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Original article

Vulnerable groups and protective habits associated with the number of symptoms caused by pesticide application in Kratie, Cambodia: a cross-sectional questionnaire study

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Abstract

Objective: The present study aimed to identify pesticide poisoning symptoms and related protective habits to effectively prevent pesticide poisoning among farmworkers in Kratie, Cambodia, where pesticide poisoning is an urgent public health problem.
Materials and Methods: This cross-sectional study based on a questionnaire survey analyzing social demographics, number of symptoms, and protective behavior regarding pesticide application was conducted in Kratie Province from January 25 to 31, 2021. In total, 210 farmworkers completed the survey. The effects of social demographics and pesticide-protective behavioral scores on the number of symptoms were investigated using multivariable regression analysis.
Results: The observed number of symptoms was 1.16 times higher among women (*P*=0.004), increased with the duration of work, and decreased with age. In addition, we identified five significant pesticide-protective behaviors: 1) preparing using gloves, 2) using protective equipment, 3) avoiding wiping sweat, 4) avoiding leaking, and 5) resting when feeling ill. Pesticide-protective behaviors tended to decrease with the duration of working years in the low-education group (B=−0.04, SE=0.01), whereas no association was observed in the high-education group (B=0.01, SE=0.01).
Conclusion: Pesticide-protective behaviors significantly correlated with fewer symptoms. The female and aging groups required continuous special education or instructions for implementing pesticide-protective actions, especially the aforementioned five protective actions.

Key words: farmworker, vulnerable groups, occupational health, Cambodia

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Introduction

Health disparity is thought to emerge from weaknesses in health systems and individual factors such as race, sex, sexual identity, age, disability, socioeconomic status, geographic location, environmental barriers, and stigmatization[1]. These conditions pose a crucial barrier to achieving better health care for all patients. In addition, disparity and vulnerability are significantly related and cannot be separated from one another[2]. Specifically, individuals can become vulnerable to disease, disability, and other personal conditions, or to societal and environmental conditions[3], which are factors with complex associations. Thus, identifying the

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related problems faced by vulnerable people is a vital public health issue. However, vulnerable people are last to be given special consideration and administered surveys[3].

To examine the conditions faced by vulnerable people, focusing on a specific group is essential. In Asian countries, the majority of residents in rural areas engage in agricultural work. In this context, farmworkers are exposed to high risks of work injuries, and the farmworker occupation is considered one of the most dangerous ones[4, 5]. In particular, various effects of chronic exposure to pesticides have been reported, including deoxyribonucleic acid (DNA) damage, neurological disorders, respiratory effects, developmental disorders, and sterility[6–10]. Consequently, farmworkers are a potentially vulnerable population owing to a combination of social and cultural risk factors as well as pesticide exposure[6]. Thus, surveying the health effects associated with pesticide poisoning among farmworkers, and identifying the group that is most affected by these problems (particularly in rural Asia where the majority of poor individuals work in agriculture), is urgently required. Nevertheless, in countries in the aforementioned area, these surveys have not been sufficiently conducted.

Cambodia, a country in Southeast Asia, is classified as a low- to middle-income country. The adult literacy rate is 84.1% for men and 76.1% for women[11]. The majority of residents are engaged in agriculture with 8.6% males and 5.2% females located in urban areas, and 59% males and 52.2% females located in rural areas. Moreover, 77.2% of male farmworkers and 79% of female farmworkers are classified in the lowest quantile of economic status, indicating that the poorest people in Cambodia are mostly farmworkers[11]. The main crops are grains, rice, vegetables, fruits, cassava, and cashew nuts[12]. A total of 70% of agricultural households use inorganic fertilizers, whereas 50% use organic fertilizers[12]. Notably, farmworkers reported several symptoms associated with pesticide application in Cambodia in a previous survey conducted in Southeast Asia[13]. Furthermore, a previous study indicated that organochlorines greatly influenced the health of pregnant women, especially in low-income groups[14]. Thus, Cambodia is a suitable area for surveying the health effects associated with pesticide poisoning among farmworkers and identifying groups highly affected by these problems[15].

The objective of this study was to identify the characteristics of several pesticide poisoning symptoms and to identify protective habits that effectively prevented these symptoms among farmworkers in Kratie, where such poisoning is an urgent public health problem[15].

