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Pesticide exposure and acute health problems among pesticide processing industry workers in Ethiopia

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ABSTRACT

Occupational exposure to pesticides` manufacturing, formulating and applications can have a potential to harm humans` health in acutely or chronically. This study aims to assess pesticide exposure and acute pesticide intoxication among pesticide processing industry workers in Ethiopia. A cross-sectional study was conducted among 90 male pesticide processing industry workers` through face-to-face interviews. Data were collected using kobo Collect v2024.1.3 and exported to SPSS version 27 for analysis. Descriptive statistics and binary logistic regression were applied for statistical data analysis. The overall prevalence of acute pesticide intoxication (API) was 80 % (95 % CI 71.1 % - 87.4 %). Approximately, 60 %, 46.7 %, 42.2 %, 38.9 % and 33.3 % of the study participants reported experiencing pesticide exposure-related muscle weakness, headache, eye irritation, skin irritations and upper respiratory tract irritation, respectively. The factor found to be associated with pesticide intoxication was the improper utilization of personal protective equipment (PPE) regardless of time and season (AOR, 11; 95 % CI, 2.29, 48.83). Pesticide exposure-related acute health effects are a significant occupational health concern in this study. Inadequate and improper use of PPE increases the risk of these health effects. Therefore, proper PPE utilization and strict enforcement are crucial for protection.

1. Introduction

Pesticides are processed in two stages: first, the chemical synthesis of active ingredients from complex organic compounds; second, the formulation of these ingredients, which involves a mixing and grinding process [1,2].

Occupational exposure to hazardous chemicals in the pesticide industry occurs at every stage of production, including the handling of active ingredients and pesticide dusts. Workers may encounter solvent vapors during manufacturing, formulating, drying, and equipment cleaning. Additionally, airborne dust exposure can occur during drying, milling, and mixing. These hazards involve high concentrations of active ingredients and exposure to inert carriers, fillers, and additives, posing significant health risks [3]. In agricultural settings, farmers are exposed to occupational hazards while mixing and loading products, applying the spray solution, and cleaning up spraying equipment [4].

When safety precautions are not properly followed; the manufacturing, formulating and application of pesticides can harm both ecosystems and humans. Human exposure to pesticides can cause both acute and chronic effects [5,6].

Acute pesticide poisoning is a primary concerns regarding pesticide exposure. Acute poisonings are categorized as suicidal, intentional, and unintentional. One third of all suicides involve self-poisoning, accounting for 13.7 % of the global total of suicides [7]. This is the leading cause of death due to pesticide intake [8]. The number of suicides committed using pesticides in developing countries is much higher than in developed countries [9]. A study revealed that there were 110,000 pesticide self-poisoning deaths` in 108 countries from 2010 to 2014 [10]. Additionally, intentional pesticide poisonings often occur in response to stressful situations and frequently result from impulsive decisions [11].

Different studies conducted on occupational exposure to pesticides have reported sign and symptoms of pesticide intoxication including high blood pressure, asthma, depression, runny nose, watery itchy eyes,

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dizziness, loss of appetite, excessive anger, neurological and neuromuscular problems, respiratory issues as well as, ocular and skin problems[12,13]. Additionally, other studies indicated that high prevalence of acute and mental health symptoms such as headaches, mucosal irritation, tachycardia, depressive signs, poor attention, short memory, fatigue, dyspnea, wheezing, coughing and poor digestion [12,14].

A study conducted among insecticide manufacturing factory workers in Iran revealed that the prevalent symptoms among those exposed were headache, itchy skin, cough and sleeping disorders compared to non-exposed individuals [13].

Furthermore, some studies conducted in few countries have reported on the prevalence of self-reported acute pesticide intoxication. Research among farmers in Phnom Penh Cambodia revealed an overall prevalence of 88 % [15], while the prevalence was 85 % among farmers and plant protection agents in the Sahel region of Burkina Faso [16]. Additionally, the prevalence was 10 % among tobacco farmers in Brazil and 16 % among farmers in Jamaica [17,18].

Moreover, studies conducted on factors related to pesticide exposure revealed that pesticide exposure and intoxication were associated with less frequent and unusual use of personal protective equipment as well as with utilization, personal hygiene, behavior, knowledge, attitudes and the amount and types of pesticides exposure [12,19,20].

