PUBLIC HEALTH RESEARCH

Chlorpyrifos Blood Level and Exposure Symptoms among Paddy Farmers in Sabak Bernam, Malaysia

Rozita Hod*, Azimatun Noor Aizuddin, Shamsul Azhar Shah, Mohd Rohaizat Hassan, Nazarudin Safian and Mohd Hasni Jaafar

Department of Community Health, UKM Medical Centre, Jalan Yaacob Latif, BandarTtun Razak, 56000 Cheras Kuala Lumpur.

**For reprint and all correspondence: Rozita Hod, Department of Community Health, UKM Medical Centre, Jalan Yaacob Latif, Bandar tun Razak, 56000 Cheras Kuala Lumpur.*
Email: gieto@gmail.com

ABSTRACT

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Introduction The extensive and intensive use of pesticides in agricultural practices has exposed farmers to various hazards resulting in varying degrees of health outcomes.

Methods We conducted a cross-sectional study among paddy farmers in Sabak Bernam district, Malaysia. The objective of this study was to gather baseline information on chlorpyrifos blood level and its relationship with pesticides exposure symptoms.

Results We detected chlorpyrifos in farmers' blood in 7 percent of the respondents, with mean 7.29 nanogram per millilitre blood (sd 5.84 nanogram per millilitre). The percentage of farmers who experienced at least one pesticide exposure symptoms was 75 percent. However, we found no significant association between chlorpyrifos blood level and its exposure symptoms. The farmers had low scores on safe practice of pesticide use even though they have high marks on knowledge and attitude. We found no significant association between the scores on knowledge, attitude and practice on pesticide use and the chlorpyrifos blood level.

Conclusions The presence of pesticide exposure symptoms proved that most of the farmers were exposed to hazardous effects of pesticides. Specific trainings on safe use and handling of pesticides should be given on regular basis to these farmers to ensure they are protected from hazardous effects of pesticides exposure.

Keywords Chlorpyrifos - paddy farmers - Sabak Bernam - pesticides exposure symptoms

INTRODUCTION

Chlorpyrifos is a broad-spectrum organophosphate insecticide. It is effective in controlling cutworms, corn rootworms, cockroaches, grubs, flea beetles, flies, termites, fire ants and lice. Some farmers use it as an insecticide on grain, cotton, field, fruit, nut and vegetable crops, and well as on lawns and ornamental plants. Others use it on sheep and turkeys, for horse site treatment, dog kennels, domestic homes, farm buildings, storage bins and commercial establishments. Chlorpyrifos acts on pests mainly as a contact poison, with some action as a stomach poison. It is available as granules, wettable powder, dustable powder and emulsifiable concentrate. In Sabak Bernam, 90 per cent of the paddy farmers used chlorpyrifos as insecticide on the paddy stalks[1]. It is popular because of its availability and reasonable price.

Preventive treatment with insecticides such as chlorpyrifos at high dose before the planting season of a new crop (soil drenching) is a common practice in some tropical intensive cropping systems. This practice may increase the risk of leaching and pesticide uptake by the new crop. The half-life of the chlorpyrifos in Malaysian soil was reported as 19.8 days[2]. In Sabak Bernam, farmers plant the paddy every 8 to 10 months because of the availability of modern farming methods. For example, they use machines like tractors to plant the paddy plant, unlike the traditional manual method that use a special hand-held tool, called *kuku kambing*. They use modern techniques to increase the rice production. We conducted this study to set up a database on the impact of chlorpyrifos exposure as well as objectively measure the chlorpyrifos blood level among the farmers.

