Original Article

Epidemio-toxicological profile of fatal poisoning cases autopsied at a tertiary care centre of North India

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Abstract

Background: Poisoning is an important health hazard and one of the leading causes of morbidity and mortality worldwide including in India. The study was conducted to understand the magnitude, pattern, and gender differentials of all poisoning fatalities in relation to the manner of death autopsied at a tertiary care center. **Methods:** A retrospective study of all fatal poisoning cases autopsied at the department of Forensic Medicine & Toxicology of a tertiary care institute in Northern India for the period 1st January 1998 to 31st December 2017 was conducted, and a profile of the victims of fatal poisoning was prepared. Data were analyzed with descriptive and inferential statistics. **Results:** The study included a total of 1099 cases of fatal poisoning autopsied at the department of Forensic medicine & Toxicology. Suicidal poisoning was reported in 90.2% of cases and accidental poisoning was seen in 8.9% of cases. Males were predominantly affected (63.8%). The majority of the victims were in the 3rd decade (40.0%) of life. The age of the victims ranged from 2 to 82 years with a mean age of 38.4 years. Agrochemical compounds were implicated in 44.4% of the total fatalities. **Conclusion:** Males in the 2nd to 4th decades of life were more prone to self-poisoning with Agrochemical compounds in the region of North India. Accidental poisoning deaths were uncommon and poisoning was not a preferred method of homicide in this region. Our approach to the study reveals that quantitative chemical (toxicological) analysis is required to further strengthen and improve the databases of the epidemiology of poisoning in this region.

Keywords: Autopsy, epidemiology, fatal, pattern, poisoning, profile

Introduction

A material or chemical is considered to be poisonous if it causes harm to the body or puts a person's life in danger when ingested, inhaled, or in touch with it.[1] A significant global public health issue is poisoning, although its type and associated morbidity and mortality vary from one country to another. Accidental and intentional exposure that results in acute poisoning has a considerable death and morbidity rate. According to estimates from the World Health Organization (WHO), there are more than three million instances of intoxication worldwide each year, resulting in 640,000 fatalities.[2] More than 90% of poisoning-related deaths take place in underdeveloped nations, especially among agricultural laborers.[3]

In advanced countries, the fatality rate from poisonings is approximately 1% to 2%, while it might reach 20% to 30% for India.[4] In India, poisoning ranks as the fourth most common cause of death.[5] According to the latest estimates, five to six

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people per lakh of the population in India pass away every year as a result of acute poisoning.[6] The type of poisoning varies based on the major agent used in a given region. In southern and central India, organophosphorus (OP) chemicals are the main factor in suicide deaths.[7,8] In contrast, aluminum phosphide is the main cause of death in Northern India.[9-11] In general, suicidal poisoning affects young adults more frequently than accidental poisoning does young children.[12]

Due to variations in socioeconomic status, cultural norms, and the ease of access to poisons in various regions, the trend of poisoning varies from country to country as well as from one region to another within a specific nation. Apart from geographical differences, the pattern of poisoning has also changed over the last several decades, as more and more new poisons and drugs are coming out each year and some of the older ones are getting obsolete.

Most poisoning cases in India are from rural India and are attending for initial treatment at the primary health center or the community health center by a primary care physician. Hence, knowledge of common poisoning agents and methods is essential for them to handle any case of acute poisoning including initial management and prompt referral.

India's regional variances are evident in the frequency and pattern of poisonings and intoxications due to a range of variables. Therefore, it is essential to conduct regular studies to comprehend the poisoning pattern in each location so that they may serve as a beneficial guiding document for the construction of medical facilities to lower poisoning-related fatality. With this background, the current study was conducted in order to estimate the epidemic-toxicological profile of fatal poisonings taking into consideration demographic information, place of consumption, kind of poison engaged, and method of poisoning. It was done so in order to take into account the changing trends and patterns of poisoning deaths over the period of time.

Material and Methods

Study settings and design

When death is abrupt, unforeseen, mysterious, or unnatural, an autopsy or post-mortem investigation is considered essential. Poisoning fatalities are classified as unnatural in India, necessitating a medico-legal investigation and a post-mortem examination.[13] To determine the poison that caused a death, toxicological analyses are a crucial aspect of the postmortem in suspicious and confirmed poisoning cases.

A retrospective hospital record-based observational analysis on probable fatal poisoning patients was conducted, which were autopsied between 1998 and 2017 at the Department of Forensic Medicine & Toxicology, All India Institute of Medical Sciences, New Delhi. In the Institute, around 800 medico-legal autopsies are performed annually. Viscera and blood samples were extracted during the postmortem and forwarded to the State Government Directorate of Forensic Science Laboratory (DFSL) for chemical analysis in order to look for poison.

