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HEALTH IMPACT ASSESSMENT OF PESTICIDE USE IN NORTHERN THAI FARMERS
การประเมินผลกระทบทางสุขภาพจากการใช้สารเคมีป้องกันกำจัดศัตรูพืช ของเกษตรกรไทยในภาคเหนือ

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Abstract

The present study aims to assess health impacts on pesticide use in 136 farmers from Baan Mai Ras Bam Rung Village, San Kong Subdistrict, Dok Kham Tai District, Phayao. Questionnaire and laboratory examination were used as tools. Pesticide use in questionnaire consisted of objectives, type and reasons of pesticide use, prevention practices from exposure, etc. Health impacts questionnaire included physical, mental, social, and spiritual health. The results showed that most farmers planted rice crop and the major pesticide use was insecticides (79.4%), followed by herbicides, fungicides, and acaricides, respectively (78.7, 40.4 and 33.1%). The reasons for the use were that facing problem of insect and blight (86.8%), requiring good product appearance (68.4%). The exposure prevention found most farmers (97.1%) wore long sleeve shirts and long trousers. Impact on physical health, major symptoms were fatigue (48.5%), parched trachea (44.9%), headache (40.4%), dizziness (36.8%), and numbness (29.4%), respectively. The average of acetylcholinesterase activity (AChE), as an indicator of organophosphate and carbamate exposure, were 6,416±1,443 μg/L. Regarding determination of cholinesterase activity by rapid test from The Government Pharmaceutical Organization, 23.5% of farmers had pesticide residues in serum at safe level, 55.1% at risk level, and 21.3% at

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unsafe level. Impact on mental, social, and spiritual health found 86.8% worried about effect on health and to the environment, 27.9% concerned regarding decreased local knowledge, and 57.4% planted organic crops for their own consumption. The relationship between AChE activity and preventive practices was negative (r = -0.172, P = 0.040). The appropriate prevention from the pesticide impact was reduced exposure.

Keywords: health impact assessment (HIA), pesticide, farmers, acetylcholinesterase activity (AChE)

บทคัดย่อ

งานวิจัยนี้มีวัตถุประสงค์เพื่อศึกษาผลกระทบทางสุขภาพจากการใช้สารเคมีป้องกันกำจัดศัตรูพืชในเกษตรกร 136 คน ที่อาศัยอยู่ในหมู่บ้านใหม่ราษฎร์บำรุง ตำบลสันโค้ง อำเภอดอกคำใต้ จังหวัดพะเยา เครื่องมือที่ใช้ ประกอบด้วย แบบสอบถาม และการตรวจวิเคราะห์ทางห้องปฏิบัติการ ข้อมูลในแบบสอบถาม ประกอบด้วย วัตถุประสงค์ ประเภทและเหตุผลการใช้สารเคมีป้องกันกำจัดศัตรูพืช การป้องกันตนเองจากการสัมผัส ฯลฯ ข้อมูลแบบสอบถามเกี่ยวกับผลกระทบทางสุขภาพ ประกอบด้วย สุขภาพทางกาย จิต สังคม และจิตวิญญาณ ผลการวิจัยพบว่า เกษตรกรส่วนใหญ่ปลูกข้าว และสารเคมีป้องกันกำจัดศัตรูพืชที่ใช้เป็นหลัก คือ สารกำจัดแมลง (ร้อยละ 79.4) รองลงมาคือ สารกำจัดวัชพืช กำจัดเชื้อรา กำจัดไร (ร้อยละ 78.7, 40.4 และ 33.1) ตามลำดับ เหตุผลที่ใช้ คือ ประสบปัญหาแมลงและศัตรูพืช (ร้อยละ 86.8) และต้องการผลิตผลที่ดี (ร้อยละ 68.4) การป้องกันตนเองจากการสัมผัส พบส่วนใหญ่ (ร้อยละ 97.1) สวมเสื้อแขนยาวและกางเกงขายาว ผลกระทบทางสุขภาพทางกาย พบอาการหลัก คือ เหนื่อยง่าย คอแห้ง ปวดหัว วิงเวียน และเหน็บชา ตามลำดับ (ร้อยละ 48.5, 44.9, 40.4, 36.8 และ 29.4) การตรวจระดับอะซิติลโคลินเอสเตอเรสในเกษตรกรเพื่อชี้วัดการสัมผัสออกาโนฟอสเฟต และคาร์บาเมต พบมีค่าเฉลี่ยเท่ากับ 6,416 ±1,443 μ/L ผลการตรวจระดับการแพ้พิษ พบส่วนใหญ่อยู่ในระดับเสี่ยง (ร้อยละ 55.1) รองลงมาคือ ปลอดภัย และไม่ปลอดภัย ตามลำดับ (ร้อยละ 23.5 และ 21.3) ผลกระทบทางสุขภาพจิต สังคม และจิตวิญญาณ พบร้อยละ 86.8 กังวลผลต่อสุขภาพ และต่อสิ่งแวดล้อมในชุมชน ร้อยละ 27.9 รู้สึกว่าภูมิปัญญาท้องถิ่นลดลงหรือหายไป ร้อยละ 57.4 ปลูกผักโดยไม่ใช้สารเคมีป้องกันกำจัดศัตรูพืชไว้รับประทานเอง การทดสอบความสัมพันธ์ระหว่าง AchE กับการป้องกันตนเอง พบเป็นลบ (r = -0.172, P = 0.040) การป้องกันผลกระทบจากสารเคมีป้องกันกำจัดศัตรูพืชที่เหมาะสม คือ ลดการสัมผัส