Materials and Methods

Study design and participants

This study had a cross-sectional design. Kratie Province, located 270 km from the capital city, Phnom Penh, is mainly a rural area with a total population of approximately 340,000, of which about 80% are farmworkers. Specifically, 68.9% of males and 72.9% of females were classified as farmworkers with a low standard of living. In 2019, Kratie Province experienced a disaster caused by chemical substances. Therefore, this province was chosen as the survey area because pesticide poisoning is an urgent problem.

The average area per agricultural holding in Kratie is 2.14 hectares[12], and the main crops are grain, rice, cassava, cashew nuts, lemongrass, citrus trees, pepper, rubber, and coconut trees. These crops require a much higher pesticide amount than grains. The province has a temperate climate, with wet and dry seasons, and the Mekong River frequently overflows during the rainy season. In this context, most farmworkers do not prefer personal-protective equipment use because of the hot climate.

Kratie Province is officially divided into six districts; of these, five are rural and one is urban. We gathered participants from five rural districts to reduce regional bias based on district differences. The selection criterion for farmworkers was as follows: age between 30 and 70 years with an exclusive engagement in agriculture for more than 5 years. The proportion of male participants was two-thirds, which was the same as in a previous survey[16]. The present study was approved by the National Ethics Committee of Cambodia (approval number 001NECHR).

Procedure

A qualitative interview on pesticide-related symptoms was conducted with 20 farmworkers in May 2020 to determine area-specific pesticide-associated symptoms, enabling the development of a validated questionnaire to count the number of symptoms. Twenty-nine pesticide-related symptoms were identified from the open-question interviews of farmworkers in Kratie and from a literature review[13, 16]. Pesticide-related symptoms were examined using multiple-choice questions such as “What kind of symptoms have you experienced when using pesticides or within 24 hours after pesticide application?”. The number of symptoms was determined by researchers.

We used a questionnaire consisting of nine questions from a previous large-scale survey in rural China to examine the protective behavior associated with pesticide use[16]. Local and Japanese experts in health and pesticides discussed the validity of this questionnaire for use in the Kratie Province and deemed it appropriate for this study. Participants answered questions on the frequency of protective behaviors by selecting from five options: always, often, sometimes, rarely, and never. The sample size was calculated with a confidence level of 95%, precision of 0.75, and the population of rural Kratie of 270,000. A 20% margin sample size was set, and subsequently, the sample size was determined to be 210.

The questionnaire survey was conducted in the Khmer language by local surveyors between 25 May and 31 May, 2021. The surveyors were trained in advance of the survey by researchers. Additionally, the researchers contacted the head of the village each district to obtain permission for the survey and negotiated the gathering of eligible farmworkers. Some of the participants were interviewed in groups using the previously mentioned gathering methods. The surveyors went door-to-door of the participants, and one participant from each household was selected. Convenient sampling was performed in each district. First, the surveyors explained the objectives and methods of the survey and informed consent was obtained from each participant. Subsequently, participants were interviewed on social demographic information, number of symptoms, and protective behavior regarding pesticide application.

The frequency of protective behavior—classified as always, often, sometimes, rarely, and never—was scored as 10, 6.5, 4.5, 2, and 0, respectively, and named the "pesticide-protective behavioral score" (Supplementary Table 1). For questions on protective behavior (e.g., "Did you read labels about the pesticides before application?"), the score was assigned according to the aforementioned methods. For questions on risky behaviors (e.g., "Did you prepare pesticides without gloves?"), the frequency of the corresponding protective behavior was assigned scores of 0, 3.5, 5.5, 8, and 10, respectively (Supplementary Table 1). The protective behaviors were as follows: "read labels, prepare with gloves, use protective equipment, avoid eating during an application, avoid wiping sweat, avoid leaking, avoid physical contact, take rest when feeling ill, and take a shower" (Supplementary Table 1).

Outcomes

The primary outcome measure was the number of symptoms experienced. The effects of social demographics and pesticide-protective behavioral scores on the number of symptoms were investigated.

