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Health Impact Associated with Pesticides Use among Vegetables Farmers in Nepal: A Secondary Analysis

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ABSTRACT

Background: The trend of pesticide use in market-oriented vegetables is steadily increasing in Nepal. Farmers in developing countries use hazardous pesticides taking few or no safety measures. This study is aimed to assess health effects of pesticide exposure among vegetable farmers in Nepal.

Methods: Analysis of secondary data obtained from Nepal Health Research Council was performed. A cross-sectional study on "Health Effects of pesticide among vegetables farmers and adaptation level of integrated pest management program in Nepal 2013" was conducted by Nepal Health Research Council among 660 farmers in four selected districts of Nepal in 2013/2014. The secondary data obtained were statistically analyzed by student's 't' test, one-way analysis of variance and Pearson correlation statistics. For all tests used, 5% level of significance was considered.

Results: Fungicide and insecticides were commonly used pesticides by vegetable farmers in Nepal. Around 51% of the pesticides used were moderately hazardous (II) while, 28% were highly hazardous (Ib). Nearly 12% participants did not use any type of Personal Protective Equipments while spraying pesticides in the field. The prevalence of self-reported poisoning and low Acetylcholinesterase levels among farmers was 51% and 10.3% respectively. Acetylcholinesterase level was found to differ significantly in male as compared to female ($P < .05$).

Conclusions: Almost half of the research participants had self-reported poisoning. Low prevalence of depressed Acetylcholinesterase levels was associated with high use of fungicide compared to organophosphate.

Keywords: Acetylcholinesterase; organophosphate; pesticide

INTRODUCTION

The use of pesticides is increasing steadily despite of its negative consequences in Nepal.[1] Farmer's exposure to pesticide may result in headache, dizziness, skin irritation, blurred vision, and can lead to neurotransmitter dysfunction, disruption of endocrine system and cancer.[2] Studies have found inhibition of neurotransmitter acetyl cholinesterase with the exposure to organophosphates and can affect the central and autonomic nervous system. Similarly, research have found the relation of organophosphates and organochlorines with diabetes and depressed hemoglobin levels in blood.[3-5] Studies showed more than 90% increment in the use of chemical pesticide for the production of vegetables in recent years, especially in southern plain (the Terai) compared to northern mountain.[6,7] The rampant use of chemical pesticides is a major occupational health concern of low income countries' farmers, including Nepal. Hence, this study aimed to measure AChE levels with self-reported acute health symptoms for assessing pesticide exposure among vegetable farmers in Nepal.

METHODS

The secondary data to conduct this study were obtained from Nepal Health Research Council (NHRC). Permission was taken from NHRC for secondary analysis and publication of this data. The study was conducted by NHRC on "Health Effects of pesticide among vegetables farmers and adaptation level of integrated pest management program in Nepal 2013" from 2013 to 2014. This was a cross sectional study carried out in four selected districts of Nepal namely Kavrepalanchowk, Nawalparasi, Ilam and Rasuwa. The sample size of 660 was calculated using the sample size calculator developed by the World Health Organization (WHO) (sample_size_calculator STEPS).[6,8] Two stage clusters sampling with probability proportionate to Size (PPS) and simple random sampling method was used to select the sample from the sampling frame of the Annual Progress Report of Potato, Vegetable and Masala Development Program 2011. Among 168 primary sampling units (PSU) of vegetable programs running across 75 districts of Nepal, 15 vegetable programs were selected using PPS

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sampling method technique. One vegetable program cover 8-10 vegetables pocket, which was considered as a secondary sampling unit (SSU). Among, 15 vegetable programs, 2 vegetables pocket were selected from each 15 vegetable programs using the simple random technique. Among selected vegetables packet 22 eligible farmers working with selected vegetable pocket were selected using systematic random sampling.