Studies conducted in various African countries revealed that the signs and symptoms of pesticide intoxication included headache, stomach cramps, muscular weakness, vomiting, dizziness, shortness of breath, blurred vision, eye irritation, diarrhea [21–23], respiratory symptoms (such as cough, shortness of breath and rhinitis), skin problems, sight problems, peripheral neuropathy, decreases libido, erectile dysfunction [24,25], lack of concentration, forgetfulness, increased fatigue [26], body weakness of neurological symptoms, perspiration, poor appetite and depression [23].

In Ethiopia, self-reported acute pesticide intoxications among large flower farm workers revealed an overall acute pesticide intoxication rate of 26 %. The most common symptoms were related to the nervous system followed by cardiovascular, gastrointestinal, respiratory, ocular and dermatologic factors [27]. Another study conducted among pesticide applicators also found that skin irritation, shortness of breath, cough and dizziness were reported more frequently compared to residents [28].

Exposure to pesticides in various settings particularly agricultural environment revealed a high prevalence of self- reported pesticide intoxications symptoms. The leading factors contributing to intoxications included improper use of personal protective equipment, inadequate personal hygiene, behavior, knowledge, attitude and the amount and types of pesticides exposure intoxications [12,19,20].

Empirical evidence has documented the acute and chronic health effects associated with pesticide exposure among populations in agricultural settings. However, reliable information regarding the health effects linked to pesticide exposure among workers in pesticide manufacturing and processing factories in low-income countries is limited, particularly in the locations of the present study. In Ethiopia, existing studies have primarily focused on workers in agricultural fields and flower farms. In this context, the study aims to investigate the acute health effects related to pesticides exposure and the contributing factors among workers in the pesticide processing industry in Ethiopia.

2. Methods

2.1. Study setting

The Pesticide Processing Share Company was founded in November 1997 in Batu Town, Oromia Regional state, Ethiopia. It was designed to produce 1500,000 liters of liquid pesticides and 1500,000 kg of dust and wettable powder annually. However, it was found that the actual capacity is much higher, reaching 2990,000 liters of liquid and 2295,000 kg of powder in one 8-hour shift over 250 days. The diatomite treatment plant can also process 1100 tons of fillers annually. During the data collection it was noted that the industry processes several organophosphate pesticides, including Malathion 50 % Emulsifiable Concentrate (EC), Malathion 5 % dust, Propiconazole 25 % EC, Diazinon 60 % EC, Chlorpyrifos 24 % Ultralow Volume (ULV), Chlorpyrifos 48 % EC, Dimethoate 40 % ULV, and Dimethoate 40 % EC. The formulations are tailored to seasonal and market demands.

2.2. Study design and participants

The cross-sectional study was conducted among male participants at a pesticide processing share company from August to September 2024. Employees from the production department, including those in technical, storage, and quality assurance roles participated in the data collection. Only male workers over six months of experience in production were included in the study [13]. Female workers were excluded due to the culture of the pesticide processing industry where they do not participate in production.

2.3. Sample size and sampling techniques

In this study, we aimed to include all male workers from production. To ensure comprehensive inclusion, we used the attendance sheet for production workers. The total numbers of production workers across various departments were 115. From these groups, we included only those workers actively engaged in production and excluded those who were on medical leave, annual leave and unwilling to participate. Ultimately, 90 male respondents were included in the study.

2.4. Data collection techniques

A questionnaire-based survey with personal interview was conducted. Data were collected using a pretested and structured questionnaire adapted from previous studies [21,22,27,29,30]. The survey included questionnaires about participants' socio-demographic traits, knowledge of pesticide exposure and its prevention methods, use of personal protective equipment (PPE), and health issues.

In the process of collecting data, the dependent variable Acute Pesticide Intoxication (API) was characterized based on the WHO standard case definition. This definition states that API encompasses as any health issues related to acute pesticide intoxication that occurred due to suspected or confirmed exposure to a pesticide within the last 48 hours over the past one year [31]. According to this definition, a person who reported experiencing at least two symptoms after being exposed to pesticides in the pesticide processing industry was said to have self-reported acute pesticide intoxication [25].

