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Epidemiological Insights into Xenobiotic-Induced Seizures: A Correlational Descriptive Study from a Poisoning Referral Center in Northwestern Iran

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Abstract

Background: Seizure is a common complication of poisoning caused by toxins and various drugs. Epidemiological insights into xenobiotic-induced seizures enable emergency physicians to anticipate seizure risk during toxic exposures, optimize triage decisions, and tailor strategies. This study aimed to investigate the epidemiological characteristics and essential factors related to xenobiotic-induced seizures.

Methods: This descriptive cross-sectional study included 122 patients who developed seizures following poisoning with drugs, alcohol, opioids, pesticides, or stimulants between July 2021 and June 2022. Sociodemographic profiles and details of the poisoning/toxic agents were collected through bedside interviews. Data were analyzed using descriptive and inferential statistics with SPSS version 21.

Results: The majority of patients were men (110, 90.2%), with a mean age of 30.5 ± 11.99 years; 61 (50%) were married, and 95 (77.9%) resided in urban areas. Suicidal poisoning was the most frequent cause (62 cases, 50.8%), followed by poisoning related to substance abuse (33 cases, 27%). Opioids particularly tramadol (75 cases, 61.5%) were the leading cause of xenobiotic-induced seizures. All patients experienced generalized tonic–clonic seizures, with 87 (71.3%) having a single episode. Significant gender and occupation-based differences were observed: suicidal poisoning was more common among women, whereas substance abuse predominated among men. Education level was also found to influence the type of poisoning agent.

Conclusion: Xenobiotic-induced seizures are predominantly associated with opioid poisoning, are prevalent among young males with suicidal tendencies and substance abuse. These findings highlight the need for targeted preventive strategies, early identification of at-risk individuals, and improved management protocols for poisoning-related seizures.

Keywords: Seizure, Epidemiology, Xenobiotic, Toxicity

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Introduction

Xenobiotics, synthetic compounds are used across various sectors and pose significant health risks. Even low-level exposure can cause toxic, mutagenic or teratogenic effects. Seizures, a common consequence of poisoning, are often triggered by xenobiotic agents such as opioids, drugs, and pharmaceuticals, and other toxins (1, 2).

Diphenhydramine, tricyclic antidepressants, tramadol and amphetamines are among the most frequently reported

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Key Messages:

↑What is "already known" in this topic:

Xenobiotic-induced seizures are a leading cause of seizure, commonly occurring as a complication of poisoning.

Tramadol and tricyclic antidepressants play a key role in causing drug-induced seizures.

→What this article adds:

The most common manner of poisoning in patients with seizure was suicide. Seizure occurs more frequently in opioid poisonings, with tramadol being the leading agent.

Existing regulations are not sufficient to prevent suicide attempts, and more efforts must be taken to reduce the consequences of drug and non-drug poisonings.

causes of drug-induced seizures (3). Tramadol may induce drowsiness, headaches, seizures, respiratory depression, tachycardia, coma, and even death. Moreover, the prolonged tramadol use can lead to dependence, with withdrawal producing both typical and atypical symptoms (4).

Antidepressants and antihistamines have been identified as major contributors to drug-induced seizures (5, 6). Bupropion, an antidepressant, particularly well known for causing seizures in cases of overdose. Due to the risk of delayed seizure onset, patients are often monitored for extended periods following an overdose. According to Offerman et al, 27.9% of their patients experienced seizures after drug overdose (7).

Stimulants such as amphetamine, cocaine, methamphetamine, methylene dioxy methamphetamine and 4-methyleneaminoric are increasingly associated with seizures due to their (CNS) stimulant effects (8, 9). A study conducted in eastern Australia reported seizures in 44 of 1019 individuals exposed to these substances, predominantly affecting young adults (10).

Another report indicates that alprazolam is the most common seizure-inducing drug among women, while methadone predominates among men. The overall incidence of acute poisoning related to substances used in addictive disorders, particularly opioids and alcohol has been rising. In contrast, seizures resulting from benzodiazepines and antidepressants poisoning have shown a declining trend. Acute poisonings involving that agents affect the nervous system have contributed to increase in mortality rates among men. Notably, the incidence of opioid-related acute poisonings has risen significantly, with the majority of cases occurring in male patients (11).

