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Epidemiological Study of Fatal Poisoning in Young Adults under Age 30 Referred to Kerman Legal Medicine Center From 2012 to 2022

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Abstract

Introduction: The rise in drug and chemical production and availability has resulted in a growing issue of poisoning. Studying the epidemiology of poisonings aids in strategic planning and decision-making for the control and reduction of poisoning cases. This study was conducted to explore the epidemiology of fatal poisonings among young adults.

Methods: This cross-sectional study utilized data from the Kerman Legal Medicine Organization records, collected through census sampling. In total, the records of 507 individuals aged 14 to 29 years, who died from poisoning and were referred to the Kerman Legal Medicine Organization between 2012 and 2022, were included in the study. The data were analyzed using chi-square and logistic regression tests (SPSS software, with $P<0.05$).

Results: The majority of those who died from poisoning were males (67.1%), unmarried (72.8%), residing in urban areas (61.5%), and had under-diploma education (50.7%). Among opioids, methadone, and among chemical poisons, paraquat, were responsible for the highest number of fatal poisonings. The education level showed an inverse relation with chemical poisoning, and a direct relation with non-opioid drug poisoning (R=-0.130, $P=0.006$). The majority of individuals who died outside the hospital had opioid poisoning.

Conclusion: A strategic macro-decision on a national scale is crucial for preventing fatal poisonings. At the regional level, it is necessary to raise awareness among students aged over 14 years about methadone, the naloxone antidote, and herbicide paraquat. Supplying naloxone nasal spray to organizations that interact with addicts can effectively decrease fatalities from poisoning.

Keywords: Legal medicine, Methadone, Opioids, Paraquat, Poisons

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Introduction

In recent years, the rise in production and widespread availability of drugs and chemicals has led to a significant issue of poisoning and subsequent mortalities in modern societies. In addition, the industrial manufacturing of drugs and alcohol has amplified the magnitude of this problem (1). Excessive use of disinfectants, detergents, and insecticides has also increased poisoning incidences (2). Although poisoning is a worldwide issue, the poisoning patterns and types of poisons vary by country or geographical region. The poisoning pattern varies based on cultural norms, occupation, religious beliefs, and other factors (3,4).

In general, and based on the type of toxic substance, poisoning can be categorized into two groups: drug-related and non-drug-related. Tramadol is responsible for a significant number of drug-related poisonings, with self-harm being a primary cause of excessive consumption (5). The widespread availability and ease of consumption contribute to the high incidence of tramadol poisoning. The majority of tramadol poisonings occur in individuals aged 21 to 30 years (5). In recent years, antidepressants and opioids have become more prominent in poisoning-related fatalities. In Iran, poisoning patterns have shifted from traditional drugs (like opium and heroin) to methadone (6). Methadone is a morphine-like analgesia, and death from methadone poisoning is often due to immunosuppression, with many cases also linked to cardiac arrhythmia (7).

Alcohol poisoning is one of the non-drug-related poisonings. In Iran, methanol poisoning is a major issue, largely due to the increased production of counterfeit and homemade alcohol (8,9). Despite alcohol consumption being uncommon in Iran, there is a growing incidence of

ethanol poisoning in the country (10). Alcohol poisoning is usually accidental, whereas some non-drug poisonings are intentional and self-inflicted. In Iran, poisoning with rice tablets (aluminum phosphide), which is often intentional, occurs frequently due to its easy availability, and has a high mortality rate (11). The occurrence of poisoning due to insecticides and pesticides varies across different geographical regions within the country. For instance, in the northern regions of the country, poisoning caused by organophosphorus pesticides is widespread due to extensive farming (12). Pesticide poisoning is not limited to northern Iran; it remains a major challenge in agricultural and rural areas nationwide (13).

Considering the significance of poisoning and its detrimental impact on the economy and society, investigations have been conducted to analyze poisoning patterns in various parts of Iran (14–17). Given that numerous poisonings result from intentional acts or abuse, certain studies have specifically concentrated on fatal cases of poisoning (18–20). Understanding fatal poisoning patterns is crucial for developing targeted preventive strategies, particularly in regions with unique epidemiological trends. Additionally, variations in poisoning types based on gender, occupation, and other factors underscore the need for tailored interventions. Given that poisoning trends are influenced by both time and location, this study provides essential insights that can inform public health policies, medical interventions, and legal medical assessments aimed at reducing fatal poisonings in the region. By examining a decade-long dataset, this research highlights the poisoning patterns and reinforces the importance of long-term surveillance to mitigate future risks.

