Scholars Journal of Medical Case Reports
Abbreviated Key Title: Sch J Med Case Rep
ISSN 2347-9507 (Print) | ISSN 2347-6559 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

Medicine and Pharmacy

Knowledge, Attitudes and Practices of Farm Workers Regarding Pesticide Use in the Souss Massa Region of Morocco

Benaicha Nadia[1*], Hagag Meriem[2], Chakri Imad[2], Loulida Hasna[3], Lahlou Laila[2]

[1]Regional Health Directorate, Morocco
[2]Faculty of Medicine and Pharmacy of Agadir, Ibn Zohr University, Morocco
[3]Medical University of South Carolina, Morocco

DOI: https://doi.org/10.36347/sjmcr.2025.v13i02.005 | **Received:** 26.12.2024 | **Accepted:** 02.02.2025 | **Published:** 06.02.2025

***Corresponding author:** Benaicha Nadia
Regional Health Directorate, Morocco

Abstract **Original Research Article**

The use of pesticides is a critical aspect of modern agriculture, with significant implications for both human health and the environment. Farm workers, in particular, are among the high-risk groups exposed to these chemicals. This study aimed to assess the knowledge, attitudes, and practices of farmers regarding pesticide use in the Souss Massa region. To gather comprehensive data, face-to-face interviews were conducted with 132 farmers using a structured questionnaire. The findings revealed that farmers had a moderate level of knowledge, with 65.9% of participants acknowledging the serious health risks associated with pesticides. However, 12.1% were uncertain and unaware of the symptoms that could result from pesticide poisoning. Only 16% of participants recognized the environmental impacts of pesticides. Furthermore, practices varied significantly, with some farmers engaging in risky behaviors. For example, 21% of workers did not use any personal protective equipment (PPE), and 32% reported working in the fields during pesticide spraying, failing to respect the pre-harvest interval. Our study also highlighted how sociodemographic factors influenced farmers' practices. Women, older farmers, more experienced farmers, and those with higher education levels were more likely to prioritize PPE usage and adopt protective measures. Additionally, men and farmers with higher education levels demonstrated a greater understanding of pesticide use and its risks. This study underscores the need for targeted educational programs to improve pesticide safety practices among farmers, contributing to healthier agricultural practices in the region.

Keywords: KAP Study, Pesticide, Morocco.

INTRODUCTION

Pesticides are essential agricultural tools that protect crops from unwanted plants, insects, bacteria, fungi, and rodents. Over the past decade, global pesticide usage has increased by nearly 50% [1]. While designed to target pests, these chemicals can also harm ecosystems and pose serious health risks to humans. Growing evidence suggests that many pesticides present significant risks not only to human health but also to other life forms and the environment [2]. The health consequences are alarming, with an estimated 3 million cases of pesticide poisoning annually worldwide, leading to more than 250,000 deaths [3].

Despite the known dangers, unsafe pesticide handling persists in both developed and developing nations [4]. In fact, the majority of pesticide poisonings occur in developing regions, where health and safety standards are often inadequate, or even nonexistent [5, 6]. A report from the Anti-Poison and Pharmacovigilance Center (CAPM) in Morocco found that pesticides ranked as the fourth leading cause of poisoning, responsible for 13.4% of all cases. Contributing factors include a lack of proper knowledge about pesticide handling and the overuse of these chemicals [7].

Farmers and farm workers are among the highest-risk groups exposed to pesticides, making awareness and knowledge of the associated risks crucial for improving safety practices [8]. Insufficient understanding of safe application methods, combined with a low perception of risks, contributes to the high incidence of pesticide exposure. Pesticide-related health issues can generally be classified into three categories: occupational, accidental, and intentional (suicidal) exposures, with occupational exposure being the most significant route for farmers in low- and middle-income countries [3]. However, the general population is also at risk, mainly through consumption of contaminated water and food, as well as living near pesticide-treated areas [9].

In recent decades, Morocco has expanded its agricultural areas, establishing greenhouses for intensive cultivation. The agricultural sector now spans 76,000 hectares, with Souss Massa being the primary region for vegetable production [10]. Despite the importance of pesticides for agricultural productivity, there is a notable gap in understanding the knowledge, attitudes, and practices (KAP) of farmers in the Souss Massa region regarding their use.

Previous studies worldwide have shown that while some farmers are aware of the hazards associated with pesticides, their practices often fail to align with recommended safety protocols [3, 4]. To address this gap, we conducted this study to explore the KAP of farmers in Souss Massa concerning pesticide use. The study aims to assess farmers' understanding of pesticide risks, evaluate their safety practices, and identify the factors influencing their attitudes toward pesticide use. Ultimately, this research will provide valuable insights into the current state of pesticide practices in the region.

Participants and Method

1. Study Design and Population

A cross-sectional descriptive study was conducted using an anonymous and confidential questionnaire to assess farmers' knowledge, attitudes, and practices regarding pesticide use. Data collection took place over a period of four months, from May 2024 to August 2024.

The study included farm workers from the Souss Massa region who were exposed to pesticides and matched the inclusion criteria for participation. The present study included individuals who fulfilled the following criteria:

- Adults, regardless of sex
- Working on a farm and exposed to pesticides directly or indirectly
- Consent to participate in this study

2. Sampling methods

The sample size was calculated using the following formula:

$$n = \frac{{Z_\alpha}^2 \times p(1-p)}{d^2}$$

Where:

n = required sample size
z = confidence level according to the standard normal distribution (z = 1.96 for a 95% confidence level)
p = estimated proportion of the population with the characteristic (p = 0.912) based on the literature) [3].
d = margin of error ($d = 0.05$)

By substituting these values into the formula:

$$n = \frac{1.96^2 \times 0.912(1-0.912)}{0.05^2} = 124$$

We added 6% to the minimum sample size to avoid missing data problems.

Therefore, the study targeted a population of 132 farm workers in the Souss Massa Region of Morocco. This statistical approach ensures a representative and adequately powered sample to draw meaningful conclusions. The survey was conducted by approaching farm workers who agreed to complete the survey, in different farms of the region.

3. Data collection tools

3.1 Questionnaire description

The questionnaire [Annexe 1,2,3] was formulated based on findings from the literature.

It is composed of four parts: socio-demographic data, knowledge of farmers regarding pesticide use, their attitudes towards it, and their practices and the protection used during their work.

