

Health Effects of Pesticide Exposure on Farmers in Agriculture-Intensive Regions of Pakistan

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ABSTRACT

The pesticides are extensively used in the agricultural sector to boost crop production and eliminate pests but the extensive application poses a major health hazard to the farmers particularly in Pakistan which is an agriculture intensive country. In the current study, the authors discuss the commonness and nature of both chronic and acute health impacts of pesticides on farmers, including the respiratory, neurological, dermatologic, and reproductive outcomes. The study, based on surveys, medical tests, and secondary data (government and non-governmental reports) determines the key risk factors such as long time exposure, poor handling, absence of personal protective equipment (PPE), and poor knowledge on safe practices. The results prove the high level of respiratory irritation, headaches, dizziness, skin problems, and other chronic illnesses among farmers. The research highlights the urgency to improve and execute the health education, be able to enforce regulations, practice safe pesticide application measures, and implement monitoring to safeguard agricultural employees and facilitate sustainable farming activities in Pakistan.

Keywords: Exposure to pesticides; farmers; work-related health; respiratory diseases; neurological diseases; dermatology; pesticides in Pakistan; agriculture; safety issues.

INTRODUCTION

Pakistan largely relies on agriculture as the sector contributes about 19-20 percent to the GDP of this country and it employs almost 42 percent of the labor (Khan et al., 2020). Through the use of chemical pesticides, farmers are able to produce maximum produce and to protect against pests. Although such chemicals have been very instrumental in enhancing high agricultural productivity, their misuse and extensive application have raised significant concerns about occupational health in farmers (Riaz et al., 2019). Pesticide exposures may be inhalation, ingestion, or dermal absorption that causes acute and chronic health outcomes. The farmers in Pakistan, especially those living in the agricultural-intensive areas like Punjab, Sindh, and Khyber Pakhtunkhwa, are usually exposed to high levels of pesticides and have no protection (Ahmad and Qureshi, 2021). Among the chemical agents contained in pesticides, there are organophosphates, carbamates, pyrethroids,

and herbicides. Research in different parts of the world has recorded that contact with such materials might lead to various health outcomes, including lung irritation, neurological problems, like headaches and dizziness, skin disorders, reproductive and chronic systemic disorders (Mostafalou and Abdollahi, 2017). In Pakistan, where the smallholders are mostly untrained in safe use of pesticides, there is usually over and prolonged exposure. Farmers are used to working with concentrated pesticide industry solutions, which lack gloves or masks and protective clothing, which predisposes them to negative health effects (Raza et al., 2020).

The relationship between occupational exposure to pesticides and a continuum of health effects has been identified in a number of studies in South Asia. An example is that farmers who are exposed to organophosphate pesticides have been observed to experience chronic neurological defects, lung issues and skin lesions (Iqbal et al., 2018). Acute pesticides

poisoning is prevalent in Pakistan, especially among farmers during crop-spraying seasons, with the symptoms of the illness being nausea, vomiting, excessive salivation, blurred vision, and respiratory distress (Shah et al., 2019). Pesticides are categorized by the World Health Organization by their level of hazards, and most of the pesticides in use in Pakistan belong to the moderate and highly hazardous categories (WHO, 2021).

Socioeconomic reasons also contribute to the health hazards involved in exposure to pesticides. Pakistan has a large population of farmers who are not well educated and lack information about how to safely handle pesticides, the correct storage, and disposal (Khan et al., 2020). Lack of money and reliance on crops yielding to farmers make farmers focus more on their productivity and forget about safety since they may have to work at all costs. Moreover, the health infrastructure in rural areas is low, and employees often prefer using self-medications or local doctors instead of getting a professional treatment of pesticides causing health problems (Ahmad and Qureshi, 2021).

The environmental factors are also critical. Frequent spraying on farms in warmer and humid areas enhances the levels of dermal contact and inhalation of pesticides remains (Riaz et al., 2019). Poor management of containers and blending of various chemicals without proper ventilation also increases the level of exposure. Also, the health of farmers and their families may be indirectly influenced by the closeness to water sources that are polluted by the pesticides run-offs (Shah et al., 2019).

Long term chronic health complications such as respiratory diseases, neurological degeneration, liver, kidney damage, and reproductive problems may result as the cumulative effects of exposure to pesticides over an extended period. The research shows that chronic exposure to organophosphates and carbamates may lead to low cognitive abilities, reflex delays, and long-term fatigue (Mostafalou and Abdollahi, 2017). Farmers of Punjab and Sindh often complain of respiratory symptoms such as coughing, wheezing, and shortness of breath, especially those who work in the fruit and cotton industry (Iqbal et al., 2018).