According to a recent report pesticide can induce seizures by disrupting normal nervous system function (12). Park et al., reported that the herbicide glufosinate-ammonium was associated with the highest incidence of seizures (31.5%) followed by pyrethroids and glycine derivatives. The study also reported that seizures typically occurred within 12 to 24 hours after ingestion and resolved within 72 hours with generalized tonic-clonic seizures being the most common type (13).

Alcohol-induced seizures typically occur during withdrawal in chronically dependent individuals with chronic dependence, most commonly within 6–48 hours after cessation (14). Tricyclic antidepressants, organophosphorus insecticides, and opium are among the leading causes of toxic seizures. Organochlorine insecticides are associated with more prolonged seizure episodes, while a wide range of substances, including benzodiazepines, amphetamines, and selective serotonin reuptake inhibitors (SSRIs) have also been implicated in seizure occurrence (15, 16).

Acute poisoning represents a main global health concern and remains one of the leading causes of emergency department visits. Because many poisoned patients present with reduced levels of consciousness and unreliable medical histories, accurate identification of the etiological agent is crucial for guiding appropriate treatment strategies. Accurate identification of the poisoning leads to appropriate management. Precise diagnosis and timely treatment selection can lead to favourable outcomes; however, this requires an epidemiological understanding of the prevalence and distribution of toxic agents (16).

Physicians trained in medical toxicology specialize in the prevention, diagnosis, and management of poisoning. Over the past decade, this field has expanded significantly in response to the emergence of new pharmaceuticals, drugs of abuse, occupational chemicals, and even weapons of mass destruction. Seizures are a common and serious neurological complication of poisoning that, if not promptly recognized and treated, may result in irreversible damage. Individuals experiencing seizure often suffer from associated psychological and behavioral disorders, as well as social isolation, which collectively diminish quality of life and impair social and familial functioning. Moreover, long-term seizure management imposes a substantial burden on healthcare systems (17).

Given these concerns, in this study we tried to determine the incidence of seizures across different types of poisoning, identify the most seizure-inducing agents, and provide evidence to guide primary prevention. Timely recognition and management of toxin-induced seizures are necessary to prevent irreversible complications and emphasize the importance of epidemiological insight into regional toxic exposure patterns. Considering a limited research on seizure prevalence related to toxic exposures in northwest Iran, this study specifically investigated seizure incidence among patients poisoned with seizure-inducing agents.

Methods

Study population

In the present descriptive cross-sectional study, the prevalence of seizure among poisoned patients admitted to the poisoning department of Sina Hospital in Tabriz was evaluated during a year from July 2016 to June 2017. Initially, the necessary permits were obtained from the Research Council of the Faculty of Pharmacy and the Ethics Committee for Research in Tabriz University of Medical Sciences. Sampling was conducted based on clearly defined inclusion and exclusion criteria. All patients who experienced seizures following intentional or unintentional exposure to drugs, pesticides, alcoholic beverages, medications, or stimulants were consecutively enrolled using a convenience sampling approach, and those with a previous history of seizure, a reason for seizure other than those mentioned, and not willing to cooperate were excluded. A total of 122 eligible patients were consecutively included over a one-year period from July 2016 to June 2017. Informed consent was obtained from eligible poisoned persons, a brief explanation of the study objective was given, and the confidentiality of information was emphasized. For each enrolled patient, data were collected through bedside interviews and review of medical records. After sampling was fulfilled, the data were coded, entered into the computer, and analyzed with using both descriptive statistics (including frequency, percentage, mean, and standard deviation) and inferential statistics (chi-square and Spearman's rho test) via SPSS-21.