One of the valuable data sources to identify the poisoning patterns is the analysis of fatal poisonings referred to legal medical centers. This study aimed to explore the pattern of fatal poisonings among young individuals aged 14 to 29 years in Kerman from 2012 to 2022.

Methods

This retrospective cross-sectional study investigated all poisoning-related deaths among young individuals (aged 14 to 29 years) in Kerman between 2012 and 2022, regardless of intent (intentional or unintentional). The study population was all the individuals who died due to poisoning and were referred to the Kerman Legal Medical Center during the specified time frame. Individuals aged 14 to 29 years who died only due to poisoning were included in the study. Individuals with incomplete records or those whose cause of death was attributed to factors other than poisoning were excluded from the study. Fatalities resulting from carbon monoxide, heavy metal, plant, food, or bite poisoning (often unintentional) were excluded from this study, as they influence poisoning patterns without involving human factors.

Sampling was based on the census method, and a checklist was used for data collection. Demographic variables included age, gender, residential location, level of education, occupation, and marital status. Additionally, information regarding the type of poisonous substance, year of death, and location of death was also recorded. Cases were categorized into four poisoning substance groups: opioids, chemicals, alcohol, and other substances. Since our dataset did not explicitly differentiate between accidental and intentional poisoning, this classification was based on relevance to poisoning trends rather than intent.

To increase the accuracy of the chi-square test and simplify the analysis, the poisonous substances were categorized into four groups: opioids (methadone, morphine, tramadol), chemicals (paraquat, rice tablet, organophosphate, rodenticide, detergent), alcohol (ethanol, methanol), and other drugs (TCA, methamphetamine, and others, which were mentioned in Table 1). The details of these categories can be found in the footnote of Table 2.

Finally, the collected data were analyzed using SPSS (version 25) software with chi-square and multinomial logistic regression tests. A significance level of 0.05 was used for all tests. This study was approved by the Ethics Committee of Kerman University of Medical Sciences (Ethical code: IR.KMU.AH.REC.1401.300), and confidentiality of personal information was taken into consideration.

Results

Out of the 507 fatalities resulting from poisoning, 340 (67.1%) were male and 167 (32.9%) were female (Table 1). Considering the population growth between 2012 and 2022, the incidence of fatal poisonings in Kerman province has surged nearly 2.7-fold over a decade. Among young individuals, the age range of 26-29 had the highest incidence of fatal poisonings.

Educational background was an important factor, as individuals with an under-diploma level of education accounted for 50.7% of all fatal poisoning cases, followed by those with a diploma education at 26.6% (Table 1). Most of the affected individuals held non-governmental occupations, and most of the females were housewives, while students accounted for nearly a fifth of all poisoning-related fatalities. Additionally, fatalities were more common among unmarried individuals (72.8%), and most cases occurred in Kerman city (61.5%) (Table 1). The predominant poisoning cases involved methadone, followed by paraquat herbicide and morphine (Table 1).

According to the results, gender exhibited a significant but weak effect on poisoning type ($P=0.048$, Table 2), with opioid and alcohol poisoning being more prevalent in males, while chemical and other drug poisonings were more frequent in females. However, multinomial logistic regression revealed that gender was not a strong predictor of poisoning type ($P=0.351$, Table 3).

Age significantly influenced poisoning type ($P=0.044$, Table 2), with opioid poisoning peaking in ages 22–25, and alcohol poisoning more common in ages 18–21 and 26–29 years. Chemical and other drug poisonings were more

Table 1. Distribution of fatal poisoning based on demographic variables and poisonous substance (in N (%))

