type		Total (n=36)
	Non-Occupational Family (n=18)	Occupational family (n=18)	
Residence located (From farm area: m)			
<10	1 (5.6%)	4 (22.2%)	5 (13.9%)
10-30	3 (16.7%)	1 (5.6%)	4 (11.1%)
31-50	2 (11.1%)	1 (5.6%)	3 (8.3%)
51-70	4 (22.2%)	4 (22.2%)	8 (22.2%)
71-90	1 (5.6%)	1 (5.6%)	2 (5.6%)
91-100	1 (5.6%)	1 (5.6%)	2 (5.6%)
101-130	4 (22.2%)	1 (5.6%)	5 (13.9%)
131-150	2 (11.1%)	5 (27.8%)	7 (19.4%)
Farm area nearest residence (rai(s)*)			
Mean± SD	3.5 (±1.3)	3.7 (±1.3)	3.6 (±1.3)
Range	2 to 5	2 to 5	2 to 5
House characteristics			
House area (m^2)			
Mean± SD	96.1 (±11.4)	89.4 (±12.1)	92.8 (±12.1)
Range	80 to 120	70 to 120	70 to 120

Characteristics	Household type: Non-Occupational Family (n=18)	Household type: Occupational family (n=18)	Total (n=36)
House floor(s)			
1	8 (44.5%)	10 (55.5%)	18 (50.0%)
2	10 (55.5%)	8 (44.5%)	18 (50.0%)

*1 rai=1,600 square meters

Table 4.16 showed the information of exposure in elderly group, the average time that they stay at home in non-occupational family were about 20 hours per day because most of respondents were unemployed. Thus, the average time of elder in non-occupational family was more than in occupational family (about 15 hours per day). Most of elder in non-occupational family reported that house's area that they used in during day was outside common area (83.3%). Elder in occupational family, the house's areas that they spend their time were in bed room (50.0%) and outside common area (50.0%). Most of respondents reported that they not always wear shoes when going outside their houses (52.8%) and 44.4% of respondents usually were shoes. The majority of participants in non-occupational family were washes their foot 3 to 4 times per day (77.8%) and 50.0% of them washes their hands 1 to 2 times per day. In occupational family, more than half of participants were washes their foot (83.3%) and hands (61.1%) 1 to 2 times per day. Most of respondents reported cleaning houses 3 to 4 times per week (50.0%), 58.3% of them used sweep follow by wet mop (30.6%). In past six months, approximately 61.1% of respondents were sometimes had an illness. The main sources of drinking water in their family were underground water (47.2%) and tab water (33.3%). Most of respondents had more than 15 glasses of water per day (41.7%) and 33.3% of them had 11 to 15 glasses of water per day.

Table 4.16 Exposure Information of studied elderly group

Characteristics	**Household type**		**Total (n=36)**
	Non-Occupational Family (n=18)	**Occupational family (n=18)**	
Stay at home (Hour(s))			
Mean± SD	20.4 (±3.9)	14.7 (±4.0)	17.6 (±4.9)
Range	10 to 24	10 to 20	10 to 24
Most house's area usage (per day)			
Bed room	3 (16.7%)	9 (50.0%)	12 (33.3%)
Outside common area	15 (83.3%)	9 (50.0%)	24 (66.7%)
Wear shoes when going outside home			
Never	-	1 (5.6%)	1 (2.8%)
Sometimes	11 (61.1%)	8 (44.5%)	19 (52.8%)
Usually	7 (38.9%)	9 (50.0%)	16 (44.4%)
Frequency of foot wash (time(s)/day)			
1-2	4 (22.2%)	15 (83.3%)	19 (52.8%)
3-4	14 (77.8%)	3 (16.7%)	17 (47.2%)
Frequency of hand wash (time(s)/day)			
3-4	9 (50.0%)	11 (61.1%)	20 (55.6%)
>5	9 (50.0%)	7 (38.9%)	16 (44.4%)

Characteristics	Household type: Non-Occupational Family (n=18)	Household type: Occupational family (n=18)	Total (n=36)
Frequency of cleaning house (time(s)/week)			
1-2	6 (33.3%)	5 (27.8%)	11 (30.6%)
3-4	9 (50.0%)	9 (50.0%)	18 (50.0%)
>5	3 (16.7%)	4 (22.2%)	7 (19.4%)
House cleaning method			
Sweep	11 (61.1%)	10 (55.5%)	21 (58.3%)
Dry mop	-	2 (11.1%)	2 (5.6%)
Wet mop	5 (27.8%)	6 (33.3%)	11 (30.6%)
Wet mop with detergent	2 (11.1%)	-	2 (5.6%)
Frequently of illness in the past six months			
Never	9 (50.0%)	5 (27.8%)	14 (38.9%)
Sometimes	9 (50.0%)	13 (72.2%)	22 (61.1%)
Source of drinking water			
Tab water	5 (27.8%)	7 (38.9%)	12 (33.3%)
Underground water	10 (55.5%)	7 (38.9%)	17 (47.2%)
Other	3 (16.7%)	4 (22.2%)	7 (19.4%)

Characteristics	Household type		Total
	Non-Occupational Family (n=18)	**Occupational family (n=18)**	**(n=36)**
Number of glasses per day			
5-10	5 (27.8%)	4 (22.2%)	9 (25.0%)
11-15	6 (33.3%)	6 (33.3%)	12 (33.3%)
>15	7 (38.9%)	8 (44.5%)	15 (41.7%)

4.2.2.2 Hand-wipe samples

A total of 108 hand wipe samples were collected from each of 54 occupational households and 54 non-occupational households. All hand wipe samples were not detected organophosphate pesticides. The majority of these samples were below the LOD, 11.1% of hand wipe samples in 6 non-occupational and 6 occupational households were detected permethrin with an average concentration $2.33 x 10^{-2}$ mg/kg in non-occupational households and occupational households. The average concentrations of cypermethrin were $2.33 x 10^{-2}$ mg/kg in non-occupational household and $2.07 x 10^{-2}$ mg/kg in occupational households.

In term of detected frequency, no significant differences of detection frequencies of hand wipe samples were found among non-occupational and occupational group (Chi-square test; $p>0.05$). The result showed that there were no significant differences between non-occupational and occupational households in all 3 groups (children, working age and elderly) for average concentration of permethrin and cypermethrin in hand wipe samples (Mann-Whitney test, $p>0.05$).Table 4.17: showed detected frequency and average concentration of PY in hand wipe samples separated by house's type and participant's group.

4.2.2.3 Foot-wipe samples

Of 108 participants were enrolled from 54 occupational households and 54 non-occupational households. Foot wipe samples were collected from each participant. All foot wipe samples were not detected organophosphate pesticides and only permethrin was detected in 7 non- occupational and 8 occupational households. The majority of these samples were below the LOD, 13.9% of foot wipe samples were detected permethrin with an average concentration $2.39x10^{-2}$ mg/kg in non-occupational households and $2.44x10^{-2}$ mg/kg in occupational households.

For detected frequency, no significant differences of detection frequencies of foot wipe samples were found among non-occupational and occupational group (Chi-square test; $p>0.05$). The result showed that there were no significant differences between non-occupational and occupational households in all 3 groups (children, working age and elderly) for average concentration of permethrin in foot wipe samples (Mann-Whitney test, $p>0.05$).Table 4.17 showed detected frequency and average concentration of PY (permethrin) in foot wipe samples separated by house's type and participant's group.

The results of hand and foot wipe samples were showed in table 4.17.

Table 4.17 Detected frequency and average concentrations of PY in hand and foot wipe samples

Pesticides	House type	Number	Range (mg/kg)	Average concentration* (mg/kg)
Hand				
Permethrin				
Non-occupational family:				
	Children (n=18)	4 (22.2%)	<LOD – 0.05	2.67×10^{-2}
	Working age (n=18)	1 (5.56%)	<LOD – 0.05	2.17×10^{-2}
	Elderly (n=18)	1 (5.56%)	<LOD – 0.05	2.17×10^{-2}
Occupational family:				
	Children (n=18)	3 (16.7%)	<LOD – 0.05	2.50×10^{-2}
	Working age (n=18)	2 (11.1%)	<LOD – 0.05	2.33×10^{-2}
	Elderly (n=18)	1 (5.56%)	<LOD – 0.05	2.17×10^{-2}
Cypermethrin				
Non-occupational family:				
	Children (n=18)	5 (27.8%)	<LOD – 0.04	2.56×10^{-2}
	Working age (n=18)	3 (16.7%)	<LOD – 0.04	2.33×10^{-2}
	Elderly (n=18)	1 (5.56%)	<LOD – 0.04	2.11×10^{-2}

Pesticides	House type	Number	Range (mg/kg)	Average concentration* (mg/kg)
Occupational family:				
	Children (n=18)	1 (5.56%)	<LOD – 0.04	$2.11x10^{-2}$
	Working age (n=18)	1 (5.56%)	<LOD – 0.04	$2.11x10^{-2}$
	Elderly (n=18)	-	-	-
Foot				
Permethrin				
Non-occupational family:				
	Children (n=18)	6 (33.3%)	<LOD – 0.05	$3.00x10^{-2}$
	Working age (n=18)	1 (5.56%)	<LOD – 0.05	$2.17x10^{-2}$
	Elderly (n=18)	-	-	-
Occupational family:				
	Children (n=18)	4 (22.2%)	<LOD – 0.05	$2.67x10^{-2}$
	Working age (n=18)	1 (5.56%)	<LOD – 0.05	$2.17x10^{-2}$
	Elderly (n=18)	3 (16.7%)	<LOD – 0.05	$2.50x10^{-2}$

Abbreviation: LOD= limit of detection

*Samples reported as below LOD were assigned LOD prior to statistical analysis.

4.2.3 Biological samples (Urinary Metabolite levels)

"Biomonitoring is an important tool that can be used to evaluate human exposure to pesticides by measuring the levels of pesticides or pesticide metabolites in biological specimens or tissues" (Sobus et al., 2010).

4.2.3.1 Children Urinary Metabolite levels

A total of 36 urine samples were analyzed to assess exposure to OP insecticides. The detection frequency of diethylphosphate metabolites in non-occupational family were as followed; DEP (22.2%), DETP (50.0%) and DEDTP (16.7%) and in occupational families were DEP (61.1%), DETP (61.1%) and DEDTP (50.0%). Figure 4.2 showed the detection frequencies of all detected metabolites.

Children of occupational family had significantly higher detection frequencies of DEP (Chi-square test, p=0.041) than children of non-occupational family. Meanwhile no significant differences of detection frequencies of DETP and DEDTP were found among these two groups (Chi-square test; p=0.738 and p=0.075 respectively).

Urinary metabolites concentration, both creatinine and non-creatinine adjusted results. The following were the range of diethylphosphate metabolites; DEP range from <LOD to 9.85 ng/mL (<LOD- 15.0 µg/g.cre), DETP range from <LOD to 19.0 ng/mL (<LOD- 27.7 µg/g.cre), DEDTP range from <LOD to 23.7 ng/mL (<LOD- 29.6 µg/g.cre) and molar summed DEPs range from <LOD to 0.30 ng/mL (<LOD- 0.39 µg/g.cre).

Figure 4.2 showed the geometric mean concentration of urinary metabolites among children. Cross comparisons of metabolite concentrations found among children of occupational and non-occupational family were done. Children of occupational family had significant higher levels than children of non-occupational family for DEP (both non-creatinine and creatinine adjusted results; Mann-Whitney test, p=0.005 and p=0.001

respectively), DETP (creatinine adjusted results; Mann-Whitney test, p=0.042), DEDTP (both non-creatinine and creatinine adjusted results; Mann-Whitney test, p=0.012 and p=0.003 respectively) and molar sum DEPs (both non-creatinine and creatinine adjusted results; Mann-Whitney test, p=0.023 and p=0.008 respectively). The results of all metabolites of children showed in figure 4.3-4.4.

According to household's types, urinary metabolites concentration found in children urine samples were further compared using different variables that included gender, house location and presence of activities during day.

There were no significant differences between male and female children for average concentration of all diethylphosphate metabolites (both non-creatinine and creatinine adjusted results; Mann-Whitney test, p>0.05). All children were cross compared between house located levels. It was found that children of level1 had significantly higher levels than children of level2 and level3 for DETP (both non-creatinine and creatinine adjusted results; Kruskal Wallis test, p=0.037 and p=0.037 respectively) and DEDTP (both non-creatinine and creatinine adjusted results; Kruskal Wallis test, p=0.006 and p=0.012 respectively).

Figure 4.2 Detected frequencies of Urinary Diethylphosphate Metabolites among Children

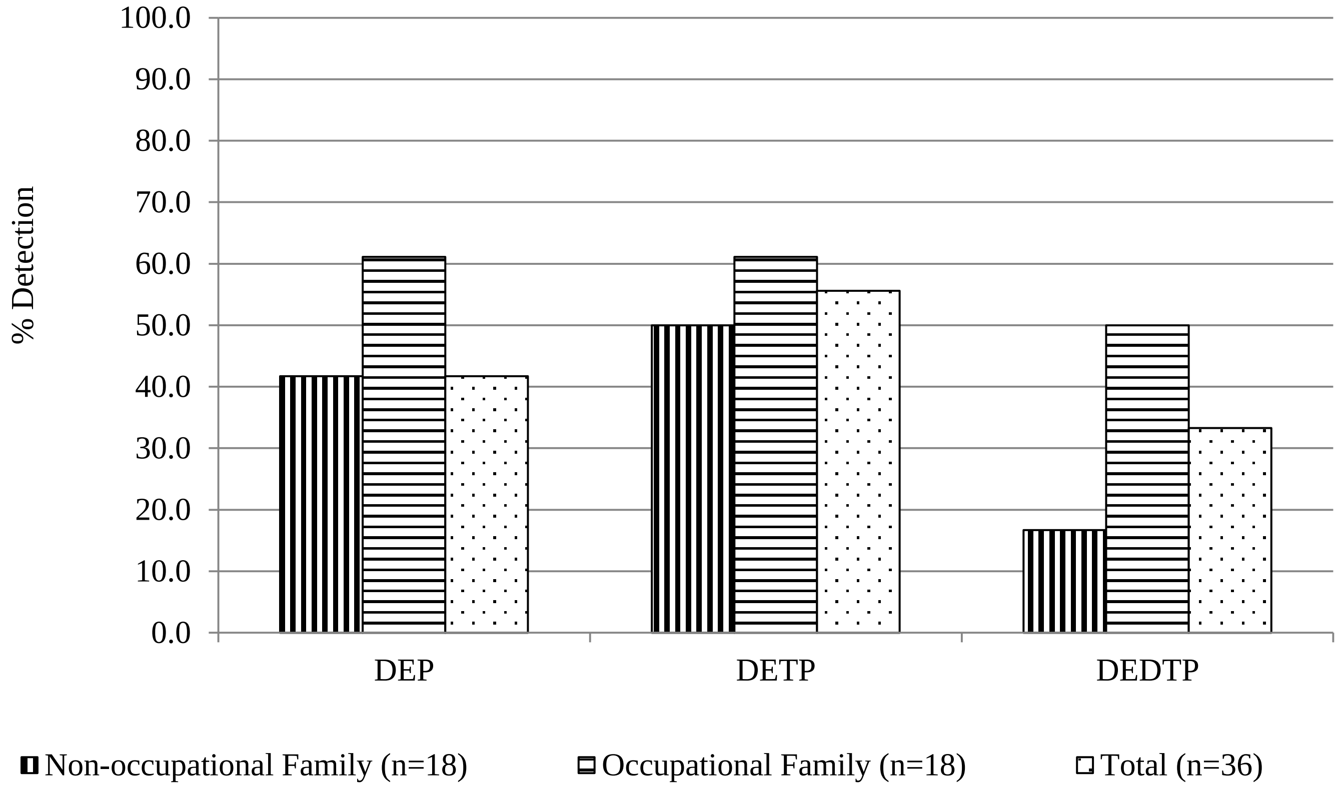


Figure 4.3 GeoMean Concentrations of Urinary Diethylphosphate Metabolites (Non-creatinine Adjusted Results) among Children

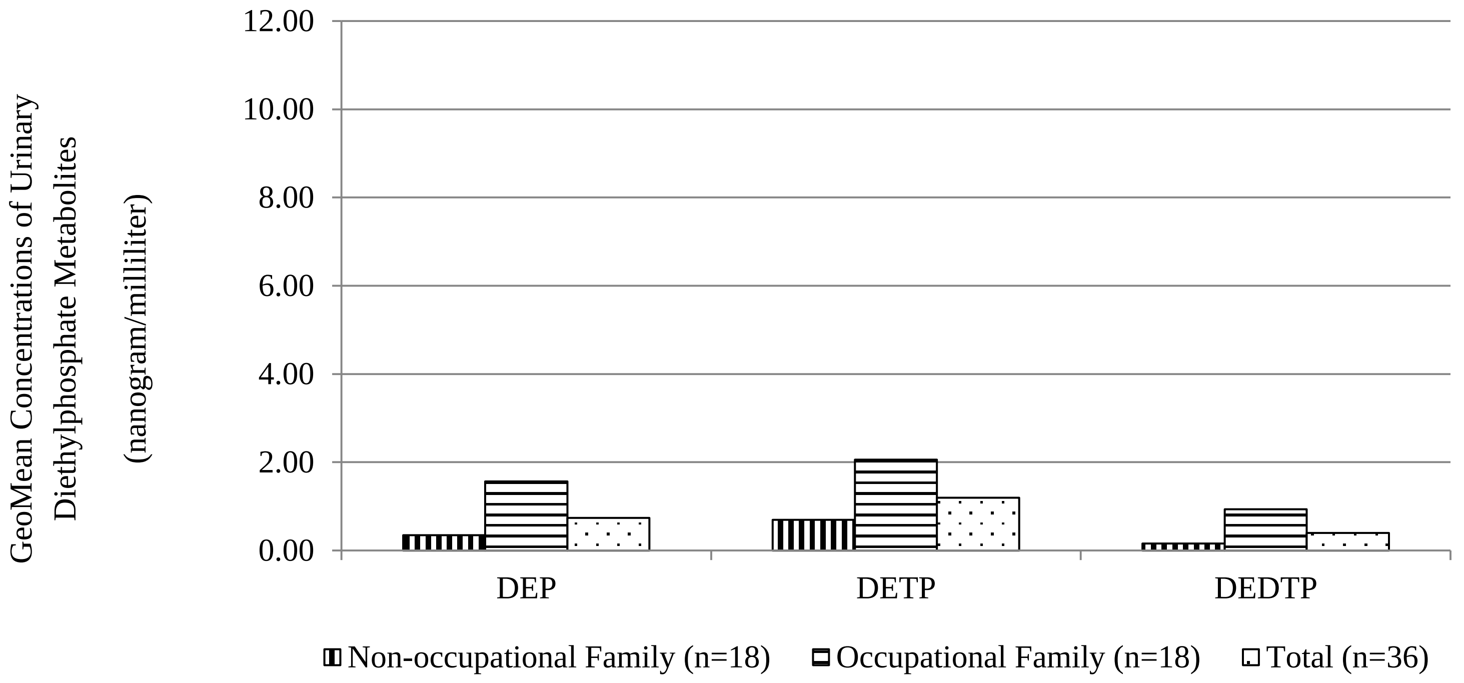
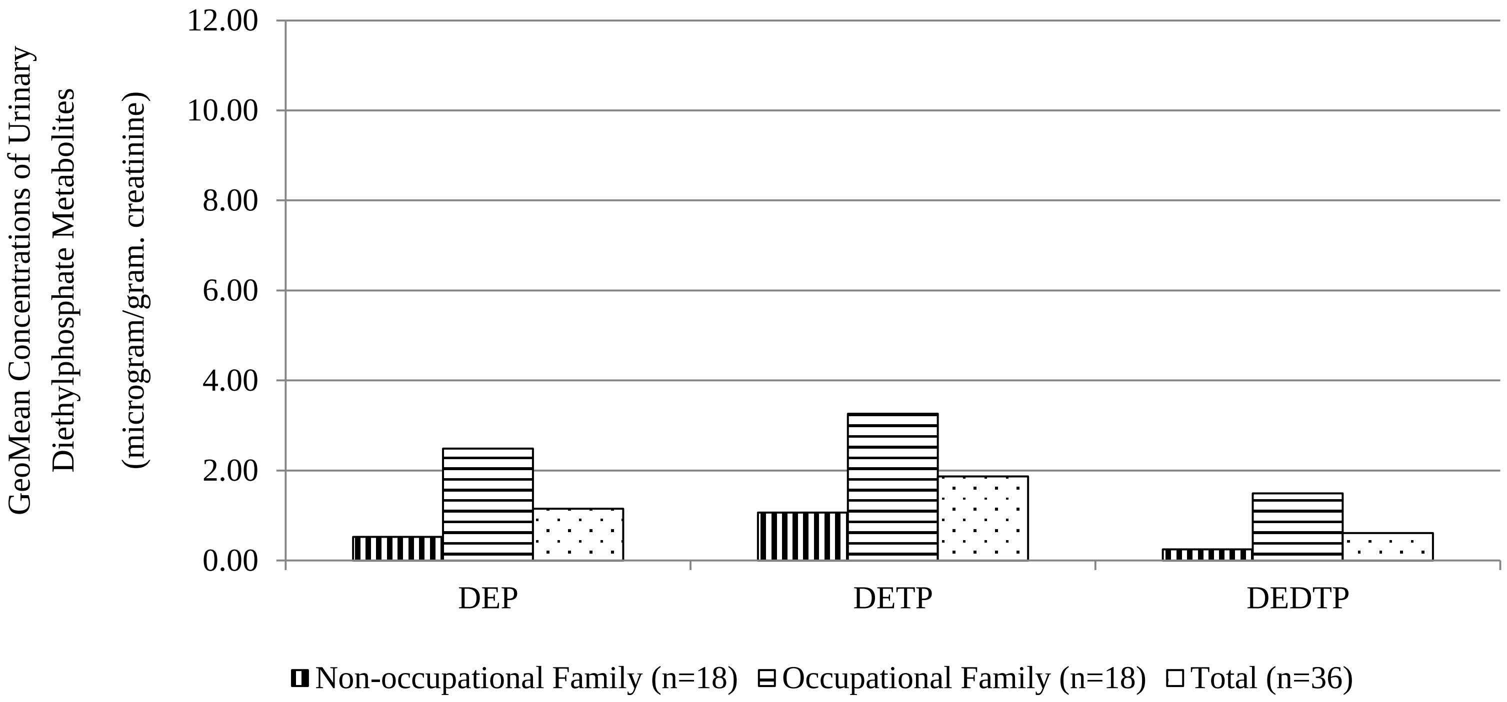


Figure 4.4 GeoMean Concentrations of Urinary Diethylphosphate Metabolites (Creatinine Adjusted Results) among Children



4.2.3.2 Working age Urinary Metabolite levels

Of the 36 participants, 36 urine samples of working age group completed analyze to assess exposure to OP insecticides. The detection frequency of diethylphosphate metabolites in non-occupational family were as followed; DEP (33.3%), DETP (72.2%) and DEDTP (27.8%) and in occupational families were DEP (44.4%), DETP (72.2%) and DEDTP (22.2%). Figure 4.5 showed the detection frequencies of all detected metabolites.

