CHOLINESTERASE LEVELS AND ADVERSE HEALTH EFFECTS AMONG RICE FARMERS USING PESTICIDES IN AGRICULTURAL AREAS, THE CENTRAL OF THAILAND

[1]WACHIRAPORN WILAIWAN, [2]CHUTHAMAT BAOKUMKONG, [3]WATTASIT SIRIWONG, [4]KITTIGUNYA PIDGUNPAI

[1,2]Faculty of Science and Technology, Valaya Alongkorn Rajabhat University under the Royal Patronage, Pathumthani Province, Postal Code 13180, Thailand
[3,4]College of Public Health Science, Chulalongkorn University, Bangkok 10330, Thailand
E-mail: [1]wachirapornwilaiwan@gmail.com, [2]odearzaao@hotmail.com

Abstract- The Organophosphate and Carbamate were primarily used in agricultural areas. They were acting as cholinesterase inhibitors. Therefore, this study aims to assess health effects caused by Organophosphate and Carbamate pesticides exposure among 133 rice farmers in the Central of Thailand This study was a cross-sectional study during pesticide application period. Face to face questionnaire and quantify enzymes erythrocyte cholinesterase (AChE) and plasma cholinesterase (PChE) in blood were used as measurement tools. Participants were consisted of 58 male and 75 female; average age (±SD) was 44.67 (±10.24) years old. The results showed that duration time as farmers were significantly associated with AChE and PChE levels (Chi- square, $p<0.05$). The rice farmers had many health effects; headache, fatigue, dizziness, stomach cramps and throat irritation. nausea, vomit, blurs vision, shivering, constriction, cramp, contracted pupils of the eyes, excessive sweating and salivation. The prevalence of AChE at risk levels was 26% and 29% of them were at risk level of PChE. In conclusion, rice farmers could be getting risk from pesticide exposure. The further studies should determine the appropriated self-prevention from pesticides exposure, a proper use of personal protective equipment (PPE) should be introduced to rice farmers.

Index Terms- Pesticides / Cholinesterase / Health Effects/ Rice farmers

I. INTRODUCTION

Thailand is considered as an agricultural that produces one of the largest quantities of rice in the world despite its expansion of industrial country. In 2009, the entire area of rice farming in Thailand covered approximately 26 million acres across the country [1]. Agrochemicals i.e. fertilizers and pesticide become a major part of farming in Thailand allowing for increased crop production and income [2]. Organophosphate (OP) and Carbamate insecticides form are the groups of chemicals that are mainly used in agriculture [3] which can be exposed to in several ways such as breath, oral cavity, and skin [4]. Their components are non-persistent in the environment. However, they are described as being highly and acutely toxic [5].

Most of organophosphate or carbamate pesticides include a high toxicity on humans due to the fact that they act as acetyl cholinesterase inhibitor, resulting in the blockage of the nervous system [6]. The activity of cholinesterase enzymes in the blood can be measured used as a biomarker for the effect of organophosphate or carbamate. AChE is typically used as biomarker of chronic exposure; PChE is a short-term indicator [7]. Therefore, this study aims to assess adverse health effects among rice farmers in the Central of Thailand from toxicity symptoms and using blood cholinesterase levels; both blood enzymes erythrocyte cholinesterase (AChE) and plasma cholinesterase (PChE) tested by Ellman method; Test-mate ChE (Model 400).

II. MATHERIALS AND METHODS

The cross-sectional study was used as the research design of this study. The study areas (Nakhon Nayok province and Chainart province) were purposively selected because there were mainly agricultural areas in the Central of Thailand. The simple random sampling was done to get 133 participants. The representatives were recruited as subjects from each house (one subject per household). Inclusion criteria were rice farmers, both male and female, aged more than 18. They were all growing rice, applying organophosphate or carbamate pesticides in agricultural areas. They loading, mixing, or/and spraying a day (24 hours) before blood collection. Those with a history of liver failure, malnutrition, cardiovascular disease, taking anti-malarial drugs, and taking amphetamine, were excluded.

