

Retrospective Analysis of Pesticide Poisoning in Rural Area

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ABSTRACT

Acute pesticide poisoning is an important public health problem. This research was done for the purposes of retrospectively examining the relationships between the recorded pesticide poisonings and socio-demographic factors.

This retrospective descriptive study was conducted between December 2017 and February 2018. It was examined that thirty-two cases presented for pesticide poisoning between January 1, 2008 and December 31, 2017 to the Emergency Service of the Kumluca Public Hospital. The hospital records were used to collect the research data. The χ^2 test and logistic regression analysis were used, as well as descriptive statistics.

It was found that 12 cases used pesticides to commit suicide, and 9 cases presented to psychiatry polyclinics after a suicide attempt. It was found that pesticide poisoning was mostly in spring. The poisonings occurred most often via the gastrointestinal tract, inhalation, skin respectively. It was found that poisoning in order to attempt suicide in women were higher, and accidental and professional poisonings in men were higher. In the logistic regression analysis, it was found that the use of pesticides to commit suicide differed according to the gender (OR = 0.070, $p < 0.05$).

This study revealed the existence of pesticide poisonings, and especially, suicidal attempts due to pesticides in a rural area.

Key Words: Pesticide, pesticide poisoning, retrospective, rural

Introduction

Acute pesticide poisoning is an important professional disease and public health problem in both undeveloped and developing countries (1-3). In many countries, the rate of pesticide poisonings is not known due to the inadequacies and weaknesses in the recording systems (4,5). Moreover, the ease with which pesticides can be obtained can increase the poisoning rate (1,5). Many of the pesticides responsible for poisoning people are neurotoxic agents, such as cholinesterase inhibitors. The soluble lipid forms of the pesticides in the organophosphate group, especially, can lead to long term systemic effects by accumulating in the liver and brain (6). In addition, severe poisoning related to certain organochlorines can lead to status epilepticus (7). Acute exposure to phosphite, which is another type of pesticide, via digestion can affect many organs, and it can also lead to death as a result of cardiac insufficiency. Individuals lose their lives due to exposure, despite intensive care, because there are no special antidotes for these products.

Acetylcholinesterase inhibition is the primary mechanism of toxicity in pesticides.

Acetylcholinesterase can be found in the central nervous system, peripheral nervous system, neuromuscular junction, and erythrocytes, and its central role is to stimulate neurotransmitter activity (8,9). When organophosphates inhibit this enzyme, acetylcholine accumulates at the synapses, causing excessive receptor stimulation (10,11). Cholinergic symptoms can be seen as a result of this type of poisoning (12), and these symptoms can last from a few minutes to a few hours. Life threatening situations can occur in the central nervous, cardiovascular, respiratory, gastrointestinal, and musculoskeletal system via the distribution of cholinergic neurons.

Mental health researchers and clinicians have recently begun to pay attention to the effects of environmental and professional exposures to certain chemicals on the neurochemical activity in the brain and the occurrence of psychiatric disorders. Current research shows that excessive exposure to organophosphates is related to high rates of depression and suicide, especially among agricultural workers (13-16). The use of pesticides for the purpose of committing suicide via digestion is an important problem in many Asian countries, including India, Sri Lanka, and Pakistan.

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Received: 16.01.2019, Accepted: 17.05.2019

■ AUTUMN ■ WINTER ■ SPRING ■ SUMMER

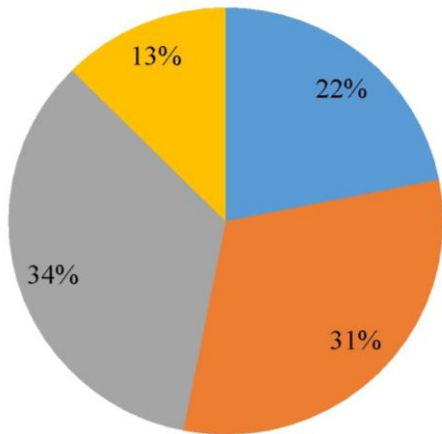


Fig 1. Seasonal distribution of poisoning cases

While the mortality rate related to deliberately trying to poison oneself is 15–30% in India, this rate is approximately 1–2% in developed countries (17,18). Worldwide, the suicide attempt rate via the use of pesticides constitutes 14–20% of all general suicide attempts (19). Nearly one million people lose their lives due to suicides every year, and it is estimated that the deaths caused by chemical products in the pesticide group number approximately 370,000 (20).

