

# Determinants, Health-Related Morbidities, And Training Needs Among Farmers Using Pesticides In Southern Punjab, Pakistan: A Cross-Sectional Survey

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## Abstract

**Objective:** To assess the health of farmers exposed to pesticides and identify factors associated with the use of personal protective equipment.

**Methods:** This cross-sectional survey was carried out using convenience sampling among 302 farmers in two districts of Punjab in 2021 through an interview-administered questionnaire. The questionnaire covered demographics, information on pesticide exposure, knowledge of PPE use, and self-reported health symptoms. All male pesticide sprayers, regardless of age or socioeconomic condition were included. Asthmatic farmers and non-pesticide applicators were excluded. Spraying by minors under the legal age for employment was also excluded from the study. Data was analysed using SPSS version 23. Frequency tabulation and association between variables were seen using the Chi-square test.  $P < 0.05$  is considered as statistically significant. All ethical issues were taken into consideration.

**Results:** The mean age of the respondents was  $29.85 \pm 10.68$  years. Most farmers, 168 (55.6%), sprayed pesticides for at least an hour every evening. Liquid pesticides were commonly used by 290 (96.0%) in quantities of up to 20 litres and applied by hand by 265 (88%). The most frequent symptoms were irritation of the eye, nose, and throat, reported by 202 (67%). The farmers used coveralls, 216 (71.5%); face masks, 176 (58.4%); eye goggles, 53 (17.4%); face shields, 26 (8.7%); and aprons, 9 (3.1%). Age, duration, amount of pesticide sprayed, and application method predicted health risks ( $p < 0.05$ ).

**Conclusion:** The study revealed a notable lack of awareness among farmers regarding pesticide spray frequency, quantity, and PPE use. The findings provide valuable insights for policymakers, healthcare professionals and agricultural workers to provide professional training for enhancing the knowledge and practices of farmer's safety and health of pesticide exposure.

**Keywords:** Pesticides, Farmers, Personal Protective Equipment, Pakistan

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## Introduction

Pesticides are any substance or a mixture of substances intended to prevent, destroy, repel, or mitigate pests. These include insecticides, rodenticides, herbicides, fungicides, biocides, and similar

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substances <sup>1</sup>. Modern agriculture relies heavily on pesticides to manage weeds, pests, and hazardous organisms in crops. This results in increased agricultural output, decreased harvest loss, and ultimately, increased food availability<sup>2</sup>.

Pesticide use among farmers has increased many folds globally, with an estimated three billion kg of pesticides applied annually, resulting in approximately 3 million cases of pesticide poisoning and 2.2 million deaths, with a significant annual increase in developing countries<sup>3</sup>.

Pakistan ranks second among South Asian countries in overall pesticide consumption, with pre

dominant use in agriculture, and its use by Pakistani farmers has tripled in recent years<sup>4, 5</sup>. In Pakistan, agricultural activities employ 42.5% of the rural population, with Punjab accounting for 88.3% of pesticide applications<sup>2, 4</sup>. More than 10,000 farmers in Pakistan's cotton-growing regions suffer from health problems as a result of incorrect and indiscriminate use of pesticides. The majority of pesticides (54.7%) were classified as moderately hazardous, but a significant portion (23.3%) were classified as highly hazardous<sup>6</sup>. In many developing countries, including Pakistan, indiscriminate use of agricultural pesticides has resulted in serious health risks.

Different factors are responsible for pesticide exposure to farmers; most are unknown to them<sup>7</sup>. They also lack pesticide training and the use of personal protective equipment (PPE)<sup>2, 8</sup>. Pesticide companies sell their products without providing farmers with adequate training. According to a study conducted in Pakistan, only 16.0% of farmers have pesticide training, and only 13.0% have access to necessary knowledge<sup>4</sup>. Health problems are more commonly associated with a lack of pesticide training<sup>9</sup> and improper pesticide application methods<sup>10</sup>.