Variable	Category	Cases (N (%))
Year	2012	28 (5.5)
	2013	21 (4.1)
	2014	22 (4.3)
	2015	41 (8.1)
	2016	39 (7.7)
	2017	54 (10.7)
	2018	31 (6.1)
	2019	49 (9.7)
	2020	58 (11.4)
	2021	77 (15.2)
	2022	87 (17.2)
Gender	Male	340 (67.1)
	Female	167 (32.9)
Age Group	14-17	77 (15.2)
	18-21	141 (27.8)
	22-25	132 (26.0)
	26-29	157 (31.0)
Education	Unknown	21 (4.2)
	Illiterate	33 (6.5)
	Under Diploma	257 (50.7)
	Diploma	135 (26.6)
	Over Diploma	61 (12.0)
Occupation	Unknown	8 (1.6)
	Unemployed	52 (10.3)
	Student	102 (20.1)
	Governmental	39 (7.7)
	Non-Governmental	215 (42.4)
	Housewife	91 (17.9)
Marital Status	Unmarried	369 (72.8)
	Married	138 (27.2)
Place of Residence	Kerman City	312 (61.5)
	Kerman Counties	175 (34.5)
	Out of Province	20 (4.0)
Place of Death	Out of Hospital	230 (45.4)
	Within Hospital	277 (54.6)
Poisonous Substance	Methadone	229 (45.2)
	Morphine	53 (10.5)
	Tramadol	27 (5.3)
	Paraquat	75 (14.8)
	Rice Tablet	28 (5.5)
	Organophosphate	8 (1.6)
	Ethanol	6 (1.2)
	Methanol	6 (1.2)
	TCAs*	4 (0.8)
	Methamphetamine	2 (0.4)
	Detergent	3 (0.6)
	Rodenticide	3 (0.6)
	Methadone + Morphine	19 (3.7)
	Methadone + Tramadol	22 (4.3)
	Other**	22 (4.3)

* TCA = Tricyclic Antidepressant; ** Including Acetaminophen, Metformin, Lidocaine, Propranolol, Barbiturate, Antipsychotic, Diltiazem, Meperidine, Cyproheptadine, Cyclobenzaprine, and Phenobarbital.

prevalent among teenagers (ages 14–17) (Table 2). The regression model confirmed age as a predictor variable ($P = 0.038$, Table 3).

Education level played a significant role in poisoning patterns ($P = 0.006$, Table 2), and regression analysis confirmed it as a predictor variable ($P = 0.031$, Table 3). Individuals with higher education had a 9.2- and 24.5-times greater likelihood of alcohol poisoning compared to those with below a diploma and diploma education ($P = 0.040$, $P = 0.020$, Table 4). Higher education levels were also associated with a 5.8-fold increased odds of non-opioid drug poisoning ($P = 0.015$, Table 4).

Occupation had a statistically significant effect ($P = 0.026$, Table 2) and was identified as a predictor variable ($P = 0.031$, Table 3). Based on the results (Table 2), government employees had a higher risk of non-opioid drug poisoning, while housewives had a higher incidence of chemical poisoning. Students had the highest opioid-related poisoning fatalities, and unemployed individuals (including students) had a lower incidence of alcohol poisoning than employed individuals. Table 4 further supported this trend, showing that students were 3.8 times less likely to experience chemical poisoning compared to housewives ($P = 0.031$).

Marital status affected poisoning type ($P = 0.017$, Table 2), but was not a strong predictor in the regression model ($P = 0.375$, Table 3). In comparison, opioid and non-opioid poisonings were more common in unmarried individuals, while chemicals and alcohol poisonings were more frequent among married individuals (Table 2).

The type of poisoning varied significantly by residence location ($P < 0.001$, Table 2 & 3). Opioid poisoning was dominant in Kerman city, whereas chemical poisoning was prevalent in county regions (Table 2). Table 4 further highlights that county residents had 13.3 times greater odds of chemical poisoning compared to city residents.

The place of death also showed statistical significance ($P < 0.001$, Tables 2 & 3). Fatal poisonings occurring outside of hospitals were primarily opioid-related, while hospital deaths were more often due to chemical poisoning. The high odds ratio (37.4) for chemical poisoning deaths within hospitals supports this finding ($P < 0.001$, Table 4). Additionally, compared to opioid poisoning, the probability of death due to non-opioid drug poisoning is higher within hospitals ($P = 0.031$, Table 4).

Finally, despite the overall increase in the number of poisoning-related deaths from 2012 to 2022, the distribution of poisonous substances between the first and second periods of this timeframe did not exhibit a statistically significant difference ($P = 0.071$, Table 2), and this factor was not a predictor in regression analysis ($P = 0.776$, Table 3).