Agriculture is one of the main means of living in rural areas in low and middle income countries; therefore, pesticides are easier to obtain in these areas. Even if pesticides are ingested at low doses, they can show highly toxic effects (21). Exposure to pesticides at acute and chronic levels can lead to many neurodegenerative diseases, such as neurobehavioral disorders, cognitive impairment, peripheral nervous system changes, neuropathy, Alzheimer’s disease, and Parkinson’s disease, as well as depression and suicide (22-24). Although depression and suicide show different results, and they can be analyzed individually, they are not totally independent from each other, because depression is the most common cause of a suicide attempt (25). Attempted suicide is a complex condition that needs to be researched and examined in many aspects. Although working in an agricultural area has been shown to be a risk factor for suicide in many studies in the literature, other situations, apart from pesticide exposure, must also be assessed. Agricultural workers can encounter many different dangers, such as chemical exposure in work areas, work equipment use, heavy machinery use, and extreme physical activity. All these can put an individual at risk for substance abuse, injuries, and suicide attempts (26). Moreover, agricultural workers can be a more

■ GIS ■ INHALATION ■ SKIN

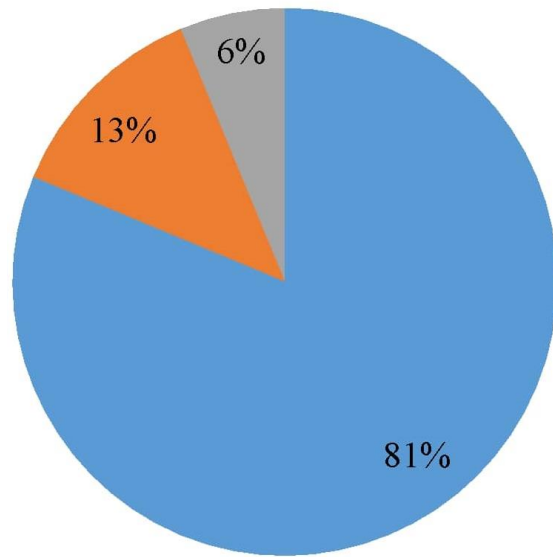


Fig 2. Distribution of cases according to the poisoning route

sensitive group with regard to the suicide risk due to many sociodemographic factors, including a low educational level, low family income level, social isolation, and insufficient personal protective equipment usage (13). In recent years, different strategies have been used in order to decrease suicide attempts with various implementations, such as keeping pesticides in locked cupboards (27). Even if this approach is advantageous, especially for the pesticide industry, an extensive study was done in Sri Lanka showed that it was not very effective (28).

Greenhouse agriculture is generally done in areas with a mild climate, and it is commonly seen in our country (Turkey), which is in the Mediterranean region. According to the United Nations Food and Agriculture Organization (FAO) data, “greenhousing” is done in a 1.2 million hectare area around the world today. The largest greenhousing area in the world includes the Mediterranean basin, and Turkey has bigger greenhousing potential than the other Mediterranean countries. Turkey ranks fourth in the world in greenhousing area. It ranks third among the Mediterranean countries, after Spain and Italy, and it ranks second after Spain in terms of the greenhousing area in which vegetables are grown. When it comes to domestic areas, the region from which the research data was taken is placed first in greenhousing production (29).

■ SUICIDE ■ ACCIDENT ■ OCCUPATIONAL ■ UNKNOWN

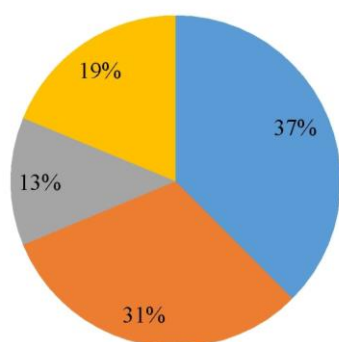


Fig 3. Distribution of cases according to poisoning situation

The epidemiological data is limited in terms of the direct effects of chronic or low dose pesticide exposure, and many epidemiological and sociodemographic factors play roles in the relationship between depression and suicide. However, recent views suggest that pesticide exposure can be a risk factor for depression and suicide. The fact that many of the suicide attempts are coded as poisonings in the country's data set makes the analysis of cases more difficult. Therefore, this research was done for the purposes of retrospectively examining the relationships between the recorded pesticide poisonings and the sociodemographic factors.