Chlorpyrifos is moderately toxic to human beings[3]. Various studies have reported adverse effects of chlorpyrifos on human body such as the central nervous system, the cardiovascular system, the respiratory system as well as skin and eye irritant [4,5,6,7]. However, studies have shown that skin absorption in human is limited[8]. The exposure symptoms include numbness, tingling sensation, incoordination, headache, dizziness, tremor, nausea, abdominal cramps, sweating and blurring of vision. Vulnerable groups would include people with respiratory problem, recent exposure to cholinesterase inhibitors, having cholinesterase impairment, or liver function disruption. There is no recorded LD_{50} for humans but animal studies have reported oral LD_{50} as 32 mg per kg in chickens, and 60mg per kg in mice[9]. Chronic toxicity because of prolonged or repeated exposure may cause impaired memory and concentration, disorientation, severe depression, irritability, confusion, headache, speech difficulties, delayed reaction times, nightmares, sleepwalking, drowsiness or insomnia. They can also experience influenza-like condition with headache, nausea, weakness, loss of appetite and malaise.

There are many overseas studies that estimate and measure the exposure routes and biological monitoring of chlorpyrifos. However, in Malaysia, these studies are quite limited. It is impotant to assess the exposure of chlorpyrifos especially among paddy farmers since they are using this pesticide extensively. The main objective of this cross sectional study is to measure chlorpyrifos blood level among paddy farmers in Selangor and to determine its relationship with the exposure symptoms.

METHODS

Sabak Bernam district has the largest number of paddy farmers in Selangor. There were a total of 19, 665 farmers registered in Selangor and out of these, 10, 213 farmers were in Sabak Bernam[10]. This was a cross sectional study. By using multistage random sampling from the list of sub-districts in Sabak Bernam, six sub-districts were selected. A total of 100 respondents were recruited into the study. The inclusion criteria were farmers using chlorpyrifos for the past six months, did not have any medical problem and agreed to give blood samples. The study tool consisted of questionnaire which the respondents filled up. The questionnaire contains information on sociodemography, use of pesticides as well as symptoms of exposure to pesticides. Written consent was obtained from the respondents for the blood sampling procedure. The respondents were given appointment date for the blood sampling. A sample of 5 ml venous blood was taken from each respondent, and stored in a glass vial containing lithium heparin which acts as anti-coagulant. The blood was centrifuged at 150 rotation per minute for 10 minutes. After this process, the venous blood separated into 2 parts, red blood cells and plasma. Using a pipett, 2 ml plasma was extracted and stored in an empty glass vial, and these samples were stored below -20^0C before undergoing analysis for chlorpyrifos level. Analysis for *chlorpyrifos* plasma level in humans was performed using liquid extraction and analysis using Gas Chromatography Shimadzu Model QP5000 GCMS. Using computerized method, calibration curve was obtained from the graph. The detection limit in this measurement was 0.1 ng/ml. For the exposure symptoms, questions asked were based on wether the respondents had experienced exposure symptoms such as headache, giddiness, eye irritation or skin irritation after pesticides application. Data analysis was performed using SPSS version 11.0. The blood samples were taken within 24 hours after the application of chlorpyrifos.

RESULTS

Table 1 shows the sociodemographic characteristics of the respondents. The mean and standard deviation for age was 46.0 ± 12.9 years. The median and interquartile range (IQR) for household monthly income was Ringgit Malaysia 666.00 (IQR Ringgit Malaysia 500.00, 1000.00). For gender, 99 percent of respondents were males. All of the respondents were Malays. Most of the respondents (52 percent) had secondary education. Only 4 percent had no formal schooling at all. Majority of the respondents (90 percent) were married. The mean duration for having worked in the agricultural sector was 21.4 years and standard deviation was 13.5 years. The mean duration of having and are still using Chlorpyrifos was 5.5 years with standard deviation of 4.9 years.

Table 2 showed the distribution of respondents based on the use of Personal Protective Equipment (PPE) by the farmers, the occurrence of pesticide exposure symptoms (health hazards effects) and the practice at the pesticide application sites.

Table 1 Sociodemographic characteristics of the respondents (n=100).