Discussion

Poisoning remains a significant public health issue, contributing to emergency cases and imposing considerable economic and social burdens. Understanding fatal poisoning patterns is essential for effective intervention

Table 2. Distribution of poisonous substance based on demographic variables (in N (%))

Variable	Groups	Poisonous Substance				*P*
		Opioid[1]	Chemical[2]	Alcohol[3]	Other[4]	
Gender	Male	242 (69.1)	72 (61.5)	11 (91.7)	15 (53.6)	0.048*
	Female	108 (30.9)	45 (38.5)	1 (8.3)	13 (46.4)	
Age (year)	14-17	48 (13.7)	22 (18.8)	0 (0.0)	7 (25.0)	0.044*
	18-21	93 (26.6)	38 (32.5)	4 (33.3)	6 (21.4)	
	22-25	98 (28.0)	28 (23.9)	0 (0.0)	6 (21.4)	
	26-29	111 (31.7)	29 (24.8)	8 (66.7)	9 (32.2)	
Education	Illiterate	17 (5.1)	12 (10.4)	3 (27.3)	1 (3.7)	0.006*
	Under Diploma	172 (51.7)	69 (60.0)	5 (45.4)	11 (40.8)	
	Diploma	103 (30.9)	23 (20.0)	1 (9.1)	8 (29.6)	
	Over Diploma	41 (12.3)	11 (9.6)	2 (18.2)	7 (25.9)	
Occupation	Unemployed	35 (10.2)	14 (12.0)	0 (0.0)	3 (11.1)	0.026*
	Student	76 (22.1)	19 (16.4)	0 (0.0)	7 (25.9)	
	Governmental	27 (7.8)	6 (5.2)	1 (8.3)	5 (18.5)	
	Non-Governmental	151 (43.9)	46 (39.7)	10 (83.4)	8 (29.7)	
	Housewife	55 (16.0)	31 (26.7)	1 (8.3)	4 (14.8)	
Marital Status	Unmarried	264 (75.4)	74 (63.2)	7 (58.3)	24 (85.7)	0.017*
	Married	86 (24.6)	43 (36.8)	5 (41.7)	4 (14.3)	
Place of Residence	Kerman City	261 (78.6)	26 (22.2)	7 (63.6)	18 (66.7)	<0.001*
	Kerman Counties	71 (21.4)	91 (77.8)	4 (36.4)	9 (33.3)	
Place of Death	Out of Hospital	212 (60.6)	4 (3.4)	3 (25.0)	11 (39.3)	<0.001*
	Within Hospital	138 (39.4)	113 (96.6)	9 (75.0)	17 (60.7)	
Year	Before 2017	153 (43.7)	35 (29.9)	5 (41.7)	12 (42.9)	0.071
	After 2017	197 (56.3)	82 (70.1)	7 (58.3)	16 (57.1)	

1. Methadone, Morphine, and Tramadol; 2. Paraquat, Rice Tablet, Organophosphate, Rodenticide, and Detergent; 3. Ethanol and Methanol; 4. TCA, Methamphetamine, and Other Mentioned in Table 1; *. Statistical significance at 0.05 using the chi-square test.

Table 3. Measure of Association for Categorical Variables

Effect	χ2	df	*P*
Intercept	0.00	0	-
Gender	3.28	3	0.351
Age (year)	17.77	9	0.03[8]*
Education	18.4	9	0.03[1]*
Occupation	23.7	12	0.023*
Marital Status	3.1	3	0.375
Place of Residence	80.4	3	<0.001*
Place of Death	91.6	3	<0.001*
Year	1.1	3	0.776

* Statistical significance at 0.05. χ2 = Chi-Square.

strategies aimed at both prevention and management. This study examined poisoning-related fatalities among young individuals aged 14 to 29 years in Kerman from 2012 to 2022, highlighting trends in poisoning substances, demographic influences, and regional variations.

Our findings indicate an overall increase in fatal poisoning cases over the past decade, aligning with observations from Oraie et al's study in Tabriz (2006–2012), which also reported a rising trend in poisonings (21). However, this contrasts with the nationwide study by Ghodsi et al which found that poisoning cases peaked in 1995 and declined thereafter (22). These differences highlight the need for regional studies to understand how poisoning patterns are influenced by regional health and behavioral factors.