2.5. Data quality assurance

Two trained data collectors, one with a Master's in Epidemiology and the other a Health Officer, were involved in the data collection process. The principal investigator conducted a day-long training session for the data collectors to ensure the quality of data collection procedures. The interview guide tool (the questionnaire) was translated from English to the local language (Afan Oromo) and then back to English to maintain consistency. The tool was pretested on 10 % of the sample size, which included nine spray workers at Syngenta flower farms near Koka town, in eastern Ethiopia. Syngenta is an international flower farm company established in 2005. Today, the farm covers 108 ha producing cuttings for Pelargonium and Mandevilla. The industry is located in the Oromia Regional Government, East Shoa zone, Lume Woreda, Koka Negawo Kebelle.

The principal investigators and data collectors provided a clear introduction on the first page of the questionnaire explaining the participant the objective of the study and aims including the involvement of industry supervisors for added clarity.

Table 1
Socio-demographic characteristics of respondents of pesticide processing industry workers, Ethiopia.

Characteristics		Frequency	Percent
Age category	20–29 years	22	24.4
	30–39 years	31	34.4
	40–49 years	24	26.7
	≥ 50 years	13	14.5
Marital status	Single	20	22.2
	Married	70	77.8
Education	Secondary school	16	17.8
	Diploma and Technical	44	48.9
	Degree and above	30	33.3
Service years	< 5 years	18	20.0
	5 – 10 years	24	26.7
	> 10 years	48	53.3
Type of employment	Permanent	88	97.8
	Contract	2	2.2
Department	Production	59	65.6
	Technique	15	16.7
	Laboratory	9	10.0
	Store	7	7.8
Job categories	Machine operators	50	55.6
	Laboratory technicians	9	10.0
	Mechanic	10	11.1
	Electrician	5	5.6
	Store man	7	7.8
	Forman	6	6.7
	Janitor	3	3.3

2.6. Data analysis

Descriptive statistics were computed to display mean frequency and percentage. Chi-square, Bivariate and Multivariate logistic regression analyses were performed to identify factors associated with self-reported acute pesticide intoxication (API) and to adjust for confounding variables. The dependent variable was coded two categories as "0" for the respondents that do not report a symptom and codes as (No) and "1" for respondents reporting at least two of these symptoms and coded as (Yes). The associations were described using an odds ratio with a 95 % confidence interval. The logistic regression model was run to examine whether there was an association between the potential explanatory variables and the outcome variables. The cutoff for statistical significance was set at a p-value ≤ 0.05. Additionally, crude and adjusted odds ratio with their corresponding 95 % confidence interval were used to measure the strength of associations between the independent and outcome variables. The model`s goodness of fit was tested using the Hosmer and Lemeshow test which should be insignificant (greater than 0.05) and multicollinearity was assessed by calculating the Variance Inflation Factor (VIF) with values of less than 10 indicating no multicollinearity. Analyses were performed using IBM SPSS Statistics 27.0.1 (SPSS Inc., Chicago, IL, USA).

2.7. Ethical approval

Ethical approval was sought from the Jimma University Institute of Health Institutional Review Board Ref. No: JUIH/IRB/127/24. The purpose of the study was explained to each participant. Written informed consent was also obtained by getting both the signature on the approved consent form from the eligible workers prior to interview and that of the person obtaining consent. Confidentiality was granted for the information collected from each study participants. Only those consenting were interviewed by the investigators.

3. Result

3.1. Socio-demographic characteristics

A total of 90 male workers from the pesticide formulation industry workers were enrolled in the study. The mean age of the participants was 37.96 ± 9.25 years. Most of the workers have diploma or technical graduates 44 (48.9 %) followed by those with a degree or higher 30 (33.3 %). The majority of the participants were operator 55 (55.6 %) followed by Mechanic 10 (11.1 %). The largest department in the pesticides processing industry was production 59 (65.6 %). The results of the socio-demographic characteristics are shown (Table 1).

Table 2
Self -reported acute pesticide intoxication symptoms among pesticide processing industry workers, Ethiopia.