Variable	Mean(SD)	Median(IQR)	n(%)
Age (year)	46.0 (12.90)		100 (100.0)
Household income (RM)		666.00 (IQR500.00–1000.00)	100 (100.0)
Gender			
Male			99(99.0)
Female			1(1.0)
Ethnicity			
Malay			100(100.0)
Others			0 (0.0)
Education level			
No schooling			4(4.0)
Primary			44(44.0)
Secondary/higher			52(52.0)
Marital status			
Married			90(90.0)
Single/widower			10(10.0)
Duration of working in agricultural sector (year)	21.4(13.5)		100(100.0)
Duration of using Chlorpyrifos(year)	5.5(4.9)		100(100.0)

Table 2 Distribution of respondents by use of personal protective equipments (PPE), occurrence of health hazards effects and by habits at the pesticide application sites.

Variable	(%)
	n=100
PPE	
Respirator	(0.0)
Full PPE attire	(38.0)
Sunshade glasses/goggles	(54.0)
Rubber gloves/hand gloves	(77.0)
Rubber boots/jungle boots	(92.0)
Long sleeves shirt	(98.0)
Trousers	(99.0)
Nose/mouth cover/mask	(100.0)
Health hazards' effects	**n= 100**
Giddiness	(41.0)
Redness of eyes	(40.0)
Headache	(25.0)
Skin rashes	(24.00
Sneezing/cough	(23.0)
Nausea	(9.0)
Blurring of vision	(7.0)

Numbness	(7.0)
Muscle cramp	(6.0)
Lethargy	(6.0)
Abdominal pain	(2.0)
Breathing difficulty	(2.0)
Diarrhoea	(1.0)
Habits	**n=100**
Eating/drinking/smoke	(6.0)
Spraying against the wind	(20.0)
Spraying below the knee level	(32.0)
Throw empty containers in the open area	(54.0)
Mixing more than 2 pesticides	(83.0)
Re-use the pesticide container	(99.0)

*Multiple response were recorded.

From this study, it was found that 75 percent of the respondents had experienced at least one of the numerous exposure symptoms. Respondents were asked what were the symptoms they had experienced within 24 hours after a pesticide application session. The most common symptom was giddiness (41 percent), redness of eyes (40%) and headache (25%). The results about habits at pesticide application sites showed that 83% of the farmers admitted they mixed more than 2 pesticides, 99% said they used the empty containers for other purposes and 54% threw the empty containers in open dumping sites.

Blood samples were taken from the farmers and out of these, 7% were detected to have *chlorpyrifos* with mean chorpyrifos level of 7.29ng/ml and standard deviation of 5.84ng/ml. The range was from 0.23ng/ml to 18.37ng/ml. The safe level for chlorpyrifos either from single exposure or repeated exposures, is not known (IPCS 1975).

Table 3 showed the comparison of various variables between the group that was detected to have chlorpyrifos in their blood, and the other group who were not detected. The variables tested were age, monthly income, number of years working in agricultural sector, number of years using chlorpyrifos, knowledge scores, attitude scores and practice scores. All the variables tested were found to be not significant.

Table 3 Comparing variables between the detected groups and the non detected groups.

	Chlorpyrifos blood levels			
Variable	**Detected n=7 Median(IQR)**	**Not detected n=93 Median(IQR)**	**Z statistics[a]**	**p value[a]**
Age(years)	43(20)	44(19.50)	-0.939	0.348
Income(RM)	600(116)	700(683.00)	-1.199	0.231
Number of years working in farms	20(6)	20(20.5)	-4.47	0.655
Number of years using Chlorpyrifos	2(3)	4(4.5)	-1.265	0.206
Knowledge scores	12(2)	14(4)	-1.265	0.206
Attitude scores	6(4)	6(2)	-0.758	0.449
Practice scores	18(2)	14(4)	-.905	0.366

[a]Mann –Whitney test *Significant at $p < 0.05$

DISCUSSION

Exposure symptoms varied depending on properties of the chemical compound. A study[11] found that 95 percent of the farmers experienced body pain while 82 percent had eye redness after pesticide application activities. Our study found that the percentage of farmers experiencing giddiness and redness of eyes were 41 percent and 40 percent respectively.