Farmers experience health symptoms because of inadvertent pesticide exposure at various stages, from the time they receive it, mix it, and apply it to the crops<sup>11, 12</sup>. Farmers do not use gloves, masks, overalls, respirators, or other personal protective equipment (PPE) during pesticide preparation and application<sup>13</sup>. These hazardous practices lead to substantial health risks for farmers<sup>14</sup>. Hence, this study assesses the current health status of farmers exposed to pesticides and identifies the factors associated with the use of personal protective equipment (PPE) in two districts of southern Punjab, Pakistan.

### Methodology

This cross-sectional study was conducted in two districts situated in southern Punjab during the year 2021. These areas of Punjab were selected because of the high pesticide consumption (88.3%) among all other provinces<sup>6</sup>.

After approval from the Ethics Review Committee of Hamdard College of Medicine & Dentistry (ERC No. HCMD/375/2020), the sample size of 292 was calculated based on the approximate prevalence of 26%<sup>4</sup> at 95% confidence interval (CI) with 0.05 bound error using Raosoft® calculator<sup>15</sup>. Using a nonprobability convenience sample, 302 male farmers were recruited. All individuals who were approached gave their consent to participate in the study. As pesticide spraying is a male-dominated occupation throughout Pakistan, this study included all male farmers engaged in pesticide spraying, regardless of age or socioeconomic status. Farmers with chronic respiratory conditions such as asthma and those who were not directly involved in pesticide application were excluded. Minors who participated in any aspect of spraying activities while being under the legal age for employment were also not included in the study. An interview-based questionnaire was designed to gather data after a review of the relevant literature<sup>12, 16, 17</sup>. After explaining the objectives of the study to the participants, trained health personnel administered the questionnaire under the supervision of the principal investigator. Participation in the survey was regarded as providing verbal informed consent.

The questionnaire included sociodemographic variables, such as age, marital status, level of education, and pesticide use. Questions regarding handling, spraying, and precautions required when applying pesticides were included. Questions regarding pesticide-related symptoms were added. A participant's self-reported identification and presence of single or multiple adverse symptoms due to pesticide exposure were considered positive. The questionnaire was piloted with five farmers and adjustments were made based on their responses.

The data were analysed using the Statistical Package for the Social Sciences (SPSS) version 23 (IBM, New York). Descriptive data are expressed as frequencies and percentages for categorical variables and as mean and SD for continuous variables. The chi-square test was used to identify associations among the variables and multiple logistic regression analysis was used to determine

the significant predictors of health risk at the 5% significance level ( $p < 0.05$ ).

### Results

A total of 302 farmers completed the questionnaires. The mean age of the respondents was  $29.85 \pm 10.68$  years, and 59% ( $n=178$ ) of them were  $\geq 25$  years old. Additionally, 69.5% ( $n=210$ ) of the respondents were either illiterate or had primary education. A large percentage of farmers, 96% ( $n=290$ ), used liquid pesticides. Furthermore, 82% ( $n=246$ ) of them sprayed  $\leq 20$  litres per acre, and 87.7% ( $n=265$ ) applied pesticides by hand. Only 12.3% ( $n=37$ ) of the respondents used tractors for spraying pesticides. The findings revealed no significant association between the nature of work for spraying and the time spent for spraying. (Table 1).

Eye irritation, general malaise, nausea, coughing, burning, stinging, itching, rashes, and blistering of the skin were commonly reported symptoms among the respondents.

Multiple logistic regression analysis was performed to adjust for various factors, assess confounding factors, and create biologically meaningful and parsimonious models. All independent variables with  $p$ -value  $< 0.05$  were included in the model. The final model included the age of the respondent, the number of sessions per day, the amount of pesticide sprayed, and the method of administration.

The method of application was significantly associated with health risks. This increased the likelihood of risks to farmers' health by 3.07 times [AOR: 3.07; 95% CI (1.223-7.495)] while adjusting other variables in the model. Farmers' age was also significantly associated with health risks. After adjusting for other variables in the model, respondents aged  $> 25$  years reported more symptoms as compared to those who were  $\leq 25$  years (68.8% vs 31.2%,  $p < 0.001$ ). They were 1.9 times more likely to be ill-health than farmers with spray duration of 2 sessions  $\leq$  per day [AOR: 1.98; 95% CI (0.817-4.838)]. (Table 2)

The possession and use of PPE were not congruent; many farmers, even if they possessed protective equipment, did not use it regularly (Table 3).