Toxicity identification in a research lab

For the purpose of finding a poisoning agent, viscera samples were the focus of the analysis. Blood samples from the admitted patients were collected, delaying the death brought on by the poison's digestion. Blood samples were also kept when alcohol or drug toxicity was suspected.

Presumptive tests (color tests and thin layer chromatography-TLC) and confirmation tests (gas chromatography-mass spectroscopy) were used to identify the poisons that the victim consumed (GC-MS). The headspace gas chromatographic method was used to determine the amount of alcohol in the blood. The "Gold standard" GC-MS drug-testing method was employed to confirm drug intake. Prior to this procedure, the majority of the negative samples were eliminated using the fast immunoassay approach. The methods utilized were verified, and the laboratory results produced at DFSL are recognized by the Indian legal system.

Current state of laboratory reporting on toxicity screening

Positive: The specimens tested positive for poison in the analysis. *Negative*: Despite having positive autopsy results for acute poisoning, no toxins could be found in the samples that had been stored. The following are the causes of the negative laboratory findings in medically significant cases of poisoning in this region of India[12]:

- Delayed examination as a result of the cases' prolonged pendency - The lengthy interval between sample collection and laboratory analysis causes the original chemical to change into an undetectable by-product.
- The specimens' improper conservation.
- Transporting samples in a hot, humid environment wastes time and damage the samples.
- Improper analytical techniques are used.
- Breakdown of toxins.
- Complete toxin digestion before death.
- Lack of infrastructure or equipment for assessing specific poisons and the existence of a negligible quantity of toxin in the specimens as a result of primary treatment.

Data collection and analysis

The autopsy records at the Department of Forensic Medicine & Toxicology (AIIMS, New Delhi) from 1st January 1998 to 31st December 2017 were accessed and retrieved. After reviewing 3,996 medico-legal postmortem reports, 1099 lethal poisoned instances were found in total. Two authors separately used a metadata spreadsheet to extract the data. Age, gender, the manner of death (accident, suicide, or homicide), type of poison, as well as other information, were recorded. They were acquired from the health records and the postmortem reports. Whether such deaths were homicidal, suicidal, or accidental was determined

based on (i) the narratives provided by the patients when they were admitted, (ii) the histories provided by the deceased relatives in cases of brought dead patients, (iii) the results of the postmortem, (iv) the type of toxin found, and (v) the findings of the police investigation. In all cases where the sample gave a negative report, we categorized the poison as "unknown".

The data collected were entered in Microsoft Excel and the analysis was performed with SPSS software version 21.0. Case features were taken into account as categorical data and expressed as proportions. The socio-demographic profile and the kind of poisons utilized were subjected to descriptive analysis. In the case of categorical variables, the results for continuous variables were provided as mean, SD (Min-Max), and frequency (%). A timeline with the number of deadly poisoning cases was organized by year. The significance of research parameters on a categorical scale between two or more groups was determined using the Chi-square/Fischer test.

Ethics-related matters

After receiving approval from the Institute Ethics Committee, the study went underway. Each instance received a special ID number to preserve anonymity, and the authors were the only ones who had access to the data.

Results

Between January 1998 and December 2017, 3,996 medico-legal postmortems were performed. These include a total of 1099 (27.5%) cases of fatal poisonings. The annual distribution of deaths due to poisoning is shown in Figure 1. Across the 20-year period, We discovered the biggest peak in the number of fatal suicidal poisoning cases (n = 79) in the year 2000 with the subsequent rise and decline over the years [Figure 1]. Males made up the majority of the deceased (n = 701, 63.8%) with the male-to-female ratio as 1.8:1. The victims ranged in age from 2 to 82 years, and the frequency peaked in the third decade of life (31.8%) before gradually declining after that. The most severely impacted age groups, which combined accounted for 61.8% of all poisoning deaths, were those in their third and fourth decades [Table 1]. On average, the victims of the poisonings were 35.8 years old (SD = 14.6). The mean ages of the male and female victims were 39.4 years (SD = 14.2) and 30.3 years (SD = 13.5). Across all the age groups, the majority (>50%) were males female victims constituting a maximum in the age—a group of 31-40 years and a minimum in the age-group of 11-20 years by proportion [Figure 2].