Organophosphorus compounds have been widely established as chemicals which have potent neurotoxic effects. They are widely used in both the industrial as well as the agricultural sectors. The neurotoxic effects can be divided into few actions[6].The primary action is the irreversible inhibition of acetylcholinesterase, resulting in acetylcholine accumulation and overstimulation of nicotinic and muscarinic receptors. This results in cholinergic effects. A delayed onset of ataxia, with

axon and myelin degeneration is another form of organophosphorus (OP) neurotoxic action. It is known as OP ester-induced delayed neurotoxicity (OPIDN). Large toxic doses of OP because acute neuronal cell death in brain, but sublethal dose produces neuronal cell death and involve oxidative stress. The exact mechanism has yet to be explored.

In this study, the exposure opportunity of farmers and their family members to be exposed to the hazards of pesticides are high, as most of the farmers store the pesticides either in their houses or near a shed behind their houses. The farmers' houses are located adjacent to the paddy fields and when the wind blows recently pesticide-sprayed paddy fields, the potential of residential areas to get pesticide mists are certainly high. Similar findings were reported[12] in which discovered 21 percent of the farmers studied were living less than 50 yards away from the pesticide mixing areas.

The percentage of respondents detected to have chlorpyrifos in their blood was 7.0%. This number is much lower compared to previous studies done in various settings and populations. A study[13] done among Malaysian residents living adjacent to agricultural areas in 2000 found 7.3% of the respondents had chlorpyrifos in their blood. In the United States[14] it was recorded as 50.0% and another study found 74.0% the respondents living in urban areas which received termite control services using chlorpyrifos had detectable level of chlorpyrifos in their blood[15]. Another study conducted among pregnant mothers and their babies found 98.0% of the respondents had detectable chlorpyrifos in them[16]. There were also studies[17] that reported chlorpyrifos blood levels of 3.9± 4.8 pg/g among exposed population and the personal air chlorpyrifos measurement recorded a mean of 14.3± 30.7 ng/m^3. Personal air sampling was found to be weakly correlated with chlorpyrifos blood level. In this study however personal air sampling was not done due to financial constraint.

Another study done among paddy farmers in Thailand yielded 58% of the farmers had been detected to have chlorpyrifos in their blood[18]. Air sampling mean was 0.062±0.092mg/m^3 and this was highly correlated with cholinesterase level (r=0.872, p=0.01).

Chlorpyrifos is an irreversible inhibitor of cholinesterase (ChE). In humans, the inhibition of ChE is believed to be the most sensitive effect of Chlorpyrifos exposure. Epidemiological studies on human populations discovered an association between umbilical cord blood chlorpyrifos level with fetal outcomes such as birth weight [17, 19, 20] However, there were debates wether low birth weight is a more critical effect compared to inhibition of ChE (Zhao et al. 2005) and which should be studied further in detail.

Comparing the variables between those detected and not detected having chlorpyrifos in their blood, there were no significant differences for variables such as age, monthly income, duration of working in agricultural sector, duration of using chlorpyrifos, knowledge scores, attitude scores and practice scores.

CONCLUSIONS

Farmers all over the world are still exposed to various exposure risks, namely pesticides. This is especially true in many poor and developing countries which rely greatly on their agricultural products as means of sustaining their population as well as to generate income for their country.

A large number of farmers are still exposed to the unsafe use of pesticides. Various studies on knowledge, attitude and practice indicate that the unsafe use of pesticides is still a dominant issue especially in developing countries. There are still high rates of acute poisoning due to chlorpyrifos exposure. Intervention studies are few but demonstrate the need for evaluation of current preventive measures and as well as policies related to pesticide usage.

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