Data were collected through pretested and structured questionnaire. A face to face interview was conducted using structured questionnaire in Nepali by trained data collector, and was back translated into English. Demographic information, pesticide use practice, handling procedure and pesticide knowledge of participants was collected using a structured questionnaire. Height and weight were measured to calculate the Body Mass Index (BMI) of participants. Height of the participants was measured using portable standard stature scale. Similarly, weight was measured using portable digital weighing scale (Seca, Germany). Hemoglobin (Hb %), blood glucose and AChE levels were measured to assess the health effect of pesticide among vegetable farmers of Nepal. The AChE and hemoglobin level were measured by WHO recommended Test-mate ChE photometric analyzer model 400 (USA) using Ellmen method. Participants were instructed to fast overnight for 8 hours to test their blood sugar. Fasting blood sugar level was measured by WHO recommended Hemocue 2.1 dm using the dry method.

The obtained secondary data were analyzed using the Statistical Package for Social Science (SPSS) version 16.0. The results of quantitative variables were analyzed using descriptive statistics and frequency distribution for all parameter. Student's't' test, ANOVA and Pearson correlation statistics were used to determine the association of AChE levels with explanatory factors. The test analysis was performed at the 5% level of significance.

RESULTS

Among 628 participants, 64.2% were male and 35.8%were female and nearly half of the participants (46.8%) were in the age group 31-45 years. Around two-fifths (38.4%) of participants were engaged in commercial farms for more than ten years. Similarly, maximum percentage of the participants (97%) were literate (able to write and read) and very few participants (3%) were illiterate.

Fungicide and insecticides were commonly used by vegetable farmers in Nepal. Mancozeb (38%), Dichlovos (18.4%), Cypermetrin (13%) were the most commonly used pesticides. Average frequency of application of pesticide was five episodes per season. According to WHO criteria, 65% use of pesticides were unlikely to present acute hazard in normal use (NH). Similarly, 51% of pesticides were classified as moderately hazardous (II); 28% as highly hazardous (Ib) and 4% as slightly hazardous (III) categories. Table 1 demonstrates the

Table 1. Commonly used pesticides by farmers.

Common name	Chemical name	Type of pesticide	WHO category*	Frequency	Percent
Mancozeb	Dithiocarbamate	Fungicide	NH	362	38.00%
Dichlorvos	Organophosphate	Insecticide	Ib	175	18.40%
Cypermetrin	Synthetic pyrethriod	Insecticide	II	124	13.00%
Chloropyrifos	Organophosphate	Insecticide	II	104	10.90%
Alphametrin	Synthetic pyrethriod	Insecticide	II	45	4.70%
Carbendazim	Carbendazim	Fungicide	NH	45	4.70%
Dimethoate	Organophosphate	Insecticide	II	39	4.10%
Emamectin Benzoate	Organophosphate	Insecticide	III	28	2.90%
Imidacloprid	Organophosphate	Insecticide	II	20	2.10%
Malathion	Organophosphate	Insecticide	II	11	1.20%

**WHO pesticide hazard classification, highly hazardous (Ib), moderately hazardous (II), slightly hazardous (III), and unlikely to present acute hazard in normal use (NH).[9]*

commonly used pesticides by farmers of Nepal.

Around four fifth of the participants (83.0%) had stored pesticides in an unlocked place/ room where children easily reach where as 12.7% participants had kept pesticides in locked in a store or boxes. Around 1.8 % of the participants had kept in the kitchen or grocery store and equal number of participants (1.8%) bought and used it immediately. Negligible proportion (0.8%) had stored it in the field. Almost all participants (99.5%) kept pesticide in original box rather than other containers (Table 2).

Table 2. Storage of pesticide in house.

Variables	Frequency (n)	Percentage (%)
Locked in a store/box	80	12.7
Left Unlocked in a place where children can reach	521	83
In a kitchen/storage room	11	1.8
In the field	5	0.8
Buy and use it immediately	11	1.8
Total	628	100

Nearly 12% participants did not use any types of PPE while spraying the pesticides in the field. Among those who used PPEs, trousers (78.3%), long sleeved shirt made of cotton and silk (75.3%), cotton general masks (60.83%) were the most common PPEs. Around 21% farmers wear the hat to protect from the sun rather than protect from pesticide exposure. Less than one tenth of the participants used the spectacles, gloves and overall cover dress. All farmers had used the chemical non-resistant PPEs which are not fully protecting the pesticide to enter the body (Table 3).

Table 3. Percentage of respondents using PPE.