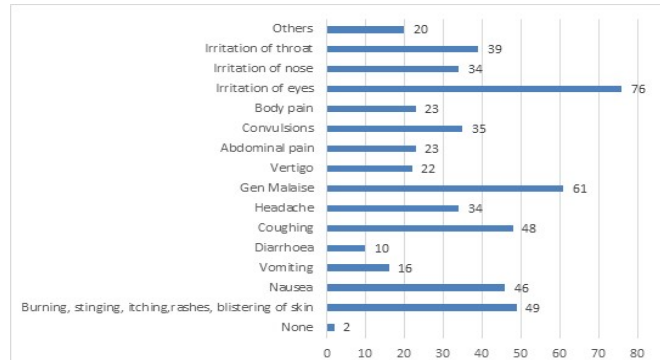


Fig 1. Frequency of individual symptoms reported by farmers using pesticides in southern Punjab

Table 1. Sociodemographic factors and frequency of health symptoms among farmers in southern Punjab, Pakistan

Characteristics	Frequency n%	Positive Symptomsn (%)	p-value*
<b>Age (in years)</b>			
> 25	124 (41.1)	69 (31.2)	< 0.001
>=25	178 (58.9)	152 (68.8)	
<b>Education level</b>			
Illiterate	113 (37.4)	78 (35.3)	0.082
Primary	97 (32.1)	68 (30.8)	
Middle	55 (18.2)	41 (18.6)	
Matric	33 (10.9)	30 (13.6)	
Only Quranic education	4 (1.3)	4 (1.8)	
<b>Nature of work for spraying</b>			
Mixing	17 (5.6)	14 (6.3)	0.379
Spraying	31 (10.3)	20 (9.0)	
Both	254 (84.1)	187 (84.6)	
<b>Time of spraying</b>			
Morning	125 (41.4)	99 (44.8)	0.014
Afternoon	9 (3.0)	9 (4.1)	
Evening	168 (55.6)	113 (51.1)	
<b>Sessions per day</b>			
> 2 session per day	248 (82.1)	194 (87.8)	< 0.001
>= 2 session per day	54 (17.9)	27 (12.2)	
<b>Amount of pesticide sprayed</b>			
>20 litres per acre	246 (81.5)	169 (76.5)	< 0.001
>= 20 litres per acre	56 (18.5)	52 (23.5)	
<b>Time spent for spraying</b>			
> 15 minutes	245 (81.1)	175 (79.2)	0.155
>=15 minutes -1 hour	57 (18.9)	46 (20.8)	
<b>Method of application</b>			
By hand	265 (87.7)	184 (83.3)	< 0.001
By Tractor	37 (12.3)	37 (16.7)	
<b>Form of pesticides</b>			
Liquid	290 (96.0)	209 (94.6)	0.032
Solid Pellets	12 (4.0)	12 (5.4)	

\* Chi-square was used as a test of significance.

**Table 2.** Multiple Logistic Regression Analysis of pesticides exposure and associated factors for health symptoms among farmers in southern Punjab, Pakistan

Characteristics	$\beta$	AOR (95% CI)	p-value*
Age (years)	≤ 25	0.411 (0.220-0.766)	< 0.005*
	> 25	Reference	
Duration of spray (Sessions per day)	≤ 2 sessions per day	1.989 (0.817-4.838)	0.130
	> 2 sessions per day	Reference	
Amount pesticide spray (litres)	≤ 20 litres	0.299 (0.140-0.640)	< 0.002*
	> 20 litres	Reference	
Method of administration	By hand	3.027 (1.223-7.495)	< 0.017*
	By tractor	Reference	

$\beta$ ; regression coefficient, OR: odds ratio, CI: Confidence Interval

\*All variables whose p-value was <0.05 were considered as significant for multivariable analysis

