ORIGINAL ARTICLE

Occupational Exposure to Pesticides among Farmers in Rural–Tribal Gujarat: Assessment of Knowledge, Practices, and Self-Reported Health Effects

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ABSTRACT

Background: Farmers in rural and tribal regions of India are frequently exposed to pesticides during mixing, spraying, and handling activities. Exposure commonly occurs through dermal contact, inhalation, and accidental ingestion, which can lead to both acute and chronic health problems. The present study aimed to assess the knowledge, attitude, and practices (KAP) regarding pesticide use and its associated health effects among farmers among rural tribal district of India. **Methodology:** A community-based cross-sectional study was conducted among 170 farmers from selected villages of one of the tribal district of Gujarat. Farmers aged 18 years and above who had been using pesticides for at least one year were included. Data were collected using a pre-designed and pre-tested structured questionnaire covering socio-demographic characteristics, knowledge and attitudes regarding pesticide use, pesticide handling practices, and self-reported health effects. Descriptive statistics were used for analysis. **Results:** Although all participants were aware that pesticide exposure could cause health problems, only 48.8% were aware of protective measures and merely 5.3% had received formal training on pesticide handling. A large proportion (91.2%) reported not using PPE during spraying, and 84.7% stored pesticides inside their houses. Nearly all participants (97.6%) reported experiencing at least one health symptom following pesticide exposure, with skin irritation and eye irritation being the most commonly reported complaints. Despite this high prevalence of symptoms, only 5.9% sought medical care. **Conclusion:** The study reveals a substantial gap between awareness and safe pesticide practices among farmers in this rural–tribal population. Unsafe handling and limited use of protective measures contribute to a high burden of self-reported health problems.

KEYWORDS

Pesticide Exposure, Agricultural Workers, Awareness, Health Hazards, Pesticide Safety.

INTRODUCTION

Pesticides are widely used in Indian agriculture to improve crop yield and control pests and plant diseases. With increasing dependence on chemical pest control, occupational exposure among farmers has become a significant public health concern. In India, where a large proportion of the rural population depends on agriculture for livelihood, unsafe pesticide handling practices continue to pose serious health risks. (1) Exposure to pesticides occurs during mixing, spraying, storage, and disposal of containers. Farmers are exposed through dermal contact, inhalation of spray droplets, and accidental ingestion. Studies conducted in different parts of India, including Karnataka, West Bengal, Puducherry, and North India, have documented inadequate knowledge and unsafe practices related to pesticide use among farmers. (1-4). Despite general awareness that pesticides may be harmful, detailed knowledge regarding protective measures remains limited. Several Indian studies have reported poor use of personal protective equipment (PPE) during spraying and inadequate adherence to safety guidelines.(5,6) Additionally, biological studies among pesticide-exposed workers in India have demonstrated DNA damage and altered cholinesterase activity, indicating the potential long-term health impact of chronic exposure.(14) Health effects associated with pesticide exposure range from acute symptoms such as skin irritation, eye redness, headache, dizziness, and respiratory difficulty to long-term complications including neurological and hematological alterations. (1,7) International and Indian evidence suggests that repeated occupational exposure significantly increases the risk of both acute and chronic morbidity among agricultural workers. (8-10) Chhota

Udaipur district of Gujarat is predominantly rural and tribal, with agriculture as the main source of income. Limited access to structured training programs, financial constraints, and reliance on informal sources of information may further increase vulnerability to unsafe pesticide practices in such regions. However, region-specific data regarding farmers' knowledge, attitudes, and practices in tribal areas of Gujarat remain limited. Therefore, the present study was conducted to assess the knowledge, attitude, and practices related to pesticide use and its associated health effects among farmers of selected areas of one of the tribal district of Gujarat.

Aim: To study the knowledge and practice of pesticide usage among farmers of selected areas.

Objectives:

- To assess the knowledge of farmers regarding pesticides exposure in selected district.
- To study the practices followed by farmers in handling and applying pesticides.
- To study health effects on farmers after using pesticides.
- To evaluate farmers' attitudes toward pesticide safety and protective measures.

Material & Methods

A community-based cross-sectional study was conducted in selected villages of selected taluka of one of the tribal district of Gujarat, to assess the knowledge, attitudes, and practices (KAP) related to pesticide usage and the associated health effects among those farmers. The study population comprised farmers aged 18 years and above who were actively engaged in agricultural activities and had been using pesticides for at least one year. The study has been conducted in accordance with ethical guidelines, and approval was sought from relevant institutional review board.