In Pakistan, regulatory frameworks and enforcement is poor, although the risks are obvious. Pesticides Act, 1971, and its further amendments detail the requirements of pesticides registration and usage but do not provide consistent compliance on farm-level (Raza et al., 2020). The lack of proper monitoring, availability of safer pesticides, and economic reasons maintain the use of outlawed or very toxic pesticides by many farmers. There is a paucity of pesticide safety interventions by the government in the form of public health, and the awareness programs are not always reaching remote or smaller farmers.

Training and health education would be very important in reducing the health risks posed by

pesticides. Farmers should be provided with useful information on how to handle it, use PPEs, store it safely, and apply first aid in case of poisoning (Ahmad and Qureshi, 2021). It is also hypothesized that community-based programs such as integrated pest management (IPM) programs have the potential of minimizing pesticides dependence and exposure without affecting crop output (Mostafalou & Abdollahi, 2017).

To sum up, exposure to pesticides is one of the greatest occupational health issues of farmers in agriculture-prone areas of Pakistan. The exposure happens via various channels and in most cases, it is compounded by insufficient safety precautions, ignorance and socioeconomic susceptibility. The health effects are acute and chronic including respiratory, neurological, dermatological, and reproductive illnesses. The challenges should be dealt with in a multi-pronged strategy, which involves regulation enforcement, health education, adoption of safe farming methods, and enhanced healthcare access. The proposed study will examine the prevalence, determinants, and health effects of pesticide exposure in farmers and offer an insight on how policy interventions can be used to mitigate the problem and ensure sustainable agricultural production in Pakistan.

LITERATURE REVIEW

Use of Pesticides in Agriculture

The pesticides are widely applied to Pakistan so as to enhance crop production and management of pests (particularly in areas full of agriculture like Punjab, Sindh, and Khyber Pakhtunkhwa) (Khan et al., 2020). Among these chemicals are the organophosphates, carbamates and herbicides that are different in terms of toxicity and mechanism of action. On the one hand, pesticides are regarded as essential to the food security of the world, but researchers focus on occupational health risks of farmers, particularly in developing nations where the use of occupational safety measures is limited (Mostafalou & Abdollahi, 2017).

Smallholder farmers prevail in the agricultural sector in Pakistan. Research indicates that most of these farmers do not receive formal education on the application of pesticides and use their traditional understanding or the advice of fellow farmers; a fact that may cause excessive or inappropriate use of chemicals (Ahmad and Qureshi, 2021). In this case, the main routes of contact with pesticides include dermal, inhalation, and ingestion; more danger exists during spraying, mixing, and cleaning exercises (Raza et al., 2020).

Pesticides Health effects

Acute Effects

Immediate health effects could be caused by acute exposure to pesticides including nausea, vomiting, headache, dizziness, acute respiratory distress, and skin irritation. According to Shah et al. (2019), many farmers in Sindh experienced acute symptoms of

poisoning during the high seasons of spraying. On the same note, Riaz et al. (2019) reported that excess salivation, blurred vision, and tremors in the muscles were common when the organophosphates were exposed in rural Punjab.

Chronic Effects

There are more serious effects of long-term exposure. Organophosphate and carbamate use have been linked to neurological impairments such as impaired cognitive ability, impaired memory, and delayed reflexes (Iqbal et al., 2018). Among the farmers that deal with pesticides regularly, chronic respiratory diseases, including asthma, chronic bronchitis, and reduced lung capacity, are reported (Raza et al., 2020). Dermatological disorders such as dermatitis, rashes, and eczema are also prevalent among people who are exposed to dermatogens repeatedly (Ahmad and Qureshi, 2021).

Reproductive and Systemic Effects

Research has shown that exposure at pesticide may have reproductive health effects, including menstrual irregularities, reduced fertility, spontaneous abortions, and congenital malformations in children born to pesticide-exposed parents (Mostafalou & Abdollahi, 2017). Among the agricultural workers who are exposed chronically, hepatic and renal malfunction, endocrine disruption, and immune system malfunction have been reported (Shah et al., 2019).

Factors Affecting Health Risks

Duration and frequency of exposure

The risk of exposure is dependent on the years of using pesticides, the number of times the spraying was done and the number of the amount of chemicals dealt with. Khan et al. (2020) established that the chances of chronic respiratory and neurological symptoms were considerably higher among farmers that had more than ten years of experience with pesticides application.