This questionnaire contains 44 questions divided into 4 parts:

→ **1st part (11 Questions):** demographic characteristics of the target population:
- Age
- Educational status
- Marital status
- Farming experience in years
- Region of origin
- Monthly income
- Crops
- Region of farming

→ **2nd part (10 Questions):** focuses on the participants' knowledge on pesticides
- Attending a training related to pesticide use
- Possible symptoms of pesticide poisoning
- Routes of pesticide poisoning
- Other ways for pest control rather than chemical pesticides use
- Knowledge of pesticide health risks
- Recognition of pesticide pictogram labels
- Reading and understanding pesticide labels
- Recognizing symptoms of acute pesticide poisoning

→ **3rd part (15 Questions):** attitudes of participants regarding pesticide use
- Believing the body developing immunity against pesticide

- Importance of taking a shower after pesticide use
- Believing that pesticides create pests resistance
- Attitudes towards pesticides risks on human health, environment, and on animals
- Difference in the amount of pesticides present in the air versus on clothes
- Believing that most farmers are tough enough to take the exposure without harm
- Amount of concern over the harmful effects of pesticides

→ **4th part (8 Questions):** practices of the participants

- Methods of spraying
- Duration and frequency of spraying
- Respecting pre-harvest intervals
- Importance of personal protective equipment (PPE) use
- Types of PPE use

3.2 Data collection

To minimize response bias, participants were not informed about the study's objectives in advance. The survey was conducted in the local language, with French or English used for non-Moroccan participants who did not speak the local language. Data collection was carried out through face-to-face interviews.

4. Judgment criteria

4.1 knowledge

Question	Response options	Correct/Ideal answer	Justification
What are the possible pesticide poisoning symptoms?	No symptoms, uncertain, headache, dizziness, nausea, vomiting, respiratory distress, conjunctivitis, skin rashes, convulsion.	headache, dizziness, nausea, vomiting, respiratory distress, conjunctivitis, skin rashes, convulsion.	There's a wide range of symptoms organized by organs affected, varying depending on the pesticide used [16].
What are the routes of pesticide poisoning	Nose/Skin/Mouth/Eyes/ None	Nose and skin and mouth and eyes	Pesticides can enter the body through three main pathways: skin contact, ingestion, and inhalation [17].
What are non-chemical ways of pesticide control?	Uncertain, non-chemical ways don't exist, glue tapes, biological control, trap cropping, cultural control.	Glue tapes, biological control, trap cropping, cultural control.	Non-chemical methods include biological control (using natural predators), crop rotation, trap cropping, mechanical control (e.g., hand weeding), using resistant plant varieties, and using sticky traps [18].
Do you know pesticides can cause ill health or even death?	Yes/No	Yes	pesticides can cause serious health effects, including poisoning, long-term illnesses like cancer, and even death if safety precautions are not followed [19].
Can you recognize and understand the meaning of the pictogram commonly found on pesticide labels?	Yes, I can recognize all of them/I can only recognize a few/ No	Yes, I can recognize all of them	workers should be trained to recognize and understand hazard pictograms [20].
Have you ever attended training related to pesticide use?	Yes/No	Yes	Workers who handle pesticides should undergo formal training on safe use [20].
Can you read and understand the information on pesticide labels?	Yes/No	Yes	Reading and understanding pesticide labels is essential for safe use [21].
I can recognize the symptoms of acute poisoning with pesticides.	Yes/No	Yes	Recognizing symptoms like nausea, dizziness, and respiratory problems is crucial, and immediate medical attention should be sought in case of acute exposure [22].

For the question, "What are the possible symptoms of pesticide poisoning?" we considered an answer correct if the respondent could mention one or more recognized symptoms. If the respondent failed to identify any symptoms, the answer was deemed incorrect.

For the question, "What are the routes of pesticide poisoning?" the answer was considered correct only if all four routes of pesticide poisoning were listed. If the respondent identified fewer than four routes, the answer was regarded as incorrect.

4.2 Attitudes

Question	Response options	Correct/Ideal answer	Criteria/Justification
As a farm-worker, do you believe that your body has developed immunity against pesticides over time?	Yes/No	No	Prolonged exposure increases health risks [16].
Do you think you need to take a bath after pesticide use?	Yes/No	Yes	Bathing after pesticide use is crucial to remove residues from the skin and prevent further exposure [23].
I think that overuse of pesticides promotes the development of resistance in pests	Yes/No	Yes	Overuse of pesticides can lead to resistance in pests, making them harder to control over time [24].
Pesticides have negative consequences on human health	Agree/strongly agree/neutral/disagree/strongly disagree	Agree/strongly agree	pesticides can cause serious health effects, including poisoning, long-term illnesses like cancer, and even death if safety precautions are not followed [25].
Pesticides have negative effe cts on the environment	Agree/strongly agree/neutral/disagree/strongly disagree	Agree/strongly agree	Pesticides present major environmental risks [26].
Pesticides have negative effects on livestock	Agree/strongly agree/neutral/disagree/strongly disagree	Agree/strongly agree	Pesticides affect non-target plants and animals and disrupts ecosystem [2].
Pesticides produce toxic waste products	Agree/strongly agree/neutral/disagree/strongly disagree	Agree/strongly agree	Some pesticides and their breakdown products are highly toxic, tend to accumulate in organisms, and persist in natural environments as residues in soil and water [27].
Continued use of pesticides will likely produce cancer and leukemia in humans	Agree/strongly agree/neutral/disagree/strongly disagree	Agree/strongly agree	Research has shown higher incidences of leukemia, non-Hodgkin lymphoma, multiple myeloma, prostate cancer as well as other cancers among farmers [28].
Most farmers are tough enough to take exposure to pesticides without harm	Agree/strongly agree/neutral/disagree/strongly disagree	Disagree/strongly disagree	All individuals are at risk of health effects from pesticide exposure without proper precautions [17].
There is too much concern over the harmful effects of pesticides	Agree/strongly agree/neutral/disagree/strongly disagree	Disagree/strongly disagree	The concerns are well-founded, as pesticides pose serious health and environmental risks [19].
Risks are just part of the job in pesticide application	Agree/strongly agree/neutral/disagree/strongly disagree	Disagree/strongly disagree	While risks exist, they can be minimized with proper safety measures and protective equipment [23].
A careful farmer can minimize dangers associated with pesticides	Agree/strongly agree/neutral/disagree/strongly disagree	Agree/strongly agree	Proper use of PPE, following label instructions, and applying safety practices can reduce dangers [29].
Most farmers I know follow label instructions very closely	Agree/strongly agree/neutral/disagree/strongly disagree	Agree/strongly agree	Compliance with label instructions is essential and ensures safe practices [30].
The amount of pesticides that gets on clothing is nothing compared to the amount of pollution in the air	Agree/strongly agree/neutral/disagree/strongly disagree	Disagree/strongly disagree	Workers can bring pesticides home on their clothes, creating a localized contamination risk [31].
The work clothing I wear is effective in reducing my exposure to pesticides	Agree/strongly agree/neutral/disagree/strongly disagree	Agree/strongly agree	When properly designed and maintained, work clothing can reduce exposure to pesticides [23].

