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SHORT COMMUNICATION

Toxico-Epidemiological Profile of Fatal Poisonings at a Tertiary Care Hospital in Visakhapatnam, India (2023): A Brief Report

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Abstract
Suicide is a global issue in modern society, with people from different cultures exhibiting distinct behavioural patterns and methods. In recent times, suicide by pesticide poisoning has become a common occurrence in India. Generating data on the toxico-epidemiology of poisoning in each region is critical for implementing targeted interventions to restrict access to these substances and, in turn, prevent self-harm. The present study was conducted on fatal poisoning cases autopsied at a tertiary care hospital in Visakhapatnam during the year 2023. The study included 195 fatal poisoning cases, with 74.4% of the victims being male, and the majority falling within the 31–40 years age group. Pesticide consumption was responsible for 80% of all deaths, and 94.87% of the cases were intentional poisoning. The herbicide paraquat alone accounted for 39.4% of the deaths in the study population. Financial issues, familial disputes, and drug addiction were the primary reasons for suicides, and the survival period varied, with most individuals dying within 24 hours. Several Highly Hazardous Pesticides (HHPs) were used for these intentional self-harm cases, emphasizing the urgent need to restrict access to these substances to save lives as envisaged by the WHO.

Keywords: Poisoning, Suicide, Pesticide, Autopsy, Mental health, HHPs

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Introduction

Poisoning is a prevalent cause of death frequently encountered in medico-legal autopsy practice across India, as it remains a common method of suicide in the country [1]. The misuse of pesticides for self-harm has been a persistent issue not only in India but also in several other Southeast Asian nations [2]. Recognizing the gravity of the problem, the WHO has consistently emphasized the need to restrict access [3] to such toxic substances as a practical and effective strategy for suicide prevention. Sadly, fatal self-poisoning with pesticides remains a widespread issue in many low- and middle-income countries (LMICs) due to limited political commitment, insufficient public dialogue around the problem, administrative challenges, and gaps in the technical infrastructure needed to ensure safe management and regulation of highly hazardous pesticides.

India currently lacks a formal poison incident reporting system to track cases of suicidal, accidental, or homicidal poisonings [4,5]. In the absence of such surveillance, multi-centre toxicoepidemiology studies become essential to understand the true scale of the problem of both fatal and non-fatal poisoning instances. Gathering this evidence is extremely necessary to identify which agrochemicals and/or other substances are commonly abused for self-harm. Furthermore, such data can help plan proper practical strategies to restrict access to these toxic substances and inform public health systems to be prepared for handling poisoning cases.

This study aims to examine the toxicoepidemiology of all fatal poisoning cases autopsied at a tertiary healthcare facility in Visakhapatnam, Andhra Pradesh. The objectives include studying the sociodemographic profile of poisoning victims, the reasons for consumption, the specific substances involved, the period of survival, and other related factors.

Methodology

This retrospective study was conducted in the Department of Forensic Medicine at Andhra Medical College, Visakhapatnam, Andhra Pradesh. The data on poisoning deaths were collected from police inquest reports, autopsy findings, toxicological analysis reports, and any available medical records. The study included all poisoning cases autopsied during the calendar year 2023, while autopsies conducted for envenomation (snake bite, bee sting, scorpion sting) were excluded. In all 195 cases included the toxicological substance identification was solely based on forensic science laboratory reports. In some cases, the generic nature of the compound was established (e.g., Organophosphate, etc.), while in others, the exact substance was identified (e.g., Chlorpyriphos, Paraquat, etc.).

As this was a record-based study involving manual data extraction from available documents, the authors acknowledge the possibility of missing a few cases of poisoning due to oversight. On average, around 2,000 autopsies (for the year 2023, n= 2010) are performed annually at Andhra Medical College/King George Hospital, Visakhapatnam, with poisoning deaths accounting for approximately 10–15% of the total cases. In general, about 25% (for the year 2023 total suicide cases n= 557) of cases involve suicide by poisoning, with other common means of taking one's life including hanging, falls from height, and railway fatalities.

Results

A total of 195 poisoning cases were included for analysis, of which 145 were male (74.4%) and 50 were female (25.6%). The age distribution of the cases is shown in Figure 1, with the highest number of victims (49 cases, 25.1%) belonging to the age group of 31–40 years.

