

Comparison of pesticide exposure and physical examination, neurological assessment, and laboratory findings between full-time and part-time vegetable farmers in the Philippines

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Abstract

Objectives This study aimed to compare the work practices and health effects of pesticide exposure between full-time and part-time vegetable farmers.

Methods Data was gathered via structured personal interview using a 9-page questionnaire, physical examination, and blood extraction for complete blood count and serum creatinine.

Results Pyrethroid was the pesticide type most used by both groups. The risk for full-time farmers was related to both the amount of exposure and the type of pesticide. There were more full-time farmers who complained of falling ill because of work. This difference was statistically significant ($P = 0.05$). The level of those seeking medical attention was also significantly different between the two groups ($P = 0.01$). In assessing the individual components of the neurologic examination, 5.22% of full-time and 8.63% of part-time farmers had abnormal cranial nerve function, and 22 (5.7%) and 9 (6.47%) had abnormal motor strength. All farmers tested for reflexes, meningeals, and autonomic from both groups were normal. Based on hematologic examination, full-time farmers had higher mean values for creatinine, white blood cell, red blood cell, hemoglobin, and hematocrit. Activity of cholinesterase enzymes in blood can be utilized as a biomarker for the effect of organophosphates; of the 232 blood cholinesterase results, 94 (40%) were abnormal.

Conclusion The study showed certain differences between full-time and part-time farmers in terms of

farming practices and health-related problems. Education on safe pesticide use and handling and better health monitoring of the farmers are recommended.

Keywords Vegetable farmers · Farming practices · Pesticide exposure · Pesticide-related health problems · Full-time and part-time farmers

Introduction

Agriculture is one of the primary economic sectors in the Philippines, contributing about 20% of the gross domestic product. Crops comprise about 47.56% of the total agricultural sector and contribute about 510 billion pesos (USD 10.6 billion) to the country's national income.

The majority of farmers in the Philippines still use pesticides, some of them banned in more developed countries. However, in Philippine agriculture, there is increasing reliance on pesticide use without thought for its deleterious effects on community, health, and environment. Although alternative methods for pest control, organic farming, and integrated pesticide management have been initiated, they are not strongly sustained.

Given that there exists an inherent risk in these farming practices, this paper attempts to elucidate differences in farming communities of Benguet Province with differing levels of pesticide exposure.

Benguet is a province in the northern portion of the Philippines belonging to the Cordillera Administrative Region. There are about 27.5 thousand farms covering 30,000 ha of agricultural land in Benguet. The province is known as the “salad bowl” of the Philippines as its major crops are tubers, roots and bulbs, and leafy vegetables, stems, and flowers. Of the 27,000 farms present in Benguet,

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14,349 are involved in tubers, roots, and bulbs; 11,515 are involved in vegetables; and 9,868 are involved in legumes. In 2005, Benguet was the top producer of broccoli and carrots, producing about 1,200 and 13,700 metric tons, contributing 87.4% and 81.4%, respectively, of the national output.

The crops grown in the study include mainly vegetables such as cabbage, potato, carrots, wombok, lettuce, sweet pea, onion leak, celery, beans, and tomato. The other major crops of the Philippines, including rice, sugarcane, coconut, corn, and banana, are grown elsewhere.

This study aimed to compare the health effects of pesticide exposure between four municipalities identified as having high exposure to pesticide and two municipalities having low exposure to pesticides.

Materials and methods

Sample population

Five hundred forty-two farmers from six communities formed the target population: 73 from community 1, 104 from community 2, 52 were from community 3, 90 from community 4, 73 from community 5, and 150 from community 6. They were selected via cluster sampling. Physical examination was carried out for 533 respondents. Complete blood count was done for 510 respondents, while serum creatinine was performed for 404 respondents.

The full-time farmers consisted of communities 1 and 6 (both located in the central part of the province) and communities 2 and 5 (both located in the northeastern part of the province). They are identified as full-time farmers, as farming is done as a full-time job, vegetable production is produced for commercial purposes, and harvest is year-round. The crops produced by this group included cabbage, potato, carrots, wombok, lettuce, sweet pea, onion leak, celery, beans, and tomato. Meanwhile, the part-time farmers came from communities 3 (located in the southeastern part of the province) and 4 (located in the mid-western part). These are part-time farmers, as farming is a secondary occupation, and vegetables are grown for personal rather than commercial use, i.e., the farmers had the side-job of seasonal vegetable harvesting. The crops produced by this group included cabbage, lettuce, coffee, and beans.

