INDIRECT EXPOSURE OF FARM AND NON-FARM FAMILIES IN AN AGRICULTURAL COMMUNITY, UBONRATCHATHANI PROVINCE, THAILAND

Saowanee Norkaew[1], Nutta Taneepanichskul[1], Wattasit Siriwong[1, 2, *], Sumana Siripattanakul[3], Mark Robson[2, 4, 5]

[1]College of Public Health Sciences, Chulalongkorn University, Bangkok 10330, Thailand
[2]Thai Fogarty ITREOH Center, Chulalongkorn University, Bangkok 10330, Thailand
[3]Faculty of Engineering and National Center of Excellence for Environmental and Hazardous Waste Management, Ubonratchathani University, Ubonratchathani 34190, Thailand, [4]School of Environmental and Biological Sciences, Rutgers University, New Brunswick, NJ, USA, [5]UMDNJ-School of Public Health, Piscataway, NJ, USA

ABSTRACT: In Thailand's agricultural communities, a number of pesticide products have been frequently used in agricultural farms and this is raising concerns about potentially adverse effects on human health and environment in the community. The objective of this study was to investigate residential pesticide exposure in farm and non-farm families in an agricultural community in Ubonratchathani province, Thailand during April, 2012. All participants signed the consent form before data collection. A total of 108 households of farm and non-farm families were recruited. Organophosphate pesticides (OPs) were collected by 24 hr indoor air sampler and wiping surface residues with 40% iso-propanol gauze pads. Both air and surface residues samples were analyzed by gas chromatography with flame photometric detector. Chlorpyrifos pesticides were detected in air samples with an average $1.28x10^{-3}$ mg/m^3 in farm families and $1.15x10^{-3}$ mg/m^3 in non-farm families. Chlorpyrifos and pirimiphos-methyl were detected in surface residue samples with an average of 0.047 mg/cm^2 and 0.032 mg/cm^2 respectively in farm families. In non-farm families, chlorpyrifos and pirimiphos-methyl were detected with an average of 0.029 mg/cm^2 and 0.024 mg/cm^2 respectively. Pesticides used in farms have contaminated the indoor environment and can be tracked in by clothes, shoes and air drift. This study described that residential pesticide exposure among families who live in agricultural communities and people in agricultural community are possibility exposed to pesticides indirectly by their main occupation in the community.

Keywords: Indirect exposure, Agricultural community, Surface residue, Pesticide exposure

INTRODUCTION

In Thailand's agricultural communities, a number of pesticide products have been frequently used in agricultural farms and this is raising concerns about potentially adverse effects on human health and environment in the community. Among agriculture areas 54.4% reported using pesticides, of which 45.9% were chemicals. The majority of agriculture areas using pesticides were in the Central and Northeastern Region (76.5 and 44.9% respectively) [1]. In the Northeastern region, the majority of agriculture areas were in Nakhon Ratchasima (6.39 million rais) and Ubonratchathani (4.40 million rais; 1 rai=1,600 m^2) province [2].

Pesticides and insecticides are chemicals that are used to control insect pests that destroy crops or transmit diseases among humans [3]. The currently used pesticides including organophosphate pesticides (OPs) are considered non persistent. These pesticides have much shorter environmental half-lives [4].

Organophosphate pesticides are neurotoxins, 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 the metabolism of acetylcholine [5]. This action is not unique to insects, but can produce the same effects in wildlife and humans.

The chili farmers in Ubon Ratchathani province currently use a wide variety of imported organophosphate pesticides to control weeds and insect infestations [6]. The survey of 330 of those chili farmers found that almost 80% of them have a low level of understanding about their pesticide use and about 85% believed that they implemented fair practices [7]. Insecticide compounds have been