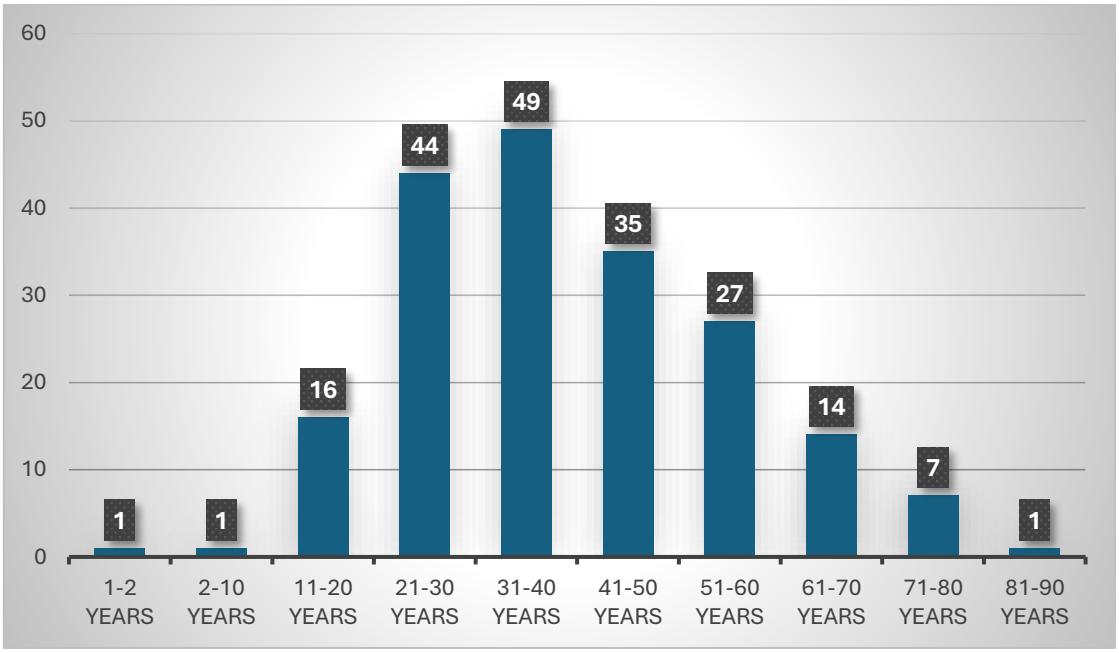

Figure 1. Age distribution of fatal poisoning cases

The occupations of the decedents due to poisoning showed a wide spectrum. The most affected were those engaged in agriculture and farming, with 36 cases. Self-employed individuals accounted for 32 cases, daily wage workers for 24 cases, housewives for 20 cases, and students for 12 cases. There were also 4 cases each among watchmen and unemployed individuals, and 3 cases involving salespersons. In addition, there were 2 software engineering professionals among the decedents. In 23 cases, the occupation was not known**.** Lastly, 35 cases were categorised as "others," that included skilled and unskilled professionals across blue-collar and white-collar backgrounds, such as technicians, plumbers, university teachers, bank managers, and other highly educated individuals. It was difficult to ascertain the economic status of the study population from available sources, hence, it was not done.

Out of the total of 195 cases, 98 were from rural areas, 95 from urban areas, and 2 from tribal areas. In terms of seasonal distribution, 71 cases occurred during the summer, 45 during the winter, and 79 during the rainy season. In terms of marital status, 146 individuals were married, and 49 were unmarried.

Out of the total 195 cases, 150 individuals consumed poison at home, 17 in agricultural fields, 23 away from home, and 5 in other locations not specified. The total number of poisoning cases in the study was 195, of which 185 were suicidal. The remaining 10 cases included 1 homicidal case involving paraquat poisoning and 9 accidental poisoning cases. These accidental cases comprised 2 instances of paraquat poisoning, 2 cases of corrosive

(hydrochloric acid) poisoning, 1 case of drug overdose (metformin), 1 case involving chlorhexidine and cetrimide antiseptic, 1 case of propoxur poisoning, 1 case of transfluthrin poisoning, and 1 case of uncategorized organophosphate poisoning.