Data collection methods

Methods included structured survey interviews by field workers, who interviewed farmers in situ using a prepared questionnaire. The 9-page questionnaire contained

information on demographics, past and present medical histories, family medical histories, obstetric and gynecological history for females, pesticide use and practices, and health effects.

Physical, hematologic, and neurological examinations were also carried out, adopted from the standard form used by the National Poisons Control and Information Service (NPCIS) of the UP-Philippine General Hospital in its toxicological assessments.

The physical examination, including examination of various body parts (head, eyes, ears, nose, throat, oral cavity, neck, lungs, heart, abdomen, extremities, and integument), were performed by 20–30 doctors. The neurologic examination assessed all cranial nerves (I–XII). These cranial nerves were assessed by a neurologist by classifying clinical findings as abnormal or normal.

For the hematologic examination, the following blood indices were measured and mean readings were referenced to the standard reading for such parameters: red blood cells, hemoglobin, hematocrit, mean corpuscular volume (MCV), mean corpuscular hemoglobin (MCH), mean cellular hemoglobin concentration (MCHC), white blood cells, platelets, creatinine clearance, and red blood cell cholinesterase.

Table 1 presents the hematologic parameters measured and their corresponding normal values. Blood extraction was done by a licenced medical technician.

Hematocrit reflects concentration of packed red blood cell (RBC) volume. It increases in cases of dehydration or increased blood cellularity. mean corpuscular volume (MCV) is an index of RBC size and is computed by dividing the hematocrit by the RBC count. MCHC is the average concentration of hemoglobin in a given volume of red blood cells; MCH is the average weight of hemoglobin of red blood cells. All three give an insight into the type of anemia a person has, if present.

Table 1 Hematologic parameters and corresponding normal values used for this study

Hematologic parameters	Normal values
Creatinine ($\mu\text{mol/L}$)	31–133
White blood cell (G/L)	5–10
Red blood cell (T/L)	4.69–61.3
Hemoglobin (g/L)	140–181
Hematocrit (L/L)	400–537
Mean corpuscular volume (fL)	80–97
MCH (pg)	27–31.2
MCHC (g/L)	310–354
Platelets (G/L)	150–424
RBC cholinesterase (Δ ph/h)	0.75–1.0

White blood cells are part of the immune system. Their values tend to increase during infectious or allergic processes and decrease in cases of typhoid fever; a decrease in production by bone marrow can also occur secondary to diseases such as neoplasm. Creatinine is a byproduct of the metabolism of muscles and is produced in a constant amount in the body. As such it is often used as a marker for renal function, wherein its clearance is used to estimate the glomerular filtration rate of the kidneys. Some pesticides adversely affect renal function by producing acute tubular necrosis.

Based on the blood parameters, certain types of anemia were analyzed. Microcytic anemia is most commonly caused by iron deficiency through inadequate intake, poor absorption, excessive iron requirements or chronic blood loss. Normocytic anemia is seen among patients experiencing acute blood loss, hemolytic disorders or suffering from a chronic disease.

Red blood cell cholinesterase was also measured in this study. Two hundred thirty-two respondents submitted for this examination while the others refused to participate. Cholinesterase corresponds to two enzymes: acetylcholinesterase and butyrylcholinesterase (also called plasma cholinesterase). Activity of cholinesterase enzymes in the blood can be utilized as a biomarker for the effect of organophosphate and carbamate exposure. The normal value for cholinesterase reference used is Δ 0.75–1.0 ph/h.

Data analysis

Blood (10–15 ml) was extracted from each respondent for blood cholinesterase, blood count, and serum creatinine by a licenced medical technician. Blood vials were transported on ice and analyzed within 24 h of extraction in the laboratory.

The health and work practices data, including the physical and neurological examinations and blood examination results, were encoded and analyzed using SPSS 13.0 software. Data analysis included descriptive and inferential statistics.