Materials and Methods

Research type: This retrospective descriptive study was conducted between December 2017 and February 2018. Thirty-two cases (14 females, 18 males) who presented for pesticide poisoning between January 1, 2008 and December 31, 2017 to the Emergency Service of the Kumluca Public Hospital were examined in this research.

Data collection: A data record form was prepared by the researchers in line with literature, and the hospital records were used to collect the research data. The form included questions about the age, gender, type of chemical or drug causing the poisoning, whether drugs were used to commit suicide or not, season in which the poisoning occurred, poisoning route, suicide attempt situation, symptoms and findings in the case, and necessity for intensive care. The poisoning situations were classified as follows: a - suicide, b - accident, c - professional, d - homicide, and e - unknown circumstances. The data was collected from the condition of the patients while they were presenting in those cases in which the records were uncertain. For instance, a case in which an

adult took the pesticide deliberately through the gastrointestinal tract was assessed as a suicide attempt, while that of a child that took the pesticide through the gastrointestinal tract was assessed as an accident. Similarly, a pesticide poisoning during implementation was classified as a professional poisoning, while poisoning someone else deliberately was classified as a homicide.

The patient results were classified as follows: a-recovery, b-escaping, c-referring, d-refusing treatment, e-death, and f-unknown circumstances. The agents to which the patients were exposed were classified as: a - insecticide or b-other.

Data Analysis: IBM SPSS (version 23.0) statistics package program was used in the assessment of data. The χ^2 test and logistic regression analysis were used, as well as descriptive statistics, in the examination of the relationships between the poisoning situation and the exposure agent, age, gender, and poisoning result.

Ethical Principles: Patient consent was not required in this study because only the recorded data was used. Approval was obtained from the Akdeniz University Medical Faculty Clinical Studies Ethics Committee (70904504/19-28), and written permission was provided by the health institution from which the data was obtained.

Limitations: Distinguishing pesticide poisonings is difficult, because poisonings are only coded in one category in hospital record systems. In addition, the agent to which the patient was exposed, the poisoning severity, and the results were not documented systematically, constituting a limitation for this research.

Results

When the general characteristics of the poisoning cases were examined, it was found that 12 cases used pesticides to commit suicide, and 9 cases presented to psychiatry polyclinics after a suicide attempt. The symptoms and findings were not generally provided, with the exception of a stomachache in one case, and severe sweating and a slight increase in the creatinine values in another case. The follow-ups included intensive care after a gastric lavage and the implementation of activated charcoal in the suicide attempts and gastrointestinal tract poisonings. The patients were followed-up in the emergency service in those poisonings that were due to inhalation and skin exposure (Table 1).