A. Measurement Tools

1) Questionnaire
The principal researcher assessed the subjects by face to face. Questionnaire consisted of two parts; part 1: obtain general information and part 2: obtain health information.
2) Blood test by Test-mate ChE (Model 400), EQM
The Test-mate ChE Cholinesterase Test System is on the basis of Ellman method. Acetylthiocholine (AcTC) or butyrylthiocholine (BuTC) is hydrolyzed by AChE or PChE,
producing carboxylic acid and thiocholine, respectively, with reaction to the Ellman reagent (DTNB, dithionitrobenzoic acid) so as to create a

yellow color that is gauged spectrophotometrically at 450 nm. The rate of color formation is in proportion to the amount of either AChE or PChE [8]. Nurses collected 20µL of blood per person in an air-conditioned room, at the primary health care center, in which optimum temperature was controlled at less than 30 C as recommended by Test-mate ChE Cholinesterase Test System (Model 400) specification. Their blood was collected after 24 hours of the last of pesticide application (loading, mixing, and/ or spraying) [9]. The analysis of cholinesterase level in erythrocyte and plasma using Test-mate was conducted by the researcher.

B. Data Analysis

Interpret level of cholinesterase: if it values less than or equal 50% from normal it indicates possible pesticide poisoning and should be removed from the exposure and/or treated with anticholinergics [10]. A cholinesterase level of more than 50% from the normal value is considered normal.

C. Ethic Consideration

The experimental protocol was approved by the Ethics Review Committee for Research Involving Human Research Subjects, Health Sciences Group, Chulalongkorn University.

III. RESULTS

General characteristics and socio-demographic (table I) 133 rice farmers who were participated in this study were men (44%) and women (56%). The average age (±SD) was 44.67 (±10.24). The majority of the respondents was in the range of 41-50 (29%) and 51 -60 (29%) while 21% and 14% of them were in the range of 31 -40 and younger than 30 years old, respectively. Only 7% of them were older than 60 years old. The study of education level shows that 92% of them had been educated; Most of them finished primary school (56%). Twenty six percentages had been graduated from secondary school. Only 1% had been finished bachelor's degree or equal. Most (40%) of participants in this study had duration time as farmers less than 10 years. However, about 17% of them had duration time as farmers more than 30 years.

A. Subjective symptoms related to organophosphate or carbamate pesticides exposure (table II)

The adverse health effects by using pesticides were report as subjective symptoms during last three month. The result shows that 47% of rice farmer had headache, fatigue, dizziness, stomach cramps and throat irritation. nausea, vomit, blurs vision, shivering, constriction, cramp, and hyperventilation were found 23% of them and 11% had contracted pupils of the eyes, excessive sweating and salivation. The trend of the symptoms was mild, moderate and severe respectively.

B. Prevalence of risky ChE levels both AChE and PChE (table III)

The prevalence of AChE at risk levels was 26% while 74% were at normal AChE levels. The prevalence of normal PChE levels in rice farmer was 71% and 29% of them were at risk levels. The results showed there were no difference between rice farmer who were at risk of AChE and PChE.

The statistical analysis was found that AChE level significantly associated with duration time as farmers. However, AChE of rice farmer was no significant association with age, gender, and education. Also, PChE level significantly associated with duration time as farmers but no significant association between PChE and age, gender, and education.

Table III ChE levels (AChE and PChE)

AChE level	Number (133)	Percentage (%)
Normal	98	74
Risk	35	26

PChE level	Number (133)	Percentage (%)
Normal	95	71
Risk	38	29

IV. DISCUSSION

The study found PChE levels related to years of pesticide exposure. The result was consistent with previous study [11]. This finding may reflect an adaptive response to long-term challenges from OPs; in other words, chronic exposure to these compounds might lead to a higher enzyme activity (PChE induction) that would reduce OP binding to biological targets [12].

The result shows farmer had headache, fatigue, dizziness, stomach cramps and throat irritation. nausea, vomit, blurs vision, shivering, constriction, cramp, and hyperventilation were found 23% of them and 11% had contracted pupils of the eyes, excessive sweating and salivation. The results were similar to previous studies which showed that the predominance of eye symptoms found, 40% among pesticide sprayers, was significantly higher ($p<0.01$) as compared to the control group. The symptoms were found to be blurred vision, lacrimation, pain in eyes, red swollen eyes, and irritation of eyes [13].

Eyes are exposed to the external environment and thereby exposed to environmental contaminants. During agricultural operations, farm workers' eyes could be exposed to pesticides while spraying if there is a lacked of proper preventive steps. As a result, these chemicals are being absorbed through the eye tissue and enter the blood circulation. Exposure of unprotected eyes to pesticides results in the absorption in ocular tissue and potential ocular toxicity [14].