Ethical consideration

Participants were informed about the nature of study, including the research objectives, purposes, and goals. They were also informed about the blood extraction procedure and its purposes and risks. They have written informed consent. Participants were also assured of data confidentiality. The informed consent form was duly approved by the Ethics Review Board of the University of the Philippines-National Institutes of Health and accompanied each interview schedule.

Results

There were more males than females in both groups. The full-time farmers ($N = 398$) had lower mean age than the part-time farmers ($N = 192$): 46.67 ± 11.978 years and 48.44 ± 12.97 years, respectively. The full-time farmers had an age range of 15–78 years, with the majority belonging to the 36–50 years age range. The part-time farmers had an age range of 21–78 years, with an almost equal distribution of respondents belonging to the 36–50 years and 51–65 years age groups. Most of the respondents for both groups were married (79.3% and 77.5%, respectively).

Household sizes ranged from farmers living alone to families as large as 22 members for full-time farmers, and 12 for part-time farmers. Most had lived in their current residence for more than 5 years (95.2% and 92.5%) with the majority of full-time farmers living less than or equal to about 50 m away from the plantation (44.3% and 35.8%). Most of the respondents from both groups lived in homes less than 50 m away from the highway. The demographic profile of the two groups was similar, except for the age distribution ($P = 0.029$), educational attainment ($P = 0.001$), number of household members ($P = 0.039$), and distance from plantation ($P = 0.001$).

The majority of the respondents from both groups were mainly agricultural workers (85–87%). The remaining 13–15% were purely housewives, pesticide applicators, growers, pesticide distributors, students or government employees.

There were a total of 831 and 266 pregnancies among the female full-time and part-time farmers, respectively; the majority of outcomes for both groups were full term (92.06% and 98.12%). There were five preterm outcomes among full-time female farmers compared with none among part-time female farmers. Some congenital abnormalities and pregnancy disorders reported among full-time female farmers were microcephaly, mental retardation, clubfoot, hydatiform mole, and ectopic pregnancy. There were about 10 times more spontaneous abortions among full-time female farmers than among part-time female farmers. However, these differences were not statistically significant ($P = 0.99$).

Pesticide use and exposure

Of full-time and part-time farmers, 96.5% and 95%, respectively, were pesticide users. About 58.7% of full-time farmers and 46.8% of part-time farmers had family members working with pesticides. For the full-time farmers, 18.27% were under the age of 15 years, and for the part-time farmers this value was 44.44%.

The majority of the farmers in both groups used pyrethroids (71.1%, 73%). For full-time farmers, this was

followed by organophosphates (67.8%) and carbamates (57%). For part-time farmers, carbamate (48%) was the second most commonly used. Organophosphate was the least used pesticide (31%). Other pesticides used by both groups included organochlorides and nitrites (Table 2). The two groups were similar in terms of pyrethroid, carbamate, and other pesticide use. However, their use of organophosphate was significantly different ($P = 0.001$), such that about 2/3 of the full-time farmers used organophosphate, while only 1/3 of the part-time farmers used it. In terms of the specific active ingredients for each pesticide type, Table 3 shows the usage by the two groups.

Both groups were similar in terms of pesticide use, pyrethroid, carbamate, and other pesticide use, but differed significantly in terms of organophosphate use ($P = 0.001$). Organophosphate was used more frequently by the full-time farmers compared to the part-time farmers.

Full-time farmers spent a longer mean time of 110.33 min spraying per load of pesticide compared with 85.43 min for part-time farmers, this difference being significant.