* *Correspondence to: Wattasit Siriwong*
E-mail: Wattasit.S@chula.ac.th

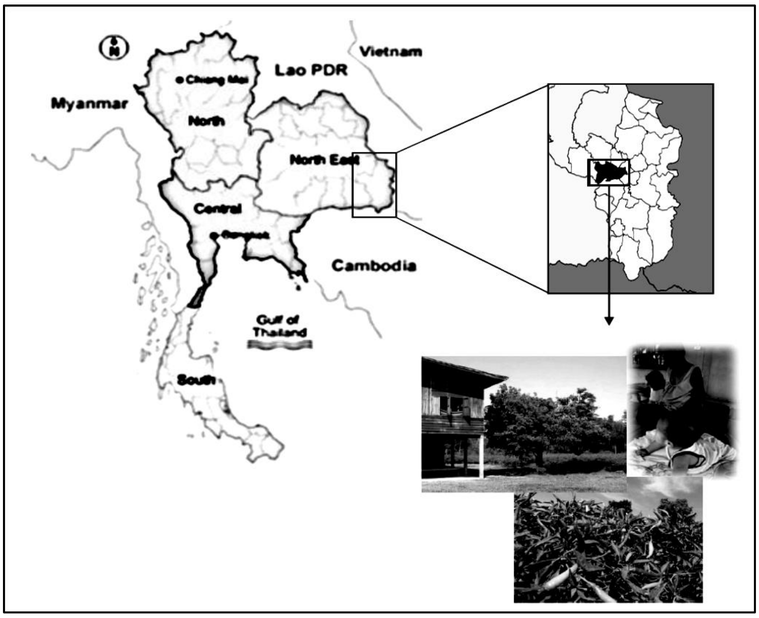

Figure 1 The study area: Hua-Rua Sub-District, Muang District, Ubonratchathani Province, Thailand

found to contaminate indoor environment, for occupational and residential purposes. Moreover, outdoor contaminants can be brought in by shoes, clothes, and air drift [8].

People living in agricultural areas may be exposed to higher levels of pesticides than in other areas because of pesticides brought into their homes by pesticide drift or by family members. Farmer's families are potentially exposed to pesticides indirectly by take-home contamination [9]. Parental occupation involving pesticide application has been associated with childhood cancers [10-12] and household pesticide use has been associated with childhood leukemia [13]. Farmer's children or children, who live in close proximity to farmland where pesticide are used, have higher exposures than do other children living in the same community [14, 15]. Pesticide levels in house dust have been correlated with urinary metabolite levels in children and adults living in the home [15].

In farm homes, families may be exposed to pesticides through home contamination even though they may not participate in farming activities. Residential environments in proximity to farm operations where pesticides are used may be contaminated through a variety of routes including airborne spread, tracking of contaminated soil into the home, 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. This study was designed to investigate residential pesticide exposure in farm families and non-farm families in an agricultural community in Ubonratchathani province, Thailand.

MATERIALS AND METHOD

This study was a cross-sectional study that focused on people living in an agricultural community including 108 households in Ubonratchathani province, northeastern, Thailand (Figure 1). In this community, the main agricultural product is chili and this area was chosen because of organophosphate pesticides are most frequently used on chili farms.

All participants signed the consent form, approved by The Ethic Review Committee for Research Involving Human Research Subjects, Health Science Group, Chulalongkorn University (COA No. 054/2555) before data collection in April, 2012.

Air sampling method

Air samples were taken with the NIOSH 5600 method. The 24 hour air samples were collected from the common area using OSHA Versatile sampler (OVS-2) sorbent tubes, containing XAD-2 resin with 13 mm quartz. Personal air pump was set and calibrated with NIOSH method before collect the samples (Figure 2). All samples were transported from the field in an ice box and transferred to a freezer. The samplers were stable at least 10 days at 25ºC and at least 30 days at 0ºC and analyzed by gas chromatography (GC) connected with flame photometric detector (FPD) [16].

Surface sampling method

Surface wipe sample: Surface wipe samples were

(a) (b)

Figure 2 Air Samples Collection by Using Personal Pump (a) and Collection Tube (b)

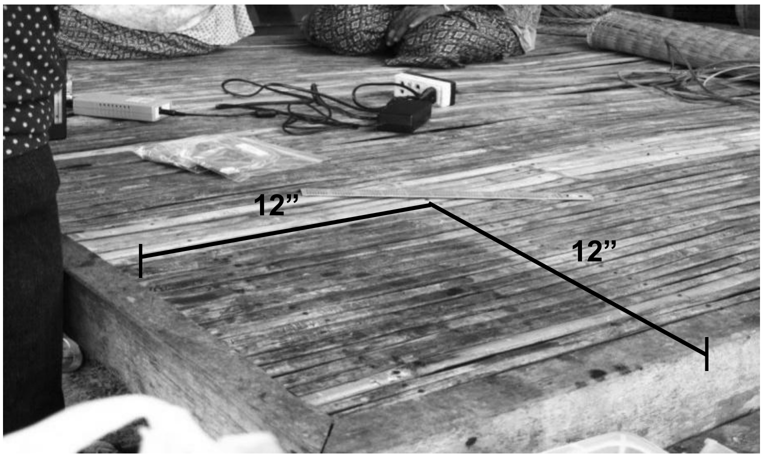

Figure 3 Surface-wipe samples collection using Daniel’s method [17]

collected in the participant’s entire house from common areas. The aluminum template (144 inch^2) was placed in an area where they stay in most of the time (Figure 3). The wipe was soaked with 40% iso-propanol (IPA) before wiping within the template. The wipe samples were placed in cleaned aluminum foil, put in plastic bags and stored in an insulated ice box. This floor wiping method is modified from Daniel’s method [17]. All surface wipe samples were extracted and the residues were identified by using GC with micro-electron capture detector (µECD) [18].