Pesticide exposure and self-reported health symptoms	Yes (Percent)
Neurological symptoms	
Headache,	42 (46.7)
Mood disturbances	34 (37.8)
Depression	31 (34.4)
Muscle weakness	54 (60.0)
Ringing in ears	21 (23.3)
Hearing loss	11 (12.2)
Trouble to sleeping	14 (15.6)
Loss of concentration	28 (31.1)
Numbness	11 (12.2)
Eye symptoms	
Eye irritations	38 (42.2)
Redness of eyes	27 (30.0)
Stinging of eyes	29 (32.2)
Blared vision	32 (35.6)
Lacrimation	14 (15.6)
Photophobia	16 (17.8)
Skin symptoms	
Skin irritation	35 (38.9)
Sweating	20 (22.2)
Rash on skin	12 (13.3)
Loss of fingernails	2 (2.2)
Respiratory symptoms	
Upper respiratory tract irritation	30 (33.3)
Runny nose	13 (14.4)
Chough	11 (12.2)
Wheezing	8 (8.9)
Shortness of breath	6 (6.7)
Tightness of chest	13 (14.4)
Cardiovascular, liver and kidney symptoms	
Hypertension	13 (14.4)
Tachycardia	10 (11.1)
Hematuria	3 (3.3)
Dysuria	13 (14.4)
Polyuria	10 (11.1)
Gastrointestinal symptoms	
Nausea	12 (13.3)
Vomiting	2 (2.2)
Abdominal cramps/pain	14 (15.6)
Diarrhea	4 (4.4)
Salivations	9 (10.0)
General or non-specific problems symptoms	
Chills	9 (10.0)
Hot sensations	15 (16.7)
Myalgia	18 (20.0)
Thirst	4 (4.4)

3.2. The prevalence of self-reported acute pesticide intoxications (API) among the pesticide processing industry workers

The overall prevalence of self-reported acute pesticide intoxication was 80 % (95 % CI: 71.1 % - 87.4 %). Among those who experienced acute pesticide intoxications, the most commonly reported symptoms included muscle weakness 60 %, headache 46.7 %, eye irritations 42.2 %, skin irritation 38.9 % and upper respiratory tract irritation 33.3 % (Table 2). Additionally, among systematic symptoms the leading were neurological symptoms 67.8 %; eye symptoms 47.8 % and Skin symptoms 22.2 % (Fig. 1).

The analysis of variables indicating the prevalence of Acute Pesticide Intoxication (API) reveals several insights. Among individuals aged 30–39, 27.8 % reported experiencing API, while 46.7 % of those with

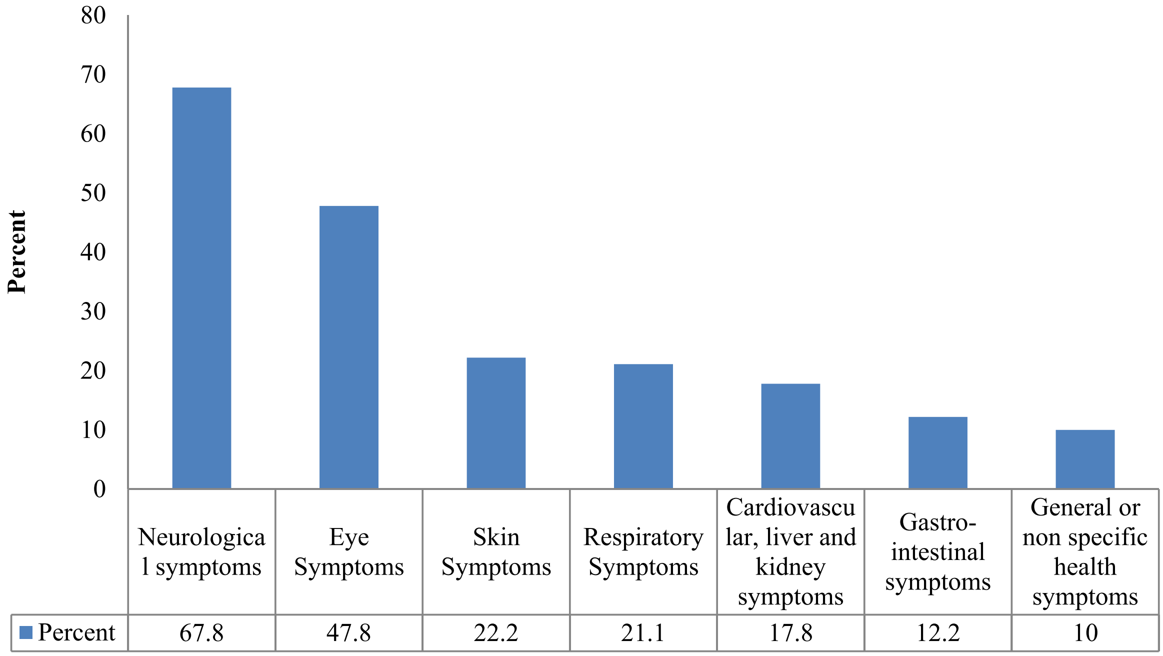

Fig. 1. ; Common systematic acute pesticide intoxications.