Participants were selected using a purposive sampling technique. This sampling approach ensured the inclusion of farmers with direct and regular exposure to pesticides, which is commonly adopted in pesticide-related KAP studies among agricultural communities.

The sample size was calculated using the standard formula for cross-sectional studies, considering the expected prevalence of pesticide exposure–related health problems, a 95% confidence level, and an acceptable margin of error. Based on these parameters, the required sample size was determined to be 170 participants. (5,11)

Data were collected using a pre-designed, pre-tested, and structured questionnaire developed specifically for the study. The questionnaire included sections on socio-demographic characteristics, knowledge regarding pesticide use and health risks, attitudes toward pesticide safety measures, practices related to pesticide handling and application, and self-reported health effects experienced following pesticide exposure.

Prior to data collection, the purpose of the study was explained to all participants, and written informed consent was obtained. Participation was voluntary, and confidentiality of the information provided was strictly maintained. The collected data were entered into Microsoft Excel and analyzed using appropriate statistical software. Descriptive statistics were applied, and the results were presented as frequencies and percentages in tables and graphical formats.

Results

Table 1 presents the socio-demographic profile of the study participants. The majority of farmers belonged to the economically productive age group, with 36.5% in the 31–45 years age group and 31.8% in the 46–60 years age group. Male farmers constituted a predominant proportion (81.2%), reflecting male dominance in agricultural activities in the study area. With regard to education, 24.1% of the participants were illiterate, while 32.9% had primary education and 43.0% had secondary or higher education, indicating low to moderate educational attainment among farmers. Most participants had long-term involvement in agriculture, with 61.2% reporting 6–10 years of farming experience and 37.1% having more than 10 years of experience.

Table 1: Socio-demographic profile of the study participants

Variables	Frequency (n=170)	Percentage (%)
Age group (years)		
18–30	28	16.5
31–45	62	36.5
46–60	54	31.8
>60	26	15.2
Sex		
Male	138	81.2
Female	32	18.8
Education		
Illiterate	41	24.1
Primary	56	32.9
Secondary & above	73	43
Years of involvement in farming		
< 2 years	0	0
2–5 years	3	1.8
6–10 years	104	61.2
>10 years	63	37.1

Table 2 presents the knowledge regarding pesticide use and its health effects among the study participants. All farmers (100%) were aware that pesticide exposure can cause health problems. However, awareness regarding the need for protective measures during pesticide use was present in less than half of the participants (48.8%). Only a small proportion of farmers (5.3%) had received formal training on pesticide use and safety, while the majority (94.7%) had not received any such training. The most common sources of information regarding pesticide use were fellow farmers (72.4%), followed by government agricultural officers (58.2%) and pesticide company representatives (53.5%), indicating a high reliance on informal sources for pesticide-related knowledge.

Table 2: Knowledge regarding pesticide usage and health hazards

Knowledge on-	Frequency (n=170)	Percentage (%)
Aware that pesticide exposure can cause health problems	170	100
Aware about the need for protective measures during pesticide use	83	48.8
Received formal training on pesticide use and safety	9	5.3
Source of information regarding pesticide use*		
Government agricultural officers	99	58.2
Fellow farmers	123	72.4
Pesticide company representatives	91	53.5
Online / social media	20	11.8
No specific source	4	2.4

** Multiple responses accepted*

Table 3 shows that the majority of farmers had a positive attitude toward pesticide safety measures. A total of 84.7% believed that personal protective equipment (PPE) is necessary during spraying, and 97.6% expressed willingness to use protective equipment regularly. Most participants (95.9%) felt that government training is required for safe pesticide use. Additionally, 74.7% believed in reading instructions before use, 67.1% recognized long-term health effects, and 90% supported the use of safer alternative pesticides.

Table 3: Attitude toward pesticide safety measures

Attitude towards*	Frequency n =170	(%)
Believe that PPE is necessary during spraying	144	84.7%
Believe that Govt. training is required for safe pesticide usage	163	95.9%
Believe in reading and following instructions before usage	127	74.7%
Believe in long-term health effects of pesticide usage	114	67.1%
Believe in use of alternative safer pesticides	153	90%
Willingness to use protective equipment regularly	166	97.6%

** Multiple responses accepted*

Table 4 presents the practices related to pesticide handling and application among the study participants. Most farmers mixed pesticides using a pipe (69.4%) or a wooden rod or stick (64.1%), while a small proportion reported mixing with bare hands (4.1%) or using protective equipment (1.8%). The majority of farmers stored pesticides inside their houses (84.7%), with very few using locked storage areas (1.8%). Use of personal protective equipment during spraying was poor, as most participants (91.2%) reported never using PPE. Disposal practices were largely unsafe, with a high proportion of farmers burying or burning containers (89.4%) or throwing them in open fields (50.0%). Washing practices after pesticide application were also suboptimal, with most farmers washing after a few hours (86.5%) rather than immediately.