Cross comparisons of urinary metabolite concentration were completed among working age of occupational family and non-occupational family. There were no significant differences of detection frequencies of all diethylphosphate metabolites (Chi-square test, $p>0.05$).

Urinary metabolites concentration, both creatinine and non-creatinine adjusted results. The following were the range of diethylphosphate metabolites; DEP range from <LOD to 29.8 ng/mL (<LOD-28.7 µg/g.cre), DETP range from <LOD to 124 ng/mL (<LOD- 107 µg/g.cre), DEDTP range from <LOD to 16.2 ng/mL (<LOD- 13.9 µg/g.cre) and molar summed DEPs range from <LOD to 1.00 ng/mL (<LOD-0.85 µg/g.cre).

Figure 4.5 showed the geometric mean concentration of urinary metabolites among working age group. Cross comparisons of metabolite concentrations found among working age of occupational and non-occupational family were done. Working age of occupational family had significant higher levels than working age of non-occupational family for DEP (creatinine adjusted results; Mann-Whitney test, p=0.038), DETP (both non-creatinine and creatinine adjusted results; Mann-Whitney test, p=0.020 and$p$=0.011 respectively) and molar sum DEPs (both non-creatinine and creatinine adjusted results; Mann-Whitney test, p=0.026 and p=0.018 respectively). The results of all metabolites of working age group showed in figure 4.6-4.7.

According to household's types, urinary metabolites concentration found in working age urine samples were further compared using different variables that included gender, house location and presence of activities during day.

There were no significant differences between male and female working age for average concentration of all diethylphosphate metabolites (both non-creatinine and creatinine adjusted results; Mann-Whitney test, $p>0.05$). All participants of working age were cross compared between house located levels. It was found that participants of level1 had significantly higher levelsthan level2 and level3 for DETP (both non-creatinine and creatinine adjusted results; Kruskal Wallis test, $p=0.005$ and $p=0.007$ respectively) andmolar sum DEPs (both non-creatinine and creatinine adjusted results; Kruskal Wallis test, $p=0.005$ and $p=0.006$ respectively).

Figure 4.5 Detected frequencies of Urinary Diethylphosphate Metabolites among working age group

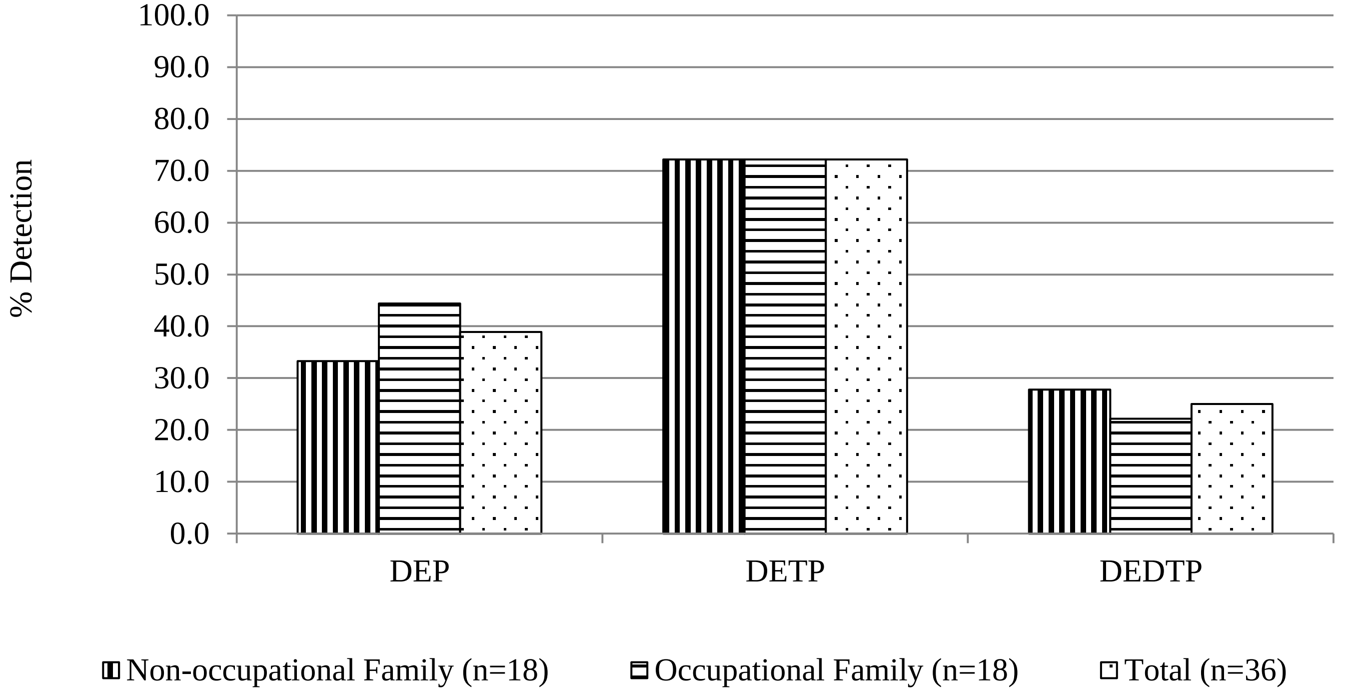


Figure 4.6 GeoMean Concentrations of Urinary Diethylphosphate Metabolites (Non-creatinine Adjusted Results) among working age group

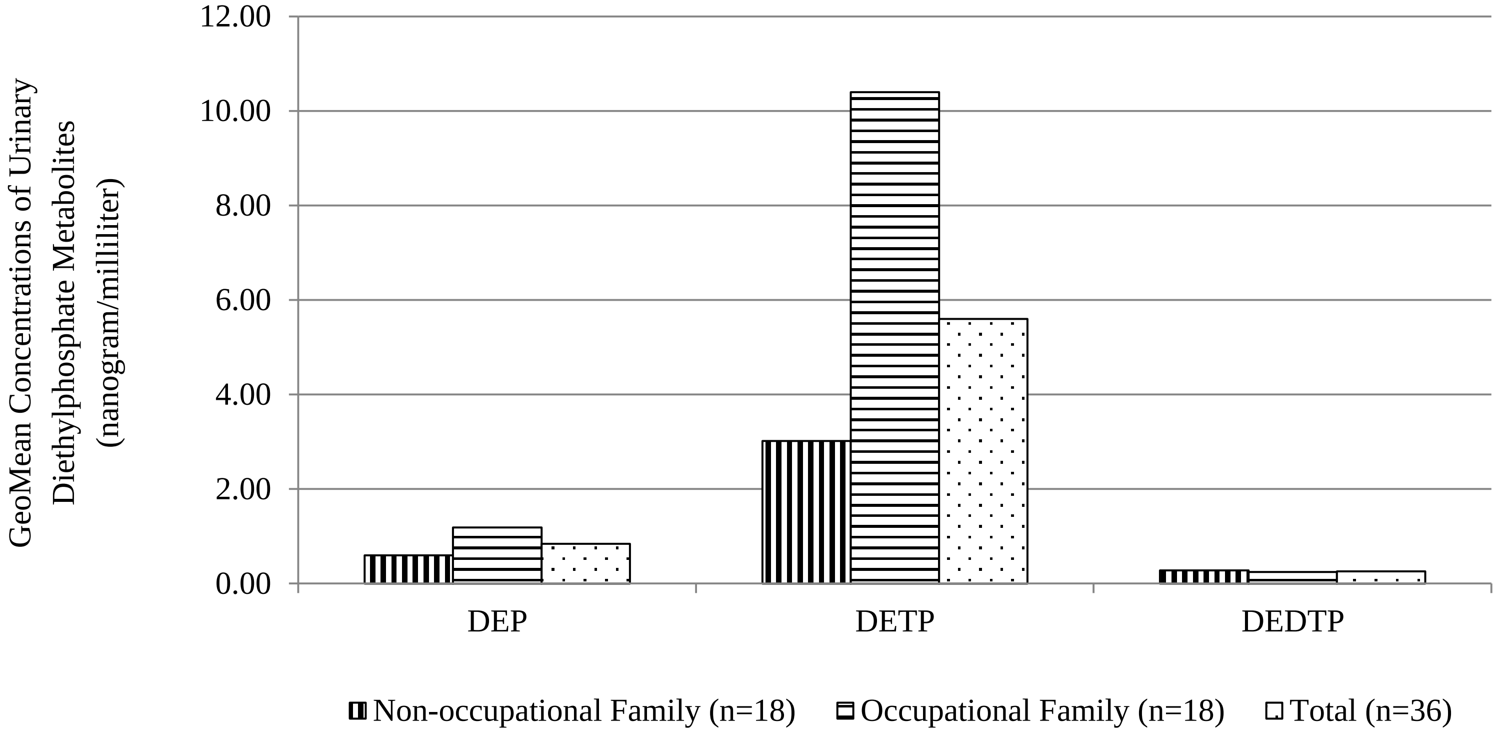
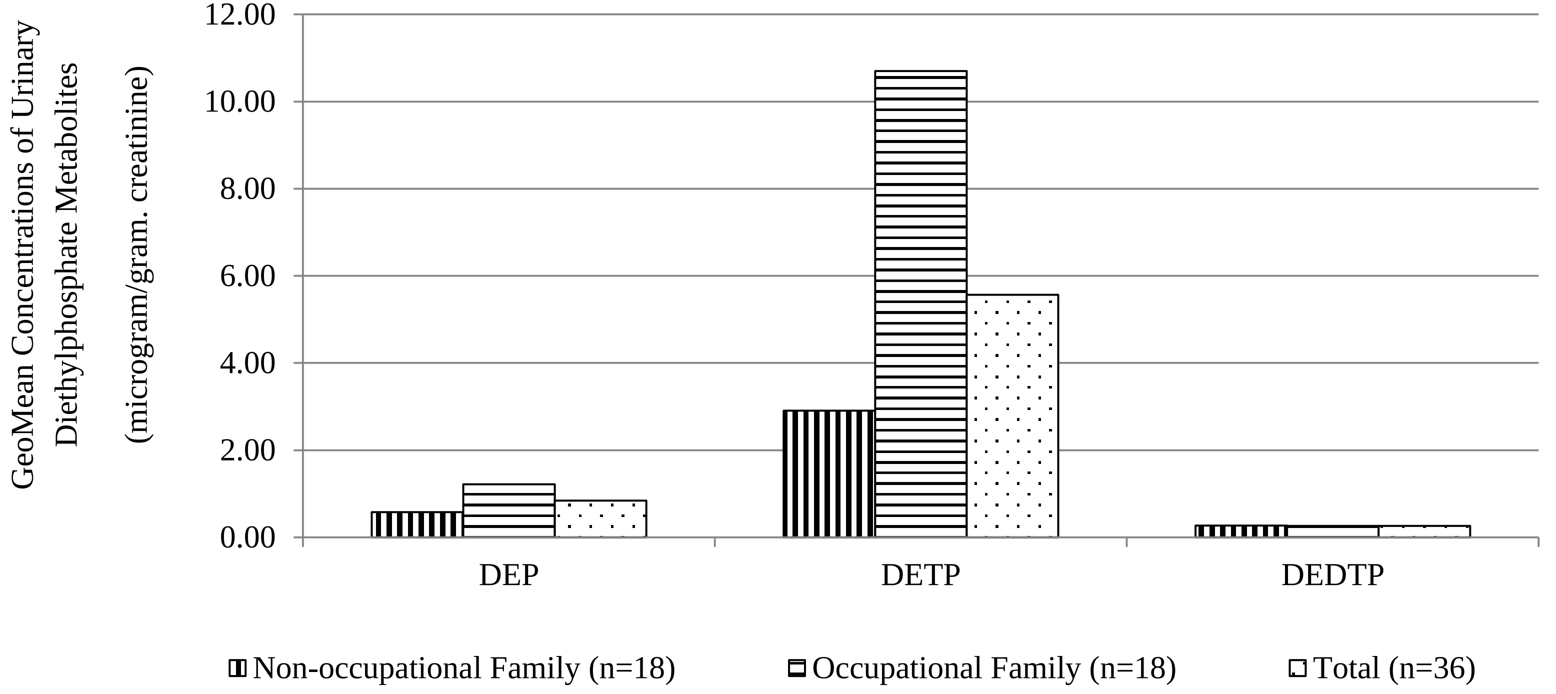


Figure 4.7 GeoMean Concentrations of Urinary Diethylphosphate Metabolites (Creatinine Adjusted Results) among working age group



4.2.3.3 Elderly Urinary Metabolite levels

A total of 36 urine samples were analyzed to assess exposure to OP insecticides. The detection frequency of diethylphosphate metabolites in non-occupational family were as followed; DEP (5.56%), DETP (27.8%) and in occupational families were DEP (44.4%), DETP (38.9%). Meanwhile both of elderly of occupational and non-occupational family were not detected DEDTP. Figure 4.8 showed the detection frequencies of all detected metabolites.

Elderly of occupational family had significantly higher detection frequencies of DEP (Chi-square test, *p*=0.018) than elderly of non-occupational family. Meanwhile no significant differences of detection frequencies of DETP (Chi-square test; *p*=0.725).

Urinary metabolites concentration, both creatinine and non-creatinine adjusted results. The following were the range of diethylphosphate metabolites; DEP range from <LOD to 7.78 ng/mL (<LOD- 7.16 µg/g.cre), DETP range from <LOD to 12.5 ng/mL (<LOD- 12.6 µg/g.cre) and molar summed DEPs range from <LOD to 0.12 ng/mL (<LOD- 0.12 µg/g.cre).

Figure 4.8 showed the geometric mean concentration of urinary metabolites among elderly. Cross comparisons of metabolite concentrations found among elderly of occupational and non-occupational family were done. Elderly of occupational family had significant higher levels than elderly of non-occupational family for DEP (both non-creatinine and creatinine adjusted results; Mann-Whitney test, *p*=0.002 and *p*=0.002 respectively).There were no significant differences of detection frequencies of DETP and molar sum DEPs (both non-creatinine and creatinine adjusted results; Mann-Whitney test, *p*>0.05). The results of all metabolites of elderly showed in figure 4.9-4.10.

According to household's types, urinary metabolites concentration found in elderly urine samples were further compared using different variables that included gender, house location and presence of activities during day.

There were no significant differences between male and female elderly for average concentration of all diethylphosphate metabolites (both non-creatinine and creatinine adjusted results; Mann-Whitney test, $p>0.05$). All elderly were cross compared between house located levels. It was found that elderly of level1 had significantly higher levels than children of level2 and level3 for DETP (both non-creatinine and creatinine adjusted results; Kruskal Wallis test, $p=0.014$ and $p=0.048$ respectively) and molar sum DEPs (non-creatinine adjusted results; Kruskal Wallis test, $p=0.034$).

Figure 4.8 Detected frequencies of Urinary Diethylphosphate Metabolites among elderly group

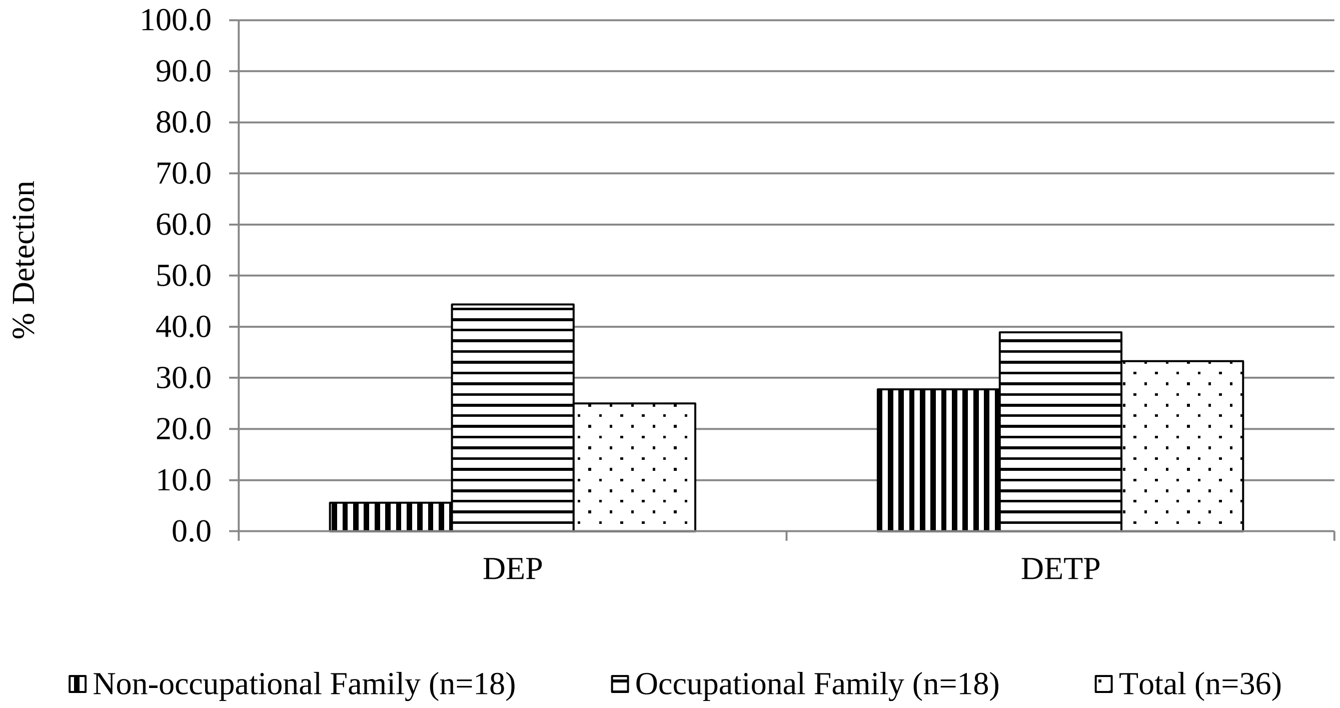


Figure 4.9 GeoMean Concentrations of Urinary Diethylphosphate Metabolites (Non-creatinine Adjusted Results) among elderly group

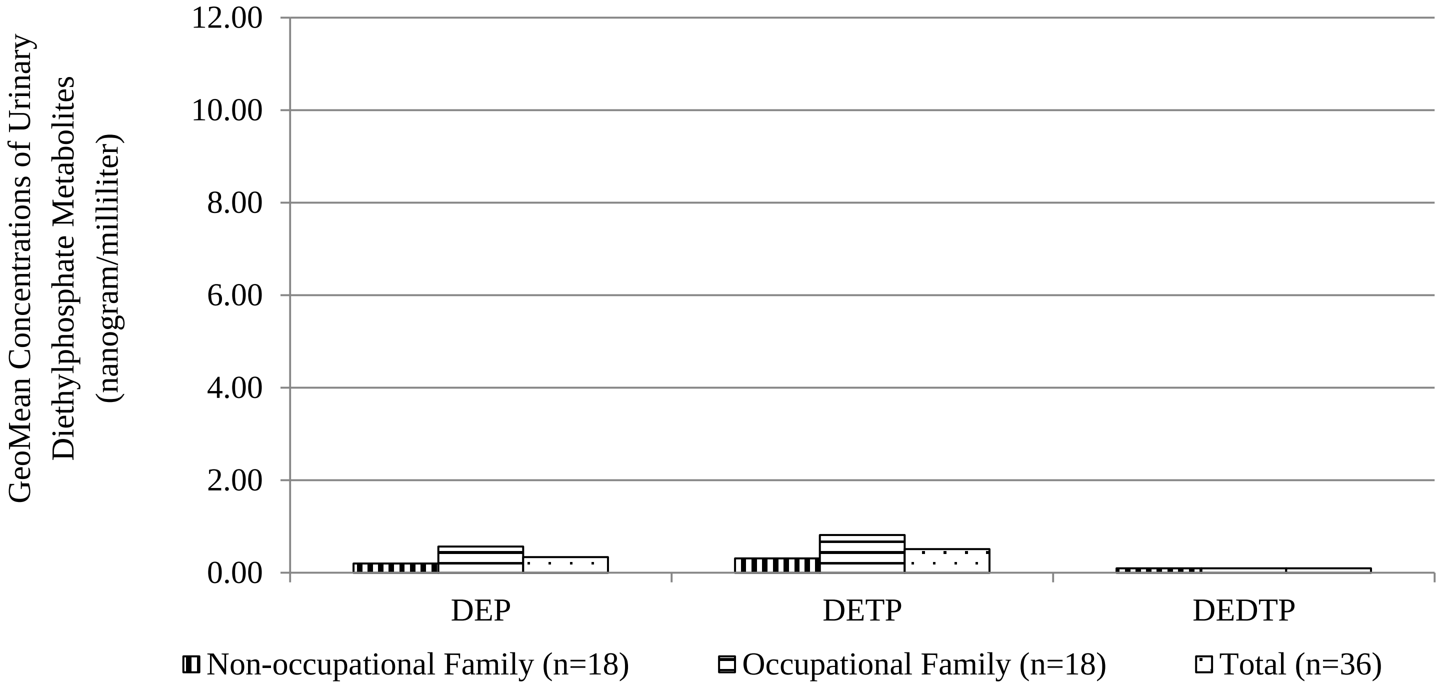


Figure 4.10 GeoMean Concentrations of Urinary Diethylphosphate Metabolites (Creatinine Adjusted Results) among elderly group

