

Factors Related to Serum Cholinesterase Level and Health Education of Insecticide Usage among Agriculturists in Wiang Kaen District, Chiang Rai Province, Thailand

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ABSTRACT

Introduction: Pesticides have been implicated in toxicity through routes including consumption of residues and inhalation. The previous reports show high amounts of agriculturists who obtained the toxic substance from pesticide throughout Thailand and Chiang Rai that leading to waste of public health funds. **Methods:** This study was surveying the 146 agriculturists by quota sampling for measuring serum cholinesterase level and assessing pre-test knowledge attitude and practice (KAP) in pesticide usage by using questionnaire as quantitative data. Only 62 people were completed the questionnaire in both pre- and post-test. The data were then analyzed the significant related factors associated with cholinesterase level by chi-square and descriptive statistical analysis. Related factors obtained were then used for preparing knowledge provided to agriculturists. Post-test of KAP and post serum cholinesterase level were later assessed. Qualitative data were also analyzed by dividing agriculturists into 2 groups of improved and non-improved of post-test KAP. The questionnaire for in-depth interview using open-ended question have been used to interview both groups for finding out the difference between two groups. **Result:** Three factors were found to be related with the enzyme cholinesterase level including family status, manure, and plant disease. KAP score of post-test questionnaire after providing knowledge to agriculturists were significantly higher at the p-values less than 0.05. In qualitative data, chemical storage, period of exposure time and eating behavior were found to be different between KAP improved and non-improved group. **Conclusion:** The knowledge program for agriculturists which prepared from related factor were efficiently improved KAP among them.

Keywords: Insecticide usage, Serum cholinesterase level, Health education program

Introduction

Pesticides have been implicated in toxicity through many routes including consumption of residues and inhalation [1,2]. Organophosphates and carbamates are widely used as insecticides in agricultural sector and patients who obtained toxic from this group of insecticides are the most common and important problems [3]. There were various researches reported that the pathophysiology of poisoning is quite complex making difficulty in treatment, so patients have a high mortality rate [4]. Worldwide, an estimated 3,000,000 people are exposed to organophosphate or carbamate agents each year, with up to 300,000 fatalities [5]. In Thailand, the reported cases of the toxic effects of substances during

2007 to 2013 were found predominantly in the central region of Thailand with about 15,262 to 22,035 cases each year (31 to 36% of the total cases), followed by the Northeastern region (27 to 31%), while the annual proportion of the North (18 to 20%) were almost equal to those of the South (18 to 19%) [6]. The incidence of toxic effects of substances chiefly non-medicinal as to source in Thailand between 2007 to 2013 were about 49,000 to 61,000 reported cases each year with morbidity rate between 76.4 and 96.6 per 100,000 populations these included all patients admitted in hospital received toxic substances [6]. From the Disease Control Department of northern Thailand reported that 13.54 per 100,000 people in northern Thailand are hospitalized due to pesticide poisoning from farming [7]. Focusing on Ban Por Klang, Wiang

Kaen district, Chiang Rai, there are 95. 23% agriculturists who use pesticides especially insecticides in their farms and data from health promoting hospital show that almost of them were found to be high risk of insecticide exposure when monitoring their serum cholinesterase level.

Serum cholinesterase level have been widely used as biomarkers for the monitoring the exposure of organophosphates and carbamates pesticides [8]. Generally, there are two cholinesterase enzymes in human body: (1) acetylcholinesterase (AChE, EC 3.1.1.7) present in the nerve system, erythrocytes, brain and several tissues, and (2) butyrylcholinesterase (BChE, EC 3.1.1.8) found in serum or plasma which is synthesized by the liver. The organophosphates and carbamates pesticides produce toxicity to humans by inhibiting acetylcholinesterase activity on erythrocyte of human and butyrylcholinesterase in plasma [9].

Therefore, this study aims to explore factors related to serum cholinesterase level among agriculturists in Wiang Kaen district, Chiang Rai for preventing agriculturists from adverse reactions of insecticide and also reduce risks of pesticide exposure for saving Thai public health funds.