All samples were sent to analyze at Central laboratory (Thailand) Co.,Ltd. in Khon-Kaen district. In term of inter and intra observer variation was controlled by using the standard laboratory analyzing residue of pesticide.

Data analysis

The licensed SPSS software for windows version 17 was used for quantitative data analysis. Descriptive statistics for frequencies and percentage distribution were used primarily to summarize and describe the data to make it more graspable. Chi-square test was used to find the association between household’s type and OPs concentration in each route. The significant of level was considered at 0.05 and 0.01, respectively. In term of statistical difference between occupational and non-occupational families pesticide exposure concentration, independent t-test was used to explain in each route of exposure (inhalation and dermal contact).

RESULT

The study population was focused on people living in an agricultural community including 108 households, 54 farmer households and 54 non-farmer households. Non-occupational family group lived on land that was not used for farming and

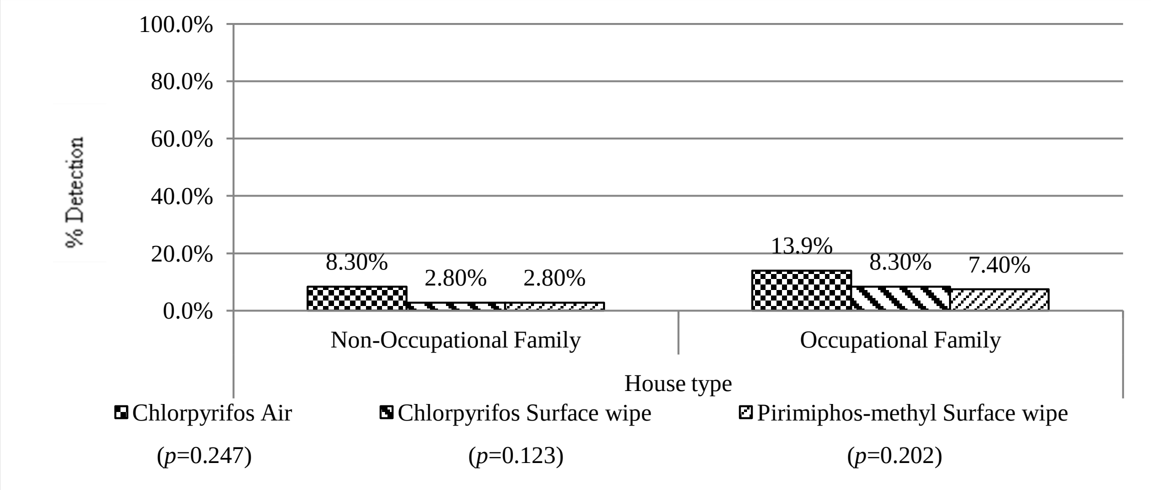

Figure 4 Detected frequency (%) of OPs in air and surface wipe samples

Table 1 Average concentrations of OPs in air and surface wipe samples.

	Pesticide	**Average concentration**		**p-value**
		Non-farm families	**Farm families**	
Air samples (mg/m^3)	Chlorpyrifos	0.00115	0.00128	0.101
Surface wipe samples (mg/cm^2)	Chlorpyrifos	0.029	0.047	0.067
	Pirimiphos-methyl	0.024	0.032	0.113

nobody in the household worked in agriculture or commercial pesticide application. For occupational family group there was at least one family member employed as a chili farmer.

In this community, both occupational and non-occupational families live near pesticide-treated farmland. The residences of the study population were not located more than 150 m from chili farmland.

Figure 4 shows the frequency of detection of OPs in air and surface wipe samples. In farm households, the frequency of OPs detection was higher than in non-farm households in both air and surface wipe samples. Chlorpyrifos was detected (13.9 and 8.3% respectively) in air and surface wipe samples. In addition, pirimiphos-methyl wad detected in surface wipe samples. Like chlorpyrifos, pirimiphos-methyl was detected more frequently in farm households than in non-farm households (7.4 and 2.8% respectively). However, there was no significant difference of detected frequencies between non-farm and farm families (Chi-square test).