Table 1. General characteristics of the pesticide poisoning cases

Age*	Gender*	Exposure agent	Route of poisoning**	Suicide situation	Poisoning season	Symptoms and findings	Psychiatric polyclinic application	Necessity for intensive care
30	Female	Insecticide	GIS	Yes	Winter	Absent	Yes	Gastric lavage, activated charcoal, follow-up in intensive care
44	Male	Insecticide	GIS	Yes	Winter	Absent	No	Gastric lavage, activated charcoal, follow-up in intensive care
1	Female	Other pesticide	GIS	No	Spring	Absent	No	Follow-up in emergency service
15	Female	Insecticide	GIS	Yes	Spring	Absent	Yes	Gastric lavage, activated charcoal, follow-up in intensive care
5	Male	Other pesticide	GIS	No	Summer	Absent	No	Clinical inpatient and follow-up
65	Male	Insecticide	GIS	No	Autumn	Absent	No	Follow-up in emergency service
2	Male	Insecticide	GIS	No	Summer	Absent	No	Gastric lavage, activated charcoal, follow-up in intensive care
64	Male	Insecticide	GIS	No	Autumn	Absent	No	Follow-up in intensive care
3	Male	Insecticide	GIS	No	Autumn	Absent	No	Clinical inpatient and follow-up
22	Female	Insecticide	GIS	Yes	Spring	Absent	No	Gastric lavage, activated charcoal, follow-up in intensive care
33	Male	Insecticide	GIS	No	Spring	Absent	No	Follow-up in emergency service
51	Male	Insecticide	Inhalation	No	Spring	Absent	No	Follow-up in emergency service
46	Female	Insecticide	GIS	Yes	Spring	Absent	Yes	Follow-up in intensive care
43	Female	Insecticide	GIS	Yes	Autumn	Absent	Yes	Gastric lavage, activated charcoal, follow-up in intensive care
22	Male	Insecticide	GIS	No	Summer	Absent	No	Gastric lavage, activated charcoal, follow-up in intensive care
2	Male	Insecticide	GIS	No	Spring	Absent	No	Clinical inpatient and follow-up
1	Male	Insecticide	GIS	No	Winter	Absent	No	Clinical inpatient and follow-up
2	Female	Insecticide	Skin	No	Spring	Absent	No	Follow-up in emergency service
26	Male	Insecticide	Inhalation	No	Autumn	Absent	No	Follow-up in intensive care
52	Male	Insecticide	GIS	No	Autumn	Stomachache	No	Gastric lavage, follow-up in

								emergency service
49	Female	Insecticide	GIS	Yes	Winter	Absent	Yes	Gastric lavage, activated charcoal, follow-up in intensive care
30	Female	Insecticide	GIS	Yes	Winter	Absent	Yes	Gastric lavage, follow-up in intensive care
17	Female	Other pesticide	GIS	Yes	Spring	Absent	Yes	Follow-up in intensive care
38	Female	Insecticide	GIS	Yes	Winter	Absent	No	Gastric lavage, activated charcoal, follow-up in intensive care
47	Female	Insecticide	GIS	No	Winter	Absent	No	Gastric lavage, activated charcoal, follow-up in intensive care
19	Male	Insecticide	GIS	Yes	Autumn	Absent	Yes	Gastric lavage, activated charcoal, follow-up in intensive care
31	Female	Insecticide	GIS	No	Winter	Absent	No	Gastric lavage, activated charcoal, follow-up in intensive care
37	Male	Insecticide	GIS	Yes	Winter	Absent	Yes	Gastric lavage, activated charcoal, follow-up in intensive care
17	Female	Insecticide	Inhalation	No	Spring	Absent	No	Follow-up in emergency service
45	Male	Insecticide	GIS	No	Winter	Absent	No	Refusing treatment
27	Male	Insecticide	Inhalation	No	Summer	Absent	No	Follow up in emergency service
72	Male	Insecticide	GIS	No	Summer	Severe sweating, slight increase in creatinine	No	Gastric lavage, activated charcoal, follow-up in intensive care

*Gender and age averages: Females (43.8%, 27.71±15.97 years old), males (56.2%, 31.66±23.60 years old)

**GIS: Gastrointestinal system

Table 2. Relationships between the gender and the poisoning data

	Gender (Number, %)		Test and significance
	Female	Male	
Exposure agent			
Insecticide	12 (85.7%)	17 (94.4%)	$\chi^2=0.706$
Other	2 (14.3%)	1 (5.6%)	$p=0.568$
Poisoning route			
GIS*	12 (85.7%)	14 (77.8%)	$\chi^2=0.664$
Inhalation	1 (7.1%)	3 (16.7%)	$p=0.717$
Skin	1 (7.1%)	1 (5.6%)	
Poisoning situation			
Suicide	9 (64.3%)	3 (16.7%)	$\chi^2=7.890$
Accident	2 (14.3%)	8 (44.4%)	$p=0.048$
Occupational	1 (7.1%)	3 (16.7%)	
Unknown	2 (14.3%)	4 (22.2%)	
Poisoning season			
Autumn	1 (7.1%)	6 (33.3%)	$\chi^2=10.231$
Winter	6 (42.9%)	4 (22.2%)	$p=0.017$
Spring	7 (50.0%)	3 (16.7%)	
Summer	0 (0.0%)	5 (27.8%)	
Patient results			
Recovery	13 (92.9%)	11 (61.1%)	$\chi^2=4.305$
Referring	1 (7.1%)	6 (33.3%)	$p=0.116$
Refusing treatment	0 (0.0%)	1 (5.6%)	

*GIS: Gastrointestinal system

It was found that 34% of the cases presented to the emergency service in the spring, with 31% in winter, 22% in autumn, and 13% in summer (Figure 1). The poisonings occurred most often via the gastrointestinal tract (81%) (inhalation 13%, skin 6%) (Figure 2).