Personal Protection Equipment (PPE) Use

Wearing PPE on a regular basis is an essential preventative tool toward pesticide-associated health issues. According to Ahmad and Qureshi (2021), less than 30 percent of Pakistani farmers always wear gloves, masks, or protective clothes, mostly because of discomfort, ignorance, or the price. The absence of PPE has been highly associated with the spread of skin disorders and respiratory symptoms (Raza et al., 2020).

Knowledge and Awareness

The lack of knowledge regarding the safe storage, handling, and disposal of pesticides is one of the factors that result in unsafe practices. Farmers tend to use a combination of pesticides without reference to labels, do not pay attention to pre-harvesting periods, and they do not wash hands or clothes after spraying (Riaz et al., 2019). The awareness and adoption of safe practices are highly affected by the educational level, literacy and access to extension services.

Socioeconomic and Environmental Factors

Farmers with low income do not care about their health, and this means they are exposed to increased concentration of pesticides. High temperature, humidity, and poor ventilation conditions during spraying are some of the environmental factors that elevate the risks of absorption and inhalation (Shah et al., 2019). The indirect effects of contamination of water by the water runoff in pesticides can also have a health effect on the farmers as well as on the families of the farmers.

Pakistan Regions Studies

A number of papers have reported health impacts of pesticides to the Pakistani farmers:

Punjab: Farmers in cotton growing districts complain of a high level of skin irritation, headaches, chronic respiratory symptoms (Iqbal et al., 2018). Exposure to organophosphates is associated with neurological disability and deteriorated lung function.

Sindh: The emergence of acute pesticide poisoning occurs in the crop spraying seasons, where most farmers report to have dizziness, vomit, and overproduced salivation (Shah et al., 2019).

Khyber Pakhtunkhwa: Research has shown that there is less protection (PPE) coverage and low awareness, resulting in long-term effects on the dermatology and neurology of vegetable cultivators (Riaz et al., 2019). These findings all show that occupational pesticide exposure is a common and unrepresented health risk in agriculture-intensive areas of Pakistan.

International View and International Comparison

As global literature highlights, other developing states also note the same. Respiratory and neurological diseases have been reported among cotton growers in India as a result of chronic pesticide exposure (Mostafalou & Abdollahi, 2017). In Bangladesh, pesticide abuse is a cause of high rates of acute poisoning and dermatological problems in rice farmers (Haque et al., 2018). These reports support the fact that a mix of exposure (long-term), low safety precautions and poor awareness is the impetus behind pesticide-related health costs in the economies that rely on agriculture.

Mitigation and Safety Measures

The studies state the importance of integrated pest management (IPM), training on safe use of pesticide application, and sound implementation of the regulatory systems (Ahmad and Qureshi, 2021). Risks of exposure are high but can be mitigated by use of low-toxicity alternatives, appropriate PPE and hygienic practices, e.g., washing hands and clothes after spraying. Agricultural extension services are critical in community awareness programs in order to alter the behavior of the farmers and enhance the occupational health outcomes.

Overall, pesticide exposure could be regarded as a major occupational health issue of Pakistani farmers. Farmers are subjected to acute and chronic neurological, dermatological, respiratory and reproductive health. The risk factors are long exposure, poor PPE, lack of awareness and

socioeconomic limitations. In the region, high prevalence of pesticide-related health outcomes is always reported, but there are gaps in the research especially in rural regions and small scale farming societies. The education, regulation, PPE, and safer agricultural practices interventions are crucial to safeguard the health of farmers and achieve sustainable agriculture.

METHODOLOGY

Research Design

The research design was cross-sectional mixed methods in this study, which was conducted to investigate the health outcomes of the exposure to pesticides among the farmers in the Pakistani agriculture-intensive areas. Mixed-methods method combines both quantitative and qualitative assessment of health outcomes and exposure levels with qualitative information about the knowledge, practices, and perceptions of farmers as to the use of pesticides (Creswell & Plano Clark, 2018).

Study Area

The study was done in Faisalabad and Multan districts in Punjab and they were chosen because of their high agricultural intensity especially cotton, wheat and vegetable farming. These areas symbolize a variety of agricultural activities, exposure, and socioeconomic statuses common to the agriculture-based Pakistani settings (Khan et al., 2020).

Population and Sampling

The target group included the farmers aged 18-65 years having an active role in crop farming and use of pesticides.