คำสำคัญ: การประเมินผลกระทบทางสุขภาพ, สารเคมีป้องกันกำจัดศัตรูพืช, เกษตรกร, อะซิติลโคลินเอสเตอเรส

Introduction

Pesticides are widely used in developing countries. The use of pesticides in developing countries is about 20% of world pesticide use, and annual pesticide consumption in Thailand is in the third rank of Asian countries[1,2]. Agriculture system in Thailand has shifted from labor to machine intensive agriculture practices over the past decades, leading to intensive use of pesticides. The first rank of pesticide import was herbicides, followed by insecticides and fungicides, respectively[3,4]. The heavy use caused high levels of pesticide residues in ecosystem (including soil, sediment, water, aquatic life, and agricultural products). Humans are placed

at the top of the food chain; therefore, pesticides are also found in the human body, and consequently cause adverse health effects. Acute and chronic health effects have been attributed to exposures to pesticides through drinking water and food[5-7]. Not only pesticides cause an effect on physical health, but also they may cause an effect on mental, social, and spiritual health[8-12].

Dok Kham Tai District, Phayao, located at northern part of Thailand, is an important area for plant cultivation and tourist attraction. The major cultivation plants in the area include rice, onion, garlic, and corn, and pesticides have been used extensively in the area to protect crops from pests. Therefore, the authors aim to assess health impacts (including physical, mental, social, and spiritual health aspects) on pesticide use among 136 farmers from Baan Mai Ras Bam Rung Village, San Kong Subdistrict, Dok Kham Tai District, Phayao.

Materials and Methods

Study population

During February 2010 to June 2010, farmers with the age of 18-75 yrs resided in Baan Mai Ras Bam Rung Village, San Kong Subdistrict, Dok Kham Tai District, Phayao, were invited to participate in the study. One hundred and thirty six farmers who were eligible for the inclusion criteria, willing to participate the study, and signed written consents.

Data collection

Questionnaire and laboratory examination were applied as a tool for data collection. Data on questionnaire were collected from individual participants by trained interviewers after they signed the consents. There were 2 aspects in the questionnaire, including pesticide use and their health impacts. The aspects of pesticide use in the questionnaire consisted of personal data, objectives and reasons for the use, category of pesticide use, labor employment for pesticide spraying, spray frequency pesticide information source pesticide consultant, protection practices from exposure, and health impacts from the uses. The aspects of health impacts included physical, mental, social, and spiritual health.

One mL of venous blood sample was collected in clot blood tube. Serum was separated and stored in the freezer (–20^{o}C) before analysis of acetylcholinesterase (AChE) activity and cholinesterase activity using rapid test from The Government Pharmaceutical Organization (GPO).

Data analysis

Descriptive statistics, including arithmetic mean (AR), standard deviation

(SD), minimum (Min), and maximum (Max) were computed. Because of non-normal distribution of AChE activity and related factors, natural logarithm transformation was applied for the variables before testing parametric tests. Pearson correlation coefficient was calculated for the association of AChE activity with related factors. The level of significance was set at P value < 0.05.

Ethical approval

The study was approved by Human Experimentation Committee, Naresuan University (23 March 2010).

Results and Discussions

Characteristics and demographic data

136 farmers were 51 males (37.5%), and 85 females (62.5%). Arithmetic mean age was 49±11 years old. Most farmers planted rice (94.9%) followed by farm, fruit, and vegetable (72.8%, 5.9%, and 2.9%, respectively).

The mean area for planting rice, farm, fruit, and vegetable was 8.2±4.6, 4.2±3.8, 1.4±1.2, 0.3±0.3 acres per family (Table 1).