Methods

Various factors which may involve in serum cholinesterase level among agriculturists from questionnaire were specified as independent variables (Figure 1). Questionnaire was constructed by Dr. Denpong Wongwichit (personal contact) and Index of Item Objective Congruence (IOC) has already been performed.

Study design

This study was claimed to be mixed method study and the result was explained by both quantitative and qualitative data analyses. Firstly, the study focused on the examination of serum cholinesterase level and then exploration factors related to enzyme cholinesterase among agriculturists in Wiang Kaen district, Chiang Rai in quantitative method. Qualitative data were obtained by in-depth interviewed of risk serum cholinesterase level agriculturists. After obtained factors related to enzyme cholinesterase level, the health education about chemical usage in agriculturists were provided.

Population and sample

Agriculturists who use chemicals in agriculture including the head of family and able to attend in blood collection for 2 times (before and after the health education; the education that used related factors to cholinesterase level to make knowledge program). The exclusion criteria were missing on a second blood collection and unwilling to participate in this study.

Serum cholinesterase level determination

Serum cholinesterase level (cholinesterase reactive paper) was purchased from Government Pharmaceutical Organization (GPO). The interpretation was followed by kits instruction which categorized into 4 levels; unsafe, risk, safe and normal by colorimetric method. Unsafe, risk and safe are groups of people who exposed a different level of organophosphate and carbamate while, normal is the people who never exposed to pesticide at that time. Since the reactive paper was sensitive to various factors such as light, heat and humidity, but only this kit was available in the community. According to the instruction, sensitivity of

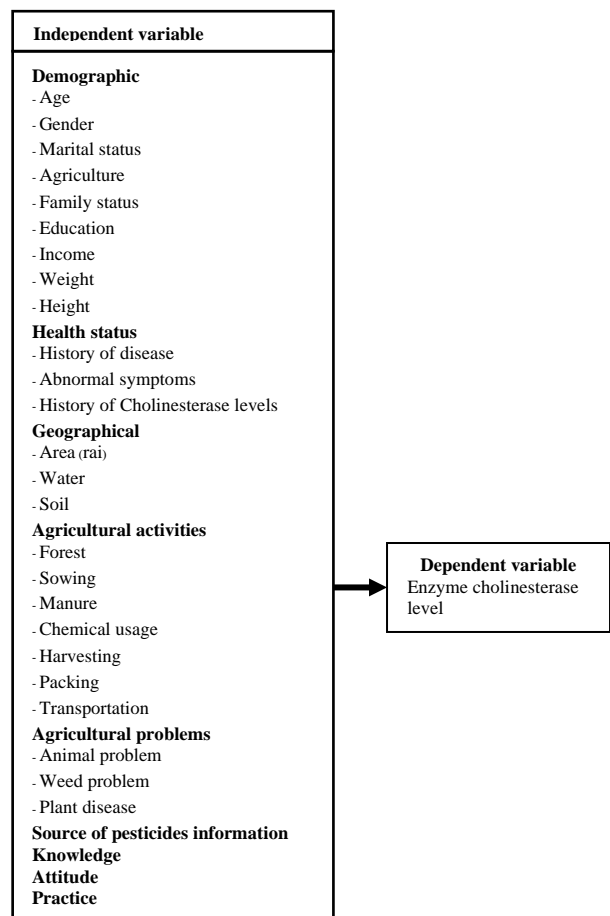


Figure 1 Conceptual framework of factors which may related to enzyme cholinesterase level among agriculturists in Wiang Kaen district, Chiang Rai

this method is 77.04%; specificity is 90.01% and positive predicted value is 90.38%

Data Collection

Pre- and post-questionnaires are the measurement tools for quantitative data collection. The assessment was assessed after 2 weeks after an intervention. During assessment the agriculturists were exposed to the chemical because of longan and pomelo planting period. The questionnaire consists of five parts

(demographic information, information of pesticide usage, knowledge, attitudes, and practice of chemical usage). To calculate knowledge, attitude and practices (KAP) score, a scoring system was prepared. Each correct answer was coded as 1, while each incorrect answer was coded as 0. In the practice section, components with better practice obtained a higher score up to 5, while respondents with poorer practice received lower scores. The final score for each category was then divided in quartiles. Four categories of knowledge, attitude and practice were outlined according to the score obtained by each respondent as low, medium, high, and very high [10]. The seven opened-end questionnaires by in-depth interview were used as qualitative data collection.