Table I
General Characteristics and socio-demographic information

Characteristics	RiceFarmers (n=133)	Percentage (%)
Age (years)		
18-30	18	14
31-40	28	21
41-50	39	29
51-60	39	29
>60	9	7
Gender		
Male	58	44
Female	75	56
Education		
Uneducated	10	8
Primary school	75	56
Secondary school	35	26
High school	8	6
Diploma	4	3
Bachelor or equal	1	1
Duration time as farmers (years)		
<10	53	40
10-20	24	18
21-30	33	25
More than 30	23	17

Table II Subjective symptoms related to organophosphate or carbamate pesticides exposure

Symptoms	Rice Farmers (n = 133)	Percentage (%)
Mild (Headache, fatigue, dizziness, stomach cramps and throat irritation)	62	47
Moderate (Nausea, vomit, blurs vision, shivering, constriction, cramp, and hyperventilation)	30	23
Severe (Contracted pupils of the eyes, excessive sweating and salivation)	14	11

The present study found that the positive associations of farmers are significantly related to central nervous system symptoms. It is reasonable to show a health report regarding the symptoms caused by organophosphates poison to insects and mammals mainly by phosphorylation of the acetylcholinesterase enzyme (AChE) at nerve endings. The consequence is a loss of existing AChE which makes organs become over motivated by the incremental acetylcholine (ACh, the impulse-conveying substance) at the nerve ending. The enzyme is vital to regular control of the transmission of impulse from nerve fibers to smooth and skeletal muscle cells, glandular cells, as well as autonomic ganglia and within the central nervous system (CNS) [15]. Moreover, the study found that farmers were significantly associated with an increase in wheezing. In addition to specific cases, an inhalation hazard, that is to say intake into the lungs through nose or mouth during customary application of pesticides. When the pesticide formulation is volatile, therefore respiratory protection would be necessary [16]. Moreover, the farmers were significantly associated with an increase of sweating which is one of the classic chronic signs [17]

Researcher's observations showed that the farmers used improperly PPE, improperly handing protective increasing the level of risk because the exposure level increasing the risk of exposure. Other studies support this, suggesting that wearing proper PPE is associated with a reduction in health hazards 18, 19]. Moreover, one of the previous studies found that the main risk factors related to agrochemical exposure depend on the use of pesticides. This includes inaccurate beliefs of from farmers regarding pesticide toxicity, the use of impaired spraying equipment, the lack of appropriate maintenance of spraying equipment, and the lack of protective gear or proper clothing [20]. There is a clear lack of uniform systems designed specifically for pesticide management in Thailand [21].

However, this study had limitation as follow. Firstly, subjective symptoms may be caused by other pesticides. Secondary, Evidence of pesticide-related symptoms was relied on self-report without physical examinations or clinical interview. The cross-sectional study design was limited to determining the causal associations of significant predictors and blood cholinesterase levels. Moreover, the standard normal ChE level from American people was use in this study. It would be better if ChE level with the standard normal from Thai people was used.

CONCLUSION

The study showed that most of the rice farmers getting health effect by pesticide exposure. Most of them had Headache, fatigue, dizziness, stomach cramps and throat irritation. The level of showed that the rice farmers could getting risk from pesticide exposure. Therefore, there should be an intervention to reduce the risk by providing knowledge for the rice farmers to encourage practice of appropriate pesticides use and proper use of PPE while working with pesticides. Moreover, knowledge to treatment of toxicity symptom related with pesticide exposure should be recommended.

ACKNOWLEDGEMENTS

This research was supported by the Higher Education Research Promotion and National Research University Project of Thailand, Office of the Higher Education Commission (AS1148A-55) and (AS581A-56);Fogarty International Center: Brain Disorders in the developing world (NIEHS:R21ES18722); Thai Fogarty Center (1D43TW007849) and The 90TH Anniversary of Chulalongkorn University Fund (Ratchadaphiseksomphot Endowment Fund).

REFERENCES

[1] Office of Agricultural Economics. Land use for agricultural purpose of Thailand at national, regional, provincial levels in the year; 2009.[cited 2012 September 1]. Available from:http://www.oae.go.th/download/use_soilNew/article_soil2552.html

[2] Wongwichit D, Siriwong W, Robson MG. Herbicide exposure to maize farmers in Northern, Thailand: Knowledge, attitude, and practices. Asia Pacific Conference on Environmental Science and Technology Advances in Biomedical Engineering. 2012: 6.