In the present study, the questionnaire was comprised of two parts: The first part covered the sociodemographic profile consisting of 7 questions consisting of age, gender,

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marital status, residence, education, occupation, and economic status; The second part focused on the specific form of the poisoning agent, including questions related to previous history of seizure, physical illness, mental illness, smoking, alcohol and drug use, mode or manner of poisoning (intentional and unintentional), method of poisoning or poisoning way, poisoning agent (medicinal, opioid, alcohol, pesticide, and stimulant), and details about the type and frequency of seizures. Both questionnaires were developed based on relevant literature, including books and articles, and reviewed by 10 faculty members from Tabriz Faculty of Pharmacy, and used after implying their correctional views. To assess the reliability of our data collection, we used a checklist for determining the epidemiological prevalence of xenobiotic-induced seizures in poisoned patients, and we employed a rigorous approach involving two independent assessors. Each assessor completed the checklist for a sample of 10 patients. To quantify the consistency of their assessments, we calculated the intraclass correlation coefficient (ICC=0.976), which provides a measure of agreement between the two assessors. A high ICC value indicates strong reliability of the checklist, ensuring that our data collection method is robust and trustworthy for capturing the prevalence of seizures in this patient population (18).

Results

This study analyzed 122 cases of poisoning-induced seizures, focusing on demographic and clinical characteristics. The study group was predominantly male (110 cases, 90.2%), with a mean age of 30.5 ± 11.99 years; 61 (50%) were married. Urban residency was common (95 cases, 77.9%). Educational attainment was highest among those holding a diploma (48 cases, 39.3%), followed by individuals with sub-diploma education (34 cases, 27.9%). Employment status varied: 67 cases (54.9%) were self-employed, 20 (16.4%) unemployed. Financial hardship was prevalent, with 79 (64.8%) reporting expenses exceeding income. The most common manner of poisoning was suicidal, accounting for 63 (50.8%) of cases, followed by euphoria (abuse) at 33 (27%). Depression was the most frequently reported psychiatric condition (24 cases, 19.7%). A substantial proportion of patients had a history of smoking (93, 76.2%), narcotics use (60, 49.2%), and alcohol consumption (36, 29.5%). All individuals experienced generalized tonic-clonic seizures; 87 (71.3%) had a single episode, while 35 cases (23.8%) experienced two seizures. Details of the variables including gender, marital status, education, employment, residence, economic status, poisoning intent, psychological history, substance use, seizure type, and age are presented in Table 1.

Table 1. Demographic and Poisoning characteristics of the participants

Variable	Category	No	%	Variable	Category	No	%
Gender	Male	110	90.2	Economic situation	Income= Expenses	35	28.7
	Female	12	9.8		Income > Expenses	8	6.6
Marital status	Single	61	50		Income < Expenses	79	64.8
	Married	61	50	Reason of poisoning	Accidental	3	2.5
Education	Illiterate	28	23		Suicide	62	50.8
	Under diploma	34	27.9		Criminal	2	1.6
	Diploma	48	39.3		Euphoria (abuse)	33	27
	University	12	9.8		Dependence (abuse)	22	18
Employment	Self- employed	67	54.9	Psychological problems	Depressed	24	19.7
	Housekeeper	12	9.8		Anxiety	7	5.7
	Worker	15	12.3		No problem	91	74.6
	Farmer	3	2.5	Smoking	Yes	93	76.2
	Unemployed	20	16.4		No	29	23.8
	Employee	3	2.5	Alcohol consumption	Yes	36	29.5
	Others	2	1.6		No	86	70.5
Residence	Rural	8	6.6	Addiction	Yes	60	49.2
	Urban	95	77.9		No	62	50.8
	Township	19	15.6	Type of seizure	Generalized Tonic-clonic	122	100
Age		Mean	SD	Description of Seizure	Single	87	71.3
		30.51	11.99		Two	35	28.6

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Table 2. The Causes of Poisoning in Patients with Seizures Due to Poisoning

Poisoning agent	Category	No	%
Drug poisoning	Benzodiazepines	8	6.5
	Antidepressants	6	4.9
	Others	4	3.3
Opioid poisoning	Methadone	11	9
	opium	10	8.2
	Tramadol	75	61.5
	buprenorphine	1	0.8
Alcohol poisoning	Methanol	2	1.6
	Ethanol	11	9
Pesticide poisoning	Insecticide	4	3.3
	herbicide	1	0.8
Poisoning with stimulants	Amphetamine	2	1.6