The study revealed that 67.1% of poisoning fatalities were male. In general, the gender ratio of fatal poisoning depends on the study's population, location, and time. A study in Khorramabad (2007–2011) revealed that 41% of fatal poisonings were among females (18). Also, in a study conducted in Golestan between 2010 and 2015, the majority of fatal poisonings were females (about 72%); however, the studied population was vulnerable groups (20). Similar to this study, the majority of poisoning fatalities in Hamedan during 2005–2007 were male (19). The gender distribution of the poisoning in Iran has been shifted over time, from women to men (23,24). In addition to the growing issue of drug addiction among men, the increase in economic and social pressures could also contribute to this phenomenon.

This study found that men had higher rates of opioid and alcohol poisoning than women. In the study conducted by Mahmoudi et al in Khorramabad, a significant correlation was also observed between gender and the motivation behind poisonings, resulting in a significantly higher incidence of suicide-motivated poisonings among women compared to men. The lower suicide-related poisoning rate in men may be due to opioid and alcohol misuse,

Table 4. Estimation of predictor variables in the model (only parameters with P < 0.05)

Predictor Variable	Reference	Category	Poisoning Type[1]	Exp(B)[3]	1/Exp(B)[3]	95% CI[4] for Exp(B)	*P*-value
Place of Death	Within Hospital	Out of Hospital	Chemical	0.027	37.4	0.009 – 0.079	<0.001*
			Other	0.368	2.7	0.148 – 0.912	0.031*
Place of Residence	Kerman Counties	Kerman City	Chemical	0.075	13.3	0.040 – 0.142	<0.001*
Education	Over Diploma	Under Diploma	Alcohol	0.109	9.2	0.013 – 0.903	0.040*
			Other	0.172	5.8	0.042 – 0.709	0.015*
		Diploma	Alcohol	0.041	24.5	0.003 – 0.605	0.020*
Occupation	Housewife	Student	Chemical	0.264	3.8	0.079 – 0.885	0.031*

1. The reference is Opioid. 2. B = Coefficient. 3. Exp(B) or 1/Exp(B) = Odd Ratio. 4. CI = Confidence Interval. * Statistical significance at 0.05.

which is less common among women due to Iranian cultural norms (18).

Our study found that fatal poisoning was more prevalent in the provincial capital than in the counties. Also, the place of residence emerged as a significant factor influencing the poisoning pattern, with chemical poisonings being more frequent in the counties. The sharp rise in chemical poisoning rates from 8.3% in Kerman city to 52.0% in the counties suggests that most cases from Kerman's counties likely originate from rural areas. In the studies conducted in other regions of Iran, poisonings were also more prevalent in urban areas (25–28). Urbanization and industrial growth, which amplify mental and psychological stress, along with the availability of drugs and opioids, contribute to the higher incidence of poisonings in these areas.

According to the results, fatal poisoning cases were more prevalent among unmarried individuals. Although the study focuses on individuals aged under 30 years, similar findings have been reported in other studies (15–18,28). Fatal poisonings are more common among unmarried individuals because most deaths from poisoning occur in young people under thirty (3,19). Nevertheless, marriage can play a role in reducing self-harm and fatal poisonings by creating a sense of responsibility towards family and community. This can be seen in the poisoning patterns, with higher rates of opioid and non-opioid drug poisonings observed among unmarried individuals. In a research investigating unintentional poisonings in Gorgan during 2008–2014, married individuals were the majority (29). However, marriage may not be a strong factor in reducing intentional poisonings. For instance, according to the research conducted by Torkashvand et al. in Rafsanjan, intentional poisoning occurred more frequently among married individuals than unmarried ones (15). These conflicting results, combined with the data from this study, suggest that this parameter may not be a strong predictor.

According to the results, both education and occupation significantly influenced poisoning patterns, and most of the individuals with fatal poisoning had an under-diploma education. Consistent with the findings of this study, Mahmoudi et al reported that most fatal poisonings occurred among individuals with a diploma or lower education level, and the education factor significantly influenced the poisoning pattern (18). A notable finding in this study was the inverse correlation between education and fatal poisoning caused by chemicals. In a study by Mahmoudi and Asaee (2008), which focused exclusively on insecticide poisoning, the highest incidence rates were observed among individuals with lower education. Additionally, based on their results, women experienced a higher prevalence of insecticide poisoning compared to men (13).