Table 2 Percentage of type of pesticide use among farmers

Type of pesticide	Full-time farmers <i>N</i> = 398		Part-time farmers <i>N</i> = 137		<i>N</i> Total
	Freq.	%	Freq.	%	
Organophosphate	270	67.8	43	31	313
Pyrethroid	281	71.1	100	73	381
Carbamate	227	57.0	66	48	293
Other pesticide	211	52.8	62	45	273

Table 3 Percentage of type of pesticide by brand name used by farmers

Brand name	Active ingredient	Chemical grouping	Full-time farmers <i>N</i> = 376		Part-time farmers <i>N</i> = 130	
			Freq.	%	Freq.	%
Tamaron	Methamidophos	Organophosphate	156	41.5	37	28.5
Dithane	Mancozeb	Carbamate	130	34.6	51	1.5
Sumicidine	Fenvalerate	Pyrethroid	137	36.4	16	12.3
Selecron	Profenofos	Organophosphate	106	28.3	27	20.9
Karate	Lambdacyhalothrin	Pyrethroid	70	18.6	19	14.6
Manzate	Mancozeb	Carbamate	61	16.2	12	5.47
Bida	Lambdacyhalothrin	Pyrethroid	55	14.6	2	1.5
Cartap	Cartap	Carbamate	52	13.8	1	0.8
Sabedong	Cypermethrin	Pyrethroid	49	13.0	18	13.8
Magnum	Cypermethrin	Pyrethroid	44	11.7	15	11.6
Lannate	Methomyl	Carbamate	36	9.6	45	39.2
Success	Spinosad		34	9.0	0	3.1
Malathion	Malathion	Organophosphate	21	5.6	7	5.47

Farming practices

Farmers from both groups were involved in mixing, applying or loading pesticides or combination of the three. For full-time farmers, there were more farmers involved in mixing (93.9%), while 88.6% of part-time farmers were involved in either mixing or loading. Practices were similar in the two groups except for mixing ($P = 0.045$), which was more prevalent among full-time farmers.

Most of the farmers from both groups used a knapsack or backpack sprayer (88.2%, 88.98%). Of full-time farmers, 11.8% used power sprayer, hand spray (0.5%), or mechanical, tank or compressor sprayer (0.25% each).

Of the full-time and part-time farmers, 91% and 87.8%, respectively, reported that they wore protective clothing but, when itemized, the majority did not wear coveralls, goggles, face shield or mask, or use respirators. Slightly more than half (50.3%) of the full-time farmers and 1/3 of the part-time farmers used gloves. Of the full-time and part-time farmers, 95% and 75%, respectively, used boots. Both groups differed significantly in their use of face mask, gloves, and boots.

Farmers from both groups used makeshift protective clothing in the form of a handkerchief around the face, hats or bonnets, jackets or pants used as arm covers, shirts used alone or wrapped in plastic, or raincoats or plastics.

There are also practices that should be done after pesticide use to minimize risk of intoxication or poisoning. Such practices include washing of hands, keeping a distance from recently sprayed areas (especially if the area is poorly ventilated), and avoiding spraying against the wind (Table 4).

Table 4 Percentage distribution of practices in pesticide use among farmers

Unsafe work practices	Full-time farmers			Part-time farmers		
	Freq.	%	N	Freq.	%	N
Wipe sweat from face with contaminated piece of fabric	185	53	349	79	64.22	123
Reenter recently sprayed area	118	31.7	372	45	36.3	124
Spray against the wind	123	42.4	290	49	45	109
Wash hands after applying pesticides and before eating	369	93.6	373	126	99.2	126
Take a bath after applying pesticides	368	98.4	374	127	100	127

Table 5 Comparison between full-time and part-time farmers in terms of pesticide exposure and illness

Pesticide exposure and illness	Full-time farmers (%)	Part-time farmers (%)	Statistical difference between the two groups
Getting ill because of work	53	44	Statistically significant difference at $P = 0.05$
Receiving medical attention because of illness	31	17	Statistically significant difference at $P = 0.01$
Pesticide exposure during application in the field	80	65	Statistically significant difference at $P = 0.01$
Exposure in farms and gardens	65	55	Statistically significant difference at $P = 0.05$
Insecticide exposure	95	88	Statistically significant difference at $P = 0.01$

Slightly more than half (53%) of the full-time farmers, and approximately 2/3 (64.22%) of the part-time farmers used contaminated cloth to wipe sweat from their faces. This difference between the two groups was significant ($P = 0.031$). Of the high- and low-exposure groups, 31.7% and 36.3%, respectively, reentered recently sprayed areas.