Table 3
Prevalence of self – reported acute pesticide intoxication among pesticide processing industry workers, Ethiopia.

Variables		Self-reported acute pesticide intoxications (API)	
		No n (%)	Yes n (%)
Age category	20–29 years	10 (11.1)	12 (13.3)
	30–39 years	6 (6.7)	25 (27.8)
	40–49 years	1 (1.1)	23 (25.6)
	≥ 50 years	1 (1.1)	12 (13.3)
Service years	< 5 years	8 (8.9)	10 (11.1)
	5–10 years	4 (4.4)	20 (22.2)
	> 10 years	6 (6.7)	42 (46.7)
Marital status	Single	8 (8.9)	12 (13.3)
	Married	10 (11.1)	60 (66.7)
Department	Production	11 (12.2)	48 (53.3)
	Technique	2 (2.2)	13 (14.4)
	Laboratory	3 (3.3)	6 (6.7)
	Store	2 (2.2)	5 (5.6)
Job Category	Operator	6 (6.7)	44 (48.9)
	Laboratory	3 (3.3)	6 (6.7)
	Mechanic	0 (0.0)	10 (11.1)
	Electrician	2 (2.2)	3 (3.3)
	Store	2 (2.2)	5 (5.6)
	Forman	3 (3.3)	3 (3.3)
	Janitor	2 (2.2)	1 (1.1)
Proper PPE utilization	No	4 (4.4)	46 (51.1)
	Yes	14 (15.6)	26 (28.9)

n = Frequency, PPE = Personal Protective Equipment

over 10 years of service and 66.7 % of married workers also reported it. The production sector showed the highest prevalence at 53.3 %, followed by the technical department at 14.4 %. In terms of job categories, operators had the highest prevalence at 48.9 % followed by mechanics at 11.1 %. Regarding the appropriate utilization of personal protective equipment (PPE) in relation to time and season, 51.1 % of workers who didn`t utilize PPE reported experiencing API (Table 3).

3.3. *Factors associated with self-reported Acute Pesticide Intoxications*

Factors associated with the prevalence of acute pesticide intoxication included age category, service years, marital status of the workers and proper utilization of personal protective equipment regardless of time and season. These were significant (P. value <0.05) in bivariate analysis and included for multivariate logistic regression. Even though age category, service years, and marital status were significant associations in the bivariate analysis, their significance diminished in the multivariate analysis due to potential confounders. Thus, the improper utilizations of personal protective equipment, regardless of time and season was significantly associated (AOR, 11; 95 % CI, 2.29, 48.83) with acute pesticide intoxications (API) in the multivariate logistic regression analysis (Table 4).

4. Discussion

This assessment is based on the evidence related to acute pesticide poisoning, pesticide exposure, and self-reported incidents of acute pesticide intoxication. It represents the first research of its kind conducted in the country regarding the exposure of workers in the pesticide processing industry. This study is essential for developing effective strategies that promote the consistent implementation of safety practices to mitigate the high prevalence of self-reported acute pesticide poisoning observed at the industry level.

The current study revealed that the prevalence rate of self- reported acute pesticide intoxication (API) was 80 %. This implies that the prevalence was higher than that found in studies conducted in Brazil among cotton farmers (10 %) [17], Jamaican farmers (16 %) [18] and Ethiopian flower farms (26 %) [27], but lower than studies conducted among Phnom Penh famers in Cambodia (88 %) [15], and in the Sahel region of Burkina Faso among farm workers and plant protection agents (85 %) [16]. These differences might be due to varying levels and types of pesticide exposure, the provision and utilization of personal protective equipment and enforcement of safety training regulations. Additionally, the awareness level of respondents regarding the impact of pesticide exposure, personal hygiene practices and work settings may also contribute to these disparities [18,30]. Furthermore, exposure to pesticide in the processing industry differs significantly from exposure in agricultural farming areas. In the industry, workers directly exposed to the active ingredient of pesticides and formulating chemicals, whereas in agricultural setting workers exposed only to formulated or diluted pesticide.