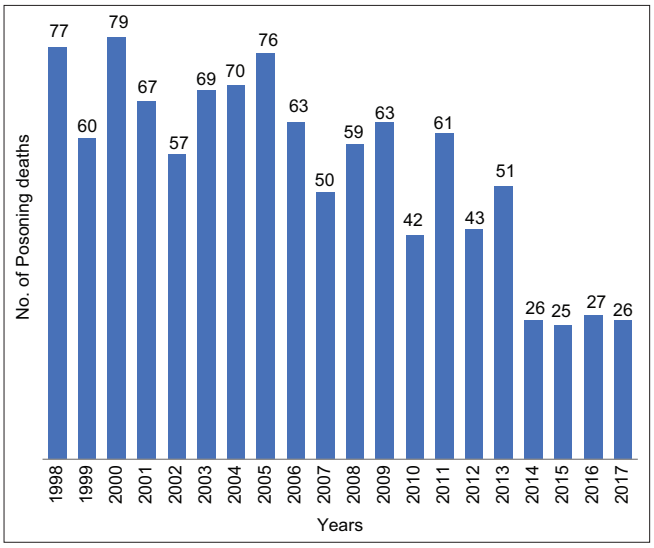

Figure 1: Year-wise distribution of fatal poisoning cases over 20 years (*n* = 1099)

With respect to the manner of death, the majority of the poisonings were suicidal (n = 991, 90.2%) followed by accidental (n = 98, 8.9%) with homicidal poisoning being the least common (n = 10, 0.9%) [Figure 3].

During the 20-year period, a total of 49 specific poisons responsible for the deaths were identified. For more analysis, These chemicals/compounds were grouped into corrosive poisons such as sulphuric acid, carbolic acid, hydrochloric acid, and sodium hydroxide, agrochemical poisons which included pesticides, insecticides, and rodenticides (such as aluminum phosphide, organophosphorus, pyrethrum, zinc phosphide, organochloride, and chlorinated hydrocarbon), Asphyxiants, animal-derived toxins, and therapeutic drugs as per [Table 2]. The most common cause of death that was documented was agrochemical poisons (44.0%) followed by cases in which the nature of the poisons could not be ascertained (31.7%) [Table 3].

With respect to the association of gender of the fatal poisoning cases with other demographic attributes, significant differences were found in the ages, manner of death, and type of poison

Table 1: Distribution of fatal poisoning cases by age and gender (*n*=1099)

Age-groups (in years)	Male *n* (%)	Female *n* (%)	Total *n* (%)
≤ 10	11 (17.7)	4 (1.0)	15 (1.4)
11-20	180 (28.9)	40 (10.1)	220 (20.0)
21-30	264 (42.4)	176 (44.2)	440 (40.0)
31-40	126 (20.2)	114 (28.6)	240 (21.8)
41-50	79 (11.3)	40 (10.1)	119 (10.8)
51-60	26 (4.2)	13 (3.3)	39 (3.5)
>60	15 (2.4)	11 (2.8)	26 (2.4)
Total	701 (63.8)	398 (36.2)	1099 (100.0)

Table 2: Distribution of fatal poisoning cases by category of poison (*n*=1099)

Poison category	Frequency	Percentage (%)
Agrochemical	488	44.4
Corrosives	114	10.4
Asphyxiants	65	5.9
Therapeutic drugs	64	5.8
Animal poisons	20	1.8
Not identified/Unknown	348	31.7

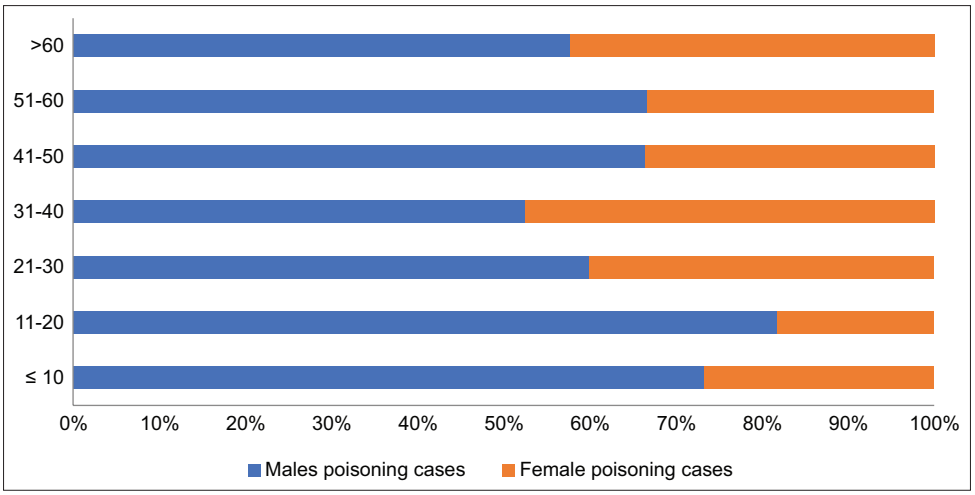

Figure 2: Distribution of fatal poisoning cases by gender across the various age-groups (*n* = 1099)