Table 3. Relationship between Reason and Poisoning Agent by Age*

Reason(manner) of poisoning	N	Mean	Std. Deviation	*P*-value
Accidental	3	49.0000	13.45	0.004
Suicide	62	27.2097	9.46	
Criminal	2	29.5000	.70	
Euphoria (abuse)	33	32.5758	12.08	
Dependence (abuse)	22	34.3182	15.01	
Total	122	30.5164	11.99	
Poisoning agent				
Opioids	85	30.5647	11.80945	0.273
Alcohol	3	31.0000	20.80865	
Pesticides	5	44.4000	12.60159	
Tricyclic antidepressants	3	28.3333	16.44182	
Benzodiazepines	4	30.2500	14.15097	
Opioids and alcohol	10	26.1000	7.40045	
Opioids and stimulants	2	27.5000	12.02082	
Others	4	25.5000	15.80084	
Total	116	30.4914	12.17160	

*The analysis was performed using ANOVA (Analysis of Variance).

Distribution of poisoning agents among patients presenting with seizures is represented in Table 2. Opioids were the most prevalent cause, with tramadol comprising 75 (61.5%) of opioid-related cases, followed by methadone (11, 9%) and opium (10, 8.2%). Other notable agents included benzodiazepines (8, 6.5%), ethanol (11, 9%), and antidepressants (6, 4.9%). Less frequent causes included insecticides (4, 3.3%) and amphetamines (2, 1.6%). These findings underscore the dominant role of tramadol and other opioids in seizure-associated poisonings.

As shows in Table 3, the mean age significantly differs among the poisoning groups with various reasons (*P*=0.004). The results of the Tukey test for pairwise comparisons indicated that the mean age in the group of poisonings with suicidal reason was significantly lower than that of poisonings due to accidental reason (*P*=0.004).

The results of Fisher's exact test in Table 4 show that women and men differ significantly in terms of the reason for poisoning (*P*=0.007), so that 11 out of 12 (91.7%) of the poisoned women studied were poisoned due to suicide, while in men, the causes of suicide and abuse were 51 out of 110 (46.4%) and 33 out of 110 (30%), respectively. The results of Fisher's exact test in Table 4 also indicate that poisoned individuals with different occupations significantly differ in terms of the reason for poisoning (*P*=0.047), with suicide being the predominant cause of poisoning among Housekeepers (10 out of 12, 83.3%) and the unemployed (12 out of 20, 60%). Additionally, 12 out of 18 (66.7%) of poisoned individuals who were employed as employees or farmers were poisoned due to abuse. No significant association was found between marital status, place of residence, education, and income level with the reason of poisoning.

Also, explanation is given for the statistically significant relationship between gender, marital status, education level, and the implicated poisoning agent among the study participants (Table 5). Men were more likely to be poisoned by opioids compared to women (85 out of 110, 77.1% vs. 4 out of 11, 36.4%). In contrast, pesticides were the causative agent in 3 out of 11 (27.3%) of poisoning cases among women, while only 2 out of 110 (1.9%) of men were poisoned by this agent. Furthermore, married individuals were more frequently poisoned by opioids and pesticides compared to their single counterparts (p=0.034). Additionally, opioids as the poisoning agent were significantly more prevalent among those with no formal education (the illiterate) and those with a high school diploma (*P*=0.046).