Table 4
Factors associated with acute pesticide intoxications (API) among pesticide processing industry workers, Ethiopia.

Variables	Self-reported acute pesticide intoxications(API)						
		No n (%)	Yes n (%)	X^2	P- value	COR (95 % CI)	AOR (95 % CI)
Age category	20–29 years	10 (11.1)	12 (13.3)	13.9	0.003 *	0.10 (0.01–0.91)* *	0.06 (0.02–1.96)
	30–39 years	6 (6.7)	25 (27.8)			0.35 (0.04 – 3.22)	0.49 (0.04–6.06)
	40–49 years	1 (1.1)	23 (25.6)			1.92 (0.11–33.41)	2.88 (0.14–57.73)
	≥ 50 years	1 (1.1)	12 (13.3)			1	1
Service years	< 5 years	8 (8.9)	10 (11.1)	8.57	0.014 *	1	1
	5–10years	4 (4.4)	20 (22.2)			4 (0.97–16.55)	2.04 (0.26 – 16.16)
	> 10 years	6 (6.7)	42 (46.7)			5.6 (1.58 – 19.81)* *	0.86 (0.06 – 12.88)
Marital status	Single	8 (8.9)	12 (13.3)	6.439	0.011 *	1	1
	Married	10 (11.1)	60 (66.7)			4 (1.31–12.23)* *	0.85 (0.14 – 5.19)
Proper PPE utilization	No	4 (4.4)	46 (51.1)	10.13	0.001 *	6.2 (1.84 – 20.78)* *	11 (2.29– 48.83)* **
	Yes	14 (15.6)	26 (28.9)			1	1

Abbreviations: n = Frequency, * Significant at P < 0.05 of chi-squared test (X^2), * * Significant at P < 0.05 bivariate analysis, * ** Significant at P < 0.05 multivariate analysis, COR- Crude odd ratio, AOR- Adjusted odd ratio, CI- Confidence intervals, PPE Personal Protective Equipment

When the study was conducted, the most commonly produced pesticides in the industry were organophosphates such as Malathion 50 % Emulsifiable Concentrate (EC), Malathion 5 % dust, Diazinon 60 % EC, Chlorpyrifos 24 % Ultralow Volume (ULV), Chlorpyrifos 48 % EC, Dimethoate 40 % ULV, and Dimethoate 40 % EC. Workers` exposure to processing organophosphate pesticides industry may experience acute symptoms known as SLUDGE (i.e. salivation, lacrimation, urination, defecation, gastric cramps, and vomiting) due to cholinergic overstimulation. Severe exposure can lead to muscle twitching, excessive sweating, and unresponsiveness [32]. The muscarinic effects of organophosphate intoxication can be recalled using the acronym DUMBELS: Diaphoresis, Urination, Miosis, Bronchospasm/Bronchorrhea, Emesis, Lacrimation, and Salivation [33].

Specific pesticides like Malathion toxicity influenced by its reactive metabolites and several factors such as product purity, exposure route, nutritional status, and gender. In mammals, insects, and plants, malathion metabolizes to malaoxon, which is significantly more toxic and responsible for its harmful effects. Symptoms of malathion exposure can include numbness, headaches, dizziness, breathing difficulties, weakness, skin irritation, abdominal cramps, and potentially death. Like other organophosphates, malathion inhibits acetylcholinesterase, leading to an accumulation of acetylcholine, overstimulation of receptors, and adverse biological effects [34].

Chlorpyrifos exposure can lead to acute toxicity, starting with symptoms such as headaches or rashes. As the condition progresses, it may cause seizures or coma, and in severe cases, it could result in death. Generally, work-related exposure to chlorpyrifos can lead to symptoms similar to those of other organophosphate pesticide intoxications including bradycardia, weakness, excessive sweating, paralysis, salivation, tearing, pulmonary oedema, headache, dizziness, fasciculations, vomiting, diarrhea, abdominal cramps and dyspnea [35].