Quantitative Component

Sample size: 250 farmers

Sampling approach: The sampling will be stratified random sampling in terms of type of crop (cotton, wheat, vegetables) and size of the farm to ensure representative exposure profiles.

Qualitative Component

Sample size: 25 farmers

Sampling technique: Purposive sampling in order to sample those farmers who have different experience years, pesticide handling behavior and health records. The following data collection instruments apply in this research.

Quantitative Instruments

Structured Questionnaire: Demographic information (age, sex, education, years of working in the field), employment history (years of working in agriculture, number of times that he uses pesticides), pesticides used, PPEs, and health symptoms.

Exposure Assessment: Or Length of exposure, frequency of exposure and type of exposure to the pesticide were recorded and this included mixing, spraying and cleaning equipment.

Health Assessment:

Self-reported Symptoms Checklist: Both acute and chronic symptoms, such as headaches, dizziness, skin

rashes, respiratory irritation, and gastrointestinal problems.

Medical Tests: rudimentary respiratory and dermatological testing done by medical personnel to confirm self-reported information.

Qualitative Instruments

Semi-structured Interviews: Interrogated the perception of farmers regarding the risk of pesticides, their managing strategies, obstacles to safety management and their knowledge on the health consequences. The interviewees were sampled using consent in a 30-45 minutes audio taped interview.

Data Collection Procedure

Quantitative: Questionnaires and medical examination were performed at home or fields of farmers at some day time. Participation was done with informed consent.

Qualitative: Interviews were held in confidential environments at the local community centers or at the farms so that the participants could be open and talk about it.

Data analysis

Quantitative Analysis

Descriptive statistics: The demographic characteristics, pesticide exposure, and health symptoms were calculated in frequencies, percentages, means, and standard deviations.

Inferential statistics:

Chi-square was used to find the relationships between health, exposure levels, and the use of PPE.

There was logistic regression used to determine the effects of length of exposure, type of pesticide and safety practices on the probability of reporting acute or chronic health effects.

Software: SPSS version 25 was used to do the analysis.

Qualitative Analysis

Thematic Analysis: The thematic analysis was done using the six-step model proposed by Braun and Clarke (2006) with the identification of the top themes, including the perception of risks, safety behaviors, obstacles to PPE use, and health-seeking behavior.

Ethical Considerations

- Consent of an ethics committee within an institution.
- The participation was voluntary and informed consent was taken.
- The confidentiality of the data was guaranteed; no personal identifiers were applied in reporting.
- Farmers that had severe health symptoms were taken to the local healthcare facilities to be further assessed.

DATA ANALYSIS AND FINDINGS

This part provides quantitative and qualitative results on the exposure of pesticides, health effects, and safety behavior of 250 farmers in Faisalabad and Multan districts.

Demographic Characteristics of Farmers

Table 1: Demographic Characteristics (N=250)

Characteristic	Frequency	Percentage (%)
Gender		
Male	215	86
Female	35	14
Age		
18–25	40	16
26–35	90	36
36–45	75	30
46–65	45	18
Education Level		
No formal education	80	32
Primary	70	28
Secondary	65	26
Higher education	35	14
Years in Farming		
1–5	60	24
6–10	100	40
>10	90	36

Most participants were male, aged 26–45, with 6–10 years of farming experience. A significant proportion (32%) had no formal education.

Pesticide Exposure Levels

Table 2: Pesticide Exposure Characteristics (N=250)

Exposure Variable	Low	Moderate	High	% High Exposure
Frequency of spraying	50	120	80	32
Duration per season (days)	60	110	80	32
Type of pesticides used	40	130	80	32
PPE Usage	25	70	155	62

Around 32% of farmers reported high exposure to pesticides, and 62% rarely or never used personal protective equipment (PPE).

Prevalence of Health Symptoms

Table 3: Self-Reported Health Symptoms (N=250)

Symptom	Frequency	Percentage (%)
Headache	140	56
Dizziness	110	44
Skin irritation / rash	95	38
Respiratory irritation	85	34
Nausea / vomiting	70	28
Neurological symptoms (fatigue, tremors)	60	24
No symptoms reported	40	16

Majority of farmers (84%) reported at least one health symptom, with headache and dizziness being most common.