Discussion

In our study, the mean age of the poisoned patients who developed seizures was approximately 30 years. The majority were male, and belonged to low socioeconomic

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Table 4. Relationship between Reason of Poisoning by categorical characteristics*

Gender→ Reason of poisoning↓	Male N (%)	Female N (%)						*P*-value
Accidental	2 (1.8)	1 (8.3)						0.007
Suicide	51 (46.4)	11 (91.7)						
Criminal	2 (1.8)	0 (0)						
Euphoria(abuse)	33 (30)	0 (0)						
Dependence(abuse)	22 (20)	0 (0)						
Total	110 (100)	12 (100)						
Marriage status→ Reason of poisoning↓	Married	Unmarried						
Accidental	3 (4.9)	0 (0)						0.141
Suicide	27 (44.3)	35 (57.4)						
Criminal	0 (0)	2 (3.3)						
Euphoria (abuse)	19 (31.1)	14 (23)						
Dependence(abuse)	12 (19.7)	10 (16.4)						
Total	61 (100)	61 (100)						
Education→ Reason of poisoning↓	Illiterate	Under diploma	Diploma	University				
Accidental	3 (10.7)	0 (0)	0 (0)	0 (0)				0.045
Suicide	13 (46.4)	22 (64.7)	22 (45.8)	5 (41.7)				
Criminal	1 (3.6)	0 (0)	1 (2.1)	0 (0)				
Euphoria (abuse)	7 (25)	8 (23.5)	14 (29.2)	4 (33.3)				
Dependence(abuse)	4 (14.3)	4 (11.8)	11 (22.9)	3 (25)				
Total	28 (100)	34 (100)	48 (100)	12 (100)				
Employment→ Reason of poisoning↓	Housekeeper	Worker	Farmer	Employee	Self-employed	Unemployed	other	
Accidental	1 (8.3)	0 (0)	0 (0)	0 (0)	2 (3)	0 (0)	0 (0)	0.047
Suicide	10 (83.3)	6 (40)	0 (0)	0 (0)	32 (47.8)	12 (60)	2 (100)	
Criminal	0 (0)	1 (6.7)	0 (0)	0 (0)	0 (0)	1 (5)	0 (0)	
Euphoria (abuse)	1 (8.3)	5 (33.3)	2 (66.7)	2 (66.7)	21 (31.3)	2 (10)	0 (0)	
Dependence(abuse)	0 (0)	3 (20)	1 (33.3)	1 (33.3)	12 (17.9)	5 (25)	0 (0)	
Total	12 (100)	15 (100)	3 (100)	3 (100)	67 (100)	20 (100)	2 (100)	
Economic situation → Reason of poisoning↓	Income= Expenses	Income > Expenses	Income < Expenses					0.360
Accidental	2 (5.7)	0 (0)	1 (1.3)					
Suicide	13 (37.1)	5 (62.5)	44 (55.7)					
Criminal	0 (0)	0 (0)	2 (2.5)					
Euphoria (abuse)	14 (40)	2 (25)	17 (21.5)					
Dependence(abuse)	6 (17.1)	1 (12.5)	15 (19)					
Total	35 (100)	8 (100)	79 (100)					

* Results for Fisher's Exact Test

groups. Epidemiological evidence indicates that seizures resulting from poisoning are most common among individuals aged 15–40 years. Although seizure incidence increases with age, reaching approximately 240 per 100,000 at age 65, poisoning due to medications and substance abuse predominantly affects younger populations. For instance, approximately 48% of patients poisoned with tramadol were aged 21–30 years, and 75.6% were male (15, 19).

In a study by Mohammadi (2020), among 120 patients with seizures, 55 were male and 65 were female, with a mean age of 52.5 ± 20.42 years; most participants were married (71.5%). In that study, cerebrovascular injury was the leading cause of seizures, although trauma, drug withdrawal, and the abuse of narcotics and medications were also significant contributors (20). Similarly, Mesgarpour (2024), reported that 40.33% of men who attempted suicide were aged 20–29 years. Overall, patients aged 20–29 accounted for the highest proportion of acute poisonings (36.36%), and poisoning was more prevalent among men (11).

These findings underscore that poisoning-related seizures disproportionately affect young adults, particularly males, and are often associated with substance use and suicidal behaviour, reflecting the need for targeted preventive and clinical interventions in this demographic.

In our cohort, the primary causes of poisoning were suicide attempts and substance abuse. Notably, 20% of patients had depressive disorders, 76% were smokers, 49% had a history of addiction, and 29% reported alcohol abuse. All patients experienced generalized tonic–clonic seizures, with the majority having a single episode, while only 28% experienced two or more seizures. Similarly, Thundiyil et al. found that seizures occurred in a significant number of the patients mostly as an attempted suicide among adults. According to this report only a single seizure was reported in 265 patients (68.6%) while 27.7% (107 cases) reported 2 or more discrete seizures and 3.6% (14 cases) were status epilepticus (3).