The reasons for attempting suicide in the study population were manifold. Debts and financial liabilities were reported in 43 cases. Familial disputes, relationship issues, and marital discord accounted for a total of 47 cases (38 involving familial disputes and relationship issues, and 9 involving marital discord). Drug addiction and substance abuse were identified in 34 cases. Chronic illnesses were reported as the reason in 17 cases. Other psychiatric conditions and feelings of being vexed with life contributed to 35 cases (26 with psychiatric conditions and 9 feeling vexed with life). In 19 cases, the reason remained unknown.

The survival periods of the poisoning cases also showed a wide variation. In 37 cases, the survival period was less than 12 hours, while 48 cases had a survival period between 12 and 24 hours. In 35 cases, the survival period ranged from 1 to 2 days, and in 24 cases, it was between 3 to 4 days. There were 21 cases where the survival period was between 5 to 7 days, 11 cases where it was between 8 to 10 days, and 13 cases where the survival period ranged from 11 to 15 days. In 3 cases, the survival period was between 16 to 31 days, and in 1 case, it lasted 1 to 2 months. The survival period was unknown in 2 cases.

Herbicides and insecticides were the most common substances involved in poisoning cases, each being reported in 78 cases. A breakdown of the substances is provided in Table 1.

Table 1. Profile of substances involved in fatal poisoning cases

S. No	Type Of Poison	No. of cases
1.	Herbicide	78
2.	Insecticide	78
3.	Corrosives	11
4.	Drug Overdose	9
5.	Undetermined Poisoning	6
6.	Rodenticide (Phosphide)	5
7.	Ethyl Alcohol	3
8.	Fungicide (Hexaconazole)	2
9.	Antiseptic (Chlorhexidine + Cetrimide)	1
10.	Engine Oil	1
11.	Oleander Seeds	1
	Total	195

Among the 78 cases of herbicide poisoning, 77 resulted from paraquat, while one was due to pretilachlor. The profile of insecticide poisoning is shown in Table 2, with organophosphate compounds being the most abused.

Table 2. Profile of Insecticides in fatal poisoning cases

S. No	Insecticide	No. of cases
1.	Uncategorised Organophosphate Compound (OPC)	32
2.	Chlorpyriphos (OPC)	15
3.	Profenophos (OPC) & Cypermethrin (Pyrethroid)	6
4.	Profenophos (OPC)	4
5.	Propoxur (Carbamate)	3
6.	Monocrotophos (OPC)	3
7.	Dimethoate (OPC)	3
8.	Chlorpyriphos (OPC) & Cypermethrin (Pyrethroid)	2
9.	Cyhalothrin (Pyrethroid)	2
10.	Emamectin Benzoate (Avermectin)	1
11.	Chlorfenapyr (Pyrrole)	1
12.	Ethion (OPC) & Cypermethrin (Pyrethroid)	1
13.	Permethrin (Pyrethroid)	1
14.	Phenyl Pyrazole	1
15.	Phorate (Nematicide)	1
16.	Imidacloprid (Neonicotinoid)	1
17.	Transfluthrin (Pyrethroid)	1
	Total	78

Discussion

This study is the first of its kind in the Visakhapatnam region and was conducted at King George Hospital. The hospital serves the healthcare needs of three North Coastal Andhra Pradesh districts, and the study population is representative of Visakhapatnam, Vizianagaram, and Srikakulam districts to some extent.

Middle-aged (31-40 years, 25.12%) males (74.4%) were the most common victims of fatal poisonings in our study, which is concordant with several studies in India [6,7]. Our study shows a changing trend of preference of herbicides like paraquat for self-harm alongside the traditional organophosphate compounds as reported by several researchers in India [8,9].

Pesticide poisoning has traditionally been more prevalent in rural areas [10]. However, in the present study, it is also increasingly observed in urban areas (95 cases, 48.7%) and among non-agrarian communities. This trend was also noted in our earlier empirical observations [11]. 94.87% of cases are intentional poisonings, indicating this as an important means of suicide alongside hanging, self-immolation, etc., in the Indian subcontinent [12].

Financial and familial issues (46.1%) were responsible for most individuals resorting to the extreme step of suicide by poisoning, a trend that aligns with the prevailing conditions observed in the general suicide trends of the country [13]. Most of the victims in the present study died within 2 days of poison consumption, indicating extreme acute toxicity of the substances consumed.