4.3 Practices

Question	Response options	Correct/Ideal answer	Criteria/Justification
After applying pesticides, how long does it take you to re-enter the plot to work?	Less than 24h/More than 24h/ no time limit	>24h	The r e-entry interval used: is 24h for a slightly toxic pesticide and 48 hours for moderately or very toxic pesticides [32].
Wearing PPE important	Yes/No	Yes	Wearing personal protective equipment (PPE) is critical to minimize exposure to harmful pesticides [22].
Do you use PPE	Yes/No	Yes	PPE includes gloves, goggles, boots, coveralls, masks [29].
Do you eat/drink/smoke/talk during pesticide use	Yes/No	No	it is strongly advised to avoid eating, drinking, smoking, or talking during pesticide application to prevent ingestion or inhalation of chemicals [22].

5. Ethical considerations

This study was carried out in accordance with the ethical guidelines set by the institutional research committee, as well as the principles outlined in the 1964 Declaration of Helsinki and its subsequent revisions [33].

Verbal consent was obtained from all participants after they were fully informed about the study's objectives. Participants' confidentiality, autonomy, and rights were fully respected throughout the study.

6. Statistical analysis

The statistical analysis was performed using Jamovi 2.6.2 version.

The qualitative variables were described numbers and percentages, then compared using the Chi2 test or fisher exact.

The quantitative variables were described as mean ± standard deviation, then compared by Student's T test for independent samples when distribution is Gaussian.

Quantitative variables with a non-Gaussian distribution are described as median and IQR inter-quartile range, then compared by non-parametric Mann-Whitney test.

RESULTS

1. Demographic information

The participants in this study ranged in age from 18 to 64 years, with an average age of 35.8 ± 10.64 years. The majority were women (75%, n = 99), while men accounted for 25% (n = 33). Most participants were married (47.7%, n = 63), followed by those who were divorced (30.3%, n = 40). Participants hailed from various regions, with the largest group from Béni Mellal-Khenifra (40.2%, n = 53). The Souss-Massa region contributed 5.3% (n = 7), and Guelmim-Oued Noun had 0.8% (n = 1). International participants included individuals from Ivory Coast and Mali (0.8%, n = 1 each), as well as Senegal (8.3%, n = 11). In terms of residence, most participants lived in Khmis Ait Amira (70.5%, n = 93), while 3.8% (n = 5) resided in Agadir.

Regarding education, the majority of participants (67.4%, n = 89) were illiterate. A smaller percentage (8.3%, n = 11) had attended Quranic school, while 9.8% (n = 13) had completed primary school. Additionally, 7.6% (n = 10) reached middle school, 4.5% (n = 6) completed high school, and only 2.3% (n = 3) had a university education. The median farming experience was four years [2.00; 10.00], with most participants having less than five years of experience. However, 18.8% had more than 10 years of experience. Monthly income was calculated based on a daily wage, assuming 30 working days, resulting in a median salary of 2,400 MAD (approximately 250 USD). Tomato was the most commonly grown crop among participants, accounting for 43.9% of the total. Raspberries and blueberries followed as the second most common crops, representing 27.3%.

2. Knowledge

1.1 Training programs

The majority of participants (97.7%, n=129), have not attended any training related to pesticide use, while only 2.3% (n=3) have received such training.

1.2 Identified symptoms of pesticide poisoning

When asked to identify symptoms of pesticide poisoning, participants most frequently mentioned suffocation (50.7%, n = 67), followed by skin irritation (35.6%, n = 47) and pruritus (34.1%, n = 45). Additionally, 11.3% (n = 15) believed that coughing could result from exposure. No other symptoms were reported. Notably, 12.1% (n = 16) of participants expressed uncertainty, indicating they were unaware of any possible symptoms associated with pesticide poisoning.

Table 1: Possible symptoms of pesticide poisoning according to participants

Symptoms	Frequency	Percentage %
Suffocation	67	50.7
Skin irritation	47	35.6
Pruritis	45	34.1
Coughing	15	11.3
Don't know any symptoms	16	12

1.3 Possible routes of pesticide poisoning

The most common response was through the nose (99.2%, n=131), while mouth exposure was noted by 78% (n=103) of participants. Fewer recognized skin contact (34.8%, n=46) and eyes (26.7%, n=35) as possible routes.

1.4 Recognition of acute pesticide poisoning symptoms

When asked, only 14.4% (n=19) of participants said they would be able to recognize the symptoms of acute pesticide poisoning, while the majority (85.6%, n= 113), stated they could not.

1.5 Awareness of pesticide risks

In our study, 65.9% (n=87) of participants were aware that pesticides can cause illness or even death. In contrast, 34.1% (n=45) indicated they did not believe pesticides could lead to such serious health issues.

1.6 Other ways for pest controls other than chemical pesticide use

When asked about other possible ways to control pests, other than chemical pesticides, all participants (100%) cited Glue bands as a way used in the farms to catch flies and other flying pests.

1.7 Recognition of pictograms on pesticide labels

15.9% (n=21) acknowledged recognizing one pictogram, and 24.2% (n=32) identified two, 5.3% (n=7) identified three pictograms, while only 1.5% (n=2) recognized four. Lastly, only 2.3% (n=3) indicated that they recognized all the five pictograms.

3. Attitudes

A majority of participants (67.4%, n = 89) believed that their bodies had developed immunity to pesticides over time, while 32.6% (n = 43) disagreed. In contrast, only 15.2% (n = 20) recognized that overusing pesticides could lead to resistance in pests, with a significant 84.8% (n = 112) disagreeing with this concept. Interestingly, all participants (100%, n = 132) unanimously agreed on the importance of taking a bath after pesticide use.