Intervention

Intervention was provided after the 1st survey among agriculturists in Wiang Kaen district, Chiang Rai. All factors were used to design the program of pesticide knowledge providing and program Prezi was used as knowledge providing media. Before providing an intervention, pre-questionnaire and baseline serum cholinesterase level were prior test.

Chart of Methodology

Total population of the community are 966 persons. Only 220 persons were our target group who use pesticide in agriculture, however, the people who unable to attend both pre- and post-serum cholinesterase enzyme level were excluded. The quota sampling was used as sampling technique and sampling for 146 persons. Sixty-two persons were completed the pre- and post-questionnaire and serum cholinesterase test. The quantitative data were obtained by interviewing using our questionnaire, while, qualitative data were obtained by using open end questionnaire of 7 persons of safe level of serum cholinesterase level (people who are normal and safe of serum cholinesterase level) and 7 persons of unsafe cholinesterase level (people who are unsafe and risk of serum cholinesterase level) as show in Figure 2.

Statistical analysis

Demographic characteristics, health status, geographical information, and agricultural role will be analyzed by descriptive statistical analysis and the factor associated with enzyme cholinesterase level were analyzed by inferential statistic using chi-square, logistic regression, and bivariate. The significance level at p-value less than 0.05 is used throughout the study.

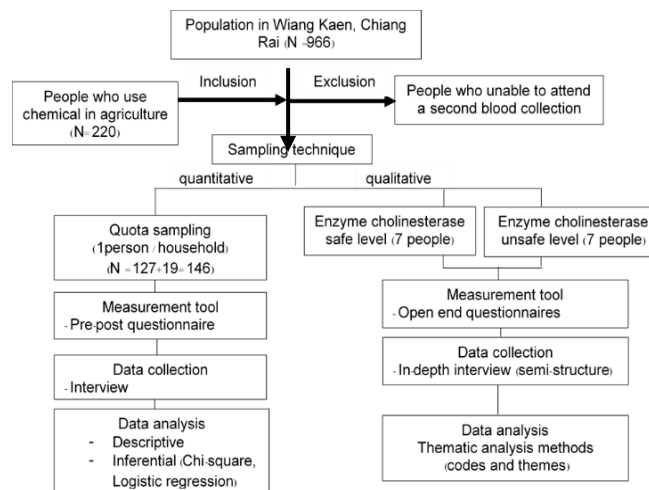


Figure 2 Methodology chart described workflow of this study

Results

The total participants were 62 persons who able to complete the pre- and post-test of questionnaire. Of these, 56.45% are male with age rank of 53-61 years old which calculated to be 53.23%. Most of them were graduated from the primary school 62.90% , low income 98.39%, had already married for 88.71%, heads of family are 56.45% , soil problem 62.90% , animal problem 95.16%, weed problem 62.90%, plant diseases 53.23%, and farming on their own 93.54% as described in Table 1. The result of serum cholinesterase level of agriculturists before intervention in Table 2 show 93.54% are not safe level and 6.45% are risky level, but the result after intervention show that 50% of people are risky level, 38.70% are not safe level and 11.29% are safe level so the results are better than before the intervention.

Table 2 show a percentage of Not safe subject before and after training. The Not safe subject was 93.54% in before intervention survey and decrease to be 38.70% after training. No one was found to have "Normal" level of cholinesterase.