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Table 5. Relationship between Poisoning Agents and some Categorical Characteristics

Gender→ Poisoning agent↓	Male N (%)	Female N (%)						*P*-value
Opioids	81 (77.1)	4 (36.4)						<0.001
Alcohol	2 (1.9)	1 (9.1)						
Pesticides	2 (1.9)	3 (27.3)						
Tricyclic antidepressants	3 (2.9)	0 (0)						
Others	1 (1)	3 (27.3)						
Benzodiazepines	4 (3.8)	0 (0)						
Opioids and alcohol	10 (9.5)	0 (0)						
Opioids and Tricyclic stimulants	2 (1.9)	0 (0)						
Total	105 (100)	11 (100)						
Marriage status → Poisoning agent↓	Married	Unmarried						
Opioids	44 (75.9)	41 (70.7)						0.034
Alcohol	2 (3.4)	1 (1.7)						
Pesticides	5 (8.6)	0 (0)						
Tricyclic antidepressants	1 (1.7)	2 (3.4)						
Others	2 (3.4)	2 (3.4)						
Benzodiazepines	2 (3.4)	2 (3.4)						
Opioids and alcohol	1 (1.7)	9 (15.5)						
Opioids and Tricyclic stimulants	1 (1.7)	1 (1.7)						
Total	58 (100)	58 (100)						
Education→ Poisoning agent↓	Illiterate	Under diploma	Diploma	University				
Opioids	20 (71.4)	22 (68.8)	37 (80.4)	6 (60)				0.046
Alcohol	2 (7.1)	0	1 (2.2)	0 (0)				
Pesticides	3 (10.7)	2 (6.3)	0 (0)	0 (0)				
Tricyclic antidepressants	0 (0)	2 (6.3)	0 (0)	1 (10)				
Others	1 (3.6)	0	2 (4.3)	1 (10)				
Benzodiazepines	2 (7.1)	0	1 (2.2)	1 (10)				
Opioids and alcohol	0	5 (15.6)	4 (8.7)	1 (10)				
Opioids and Tricyclic stimulants	0	1 (3.1)	1 (2.2)	0 (0)				
Total	28 (100)	32 (100)	46 (100)	10 (100)				
Employment→ Poisoning agent↓	Housekeeper	Worker	Farmer	Employee	Self-employed	Unemployed	other	
Opioids	6 (54.5)	12 (80)	3 (100)	3 (100)	47 (75.8)	13 (65)	1 (50)	0.059
Alcohol	0 (0)	1 (6.7)	0 (0)	0 (0)	0 (0)	2 (10)	0 (0)	
Pesticides	3 (27.3)	1 (6.7)	0 (0)	0 (0)	1 (1.6)	0 (0)	0 (0)	
Tricyclic antidepressants	0 (0)	0 (0)	0 (0)	0 (0)	2 (3.2)	0 (0)	1 (50)	
Others	2 (18.2)	0 (0)	0 (0)	0 (0)	0 (0)	2 (10)	0 (0)	
Benzodiazepines	0 (0)	1 (6.7)	0 (0)	0 (0)	3 (4.8)	0 (0)	0 (0)	
Opioids and alcohol	0 (0)	0 (0)	0 (0)	0 (0)	7 (11.3)	3 (15)	0 (0)	
Opioids and Tricyclic stimulants	0 (0)	0 (0)	0 (0)	0 (0)	2 (3.2)	0 (0)	0 (0)	
Total	11 (100)	15 (100)	3 (100)	3 (100)	62 (100)	20 (100)	2 (100)	
Economic situation → Poisoning agent↓	Income= Expenses	Income > Expenses	Income < Expenses					
Opioids	28	7 (100)	50 (64.9)					0.905
Alcohol	0 (0)	0 (0)	3 (3.9)					
Pesticides	1 (3.1)	0 (0)	4 (5.2)					
Tricyclic antidepressants	0 (0)	0 (0)	3 (3.9)					
Others	0 (0)	0 (0)	4 (5.2)					
Benzodiazepines	1 (3.1)	0 (0)	3 (3.9)					
Opioids and alcohol	2 (6.3)	0 (0)	8 (10.4)					
Opioids and Tricyclic stimulants	0 (0)	0 (0)	2 (2.6)					
Total	32 (100)	7 (100)	77 (100)					