Table 2: Participants attitudes to pesticide use

Attitudes	Frequency	Percentage %
Overtime, the body develops immunity against pesticides	89	67.4
Pests can't develop resistance against pesticides	112	84.4
It is essential to take a bath after pesticide use	132	100

Among the participants, 38.6% (n = 51) strongly agreed that pesticides have negative consequences on human health, while 25% (n = 33) disagreed. Perceptions regarding the risks of pesticide exposure varied: only 6.8% (n = 9) strongly believed that prolonged pesticide use could lead to cancer or leukemia, while a significant 72.7% (n = 96) disagreed with the notion that most farmers could withstand pesticide exposure without harm. Additionally, 25.8% (n = 34) felt there was excessive concern over the harmful effects of pesticides, though 84% (n = 101) acknowledged that risks were simply part of the job. Nearly all participants (97%, n = 128) believed that a careful farmer could minimize the dangers of pesticide use, reflecting a proactive attitude toward safety. Regarding protective measures, 68.1% (n = 90) asserted that their work clothing effectively reduced pesticide exposure. However, 66% (n = 87) believed the amount of pesticide residue on clothing was negligible compared to air pollution.

4. Practices

4.1 Application methods

All participants (100%) reported using a motorized sprayer with a knapsack for pesticide application on their farms. To spray the entire field, 47.7% (n = 63) stated it took less than an hour, 44% (n = 58) reported it took between one and three hours, while 8% (n = 11) indicated it required more than three hours. The frequency of pesticide application varied among participants: 60% (n = 80) reported spraying multiple times a week, 31% (n = 41) sprayed once a week, and 8.3% (n = 11) applied pesticides daily. Regarding re-entry to the field after pesticide application, 56% (n = 74) waited more than 24 hours before resuming work, 12% (n = 16) waited less than 24 hours, and an alarming 32%

(n = 42) reported that pesticides were being sprayed while others were actively harvesting.

4.2 Personal protective equipment

The majority of participants (96.2%, n = 127) recognized the importance of wearing personal protective equipment (PPE), while only 3.8% (n = 5) disagreed. Among those who acknowledged the importance of PPE, 80.3% (n = 106) were unaware of the specific reasons for its use. A small proportion (6.8%, n = 9) believed PPE protects against workplace air pollution, 3.8% (n = 5) associated it with general protection against hazards, 2% (n = 3) cited clothing protection, and 3.8% (n = 5) mentioned protecting crops from contamination.

Regarding the protective equipment used, 78% (n = 103) of participants reported wearing nose masks, often improvised from clothing or scarves. Additionally, 46% (n = 61) used gloves, 19% (n = 25) wore wide-brimmed hats, 31% (n = 41) had overalls, 7.6% (n = 10) used special boots, and only 5% (n = 7) wore goggles. Alarmingly, 21% (n = 28) reported using no protective equipment at all.

4.3 Practices during pesticide use

Among the 26 participants surveyed about their practices during pesticide application, 53% (n = 14) reported eating, 80% (n = 21) reported drinking water, none reported smoking (0%), and all (100%, n = 26) reported engaging in conversation with each other.

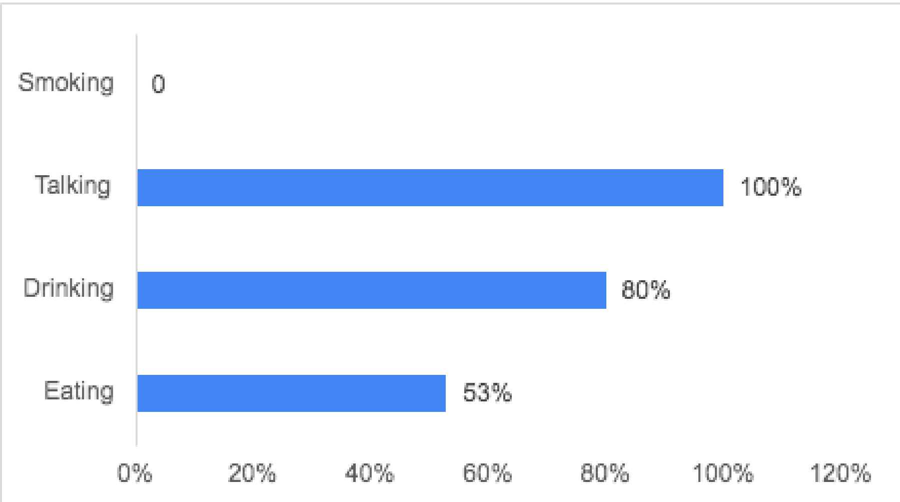

Figure 1: Practices during pesticide

5. Sociodemographic factors influencing the knowledge attitudes and practices of farmers: Analytical study

5.1 Age's influence

Our statistical analysis revealed that age does not significantly influence farm workers' overall knowledge regarding pesticide use. However, certain age-related differences in beliefs and perceptions were observed:

- Older farm workers (mean age: 38.0 ± 11.0 years) were more likely to believe that their bodies had developed immunity to pesticides over time, compared to younger workers who did not share this belief (mean age: 31.4 ± 8.49 years) ($p < 0.001$).
- Farmers who strongly agreed or agreed that pesticides negatively affect livestock were older (mean age: 37.9 ± 10.8 years) than those who disagreed or remained neutral (mean age: 33.2 ± 9.94 years) ($p < 0.012$).
- Younger farmers (mean age: 31.1 ± 7.77 years) were more likely to believe that farmers are "tough enough" to withstand pesticide exposure without harm, whereas older farmers were more likely to disagree or remain neutral on this statement (mean age: 37.2 ± 11.0 years) ($p < 0.006$).
- Farmers who agreed that the amount of pesticide residue on clothing is minimal compared to air pollution were older (mean age: 37.7 ± 10.6 years) than those who disagreed or were neutral (mean age: 32.3 ± 9.81 years) ($p < 0.005$).
- Farmers who believed in the importance of wearing PPE were older (mean age: 36.4 ± 10.5 years) compared to those who did not consider PPE necessary (mean age: 22.6 ± 4.44 years) ($p < 0.003$).
- Similarly, farmers who actively wore PPE were older (mean age: 37.1 ± 9.87 years) than those who did not wear PPE (mean age: 31.3 ± 12.3 years) ($p < 0.010$).

5.2 Gender's influence

Men (30.3%) were more likely than women (12.1%) to be aware of all routes of pesticide entry into the body (mouth, nose, eyes, skin), while 87.9% of women and 69.7% of men were unaware of all possible routes (p = 0.015). A higher percentage of men (97%) could cite at least one symptom of pesticide poisoning, compared to 82.8% of women. Conversely, 17.2% of women and only 3% of men could not identify any symptoms (p = 0.040).