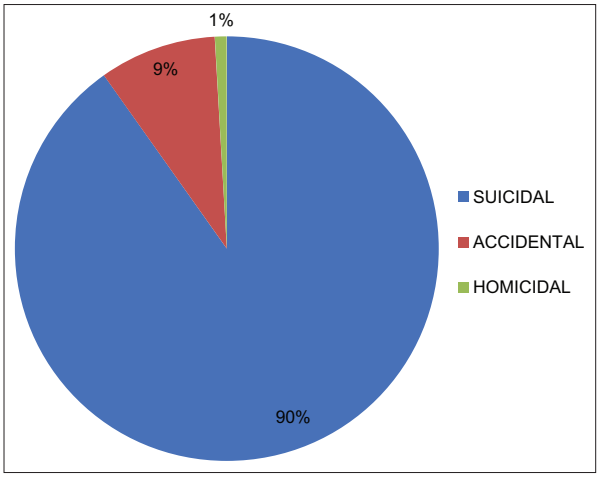

Figure 3: Distribution of manner of death among the fatal poisoning cases (*n* = 1099)

Table 3: Association of Gender with the other demographic attributes among fatal poisoning cases (*n*=1099)

Demographic attribute	Male *n* (%)	Female *n* (%)	X^2	*P*
Mean age (in years)	34.72±12.5	42.45±14.2	-	<0.0001*
Age-group (in years)				
<20	191 (27.3)	44 (11.1)	39.61	<0.00001*
21-60	495 (70.6)	343 (86.1)		
>60	15 (2.1)	11 (2.8)		
Manner of death				
Suicidal	623 (88.9)	368 (92.4)	12.19	0.002*
Accidental	75 (10.7)	23 (5.8)		
Homicidal	03 (4.3)	07 (1.8)		
Poison category				
Agrochemical	301 (42.9)	187 (47.0)	17.21	0.0001*
Other poisons	149 (21.3)	114 (28.6)		
Unknown	251 (35.8)	97 (24.4)		

*Statistically significant

agents consumed between males and females. Male victims of the fatal poisonings were much younger than the female victims ($p < 0.0001$). Similarly, male victims of accidental and homicidal poisonings were proportionately more numerous than the victims who were women ($p < 0.002$). Additionally, it was shown that the proportion of male victims with unidentified poisons was substantially higher than that of female victims ($p < 0.0001$).

Discussion

In our settings, the proportion of deaths involving poisoning that comprised all postmortem performed throughout the research period was 27.5% which is quite higher than found in other previous studies from Northern,[13-16] Western[17,18] and southern India[19] but similar to some other countries like Korea,[20] Germany,[21] and Bangladesh.[22]

In our research, self-poisoning was the cause of more than 90% of the lethal poisonings. This pattern is consistent with earlier Indian studies[9-11,13,23,24] and is explained by the widespread perception that poisoning kills with little discomfort or agony. Nevertheless, intentional poisoning was shown to occur less frequently in Pakistan and Denmark than that seen in our study.[25,26]

Only 0.9% of the total fatal poisoning cases were homicidal in nature suggesting that in this region of the country, intoxication is no longer the predominant method of homicide, comparable to the findings of previous studies done in Northern,[9-11,13-16,27] Western[17,18] and Southern India.[19] The decline in homicidal poisoning deaths across India could be attributed to modern, sophisticated sample analysis techniques and reliable methods of toxin detection making homicide easily detectable.[24]

Males were more common victims of fatal poisonings than females which can be linked to the fact that males experience temptations, challenges, stressors, and strains more severely than females do.[28-30] In our study, men made up 1.8 times as many poisoning victims as women did which was found similar to some other studies.[8,9,14,21-23] However, research from Odisha, Eastern India, and Dhaka, Bangladesh found that the mortality rate for

men and women from poisonings was roughly comparable[21,32] whereas, in Peshawar, Pakistan, there were noticeably more men than women.[26] According to surveys conducted in Imphal, Maharashtra, Norway, and Imphal, India, women predominate in poisoning deaths.[7,25,26] It's still not apparent why women are more prevalent in certain areas of the country.