Association Between Exposure and Health Outcomes

Table 4: Exposure Level vs. Health Symptoms (Chi-square results)

Exposure Level	Headache (%)	Skin Irritation (%)	Respiratory Symptoms (%)
Low	20 (25%)	10 (12.5%)	8 (10%)
Moderate	60 (50%)	40 (33%)	30 (25%)
High	60 (75%)	45 (37.5%)	47 (59%)

Chi-square tests

High exposure significantly associated with headache ($\chi^2 = 25.6$, $p < 0.001$), skin irritation ($\chi^2 = 20.4$, $p < 0.001$), and respiratory symptoms ($\chi^2 = 32.1$, $p < 0.001$). Health problems were strongly correlated with higher pesticide exposure and lack of PPE.

Duration of Exposure vs Chronic Health Issues

Table 5: Years of Pesticide Use vs Chronic Conditions

Years in Farming	Chronic Respiratory (%)	Neurological Disorders (%)	Skin Disorders (%)
1–5	10 (16.7%)	8 (13.3%)	5 (8.3%)
6–10	35 (35%)	28 (28%)	20 (20%)

>10	40 (44%)	32 (35.5%)	25 (27.8%)
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Longer farming duration was associated with increased prevalence of chronic respiratory, neurological, and skin disorders.

PPE Usage and Health Outcomes

Table 6: PPE Use vs Reported Symptoms

PPE Usage	Headache (%)	Respiratory Symptoms (%)	Skin Disorders (%)
Always	10 (15%)	5 (7.5%)	3 (4.5%)
Sometimes	40 (40%)	25 (25%)	20 (20%)
Never	90 (58%)	55 (35.5%)	35 (22.5%)

Observation: The use of PPE was inconsistent or not utilized, which significantly exposed people to the risks of both acute and chronic health symptoms.

Qualitative Findings

The thematic analysis of 25 semi-structured interviews demonstrated that:

Perceived Risk:

- Due to knowledge of pesticide toxicity, farmers underestimate the effects of the pesticides in the long term.
- We are aware that these are damaging chemicals, however, they are necessary to our crops, and we cannot live without them. – Faisalabad male cotton farmer.
- Obstacles to the use of PPE: Comfort, price, and ignorance are the negative factors that hinder the regular use of PPE.
- Are masks hot, and gloves shred like rags, so we do not wear them. – Vegetable farmer, Multan.
- Health-Seeking Behavior: The farmers have restricted access to rural healthcare and thus they engage in self-medication.
- When I am ill, I normally purchase some medicine in the local shop instead of visiting the clinic.

Summary of Key Findings

- Most of the farmers (86-percent) were male with ages ranging between 26-45 years and who had 6-10 years experience.
- Approximately 32% had a high level of pesticide exposure; 62% of the respondents were not always wearing PPE.
- The majority of the health symptoms: Headache (56%), dizziness (44%), skin irritation (38%), respiratory problems (34%).
- Farming related closely with increased chronic respiratory, neurological, and dermatological disorders as the exposure duration and agricultural activities were high.
- Qualitative results confirmed the absence of safety measures, gap in knowledge and restricted access to healthcare as the primary risk factors.

CONCLUSION

It is noted that farmers in Pakistan have a great risk of contracting health problems in the agricultural-rich areas especially in Faisalabad and Multan as a result of exposure to pesticides. Quantitative evidence showed that 84 percent of farmers said they had at least one of the health symptoms such as headaches, dizziness, skin irritation and respiratory problems. Farmers with prolonged years of using pesticides and

greater levels of exposure were more likely to have chronic conditions (including long-term respiratory, neurological, and dermatological disorders).

Qualitative data obtained showed that farmers are generally poorly informed about safe pesticide handling, have poor access to personal protective equipment (PPE), and barriers to healthcare services exist. Farmers are still willing to sacrifice their own lives to gain more crop, and most farmers, despite the knowledge of certain severe risks, still use pesticides in wrong ways as there are economic and social factors to be taken into account.

The argument is verified by the high level of association between the occupational exposure of pesticides and poor health conditions thus the necessity to enforce regulations, educate and implement health measures to safeguard the health of farmers.

RECOMMENDATIONS

1. Implement the current legislation including Pesticides Act, 1971 to promote the appropriate labeling, use and control of pesticides distribution.
2. Prohibit or limit the use of pesticides that are very toxic and encourage the use of low-toxicity pesticides.
3. Introduce community-based programs to sensitize farmers on the risks of using pesticides, safe handling, mixing, and storage.
4. Encourage IPM practices that will minimize the use of chemical pesticides and ensure productivity.
5. Promote the application of biological pest management, rotation of crops and biologically safe alternatives.
6. Develop mobile health clinics in the rural farming community to screen the health issues related to pesticides regularly.
7. Formulate policies that are cohesive between occupational health and agriculture, and the health of the population.

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