A significant gender disparity was observed in reading and understanding pesticide labels: none of the women (0%) could comprehend labels, while 15.2% of men were able to read and understand them. This suggests that label literacy is generally low, with a particularly stark difference for women (p < 0.001). Men (54.5%) were more likely than women (33.3%) to strongly agree or agree that pesticides have negative effects on the environment. In contrast, 66.7% of women and 45.5% of men disagreed or were neutral on this issue (p = 0.030).

Men (36.4%) were more likely than women (17.2%) to agree that the continued use of pesticides could lead to cancer and leukemia in humans. On the other hand, 82.8% of women and 63.6% of men disagreed or were neutral on this point (p = 0.021).

All women (100%) believed that wearing PPE is important, compared to 84.8% of men (p < 0.001). A higher percentage of women (89.9%) reported wearing PPE, compared to 45.5% of men. Conversely, only 10.1% of women and 54.5% of men did not wear PPE (p < 0.001).

5.3 Farming experience's influence

Farmers who reported the ability to read and understand pesticide labels had significantly less farming experience (median = 1.00 year) compared to those who could not (median = 4.00 years, $p = 0.032$). Conversely, farmers capable of recognizing acute poisoning symptoms demonstrated significantly more farming experience (median = 7.00 years) than those unable to do so (median = 4.00 years, $p = 0.022$). Acknowledging the negative health impacts of pesticides was also associated with slightly greater farming experience (median = 5.00 years) compared to those who disagreed or were neutral on this issue (median = 4.00 years, $p = 0.042$).

Farmers with greater experience (median = 10.0 years) were significantly more likely to recognize the environmental harms of pesticide use compared to those with less experience (median = 4.00 years, $p < 0.001$). Similarly, recognition of the harmful effects of pesticides on livestock was higher among more experienced farmers (median = 9.00 years) than among less experienced ones (median = 2.00 years, $p < 0.001$). Agreement that pesticides generate toxic waste products was also correlated with greater farming experience (median = 7.00 years) compared to those with less experience (median = 3.50 years, $p < 0.001$), reflecting an increased awareness of environmental hazards over time.

Additionally, farmers who rejected the notion that pesticide risks are an unavoidable part of the job had more farming experience (median = 8.00 years) than those who accepted this fatalistic view (median = 4.00 years, $p = 0.018$). A similar trend was observed regarding clothing exposure risks, with more experienced farmers (median = 5.00 years) challenging the perception that clothing exposure is negligible compared to air pollution, in contrast to those who agreed with this view (median = 4.00 years, $p = 0.031$). Furthermore, farmers who disagreed that work clothing offers sufficient protection against pesticides had significantly greater farming experience (median = 6.50 years) than those who believed otherwise (median = 4.00 years, $p = 0.005$).

Experience also appeared to influence personal protective equipment (PPE) practices. Farmers who recognized the importance of PPE had significantly more farming experience (median = 5.00 years) than those who did not (median = 1.00 year, $p = 0.006$), suggesting that experience fosters awareness of PPE's protective role. Similarly, farmers who reported wearing PPE had greater experience (median = 5.00 years) compared to those who did not (median = 2.00 years, $p = 0.023$), indicating that experience promotes safer practices.

5.4 Educational level's influence

Farmers with higher education levels demonstrated greater knowledge of pesticide entry routes (mouth, nose, eyes, skin). Only 10% of those with no formal education or Quranic schooling recognized all routes, compared to 37.9% of farmers with primary, middle, or high school education. This knowledge slightly decreased among university-educated farmers to 33.3% ($p = 0.001$). Education level also significantly influenced the ability to read and understand pesticide labels. None of the farmers with Quranic or no formal education (0%) reported being able to read labels, while this capability increased to 13.8% among primary, middle, and high school graduates, and to 33.3% among those with university education ($p < 0.001$). Belief in being "tough enough" to endure pesticide exposure without harm decreased as education level rose. Among Quranic or illiterate farmers, 19% agreed with this belief, whereas all university-educated farmers (100%) disagreed or remained neutral ($p = 0.027$).

Attitudes regarding pesticide risks as an unavoidable aspect of application also varied by education level. Agreement with this belief was highest among Quranic or illiterate farmers (69%), decreased to 55.2% among primary, middle, and high school graduates, and slightly rose to 66.7% among university graduates ($p = 0.036$). However, no statistically significant relationship was observed between education level and the use ofpersonal protective equipment (PPE).

DISCUSSION

In our study, participants' ages ranged from 18 to 64 years, with a mean age of 35.8 ± 10.64 years. This is notably younger than the average age of 45 years reported by Ben Khadda *et al*., (2021) in Fez Meknes, Morocco [42]. Comparable studies found the median age of farming populations to be approximately 40 years, with age ranges spanning 18 to 80 years in Southern India [4] and 20 to 81 years in Indonesia [48]. The relatively younger age distribution of our sample contrasts with these findings, suggesting a distinct demographic profile in our study area.

Women comprised 75% of our participants, resulting in a male-to-female ratio of 0.33. This starkly contrasts with similar studies where male participants predominated. For instance, Ben Khadda *et al*., (2021) reported an entirely male sample in Fez Meknes, Morocco [42], and other studies have noted male representation ranging from 69% to 95% [3, 4, 48, 51, 52]. This divergence highlights potentially unique gender dynamics in our study area, with significantly higher female involvement in farming compared to other regions.

The illiteracy rate among our participants was high, with 67.4% lacking formal education, 9.8% having attended primary school, and only 2.3% attaining university education. This is higher than the 43.3% illiteracy rate reported by Ben Khadda *et al*., (2021) among Moroccan farmers, where 29.1% had received primary education [42]. Similarly, Benaboud *et al*., (2020) found a lower illiteracy rate of 26% in Oriental Morocco, with comparable primary education levels [50]. By contrast, studies from Nigeria, Indonesia, and Malaysia reported literacy rates exceeding 85%, with most farmers having completed secondary or tertiary education [3, 48, 51]. These findings suggest significantly lower educational attainment among our participants relative to other regions.

The median farming experience in our sample was 4 years, with most participants having fewer than 5 years of experience, though 18.8% had over a decade of experience. This contrasts with Ben Khadda *et al*., (2021), who reported an average farming experience of 11.5 years [42], and even longer experience among Indonesian farmers, averaging 18.7 years [48]. In Malaysia, 41.1% of farmers reported 11 to 19 years of farming experience, while only 29.2% had less than 5 years [51]. These findings indicate that our sample predominantly comprises relatively newer entrants to farming compared to these other regions.

In our study, 97.7% of participants reported no prior training on pesticide use, with only 2.3% having received any form of training. This aligns with findings by Ben Khadda *et al.*, (2021), where 88% of farmers similarly lacked formal training on pesticide use [42], underscoring a widespread deficiency in education on safe pesticide practices across regions.