Used pesticide containers were either buried (34.8%), thrown away (31.4%), sold (20.2%) or burned (6.9%). The majority of the farmers from both groups buried the used pesticide containers, followed by destroying or throwing the container away. Of full-time farmers, 20.2% sold the pesticide container, while 12.8% of the part-time farmers burned it. Other respondents from both groups kept their pesticides in storage areas, while the remaining left them either beside or inside the house; in the backyards, garden or fields; or stored the used containers inside their storehouses. The two groups differed significantly in terms of disposal method for used pesticide containers. More full-time farmers sold or destroyed their used pesticide containers than did part-time farmers. In contrast, there was a higher percentage of part-time farmers who burned or buried their used pesticide containers.

Pesticide exposure and illness

The difference between the full-time and part-time farmers is shown in Table 5. There were more full-time farmers who complained of falling ill because of work. This difference was statistically significant ($P = 0.05$). However, only about 31% of the full-time farmers, and 17% of the part-time farmers reported receiving or seeking medical attention for their illness and/or exposure; this behavior

was significantly different between the two groups ($P = 0.01$).

Exposure commonly occurred in the farm or field (65% for high-exposure, 55% for low-exposure groups). The majority of the farmers from both groups were exposed to insecticides, and the two groups were significantly different in this regard.

Symptoms

Muscle pain was the most common general symptom felt by both groups of farmers. This was followed by weakness and easy fatiguability. Paresthesia and localized fasciculation were the top motor symptoms experienced by the full-time farmers, with 9.8% affected by each symptom, followed by tremors (7.8%) and convulsion (5.6%). For the part-time farmers, localized fasciculation was the top motor symptom, followed by paresthesia and tremors.

Physical and neurologic examination

Two hundred and seventy-nine (69.8%) of the full-time farmers, and 100 (71.94%) of the part-time farmers had at least one abnormal physical examination finding. However, only 42.6% of the full-time farmers, and 35.8% of the part-time farmers had an abnormal clinical diagnosis. Both groups were similar in all physical examination findings except for the nose, throat, chest, and lungs ($P = 0.05$).

A neurologic examination was conducted. Of the full-time and part-time farmers, 22 and 2, respectively, had abnormal neurologic diagnosis.

In assessing the individual components of the neurologic examination, 5.22% of the full-time farmers, and 8.63% of the part-time farmers had abnormal cranial nerve function. Of the full-time and part-time farmers, 22 (5.7%) and 9 (6.47%), respectively, had abnormal motor strength. All individuals tested for reflexes, meningeals, and autonomies from both groups were normal. Three out of 139 part-time farmers had cerebellar dysfunction characterized by dysmetria, inability to walk with feet in tandem, and difficulty maintaining balance.

Similar to the results in health symptoms, most of the farmers had normal physical examination findings. A physical examination at any one point in time is a cross-section of a person's physiological make-up at that particular time. Most of the symptoms that the respondents reported had occurred in the past. Likely, any abnormalities associated with acute pesticide exposure had resolved prior to the physical examination.

Hematologic parameters

The hematologic examination revealed that the full-time farmers had higher mean values for creatinine (89.6 vs. 86.4 $\mu\text{mol/L}$), white blood cell (7.4 vs. 7.0 G/L), red blood cell (5.2 vs. 4.7 T/L), hemoglobin (148.4 vs. 147.7 g/L), hematocrit (0.429 vs. 0.415 L/L), MCH (31.2 vs. 31.1 pg), MCHC (351.5 vs. 350.4 g/L), and platelets (278 vs. 263 G/L). MCV was slightly higher for part-time farmers (88.7 fl) than for full-time farmers (88.2 fL) (Table 6).

About 20 full-time farmers (mean reading 148.43 g/L) and 7 part-time farmers (mean reading of 146.68 g/L) had low hemoglobin. About 65% and 57.14%, respectively, had microcytic anemia, as evidenced by corresponding low MCV and low MCH values. Around 15% and 14.29%, respectively, had normocytic anemia, with low hemoglobin but normal MCV and MCH values.

Among the farmers, however, most of those with anemia at the time of extraction did not exhibit pancytopenia, making aplastic anemia an unlikely diagnosis.