Finding out the significant factors associated with serum cholinesterase level among agriculturists were family status who are head of family, using the manure during plantation, and having a problem about plant disease with p-value 0.001, 0.006 and 0.027, respectively (Table 3).

Table 1 General characteristics among agriculturists in Wiang Kaen district, Chiang Rai

Characteristics	n (%)	Characteristics	n (%)
Demographic		Income (per year)	
Gender		5,000-203,999 Baht	61(98.39)
Male	35(56.45)	>204,000 Baht	1(1.61)
Female	27(43.55)	Expense (per year)	
Age		4,000-183,199 Baht	61(98.39)
<43 years old	2(3.23)	>184,200 Baht	1(1.61)
44-52 years old	17(27.42)	Period of farming (year)	
53-61 years old	33(53.23)	1-14 year	4(6.45)
62-70 years old	8(12.90)	15-28 year	22(35.48)
>71 years old	2(3.23)	29-42 year	43(69.35)
Marital status		43-56 year	23(37.10)
Single	2(3.23)	57-70 year	3(4.84)
Married	55(88.71)	Area (rai)	
Widow	2(3.23)	1-13 Rai	30(48.39)
Divorce	2(3.23)	14-26 Rai	26(41.94)
Separate	1(1.61)	27-39 Rai	3(4.84)
Weight		40-52 Rai	2(3.23)
44-52 kg	12(19.35)	53-65 Rai	1(1.61)
53-61 kg	24(38.71)	Water problem	
62-70 kg	18(29.03)	Yes	34(54.84)
71-79 kg	6(9.68)	No	28(45.16)
80-85 kg	2(3.23)	Soil problem	
Height		Yes	39(62.90)
148-153 cm	14(22.58)	No	23(37.10)
154-159 cm	12(19.35)	Cheap products problem	
160-165 cm	23(37.10)	Yes	50(50)
166-171 cm	10(16.13)	No	12(19.35)
172-175 cm	3(4.84)	Agricultural activities	
Family member(s)		Forest clearing before farming	
1 person	1(1.61)	Yes	27(43.55)
2 persons	8(12.90)	No	35(56.45)
3 persons	18(29.03)	Sowing	
4 persons	18(29.03)	Yes	42(67.74)
5 persons	10(16.13)	No	20(32.26)
6 persons	3(4.84)	Manure	
7 persons	4(6.45)	Yes	49(79.03)
Family member(s) who are agriculturist		No	13(20.97)
1 person	13(20.97)	Chemical usage	
2 persons	43(69.35)	Yes	55(88.71)
3 persons	5(8.06)	No	7(11.29)
4 persons	1(1.61)	Harvesting	
Period of settle in the community		Yes	48(77.42)
<31 years	6(9.68)	No	14(22.58)
32-43 years	5(8.06)	Packing	
44-55 years	25(40.32)	Yes	13(20.97)
56-67 years	23(37.10)	No	49(79.03)
>68 years	3(4.84)	Transportation	
Family status		Yes	17(27.42)
Head of family	35(56.45)	No	45(72.58)
Spouse	21(33.87)	Farm on their own land	
Child	6(9.68)	Yes	58(93.54)
Education		No	4(6.45)
Illiterate	13(20.97)	Hire	
Primary school	39(62.90)	Yes	8(12.90)
Secondary school	5(8.06)	No	54(87.09)
High school	5(8.06)		

Interestingly, most of the agriculturists who use manure for their agriculture (93.54 %) were in risk group or people who were unsafe, risk, safe of serum cholinesterase level, while only 6.45% were non-pesticide exposure group. When calculated the risk of

manure by univariate regression, it was found that agriculturists who use manure for their agriculture has greater risk than agriculturists who do not use for 14.4 times (Table 4).