Table 4: Practices related to pesticide handling and application

Practice variables	Frequency (n=170)	Percentage (%)
Method of mixing pesticides*		
Mixing with bare hands	7	4.1
Mixing using protective equipment	3	1.8
Mixing using pipe	118	69.4
Mixing using wooden rod / stick	109	64.1
Place of storage of pesticides*		
Stored in locked storage area	3	1.8
Stored inside the house	144	84.7
Stored in open area near the farm	27	15.9
Use of personal protective equipment (PPE) during spraying		
Always	5	2.9
Sometimes	11	6.5
Never	155	91.2
Disposal of empty pesticide containers*		
Reuse for household purposes	11	6.5
Bury / burn containers	152	89.4
Throw in open fields	85	50
Dispose in designated waste area	4	2.4
Washing practices after pesticide application*		
Immediately after use	17	10
After a few hours	147	86.5
Only at the end of the day	10	5.9
Never	4	2.4

** Multiple responses accepted*

Fig.1 shows that majority of farmers (97.6%) reported experiencing at least one health problem following pesticide exposure, while only 2.4% reported none.

Fig.2 shows that out of 166 participants; skin irritation (97.59%) and eye irritation/redness (82.53%) were the most commonly reported health effects after pesticide exposure, followed by headache or dizziness (22.90%), nausea or vomiting (10.24%), and breathing difficulty (5.40%) among affected farmers (n = 166).

Fig.3 shows that out of 166 participants; only a small proportion of farmers (6.02%) sought medical help after pesticide exposure, while the majority (93.98%) did not seek any medical treatment.

Figure 1: Experience of health problems after pesticide exposure (n=170)

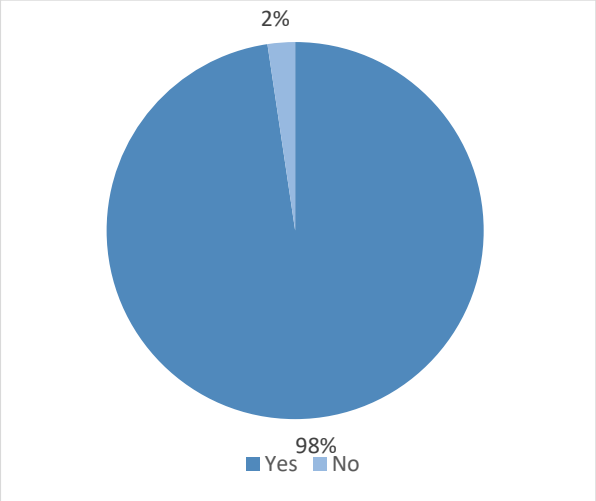
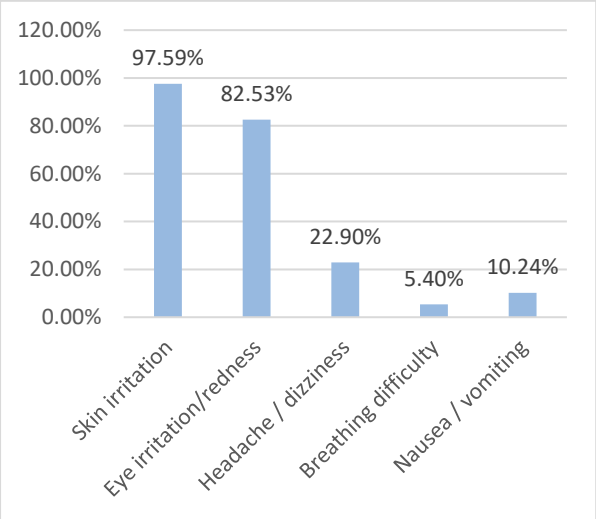
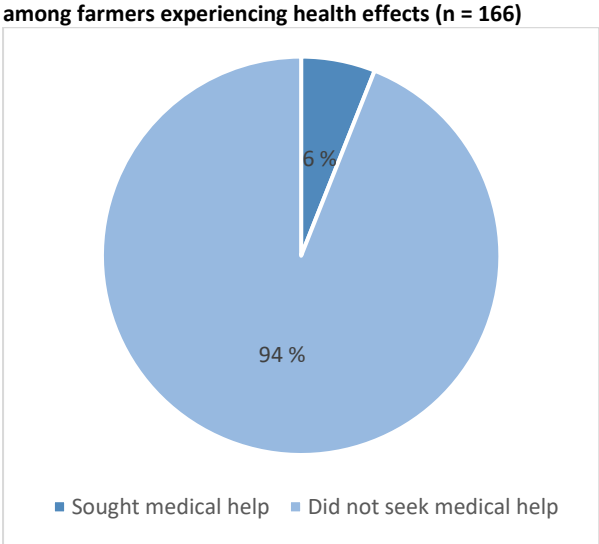