Data analysis

First, the social demographics of the participants were summarized based on sex. The χ^2 test or Mann–Whitney U test were used to determine differences between the sexes. Second, the proportion of participants with each symptom associated with pesticide application was summarized based on sex. The median pesticide-protective behavioral score was then determined for each of the nine categories, and the average was calculated. The average pesticide-protective behavioral scores and the number of symptoms according to the main variables were described. A multivariate linear regression model was constructed to determine the effect of social demographics on the sum of the pesticide-protective behavioral scores. Sex, age, years of education, and district were used as explanatory variables. The same multivariate linear regression model was performed for years of education (less than 3 years or more than 4 years). Finally, multivariable Poisson regression analysis was used to determine the effect of social demographics and each pesticide-protective behavioral score on the primary outcome. After comparing the predictive power of the outcome variables, the participant sex, age, years of education, working experience, instructed experience, and all pesticide- protective behavioral scores were added as explanatory variables. A literature review and Akaike information criterion were used to choose the appropriate multipliable models. Statistical significance was set at $P<0.05$. All analyses were performed using STATA IC15 (Lightstone, TX, USA, version 15).

Results

A total of 210 farmworkers provided consent, completed the survey, and were included in the analysis. Of the total, 142 individuals were male, the median (interquartile range) age was 45.4 (IQR=38–55) years, and the number of years of education was lower among women than among men. Only 30 individuals (14.3%) had previously received instructions on pesticide application (Table 1).

A total of 206 individuals experienced at least one symptom during pesticide application or within 24 h of pesticide application. The major symptoms were neurological and included dizziness, muscular pain, headache, fatigue, and weakness. In addition, mucous membrane irritation symptoms, including eye problems, were frequently found among farmworkers. However, the appearance of dermatological symptoms was comparatively low among Kratie farmworkers (Table 2).

We also found that farmworkers frequently exhibited protective behavior, avoided eating during applications, avoided leaking of pesticides, rested when they felt ill, and showered after an application. However, they rarely used personal-protective equipment (Table 3). The number of symptoms was higher among women, aging adults, and those who had lower pesticide-protective scores (Table 4). We also found that the pesticide-protective behavioral scores did not differ according to sex and age. However, the farmworkers in the high-education group and those from a prominent rural area in the Prek Prosorb, Sambour, and Snuol districts frequently exhibited protective behaviors regarding pesticide applications (Supplementary Table 2). The multivariable linear regression model for pesticide-protective behavioral scores according to years of education showed that the protective behavior decreased with working years only in the low-education group, whereas no association was found in the high-education group (Table 5).

Moreover, the number of symptoms was 1.16 times

Table 1 Participant characteristics

	Male (n=142)	Female (n=68)	*P* value
Age (median (IQR))	46.5 (38–55)	45 (37–52.5)	0.246
Years of education (median (IQR))	4 (3–7)	3 (1.5–5)	0.009
Years spent working (median (IQR))	20 (10–30)	20 (20–32.5)	0.188
District address n (%)			0.204
Chet Borey	68 (66.0)	35 (34.0)	
Prek Prosorb	21 (77.8)	6 (22.2)	
Sambour	20 (80.0)	5 (20.0)	
Snuol	16 (53.3)	14 (46.7)	
Chhlong	17 (68.0)	8 (32.0)	
Experience of having received instructions previously n (%)	19 (63.3)	11 (36.7)	0.588

IQR: interquartile range.

Table 2 Symptoms associated with pesticide application; n (percentage to the whole)

	Male n (%)	Female n (%)
Unpleasant smell	117 (82.4)	55 (80.9)
Dizziness	83 (58.5)	43 (63.2)
Eye problems	86 (60.6)	35 (51.5)
Muscular pain	82 (57.8)	38 (55.9)
Headache	75 (52.8)	46 (67.7)
Fatigue	77 (54.2)	43 (63.2)
Weakness	79 (55.6)	40 (58.8)
Thirst	66 (46.5)	26 (38.2)
Poor appetite	56 (39.4)	31 (45.6)
Hyperhidrosis	55 (38.7)	29 (42.7)
Taste change	48 (33.8)	28 (41.2)
Dyspnea/short breath	45 (31.7)	25 (36.8)
Arrhythmia or tachycardia	46 (32.4)	23 (33.8)
Numbness	46 (32.4)	23 (33.8)
Chest pain or chest stuffiness	41 (28.9)	25 (36.8)
Hot sensation	36 (25.4)	23 (33.8)
Cough	42 (29.6)	17 (25.0)
Laryngeal itch and pain	36 (25.4)	27 (39.7)
Pruritus	30 (21.1)	31 (45.6)
Fever	31 (21.8)	22 (32.4)
Vomiting and nausea	27 (19.0)	19 (27.9)
Urticaria	23 (16.2)	20 (29.4)
Diarrhea	16 (11.3)	14 (20.6)
Swelling	13 (9.2)	10 (14.7)
Blister	11 (7.8)	10 (14.7)
Dermatitis	13 (9.2)	4 (5.9)
Allergy	3 (2.1)	10 (14.7)
Syncope	7 (4.9)	2 (2.9)
Other	1 (0.7)	1 (1.5)