When the case distribution was examined according to the poisoning situation, the highest number of poisonings was related to suicides (37%). In addition, 31% of the patients were poisoned accidentally, 13% of them were poisoned during occupational application, and in 19% of them, the poisoning situation was unknown (Figure 3).

When the relationships between the poisoning data and the genders of the cases were examined, it was found that poisoning in order to attempt suicide in women were higher, and accidental and professional poisonings in men were higher. In addition to this, poisoning was seen more often in women in the spring and winter, while it was seen more often in the autumn and summer in men ($p < 0.05$). No statistical significances were found among the exposure agents, poisoning routes,

poisoning situations, and patient results according to the gender ($p > 0.05$) (Table 2).

In the multivariable analysis was done using logistic regression, it was found that the use of pesticides to commit suicide differed according to the gender [Odds Ratio (OR) = 0.070, $p = 0.009$]. However no relationship was confirmed between the pesticide exposure type and the use of pesticides to commit suicide (OR = 0.214, $p = 0.311$) (Table 3).

Discussion

The WHO describes pesticide poisoning as the most important suicide instrument in the world (30). The unprotected and unconscious use of pesticides threatens human life, and it can lead to environmental problems. Pesticide poisoning can occur as a result of agricultural usage, accidental exposure, and purposeful use to commit suicide and murder (31). Although most pesticides are used in developed countries and countries with higher economic power, most pesticide poisonings occur in undeveloped and developing countries.

Table 3. Logistic regression analysis of the use of pesticides to commit suicide, gender of the cases, and pesticide exposure types

Characteristics	OR (Odds Ratio)	p*
	(95% CI)	
	Used for committing suicide	
Gender (Female-Male)	0.070 (0.010–0.512)	0.009
Exposure agent (Insecticide-Other)	0.214 (0.011–4.223)	0.311

*p < 0.05

This situation generally stems from a lack of information about safe standards, not using personal protective equipment, not reading the pesticide labels, and not having enough information about the harm that pesticides can do (32).

This research determined that the gender and average age of the cases were similar. In addition, the vital signs and findings (except for a stomach ache in one case, and severe sweating and a rise in the creatinine in another case) after the poisonings were not found. No deaths due to poisoning were seen in any of the cases, and it was confirmed that they were followed-up with emergency service interventions and intensive care. Several symptoms, such as depression, joylessness, fatigue, lack of energy, stress, and anxiety, were seen in one study in people experiencing pesticide poisoning, and a decrease in energy and activity was confirmed in the poisoned group (33). In addition, findings regarding regression in the neurobehavioral functions, such as the coordination, reaction time, continuous attention, and memory weakness, in the poisoning cases were confirmed in several studies (34,35). The symptom durations and findings after poisoning were related to several factors, including the quantity and density of the exposure agent and the time that passed until presenting to the health institution, and it is believed that the differences among the study results stem from this situation.

It was also found that the pediatric cases tended experienced pesticide poisoning accidentally. In support of our study findings, many of the previous studies also determined that children experienced pesticide exposure accidentally (36-38). Children are curious by nature, and they like discovering new things, which means that they have a tendency to get hurt. A poisoning can occur when the negligence of the parents is added to a child's sense of wonder. For this reason, pesticides and chemicals must be kept away and stored in locked cupboards. It is very important that measures be taken to keep these substances where children cannot reach them.

The results of this research showed that the poisonings occurred more often in the spring and winter months. In the study, which differed from our findings, it was determined that the pesticide poisoning cases occurred most often in the summer and winter months (39). It was reported that they occurred most often in the spring and summer, and that the deaths due to pesticide poisoning reached the highest level in June (40). In addition, it was reported that poisoning occurred most often during the summer months (41). When this difference among the study results is considered in terms of the pesticide usage time, it can be explained by the pesticide use during different times of the year and in different geographical regions. However, when the poisoning situation is assessed, it is believed that their use to commit suicide is not affected by the season, and that this can occur at any time of the year. The fact that suicidal poisonings contribute toward the biggest share of the cases in all of the studies also supports this view.