When asked to identify symptoms of pesticide poisoning, participants most frequently cited suffocation (50.7%, n = 67), followed by skin irritation (35.6%, n = 47) and pruritus (34.1%, n = 45). A smaller proportion (11.3%, n = 15) associated coughing with pesticide exposure. However, no other symptoms were mentioned, and 12.1% (n = 16) of participants expressed uncertainty, being unable to identify any potential symptoms of pesticide poisoning. This contrasts with the broader spectrum of symptoms described in the literature, including dizziness, headache, body aches, diarrhea, nausea, chills, stomach cramps, salivation, pupil constriction, increased pulse, loss of consciousness, and convulsions [48].

Our study revealed that 99.2% of participants recognized inhalation as a primary route of pesticide exposure, followed by oral ingestion (78%). However, fewer participants identified skin contact (34.8%) or eye contact (26.7%) as exposure routes. These findings are consistent with a study in Nigeria, where inhalation (58.8%) and ingestion (54.5%) were also the most recognized routes of pesticide exposure among farmers [3]. This suggests a consistent understanding of key exposure routes, although awareness of skin and eye contact remains limited.

Furthermore, 65.9% of participants in our study acknowledged the severe health risks associated with pesticide use, including potential fatality, while 34.1% were unaware of such dangers. This contrasts with findings from Southern India, where 75.43% of farmers reported full awareness of pesticide-related risks [4].

When assessing label comprehension, 49.2% of participants reported the ability to recognize and understand pesticide pictograms, while 50.8% could not. This contrasts sharply with data from Oriental Morocco, where only 2.5% of respondents reported an inability to understand pictograms [50]. The lower familiarity with pictograms among participants in our study highlights a critical gap in label comprehension and points to the need for targeted educational interventions for local farmers.

In our study, 75% of participants acknowledged the adverse health effects of pesticides. This finding aligns with studies from Malaysia and Nigeria, where 90.3% and 94.6% of farmers, respectively, recognized the health risks associated with pesticide use [3, 51]. Similarly, research conducted in Southern India reported 75.43% awareness of pesticide-related health hazards [4]. These consistently high levels of awareness across diverse regions indicate a widespread understanding of the health implications of pesticide use.

In contrast, only 16% of participants in our study recognized the environmental impacts of pesticides. This is markedly lower than the awareness levels reported in Malaysia (76.4%) and Nigeria (85.6%) [3, 51], highlighting a significant gap in environmental awareness within our study area. This discrepancy underscores the need for educational initiatives to emphasize the ecological consequences of pesticide usage.

All participants in our study (100%) agreed on the importance of bathing after pesticide application, a finding consistent with Fez Meknes, where 97.7% of farmers reported similar hygiene practices [42]. However, this contrasts sharply with data from Saudi Arabia, where only 45.6% of farmers consistently bathed after using pesticides [53]. These differences suggest variability in hygiene practices across regions, with our sample exhibiting notably high adherence to post-application hygiene.

Our study reveals that older farmers are more inclined to use personal protective equipment (PPE), possibly due to increased awareness of pesticide risks with age. This contrasts with Nwadike *et al*., (2021), who found that older farmers were less consistent in using PPE, such as masks and gloves, often citing a perceived immunity to pesticides as a reason [3].

In terms of gender, men in our study exhibited greater knowledge of pesticide exposure routes and poisoning symptoms compared to women, indicating a gender disparity in risk awareness. Men were also more likely to acknowledge that prolonged pesticide use could lead to serious illnesses like cancer and leukemia, suggesting a higher awareness of long-term health risks. However, women, while less informed about pesticide labels, consistently prioritized PPE usage more than men.

Our results indicate a strong correlation between farming experience and PPE awareness, as well as recognition of pesticide risks to health and the environment. Experienced farmers were more likely to perceive pesticides as harmful, likely due to prolonged exposure and cumulative observations over time. This aligns with Ben Khadda *et al*., (2021), who found that farming experience enhances farmers' understanding of pesticide impacts and improves proper PPE usage [42].

Additionally, higher educational levels were associated with improved understanding of pesticide exposure risks and greater adoption of PPE. Farmers with university education demonstrated a better ability to read and comprehend pesticide labels, which was linked to fewer misconceptions about resilience to pesticide risks. These findings are consistent with Benaboud *et al*., (2021), Nwadike *et al*., (2021), and Lu (2022) [3, 50, 52], who reported that advanced education promotes safety practices and accurate identification of pesticide symbols. This underscores the critical role of education in fostering risk awareness and encouraging safe pesticide handling practices.

This study highlights several key avenues for future research. Conducting similar KAP studies in other agricultural regions of Morocco would yield valuable comparative data, helping to identify regional variations in pesticide knowledge and practices. Moreover, implementing targeted training programs based on the findings of this research could significantly enhance farm workers' understanding of safe pesticide handling. Such initiatives would not only improve health outcomes for workers but also contribute to creating a safer agricultural environment. Future research should assess the effectiveness of these educational interventions, with a focus on their impact on safety practices among farm workers and their role in reducing the risks associated with pesticide exposure. By identifying gaps in knowledge and safety practices, the study's findings can provide valuable insights for policymakers, aiding in the creation of safer workplaces and the establishment of necessary safety standards.

This study had several limitations that warrant acknowledgment. One significant challenge was the timing of data collection, which coincided with the end of the harvest season. This resulted in a reduced number of workers on the farms, thereby limiting the pool of potential participants. Additionally, many prospective participants faced literacy challenges, which not only impeded their ability to complete the questionnaire but also precluded the use of online survey distribution. Despite these challenges, the findings of this research remain impactful. By emphasizing the need for education and safe farming practices, this study has the potential to promote healthier working environments that benefit not only farm workers but also the surrounding ecosystems and communities.

In conclusion, this study highlights that while farmers in the Souss Massa region demonstrate a moderate understanding of pesticide safety, unsafe practices remain prevalent, with many neglecting critical safety measures. Sociodemographic factors—including age, gender, farming experience, and education level—significantly influence farmers’ knowledge, attitudes, and practices related to pesticide use.

The findings align with existing research, which underscores a persistent gap between knowledge and practice in agricultural settings. Addressing this gap requires the implementation of targeted training programs designed to improve knowledge and promote adherence to protective measures.

However, the study’s limitations, such as the relatively small sample size, call for further research involving larger and more diverse populations to validate these results. Strengthening farmers’ knowledge and practices in pesticide use is essential to fostering sustainable agricultural practices while protecting human health and the environment.