Table 1 Agriculture area for cultivation

Agriculture area (Acres)	AR	SD	Min	Max
Rice crop	8.2	4.6	0.8	26.0
Farm crop	4.2	3.8	0.1	18.4
Fruit crop	1.4	1.2	0.1	4.0
Vegetable crop	0.3	0.3	0.004	0.8

AR = arithmetic mean, SD = standard deviation, Min = minimum, Max = maximum

Pesticide use and types of crop

It showed that most farmers cultivated rice crop and the major pesticide use was insecticides (79.4%), followed by herbicides, fungicides, acaricides (78.7%, 40.4%, 33.1%, respectively). The second crop was farm crop and the major pesticide use was herbicides (64%), followed by insecticides (32.4%), fungicides (25.7%), and acaricides (9.6%) (Table 2). The results were in agreement with the statistical data of pesticide imports of Thailand in 2009, presenting that the three most imported pesticides were herbicides (69,965 tons/yr), insecticides (8,657 tons/yr), and fungicides (6,426 tons/yr), respectively[3,4]. It is possible that herbicides are cheaper, more efficient, and more practical to use than weeding cost[13,14].

Table 2 Objective of pesticide use classified by crop types

Objectives	Types of crop							
	Rice		Farm		Fruit		Vegetable	
	frequency	%	frequency	%	frequency	%	frequency	%
Insecticides	108	79.4	44	32.4	6	4.4	2	1.5
Herbicides	107	78.7	87	64.0	4	2.9	1	0.7
Fungicides	55	40.4	35	25.7	4	2.9	3	2.2
acaricides	45	33.1	13	9.6	2	1.5	3	2.2
Others	3	2.2	4	2.9	0	0	2	1.5

Table 3 presents data of pesticide use, including reasons of use, labor employment for spraying, frequency of spraying, channel of pesticide information, and advisory person of pesticide use. The reasons of pesticide use were that farmers faced a problem of insect and blight (86.8%), needed a good product appearance (68.4%), and protect crop before facing a problem (39%). 64% of farmers did not employ labors for spraying, and 69.9% sprayed a time per month or less. The three major channels that farmers got pesticide information were poster, chemical dealer, and television, respectively (89, 66.2 and 50%). Farmers were received information of pesticide use by oral communication from neighbors (50%) and government officers (41.9%). The study of Lichtenberg and Zimmerman[15] suggested that farmers who found information from chemical dealers more important expressed greater concern about injury to wildlife and pesticides in drinking water but less concern about general environmental quality problems associated with pesticides.

Table 3 Pesticide use characteristics

	Parameters	Frequency	%
Reasons for the use	Facing a problem of insect and blight	118	86.8
	Requiring good product appearance	93	68.4
	Protecting crop before facing a problem	53	39.0
	requiring fast effectiveness	50	36.8
	Following neighbor	49	36.0
	Saving time, labor, and cost	42	30.9
Labor employment for pesticide spraying	No employment	87	64.0
	Employment in partial	32	23.5
	Overall employment	17	12.5
Spray frequency	one time per month or less	95	69.9
	one time per week	28	20.6
	2-3 time per week	12	8.8
	No use	1	0.7
Pesticide information source	Poster	121	89.0
	Chemical dealer	90	66.2
	Television	68	50.0
	Radio	55	40.4
	Brochure	4	2.9
Pesticide consultant	Neighbor	68	50.0
	Government officer	57	41.9

Preventive practices during application

Preventive practices from pesticide exposure during application are presented in Table 4. The results showed that most farmers protected themselves by wearing common protection equipments, including long sleeve shirt (97.1%), long trousers (97.1%), hat (82.6%), and face mask (91.2%). However, the farmers' wearing was not appropriate to protect the pesticide exposure due to lack of suitable personal protective equipments(16). Furthermore, protective behaviors in some farmers were not proper, For example, farmers do not read pesticide information displayed on a product label carefully before use, not use pesticide amounts as indicated on the label, not stop spraying while windy, not check and repair sprayer before use, mix the pesticides with hand, use mouth to

blow spray nozzle, drink, smoke, and eat during application. It seems to be unaware of pesticide risks and lack safety education. Unsuitable of pesticide information displayed on a product label also caused lack safety education in farmers because the fonts in labels were too small, and the instructions were too long. Therefore, pesticide safety education is necessary in order to induce awareness and protective behavior among farmers[14, 17-20].