Increases in hemoglobin, hematocrit, and RBC may reflect polycythemia secondary to high altitude. Benguet province is 2000 m above sea level at its highest peak. As altitude increases, atmospheric pressure decreases. This means that the oxygen pressure in air also decreases, which in turn leads to a decrease in the capacity of red blood cells to bind oxygen. The human body adapts to this by increasing the volume of erythrocytes or red blood cells. This in turn increases hemoglobin and hematocrit as well.

Creatinine is a byproduct of the metabolism of muscles and is produced in a constant amount in the body. As such it is often used as a marker for renal function, wherein its clearance is used to estimate the glomerular filtration rate of the kidneys. Some pesticides adversely affect renal function by producing acute tubular necrosis. Creatinine clearance ranged from 6.6 to 957 mL/min with mean of 89.6 mL/min for the full-time farmers, and it ranged from 27 to 171 mL/min with mean of 86.4 mL/min for the part-time farmers.

Of the 232 blood cholinesterase results, 94 (40%) were abnormal (Table 7). The normal value for cholinesterase reference used is Δ 0.75–1.0 ph/h.

Discussion

Worldwide there are numerous studies documenting the relationship between farming practices, pesticide use and exposure, and its effect on farmers' health. The health and environmental impacts of pesticide exposure to Filipino farmers have been correlated both here and abroad [1–5].

The full-time and part-time farmers groups were similar in demographics, with the majority of respondents in both

Table 6 Results of hematologist examination between full-time and part-time farmers

Hematologic parameters	Normal values	Full-time farmers		Part-time farmers	
		Mean	Range	Mean	Range
Creatinine ($\mu\text{mol/L}$)	31–133	89.6	6.6–957	86.4	27–171
White blood cell (G/L)	5–10	7.4	3.9–81	7.0	4.3–10.7
Red blood cell (T/L)	4.69–61.3	5.2	2.8–151	4.7	1.04–6.82
Hemoglobin (g/L)	140–181	148.4	76–206	146.7	68–236
Hematocrit (L/L)	400–537	0.429	0.103–0.581	0.415	0.106–0.641
Mean corpuscular volume (fL)	80–97	88.2	27.3–100.7	88.7	61.6–97.3
MCH (pg)	27–31.2	31.2	13.4–65.2	31.1	18.5–35.1
MCHC (g/L)	310–354	351.5	265–391	350.4	300–369
Platelets (G/L)	150–424	278.0	135–526	263.0	59–438

Table 7 Red blood cell cholinesterase (RBC) readings among farmers

RBC	Number	Percentage
Abnormal	93	40
Normal	139	60
Total	232	100

groups falling between the ages of 36–50 years, and being married. Most from both groups lived in households with 4–6 members.

Abortive outcomes among pregnant women are affected by a variety of factors. These factors may include poor prenatal care, inaccessible health facilities, infectious diseases, and chromosomal and genetic abnormalities. Direct and indirect exposure to pesticides by both pregnant women and their husbands have been implicated in a wide variety of adverse reproductive effects including disturbances in the menstrual cycle, reduced fertility, spontaneous abortion, developmental defects, and stillbirths [6].

In this study, there were 10 times more abortions among full-time farmers compared with among part-time farmers. Among women exposed to pesticides, the risk for spontaneous abortion increases with exposure anytime before or after conception [7].

Pesticides have adverse effects and their effects may be potentiated in children. It is disturbing that there are still 9% of children below the age of 15 years who work with and therefore are directly exposed to pesticide in this study. Guillette et al. [8] conducted a study on effects of pesticide exposure on preschool children in Mexico. Children who were exposed had less generalized physical endurance, decrease in ability to catch a ball, lesser fine eye–hand coordination, and difficulty grasping the concept of repeating numbers, of 30 min recall, and of ability to draw persons.

About 95% from both groups used pesticides. While more than 3/4 from both groups received instruction on pesticide use, understanding and practice seemed to be a different matter. Both groups were different in terms of organophosphate exposure. In the study of Clarke et al. [9] in Ghana, organophosphates were the most commonly used pesticides, followed by carbamates and organochlorides. The same trend was seen among farmers in Sri Lanka and Brazil [10].