Table 1 General characteristics among agriculturists in Wiang Kaen district, Chiang Rai (n=62) (Continued)

Characteristics	n (%)	Characteristics	n (%)
Agricultural problems			
Animal problem			
Yes	59(95.16)	Recover by themselves after illness	
No	3(4.84)	Yes	23(37.10)
Weed problem			
Yes	39(62.90)	No	39(62.90)
No	23(37.09)	Go to district hospital after illness	
Plant diseases			
Yes	33(53.23)	Yes	7(11.29)
No	29(46.77)	No	55(88.71)
Health status			
Rash			
Yes	7(11.29)	Go to health promoting hospital after illness	
No	55(88.71)	Yes	31(50)
Tired			
Yes	18(29.03)	No	31(50)
No	44(70.97)	History of cholinesterase level	
Numb			
Yes	9(14.52)	Never determined	29(46.77)
No	53(85.48)	Determined, normal	15(24.19)
Headache			
Yes	19(30.65)	Determined, safe	6(9.677)
No	43(69.35)	Determined, risk	7(11.29)
Sweating			
Yes	17(27.42)	Determined, unsafe	3(4.83)
No	45(72.58)	Source of pesticides information	
Nausea			
Yes	2(3.22)	Radio	
No	60(96.77)	Yes	14(22.98)
Amblyopia			
Yes	6(9.68)	No	48(77.42)
No	56(90.32)	TV	
Tremble			
Yes	1(1.61)	Yes	40(64.52)
No	61(98.39)	No	22(35.48)
Angina			
Yes	1(1.61)	Newspaper	
No	61(98.39)	Yes	8(12.90)
Faint			
Yes	7(11.29)	No	54(87.09)
No	55(88.71)	Village headman	
Unconscious			
Yes	1(1.61)	Yes	7(11.29)
No	61(98.39)	No	55(88.71)
Practice before intervention			
Medium level			
18(29.03)			
High level			
44(70.97)			
Attitude before intervention			
Low level			
12(19.35)			
Medium level			
21(33.87)			
High level			
23(37.10)			
Very high level			
6(9.68)			
Practice before intervention			
Medium level			
3(4.83)			
High level			
59(95.16)			

The in-depth interviewing found that there were different factors between people who improve serum cholinesterase result (their serum cholinesterase level result was safer) and unimproved group (their serum cholinesterase level result was not change or unsafe) that associated with enzyme cholinesterase level. These factors were chemical storage before and after use, eating behavior and time to exposure the chemicals (Table 5). As observed during in-depth interview, the people who had an improvement of serum cholinesterase level, were kept their pesticide outside their home after obtained an intervention. Moreover, they tend to consume their own vegetable which grown around their home and clean them with flowing water.

Moreover, after intervention of health education providing, knowledge, attitude and practice of chemical usage among agriculturists were all improved to the higher category (Table 6). Knowledge of 62 agriculturists in Wiang Kaen district, Chiang Rai were all improved to high level, while, attitude and practice of 30 agriculturists were improved to be very high without low level of attitude and practice remaining.

Discussion

There are 3 factors found to be related in unsafe serum cholinesterase level among agriculturists in Wiang Kaen district, Chiang Rai in this study

Table 2 The serum cholinesterase level of agriculturists before and after intervention (n=62)

Result	Before intervention		After intervention	
	n	Percentage (%)	n	Percentage (%)
Normal	0	0.00	0	0.00
Safe	0	0.00	7	11.29
Risky	4	6.45	31	50.00
Not safe	58	93.54	24	38.70
Total	62	100.00	62	100.00

Table 3 Factors associated with cholinesterase level among agriculturists in Wiang Kaen district, Chiang Rai (n=62)

Variables	Normal n(%)	Risk n(%)	χ^2	p-value
Family status				
Head of family	1(2.86)	34(97.14)	15.92	0.001*
Spouse	2(9.52)	19(90.48)		
Child	1(16.67)	5(83.33)		
Manure usage				
Yes	1(1.61)	48(77.41)	7.53	0.006*
No	3(4.84)	10(16.13)		
Plant disease				
Yes	0(0.00)	33(53.22)	4.87	0.027*
No	4(6.45)	25(40.32)		

*Significant at p-value < 0.05

Table 4 Factors associated with cholinesterase level by univariate regression (n=62)