Figure 2: Distribution of specific health effects experienced after pesticide exposure (n = 166)



**Numbers include multiple response*

Fig.3: Medical help sought after pesticide exposure among farmers experiencing health effects (n = 166)



DISCUSSION

The present study assessed the knowledge, attitude, and practices related to pesticide use among farmers in a rural–tribal area of Gujarat. Although all farmers were aware that pesticides can cause health problems, only 48.8% knew about protective measures and just 5.3% had received formal training. Similar findings have been reported in studies from Karnataka and Puducherry, where awareness of pesticide hazards ranged between 85–95%, but formal training was reported among only 8–15% of farmers. (5,11) Sachan et al. also found gaps between awareness and actual safe practices among farmers in North India, where nearly 90% were aware of risks but only about 20–30% followed recommended safety measures.(12) In our study, 91.2% of farmers reported that they never used personal protective equipment (PPE) while spraying pesticides. This is comparable to findings from other Indian studies, where non-use of PPE ranged between 60–85% among agricultural workers. (6) Singh et al. showed that poor protective practices were linked with measurable biological changes in exposed workers, highlighting the importance of using PPE. (13) Unsafe storage and disposal practices were common in this study, about 84.7% of farmers stored pesticides inside their houses. Similar unsafe storage habits have been reported in West Bengal and Odisha, where approximately 65–75% of farmers stored pesticides inside residential areas. (2,12) Storing pesticides at home increases the risk of exposure to other family members, especially children. A very high proportion of farmers (97.6%) reported experiencing at least one health problem after pesticide exposure. This percentage appears higher than findings from other Indian studies, where around 60–80% of farmers reported acute symptoms. (6,7) The most common complaints in our study were skin irritation (97.59%) and eye irritation or redness (82.53%), followed by headache or dizziness (22.90%), nausea or vomiting (10.24%), and breathing difficulty (5.40%)which is consistent with previous Indian and international studies reporting dermal and ocular symptoms in 50–75% of exposed workers (8,14).Long-term symptoms such as fatigue, body pain, and memory issues were reported by 67.1% of farmers. Other studies evaluating pesticide-exposed workers have also reported chronic symptoms and biological alterations among 40–60% of workers with prolonged exposure. (13) Even though many farmers experienced symptoms, only 6.02% sought medical help after pesticide exposure, indicating very low health-seeking behaviour among affected farmers. Similar low health-seeking behavior has been observed in other studies, where less than 15–20% of affected farmers sought professional medical care. (7,9) Many farmers may consider these symptoms as normal or not serious enough to visit a doctor. Overall, our findings are similar to other Indian studies showing that while farmers may know that pesticides are harmful, safe practices are still not properly followed. The high number of health problems reported in this rural–tribal population shows the need for regular training programs, better availability of protective equipment, and stronger implementation of pesticide safety guidelines at the local level.

Conclusion

The present study shows that although farmers are generally aware that pesticides can cause health problems, significant gaps remain in detailed knowledge, protective practices, and formal training. The high prevalence of unsafe handling, improper storage, and low use of personal protective equipment highlights the ongoing risk of occupational exposure in this rural–tribal population. The very high proportion of self-reported health symptoms further emphasizes the public health importance of the issue. These findings clearly indicate the need for structured and regular training programs for farmers, improved accessibility and affordability of protective equipment, and stronger implementation of pesticide safety regulations at the community level. Special attention should be given to the farmers belong to rural tribal regions, where limited awareness and resources may increase vulnerability to pesticide-related health problems.

Recommendation

Strengthening farmer education and occupational safety practices can play a crucial role in reducing preventable health risks associated with pesticide exposure.

Authors Contribution

All authors have contributed equally.

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Nil

Conflict of Interest

There are no conflicts of interest.

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Declaration of Generative AI and AI Assisted Technologies in the Writing Process

The authors haven't used any generative AI/AI assisted technologies in the writing process.

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