**Table 3.** Availability and use of safety tools among farmers in Pakistan

Safety tools	Availability n(%)	Utilization n(%)
Coverall	235 (77.8)	168 (71.5)
Face masks	89 (29.5)	52 (58.4)
Hand gloves	58 (19.2)	20 (34.5)
Eye goggles	46 (15.2)	8 (17.4)
Waterproof boots	23 (7.6)	2 (8.7)
Face shield	46 (15.2)	4 (8.7)
Aprons	32 (10.6)	1 (3.1)

## Discussion

This study provided information on the current state of pesticide safety practices, factors influencing the use of various protective measures, and symptoms of illness among farmers. The majority of survey respondents were indigenous males aged 19–30 years. Only about half of the farmers had completed elementary school (up to five years of schooling) or secondary school (up to eight years of schooling). Farmers who were older and used more pesticides experienced more severe symptoms. Farmers who sprayed tractors twice daily had fewer symptoms.

Our research revealed that an increase in pesticide use is significantly associated with an increase in harmful effects. This is consistent with research from Ghana and Iran<sup>8, 18</sup> and could be due to failure to use the appropriate amount of pesticides.

The most prevalent illnesses among farmers in both districts were related to the eye, respiratory system, digestive system, and skin. This is consistent with previous studies from Pakistan<sup>9, 19</sup> and other regions<sup>20, 21</sup>. Farmers were more likely to have eye and dermatological problems, and 4.6% had convulsions. Wearing the same clothes to work and not washing their faces and eyes after spraying can increase the risk of developing eye and skin conditions. Pesticides can quickly enter the body through the skin and lungs, wreaking havoc on the respiratory system<sup>22</sup>. Our results are consistent with previous investigations<sup>15</sup>, and other developing countries, such as Kenya, and Ghana<sup>18</sup> that reported a lack of PPE use.

This finding emphasizes the need for agricultural department employees to assist and motivate farmers to use advanced spraying techniques. According to the findings of the study, 96% of farmers used pesticides in liquid form and 87.7% applied pesticides by hand. Gloves and face masks are not commonly used for mixing and applying insecticides. One reason for this low use of PPE could be that it causes them to sweat and feel tired, especially in hot weather, which makes compliance more difficult. Consequently, farmers frequently suffer from both acute and chronic pesticide poisoning. It is clear that farmers do not perceive the risks associated with pesticide noncompliance. One of the key indicators of awareness and behavioural changes among farmers is their educational background. Farmers with limited formal education may be more vulnerable to pesticide toxicity.

According to our findings, 97% of the farmers sprayed pesticides in the morning or late afternoon. This finding is consistent with the results of another study<sup>10</sup>. One possible explanation for selecting these times is that the majority of pests emerge on

farmland during these two hours and mist amplifies pesticide spread during these hours. The ambient temperature rises in the afternoon, causing more sweating and increasing the risk of skin poisoning. This indicates that farmers in these two districts are well informed about the best time to spray pesticides to optimize crop yield while lowering dermal exposure and health effects.

Our findings are consistent with studies conducted in other countries where nearly 80% of farmers had never received pesticide training from agricultural experts<sup>2,23,24</sup>. According to studies conducted in Pakistan and Ethiopia, more than 80% of farmers had never received pesticide training from agricultural experts<sup>2</sup>. It is critical that extension officers receive ongoing training on new and emerging pest management issues as well as safe pesticide use. Our study has some limitations, even though the sample size was adequate and a structured pretested questionnaire was used. We conducted this research in two provinces of Punjab, Pakistan, and recruited easily accessible people. This may result in individuals with serious health conditions being overlooked. Self-reported symptoms, which may differ depending on individual perceptions, were also included. Therefore, the findings of this study cannot be extrapolated to other areas.

### **Conclusion**

The present study highlights that the majority of farmers in the two rural districts of Punjab, Pakistan suffer from pesticide-related health problems. Although they have a better understanding of the spraying time, the majority of them are unaware of mixing, pesticide application to crops, and spray duration. This highlights the importance of agricultural and/or health training for farmers. Conducting similar research in other provinces to ascertain the current usage, practices, and availability of farmer training facilities in Pakistan is recommended for policymakers.

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