Similar to studies conducted in other regions of India and overseas, the majority of the victims of lethal poisonings in our study (61.8%) belonged to the age range of 21 to 40 years.[6,9,10,14,15,22,23,31,33] Given that this age group makes up a sizeable portion of India's population (36% of the total, according to the 2011 Census), it is reasonable to expect that the number of fatal poisoning cases will peak in the third and fourth decades. This increase can be attributed to the extreme stress that people experience at this time in their lives. Only 15 fatal poisoning incidents involving children under 10 years old were reported during the research period. Surveys conducted in both Europe and the Indian subcontinent have produced results that are similar.[10,13,14,25,34] The majority of poisoning cases in children involve unintentional ingestion, and the fact that accidental poisoning kills fewer kids is largely attributable to increased public awareness, appropriate safety measures, and therapeutic interventions.[35] Children are more likely to accidentally poison themselves when poisonous materials are kept in settings that are easy to access.[36]

The majority of earlier, comparable research indicated the prevalence of poisoning cases and the age distribution of victims without taking a gender-specific approach. The majority of the fatality instances, in both males and females, were between the ages of 31 and 40 years when we evaluated with a gender-specific approach through our study. However, the study by Parekh *et al*.[27] from Gujrat, Western India found the age group of 11-40 years in females and 21-50 years in males to be the commonest age group. It would be advised to conduct more research with the aim of identifying gender-specific risk factors for lethal poisoning in the relevant critical decades of age.

The major bulk (44.4%) of all poisoning fatalities were attributed to agrochemical poisons, followed by poisons of unknown composition (31.7%), and corrosive agents (10.4%). Our results were similar to those of studies conducted at Yawatmal and Jamnagar in Western India,[1,17] Shimla in Northern India,[13] and Orrisa in Eastern India,[12] but not to those of other studies conducted in Northern India, where the pesticide aluminum phosphide has replaced mercury as the primary cause.[2,8,15,16]

In India, poisoning cases are more common in rural areas compared to urban ones owing to the ease of access to agrochemical poisons.[37,38] The poison victims in the majority of the cases first present to the nearest primary health centers manned by a medical officer, particularly in rural areas. Therefore, knowledge of the common poisons along with the commonest mode of poisoning in this region of the country would help the primary care physicians in better management of such cases and timely reference to the higher centers such as district hospitals or medical colleges after providing the initial management.

Conclusion

Based on an analysis of 20 years work of autopsy records (1998 to 2017) from a North Indian tertiary care hospital, we discovered that most lethal poisoning cases were males in their second to fourth decades of life, which is thought to be the most active and productive time of life. The most common poison used was agrochemical poisons, and suicidal poisoning was the predominant manner of poisoning. According to statistical analysis, a male in his third decade of existence is most at risk for dying from suicidal ingestion of agricultural chemicals. These findings can help administrators and policymakers plan effective interventions to reduce the incidence of fatal poisonings in India.

Limitations

Limitations exist mainly because this was a retrospective study, which has the drawback of having recorded with gaps. The fact that the post-mortem viscera and blood were only subjected to qualitative examination is a significant drawback of the study. The specific material or compound was also not further classified within a class of compounds, particularly an organophosphate compound group. Our method of conducting the study highlights the need for quantitative chemical (toxicological) analysis to strengthen and enhance the databases of poisoning epidemiology in our area.

Key points

- Fatal poisonings account for around one-third of all unnatural deaths in this region of India;
- Majority (63.8%) of the victims of fatal poisonings were males with a male to female ratio of 1.9:1;
- Majority (81.8%) of victims of fatal poisonings were younger ones, being in 2nd to 4th decade of life
- A most common mode of poisoning was self-poisoning (90.2%) followed by accidental poisoning (8.9%) and the most common agent was agrochemical compounds (44.4%);
- Significant difference was observed between the male and female victims of fatal poisonings with respect to age distribution, manner of poisoning, and category of poisonous substance used.

Take home message

- Poisoning is an important cause of unnatural deaths in the northern region of India and younger ones in the 2nd to 4th decade of life are more prone to suicidal poisonings.

The novelty of the study

- The study analyzed 20 years of data on fatal poisonings autopsied at a premier medical institute in Northern India.

Ethical approval

The study was conducted after clearance from the Institutional Ethics Committee (IEC), All India Institute of Medical Sciences (AIIMS), New Delhi, India.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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