Variables	Frequency (n)	Percentage (%)
Trousers	490	78
Long sleeved shirt	473	75.3
Masks	382	60.8
Hat	131	20.9
Gloves	61	9.7
Spectacles	37	5.9
Overall cover	32	5.1

Among 628 participants, 317participants (50.5%) complained about discomfort immediately after spraying pesticides (not shown in table). About 43.7% of the participants complained headache, followed by blurred vision 25.4%, back pain 24.3%, dizziness and nausea 19.7% (Table 4). More than one tenth of the participants complained of dry mouth, skin irritation and muscular illness and less than one tenth of the participants suffered from extreme tiredness, loss of appetite, respiratory difficulties and speech difficulty.

Table 4. Acute Toxicity Syndrome among farmers.

Variables	Frequency (n=317)	Percentage
Headache	275	43.7
Blurred vision	160	25.4
Back pain	153	24.3
Dizziness	124	19.7
Nausea	124	19.7
Skin irritation	95	15.1
Dry mouth	76	12.1
Muscular weakness	71	11.3
Extreme tiredness	53	8.4
Loss of appetite	48	7.6
Respiratory difficulties	40	6.3
Speech difficulty	38	6

Prevalence of low AChE level was 10.3% among vegetable farmers of Nepal (Table 5). Prevalence of diabetes, including those on medication was 4.5%. The proportion of low AChE among organophosphate exposed farmers was 9%. The prevalence of anemia among male and female were 43.9% and 53.3% respectively.

Table 5. Prevalence of Diabetes, Low AChE and Anemia.

Variables	Frequency	Percentage
Low AChE	64/624	10.3
Low AChE among OP exposure	32/376	9
Diabetes (>110mg/dl)	28/624	4.5
Anemia (<11mg/dl) in Female	120/624	53.3
Anemia (<12 mg/dl) in Male	175/624	43.9

Analyzing AChE level in relation to individual characteristics found that AChE level differed significantly in male as compared to female, which was significant at the 5% level of significance. However, in relation to received IPM training, organophosphate user, use of PPE and age category, bivariate analysis did not reach statistical significance. Similarly, AChE level was found to be negatively correlated in relation to years in farming (i.e. decrease in AChE level with increase in years in farming) though the correlation analysis did not reach statistical significance (p>005).

DISCUSSION

Fungicide and insecticides were common pesticides used by vegetable farmers in Nepal.[9,10] Nearly 65% of the participants used fungicides and among insecticide 60% used organophosphate, and 27% used pyrethriod. Even though the majority of farmers were literate and have knowledge related to pesticide harm, the prevalence of self-reported acute toxicity syndrome was high (51%) among vegetable farmers. The prevalence of self-reported acute toxicity syndrome were similar to study conducted in Bolivia, Colombia and Kenya that suggested exposure to acute toxic doses of pesticides.[11,12] Study conducted by Atreya et.al (2011)[10] suggests that exposure to high level of organophosphate is related to depression in Ache level; however increase in self-reported acute toxicity syndrome is associated with exposure to fungicide and pyrethoids. The use of fungicides and pyrethroid insecticides compared to organophosphate in this study were sufficient to claim high prevalence of self-reported acute toxicity syndrome.[10] Similarly, other factors related to high prevalence of self-reported acute toxicity syndrome may be due to lack of training in pesticide use, ignorance about potential dangers to health and environment, inappropriate mixing, repeated application of pesticides, inadequate PPE use, poor hygienic practices.[13] Training and educating farmers in safe use and handling of pesticides should reduce incidents of self-reported acute toxicity syndrome among vegetables farmers in Nepal. Training program should encourage farmers to use appropriate PPE and recommended amount of pesticide while spraying pesticide to reduce acute pesticide poisoning symptoms. Further, promoting vegetables farmers to use the alternatives to synthetic chemical pesticides (mostly biological means) should be encouraged for pest suppression in agriculture. Large numbers of farmers cultivated crops with traditional technique rather than integrated pest management (IPM) technique. IPM has been proven effective in many parts of the world for reducing pesticide use.[7,14] The government should give emphasis on research and extension activities related to IPM, promoting IPM as an alternative to chemical pesticides in Nepal.