Table 3 Pesticide-protective behavioral score during pesticide application (10=always, 0=never)

Score name	Median (IQR)
Read labels	4.5 (0, 6.5)
Prepared using gloves	5.5 (0, 10)
Used protective equipment	0 (0, 4.5)
Avoided eating during application	10 (10, 10)
Avoided wiping sweat	5.5 (3.5, 10)
Avoided leaking	10 (5.5, 10)
Avoided physical contact	4.5 (2, 6.5)
Rested when feeling ill	10 (8, 10)
Took a shower	10 (10, 10)
Average	6.4 (5.3, 7.2)

IQR: interquartile range.

higher among women, increased with work duration, and decreased with age. Pesticide-protective behavioral scores—based on factors including preparing using gloves, using protective equipment, avoiding wiping sweat, avoiding leaking, and resting when feeling ill—significantly decreased with the number of symptoms (Table 6). The same Poisson analysis model with the complete score is shown in Supplementary Table 3 and shows that the results were almost consistent with the model in Table 6.

Discussion

Research on the health effects associated with pesticide poisoning among farmworkers (who comprise a potentially vulnerable population) and identification of the highly affected group are urgently required in rural Asia. This issue has been studied in rural Cambodia.

Using multivariate analysis, this study found that the number of symptoms was 1.16 times higher among women (P=0.004), increased with the duration of work, and decreased with age. These findings are consistent with those of a previous study in Southeast Asia[13]. It is worth noting that the effects of pesticides might be more significant in women than in men because of physical features; therefore, the side effects of pesticide application could be an issue among full-time female farmers. Hence, educating these populations on pesticide protection should be prioritized.

Table 4 Average pesticide-protective behavioral score and number of symptoms by main valuables

	Average pesticide protective behavioral score (Median (IQR))	The number of symptoms (Median (IQR))
Sex		
Male	6.2 (5.3, 7.1)	7.5 (4, 14)
Female	6.7 (5.4, 7.4)	10 (7, 14)
Age		
Under 50 years old	6.4 (5.3, 7.1)	8.5 (5, 13.5)
50 and over 50 years old	6.4 (5.4, 7.4)	10 (3, 14)
Education		
Under 4 years	6.2 (5.2, 6.9)	9 (4, 14)
4 and over 4 years	6.7 (5.6, 7.4)	9 (5, 14)
Pesticide protective behavioral score		
Under 6.5		11 (7, 16)
6.5 and over 6.5		6.5 (3, 11)

IQR: interquartile range.

Table 5 Multivariable liner regression model for pesticide-protective behavioral scores by education years

	More than four education years (n=117)				Less than three education years (n=93)			
	B	SE	β	*P* value	B	SE	β	*P* value
Sex (ref. male)	0.07	0.31	0.023	0.809	0.46	0.29	0.163	0.108
Age (years)	−0.02	0.02	−0.162	0.221	0.03	0.02	0.236	0.068
Working years	0.01	0.01	0.105	0.415	−0.04	0.01	−0.356	0.009
Instruction (ref. none)	−0.74	0.39	−0.177	0.063	0.40	0.37	0.105	0.280
District address (ref. Chet Borey)								
Prek Prosorb	0.59	0.38	0.157	0.124	1.57	0.49	0.313	0.002
Sambour	0.45	0.43	0.105	0.292	1.74	0.45	0.400	0.000
Snuol	0.93	0.40	0.236	0.021	0.79	0.40	0.195	0.051
Chhlong	0.00	0.40	0.001	0.994	−0.89	0.54	−0.178	0.101

B: unstandardized regression coefficient; SE: standard error; β: standardized coefficient.