Factors	Normal	Risk group	OR (95% CI)	p-value
Manure	4(6.45)	58(93.54)	14.4(1.3- 13.0)	0.027*

*Significant at p-value < 0.05

Table 5 Result of qualitative study about chemical usage between improved and unimproved group of serum cholinesterase level

Difference	Improved group	Non-improved group
Chemical storage before and after use	Separate chemicals storage outside the home	Kept the chemicals in the house or in the kitchen
Eating behavior	Did not bought the vegetables from the market	Bought the vegetables from the market
Time to exposure the pesticides	Last time more than 2 days	Last time less than 2 days

including family status who are head of family, using the manure during plantation, and having a problem about plant disease. As Thai tradition, the head of family should be the leader of farm works and be the most risk person to contact to pesticides. During plantation, manure was widely used to improve agricultural productivity. As manure is one of significant factor and seem to be nonsense to describe the relation between this factor and unsafe serum cholinesterase, but data obtaining from agriculturist might be miscommunicated and confused about pesticide usage or manure usage. Another hypothesis is during manure usage, agriculturists might be directly contact to pesticide which has recently been applied to plants. Moreover, the agriculturists who had plant disease must use higher dose of pesticides and have a

higher risk than those who have no plant disease problems.

Comparing with previous researches, the review about occupational pesticide exposures and respiratory health, found in occupational settings, persons working directly and frequently with pesticides are groups with the highest risk of exposure [1]. Multiple logistic regression analysis revealed 7 factors were independently associated with abnormal serum cholinesterase level: male gender, marital status, being a permanent worker, spraying pesticide more than 3 times per month, having moderate or poor pesticide-use behaviors, and low perceived susceptibility and severity of pesticide use [11]. Furthermore, the frequency and duration of pesticide handling both on a seasonal and lifetime basis are directly affects the exposure [12]. Especially agriculturists who regard to

marital status of the subjects, 98 cases were married and 92 were unmarried [13]. Gender also affects on the serum cholinesterase level (p -value=0.002), indicating that people with pesticides in the blood were at a risk level and the level of insecurity is mostly in males (52%) [14].

Table 6 The score of KAP in chemical usage before and after intervention among agriculturists in Wiang Kaen district, Chiang Rai

Score (n=62)	Pre-test (n)	Post-test (n)
Knowledge		
Low	0(0.00)	0(0.00)
Medium	18(29.03)	0(0.00)
High	44(70.96)	62(100.00)
Attitude		
Low	12(19.36)	0(0.00)
Medium	21(33.87)	7(11.29)
High	23(37.10)	25(40.32)
Very high	6(9.68)	30(48.40)
Practice		
Low	12(19.36)	0(0.00)
Medium	21(33.87)	7(11.29)
High	23(37.10)	25(40.32)
Very high	6(9.68)	30(48.40)

The study of effectiveness of an educational program to promote pesticide safety among pesticide handlers of South India found that the average baseline KAP score of 30.88 ± 10.33 improved after education significantly (p -value<0.001) [15]. These indicating that they might be other risk factors related to cholinesterase level and vary depending on each area. In addition, previous study found a strongly significant association between level of knowledge and serum cholinesterase level (p -value<0.001) [16]. This means knowledge providing activity is important to improve serum cholinesterase level and also KAP score among small group of agriculturists [17].

Conclusion

There were 3 factors associated with unsafe serum cholinesterase level among agriculturists in Wiang Kaen district, Chiang Rai and used to prepare an intervention. The health education providing intervention program for agriculturists which prepared from related factors were efficiently improved KAP among them. In addition, the qualitative data found the different behavior between groups of improved and non-improved serum cholinesterase level by observing and in-depth interviewing. However, due to a limitation of time, only 2 weeks of assessment have been carried out. For more sustainable, repeating of an intervention to the community and assess the effect of intervention by measuring KAP score and serum cholinesterase enzyme level in longer period should be performed.

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