Based on the results of our study, a correlation between education levels and non-opioid drug poisoning fatalities was observed. The research conducted by Afzali et al. in Hamadan revealed a correlation between education levels and motivation, and among illiterate individuals, intentional consumption was less common, while abuse rates were higher (19). In this study, people with non-governmental occupations accounted for the highest number of fatal poisonings, followed by students and housewives. The findings regarding the occupation factor in fatal poisoning are consistent with the results of the study conducted in the same region in 2022 (30).

Our analysis revealed that most poisoning-related deaths occurring outside hospitals were attributed to opioid use, whereas chemical poisoning cases were more common in hospitals. This mirrors findings from Afzali and Rashidi in Hamedan, which identified a predominance of hospital-related deaths due to chemical agents (31). These outcomes can be used to develop strategies for reducing fatal poisoning. Given that many opioid poisoning cases never make it to the hospital, it is crucial to educate students about the risks of opioids, particularly methadone and tramadol. Furthermore, efforts should be made to raise public awareness about naloxone as an opioid antidote, and the availability of naloxone nasal spray should be expanded to those who frequently interact with individuals struggling with addiction (e.g., law enforcement personnel).

Our study identified methadone, paraquat, morphine, tramadol, and rice tablets as the most common poisons. Notably, nearly half of the fatal poisonings were attributed to methadone. Opioids and pesticides are the leading causes of fatal poisoning (32). The incidence of methadone poisoning has surged sharply in Iran over the past few years (6,7,33). Since the introduction of pharmaceutical methadone (in syrup and tablet forms) in Iran in 2003, its usage has surged, especially after 2005. For example, methadone poisoning cases in Tehran province increased

by a factor of 6 and 87.5 in 2005 and 2010 compared to 2000 (6). The sudden increase of addiction treatment centers in Iran and the widespread availability and distribution of methadone syrup have contributed to this surge (33).

In addition to methadone, tramadol poisoning is also on the rise in Iran (34,35). Given the decline in morphine and heroin poisonings, it is crucial to raise public awareness about the newer substances (methadone and tramadol), ensuring they are recognized as equally dangerous as previous opioids. Also, in addition to raising public awareness about the naloxone antidote, there should be deliberate planning for the targeted distribution of naloxone, with a particular focus on the nasal spray form.

Paraquat was also a major contributor to fatal poisonings. This agricultural poison affects all major body systems, including respiratory, cardiovascular, nervous, glandular, and digestive systems (36). According to the findings from Afzali and Rashidi's study in Hamedan, approximately 15% of fatal poisonings were attributed to paraquat (31). In most cases, paraquat poisoning is a consequence of suicide attempts and has a high mortality rate (37). The decisive factor in the survival of paraquat poisoning is the urgency of treatment (36). Therefore, it is necessary to enhance the knowledge of emergency department staff and the awareness of the public regarding this toxic substance. Furthermore, it is essential to monitor the distribution of paraquat, rice tablets, and other agricultural poisons based on experiences from other countries.

Unfortunately, proposing a specific method to reduce poisonings within this context remains challenging. However, at a regional scale, distributing an informational booklet in high schools can help raise awareness about the risks associated with methadone, tramadol, paraquat, and rice tablets. The booklet would also educate students (aged 14 and above) on how to respond to poisoned individuals, including the use of naloxone. Moreover, a documentary film that explores the detrimental impact of these substances and poisons on the human body, featuring interviews with poisoned individuals, and showing the documentary in classrooms, can create a powerful visual and mental impression. Implementing naloxone nasal spray distribution among law enforcement personnel who engage with drug-addicted individuals daily can effectively lower fatalities resulting from opioids.

Conclusion

Over the past decade, methadone and paraquat have played a significant role in fatal poisonings in Kerman. As a result, strategic planning and decision-making should prioritize these substances. Addressing several factors that contribute to fatal poisonings, such as addiction, social isolation, economic stress, unemployment (particularly among educated individuals), urbanization pressures, and easy access to drugs and toxins, requires significant policy decisions. Additional studies are required in both this region and other regions of Iran to investigate the epidemiology and demographic characteristics of poisonings.

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Authors' Contribution

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Competing Interests

The authors declare that they have no conflict of interests.

Data Availability

All necessary data will available from the corresponding author upon reasonable request.

Ethical Approval

This study was approved by the Ethics Committee of Kerman University of Medical Sciences (Ethical code: IR.KMU.AH.REC.1401.300)

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