Table 6 Poisson regression model (adjusted incidence-rate ratios) for number of symptoms associated with pesticide application

	IRR	SE	*P* value
Sex (ref. male)	1.16	0.058	0.004
Age (years)	0.99	0.003	0.019
Working years	1.01	0.003	0.002
Education years	0.99	0.008	0.338
Instruction (ref. none)	1.01	0.067	0.922
Pesticide protective behavioral score			
Read labels	1.01	0.007	0.122
Prepared using gloves	0.97	0.005	<0.001
Used protective equipment	0.98	0.006	<0.001
Avoided eating during application	1.01	0.008	0.062
Avoided wiping sweat	0.96	0.008	<0.001
Avoided leaking	0.98	0.010	0.018
Avoided physical contact	1.00	0.007	0.720
Rested when feeling ill	0.98	0.007	0.008
Took a shower	1.00	0.007	0.970

IRR: incidence-rate ratios; SE: standard error.

Moreover, we observed several preventive behaviors that were effective in reducing the health effects of pesticides. In particular, five of the nine behaviors (preparing using gloves, using protective equipment, avoiding wiping sweat, avoiding pesticide leakage, and resting when feeling ill) significantly suppressed the number of pesticide poisoning symptoms. Additionally, four of the five behaviors have been correlated with pesticide poisoning in previous studies[16]. However, many farmworkers do not engage in these protective behaviors, and our study found that it is necessary to educate farmers on these practices. Specifically, particular groups—women and those who have worked for long durations—could be prioritized for these educational interventions.

The protective behaviors for pesticide use might decrease during the working year only among the low-education group, as we found no association on multivariable analysis in the high-education group. The low-education group required special and longer instructions for pesticide-protective actions; therefore, further research is required on this issue.

In the present study, most of the symptoms related to pesticide application were neurological. A total of 98% of the farmworkers in Kratie had at least one pesticide poisoning symptom after pesticide application or within 24 h. In this context, many other diseases and neurological symptoms have been reported in previous studies, including cancer, DNA damage, respiratory effects, developmental disorders, and sterility[8]. However, some of these symptoms are silent and often not apparent until the disease worsens. The number of non-communicable diseases that are also silent diseases has been increasing in Cambodia. Thus, health checkups should be widely conducted in vulnerable populations to identify these silent diseases in the early stages. Verifying the credibility of pesticide effects is difficult without an evaluation of the baseline health status determined by widespread health checkups among farmworkers.

Several limitations of this study should be considered when interpreting the findings. First, the frequency of symptoms was not measured in this study, and information on the frequency of each symptom is needed to more accurately understand symptoms related to pesticide application. Second, we did not obtain important information about economic disparities in the study population (e.g., economic status and family structure). Third, while we selected five rural districts in Kratie, convenience sampling was conducted in each district. Fourth, there are wide variations in agricultural products, soils, and climates within Cambodia; hence, the generalization of these results to all of Cambodia requires caution. Fifth, the Cronbach's score for pesticide-protective behavior was 0.4519; thus, the reliability of pesticide-protective behavior was not confirmed. The reason for this finding might be that the questionnaire was minimal. Nevertheless, the questionnaire was created after discussions between medical staff, specialists in pesticide use, and local staff. Further improvement of the questionnaire is required. Finally, we did not obtain information on the type of pesticides used. Although the present study had these limitations, it is the first to identify groups with several symptoms associated with pesticide application and to determine associated protective behavior in rural Cambodia, where pesticide poisoning is a significant problem.

Conclusions

The present study identified a group vulnerable to pesticide poisoning as well as significant protective behaviors associated with self-reported symptoms caused by pesticide application. Women and those with longer work durations might have to be prioritized for education regarding pesticide protection. We also found that using gloves, using protective equipment, avoiding wiping sweat, avoiding pesticide leakage, and resting when feeling ill were significant protective behaviors. Moreover, further research is required to investigate objective health effects and self-reported symptoms to protect the health of farmworkers, a vulnerable, hard-working population.