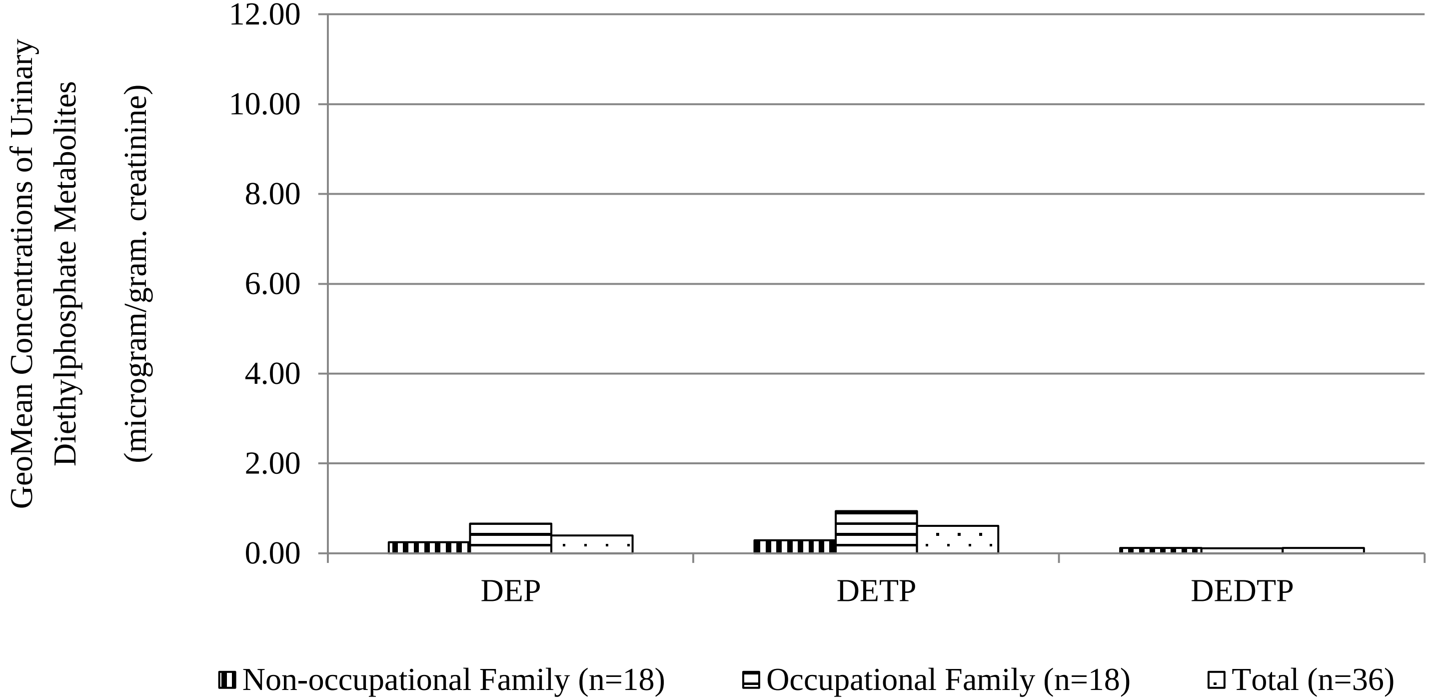


Figure 4.11 Detected frequencies of Molar Summed Urinary Diethylphosphate Metabolites

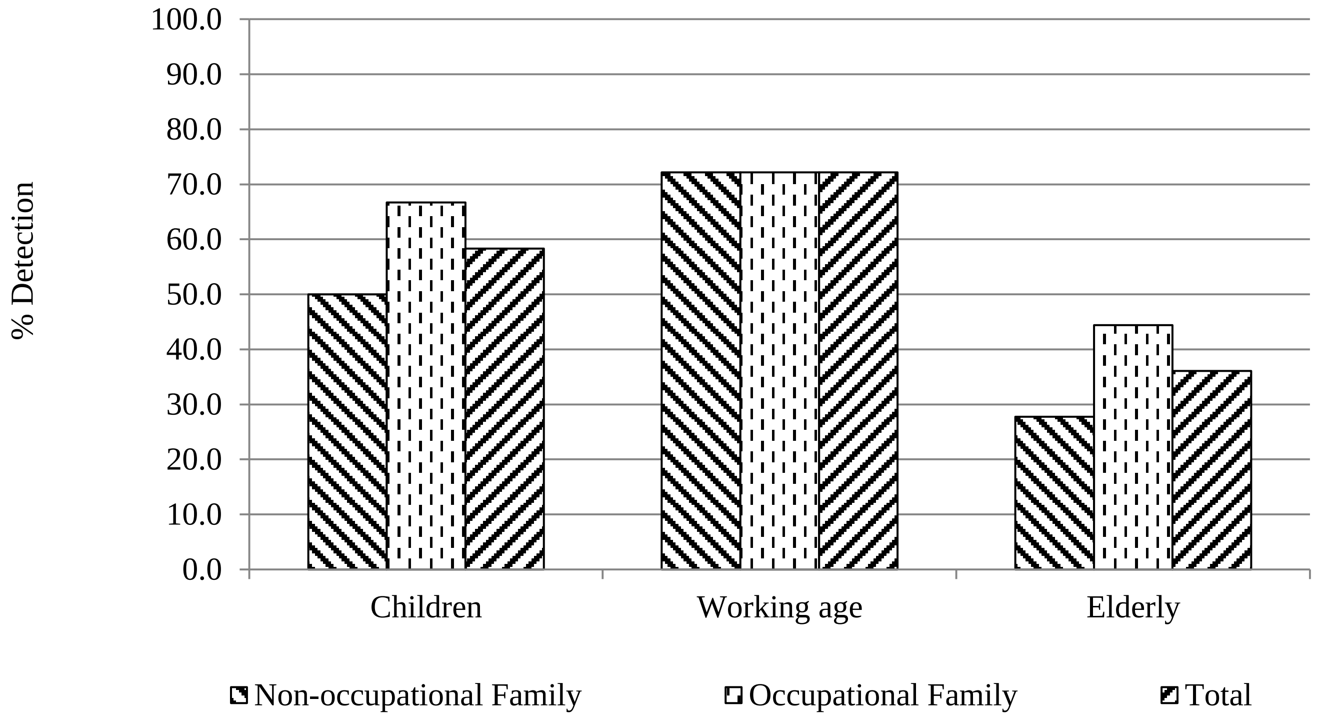


Figure 4.12 GeoMean Concentrations of Molar Summed Urinary Diethylphosphate Metabolites (Non-creatinine Adjusted and creatinine Adjusted Results) among Children

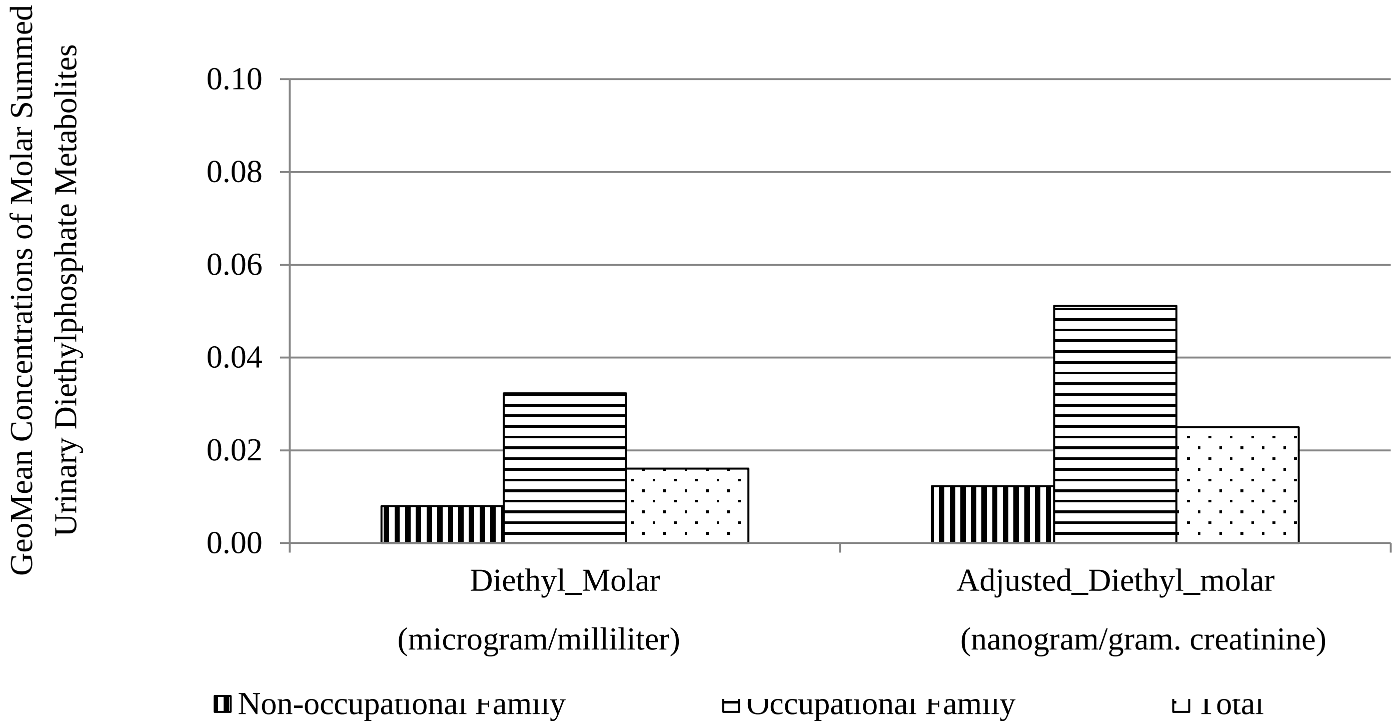


Figure 4.13 GeoMean Concentrations of Molar Summed Urinary Diethylphosphate Metabolites (Non-creatinine Adjusted and creatinine Adjusted Results) among working age group

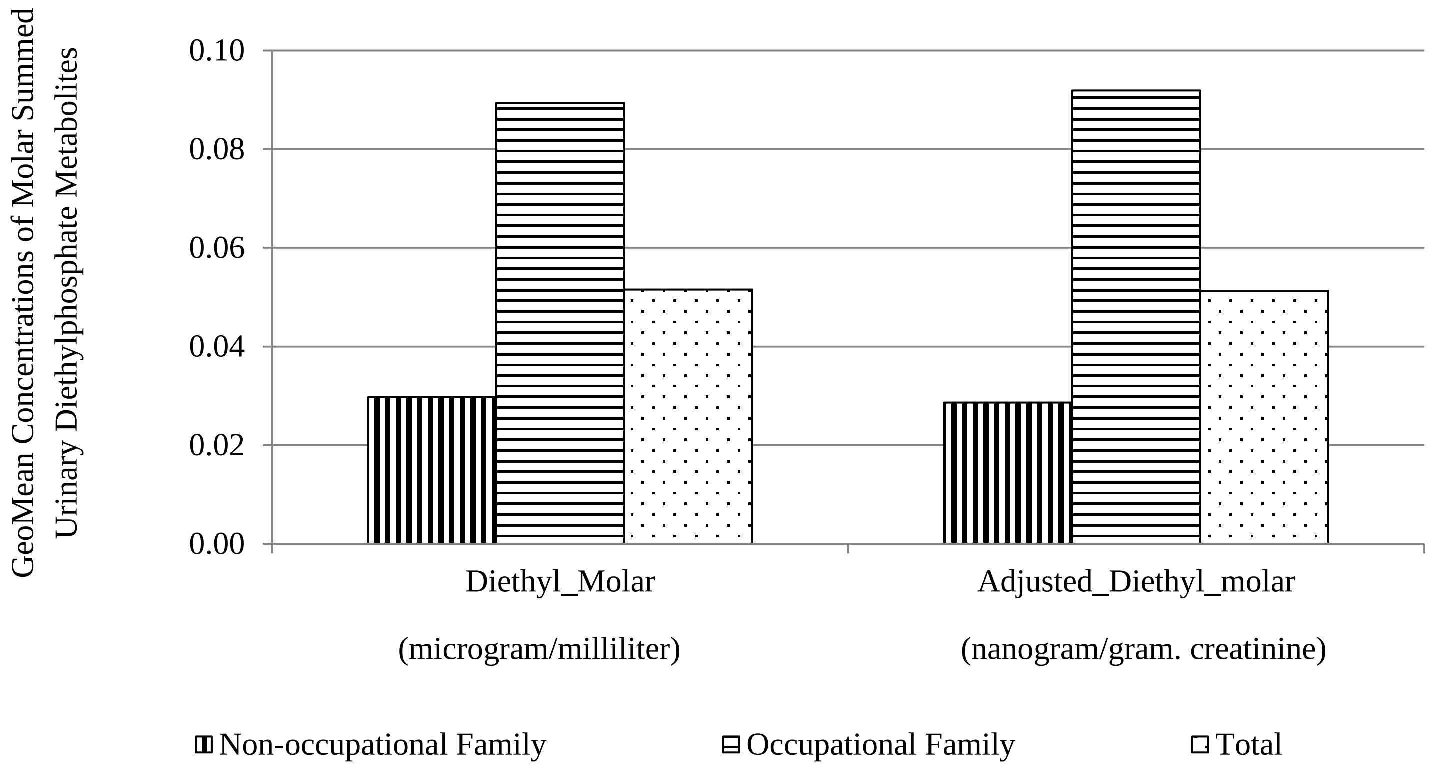
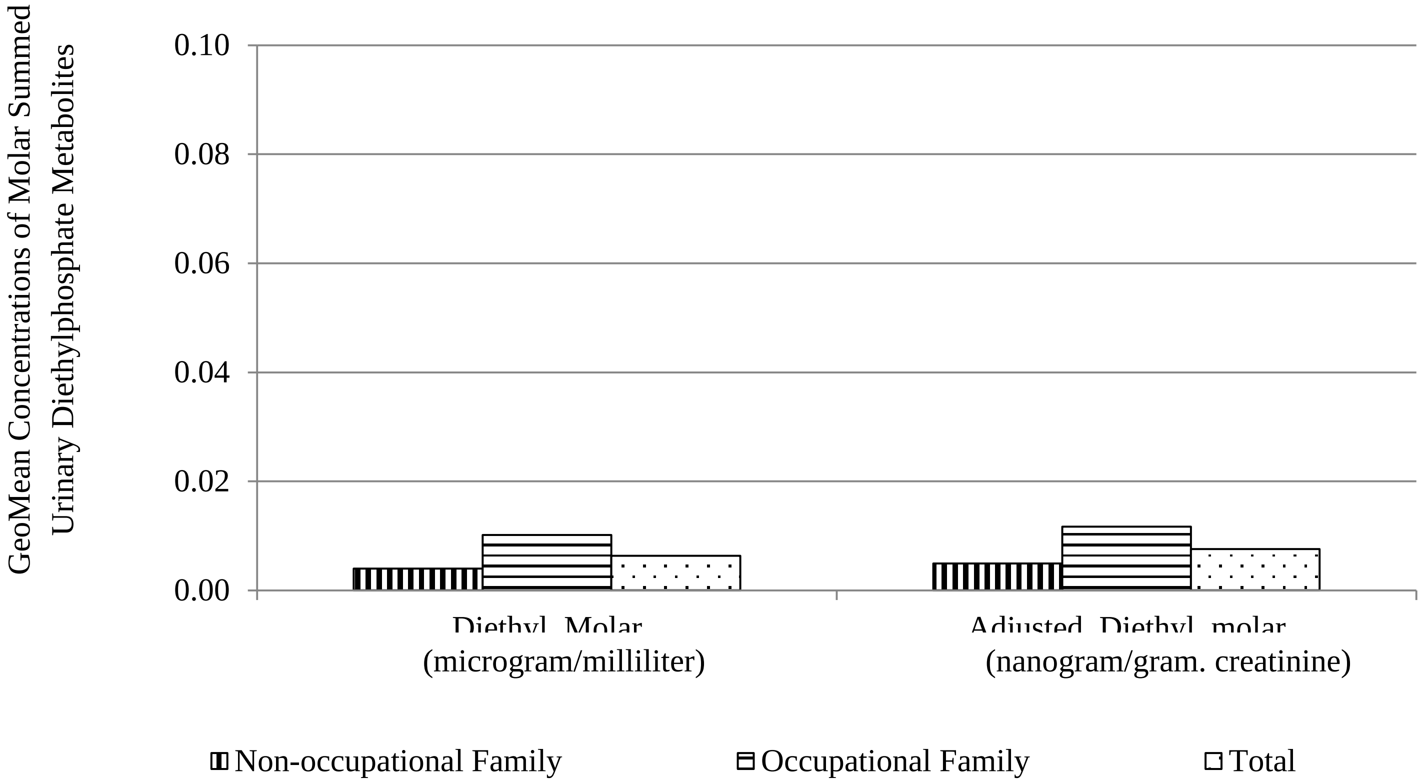


Figure 4.14 GeoMean Concentrations of Molar Summed Urinary Diethylphosphate Metabolites (Non-creatinine Adjusted and creatinine Adjusted Results) among elderly group



4.3 Association between environmental factors and residential pesticide contamination

4.3.1 Environmental samples and environmental factors

For air samples were detected only OPs pesticide and the association between environmental samples and environmental factors were treated as Spearman's rank correlation coefficients (Table 4.18). In non-occupational family, the association between air samples and house located were low negative correlation (Spearman's rank correlation coefficient -0.367 at p=0.01), the association between air samples and house cleaning frequencies were low positive correlation (Spearman's rank correlation coefficient 0.091 at p=0.05). Meanwhile the association in occupational family was in same level of correlation in all of environment factors. The association between air samples and house located were negative correlation (Spearman's rank correlation coefficient -0.465 at p=0.01), the association between air samples and house cleaning frequencies were low positive correlation (Spearman's rank correlation coefficient 0.092 at p=0.05).

For surface wipe samples were detected both of OPs and pyrethroid insecticide, the association between OPs pesticide residue concentrations and house located were negative correlation (Spearman's rank correlation coefficient -0.453 at p=0.01) in non-occupational family households. Meanwhile in occupational family households, the association between OPs pesticide residue concentrations and house located were high negative correlation (Spearman's rank correlation coefficient -0.739 at p=0.01).

For pyrethroid insecticide residues in surface wipe samples and house cleaning frequency were found negative correlation in occupational households (Spearman's rank correlation coefficient -0.312 at p=0.05). Interestingly, the association between pyrethroid insecticide concentrations in surface wipes sample and frequency of household insecticide use were positive correlation in both of non-occupational and occupational households (Spearman's rank correlation coefficient 0.630 and 0.593 at p=0.01 respectively). The association between pyrethroid concentrations in surface wipes and frequency of hand wash were negative correlation in non-occupational and occupational household (Spearman's rank correlation coefficient -0329 and -0.278 at *p*=0.05 respectively). For occupational household, the association between pyrethroid concentrations in surface wipes and the latest household insecticide use were low positive correlation (Spearman's rank correlation coefficient 0.399 at *p*=0.01).

Moreover, personal samples; hand and foot wipe samples were detected only pyrethroid insecticides. In non-occupational households, the association between hands wipes samples and frequency of household insecticide use were positive correlation (Spearman's rank correlation coefficient 0.423 at *p*=0.01), also with frequency of hand wash were negative correlation (Spearman's rank correlation coefficient -0.433 at *p*=0.01). For occupational households, the association between hands wipes samples and frequency of household insecticide use were positive correlation (Spearman's rank correlation coefficient 0.322 at *p*=0.05), and with frequency of hand wash were negative correlation (Spearman's rank correlation coefficient -0.336 at *p*=0.05).

For foot wipe samples; in non-occupational household, the association between pyrethroid insecticide concentration and house cleaning frequency were negative correlation (Spearman's rank correlation coefficient -0.289 at *p*=0.05). Also, the association between pyrethroid insecticide concentration and frequency of foot wash were negative correlation (Spearman's rank correlation coefficient -0.273 at *p*=0.05), and frequencies of shoe's wear were positive correlation (Spearman's rank correlation coefficient 0.387 at *p*=0.01).

Table 4.18 Association between environmental samples and environmental factors

Environmental Samples	Pesticide	House type	Variables	Spearman's rho
Air samples	Organophosphate	Non-occupational family	House located	-0.367**
		Occupational family	House located	-0.465**
Surface wipe	Organophosphate	Non-occupational family	House located	-0.453**
			House cleaning frequencies	-0.255
		Occupational family	House located	-0.739**
			House cleaning frequencies	-0.025
	Pyrethroid	Non-occupational family	House cleaning frequencies	-0.312*
			Frequency of household insecticide use	0.630**
			Frequency of hand wash	-0.329*
			Frequency of foot wash	-0.238
			Latest household insecticide use	0.237

Environmental Samples	Pesticide	House type	Variables	Spearman's rho
		Occupational family	House cleaning frequencies	0.017
			Frequency of household insecticide use	0.593**
			Frequency of hand wash	-0.278*
			Frequency of foot wash	0.079
			Latest household insecticide use	0.399**
Hand wipe	Pyrethroid	Non-occupational family	House cleaning frequencies	-0.144
			Frequency of household insecticide use	0.423**
			Frequency of hand wash	-0.433**
			Latest household insecticide use	0.131
		Occupational family	House cleaning frequencies	0.039
			Frequency of household insecticide use	0.322*
			Frequency of hand wash	-0.336*
			Latest household insecticide use	0.139

Environmental Samples	Pesticide	House type	Variables	Spearman's rho
Foot wipe	Pyrethroid	Non-occupational family	House cleaning frequencies	-0.289*
			Frequency of household insecticide use	0.213
			Frequency of foot wash	-0.273*
			Frequency of shoe's wear	0.387**
			Latest household insecticide use	-0.022
		Occupational family	House cleaning frequencies	-0.103
			Frequency of household insecticide use	0.244
			Frequency of foot wash	-0.065
			Frequency of shoe's wear	0.436**
			Latest household insecticide use	0.135

**. Correlation is significant at the 0.01 level., *. Correlation is significant at the 0.05 level

4.3.2 Environmental samples and personal samples

For surface, hand and foot wipe samples were detected pyrethroid insecticide. In non-occupational household, the association between surface wipe and hand wipe sample were positive correlation (Spearman's rank correlation coefficient 0.511 at p=0.01) and in occupational households were positive correlation (Spearman's rank correlation coefficient 0.473 at p=0.01). However, in occupational households; the association between surface wipe and foot wipe sample were positive correlation (Spearman's rank correlation coefficient 0.485 at p=0.01) as show in table 4.19.