The use of personal protective equipment (PPE) is encouraged by the Department of Agriculture, but the practice is not strictly enforced. Of the PPEs, the groups differed significantly in their use of face mask, gloves, and boots. Proper protective clothing was replaced by makeshift items such as handkerchiefs, hats or bonnets to cover the face, old shirts, and jackets or pants used as arm covers,

which may not actually protect the farmers. Different studies have already been published to investigate the use of PPE during pesticide use. Most often, gloves are the most commonly used PPE because hands are the most exposed areas, often associated with poor hand-washing practices after pesticide activities [11, 12]. However, farmers still failed to employ protective equipment themselves. Cheng and Bersamina [13] conducted a previous study of the hazardous effects of pesticides in the farming community of Benguet. In their study with 2000 respondents, 5% wore boots and no respondents wore the other PPEs. Reasons cited by the farmers included that these protective gears are more of a hindrance than a help.

Other practices that increased the risk for possible pesticide exposure were spraying against the wind (as less than a half of them do) and reentering recently sprayed areas. Spillage of pesticides, from either a defective backpack sprayer while spraying the pesticide or while mixing it, was also a risk factor for exposure. However the two groups were similar in this regard.

Although there are no significant differences in exposure of family members to pesticide, it remains alarming that family members, even the young, were exposed to or in contact with chemicals.

In terms of symptoms, muscle pain was the most common symptom experienced by the farmers from both groups, followed by muscle pain. For full-time farmers, weakness (62.4%) and easy fatiguability (53.96%) followed next. This is consistent with existing data on self-reported symptoms of farmers exposed to pesticides. Dizziness, headache, skin irritation, and burning sensation on the face are common self-reported symptoms by farmers in Malaysia, Ghana, the Gaza Strip, and Tanzania [14–17]. Among the farmers, tears or eye redness are also common, as well as nausea and salivation for gastrointestinal symptoms. Farm workers exposed to pesticide usually complained of wheezing and breathlessness [18]. Some respiratory problems such as chronic bronchitis and asthma have also been associated with pesticide use [19].

Pesticide poisoning in agricultural areas may be more chronic than acute and the symptoms of chronic intoxication may be so nonspecific as to be nonattributable by the farmer to pesticide exposure.

However, both groups in this study were significantly different in neurologic diagnosis such that full-time farmers had significantly more abnormal cases than part-time farmers. If this is related to pesticides, it may be because full-time farmers used organophosphates more than part-time farmers, as these pesticides are known neurotoxic agents.

Of full-time and part-time farmers, 20 and 7, respectively, had anemia (low hemoglobin). In Thailand, pesticide use has been correlated with occurrence of aplastic anemia. Aplastic anemia is defined as total reduction in

blood cells with corresponding hypocellular marrow. There is an estimated relative risk of 2.1 for organophosphates and 6.4 for DDT and 7.4 for carbamates [20].

The study also showed that 40% had abnormal red blood cell cholinesterase reading. The activity of cholinesterase enzymes in the blood can be utilized as a biomarker for the effect of organophosphates. An exposed person will show abnormally low levels of activity of cholinesterase enzymes measured in the serum or in red blood cells (as RBC cholinesterase). The latter is more closely correlated with cholinesterase activity in the nervous system [21].

Conclusions

This study has shown differences in pesticide use, farming practices, and health conditions between full-time and part-time farmers. Full-time farmers manifested more abnormal health findings compared with part-time farmers.

There were more full-time farmers who complained of falling ill because of work. This difference was statistically significant ($P = 0.05$). The level of seeking medical attention was also significantly different between the two groups ($P = 0.01$).

Based on hematologic examination, full-time farmers had higher mean values for creatinine, white blood cell, red blood cell, hemoglobin, and hematocrit. Of full-time and part-time farmers, 20 and 7, respectively, had anemia (low hemoglobin). Of 232 blood cholinesterase results, 94 (40%) were abnormal.

Further studies are needed to elucidate the differences in symptomatology and neurophysical examination findings between full-time and part-time farmers. Although both groups showed a high percentage who had received instructions on proper pesticide use and application, there still exist discrepancies in practices among farmers. Important among these are the use of makeshift PPEs, which the farmers utilize in the belief that they are adequate protection when in fact they may promote further exposure to pesticides.

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