Table 4 Preventive practices from pesticide exposure during application

Parameters	No action		Sometimes		Every time	
	frequency	%	frequency	%	frequency	%
Wearing long sleeve shirt	1	0.7	3	2.2	132	97.1
Wearing long trousers	1	0.7	3	2.2	132	97.1
No blow spray nozzle with mouth	4	2.9	3	2.2	129	94.9
Mixing the pesticides with stick	3	2.2	4	2.9	129	94.9
Wearing hat	4	2.9	6	4.4	126	92.6
Wearing face mask	2	1.5	10	7.4	124	91.2
Reading pesticide label carefully before use	3	2.2	11	8.1	122	89.7
Using pesticide amounts as indicated on the label	2	1.5	13	9.6	121	89.0
No drink, smoke, and eat during application	3	2.2	12	8.8	121	89.0
Wearing gloves	6	4.4	12	8.8	118	86.8
Applying with direction wind and stop spraying while windy	3	2.2	16	11.8	117	86.0
Checking and repairing sprayer before use	11	8.1	13	9.6	112	82.4

HIA of pesticide use

Impacts on physical health: The results from questionnaire showed that the main symptoms from pesticide exposure were fatigue, parched trachea, headache, dizziness, and numbness (48.5, 44.9, 40.4, 36.8 and 29.4% respectively). The results were in agreement with the previous studies, suggesting that pesticide poisoning effects may include nausea, vomiting, dizziness, abdominal pain, numbness, tremor in the extremities, fatigue, headaches, diarrhea, vomiting, generalized weakness, respiratory problems,

cephalea, fever, stomach discomfort, and blurred vision[8,19,21].

The results from laboratory examination showed that the average of AChE activity, as an indicator of organophosphate and carbamate exposure, were 6,416±1,443 μg/L, with range of 2,235-11,583 μg/L. Regarding determination of cholinesterase activity by rapid test from GPO, 23.5% of farmers had pesticides in serum at safe level, 55.1% at risk level, and 21.3% at unsafe level (Table 5). The results were also found a negative association between AChE activity and rapid test results ($r = -0.361$, $P = 0.000$) (Table 6). It is possible that the major pesticides use for crops were insecticides, and many insecticides are classified as organophosphate and carbamate groups. Exposure to organophosphates and carbamates can be indicated by cholinesterase determination. Another possibility was that most farmers sprayed pesticides themselves and they had protective behavior improperly during application. Although most farmers sprayed pesticides one time per month or less, they sprayed themselves, and did not employ labors for spraying. Furthermore, they protected themselves during application by common wearing, such as long sleeve shirt, long trousers, hat, and face mask. The remarkable findings were a negative association between AChE activity and preventive practices from pesticide exposure ($r = -0.172$, $P = 0.040$), suggesting that suitable preventive practices during application could reduce pesticide exposure in farmers.

Table 5 Cholinesterase activities resulted from rapid test in 136 farmers' serum

Cholinesterase activity	Frequency	%
Normal level	0	0
Safe level	32	23.5
Risk level	75	55.1
Unsafe level	29	21.3

Table 6 Factors affecting Acetylcholinesterase activity (AChE)

Parameters	Pearson correlation (r)	P value
AChE * Rapid test results	-0.361	0.000*
AChE * Agriculture area per family	0.263	0.006*
AChE * preventive practices during application	-0.172	0.040*

* P value < 0.05

Impact on mental, social, and spiritual health: Most farmers concern were regarded to their health and environmental effects (86.8%). Some farmers concerned regarding the decreased of localing knowledge (27.9%) and supportive system in community (22.8%), and the competition for planting (24.3%). A half of farmers planted organic crops for eating oneself (57.4%) and needed to employ labors for spraying pesticides (50%) (Table 7).

Table 7 Health impact assessment of pesticide use

Health impacts		Frequency	%
Physical health	Fatigue	66	48.5
	Parched trachea	61	44.9
	Headache	55	40.4
	Dizziness	50	36.8
	Numbness	40	29.4
	Eye irritation	35	25.7
	Breathless	31	22.8
	Hyper ventilation	26	19.1
	Rash, roseola	26	19.1
	Arm/leg weakness	22	16.2
Mental health	Concern regarding their health effects	118	86.8
	Concern regarding environmental effects in their community	118	86.8
	Concern regarding health effects on their offspring	107	78.7
	Concern regarding health effects on consumers	100	73.5
	Feel sick from their pesticide use	71	52.2
	Feel moody from their pesticide use	44	32.4
Social health	Decreased local knowledge	38	27.9
	Competition for planting	33	24.3
	Decreased supporting system in countryside	31	22.8
	Decreased relationship of people in community	24	17.6
	Decreased religious ceremony	20	14.7
Spiritual health	Cultivating organic crops for eating oneself	78	57.4
	Requiring employment for spraying	68	50.0
	Quarrel with neighbor field from pesticide uses	11	8.1

In conclusion, the major health impacts of pesticide uses included fatigue symptom, serum pesticides residues in risk and unsafe levels, concerns of health and environmental effects, decreases of local knowledge, and cultivation of organic crops for eating oneself. The remarkable finding was a negative association between AChE activity and preventive practices during application ($r = -0.172$, $P = 0.040$), suggesting that suitable preventive practices during application could reduce pesticide exposure in farmers.

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