This study found 51% of pesticides used were classified as moderately hazardous (II) and 28% as highly hazardous (Ib) according to WHO classification. Nearly 12% participants did not use any type of PPE while spraying the pesticides in the field. Less knowledge regarding instructions displayed on the labels of the pesticides and inadequate use of PPE might have probably increased pesticide exposure and related symptoms among vegetable farmers of Nepal. A similar finding about inadequate use of PPE and increased pesticide exposure and related symptoms has been reported by several other studies from Combodia, Gaza, Indonesia, Kenya, Pakistan and Nepal.[15-17] Previous studies have shown that inadequate use of PPE might be associated with cultural or financial factors, or may result from the discomfort of working under the prevailing hot and humid climatic conditions.[12,18] Therefore, adequate training on use of suitable PPE, availability of PPE in pesticide/general store at reasonable prize and at least use of gloves apron and face shield during pesticide spray is recommended to reduce pesticide exposure among vegetables farmers in Nepal.

Similarly, our study supports the finding that farmers in developing countries store pesticides in an unlocked place/ room where children easily reach. [16,19] Easy access to pesticide puts the environment and the health of the farmers and their families at risk. Many studies have shown that easy access to pesticides is directly linked to suicides.[20,21]Adopting the measures like: following instructions on the pesticide use, keeping pesticide in its original container, storing it in a safe place and buying only the exact amount of pesticide required may help to reduce exposure risks.[22]

The prevalence of diabetes and low Hb level among vegetable farmers was found high. Our finding was similar to findings reported from India and southwest Nigeria that showed depression in hemoglobin values in relation to pesticide exposure. [23] Similarly, Montgomery, et. al. (2008) found that long time exposure to organophosphate may contribute to increase in glucose homeostasis.[24] The mechanism on how the exposure to pesticide contributes to low level of Hb and increased risk of diabetes is not well understood. This finding may help future understanding of low level of Hb and increased risk of diabetes in terms of pesticide exposure.

Our study observed low prevalence of depressed AChE (10.3%) among vegetable farmers in Nepal. AChE depression is associated with exposure to organophosphate and carbamates insecticide.[25] According to our study, use of organophosphate and carbamates insecticide is less compared to fungicide and pyrethoid insecticide. The low prevalence of depressed AChE level among vegetable farmers may be due to limited sample size and predominant use of fungicides and pyrethoid insecticide. Similarly, due to lack of control group in the study, it was not possible to compare the change of AChE level among those who only sprayedorganophosphate and carbamates pesticides compared to those who did not but were exposed to the similar working environment. However, the findings of the study provide noteworthy meaning that AChE inhibition is not an indicator of exposure to pyrethroids and fungicides. These pesticides are found to increase acute health symptoms, thus future research should include biological indicators for assessing exposure to pyrethroids and fungicides.[26,27]

Except for sex and years in farming, no other factor could significantly influence AChE levels. Negative correlation was found between AChE level in relation to years in farming (r= -0.0313). The findings of this study were consistent with Ishak et. al. who found that AChE levels was strongly negatively correlated in relation to years in farming.[28] This might be due to long term exposure to pesticides and may lead to a higher AChE inhibition. Similarly, student's 't'-test showed AChE level was found to differ significantly in male as compared to female ($P <$ .05). Our finding was different than El-Kettani et. al. in Morocco, who found no significant difference in AChE levels between the sexes.[29] However, the result was consistent with Kachaiyaphum et.al 2010 who found that male farm workers were more likely to develop abnormal AChE levels than females.[30] This might be due to the fact that most farm workers were male and female were mainly supposed to participate in house related activities rather than spraying pesticides in field.

CONCLUSIONS

Fungicide, especially mancozeb was most common pesticide rather than organophosphate in Nepal having significantly more symptoms of self reported pesticide intoxication to people exposed to its unsafe levels. Our study observed low prevalence of depressed AChE (10.3%) among vegetable farmers in Nepal. However, more detailed studies with large sample size and monitoring AChE inhibition among organophosphte and carbamates pesticide users could have resulted in a better conclusion.

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