REFERENCES

1. Pesticides use, pesticides trade and pesticides indicators [Internet]. FAO; 2022 [cited 2024 Nov 13]. Available from: http://www.fao.org/documents/card/en/c/cc0918en
2. Gyawali, K. (2018). Pesticide uses and its effects on public health and environment. *Journal of Health Promotion*, *6*, 28-36.
3. Nwadike, C., Joshua, V. I., Doka, P. J., Ajaj, R., Abubakar Hashidu, U., Gwary-Moda, S., ... & Moda, H. M. (2021). Occupational safety knowledge, attitude, and practice among farmers in Northern Nigeria during pesticide application—a case study. *Sustainability*, *13*(18), 10107.
4. Sai, M. V. S., Revati, G. D., Ramya, R., Swaroop, A. M., Maheswari, E., & Kumar, M. M. (2019). Knowledge and perception of farmers regarding pesticide usage in a rural farming village, Southern India. *Indian Journal of Occupational and Environmental Medicine*, *23*(1), 32-36.
5. FAO; WHO. International Code of Conduct on Pesticide Management Guidelines on Highly Hazardous Pesticides 2016. [cited 2024 Sep 27]. Available from: http://www.fao.org/3/i5566e/i5566e.pdf
6. Blair, A., Ritz, B., Wesseling, C., & Freeman, L. B. (2015). Pesticides and human health. *Occupational and Environmental Medicine*, *72*(2), 81-82.
7. Berni, I., Menouni, A., El, I. G., Duca, R. C., Kestemont, M. P., Godderis, L., & Jaafari, S. E. (2021). Understanding farmers' safety behavior regarding pesticide use in Morocco. *Sustainable Production and Consumption*, *25*, 471-483.
8. Damalas, C. A., & Koutroubas, S. D. (2018). Farmers' behaviour in pesticide use: A key concept for improving environmental safety. *Current Opinion in Environmental Science & Health*, *4*, 27-30.
9. Sine, H. (2022). Étude du Biomarqueur cholinestérase sérique, chez les personnes exposées professionnellement aux pesticides au niveau de la Région Souss Massa. University Mohammed V; 2022.
10. Salghi, R., Luis, G., Rubio, C., Hormatallah, A., Bazzi, L., Gutiérrez, A. J., & Hardisson, A. (2012). Pesticide residues in tomatoes from greenhouses in Souss Massa Valley, Morocco. *Bulletin of environmental contamination and toxicology*, *88*(3), 358-361.
11. Haut-Comissariat Au Plan. Direction Régionale de Souss Massa. Présentation de la région de Souss Massa [Internet]. [cited 2024 Sep 27]. Available from: https://www.hcp.ma/region-agadir/Presentation-de-la-region-de-Souss-Massa_a16.html
12. HAUT-COMISSARIAT AU PLAN [Internet]. 2024. Recensement général de la Population et de l'Habitat. Available from: https://www.hcp.ma/Population-legale-du-Royaume-du-Maroc-repartie-par-regions-provinces-et-prefectures-et-communes-selon-les-resultats-du_a3974.html
13. Ministère de l'équipement et de l'eau. MONOGRAPHIE DE LA RÉGION SOUSS MASSA. [cited 2024 Sep 27]. Available from: https://www.equipement.gov.ma/carte-region/RegionAgadir/Presentation-de-la-region/Monographie/Documents/Monographie-de-la-region-Souss-Massa.pdf
14. Royaume Du Maroc Région Souss Massa. Economie et Potentialités: Agriculture [Internet]. [cited 2024 Sep 27]. Available from: https://www.soussmassa.ma/fr/agriculture
15. Royaume du Maroc Ministère de l'Agriculture et de la Pêche Maritime. Souss Massa: Monographie [Internet]. Available from: https://ormvasm.ma/index.php/fr/accueil/monographie.html
16. Reigart, J. R., & Roberts, J. R. (2013). Recognition and Management of Pesticide Poisonings. 6th ed. Washington, D.C.: U.S. Environmental Protection Agency; 2013.
17. Damalas, C. A., & Koutroubas, S. D. (2016). Farmers' exposure to pesticides: toxicity types and ways of prevention. *Toxics*, *4*(1), 1.
18. Flint, M. L., & Dreistadt, S. H. (2018). Integrated Pest Management for Home Gardeners and Landscape Professionals. 2nd ed. Oakland: University of California Agriculture and Natural Resources; 2018.
19. World Health Organization (WHO). Pesticide residues in food: Health impacts. 2020 [cited 2024 Oct 20]. Available from: https://www.who.int/news-room/fact-sheets/detail/pesticide-residues-in-food
20. United Nations. Globally Harmonized System of Classification and Labelling of Chemicals (GHS). 8th ed. New York: United Nations; 2019.
21. U.S. Environmental Protection Agency (EPA). Read the Label First: How to use pesticides safely. Washington, D.C.: EPA; 2017.
22. Keifer, M. C. (2000). Effectiveness of interventions in reducing pesticide overexposure and poisonings. *Am J Prev Med*, *18*(4 Suppl), 80-89.
23. International Labour Organization (ILO). Safety and health in agriculture. Geneva: ILO; 2011.
24. Gurr, G. M., Wratten, S. D., & Luna, J. M. (2003). Multi-function agricultural biodiversity: pest management and other benefits. *Basic and Applied Ecology*, *4*(2), 107-116.
25. Popp, J., Pető, K., & Nagy, J. (2013). Pesticide productivity and food security. A review. *Agronomy for sustainable development*, *33*, 243-255.
26. Sharma, A., Kumar, V., Shahzad, B., Tanveer, M., Sidhu, G. P. S., & Handa, N. (2019). Worldwide