Table 4.19 Association between environmental samples and personal samples

Pesticides	**House type**	**Variables**	**Spearman's rho**
Pyrethroid	Non-occupational family	Surface wipe & Hand wipe	0.511**
		Surface wipe & Foot wipe	0.264
	Occupational family	Surface wipe & Hand wipe	0.473**
		Surface wipe & Foot wipe	0.485**

**. Correlation is significant at the 0.01 level.

*. Correlation is significant at the 0.05 level.

4.3.3 Environmental samples and biological samples

For urine metabolite levels, DAPs concentrations of OPs insecticides were measured in participant urine samples. Also, in air samples and surface wipe samples were detected OPs insecticides. Thus, the association between urine metabolite levels and air samples and surface wipe samples were conducted. The association between urinary metabolite levels and air samples and surface wipe samples were positive correlation (Spearman's rank correlation coefficient 0.379 and 0.424 at p=0.01).

Meanwhile, in non-occupational households, the association between urinary metabolite levels and air samples and surface wipe samples were positive correlation (Spearman's rank correlation coefficient 0.320and 0.423 at p=0.05 and p=0.001 respectively). For occupational households, the association between urinary metabolite levels and air samples and surface wipe samples were positive correlation (Spearman's rank correlation coefficient 0.402and 0.385 at p=0.01) as show in table 4.20.

Table 4.20 Association between environmental samples and biological samples

Pesticides	House type	Variables	Spearman's rho
Organophosphate	Non-occupational family	Urinary metabolite levels & Air samples	0.320*
		Urinary metabolite levels & Surface wipe	0.423**
	Occupational family	Urinary metabolite levels & Air samples	0.402**
		Urinary metabolite levels & Surface wipe	0.385**

**. Correlation is significant at the 0.01 level.

*. Correlation is significant at the 0.05 level.

CHAPTER V

DISCUSSION

5.1 Household insecticide used

In this study, the results showed the age ranged from 19 to 84 years. For local traditional in Thailand, elderly people will be living with their family when retired. Then, the majority of this study was in range of 41-70 years. These findings are similar to other research that demonstrated that 26.0% of the participants were between the ages of 41 to 50 years (Recena et al., 2006). The majority of the participants were female (52.8%), 80.6% of respondents graduated from primary school, which was in accordance with a study conducted in Brazil where 83.2% of workers had less than 8 years of education (Recena et al., 2006). Also, in another research study undertaken in Nepal, data revealed that most of participants had less than 8 years of education (Atreya, 2007).

This study found that 73.1% of the participants reported using household insecticide which is similar to another study in northern California that showed total of 80% of the participants reported using insecticides in their houses (Wu et al., 2011) and in Uganda found that most of the participants used pesticides as household pests control (Nalwangka and Ssempebwa, 2011).

In addition, house's hygiene cause health problems and home environment is widely considered to be the most common pesticide-treated indoor environment (WHO, 1997). Inappropriate manage of household wastewater cause a number of environmental and health hazards such as pools of wastewater may provide breeding sites for mosquitoes (Nalwangka and Ssempebwa, 2011). Including poor garbage disposal and unwashed plates and dishes are sources of food for pests for example ants and cockroaches. Spray application in kitchen may contaminate on cookware or surface that may come in contact with food (Vonderheide et al., 2009).In addition, use of insecticides in bedroom or common room where family's member spend amount of time may result in increased inhalation and dermal exposure (Wu et al., 2011)

Household insecticides were used to treat problem insects such as mosquitoes, ants, and cockroaches. These pests have been implicated with causing disease in households, for example malaria and asthmatics (Nalwangka and Ssempebwa, 2011). On the other hand, a study in Minnesota reported that 88% of household with children used pesticides in their house (Adgate et al., 2000). For pesticide applications 70.9% used sprays, 26.6% used mosquito coil and 2.5% of them used insecticides chalk for pest control in their house. Insecticides chalk was known used to be effective at killing the specific insect; such as ants. In other hand, the research undertaken in Uganda and northern California were found that the majority of household pests control method are insecticides spray followed by using coils and insecticide chalks (Wu et al., 2011; Nalwangka and Ssempebwa, 2011).

All household insecticides used in this area contained pyrethroids, for example in sprays; the active ingredients were esbiothrin, d-tetramethrin, cypermethrin, prallethrin, imiprothrin and permethrin. Mosquito coil were also common used and the active ingredients were esbiothrin and d-allethrin. Pyrethroids exhibit neurotoxin effects by modulating sodium channel voltages. In the past several years, the use of synthetic pyrethroids has escalated as the use of the more toxic OP and carbamate insecticides has been curtailed. Many products that are routinely found in retail stores for home use contain pyrethroids (Barr, 2008). In 2011, Nalwangka and Ssempebwa reported that all pesticide sprays used contained pyrethroid such as cypermethrin, permethrin, and pyrethrin formulations (Nalwangka and Ssempebwa, 2011).

From the result, household insecticides use contained only pyrethroid and could be conclude that if found other insecticides or pesticides residue in household that may contaminate from agriculture activities in the community.

5.2 Residential Pesticide Contamination

In this study agricultural pesticides and household insecticides exposure are primarily concerned in the home environment. Moreover, the results were examined the most factors that contaminate in household among agricultural community.

5.2.1 Environmental samples

In this study, the greatest number of detections was in surface wipe samples. The results showed that chlorpyrifos was detected in air samples with an average concentration $1.28 x 10^{-3}$ mg/m^3 in occupational houses and $1.15 x 10^{-3}$ mg/m^3 in non-occupational houses. Organophosphate insecticides (e.g., chlorpyrifos and profenofos) are used the most in chili crop. Thus, indirect exposure of people in community to insecticides may occur through air and surface. Surface wipe samples were detected chlorpyrifos with an average concentration $2.89 x 10^{-2}$ mg/kg in non-occupational households and $4.67 x 10^{-2}$ in occupational households. Ten point two percent of surface wipe samples were detected pirimiphos-methyl with average concentration $2.44 x 10^{-2}$ mg/kg in non-occupational households and $3.18 x 10^{-2}$ in occupational households. Additional, both of air and surface wipe samples had average concentrations in occupational houses were higher than non-occupational houses.

These findings are similar to other research that found chlopyrifos had the high mean concentration in each season for indoor air (366.6, 205.4 and 120.3 ng/m^3 in summer, spring, and winter season, respectively) (Whitmore et al., 1994). In 2005, Curwin et al collected 99 indoor air samples and reported that chlopyrifos was detected in indoor air samples with range 0.04-0.23 $\mu g/m^3$ from farm households and range 0.01-0.05 $\mu g/m^3$ from non-farm households. This research also found chlopyrifos in house wipe samples in both of farm and non-farm households with range 0.32-25 ng/cm^2 from farm houses and with range 0.22-3.8 ng/cm^2 from non-farm houses (Curwin et al., 2005).

On the other hand, previous researches were collected houses dust from floors and carpets. A study in Arizona found that chlopyrifos in houses dust with a geometric mean 113 ng/g (CDC, 2002). In 2002, Curl et al found chlorpyrifos in houses dust from farm worker houses with a geometric mean 50 ng/g. This study reported that in farm households are more contaminated than non-farm household (Curl et al., 2002). In 2000, Fenske et al reported that soil and house dust concentrations of organophosphorus pesticides were elevated in homes of agricultural families when compared to non-agricultural homes in the same community (Fenske et al., 2000).

Also, in 2009, Stout II et al reported that about 78% of floor wipes were detected chlorpyrifos with an average concentration 0.50 ng/cm^2 (Stout II et al., 2009). In other research study undertaken in California, data revealed that pesticide level in houses dust from farm houses are higher that non-farm houses (Bradman et al., 1997). These is notice that chlorpyrifos was most frequently detected in many research. After organochlorine pesticides were banned, non-persistent pesticides were developed and widely used in agricultural applications (Barr, 2008). Non-persistent pesticides are called current-use pesticides including organophosphate, carbamates and pyrethroid insecticides.

In term of house location, the result showed that there were no significant differences between non-occupational and occupational households in the same level of house's distance for average concentration of all OPs in air and surface wipe samples (Mann-Whitney test, $p>0.05$). All households were cross compared of OPs concentration between house located levels. It was found that all households of level1 had significantly higher levels than level2 and level3 (Kruskal Wallis test, $p<0.001$).

Also, in 1995, Simcox et al, found that pesticide levels in dust increased with increasing distance. Lu et al, also reported the concentration of OP pesticides in house dust for agricultural population living more than ¼ mile from farmland were higher than those of the reference population (Lu et al., 2000).In 2001, Lewis et al, demonstrated that the pesticides applied outside dwellings are re-deposited inside the dwelling within hours (Lewis et al., 2001).

This is consistent with the ideas that agricultural pesticides are re-suspended into the air and re-deposited as they fall on surfaces (Lewis et al., 2001). The result of air and surface wipe samples explain that house's distance is importance factors of agricultural pesticide exposure than family's occupation because in level 1 had higher OPs concentration than house's distance in level 2 and 3 in both of farmer and non-farmer's family. Residence adjoining to chili farm can be contaminated by air drift during application and by subsequent wind circulation of dust from chili farms.

The majority of these samples were detected permethrin. More than half of surface wipe samples (56.5%) were detected pyrethroid insecticides (permethrin) in 25 non-occupational households and 25 occupational households with average concentration 12.4×10^{-2} mg/cm^2, 10.8×10^{-2} mg/cm^2 respectively. Of 8.33% of surface wipe samples were detected cypermethrin in non-occupation households with average concentration 3.33×10^{-2} mg/cm^2 and 1.85% in occupational households with average concentration 2.29×10^{-2}mg/cm^2.

Currently, pyrethroid insecticides are marketed to consumers and applied by pest control to control general insect pests. A study on residential pesticides in the U.S. (Stout II et al., 2009) found that the most commonly detected of floor wipes were permethrin (89%)and cypermethrin (46%) with an average concentration 2.9 ng/cm^2 for cypermethrin. In addition, they reported the highest measured GM (GeoMean) were *cis*- and *tran*- permethrin (0.11 and 0.14ng/cm^2, respectively), follow by chlopyrifos (0.01ng/cm^2) and cypermethrin (0.03ng/cm^2).The high surface loading for pyrethrion insecticides are consistent with its current popularity for residential use.

All households were cross compared of OPs and pyrithroid concentration of surface wipe samples between house located levels. It was found as same as in air samples that all households of level1 had significantly higher levels of OPs concentration than level2 and level3 (Kruskal Wallis test, $p<0.001$).

These result showed that house's location and household insecticides use are factors that could cause the high household organophosphate and pyrethroid insecticides exposure. A study of indoor surface loading from famer's house in North Carolina and Virginia (Quandt et al., 2004) found that in this area higher indoor surface loadings were expected due to proximity of house to agricultural fields and spray drift. In 2008, the study in Boston, Massachusetts found that the concentration of permethrin and cypermethin from the kitchen floor were 0.68 and 0.37 ng/cm^{2}respectively and the median concentration (Julien et al., 2008).The finding from this study showed that floor may be a store of pesticides residue in the house.

For drinking water samples, most of participants consume groundwater (48.1%) follow by tab water (33.3%) and others (18.5%), such as bottled water and rain water. A total of 54 drinking water samples from occupational houses and 54 drinking water samples from non-occupational houses were not detected organophosphate pesticides and pyrethroid insecticides. This may be due to the clay and silt soil in the Hua-Rua sub-district and in addition, organophosphate pesticides and pyrethroid insecticides have short half-lives (non- persistence pesticides). The data of ground water from Department of Groundwater Resources showed pH levels of groundwater in Hua-Rua sub-district range from 6.0-8.5 (DGR., 2012).

These findings are similar to other research in Hua-Rua sub-district that found heavy metal contamination in ground water and the highest concentration of arsenic in shallow groundwater was 8.98 μg/L. Only one out of twelve wells was acceptable level for non-carcinogen which had the Hazard Quotient value of arsenic were lower than one (HQ<1). Moreover, local people who generally drinking groundwater in this area can be get carcinogenic effect or cancer from arsenic contamination (Wongsasuluk et al., 2011).

From results, groundwater in this area contaminated with arsenic (As) and local people in community may be exposed from heavy metal contaminated. Thus, the education and information regarding quality of groundwater should be providing to the community.

5.2.2 Personal samples

5.2.2.1 Hand and Foot wipe samples

All hand wipe samples were not detected organophosphate pesticides. The majority of these samples were below the LOD, 11.1% of hand wipe samples were detected permethrin with an average concentration $2.33 x 10^{-2}$ mg/kg in non-occupational households and occupational households. The average concentrations of cypermethrin were $2.33 x 10^{-2}$ mg/kg in non-occupational household and $2.07 x 10^{-2}$ mg/kg in occupational households. Unlike previous studied that have focus on OP pesticides (Fenske et al., 2002). The result showed that hand wipe samples were detected permethrin and permethrin which presences of common residential insecticides use in study area. This result similar to the study in the U.S. reported that organophosphate and pyrethroid insecticides were present in most homes (Quandt et al., 2004).

In term of detected frequency, no significant differences of detection frequencies of hand wipe samples were found among non-occupational and occupational group (Chi-square test; $p>0.05$). The result showed that there were no significant differences between non-occupational and occupational households in all 3 groups (children, working age and elderly) for average concentration of permethrin and cypermethrin in hand wipe samples (Mann-Whitney test, $p>0.05$).

Previous study in North Carolina and Virginia reported that children of farmer's family were detected chlorpyrifos, *cis*- and *tran*-permethrin in hand wipe samples with mean concentration 6.1, 8.0 and 13.5 $\mu g/m^2$, respectively (Quandt et al., 2004). On the other hand, Fenske et al reported that a study in 1998 of children's hand wipe and found cholpyrifos residue on their hands (Fenske et al., 2002).

For foot wipe samples, 13.9% of foot wipe samples were detected permethrin with an average concentration $2.39 x 10^{-2}$ mg/kg in non-occupational households and $2.44 x 10^{-2}$ mg/kg in occupational households.

The result showed that there were no significant differences between non-occupational and occupational households in all 3 groups (children, working age and elderly) for average concentration of permethrin in foot wipe samples (Mann-Whitney test, $p>0.05$).It is difficult to interpret the health significance of amounts of pesticides measured in the wipe samples (Quandt et al., 2004).

There is no standard for presenting these data or compare with another study. Thus, the result showed that permethrin can be contaminated by dermal route via foot. Permethrin and cypermethrin are commonly of the active ingredients in household insecticides used in this community and the findings from this study confirm that household insecticide users may be contaminate via dermal routes.

5.2.3 Biological samples

Because of organophosphate pesticides are mostly used in this community and people in community may expose from farmer's activities. Thus, this study was specific analyzed organophosphate pesticides. Urine samples were analyzed to assess exposure to OP pesticides and the six common dialkylphosphate (DAP) metabolites of OP insecticides were measured.

5.2.3.1 Children Urinary Metabolite levels

The results presented in this study provide the urinary metabolites of Children of occupational family had significantly higher detection frequencies of DEP (Chi-square test, p=0.041) than children of non-occupational family.

GeoMean concentrations of urinary diethylphosphate metabolites, both creatinine and non-creatinine adjusted results. The following were the range of diethylphosphate metabolites; DEP 0.74ng/mL (1.15µg/g.cre), DETP 1.20ng/mL (1.87µg/g.cre), DEDTP 0.40ng/mL (0.61µg/g.cre) and molar summed DEPs range from 0.02ng/mL (0.03 µg/g.cre).

These results were relative with another study of children from northern; Thailand (Panuwet, 2008) found that GeoMean concentrations of urinary diethylphosphate metabolites of DEP 1.72ng/mL (1.37 µg/g.cre), DETP 1.57ng/mL (1.25 µg/g.cre), DEDTP 0.30ng/mL (0.24 µg/g.cre).

Previous study in pre-school children in agricultural community, they reported that in dry season (April-May), farm children excreted significantly higher levels of all DAP metabolites than the reference children. In addition, the results showed that GeoMean concentrations of urinary diethylphosphate metabolites in dry season (creatinine adjusted) of DEP 4.74 µg/g.cre, DETP 2.53 µg/g.cre. and DEDTP 3.06 µg/g.cre (Petchuay et al., 2006). This study found higher of all DEPs metabolites concentration than our study.

A study of children in agricultural worker's homes reported that GeoMean concentration of urinary molar summed diethylphosphate (DEPs) metabolite among children 0.09 µmol/g. (creatinine-adjusted) (Curl et al., 2002).

Cross comparisons of metabolite concentrations found among children of occupational and non-occupational family were done. Children of occupational family had significant higher levels than children of non-occupational family for DEP (both non-creatinine and creatinine adjusted results; Mann-Whitney test, p=0.005 and p=0.001 respectively), DETP (creatinine adjusted results; Mann-Whitney test, p=0.042), DEDTP (both non-creatinine and creatinine adjusted results; Mann-Whitney test, p=0.012 and p=0.003 respectively) and molar sum DEPs (both non-creatinine and creatinine adjusted results; Mann-Whitney test, p=0.023 and p=0.008 respectively).

In contrast, previous study reported that the comparisons of urinary metabolite concentration between children of agricultural family and non-agricultural family were no significant differences of levels of dialkylphosphate (both non-creatinine and creatinine adjusted results; Mann-Whitney test, p>0.05) (Panuwet P., 2008).

There were no significant differences between male and female children for average concentration of all diethylphosphate metabolites (both non-creatinine and creatinine adjusted results; Mann-Whitney test, p>0.05). Result of some studies were similar, a study of children in 2008 found negative correlation between age and molar sum-DAPs (creatinine adjusted results) (Panuwet P., 2008).

5.2.3.2 Working age Urinary Metabolite levels

Cross comparisons of urinary metabolite concentration were completed among working age of occupational family and non-occupational family. There were no significant differences of detection frequencies of all diethylphosphate metabolites (Chi-square test, $p>0.05$). As same as the results in Iowa, reported that detected frequencies of chlopyrifos in urine levels between adult of farm and non-farm family were no significantly differences (Curwin et al., 2007).

Urinary metabolites concentration, both creatinine and non-creatinine adjusted results. The following were GeoMean concentration of molar summed DEPs range from 0.05ng/mL (0.05 µg/g.cre). In contrast, the results from Curwin et al, showed that the GeoMean concentration of chlorpyrifos in adult males and females in non-farm family were 12 µg/L and 13 µg/L, respectively. However, adult males and females in farm family had higher GeoMean concentration of chlorpyrifos than non-farm family (17 µg/L and 14 µg/L, respectively (Curwin et al., 2007).

In addition, Curwin et al, reported that chlorpyrifos still to be use in households. Thus, people who used chlorpyrifos as household insecticides could be exposing more than this study.

5.2.3.3 Elderly Urinary Metabolite levels

The detection frequency of diethylphosphate metabolites in non-occupational family were as followed; DEP (5.56%), DETP (27.8%) and in occupational families were DEP (44.4%), DETP (38.9%). Meanwhile both of elderly of occupational and non-occupational family were not detected DEDTP. From the results showed that elderly were expose lass than children and working age group and can assumed that their activities during day may not contaminated to pesticides.

Elderly of occupational family had significantly higher detection frequencies of DEP (Chi-square test, p=0.018) than elderly of non-occupational family. Meanwhile no significant differences of detection frequencies of DETP (Chi-square test; p=0.725). This result could be concern about take-home pesticides exposure may have association with elderly activities. From observation, elderly in this study area not have activities during day too much; they only used the common area outside their home during day.

There is no presenting these data or compare with another study. Thus, the result showed that elderly can be contaminated by agricultural pesticides as same as children and working age while stay at home.

Overall, Cross comparisons of diethylphosphate metabolites concentrations found among family's member of occupational and non-occupational family were done. Family's member of occupational family had significant higher levels than non-occupational family. Curwin et al. (2007) found that "farm family members generally had higher urinary pesticide levels for chlorpyrifos than non-farm family members". "The metabolite concentration decreased with increasing distance from farmland" (Lu et al., 2000). The National Health and Nutrition Examination Survey (NHANES) reported the estimates of GeoMean levels for chlorpyrifos in adult males, adult female and children were 2.0, 1.5 and 2.8 µg/L, respectively (CDC, 2005).

5.3 Association between environmental factors and residential pesticide contamination

5.3.1 Environmental samples and environmental factors

For air samples were detected only OPs pesticide (chlorpyrifos) which usually applying to chili farm (Norkaew et al., 2010). The association between air samples and house located were negative correlation (Spearman's rank correlation coefficient -0.367 at p<0.01) in both of non-occupational and occupational households.

In addition, surface wipe samples; the association between OPs pesticide residue concentrations and house located were negative correlation (Spearman's rank correlation coefficient -0.453 at p<0.01) in non-occupational family households. Meanwhile in occupational family households, the association between OPs pesticide residue concentrations and house located were high negative correlation (Spearman's rank correlation coefficient -0.739 at p<0.01).

A study of organophosphorus pesticides in 2001 reported that the pesticides applied outside households are re-drop inside the household within hours (Lewis et al., 2001). This is consistent with the ideas that agricultural pesticides are re-suspended into the air and re-deposited as they fall on surfaces (Lewis et al., 2001).Lu et al, also reported the concentration of OP pesticides in house dust for agricultural population living more than ¼ mile from farmland were higher than those of the reference population (Lu et al., 2000). Previous studies were supported the result that house's location are the importance factors of pesticides exposure among people in agricultural community.

For pyrethroid insecticide residues in surface wipe samples, the association between pyrethroid insecticide concentrations in surface wipes sample and frequency of household insecticide use were positive correlation in both of non-occupational and occupational households (Spearman's rank correlation coefficient 0.630 and 0.593 at p<0.01 respectively). The frequency of household insecticides use could be reduced regarding the results showed the positive correlation between pyrethroid insecticides residue on surface and frequency of insecticides used.

Moreover, personal samples; hand and foot wipe samples were detected only pyrethroid insecticides. In non-occupational households, the association between hands wipes samples and frequency of household insecticide use and type of household insecticide use were positive correlation (Spearman's rank correlation coefficient 0.423 and 0.364 at $p<0.01$ respectively) that showed household insecticides can be contaminated via dermal and ingestion route. However, the association between pyrethroid concentration of hands wipes samples and frequency of hand wash were negative correlation (Spearman's rank correlation coefficient -0.433 at $p<0.01$) that showed the solution to reduce the residue of pyrithroid insecticides exposure. For occupational households, the association between hands wipes samples and frequency of household insecticide use were positive correlation (Spearman's rank correlation coefficient 0.322 at $p<0.05$), and with frequency of hand wash were negative correlation (Spearman's rank correlation coefficient -0.336 at $p<0.05$).