Diazinon, the another organophosphate pesticide, is regarded as a moderately hazardous. High-level exposure to diaznon results cholinergic symptoms that can arise from significant inhibition of acetyl cholinesterase (AChE). Symptoms of muscarinic toxicity include bronchoconstriction, increased secretions, bradycardia, nausea, diarrhea, hypotension, miosis, and urinary incontinence. Nicotinic effects include tachycardia, hypertension, muscle twitching, and cramping. Severe exposure poses risks of respiratory and cardiac failure, which can be lethal if medical attention is delayed; central nervous system effects include anxiety, confusion, drowsiness, seizures, and respiratory depression [36].

The current study showed that the frequent self-reported symptoms reported include muscle weakness, headache and eye irritations were among the leaders. This finding was similar with other studies conducted in different countries with in different study settings [12,14,21–23,26,28,37]. Comparable to this study setting, another investigation on Iranian workers in insecticide production factories found that headache, itchy skin, coughing, and sleep disturbances were more common in exposed workers than in non-exposed workers [13].

Additionally, this finding revealed that the leading systematic self-reported acute pesticide intoxication symptoms were neurological symptoms followed by ocular and skin problems or dermatological symptoms. This study also similar to other studies [23–26]. These similarities might be due to all pesticides are toxic; they are also potentially hazardous to humans irrespective of the type of occupation. Hence, people who utilize pesticides or regularly exposed with them must recognize the relative toxicity, potential health effects, and preventative actions to reduce exposure to the products they use [38]. Organophosphate pesticides inhibit acetylcholinesterase (AChE), leading to cholinergic symptoms and inducing neuropathy in the nervous system. This occurs through specific interactions with nicotinic or muscarinic receptors, phosphorylating acetylcholinesterase or neuropathic target esterase, which heightens neurological effects [36,39].

Besides to the acute effect of occupational pesticide exposure, the long term exposure of the pesticide industry workers might lead to cancer, neurological disorders, birth defects, reproductive harm, leukaemia, lymphoma, brain tumors, male sterility, neurobehavioral disorders, peripheral neuropathies, neurodegenerative diseases and endocrine disruptions [40,41]. So, from this study if acute symptoms are the main problem of the workers, the workers long term exposure to pesticide leads to chronic health problems. Hence, appropriate safety measures are the main activities should be followed in this industry.

Furthermore, regarding to the main leading factor, the odds of developing pesticide exposure related health outcomes were 11 times higher among the workers who didn't use PPE compared to their counterparts who did use PPE (95 % CI: 2.29, 48.83). The result was aligned with the study conducted in Brazil [12] and Indonesia [19,20]. The reason these studies are similar is that if industry workers and farmers do not properly utilize personal protective equipment, they are exposed to high doses of pesticides. If the pesticides entered to human being it starts to manifest itself by developing sign and symptoms of the acute pesticide intoxications systematically or locally. Using Personal Protective Equipment (PPE) can greatly reduce exposure to pesticides potential routes of entry include dermal, respiratory, eye, and oral exposure. When workers properly utilize PPE consistently, regardless of time or season, they minimize or block these routes of pesticide entry to their bodies. This, in turn, reduces the risk of acute pesticide intoxication (API) [42–44].

5. Conclusion

Pesticide exposure-related acute health effects are a significant occupational health concern in this study. Among the acute health effects muscle weakness, headache, eye irritations and skin disorders are the leading symptoms. Inadequate and improper use of PPE increases the risk factors of these health effects. Additionally, even though the study followed the WHO definition of pesticide intoxication as strength; relaying of the study on self-reported questionnaires alone and recall bias were among the limitations. Therefore, it is necessary to carryout additional test like biological test to assess pesticides` exposure biomarkers among the workers and proper PPE utilization and strict enforcement are crucial for protection.

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CRediT authorship contribution statement

Mekonen Seblework: Writing – review & editing, Visualization, Validation, Software, Methodology, Formal analysis, Data curation. **Gure Abera:** Writing – review & editing, Methodology, Formal analysis. **Tucho Gudina Tefera:** Methodology, Formal analysis . **Hailu Ashenafi:** Writing – original draft, Visualization, Supervision, Software, Resources, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

Data will be made available on request.

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