Collectively, these findings highlight the significant role of substance abuse and suicide attempts in poisoning-related seizures, particularly among young adult males, and underscore the importance of targeted preventive measures and early intervention strategies in this population.

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Our findings indicate that opioids were leading cause of xenobiotic-induced seizures, with tramadol being the most frequently implicated agent. Among the 122 patients with seizure, approximately 75 had consumed tramadol. Ethanol was the the second most common agent, observed in 11 patients, followed by benzodiazepines and tricyclic antidepressants. The lowest incidence was observed with stimulants and pesticides. Overall, opium-based poisonings, including tramadol, were the most prevalent poisoning followed by benzodiazepine, acetaminophen, antipsychotic medications, organophosphates, aluminum phosphide, amphetamine, pesticide, tricyclic antidepressant, alcohol, carbon monoxide nonsteroidal anti-inflammatory drugs (17).

In the study of Wills (2005) identified tramadol, tricyclic antidepressants and diphenhydramine as the most common causes of seizures, accounting tricyclic antidepressants 7.7%, diphenhydramine 8.3% and tramadol 7.5% of cases (15).

In Switzerland, Reichert (2014) found that the most frequent seizure-inducing substances included mefenamic acid (51 cases), citalopram (34), trimipramine (27), venlafaxine (23), tramadol (15), diphenhydramine (14), amitriptyline (12), carbamazepine (11), maprotiline (10), and quetiapine (10), with antidepressants collectively accounting for 136 cases (21).

These variations across studies underscore the influence of temporal, regional, and demographic factors on the types of substances implicated in seizure-inducing poisonings. Understanding these epidemiological differences is crucial for tailoring prevention, early detection, and management strategies in different populations.

The relationship between the reason of poisoning and the poisoning agent across age groups showed that the mean age of individuals with suicidal poisoning was significantly lower than that of those with accidental poisoning. This indicates that suicide-related poisonings occur more frequently among younger individuals. Previous studies support this finding, reporting that most poisoning cases occur in individuals aged 18–27 years, with intentional poisonings accounting for 90.2% of cases. The mean age of suicidal poisonings was significantly lower than that of accidental cases (23.3 vs. 30.3 years). Overall, suicide accounted for a substantial proportion of the poisoning incidents (65.6%), and females were more likely than males to attempt suicide (22, 23).

In our study, 66.7% of employed individuals (including farmers and laborers) were poisoned due to opioid abuse, with tramadol, methadone, and opium being the primary agents. Similarly, in the study by Nasiri (2021), the most common cause of poisoning was drug abuse (58.1%), involving substances such as opium, heroin, methadone, alcohol, and tramadol. A total of 179 patients (45%) had a history of substance abuse or mental illness. Among patients with suicide attempts or intentional poisoning, there were 54 men and 85 women, with men showing a higher tendency for alcohol poisoning compared to women (24).

Relationship between the reason of poisoning by categorical characteristics showed that higher percentage women were poisoned due to suicide, while in men, the most common causes were suicide and abuse. Suicide was the predominant cause of poisoning among housekeepers and unemployed individuals.

In the study of Pires (2014), the majority of patients were single, unemployed and residing in urban centers. Additionally, patients had a diagnosed psychiatric disease, had a history of suicidal self-poisoning/ drug abuse (23).

As shown in Table 5, opioid poisoning was most prevalent among men, while pesticide poisoning was more frequently among women. Poisoning involving opioids and pesticides was also more common among married patients than in single ones. Furthermore, opioid poisoning was the leading cause of poisoning among patients with lower educational levels (below diploma).