For foot wipe samples; in non-occupational household, the association between pyrethroid insecticide concentration and house cleaning frequency were negative correlation (Spearman's rank correlation coefficient -0.289 at $p<0.05$). This result showed that household insecticides users can be reduce insecticides exposure via dermal route by increasing frequency of cleaning their floor.

Interestingly, the association between pyrethroid insecticide concentration and frequencies of shoe's wear were positive correlation (Spearman's rank correlation coefficient 0.387 at $p<0.01$). This result can be assumed that participant's shoe may be contaminated with household insecticides and from observation they were not cleaning their shoe both of before and after used. Thus, if they usually wearing shoe without cleaning, not reduces the contaminated from insecticides.

These results suggest that housing quality predicts household insecticide levels. Houses that are harder to clean may provide better habitats for pests as well as prevent the removal of pesticide containing dust (Quandt et al., 2004).

5.3.2 Environmental samples and personal samples

In non-occupational household, the association between surface wipe and hand wipe sample were positive correlation (Spearman's rank correlation coefficient 0.511 at p<0.01) and in occupational households were positive correlation (Spearman's rank correlation coefficient 0.473 at p<0.01). In addition, in occupational households; the association between surface wipe and foot wipe sample were positive correlation (Spearman's rank correlation coefficient 0.485 at p<0.01).

From the result, the concentration of pesticides residue on the surface predicted pesticides on hand and foot. This was relative with another study of agricultural and residential pesticides in wipe samples from farm-worker family residences in North Carolina and Virginia reported that in both of farm's pesticides and residential pesticides, presence of pesticides on the floor predicted on hand (Quandt et al., 2004).

5.3.3 Environmental samples and biological samples

For urine metabolite levels, DAPs concentrations of OPs insecticides were measured in participant urine samples. Also, in air samples and surface wipe samples were detected OPs insecticides. Thus, the association between urine metabolite levels and air samples and surface wipe samples were conducted. The highly detectable percentage of air and surface wipe samples were found from this study, the correlation between inhalation and dermal routes and urinary metabolite was found.

The association between urinary metabolite levels and air samples and surface wipe samples were negative correlation in both of non-occupational and occupational households. Likely previous study in 2000, reported that the metabolite concentration decreased with increasing distance from farmland (Fenske et al., 2000). This result showed that agricultural pesticides can be contaminated via air drift and residue in air and floor.

5.4 Risk communication

The goal of risk communication is "to rectify the knowledge gap" between the researcher of scientific information and those receiving the information (Frewer, 2004). Risk communication focused on communicating general risk messages to communities, not on communicating specific exposure or risk data to individuals. The collection of all samples presents a responsibility to return information to the affected participants.

From the results demonstrated that people in this community may expose via inhalation and dermal pathways including indirect ingestion can occur as well. Also, these study confirm the theory that relatively non-persistent chemical for example, OP pesticides can be stable in residences. However, to illuminate a relationship between environmental factors and biological levels in this population, this finding showed that urine metabolite levels had association between air and surface wipe samples. Therefore, people in this community could be able to acknowledge the information of pesticides and insecticides expose's pathways and prevention from their activities that can be contaminated of agricultural and household insecticides.

The previous study in Hua-Rua sub-district reported that the sources of information which the respondents obtain pesticide knowledge information were from agricultural officer 17.89%, television 15.75% respectively. Other sources were pesticide salesman 14.56%, documents 12.72% and radio 12.42% (Norkaew et al., 2010). According this reported, most of people in this community obtain pesticide knowledge information from agricultural officer. Thus, it is should be developed education and promoted by the public health and/or agricultural officer, which can assess people health risk.

The intervention measurements should be developed for enhancing the suitable practice for pesticides and insecticides using and improve the quality assured information still need to give better advice to users. Including, develop a community-based intervention to reduce the take-home exposure pathway and considered for improving knowledge of people of harmful effects of agricultural pesticides and household insecticides.

In addition, Bureau of Epidemiology reported that in 2007, Thailand had 1,452 patients from pesticides toxic. In 2008, Ubonratchathani province had 42 patients from pesticides toxic and increased to 75 patients in 2009 (Unpublished Data, Hua-rua Tambon Health Promoting Hospital, 2012). Agricultural pesticides and household insecticides are wildly available in Thailand, with a high number of products which is easy to purchase. The individual behavior when using pesticide and insecticide products has leaning to affect pesticide exposure.

A research from Department of Agriculture 2011, suggested the practice for pesticide and insecticide user. For example, read instruction carefully, stored pesticides/insecticides away from food/kid and wash hands, face and shower immediately after using pesticides/ insecticides (Department of agricultural, 2011). Base on the recommendation from Department of agricultural, public education is necessary to address the knowledge gap revealed in the study. Therefore educational programs should be organized for improving knowledge about harmful effects of agricultural pesticide and household insecticide and it should focus mainly on increasing the awareness of the people of the importance of prevent themselves from pesticide exposure.

CHAPTER VI
CONCLUSIONS

6.1 Conclusion

To evaluate the pesticide exposures in people living in agricultural community to multi-exposure pathways, the specific measurement tools were used with each pathway's samples. The study population was focused on people who living in agricultural community including 108 households. 54 occupational households: children 18 houses, working age 18 houses, elder 18 houses and 54 non-occupational households: children 18 houses, working age 18 houses, elder 18 houses were recruited to participate.

For household insecticide uses, found that the majority of the participants were female (52.8%) and 47.2% were male, 80.6% of respondents graduated from primary school. About half of respondents (52.7%) had an income less than 5,000 baht per month, of 33.4% had an income 5,001-10,000 baht per month. Approximately, 49.1% of the respondents were employees, of 24.1% were farmers, of 13.0% were local business owners such as local food shop or grocery shop, and 11.1% of them were unemployed.

This study found that 73.1% of the participants reported using household insecticide as household insect control. Household insecticides were used to treat problem insects such as mosquitoes, ants, and cockroaches. For pesticide applications 70.9% used sprays, 26.6% used mosquito coil and 2.5% of them used insecticides chalk. All household insecticides used in this area contained pyrethroids. This finding could be concluding most of people in agricultural community commonly used insecticides in their households. From the result, household insecticides use contained only pyrethroid and that may contaminated to family's members.

The high detection frequencies observed for cholrpyrifos, permethrin and cypermethrin suggest these compounds are essentially pervasive in their common areas and that popular use in this community has a major influence on their occurrence in homes.

In this study, the greatest number of detections was in surface wipe samples follow by air samples. The results showed that chlorpyrifos was detected in Surface wipe samples were detected chlorpyrifos with an average concentration $2.89x10^{-2}$ mg/kg in non-occupational households and $4.67x10^{-2}$ in occupational households and in air samples with an average concentration $1.28x10^{-3}$ mg/m^3 in occupational houses and $1.15x10^{-3}$ mg/m^3 in non-occupational houses. Organophosphate insecticides (e.g., chlorpyrifos and profenofos) are used the most in chili crop. Thus, indirect exposure of people in community to insecticides may occur through air and surface. Ten point two percent of surface wipe samples were detected pirimiphos-methyl with average concentration $2.44x10^{-2}$ mg/kg in non-occupational households and $3.18x10^{-2}$ in occupational households. Additional, both of air and surface wipe samples had average concentrations in occupational houses were higher than non-occupational houses. This finding could be concluding that occupational family may more exposed from take-home of agricultural pesticides.

In term of house location, the result showed that there were no significant differences between non-occupational and occupational households in the same level of house's distance for average concentration of all OPs in air and surface wipe samples. All households were cross compared of Ops concentration between house located levels. It was found that all households of level 1 had significantly higher levels than level 2 and level 3. The association between air samples and house located were negative correlation as well as in surface wipe samples; the association between OPs pesticide residue concentrations and house located were negative correlation

This result could be concluding that pesticide levels residue in household increased with increasing distance and explain that house's distance is importance factors of agricultural pesticide exposure than family's occupation because in level 1 had higher OPs concentration than house's distance in level 2 and 3 in both of farmer and non-farmer's family. Residence adjoining to chili farm can be contaminated by air drift during application and by subsequent wind circulation of dust from chili farms.

The majority of surface samples were detected permethrin. More than half of surface wipe samples (56.5%) were detected pyrethroid insecticides (permethrin) and 8.33% were detected cypermethrin. From the result of household insecticides used, reported that household insecticides use contained only pyrethroid. The finding from this study showed that floor may be a store of pesticides residue in the house and confirmed that household insecticides used were residue on the surface and can contaminate to family's members.

The majority of hand and foot wipe samples were detected permethrin and cypermethrin. As same as the reason from surface wipe samples, dermal route may contaminate via hand and foot of the household insecticide user and their family.

The association between pyrethroid insecticide concentrations in surface, hand and foot wipe and frequency of household insecticide use were positive correlation in both of non-occupational and occupational households. In addition, the association between surface wipe and hand wipe were positive correlations which mean pesticides on the floor predicted on hand. The frequency of household insecticides use could be reduced regarding the results showed the positive correlation between pyrethroid insecticides residue on surface and frequency of insecticides used.

Urine samples were analyzed to assess exposure to OP insecticides. Six DAP metabolites are the most commonly measured metabolites for assessing human exposure to OP pesticides. Because of organophosphate pesticides are mostly used in this community and people in community may expose from farmer's activities. Thus, this study was specific analyzed organophosphate pesticides. These results showed that GeoMean concentrations of molar summed DEPs urinary metabolites in working age higher than children and elderly group, respectively. This finding concludes that the activities among each group may effect to the concentration of urinary metabolite levels and family's member of occupational family had significant higher levels than non-occupational family.

For urine metabolite levels, DAPs concentrations of OPs insecticides were measured in participant urine samples. Thus, the association between urine metabolite levels and air samples and surface wipe samples were conducted. The highly detectable percentage of air and surface wipe samples were found from this study.

The association between urinary metabolite levels and air samples and surface wipe samples were positive correlation. This finding could be concluding the correlation between inhalation and dermal routes and urinary metabolite was found.

6.2 Limitation of the study

1. This study was focused only the common pesticides that use in this community and other groups of pesticides were not investigated.
2. For biological samples, the urinary metabolites only analyzed DAPs. In this study found pyrethroid insecticides residue in surface, hand and foot wipe. Thus, specific metabolites of pyrethroid insecticides should be analyzed in further study.
3. Other sources of exposure may be involved, for example dietary exposure which may be important pathways of exposure.
4. Symptoms related to OP pesticides and PY insecticides in this study were not specifically examine.

6.3 Recommendations

1. Further research need to assess other pesticides related toxicological of pesticides in more detail and investigating the relationship between pesticides exposure and health effects.
2. For risk communication step, the education program involved agricultural pesticide and household insecticide exposure protection should be provided for this community.
3. The government should ensure that the pesticides and insecticides instruments are easy to understand including direction and health hazard of pesticides use and this data can provide baseline information for evaluating the impact of policies associated with pesticide use reduction.
4. The regulation of chemical using should be provided, because pesticides and insecticides are widely used and pesticide use should be avoided in areas where children are likely to play. If a household insecticide application is necessary, it is important to follow the label instructions.

REFERENCES

AOAC (Association of official Agricultural Chemists). 1993. Peer Verified Methods Program. Manual on Policies and Procedures Arlington, VA, USA.

Arcury, T. A., Quandt, S. A., Cravey, A. J., Elmore, R. C. and Russell, G. B. 2001. Farmworker reports of pesticide safety and sanitation in the work environment. Am J Ind Med. 39: 487-498.

Azaroff, L. F. 1999. Biomarkers of exposure to organophosphorus insecticides among farmer's family in rural El Salvador: Factors associated with exposure. Environ Research. 80: 138-147.

Babina, K., Dollard, M., Pilotto, L. and Edwards, W. J. 2012. Environmental exposure to organophosphorus and pyrethroid pesticides in South Australian preschool children: A cross sectional study. Environmental International. 48: 109-120.

Barr, D. B., Panuwet, P., Nguyen, J. V., Udunka, S. and Needham, L. L. 2007. Assessing Exposure to Atrazine and Its Metabolites Using Biomonitoring. Environmental Health Perspectives. 115: 1474–1478.

Barr, D. B. 2008. Biomonitoring of exposure to pesticides. Journal of Chemical Health and Safety. 15 (6): 20-29.

Bearer, C. F. 1995. How are children different from adults?. Environmental Health Perspectives. 103: 7–12.

Bell, E. M., Hertz-Picciotto, I. and Beaumont, J. J. 2001. Case-cohort analysis of agricultural pesticide applications near maternal residence and selected causes of fetal death. American Journal of Epidemiology**.** 154**:** 702–710.

Bouvier, G**.,** Blanchard, O., Momas, I. and Seta, N. 2006. Pesticide exposure of non-occupationally exposed subjects compared to some occupational exposure: A French pilot study. Science of The Total Environment. 366: 74-91.

Bradman, M. A., Harnly, M. E., Draper, W., Seidel, S., Teran, S., Wakeham, D., et al. 1997. Pesticide exposure to children from California's Central Valley: Results of pilot study. Journal of Exposure Analysis and Environmental Epidemiology. 7(2): 217-234.

Centers for Disease Control and Prevention (CDC). 2002. Pesticide exposure in children living in agricultural areas along the United States-Mexico boarder, Yuma Country, Arizona, US Centers for Disease Control, National Center for Environmental Health, Health Studies Branch, Alanta, GA.

Coronado, G. D., Thompson, B., Strong, L., Griffith, W. C. and Islas, I. 2004. Agricultural task and exposure to organophosphate pesticides among farmworkers. Environmental Health Perspectives. 112 (2): 142-147.

Curl, C. L., Frenske, R. A., Kissel, J. C., Shirai, J. H., Moate, T. F., Griffith, W., et al. 2002. Evaluation of take-home organophosphorus pesticide exposure among agricultural workers and their children. Environmental Health Perspectives. 110(12): A787-92.

Curwin, B. D., Sanderson, W. T., Reynolds, S. J., Hein, M. J. and Alavanja, M. C. 2002. Pesticide use and practices in an Iowa farm family pesticide exposure study. Journal of Agricultural Safety and Health. 8: 423–433.

Curwin, B. D., Hein, M. J., Sanderson, W. T., Striley, C., Heederik, D., Kromhout, H., Reynolds, S. J. and Alavanja, M. C. 2006. Urinary Pesticide Concentrations Among Children, Mothers and Fathers Living in Farm and Non-Farm Households in Iowa. The Annals of Occupational Hygiene. 51: 53–65.

Daniels, J. L., Olshan, A.F. and Savitz, D.A. 1997. Pesticides and childhood cancers. Environmental Health Perspectives. 105: 1068–1077.

Department of Agriculture, Thailand. Pibai magazine [Online]. 2011. Available from: http://it.doa.go.th/pibai/pibai/n14/v_7-aug/rai.html [11, November 2012]

Department of Groundwater Resources. Well data in Ubonratchathani Province [Online]. 2012. Available from: http://www.dgr.go.th/well_web/WellWEB/welldata/UbonRatchathani.htm [14, January 2013]

Eskenazi, B., Bradman, A. and Castorina, R. 1999. Exposures of children to organophosphate pesticides and their potential adverse health effects. Environmental Health Perspectives. 107: 409–419.

Fenske, R. A., Lu, C., Simcox, N. J., Loewenherz, C., Touchstone, J., Moate, T. F., Allen, E. H. and Kissel, J.C. 2000. Strategies for assessing children's organophosphorus pesticide exposures in agricultural communities. Journal of Exposure Analysis and Environmental Epidemiology. 10: 662-671.

Fenske, R. A., Lu, C., Barr, D. and Needham, L. 2002. Children's exposure to chlorpyrifos and parathion in an agricultural community in central Washington State. Environmental Health Perspectives. 110: 549–553.

Flower, K. B., Hoppin, J. A., Lynch, C. F., Blair, A., Knott, C., Shore, D. L. and Sandler, D. P. 2004. Cancer risk and parental pesticide application in children of Agricultural Health Study participants. Environmental Health Perspectives. 112: 631–635.

Frewer, L. 2004. The public and effective risk communication. Toxicology Letters. 149: 391-397.

Garry, V. F., Harkins, M. E., Erickson, L.L., Long-Simpson,L. K., Holland, S. E. and Burroughs, B. L. 2002. Birth defects, season of conception, and sex of children born to pesticide applicators living in the Red River Valley of Minnesota, USA. Environmental Health Perspectives. 110: 441–449.

Hardt J. and Angerer J. 2000. Determination of Dialkyl Phosphates in Human Urine using Gas Chromatography–Mass Spectrometry. Journal of Analytical Toxicology. 24: 678-684.

Hogenkamp, A., Vaal, M. and Heederik, D. 2004. Pesticide exposure in dwellings near bulb growing fields in The Netherlands: An explorative study. Ann Agric Environ Med. 11: 1-5.

Jaipieam, S. 2008 Risk assessment of multi-route exposure to organophosphate pesticide if vegetable growers (A case study at Bang Rieng Sub-districtt, Khuan Nieng Districtt, Songkhla Province) Doctor dissertation, Enviromental Management (Interdisciplinary Programs), Graduate School, Chulalongkorn University.

Julien, A., Adamkiewicz, G., Levy, J. L., Bennett, D., Nishioka, M. and Spengler, J. D. 2008. Pesticide loadings of select organophosphate and pyrethroid pesticides in urban public housing. Journal of Exposure Science and Environmental Epidemiology. 18(2): 167-174.

Kiely, T., Donaldson, D. and Grube, A. 2004. Pesticide industry sales and usage: 2000 and 2001 market estimates. U.S. Environmental Protection Agency, Washington, DC.

Koch, D., Lu, C., Fisker-Anderson, J., Jolley, L. and Fenske, R. A. 2002. Temporal association of children's pesticide exposure and agricultural spraying: Report of a longitudinal biological monitoring study. Environmental Health Perspectives. 110 (8): 829-833.

Leng, G., Kuhn, K. H., Dunemann, L. and Idel, H. 1996. Gas chromatography and mass spectrometry method for detection of selected pyrethroid metabolites in urine. Zentralbl Hyg Umweltmed. 198: 443–451.

Lewis, R. G., Fortune, C. R., Blanchard, F. T. and Camann, D. E. 2001. Movement and deposition of two organophosphorus pesticides within a residence after interior and exterior applications. Journal of the Air & Waste Management Association. 51: 339.

Loewenherz, C., Fenske, R. A., Simcox, N. J., Bellamy, G. and Kalman, D. 1997. Biological monitoring of organophosphorus pesticide exposure among children of agricultural workers in central Washington State. Environmental Health Perspectives. 105: 1344–1353.

Lu, C., Fenske, R. A., Simcox, N. J. and Kalman, D. 2000. Pesticide exposure of children in an agricultural community: Evidence of household proximity to farmland and take-home exposure pathways. Environ Research. 84: 290–302.

Ma, X., Buffler, P. A., Gunier, R. B., Dahl, G., Smith, M. T., Reinier, K. and Reynolds, P. 2002. Critical windows of exposure to household pesticides and risk of childhood leukemia. Environmental Health Perspectives. 110: 955–960.

McCauley, L. A., Micheals, S., Rothlein, J., Muniz, J., Lasarev, M. and Ebbert, C. 2003. Pesticide exposure and self reported home hygiene: Practices in agricultural families. Amer Assoc Occup Health Nurses J. 51 (3): 113-119.

Maroni, M. and Fait, A. 1993. Health effects in man from long-term exposure to pesticides: a review of the 1975–1991 literature. Toxicology. 78: 1–180.

Meinert, R., Schuz, J., Kaletsch, U., Kaatsch, P. and Michaelis, J. 2000. Leukemia and non-Hodgkin's lymphoma in childhood and exposure to pesticides: results of a register-based case-control study in Germany. American Journal of Epidemiology. 151: 639–646.

Naeher, L. P., Tulve, N. S., Egeghy, P. P., Barr, D. B., Adetona, O., Fortmann, R. C., Needham, L. L., Bozeman, E., Hilliard, A. and Sheldon, L. S.. 2010. Organophosphorus and pyrethroid insecticide urinary metabolite concentrations in young children living in a southeastern United States city. Science of the Total Environment. 408: 1145–1153.

National Statistical Office of Thailand (TNSO), Thailand. Agricultural Census [Online]. 2003a. Available from: http://web.nso.go.th/en/census/agricult/cen_agri03-1.htm [9, September 2012]

National Statistical Office of Thailand (TNSO), Thailand. Agricultural Census [Online]. 2003b. Available from: http://service.nso.go.th/nso/nsopublish/service/agricult/agr_northeast_46.pdf. [9, September 2012]

Norkaew. S., Siriwong, W., Siripattanakul, S. and Robson, G.M. 2010. Knowledge, Attitude, and Practice (KAP) of Using Personal Protective Equipment (PPE) for Chilli-Growing Farmers in Huarua Sub-District, Mueang District, Ubonrachathani Province, Thailand. Journal of Health Research. 24(2): 93-100.

Olsson, O. A., Baker, S. E., Nguyen, V. J., Romanoff, L. C., Udunka, O. S., Walker, D. R. and Barr, D. B. 2004. A liquid chromatography tandem mass spectrometry multiresidue method for quantification of specific metabolites of organophosphorus pesticides, synthetic pyrethroids, selected herbicides and DEET in humanurine. Analytical Chemistry. 76: 2453–2461.

Panuwet, P., Prapamontol, T., Chantara, S., Thavornyuthikarn, P., Montesano, M. A., Whitehead Jr, R. D. and Barr, D. B. 2008. Concentrations of urinary pesticide metabolites in small-scale farmers in Chiang Mai Province, Thailand. Science of The Total Environment. 407: 655-668.

Panuwet, P., Prapamontol, T., Chantara, S. and Barr, D. B. 2009. Urinary pesticide metabolites in school students from northern Thailand. International Journal of Hygiene and Environmental Health. 212: 288-297.

Petchuay, C., Visuthismajarn, P., Vitayavirasak, B., Hore, P. and Robson, M. G. 2006. Biological Monitoring of Organophosphate Pesticides in Preschool Children in an Agricultural Community in Thailand. International Journal of Occupational and Environmental Health. 12: 133–141.