Author contributions: The author contributions were as follows: conceptualization, Y.K. and L.S.; methodology, Y.K. and L.S.; software, Y.K.; validation, Y.K. and L.S.; formal analysis, Y.K.; investigation, L.S. and S.H.; resources, Y.K. and M. T.; data curation, L.S.; writing and original draft preparation, Y.K.; writing and review and editing, M.T., Y.N., N.L., and M.O.; visualization, Y.K.; supervision, M.T., Y.N., N.L., and M.O.; project administration, Y.K., L.S., M.T., and N.L.; funding acquisition, Y.K. All authors read and agreed to the published version of the manuscript.

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References

1. Veinot TC, Mitchell H, Ancker JS. Good intentions are not enough: how informatics interventions can worsen inequality. J Am Med Inform Assoc 2018; 25: 1080–1088. [Medline] [CrossRef]
2. Grabovschi C, Loignon C, Fortin M. Mapping the concept of vulnerability related to health care disparities: a scoping review. BMC Health Serv Res 2013; 13: 94. [Medline] [CrossRef]
3. Bracken-Roche D, Bell E, Macdonald ME, *et al*. The concept of ‘vulnerability’ in research ethics: an in-depth analysis of policies and guidelines. Health Res Policy Syst 2017; 15: 8. [Medline] [CrossRef]
4. Amshoff SK, Reed DB. Health, work, and safety of farmers ages 50 and older. Geriatr Nurs 2005; 26: 304–308. [Medline] [CrossRef]
5. Das B. Agricultural work related injuries among the farmers of West Bengal, India. Int J Inj Contr Saf Promot 2014; 21: 205–215. [Medline] [CrossRef]
6. Curl CL, Spivak M, Phinney R, *et al*. Synthetic pesticides and health in vulnerable populations: agricultural workers. Curr Environ Health Rep 2020; 7: 13–29. [Medline] [CrossRef]
7. Jaacks LM, Diao N, Calafat AM, *et al*. Association of prenatal pesticide exposures with adverse pregnancy outcomes and stunting in rural Bangladesh. Environ Int 2019; 133(Pt B): 105243. [Medline] [CrossRef]
8. Jepson PC, Murray K, Bach O, *et al*. Selection of pesticides to reduce human and environmental health risks: a global guideline and minimum pesticides list. Lancet Planet Health 2020; 4: e56–e63. [Medline] [CrossRef]
9. The Lancet. Phasing out harmful use of pesticides. Lancet 2017; 389: 1076. [CrossRef]
10. Adachi S, Sawaki J, Tokuda N, *et al*. Japan Environment and Children’s Study Group. Paternal occupational exposure to chemicals and secondary sex ratio: results from the Japan Environment and Children’s Study. Lancet Planet Health 2019; 3: e529–e538. [Medline] [CrossRef]
11. National Institute of Statistics, Directorate General for Health, ICF International. Demographic and Health Survey 2014. https://dhsprogram.com/pubs/pdf/FR312/FR312.pdf. Published September 2015. (Accessed Feb. 25, 2021)
12. National Institute of Statistics, Ministry of Agriculture, Forestry and Fisheries. Census of Agriculture in Cambodia 2013. National Report on Final Census Results. http://www.fao.org/fileadmin/templates/ess/ess_test_folder/World_Census_Agriculture/Country_info_2010/Reports/Reports_5/KHM_ENG_REP_2013.pdf. Published December 2015. (Accessed Feb. 25, 2021)
13. Schreinemachers P, Chen HP, Nguyen TTL, *et al*. Too much to handle? Pesticide dependence of smallholder vegetable farmers in Southeast Asia. Sci Total Environ 2017; 593-594: 470–477. [Medline] [CrossRef]
14. Steinholt M, Xu S, Ha SO, *et al*. Serum concentrations of selected organochlorines in pregnant women and associations with pregnancy outcomes. A cross-sectional study from two rural settings in Cambodia. Int J Environ Res Public Health 2020; 17: 7652. [Medline] [CrossRef]
15. Kobashi Y, Saeki K, Tsubokura M, *et al*. Surgical symptomatic knowledge among medical staff and community health workers in rural Cambodia: a descriptive study for workforce improvement. J Rural Med 2020; 15: 57–62. [Medline] [CrossRef]
16. Zhang X, Zhao W, Jing R, *et al*. Work-related pesticide poisoning among farmers in two villages of Southern China: a cross-sectional survey. BMC Public Health 2011; 11: 429. [Medline] [CrossRef]