[3] Jaga K, Dharmani C. Sources of exposure to and public health implications of organophosphate pesticides. RevPanam Salud Publica. Vol. 14(3), pp. 171-85, Sep 2003.

[4] Health Information System Development Office. Occupational disease; 2009. [cited 2012 September 1]. Availablefrom:http://www.hiso.or.th/hiso/tonkit/tonkits_17.php.

[5] Zou MQ, Yang R, Wang DN, Li JF, Jin QH. A novel immobilized cholinesterase for on-site screening of organophosphate and carbamate compounds. Pesticide Biochemistry and Physiology. Vol. 86, pp. 162-166, 2006.

[6] Deerasamee O. Determination of organophosphate pesticides using gas chromatography. Applied Analytical and Inorganic Chemistry; 2009.

[7] Brown AE, Miller M, Keifer M. Cholinesterase Monitoring -- A Guide for the Health Professional. Pesticide Information Leaflet; 2006.

[8] EQM Research, Inc. Test-mate ChE Cholinesterase Test System (Model 400). Instruction Manual. EQM Research, Inc; 2003.

[9] Mason HJ, Health & Safety Laboratory, Lane B. The recovery of plasma cholinesterase and erythrocyte acetylcholinesterase activity in workers after over-exposure to dichlorvos. Occupational Medicine. Vol. 50(5), pp. 343-347, 2000.

[10] Coye MJ, Lowe JA, Maddy KT. Biological monitoring of agricultural workers exposed to pesticides: I. Cholinesterase activity determinations. Journal of Occupational and Environmental Medicine. Vol. 28, pp. 619-627, 1986.

[11] Catano HC, Carranza E, Huaman C, Hernandez AF. Plasma Cholinesterase Levels and Health Symptoms in Peruvian Farm Workers Exposed to Organophosphate Pesticides. Archives of Environmental Contamination and Toxicology. Vol. 55, pp. 153-159, 2008.

[12] Kashyap SK. Health surveillance and biological monitoring of pesticide formulators in India. Toxicology Letters. Vol. 33, pp. 107-114, 1986.

[13] Fareed M, Kesavachandran CN, Pathak MK, Bihari V, Kuddus M, Srivastava AK. Visual disturbances with cholinesterase depletion due to exposureof agricultural pesticides among farm workers. Toxicological & Environmental Chemistry. Vol. 94(8), pp. 1601-1609, 2012.

[14] Jaqa K, Dharmai C. Sources of exposure to and public health implications of organophosphate pesticides. Rev Panam Salud Publica/Pan Am J Public Health. Vol. 14(3), pp. 171-85, 2003.

[15] USEPA United State Environmental Protection Agency. Recognition and Management of Pesticide Poisoning. Washington, DC.: USEPA; 1999.

[16] Food and Agriculture Organization of the United (FAO). Guideline for personal protection when working with pesticides in tropical climates; 1990. [cited November 10, 2012]Availablefrom:http://www.fao.org/ag/AGP/AGPP/Pesticid/Code/Download/PROTECT.pdf

[17] USEPA United State Environmental Protection Agency. Recognition and Management of Pesticide Poisoning. Washington, DC.: USEPA; 1999.

[18] Taneepanichskul N, Norkaew S, Siriwong W, Robson MG. Health effects related to pesticide using and practicing among Chilli-growing farmers, Northeastern, Thailand. Journal of Medicine and Medical Sciences. Vol. 3(5), pp. 319-325, 2012.

[19] Norkaew S, Siriwong W, Siripattanakul S, Robson MG. Knowledge, Attitude, and Practice (KAP) of using Personal Protective Equipment (PPE) for Chill Growing Farmers in Huarua sub-district, Mueang district, Ubonrachathani province, Thailand. Journal of Health Research. Vol. 24, pp. 93-100, 2010.

[20] Raksanam B, Taneepanichskul S, Robson MG, Siriwong w. Health Risk Behaviors Associated With Agrochemical Exposure Among Rice Farmers in a Rural Community, Thailand: A Community Based Ethnography. Asia-Pacific Journal of Public Health; 2012.

[21] Panuwet P, Siriwong W, Prapamontol T, Ryan PB, Fiedler N, Robson MG, Barr DB. Agricultural pesticide management in Thailand: status and population health risk. Environmental Science & Policy. Vol. 17, pp. 72-81, 2012.

★★★