Quandt, S. A., Arcury, T. A.,Rao, P., Snively, B. M., Camann, D.E., Doran, A. M., Yau, A. Y., Hoppin, J. A. and Jackson, D. S. 2004. Agricultural and residential pesticides in wipe samples from farm worker family residences in North Carolina and Virginia. Environmental Health Perspectives.112(3): 382-387.

Renwick, A. G. 1998. Toxicokinetics in infants and children in relation to the ADI- and TDI. Food Addit Contam. 15: 17–35.

Richter, E. D. and Chlamtac, N. 2002. Ames, pesticides, and cancer revisited. International Journal of Occupational and Environmental Health. 8: 63–72.

Salameh, P. R., Baldi, I., Brochard, P., Raherison, C., Abi Saleh, B. and Salamon, R. 2003. Respiratory symptoms in children and exposure to pesticides. European Respiratory Journal. 22: 507–512.

Simcox, N.J., Fenske, R. A., Wolz, S. A., Lee, I. C. and Kalman, D. A. 1995. Pesticides in household dust and soil: Exposure pathways for children of agricultural families. Environmental Health Perspectives. 103(12): 1126-1134.

Siriwong, W. 2006. Organophosphate pesticide Residues in Aquatic Ecosystem and Health Risk Assessmen of Local Agriculture Community. Doctor dissertation. Enviromental Management (Interdisciplinary Programs) Graduated School, Chulalongkorn University.

Siriwong, W., Thirakhupt, K., Sitticharoenchai, D., Borjan, M., Keeithmaleesatti, S., Burger, J. and Robson, M. 2009. Risk assessment for dermal exposure of organophosphate pesticide for local fishermen in the Rangsit agricultural area, central Thailand. Human and Ecological Risk Assessment: An International Journal. 15: 636-646.

Sobus, J. R., Morgan, M. K., Pleil1, J. D. and Barr, D. B. 2010. Biomonitoring: Uses and Considerations for Assessing Nonoccupational Human Exposure to Pesticides. Hayes' Handbook of Pesticide Toxicology. 1021-1036.

Stout II, D. M., Bradham, K. D., Egeghy, P. P., Jones, P. A., Croghan, C. W., Ashley, P. A., Pinzer, E., Friedman, W., Brinkman, M. C., Nishioka, M. G. and Cox, D. C. 2009. American Healthy Homes Survey: A National Study of Residential Pesticides Measured from Floor Wipes. Environmental Science and Technology. 43: 4294-4300.

Thompson, B., Coronado, G. D., Grossman, J. E., Puschel, K., Solomon, C. C., Islas, I., et al. 2003. Pesticide take-home pathway among children of agricultural workers: Study design, method, and baseline findings. J Occup Environ Med. 45: 42-53.

United State Environmental Protection Agency (US EPA). 1986. Pesticide Tolerances for Chlopyrifos, 40CFR Part 180 Vol. 51(53): 9449-94540.

United State Environmental Protection Agency (US EPA). 1989. Exposure Assessment methods handbook. Office of Health and Environmental. US Environmental Protection Agency, Cincinnati, Ohio.

United State Environmental Protection Agency (US EPA). 1992. Guidelines for Exposure Assessment. Cleaning ton D.C: Risk assessment Forum.

United State Environmental Protection Agency (US EPA). 1997. Exposure factors handbook. Washington, DC.

United State Environmental Protection Agency (US EPA). 2002. Interim reregistration eligibility decision for chlorpyrifos.

United State Environmental Protection Agency (US EPA). Types of pesticides [Online]. 2006. Available from: http://www.epa.gov/pesticides/about/types.htm. [2, December 2012]

United State Environmental Protection Agency (US EPA). 2008. Sampling Guidance for Unknown Contaminates in Drinking Water. Office of Water. U.S. Environmental Protection Agency, Pennsylvania Avenue, NW, Washington, DC.

United State Environmental Protection Agency (US EPA). Pesticide Registration Manual: Chapter 1 - Overview of Requirements for Pesticide Registration and Registrant Obligations [Online]. 2010. Available from: http://www.epa.gov/pesticides/bluebook/chapter1.html. [2, December 2012]

Whitmore, R. W., Immerman, F. W., Camann, D. E., Bond, A. E., Lewis, R. G. and Schaum, J. L. 1994. Non-Occupational Exposures to Pesticides for Residents of Two U.S. Cities. Archives of Environmental Contamination and Toxicology. 26: 47-59.

Wongsasuluk, P., Chotpantarat, S. and Siriwong, W. 2011. Human Health Risk Assessment Associated with Arsenic (As) in Drinking Shallow Groundwater wells at Ubon Ratchathani Province, Thailand. 2011 2nd International Conference on Environmental Science and Technology. 6(2011).

Zahm, S. H. and Ward, M. H. 1998. Pesticides and childhood cancer. Environmental Health Perspectives. 106: 893–908.

Zartarian, V., Bahadori, T., and McKone, T. 2005. Adoption of an official ISEA glossary. Journal of Exposure Analysis and Environmental Epidemiology. 15: 1-5.

APPENDICES

APPENDIX A

QUESTIONNAIRE (English version)

CODE______

Pesticide Exposure of Family in Chili Farm Community, Hua-Rua sub-district, Muang district, Ubonratchathani province, Thailand

---

Description

1. Questionnaire for interview only people who living in an agricultural community.

2. Questionnaires are total 5 pages. Consisted with 2 parts as following:

   Part1: Socio-demographics

   Part2: Information regarding pesticide exposure

3. Place an (/) in the ❍

Name____Date__________Interviewer

Part 1: General Information

1. Gender ❍ Male ❍ Female
2. Age ______________________ Years

   Child's age______________________ Years

   Relationship to child ______________________
3. Weight ______________________ Kilograms.
4. Height ______________________C.M.
5. Occupational ______________________
6. Family income ______________________ Baht/Month
7. Educations

   ❍ 1 Never ❍ 2 Primary school

   ❍3 Secondary school ❍ 4 High school

   ❍5 Diploma ❍ 6 Bachelor's degree

   ❍7 Higher Bachelor's degree ❍8 Other ___________
8. How long has your family lived in this area ?

   ________________Years
9. How far that your residence located from agricultural farm?

   _______________m.
10. How many area of the agricultural farm that located near your residence?

    __rai(s)
11. House characteristics

    Area ______________________m^2

    How many floors? ______________________floor(s)
12. How frequently do you clean your house floor?

    ________________time(s)/week
13. How is the floor clean?

    ❍ Sweep ❍ Dry mop

    ❍ Wet mop ❍Wet mop with detergent

    ❍ Other ______________________

14. Do you use household insecticides in your home?

❍ Yes ❍ No

What kind of pesticides has been used in your home? (e.g. insecticide)

1. ______________________

2. ______________________

3. ______________________

How frequently do you use pesticides in your home? ____time(s)/week

What type of pesticides has been used in your home?

❍ Spray ❍ Coil

❍ Bait ❍ Candle

❍ Other______________________

15. Last time that you used the pesticides in your home __________________

Part 2: Exposure Information

1. How long do you stay in your home? ____________________ hr/day
2. Where do you spend time for stay in the day?

   ❍ Bed room ❍ In house common area

   ❍ Outside common area ❍ Other____________________
3. Do you always wear shoes when going outside your home?

   ❍ Usually ❍ Sometimes ❍ Never
4. How many times do you wash your hands in the day?

   _______________time(s)
5. How many times do you wash your feet in the day?

   _______________time(s)
6. How frequently do you have an illness in the past six months?

   ❍ Often ❍ Sometimes ❍ Never
7. Source of drinking water

   ❍ Tab water ❍ Underground water❍ Other

   ____
8. Number of glasses _______________________glasses/day

For Parent: Children information

1. How long does your child stay in the home? ______________________ hr/day
2. Where does your child spend time for stay in the day?
   ❍ Bed room ❍ In house common area
   ❍ Outside common area ❍ Other______________________
3. Does your child always wear shoes when going outside the home?
   ❍ Usually ❍ Sometime ❍ Never
4. How many times does your child wash his/her hands in the day?
   ______time(s)
5. How frequently does your child suck fingers into mouth in the day?
   ❍ Often ❍ Sometimes ❍ Never
6. How many times does your child wash his/her feet in the day?
   __________time(s)
7. How frequently does your child have an illness in the past six months?
   ❍ Often ❍ Sometimes ❍ Never
8. Source of drinking water
   ❍ Tab water ❍ Underground water ❍ Other ____________________
9. Number of glasses _________________________glasses/day

For farm family: farmer information

1. Duration of application/ time ________________Hour(s)
2. Frequency of spraying pesticide ________________times / day

   ________________days / week

3. Source of drinking water

   ❍ Tab water ❍ Underground water❍ Other

   ____

4. Number of glasses ________________glasses/day
5. Personal protective equipment (PPE)use

   Gloves

   ❍ Usually ❍ Sometimes ❍ Never

   Mask

   ❍ Usually ❍ Sometimes ❍ Never

   Boots

   ❍ Usually ❍ Sometimes ❍ Never

APPENDIX B

QUESTIONNAIRE (Thai version)

CODE______

การรับสัมผัสสารกำจัดศัตรูพืชของผู้อยู่อาศัยในชุมชนเกษตรกรรมผู้ปลูกพริก

ตำบลหัวเรือ อำเภอเมือง จังหวัดอุบลราชธานีประเทศไทย

คำชี้แจง

1. แบบสัมภาษณ์ที่ใช้สัมภาษณ์ผู้อาศัยในพื้นที่เกษตรกรรม
2. แบบสัมภาษณ์นี้มีจำนวนทั้งสิ้น จำนวน 5 หน้า แบ่งออกเป็น 2 ส่วนดังนี้

   ส่วนที่ 1 ข้อมูลทั่วไป

   ส่วนที่ 2 ข้อมูลการรับสัมผัสสารกำจัดศัตรูพืช

3. ให้ใส่เครื่องหมาย (/) ลงใน ❍ หน้าข้อความ และเติมข้อความในช่องว่าง (_____)

ชื่อ________________________สกุล_____________________วัน/เดือน/ปี_______ผู้สัมภาษณ์

ส่วนที่ 1: ข้อมูลทั่วไป

1. เพศ O ชาย O หญิง
2. อายุ ____________________ ปี
3. น้ำหนัก ____________________ กิโลกรัม
4. ส่วนสูง ____________________เซ็นติเมตร
5. อาชีพ ____________________
6. รายได้ ____________________บาท/เดือน
7. ระดับการศึกษา

   ❍1 ไม่ได้เรียน ❍ 2 จบประถมศึกษา (ป 1 – ป 6)

   ❍3 จบมัธยมต้น/เทียบเท่า ❍ 4 จบมัธยมปลาย/ปวช/เทียบเท่า

   ❍5.จบอนุปริญญา/ปวส ❍6 จบปริญญาตรี/เทียบเท่า

   ❍7 สูงกว่าปริญญาตรี ❍8 อื่นๆ (ระบุ).................
8. ท่านอยู่ในชุมชนนี้มากี่ปี____________________ปี
9. ที่อยู่อาศัยของท่านตั้งอยู่ห่างจากพื้นที่เกษตรกรรมเป็นระยะทาง________________เมตร
10. พื้นที่เกษตรกรรมที่ใกล้เคียงที่อยู่อาศัยของท่านมีพื้นที่เพาะปลูก________________ไร่
11. ลักษณะที่อยู่อาศัยของท่าน

    ขนาด ____________________ตารางเมตร

    จำนวน ____________________ชั้น
12. ท่านทำความสะอาดภายในที่อยู่อาศัย ____________________ครั้ง/สัปดาห์

13. ท่านทำความสะอาดที่อยู่อาศัยโดยวิธีใด

❍กวาด ❍ ถูด้วยผ้าแห้ง

❍ ถูด้วยผ้าชุบน้ำ ❍ ถูด้วยผ้าผสมน้ำยาทำความสะอาด

❍ อื่นๆ____________________

14. ท่านใช้สารเคมีกำจัดแมลงในครัวเรือนหรือไม่

❍ ใช่ ❍ไม่

ท่านใช้สารเคมีกำจัดแมลงชนิดใด

1. ____________________

2. ____________________

3. ____________________

ท่านใช้สารเคมีกำจัดแมลงจำนวน ____________________ครั้ง/สัปดาห์

ท่านใช้สารเคมีชนิดใดในการกำจัดแมลง

❍ สเปรย์ ❍ แบบขด ❍ แบบเหยื่อล่อ

❍ เทียน ❍ อื่นๆ____________________

15. ท่านใช้สารเคมีกำจัดแมลงครั้งสุดท้ายเมื่อใด____________________

ส่วนที่ 2: ข้อมูลการรับสัมผัสสารกำจัดศัตรูพืช

1. ท่านใช้เวลาอยู่ในที่อยู่อาศัย ____________________ ชั่วโมง/วัน

2. ท่าน ใช้พื้นที่บริเวณใดในที่อยู่อาศัยมากที่สุด

❍ห้องนอน ❍ ห้องนั่งเล่น

❍ พื้นที่ด้านนอก ❍ อื่นๆ____________________

3. ท่านสวมรองเท้าขณะเดินภายนอกที่อยู่อาศัยทุกครั้งหรือไม่

❍ทำเป็นประจำ ❍ทำบางครั้ง ❍ไม่ทำเลย

4. ท่าน ล้างมือ ____________________ครั้ง/วัน

5. ท่าน ล้างเท้า ____________________ครั้ง/วัน

6. ในระยะเวลา 6 เดือน ที่ผ่านมา ท่านมีอาการเจ็บป่วยหรือไม่

❍ เป็นประจำ ❍ เป็นบางครั้ง ❍ ไม่เป็นเลย

7. แหล่งน้ำดื่มของครอบครัวท่าน

❍น้ำประปา ❍ น้ำใต้ดิน ❍ อื่นๆ________________

8. ปริมาณน้ำที่ท่านดื่ม________________แก้ว/วัน

<u>สำหรับผู้ปกครองของเด็ก: ข้อมูลเด็ก</u>

1. บุตรหลานของท่าน ใช้เวลาอยู่ในที่อยู่อาศัย __________________ ชั่วโมง/วัน

2. บุตรหลานของท่าน ใช้พื้นที่บริเวณใดในที่อยู่อาศัยมากที่สุด

❍ห้องนอน ❍ ห้องนั่งเล่น

❍ พื้นที่ด้านนอก ❍ อื่นๆ__________________

3. บุตรหลานของท่าน สวมรองเท้าขณะเดินภายนอกที่อยู่อาศัยทุกครั้งหรือไม่

❍ทำเป็นประจำ ❍ทำบางครั้ง ❍ไม่ทำเลย

4. บุตรหลานของท่าน ล้างมือ __________________ครั้ง/วัน

บุตรหลานของท่านมีพฤติกรรมอมมือ/เอามือเข้าปากหรือไม่

❍ ทำเป็นประจำ ❍ ทำบางครั้ง ❍ ไม่ทำเลย

5. บุตรหลานของท่าน ล้างเท้า __________________ครั้ง/วัน

6. ในระยะเวลา 6 เดือน ที่ผ่านมา บุตรหลานของท่านมีอาการเจ็บป่วยหรือไม่

❍ เป็นประจำ ❍ เป็นบางครั้ง ❍ ไม่เป็นเลย

7. แหล่งน้ำดื่มของครอบครัวท่าน

❍น้ำประปา ❍ น้ำใต้ดิน ❍ อื่นๆ______________

8. ปริมาณน้ำที่บุตรหลานของท่านดื่ม______________แก้ว/วัน

<u>สำหรับครอบครัวเกษตรกร: ข้อมูลเกษตรกร</u>

1. ท่านใช้เวลาในการฉีดสารเคมีกำจัดศัตรูพืช ______________ชั่วโมง/ครั้ง

2. ท่านฉีดพ่นสารเคมี ______________ครั้ง/วัน

______________วัน/สัปดาห์

3. แหล่งน้ำดื่มของครอบครัวท่าน

❍ น้ำประปา ❍ น้ำใต้ดิน ❍ อื่นๆ______________

4. ปริมาณน้ำที่ท่านดื่ม ______________แก้ว/วัน

5. การใช้อุปกรณ์ป้องกันสารเคมีส่วนบุคคล

<u>ถุงมือ</u>

❍ ทำเป็นประจำ ❍ ทำบางครั้ง ❍ ไม่ทำเลย

<u>หน้ากาก</u>

❍ ทำเป็นประจำ ❍ ทำบางครั้ง ❍ ไม่ทำเลย

<u>รองเท้าบูท</u>

❍ ทำเป็นประจำ ❍ ทำบางครั้ง ❍ ไม่ทำเลย

APPENDIX C

NIOSH 5600 METHOD

ORGANOPHOSPHORUS PESTICIDES 5600

Formula: Table 1 | MW: Table 1 | CAS: Table 1 | RTECS: Table 1

METHOD: 5600, Issue 1 | **EVALUATION: FULL** | **Issue 1: 15 August 1994**

OSHA : Table 2
NIOSH: Table 2
ACGIH: Table 2

PROPERTIES: Table 3

SYNONYMS: Table 4

SAMPLING

SAMPLER: FILTER/SOLID SORBENT TUBE (OVS-2 tube: 13-mm quartz filter; XAD-2, 270 mg/140 mg)

FLOW RATE: 0.2 to 1 L/min

VOL-MIN: 12 L
-MAX: 240 L; 60 L (Malathion, Ronnel)

SHIPMENT: cap both ends of tube

SAMPLE STABILITY: at least 10 days at 25 °C
at least 30 days at 0 °C

BLANKS: 2 to 10 field blanks per set

ACCURACY

RANGE STUDIED: Table 5, Column A

ACCURACY: Table 5, Column B

BIAS: Table 5, Column C

OVERALL PRECISION ($\hat{S}_{rT}$): Table 5, Column D

MEASUREMENT

TECHNIQUE: GC, FLAME PHOTOMETRIC DETECTION (FPD)

ANALYTE: organophosphorus pesticides, Table 1

EXTRACTION: 2-mL 90% toluene/10% acetone solution

INJECTION VOLUME: 1-2 µL

TEMPERATURE
-INJECTION: 240 °C
-DETECTOR: 180 °C to 215 °C (follow manufacturer's recommendation)
-COLUMN: Table 6

CARRIER GAS: He at 15 psi (104 kPa)

COLUMN: fused silica capillary column; Table 6

DETECTOR: FPD (phosphorus mode)

CALIBRATION: standard solutions of organophosphorus compounds in toluene

RANGE: Table 8, Column C

ESTIMATED LOD: Table 8, Column F

PRECISION ($\hat{S}_r$): Table 5, Column E

APPLICABILITY: The working ranges are listed in Table 5. They cover a range of 1/10 to 2 times the OSHA PELs. This method also is applicable to STEL measurements using 12-L samples. This method may be applicable to the determination of other organophosphorus compounds after evaluation for desorption efficiency, sample capacity, sample stability, and precision and accuracy.

INTERFERENCES: Several organophosphates may co-elute with either target analyte or internal standard causing integration errors. These include other pesticides (see Table 7), and the following: tributyl phosphate (plasticizer), tris-(2-butoxy ethyl) phosphate (plasticizer used in some rubber stoppers), tricresyl phosphate (petroleum oil additive, hydraulic fluid, plasticizer, flame-retardant, and solvent), and triphenyl phosphate (plasticizer and flame-retardant in plastics, lacquers, and roofing paper).

OTHER METHODS: This method may be used to replace previous organophosphorus pesticide methods. See Table 10 for partial listing. The OVS-2 tube is similar in concept to the device of Hill and Arnold [11], but offers greater convenience and lower flow resistance.

REAGENTS:

1. Organophosphorus analytes listed in Table 1. and (optional) triphenyl phosphate, analytical standard grade.*
2. Toluene, pesticide analytical grade.*
3. Acetone, ACS reagent grade or better.*
4. Desorbing solution. Add 50 mL acetone to a 500-mL volumetric flask. Dilute to volume with toluene.
   NOTE: For optional internal standard, add 1 mL of a 5 mg/mL solution of triphenyl phosphate in toluene to 500 mL desorbing solution.
5. Organophosphorus stock solutions, 10 mg/mL. Prepare individual standard stock solutions of each pesticide of interest in 90/10 toluene/acetone (V/V). All pesticides in Table 1 were found to be soluble to at least 10 mg/mL.
6. Spiking solutions for calibration (step 9) and media fortification (steps 10, 11).
   NOTE: Spiking solutions may contain more than one analyte.
   a. Spiking solution SS-1: Dilute the volume of stock solution indicated in column F of Table 11 to 10 mL with toluene or 90/10 toluene/acetone.
   b. Spiking solution SS-2: Dilute 1 mL of SS-1 solution with toluene in a 10-mL volumetric flask.
7. Purified gases: Helium, hydrogen, nitrogen, dry air, and oxygen, (if required by detector).

* See Special Precautions

EQUIPMENT:

1. Sampler: glass tube, 11-mm ID x 13-mm OD x 50 mm long, with the outlet end drawn to a 6-mm o.d. x 25 mm long tube. The enlarged part of the tube contains a 270-mg front section of 20/60 mesh XAD-2 sorbent or equivalent held in place by a 9 to 10-mm o.d. quartz fiber filter and polytetrafluoroethylene (PTFE) retaining ring. The front section is separated from the back section of 140 mg XAD-2 sorbent or equivalent with a short plug of polyurethane foam. The back section is held in place by a long plug of polyurethane foam. The tube is available commercially as the OVS-2 sampler. See Figure 2.
   NOTE: Some OVS-2 tubes contain glass fiber filters, as specified in the OSHA methods (see Table 10). These tubes, however, did not perform as well for the more polar analytes (amides, phosphoramides, and sulfoxides; see Table 9). Low or erratic recoveries for Malathion may be encountered with glass fiber filters.
2. Personal sampling pump, 0.2 to 1 L/min. with flexible connecting tubing, preferably silicon, polyethylene, or PTFE tubing.
3. Vials, 4-mL with PTFE-lined cap; 2-mL GC autosampler vials with PTFE-lined crimp caps.
4. Gas chromatograph, flame photometric detector with 525-nm bandpass filter for phosphorus mode, integrator, and column (Table 6).
5. Syringes, 5-mL and 100-, 50-, and 10-mL for making standard solutions and GC injections.
6. Volumetric flasks, 500-, 10-, and 2-mL.
7. Tweezers.
8. GC vial crimper.
9. Small ultrasonic cleaning bath.

SPECIAL PRECAUTIONS: Organophosphorus compounds are highly toxic. Special care must be taken to avoid inhalation or skin contact through the wearing of gloves and suitable clothing when handling pure material [13-17].