pesticide usage and its impacts on ecosystem. *SN Appl Sci*, *1*(11), 1446.
27. L'Association Marocaine Santé, Environnement et Toxicovigilance. RAPPORT NATIONAL SUR LA SITUATION DES PESTICIDES HAUTEMENT DANGEREUX (HHPs) AU MAROC. [cited 2024 Sep 17]. Available from: https://ipen.org/sites/default/files/documents/final_rapport_national_sur_la_situation_des_pesticides_hautement_dangereux_maroc_final_6juin2020_1.pdf
28. Payán-Rentería, R., Garibay-Chavez, G., Rangel-Ascencio, R., Preciado-Martínez, V., Muñoz-Islas, L., Beltrán-Miranda, C., ... & De Celis, R. (2012). Effect of chronic pesticide exposure in farm workers of a Mexico community. *Archives of environmental & occupational health*, *67*(1), 22-30.
29. Occupational Safety and Health Administration (OSHA). Guidelines for Agricultural Worker Safety: PPE Recommendations. Washington, D.C.: U.S. Department of Labor; 2016.
30. Lekei, E. E., Ngowi, A. V., & London, L. (2014). Farmers' knowledge, practices and injuries associated with pesticide exposure in rural farming villages in Tanzania. *BMC Public Health*, 14, 389.
31. Fenske, R. A., Lu, C., Negrete, M., & Galvin, K. (2013). Breaking the take home pesticide exposure pathway for agricultural families: workplace predictors of residential contamination. *American journal of industrial medicine*, *56*(9), 1063-1071.
32. Government of British Columbia. The Official Website of the Government of British Columbia. 2022 [cited 2024 Oct 20]. Pesticide re-entry intervals. Available from: https://www2.gov.bc.ca/gov/content/industry/agriculture-seafood/animals-and-crops/plant-health/pesticides-agriculture/pesticide-safety/re-entry-intervals
33. World Medical Association Declaration of Helsinki: Ethical Principles for Medical Research Involving Human Subjects Revised October 7, 2000. HIV Clin Trials. 1 févr 2001;2(1), 92-95.
34. Idrissi, M., Aït, D. N., Ouammi, L., Rhalem, N., Soulaymani, A., & Soulaymani, R. B. (2010). Intoxication aigüe par les pesticides: Données du Centre Anti Poison du Maroc (1989-2007). *Toxicologie Maroc*, *4*(1), 5-7.
35. Abubakar, Y., Tijjani, H., Egbuna, C., Adetunji, C. O., Kala, S., Kryeziu, T. L., ... & Patrick-Iwuanyanwu, K. C. (2020). Pesticides, history, and classification. In *Natural remedies for pest, disease and weed control* (pp. 29-42). Academic Press. Available from: https://linkinghub.elsevier.com/retrieve/pii/B9780128193044000038
36. Kaur, R., Mavi, G. K., Raghav, S., & Khan, I. (2019). Pesticides classification and its impact on environment. *Int. J. Curr. Microbiol. Appl. Sci*, *8*(3), 1889-1897.
37. WHO Recommended Classification of Pesticides by Hazard and Guidelines to Classification, 2019 Edition. 2nd ed. Geneva: World Health Organization; 2020. 1 p.
38. Ouakhssase, A., & Addi, E. A. (2023). Monitoring 432 potential pesticides in tomatoes produced and commercialized in Souss Massa region-Morocco, using LC-MS/MS and GC-MS/MS. *Environmental Pollution*, *337*, 122611.
39. FAO: Food and Agricultural Organization. FAOSTAT pesticide use. In. Available from: https://www.fao.org/faostat/en/#data/RP/visualize (consulted on 17/09/2024).
40. Imane, B., Mariam, A., Chakib, N., & Ahmed, Z. (2016). Pesticide use pattern among farmers in a rural district of Meknes: Morocco. *Open Access Library Journal*, *3*(12), 1-19.
41. Zhang, W. (2018). Global pesticide use: Profile, trend, cost / benefit and more. 2018.
42. Ben Khadda, Z., Fagroud, M., El Karmoudi, Y., Ezrari, S., Berni, I., De Broe, M., ... & Sqalli Houssaini, T. (2021). Farmers' knowledge, attitudes, and perceptions regarding carcinogenic pesticides in fez meknes region (Morocco). *International journal of environmental research and public health*, *18*(20), 10879.
43. Id El Mouden, O., Salghi, R., Zougagh, M., Rios, A., Chakir, A., El Rachidi, M., ... & Hormatallah, A. (2013). Pesticide residue levels in peppers cultivated in Souss Masa valley (Morocco) after multiple applications of azoxystrobin and chlorothalonil. *International journal of environmental analytical chemistry*, *93*(5), 499-510.
44. Alavanja, M. C., & Bonner, M. R. (2012). Occupational pesticide exposures and cancer risk: a review. *Journal of Toxicology and Environmental Health, Part B*, *15*(4), 238-263.
45. Wahab, A., Hod, R., Ismail, N. H., & Omar, N. (2016). The effect of pesticide exposure on cardiovascular system: a systematic review. *Int J Community Med Public Health*, *3*(1), 1-10.
46. Rhalem, N., Khattabi, A., Achour, S., Soulaymani, A., & Bencheikh, R. S. (2009). Facteurs prédictifs de gravité de l'intoxication aux pesticides. Expérience du Centre Antipoison du Maroc. In *Annales de Toxicologie Analytique* (Vol. 21, No. 2, pp. 79-84). EDP Sciences.
47. Berni, I., Menouni, A., El Ghazi, I., Godderis, L., Duca, R. C., & El Jaafari, S. (2021). Health and ecological risk assessment based on pesticide monitoring in Saïss plain (Morocco) groundwater. *Environmental Pollution*, *276*, 116638.
48. Dewi, Y. A., Yulianti, A., Hanifah, V. W., Jamal, E., Sarwani, M., Mardiharini, M., ... & Harsanti, E. S. (2022). Farmers' knowledge and practice regarding good agricultural practices (GAP) on safe pesticide usage in Indonesia. *Heliyon*, *8*(1), e08708.
49. Oliveira Pasiani, J., Torres, P., Roniery Silva, J., Zago Diniz, B., & Dutra Caldas, E. (2012).

Knowledge, attitudes, practices and biomonitoring of farmers and residents exposed to pesticides in Brazil. *International journal of environmental research and public health*, *9*(9), 3051-3068.

50. Benaboud, J., Elachour, M., Oujidi, J., & Chafi, A. (2021). Farmer's behaviors toward pesticides use: insight from a field study in Oriental Morocco. *Environmental Analysis, Health and Toxicology*, *36*(1), e2021002.
51. Sabran, S. H., & Abas, A. (2021). Knowledge and awareness on the risks of pesticide use among farmers at Pulau Pinang, Malaysia. *Sage Open*, *11*(4), 21582440211064894.
52. Lu, J. L. (2022). Knowledge, attitudes, and practices on pesticide among farmers in the Philippines. *Acta Medica Philippina*, *56*(1).
53. Mubushar, M., Aldosari, F. O., Baig, M. B., Alotaibi, B. M., & Khan, A. Q. (2019). Assessment of farmers on their knowledge regarding pesticide usage and biosafety. *Saudi journal of biological sciences*, *26*(7), 1903-1910.