Air samples

A total of 108 households participated, 54 occupational households and 54 non-occupational households. Approximately 77.8% of air samples were below the LOD for organophosphate pesticides (LOD= 0.001 mg/m^3). Chlorpyrifos was detected in air samples taken from 16 occupational residences and 9 non-occupational houses with a concentration range 0.001-0.002 mg/m^3 and with an average concentration of $1.28x10^{-3}$ mg/m^3 in occupational houses and $1.15x10^{-3}$ mg/m^3 in non-occupational houses. The concentrations in occupational families were higher than in non-occupational families, but there was no significant difference in pesticide concentration between non-farm and farm families (Mann Whitney test). Table 1 shows the average concentration in air samples separated by house's type.

Surface-wipe samples

Surface wipe samples were collected from each household, in total 108 households. Chlorpyrifos was detected in 11.1% of surface wipe samples from 3 non-farm and 9 farm households with an average concentration of $2.89x10^{-2}$ mg/cm^2 in non-occupational households and $4.67x10^{-2}$ mg/cm^2 in occupational households (LOD= 0.02 mg/cm^2). Pirimiphos-methyl was detected in 10.2% surface wipe samples with an average concentration of $2.44x10^{-2}$ mg/cm^2 in non-occupational households and $3.18x10^{-2}$ mg/cm^2 in occupational households (LOD= 0.02 mg/cm^2). Additionally, the average concentrations in occupational houses were higher than in non-occupational houses. However, no significant differences in pesticide concentrations between non-farm and farm families (Mann Whitney test) were observed. Table 1 shows the average concentration in surface wipe samples separated by house's type.

DISCUSSION

In this study, the results showed that chlorpyrifos was detected in air samples with an average concentration of $1.28x10^{-3}$ mg/m^3 in occupational houses and $1.15x10^{-3}$ mg/m^3 in non-occupational houses. Organophosphate pesticides (e.g., chlorpyrifos and profenofos) are used the most in chili crops. Thus, indirect exposure of people in the community to pesticides may occur from inhalation and contact with a contaminated surface. Chlorpyrifos was detected in surface wipe samples with an average concentration of $2.89x10^{-2}$ mg/cm^2 in non-occupational households and $4.67x10^{-2}$ mg/cm^2 in occupational households. Pirimiphos-methyl was detected in 10.2% of surface wipe samples with an average concentration of $2.44x10^{-2}$ mg/cm^2 in non-occupational households and $3.18x10^{-2}$ mg/cm^2 in occupational households. The average concentrations of air and surface wipe samples in occupational houses were higher than in non-occupational houses. These findings are similar to other research that found that chlopyrifos had a 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) [19]. In 2005, Curwin et al collected 99 indoor air samples and reported that chlopyrifos was detected in indoor air samples with a range of 0.04-0.23 $\mu g/m^3$ in farm households and a range of 0.01-0.05 $\mu g/m^3$ in 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 in farmer houses and 0.22-3.8 ng/cm^2 in non-farm houses [18].

On the other hand, previous research collected dust from floors and carpets in houses. A study in Arizona found chlopyrifos in house dust with a geometric mean of 113 ng/g [20]. In 2002, Curl et al found chlorpyrifos in house dust from farm worker houses with a geometric mean of 50 ng/g. This study reported that farm households are more contaminated than non-farm households [21]. Also, in another study undertaken in California, data revealed that pesticide levels in house dust from farm houses are higher than in non-farm houses [22]. These is an indication that chlorpyrifos was most frequently detected in many studies. After organochlorine pesticides were banned, non-persistent pesticides were developed and widely used in agricultural applications [5]. Non-persistent pesticides are called current-use pesticides including organophosphate, carbamates and pyrethroid insecticides.

CONCLUSIONS AND RECOMMENDATIONS

Chili farmers in this community use a wide variety of organophosphate (OPs) pesticides and this study found organophosphate pesticides in air and surface wipe samples. This study found no significant differences of other pesticides concentration among both of occupational and non-occupational households. As expected, people in the community were exposed to pesticides used in their community. Family members may have also been indirectly exposed to pesticides used in the farm. And it could be assumed that people in this community may be exposed either by inhalation or dermal pathway.

It seems likely that people's exposure to pesticides was influenced more directly by agricultural activities. The recommendation to reduce risk from indirect pesticide exposure will be advised and risk management and risk communication regarding prevention or reducing risk should make suggestions to this community about house cleaning methods and knowledge about hazards of pesticides and insecticides.

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