Toluene is flammable and toxic. Acetone is highly flammable. Prepare all samples in a well ventilated hood.

SAMPLING:

1. Calibrate each personal sampling pump with a representative sampler in line.
2. Connect the sampler to personal sampling pump with flexible tubing. The sampler should be placed vertically with the large end down, in the worker's breathing zone in such a manner that it does not impede work performance. [4, 12]
3. Sample at an accurately known flowrate between 0.2 and 1 L/min for a total sample size of 12 to 240 L.

4. Cap both ends of the sampler with plastic caps and pack securely for shipment.

SAMPLE PREPARATION:

5. Remove cap from large end and remove PTFE retainer ring; transfer filter and front XAD-2 section to a 4-mL vial. Transfer the short polyurethane foam plug along with back-up XAD-2 section to a second 4-mL vial.
6. Add 2 mL of desorbing solvent to each vial using a 5-mL syringe or 2-mL pipette. Cap each vial.
7. Allow to stand 30 minutes, immerse vials approximately 15 mm in an ultrasonic bath for 30 minutes. Alternatively, place the vials in a shaker or tumbler for 1 hour.
8. Transfer 1 to 1.5 mL from each 4-mL vial to a clean 2-mL GC vial, cap and label.

CALIBRATION AND QUALITY CONTROL:

9. Calibrate daily with at least six working standards covering the analytical range of the method for individual analytes.
   a. Add known amounts of calibration spiking solution (SS-1 or SS-2 according to schedule in Table 11) to desorbing solution in 2-mL volumetric flasks and dilute to the mark.
      NOTE: If an internal standard is included in the desorbing solution, then exactly 2 mL of desorbing solution in a volumetric flask must be concentrated slightly under a gentle stream of nitrogen in order to accommodate the specified volume of the spiking solutions. After adding the spiking solutions to the slightly concentrated desorbing solution, dilute to the 2-mL mark with toluene or 90/10 toluene/acetone.
   b. Include a calibration blank of unspiked desorbing solution.
   c. Analyze together with field samples, field blanks, and laboratory control samples (steps 12 and 13).
   d. Prepare calibration graph (peak area vs. µg analyte), or if internal standard (IS) is used (peak area of analyte/peak area of IS vs. µg analyte).
10. Prepare Laboratory Control Samples (LCS) with each sample set, in duplicate.
    a. Remove cap from large end of sampler tube. Apply 30 µL of spiking solution SS-1 to face of quartz fiber filter. Cap and allow to stand for a minimum of 1 hour. Preferably, these should be prepared as soon as samples arrive and should be stored with the field samples until analyzed.
    b. Include an unspiked sampler as a media blank.
    c. Analyze along with field samples and blanks, and liquid calibration standards (steps 12 through 16).
11. When extending application of this method to other organophosphorus compounds, the following minimal desorption efficiency (DE) test may be performed as follows:
    a. Determine the NIOSH REL, OSHA PEL, or ACGIH TLV in mg/m ^{3}.
    b. Prepare spiking solution SS-1 (refer to Table 11, or use the following formulae, which are specific for the calculation of the weight of analyte to add to 10 mL toluene/acetone 90:10).
       For REL > 1 mg/m^3 (assuming 12-L collection vol.), let W = REL x 4 m ^{3}
       For REL ≤ 1 mg/m^3 (assuming 120-L collection vol.), let W = REL x 40 m ^{3}
       where W = weight (mg) of analyte to dissolve into 10 mL of desorbing solvent.
       Let [SS-1] = W/10 mL where [SS-1] = concentration of spiking solution SS-1 in mg/mL.
       Let [SS-2] = [SS-1] x 0.1 where [SS-2] = concentration of spiking solution SS-2.
    d. Prepare three tubes at each of five levels plus three media blanks. Concentration at each level may be calculated using formulae in entry 20, part II of Table 11.
       i. Remove plastic cap from large end of sampler, apply appropriate volume of spiking solution to face of quartz fiber filter following schedule in part I of Table 11.
       ii. Cap and allow sampler to stand overnight.
    e. Prepare tubes for analysis (Steps 5 through 8).
    f. Analyze with liquid standards (Steps 12 and 13).

g. Prepare a graph of desorption efficiency (DE) vs. µg of analyte.
h. Acceptable desorption criteria for 6 replicates is >75% average recovery with a standard deviation of <±9%.

MEASUREMENT:

12. Set gas chromatograph according to manufacturer's recommendations and to conditions listed in Table 6 and on page 5600-1. Inject sample aliquot manually using solvent flush technique or with autosampler. See Table 7 for retention times of selected analytes.
    NOTE: If peak area is greater than the linear range of the working standards, dilute with desorbing solution or with desorbing solution (containing internal standard) and reanalyze. Apply the appropriate dilution factor in calculations.
13. Measure peak area of analyte and of internal standard.

CALCULATIONS:

14. Determine the mass in µg (corrected for DE) of respective analyte found in the sample front (W and back (W_b) sorbent sections, and in the media blank front (B_f) and back (B_b) sorbent sections.
    NOTE: The filter is combined with the front section. If $W_b > W_f/10$, report breakthrough and possible sample loss.
15. Calculate concentration, C, of analyte in the air volume sampled, V (L):

$$C = \frac{(W_f + W_b - B_f - B_b)}{V}, \ mg/m^3.$$

CONFIRMATION:

16. Whenever an analyte is detected, and its identity is uncertain, confirmation may be achieved by analysis on a second column of different polarity. If primary analysis was performed using a non-polar or weakly polar column (DB-1 or DB-5), confirmation should be accomplished by reanalysis on a polar column (DB-1701 or DB-210). See Table 7 for approximate retention times for each column type. Fewer analytes co-elute on DB-210 than on DB-1701. Relative retention times are more convenient for the identification of unknown analytes. If Parathion is not used as the retention time reference compound, then another related compound such as tributyl phosphate, Ronnel, or triphenyl phosphate may be substituted.

EVALUATION OF METHOD:

This method was evaluated over the ranges specified in Table 5 at 25 °C using 240-L air samples. Sampler tubes were tested at 15% and 80% relative humidity and at 10 °C and 30 °C. In these tests, test atmospheres were not generated; instead, analytes were fortified on the face of the sampler filters. This was followed by pulling conditioned air at 1 L/min. for 4 hours. No difference in sampler performance was noted at any of these temperature/humidity combinations. Evaluations of sampler precision and stability were conducted at 30 °C and 15% relative humidity. Overall sampling and measurement precisions, bias, accuracy, and average percent recovery after long-term storage are presented in Table 5. No breakthrough was detected after 12 hours of sampling at 1 L/min with a sampler fortified with the equivalent of 4x the NIOSH REL. Malathion and Ronnel were tested at 1/40 x REL, Sulprofos at 1/20 x REL (See Table 5, note 4). All criteria [9] were met.

APPENDIX D

Urine collection protocol (English)

COLLECTION PROCEDURE

1. Materials needed for urine collection.
    - Urine collection bottle.
    - Zip-lock plastic bag.
2. Instructions for urine collection.

    The following instructions should be explained to the participant prior to urine collection:

    1. Wash your hands with soap and water.
    2. The collection cup should not be opened until just before urination.
    3. Leave the cap turned up while urinating, then recap the filled container immediately.
    4. It is most important that the inside of the container and the cap not be touch or come into contact with clothing or external surface.
3. Instructions for urine storage.

    Immediately place container in the freezer in refrigerator until the sample is collected during the time of schedule visit.

APPENDIX E

Urine collection protocol (Thai)

ขั้นตอนการเก็บตัวอย่างปัสสาวะ

1. <u>อุปกรณ์ในการเก็บตัวอย่างปัสสาวะ</u>

   - ภาชนะ (ขวด/ถ้วยและฝา พลาสติก) สำหรับเก็บตัวอย่างปัสสาวะ
   - ถุงซิปล็อค

2. <u>วิธีการเก็บตัวอย่างปัสสาวะ</u>

   ผู้เข้าร่วมงานวิจัยจะได้รับคำอธิบายถึงวิธีการเก็บก่อนการเก็บตัวอย่างปัสสาวะ

   1. ล้างมือด้วยสบู่ให้สะอาด
   2. ไม่ควรเปิดฝา ภาชนะก่อนทำการปัสสาวะ
   3. หงายฝาขึ้นขณะปัสสาวะลงในภาชนะเก็บตัวอย่างปัสสาวะ และปิดฝาภาชนะทันทีที่เก็บตัวอย่างปัสสาวะเรียบร้อยแล้ว
   4. **ข้อควรระวัง** ไม่ควรให้ภายในและฝาของภาชนะเก็บตัวอย่าง สัมผัสกับเสื้อผ้า หรือสิ่งปนเปื้อนอื่นๆก่อนทำการเก็บตัวอย่างปัสสาวะ

3. <u>วิธีการเก็บรักษาตัวอย่างปัสสาวะ</u>

   นำภาชนะที่ทำการเก็บตัวอย่างปัสสาวะเรียบร้อยแล้วเข้าตู้เย็นในช่องแช่แข็งทันที จนกว่าผู้ทำการวิจัยจะทำการเก็บเพื่อนำมาวิเคราะห์ในวันเก็บตัวอย่างสิ่งแวดล้อมภายในที่อยู่อาศัย

APPENDIX F

Results of air samples

Table F-1: Detected frequency and average concentration of OPs (chlorpyrifos) in air samples.

Pesticides	House type	Number (n=108)	Range	Average concentration* (mg/m^3)
Chlorpyrifos				
	Non-occupational family:	9 (8.33%)	<LOD - 0.002	$1.15x10^{-3}$
	Level 1	6 (5.56%)	<LOD - 0.002	$1.33x10^{-3}$
	Level 2	3 (2.78%)	<LOD - 0.002	$1.11x10^{-3}$
	Level 3	<LOD		$1.00x10^{-3}$
	Occupational family:	15 (13.9%)	<LOD - 0.002	$1.28x10^{-3}$
	Level 1	11 (10.2%)	<LOD - 0.002	$1.61x10^{-3}$
	Level 2	3 (2.78%)	<LOD - 0.002	$1.17x10^{-3}$
	Level 3	1 (0.93%)	<LOD - 0.001	$1.06x10^{-3}$

APPENDIX G

Results of surface wipe samples

Table G-1: Detected frequency and average concentration of OPs and PY in surface wipe samples

Pesticides	House type	Number (%)	Range	Average concentration* (mg/cm^2)
Chlorpyrifos				
	Non-occupational family:	3 (2.78%)	<LOD – 0.18	$2.89x10^{-2}$
	Level 1	3 (2.78%)	<LOD – 0.18	$4.67x10^{-2}$
	Level 2	<LOD	<LOD	$2.00x10^{-2}$
	Level 3	<LOD	<LOD	$2.00x10^{-2}$
	Occupational family:	9 (8.33%)	<LOD – 0.18	$4.67x10^{-2}$
	Level 1	9 (8.33%)	<LOD – 0.18	$10.0x10^{-2}$
	Level 2	<LOD	<LOD	$2.00x10^{-2}$
	Level 3	<LOD	<LOD	$2.00x10^{-2}$
Pirimiphos-methyl				
	Non-occupational family:	3 (2.78%)	<LOD – 0.1	$2.44x10^{-2}$
	Level 1	3 (2.78%)	<LOD - 0.1	$3.33x10^{-2}$
	Level 2	<LOD	<LOD	$2.00x10^{-2}$
	Level 3	<LOD	<LOD	$2.00x10^{-2}$
	Occupational family:	8 (7.41%)	<LOD – 0.1	$3.18x10^{-2}$
	Level 1	8 (7.41%)	<LOD – 0.1	$5.56x10^{-2}$
	Level 2	<LOD	<LOD	$2.00x10^{-2}$
	Level 3	<LOD	<LOD	$2.00x10^{-2}$

Pesticides	House type	Number (%)	Range	Average concentration* (mg/cm^2)
Permethrin				
	Non-occupational family:	25 (23.2%)	<LOD – 0.36	$12.4x10^{-2}$
	Level 1	10 (9.26%)	<LOD – 0.36	$16.6x10^{-2}$
	Level 2	8 (7.41%)	<LOD – 0.36	$9.50x10^{-2}$
	Level 3	7 (6.48%)	<LOD – 0.36	$11.0x10^{-2}$
	Occupational family:	25 (23.2%)	<LOD – 0.36	$10.8x10^{-2}$
	Level 1	11 (10.2%)	<LOD – 0.36	$18.4x10^{-2}$
	Level 2	7 (6.48%)	<LOD – 0.36	$9.83x10^{-2}$
	Level 3	7 (6.48%)	<LOD – 0.22	$4.11x10^{-2}$
Cypermethrin				
	Non-occupational family:	9 (8.33%)	<LOD – 0.1	$3.33x10^{-2}$
	Level 1	6 (5.56%)	<LOD – 0.1	$4.67x10^{-2}$
	Level 2	3 (2.78%)	<LOD – 0.1	$3.33x10^{-2}$
	Level 3	<LOD	<LOD	$2.00x10^{-2}$
	Occupational family:	2 (1.85%)	<LOD – 0.1	$2.29x10^{-2}$
	Level 1	<LOD	<LOD	$2.00x10^{-2}$
	Level 2	2 (1.85%)	<LOD – 0.1	$2.89x10^{-2}$
	Level 3	<LOD	<LOD	$2.00x10^{-2}$

Abbreviation: LOD = limit of detection

*Samples reported as below LOD were assigned LOD prior to statistical analysis.

APPENDIX H

Children Urinary Metabolite Results

Table H-1: Urinary Result of Diethylphosphate (DEP) Metabolite

Participant / house type	Number (% Detection)	Statistic Categories	Concentration	
			Unadjusted ng/mL	Adjusted µg/g.cre.
Children (n=36)	15 (41.7%)	GeoMean	0.74	1.15
		Range	<LOD – 9.85	0.25 – 15.0
		Percentile		
		25^{th}	<LOD	0.32
		50^{th}	<LOD	0.36
		75^{th}	3.59	5.53
		95^{th}	9.59	14.9
Non-occupational Family (n=18)	4 (22.2%)	GeoMean	0.35	0.53
		Range	<LOD – 3.67	0.25 – 4.60
		Percentile		
		25^{th}	0.20	0.31
		50^{th}	0.20	0.34
		75^{th}	0.44	0.63
		95^{th}	3.67	4.60
Occupational Family (n=18)	11 (61.1%)	GeoMean	1.57	2.49
		Range	<LOD – 9.85	0.32 – 15.0
		Percentile		
		25^{th}	0.20	0.35
		50^{th}	3.11	5.29
		75^{th}	8.70	12.6
		95^{th}	9.85	15.0

Abbreviation: LOD= limit of detection, LOD<0.20

*Samples reported as below LOD were assigned LOD prior to statistical analysis.

Table H-2: Urinary Result of Diethylthiophosphate (DETP) Metabolite

Participant / house type	Number (% Detection)	Statistic Categories	Concentration Unadjusted ng/mL	Concentration Adjusted µg/g.cre.
Children (n=36)	20 (55.6%)	GeoMean	1.20	1.87
		Range	<LOD – 19.0	0.29 – 27.7
		Percentile		
		25^{th}	<LOD	0.34
		50^{th}	1.11	1.69
		75^{th}	8.85	11.5
		95^{th}	18.8	26.3
Non-occupational Family (n=18)	9 (50.0%)	GeoMean	0.70	1.07
		Range	<LOD – 11.31	0.29 – 14.1
		Percentile		
		25^{th}	0.20	0.34
		50^{th}	0.62	0.88
		75^{th}	2.40	3.09
		95^{th}	11.3	14.1
Occupational Family (n=18)	11 (61.1%)	GeoMean	2.06	3.26
		Range	<LOD – 19.0	0.31 – 27.7
		Percentile		
		25^{th}	0.20	0.35
		50^{th}	5.22	8.52
		75^{th}	12.3	20.7
		95^{th}	19.0	27.7

Abbreviation: LOD= limit of detection, LOD<0.20

*Samples reported as below LOD were assigned LOD prior to statistical analysis.

Table H-3: Urinary Result of Diethyldithiophosphate (DEDTP) Metabolite

Participant / house type	Number (% Detection)	Statistic Categories	Concentration Unadjusted ng/mL	Concentration Adjusted µg/g.cre.
Children (n=36)	12 (33.3%)	GeoMean	0.40	0.61
		Range	<LOD – 23.7	0.13 – 29.6
		Percentile		
		25th	<LOD	0.16
		50th	<LOD	0.18
		75th	2.30	3.07
		95th	20.2	27.6
Non-occupational Family (n=18)	3 (16.7%)	GeoMean	0.16	0.25
		Range	<LOD – 2.40	0.12 – 3.00
		Percentile		
		25th	<LOD	0.14
		50th	<LOD	0.17
		75th	0.10	0.18
		95th	2.40	3.00
Occupational Family (n=18)	9 (50.0%)	GeoMean	0.94	1.49
		Range	<LOD – 23.7	0.15 – 29.6
		Percentile		
		25th	0.10	0.17
		50th	1.05	1.63
		75th	10.8	17.5
		95th	23.7	29.6

Abbreviation: LOD= limit of detection, LOD<0.10

*Samples reported as below LOD were assigned LOD prior to statistical analysis.

Table H-4: Urinary Result of Molar Summed Diethylphosphate (DEPs) Metabolite

Participant / house type	Number (% Detection)	Statistic Categories	Concentration	
			Unadjusted ng/mL	Adjusted µg/g.cre.
Children (n=36)	21 (58.3%)	GeoMean	0.02	0.03
		Range	<LOD – 0.30	<LOD – 0.39
		Percentile		
		25th	<LOD	<LOD
		50th	<LOD	0.02
		75th	0.09	0.12
		95th	0.28	0.38
Non-occupational Family (n=18)	9 (50.0%)	GeoMean	0.01	0.01
		Range	<LOD - 0.10	<LOD – 0.13
		Percentile		
		25th	<LOD	0.01
		50th	0.01	0.01
		75th	0.02	0.03
		95th	0.10	0.13
Occupational Family (n=18)	12 (66.7%)	GeoMean	0.03	0.05
		Range	<LOD – 0.30	<LOD – 0.39
		Percentile		
		25th	<LOD	<LOD
		50th	0.05	0.09
		75th	0.19	0.31
		95th	0.30	0.39

Abbreviation: LOD= limit of detection

*Samples reported as below LOD were assigned LOD prior to statistical analysis.

APPENDIX I

Working age Urinary Metabolite Results

Table I-1: Urinary Result of Diethylphosphate (DEP) Metabolite

Participant / house type	Number (% Detection)	Statistic Categories	Concentration	
			Unadjusted ng/mL	Adjusted µg/g.cre.
Working age (n=36)	14 (38.9%)	GeoMean	0.84	0.84
		Range	<LOD – 29.8	<LOD – 28.7
		Percentile		
		25th	<LOD	<LOD
		50th	<LOD	0.23
		75th	6.29	6.50
		95th	27.7	24.8
Non-occupational Family (n=18)	6 (33.3%)	GeoMean	0.60	0.58
		Range	<LOD – 9.79	0.16 – 8.30
		Percentile		
		25th	0.20	0.20
		50th	0.20	0.21
		75th	6.15	5.53
		95th	9.79	8.30
Occupational Family: (n=18)	8 (44.4%)	GeoMean	1.19	1.22
		Range	<LOD – 29.8	0.16 – 28.7
		Percentile		
		25th	0.20	0.22
		50th	0.20	0.26
		75th	25.4	22.6
		95th	29.8	28.7

Abbreviation: LOD= limit of detection, LOD<0.20

*Samples reported as below LOD were assigned LOD prior to statistical analysis.

Table I-2: Urinary Result of Diethylthiophosphate (DETP) Metabolite

Participant / house type	Number (% Detection)	Statistic Categories	Concentration	
			Unadjusted ng/mL	Adjusted µg/g.cre.
Working age (n=36)	26 (72.2%)	GeoMean	5.60	5.57
		Range	<LOD – 124	<LOD – 107
		Percentile		
		25th	<LOD	0.25
		50th	10.3	9.87
		75th	38.2	42.5
		95th	103	91.2
Non-occupational Family: (n=18)	13 (72.2%)	GeoMean	3.02	2.91
		Range	<LOD – 15.6	<LOD – 13.9
		Percentile		
		25th	0.20	0.24
		50th	7.47	7.32
		75th	11.1	11.2
		95th	15.6	13.9
Occupational Family: (n=18)	13 (72.2%)	GeoMean	10.4	10.7
		Range	<LOD – 124	0.16 – 107
		Percentile		
		25th	0.20	0.28
		50th	36.8	41.2
		75th	79.8	83.7
		95th	124	107

Abbreviation: LOD= limit of detection, LOD<0.20

*Samples reported as below LOD were assigned LOD prior to statistical analysis.

Table I-3: Urinary Result of Diethyldithiophosphate (DEDTP) Metabolite

Participant / house type	Number (% Detection)	Statistic Categories	Concentration	
			Unadjusted ng/mL	Adjusted µg/g.cre.
Working age (n=36)	9 (25%)	GeoMean	0.26	0.26
		Range	<LOD – 16.2	<LOD – 13.9
		Percentile		
		25^{th}	<LOD	<LOD
		50^{th}	<LOD	0.11
		75^{th}	1.14	0.99
		95^{th}	14.2	12.0
Non-occupational Family (n=18)	5 (27.8%)	GeoMean	0.28	0.27
		Range	<LOD – 13.8	<LOD – 11.7
		Percentile		
		25^{th}	<LOD	<LOD
		50^{th}	<LOD	<LOD
		75^{th}	1.51	1.35
		95^{th}	13.8	11.7
Occupational Family (n=18)	4 (22.2%)	GeoMean	0.25	0.26
		Range	<LOD – 16.2	<LOD – 13.9
		Percentile		
		25^{th}	<LOD	<LOD
		50^{th}	<LOD	<LOD
		75^{th}	0.60	0.60
		95^{th}	16.2	13.9

Abbreviation: LOD= limit of detection, LOD<0.10

*Samples reported as below LOD were assigned LOD prior to statistical analysis.