In a study by Rezaei (2023) (25), 83.8% of the patients were male and 16.2% were female.

The majority of poisoning cases (89.1%) were unintentional and resulted from substance abuse, primarily involving tramadol (42.8%), narcotic drugs (26.6%), and alcohol (19.7%), ranking first to third, respectively.

These findings indicate that unintentional poisoning constitutes a large proportion of toxicity cases, mainly associated with drug abuse such as tramadol and narcotic substances. A high incidence of poisoning was observed among married individuals, those with lower education, and residents of urban areas. Patients with prior medical histories often presented with addiction or psychiatric disorders, emphasizing the importance of integrated mental health interventions in managing poisoning cases (26).

According to Tsutaoka (2015) (27), the mean age of patients was 27.4 years (SD = 19.9), with 43.6% males and 56.4% females. A history of mental disorders was reported in 24.5% of patients. Most cases of tramadol toxicity occurred among young and middle-aged adults, leading to complications such as seizure, respiratory depression, coma, drowsiness or lethargy, slurred speech, hallucination or delusion and confusion.

Conclusion

According to the results of this study, the mean age of poisoned patients was 30.5 years. Most patients were male, self-employed, and lived in urban areas. A majority had low educational attainment (diploma or below) and unfavorable economic conditions. Psychological disorders were more common than physical illnesses, with depression being the most frequently reported condition. Most poisoned patients were smokers and nearly half of them had a history of drug abuse.

Among patients who experienced seizures, suicide was the most common cause of poisoning, with opioids, particularly tramadol being the leading agents.

Among female patients, suicide was the predominant cause of poisoning, whereas in males, both suicide and substance abuse were common. Opioid poisoning was most prevalent among men, while pesticide poisoning was more frequent among women.

In this study, most poisoning cases were intentional and involved opioid agents, with higher prevalence among younger individuals. Therefore, authorities should prioritize psychiatric screening in poisoning cases, ensure early

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intervention, and regulate access to high-risk substances to prevent recurrence. Accurate identification of poisoning causes and timely treatment can improve outcomes.

However, given the high prevalence of seizures associated with substance withdrawal, addressing underlying social and psychological factors is essential for effective prevention.

Greater awareness of opioid-related complications and stricter monitoring of their distribution could help reduce associated harms. Moreover, this study emphasizes the urgent need for continuous oversight of pharmacists and unauthorized centres involved in the production and distribution of tramadol.

This study had several limitations. It was conducted at a single referral center in Northwestern Iran, which may limit generalizability of the findings. Reliance on self-reported data introduces the possibility of recall bias. Furthermore, the cross-sectional design prevents causal inference and may overlook long-term trends. Confounding factors such as socioeconomic status and access to mental health care were not fully examined, and multivariable analysis was not performed.

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Conflict of Interests

The authors declare that they have no competing interests.

Authors' Contributions

All authors participated in the conceptualization and design of the study. Material preparation and data collection were carried out by Niloufar Akhoundi Koushki, Sana Mojtahedi. Arefeh Davoudi, Javad Ahmadian Harris made significant contributions to data analysis. Preparation of the initial draft of the manuscript and linguistic corrections were made by Ali Banagozar Mohammadi, Ali Ostadi, and Hassan Rezazadeh. All authors reviewed and approved the final manuscript.

Ethical Considerations

All methods were carried out in accordance with relevant guidelines and regulations. Ethical clearance was obtained from the Regional Ethics Committee (Research Ethics Committees of Tabriz University of Medical Sciences. Ethics code: REC.TBZMED.IR.1395.633). Also, during hospitalization, informed consent was obtained from all subjects and/or their legal guardian(s) for human data use; and the patients' information remained confidential in this study.

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Data Availability

The datasets used and/or analyzed during the current study available from the corresponding author on reasonable request.

AI Use Statement

It is hereby declared that no artificial intelligence (AI) or AI-based technologies were used in the design, analysis, interpretation, writing, linguistic editing, or revision of this manuscript, and all aspects of the work were performed solely by the authors.

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