This research confirmed that the poisonings occurred most often through the gastrointestinal tract. Previous studies also showed that most of the pesticide poisoning cases occurred through the gastrointestinal tract, with cutaneous exposure being secondary (38,39,42). While exposure through the gastrointestinal system can occur accidentally, and this route can be used to commit suicide, it is believed that exposure through the skin and inhalation tends to occur accidentally or during professional implementation.

Based on the study results, the agent causing poisoning was generally an insecticide. As in this study, previous research conducted in many developing countries has determined that insecticides are the main pesticide agent causing poisoning (17,31,42,43). One study conducted in Brazil confirmed that insecticides were responsible for 75% of the poisonings that occurred between 1992 and 2002 (44). Similarly, in a study, it was found that herbicides and fungicides were the main pesticides that were responsible for poisoning, in addition to insecticides (33).

This research showed that the poisonings occurred most often with an intention to commit suicide. Following this, they occurred accidentally and through professional implementation. One study reported that the high suicide rates were seen in agricultural workers were related to acute and chronic pesticide exposure and affective disorders (45). Additionally, it was shown that exposure to pesticides increased psychiatric disorders and suicidal behaviors (14,34,46,47). A study conducted in Brazil reported that the mortality rate due to suicides in agricultural workers between 20 and 39 years old who used pesticides frequently (professionally) was significantly high when compared to the general population (13). However, one large scale cohort study showed that there was no relationship between pesticide exposure and suicide attempts (48). Like our study findings, it was found that the number of suicidal poisonings was higher than that of accidental poisonings (42). Moreover, another study in Costa Rica reported that professional poisonings were the third most frequently seen poisoning type, after poisonings to commit suicide and accidentally (49). It has also been reported in other studies that 60–80% of pesticide poisonings were the result of a suicide attempt (31,38,40,50). Other studies in the literature support our finding that accidental poisoning is the second most common type, following suicidal poisoning (51,52).

It was found that the suicidal poisoning rate was higher in women, while accidental poisonings and poisonings during professional use were higher in men. The first study about the relationship between pesticides and suicide attempts was done in the 1990s. Following the first decade, several studies about pesticide exposure leading to many health problems as well as increasing suicide attempts and their relationships with agricultural workers were published. Some of these studies reported that the frequency of depression was higher in male agricultural workers than in the men in all other fields. Results also show that the suicide risk was higher (14). Studies supporting our findings shown that the rates of self-poisoning with the use of pesticides were high, especially young women (53,54). Men tend to experience pesticide poisoning accidentally and professional poisoning more often because, generally, men implement chemical pesticides while working in greenhouses (42). One study found that pesticide poisoning occurred among 18–35 year-olds more often, with 64.6% of the poisonings being suicidal, 34.4% of them occurring accidentally, and 1% of

them occurring for an unknown reason (38). A study was done in China reported that one of the most common suicide methods was pesticide poisoning in women and men, and that the suicide risk was high for both genders over 45 years of age (55).

Conclusion

This study is important, because it was the first study in the region in which the research data was examined. It revealed the existence of pesticide poisonings, and especially, suicidal attempts due to pesticides in a rural area. However, the data about the causative agents, poisoning situations, and results could not be documented sufficiently due to insufficient hospital records and a lack of systematic records. Moreover, the hospital record systems do not reflect the care burden for pesticide poisonings directly, and the hospital does not provide facilities for public health initiatives toward poisoning interventions. In this sense, reliable data is needed to create effective initiatives toward decreasing pesticide poisonings as a primary policy in terms of public health. The implementation of systematic data record systems will be effective for revealing the real dimension of pesticide poisonings, and planning initiatives will directly decrease the care burden. Cases, such as professional poisoning, that are not reported to the hospital and deemed to be not serious must be confirmed with personal statements or social research, and farmers must be educated about the use of personal protective equipment. Educational and consciousness-raising studies must be conducted with farmers regarding the storage of these chemicals to prevent pesticide poisoning at home, especially in children.

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