Table I-4: Urinary Result of Molar Summed Diethylphosphate (DEPs) Metabolite

Participant / house type	Number (% Detection)	Statistic Categories	Concentration	
			Unadjusted ng/mL	Adjusted µg/g.cre.
Working age (n=36)	26 (72.2%)	GeoMean	0.05	0.05
		Range	<LOD – 1.00	<LOD – 0.85
		Percentile		
		25th	<LOD	<LOD
		50th	0.07	0.07
		75th	0.23	0.25
		95th	0.84	0.71
Non-occupational Family (n=18)	13 (72.2%)	GeoMean	0.03	0.03
		Range	<LOD – 0.23	<LOD– 0.19
		Percentile		
		25th	<LOD	<LOD
		50th	0.05	0.05
		75th	0.09	0.09
		95th	0.23	0.19
Occupational Family (n=18)	13 (72.2%)	GeoMean	0.09	0.09
		Range	<LOD – 1.00	<LOD – 0.85
		Percentile		
		25th	<LOD	<LOD
		50th	0.22	0.24
		75th	0.63	0.58
		95th	1.00	0.85

Abbreviation: LOD= limit of detection

*Samples reported as below LOD were assigned LOD prior to statistical analysis.

APPENDIX J

Elderly Urinary Metabolite Results

Table J-1: Urinary Result of Diethylphosphate (DEP) Metabolite

Participant / house type	Number (% Detection)	Statistic Categories	Concentration	
			Unadjusted ng/mL	Adjusted µg/g.cre.
Elderly (n=36)	9 (25.0%)	GeoMean	0.34	0.40
		Range	<LOD – 7.78	<LOD – 7.16
		Percentile		
		25th	<LOD	0.24
		50th	<LOD	0.25
		75th	<LOD	0.31
		95th	7.19	6.87
Non-occupational Family (n=18)	1 (5.56%)	GeoMean	0.20	0.25
		Range	<LOD	<LOD – 0.31
		Percentile		
		25th	<LOD	0.22
		50th	<LOD	0.25
		75th	<LOD	0.27
		95th	<LOD	0.31
Occupational Family (n=18)	8 (44.4%)	GeoMean	0.57	0.66
		Range	<LOD – 7.78	0.24 – 7.16
		Percentile		
		25th	<LOD	0.25
		50th	<LOD	0.27
		75th	1.82	1.89
		95th	7.78	7.16

Abbreviation: LOD= limit of detection, LOD<0.20

*Samples reported as below LOD were assigned LOD prior to statistical analysis.

Table J-2: Urinary Result of Diethylthiophosphate (DETP) Metabolite

Participant / house type	Number (% Detection)	Statistic Categories	Concentration	
			Unadjusted ng/mL	Adjusted µg/g.cre.
Elderly (n=36)	12 (33.3%)	GeoMean	0.51	0.61
		Range	<LOD – 12.5	<LOD – 12.6
		Percentile		
		25th	<LOD	0.25
		50th	<LOD	0.26
		75th	1.41	1.54
		95th	12.4	11.2
Non-occupational Family (n=18)	5 (27.8 %)	GeoMean	0.31	0.29
		Range	<LOD – 2.06	<LOD – 2.27
		Percentile		
		25th	<LOD	0.24
		50th	<LOD	0.28
		75th	0.45	0.53
		95th	2.06	2.27
Occupational Family (n=18)	7 (38.9%)	GeoMean	0.82	0.94
		Range	<LOD – 12.5	<LOD – 12.6
		Percentile		
		25th	<LOD	0.25
		50th	<LOD	0.26
		75th	6.09	6.22
		95th	12.5	12.6

Abbreviation: LOD= limit of detection, LOD<0.20

*Samples reported as below LOD were assigned LOD prior to statistical analysis.

Table J-3: Urinary Result of Molar Summed Diethylphosphate (DEPs) Metabolite

Participant / house type	Number (% Detection)	Statistic Categories	Concentration	
			Unadjusted ng/mL	Adjusted μg/g.cre.
Elderly (n=36)	13 (36.1%)	GeoMean	0.006	0.008
		Range	<LOD – 0.12	<LOD – 0.12
		Percentile		
		25th	<LOD	<LOD
		50th	<LOD	<LOD
		75th	<LOD	<LOD
		95th	0.12	0.11
Non-occupational Family (n=18)	5 (27.8%)	GeoMean	0.004	0.005
		Range	<LOD	<LOD – 0.02
		Percentile		
		25th	<LOD	<LOD
		50th	<LOD	<LOD
		75th	<LOD	<LOD
		95th	0.01	0.02
Occupational Family (n=18)	8 (44.4%)	GeoMean	0.01	0.01
		Range	<LOD – 0.12	<LOD – 0.12
		Percentile		
		25th	<LOD	<LOD
		50th	<LOD	<LOD
		75th	0.05	0.05
		95th	0.12	0.12

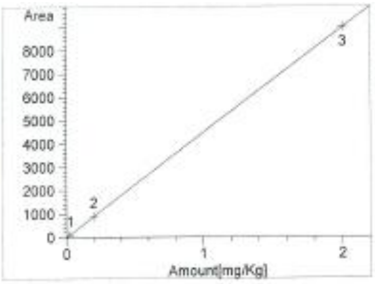
Abbreviation: LOD= limit of detection, LOD<0.10

*Samples reported as below LOD were assigned LOD prior to statistical analysis.

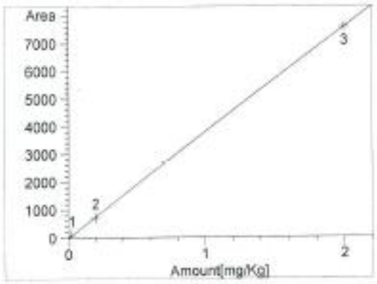
Appendix K

Calibration Curve and Laboratory Analysis

Pirimiphos-methyl and Chlopyrifos calibration curve

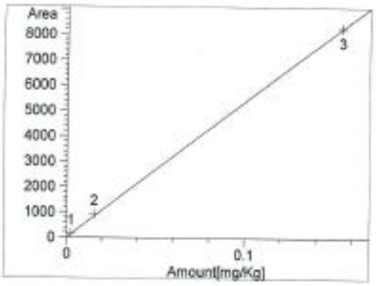


Pirimiphos-methyl at exp. RT: 16.551
FPD1 A,
Correlation: 0.99999
Residual Std. Dev.: 21.92448
Formula: y = mx + b
m: 4496.59181
b: -10.99293
x: Amount[mg/Kg]
y: Area

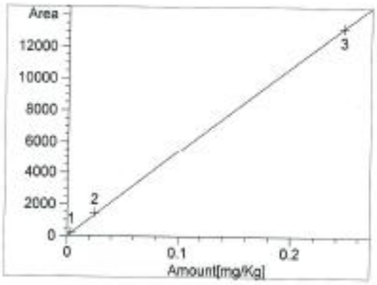


Chlopyrifos at exp. RT: 17.306
FPD1 A,
Correlation: 0.99997
Residual Std. Dev.: 35.55799
Formula: y = mx + b
m: 3802.74265
b: -9.63632
x: Amount[mg/Kg]
y: Area

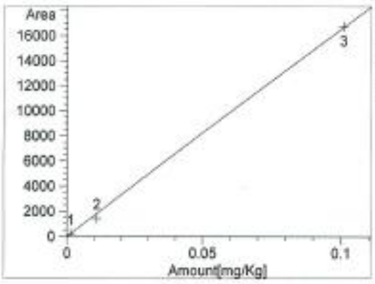
Permethrin and Cypermethrin calibration curve



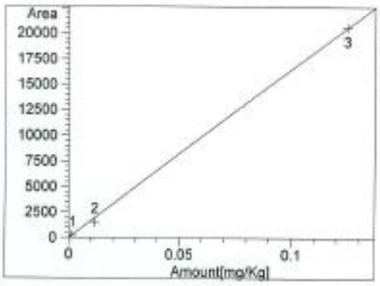
Permethrin I at exp. RT: 33.506
ECD2 B,
Correlation: 0.99995
Residual Std. Dev.: 56.03342
Formula: y = mx
m: 53754.41383
x: Amount [mg/Kg]
y: Area



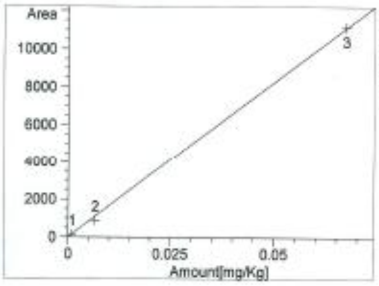
Permethrin II at exp. RT: 33.904
ECD2 B,
Correlation: 0.99995
Residual Std. Dev.: 89.36581
Formula: y = mx
m: 53753.82070
x: Amount [mg/Kg]
y: Area



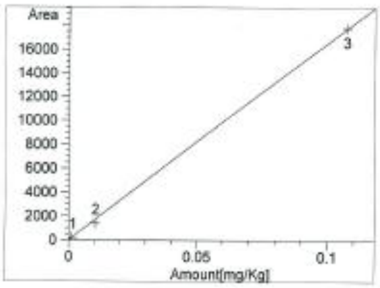
Cypermethrin I at exp. RT: 36.557
ECD2 B,
Correlation: 0.99972
Residual Std. Dev.: 278.42155
Formula: y = mx
m: 165469.38438
x: Amount [mg/Kg]
y: Area



Cypermethrin II at exp. RT: 36.888
ECD2 B,
Correlation: 0.99980
Residual Std. Dev.: 294.69236
Formula: y = mx
m: 165584.79999
x: Amount[mg/Kg]
y: Area

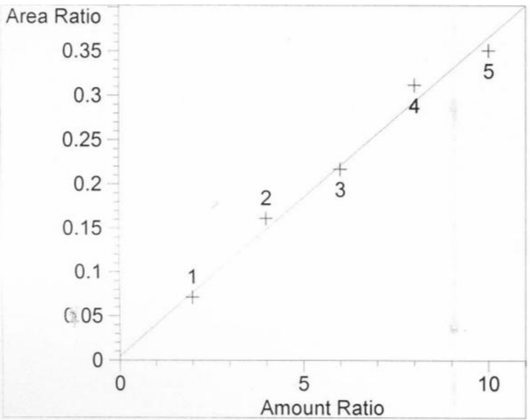


Cypermethrin III at exp. RT: 37.057
ECD2 B,
Correlation: 0.99978
Residual Std. Dev.: 167.29616
Formula: y = mx
m: 165550.96293
x: Amount[mg/Kg]
y: Area

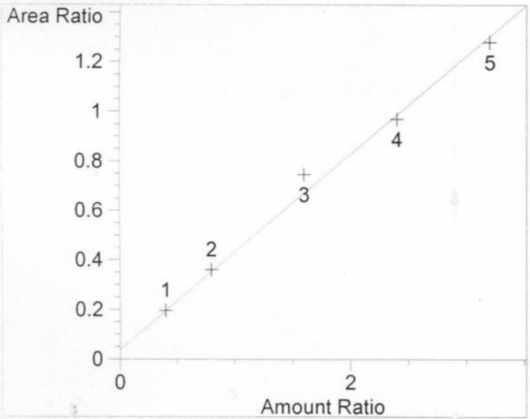


Cypermethrin IV at exp. RT: 37.175
ECD2 B,
Correlation: 0.99978
Residual Std. Dev.: 262.82658
Formula: y = mx
m: 165563.43525
x: Amount[mg/Kg]
y: Area

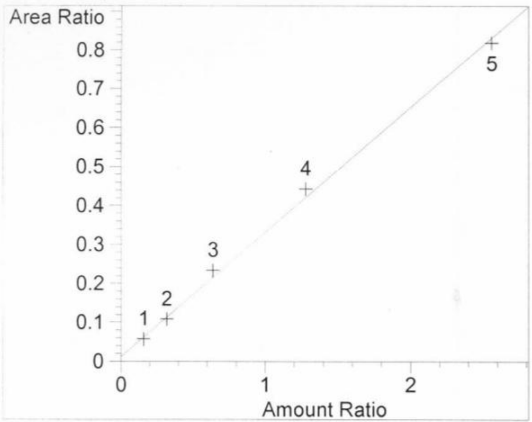
Urinary metabolite calibration curve



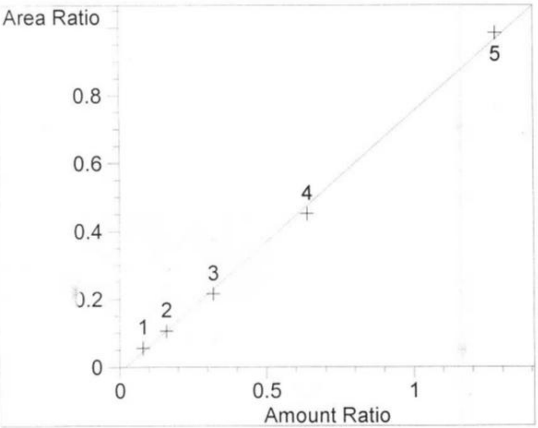

```
DMP at exp. RT: 3.840
FPD1 B,
Correlation:                0.99580
Residual Std. Dev.:         0.01392
Formula: y = mx + b
      m:       3.61839e-2
      b:       4.44552e-3
      x: Amount Ratio
      y: Area Ratio
```



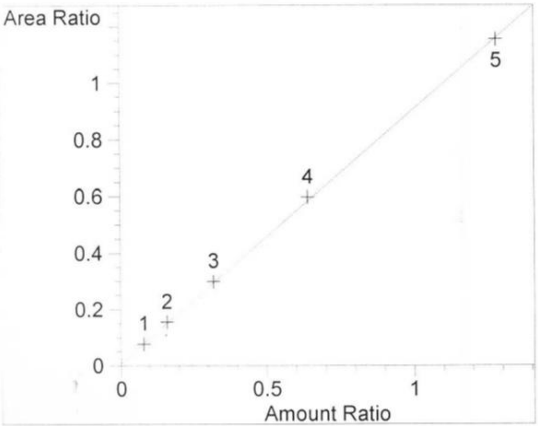

```
DEP at exp. RT: 4.600
FPD1 B,
Correlation:                0.99673
Residual Std. Dev.:         0.04426
Formula: y = mx + b
      m:       3.95863e-1
      b:       3.72111e-2
      x: Amount Ratio
      y: Area Ratio
```



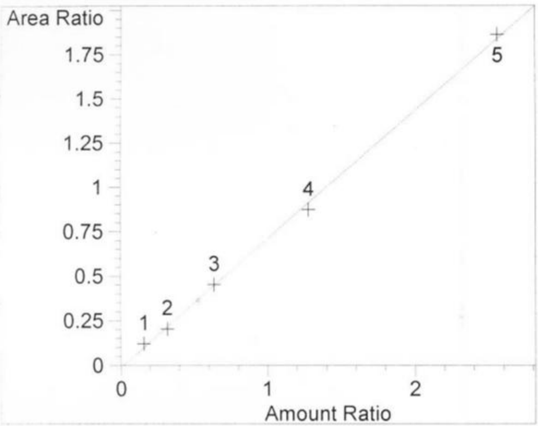

```
DMTP at exp. RT: 5.280
FPD1 B,
Correlation:                0.99881
Residual Std. Dev.:         0.01684
Formula: y = mx + b
      m:       3.20705e-1
      b:       1.19945e-2
      x: Amount Ratio
      y: Area Ratio
```



DMDTP at exp. RT: 6.380
FPD1 B,
Correlation: 0.99895
Residual Std. Dev.: 0.01893
Formula: y = mx + b
m: 7.68148e-1
b: -1.53890e-2
x: Amount Ratio
y: Area Ratio



DETP at exp. RT: 6.460
FPD1 B,
Correlation: 0.99986
Residual Std. Dev.: 0.00824
Formula: y = mx + b
m: 9.00562e-1
b: 7.48935e-3
x: Amount Ratio
y: Area Ratio



DEDTP at exp. RT: 7.260
FPD1 B,
Correlation: 0.99942
Residual Std. Dev.: 0.02664
Formula: y = mx + b
m: 7.24304e-1
b: -1.31402e-2
x: Amount Ratio
y: Area Ratio

Appendix L

Risk communication material


รู้ทันอันตราย...
สารเคมีกำจัดแมลงใกล้ตัว
สารเคมีกำจัดแมลง สามารถเข้าสู่คนได้ 3 ทาง คือ
ทางปาก โดยการกิน การดื่ม หรือโดยอุบัติเหตุ
ทางการหายใจ โดยการสูดดมไอของสาร ซึ่งสารเคมี
ทางผิวหนัง โดยการสัมผัสหรือจับต้องสารเคมีกำจัดแมลง ทำให้เกิดการดูดซึมเข้าสู่ผิวหนัง ซึ่งหาก ผิวหนังมีบาดแผล จะทำให้สารพิษดูดซึมสู่ผิวหนังได้ดี โดยเฉพาะสารพิษที่อยู่ในรูปของเหลว สามารถซึมผ่านผิวหนังได้ดีและรวดเร็วกว่ารูปแบบอื่น
อาการที่เกิดจากการแพ้สารเคมีกำจัดแมลง
อ่อนเพลีย มึนงง ปวดศรีษะและเมื่อยตามตัว แน่นหน้าอก หายใจหอบ มีอาการสั่นกล้ามเนื้อกระตุก มองเห็นภาพได้ลางเลือน ม่านตาหรี่ น้ำลายและเหงื่อออกมาก คลื่นไส้ อาเจียน ปวดท้อง ท้องร่วง อาจถ่ายอุจจาระและปัสสาวะโดยกลั้นไม่อยู่ ถ้ามีอาการรุนแรงอาจชักและหมดสติ อาจหยุดหายใจ และถึงตายได้
การปฐมพยาบาลเบื้องต้น
ให้เคลื่อนย้ายผู้ป่วยออก จากบริเวณที่มีสารเคมีกำจัดแมลง ถ้าสารเคมีกำจัดแมลงถูกผิวหนังให้ถอดเสื้อผ้าที่เปื้อนสารเคมีกำจัดแมลงออก
รีบชำระร่างกายของผู้ป่วยให้สะอาดด้วยน้ำและสบู่ อย่าขัดถูผิวหนังเพราะจะทำให้สารพิษซึมเข้าสู่ผิวหนังได้ง่าย
ถ้าสูดดมสารเคมีกำจัดแมลงเข้า ไปให้นำผู้ป่วยไปพักผ่อนในที่ที่มีอากาศถ่ายเทสะดวกและอบอุ่น คลายเสื้อผ้าให้หลวม
ถ้าสารเคมีกำจัดแมลงเข้าตาให้ล้างด้วยน้ำสะอาดหลายๆ ครั้ง นานประมาณ 15 นาที ห้ามใช้ยาล้างตา ในกรณีที่สารเคมีกำจัดแมลงเข้าปากให้บ้วนปากด้วยน้ำสะอาดหลายๆ ครั้ง
ถ้าผู้ป่วยกินสารเคมีกำจัดแมลงเข้าไปให้ปฏิบัติตามคำแนะนำในฉลากหรือทำให้อาเจียนแต่ห้ามใช้กับผู้ป่วยที่หมดสติและเป็นโรคหัวใจ การทำให้ผู้ป่วยอาเจียนโดยให้ผู้ป่วย รับประทานไข่ขาวดิบ ขนาดที่ใช้ คือ เด็ก 4 ฟองและผู้ใหญ่ 8 ฟอง และรีบนำผู้ป่วยส่งแพทย์ทันทีพร้อมด้วยภาชนะบรรจุ และฉลากวัตถุมีพิษนั้น
“การปฏิบัติตนเพื่อให้ปลอดภัย ต่อผู้ใช้ ผู้อยู่อาศัย”
1 อ่านฉลากข้างภาชนะบรรจุให้ละเอียดทุกครั้งก่อนใช้
2 ควรระมัดระวังในการเทหรือรินสารเคมีกำจัดแมลงเพื่อหลีกเลี่ยงการสัมผัสทางผิวหนัง
3 ระหว่างฉีดพ่นควรสวมเครื่องป้องกันตัว เช่น สวมเสื้อผ้าที่มิดชิด ใส่ถุงมือ หรือใช้ผ้าปิดปาก ปิดจมูก
4 อย่าฉีดพ่นในห้องที่มีเด็ก ผู้ป่วยผู้อยู่อาศัยและสัตว์เลี้ยง รวมทั้งในบริเวณที่มีอาหารและบริเวณที่มีเปลวไฟ หากจำเป็นต้องฉีดพ่นในห้องที่มีอาหารต้องปิดครอบอาหารให้มิดชิด หรือนำออกนอกบริเวณที่ใช้สารเคมี
5 ควรเก็บสารเคมีกำจัดแมลงที่ใช้ในบ้านให้ห่างไหลจากเด็ก หรือเก็บไว้ในตู้ล๊อคที่ปลอดภัย
6 หลังฉีดพ่นควรปิดห้องไว้ชั่วระยะเวลาหนึ่ง เพื่อให้ละอองของสารเคมีกำจัด-แมลงที่กระจายในอากาศบริเวณนั้น เจือจางลง
7 หากมีการฉีดพ่นสารเคมีกำจัดแมลงในพื้นที่เกษตรกรรมใกล้บ้าน ควรปิดประตูหน้าต่างให้เรียบร้อย หรือหลีกเลี่ยงบริเวณที่มีการฉีดพ่นให้มากที่สุด
8 ทำความสะอาดพื้นห้องอย่างสม่ำเสมอเพื่อกำจัดสารเคมีที่ตกตามพื้น
9 ล้างมือ ล้างหน้า อาบน้ำ และเปลี่ยนเสื้อผ้าทุกครั้งหลังการฉีดพ่นสารเคมีกำจัดแมลง
Acknowledgement:
College of Public Health Sciences, Chulalongkorn University
CU.GRADUATE SCHOOL THESIS GRANT.
Thai Fogarty Center (Grant Number: 1 D43 TW007849 Fogarty International Center - National Institutes of Health)
The higher education research promotion and national research university project of Thailand, Office of the higher education commission

VITAE

Name : Miss. Saowanee Norkaew

Date of Birth : 22^{nd} July 1983

Place of Birth : Ubonratchathani Province, Thailand

Educational Achievement :

- Bachelor of Science (Agricultural Industry), King Mongkut's Institute of Technology Ladkrabang, Bangkok, Thailand.
- Master of Public Health, College of public health science, Chulalongkorn University, Bangkok, Thailand

Research Experience :

- Physicochemical characteristics of Thai honeys.
- Knowledge, Attitude, and Practice (KAP) of using Personal Protective Equipment (PPE) for chilli-growing farmers in Huarua sub-district, Mueang district, Ubonrachathani province, Thailand.