The Highly Hazardous Pesticides (HHPs) identified in the study include paraquat (herbicide), chlorpyrifos (organophosphate), dimethoate (organophosphate), ethion (organophosphate), monochrotophos (organophosphate), phorate (nematicide),

prophenophos (organophosphate), and profenophos and cypermethrin (organophosphate/pyrethroid combination). They fall within categories 1 and 2 as per WHO criteria, though classifications can sometimes vary slightly depending on the specific formulations.

As of March 1, 2021, India has registered a total of 293 pesticides for use. In the 2019–2020 period, the total annual consumption of technical-grade chemical pesticides amounted to 61,703 MT. Of these, nearly 80% of the pesticides consumed in India fall under the category of extremely or highly hazardous pesticides [14].

A systematic review of lethal poisonings in India from 1999 to 2018 found that 94.5% of deaths were attributed to pesticide poisoning, with aluminum phosphide and organophosphates being the most common culprits. The review also highlighted paraquat as an emerging concern. In contrast, our study from 2023 shows a surge in paraquat-related deaths, while fatalities from rodenticides like aluminum phosphide have decreased [15]. It is worth mentioning that the choice of pesticide for self-harm is greatly influenced by word of mouth regarding the toxicity of various substances. Lately, paraquat has been ruling the roost, as it has no antidote and almost always leads to death.

Our findings indicate a higher incidence of paraquat poisoning compared to other studies, as previously discussed, which may be attributed to the elevated usage of this herbicide in coastal regions. Of the 77 cases, all except three—two accidental and one homicidal—were suicides. The choice of paraquat for suicide is primarily due to its severe acute toxicity and the absence of a specific antidote, making management purely supportive. There are also several reasons for high mortality apart from the lethality of the substance. Since organophosphate compound (OPC) abuse for suicide was quite common for a while, many primary care physicians confuse paraquat with OP compounds and atropinize the patient, which can sometimes be harmful. Similarly, the point-of-care test for paraquat (dithionate test) is generally not available in public hospitals, adding to the challenge of diagnosis. The clinical pattern of toxic manifestations is complex, sometimes causing acute renal failure and sometimes leading to toxic hepatitis or paraquat lung if patient survives a few days [11]. A weight-of-evidence approach like GRADE (Grading of Recommendations, Assessment, Development, and Evaluation) should be used to develop clinical guidelines for paraquat poisoning management in an effective manner.

Limiting access to means of suicide, such as Highly Hazardous Pesticides (HHPs), has proven effective in reducing suicide rates in some countries [16]. It is now time for a thorough review of the availability of pesticides, balancing the needs of agriculture with the imperative to prevent suicides.

The results of this study highlight that pesticide poisoning is no longer confined to agricultural workers. Easy accessibility and socioeconomic stressors have contributed to a rising number of cases among urban populations, including low-income communities, migrant workers, and youth [17,18]. This shift strengthens the urgent need for a multi-sectoral approach to prevention, moving beyond traditional agricultural safety measures. Effective interventions must include strict regulations on the sale and distribution of highly hazardous pesticides, improved

enforcement of safe storage practices, and public awareness campaigns to educate communities on the risks associated with pesticide exposure [19]. By the same token, integrating pesticide control measures with broader suicide prevention strategies—such as mental health support services, crisis helplines, and community-based interventions—can help address the underlying drivers of self-harm and poisoning incidents [20,21].

Drawing on successful international models, India can implement policies similar to Sri Lanka's pesticide bans, which led to a decline in suicide rates [22], or the European Union's stringent pesticide regulations [23]. A phased approach to restricting access to highly toxic pesticides and promoting safer alternatives like large-scale adoption and monitoring of integrated pest management (IPM) could substantially reduce poisoning cases. Government-led initiatives should prioritize farmer support programs to ensure that economic pressures do not push agricultural workers toward hazardous pesticide use or self-harm [24]. More to that, providing financial incentives and training for adopting mandatory IPM practices could accelerate the transition to safer pest control methods.

Strengthening healthcare systems to improve poisoning management, investing in early warning systems to identify at-risk individuals, and fostering collaborations between public health, agriculture, and regulatory bodies will address this growing crisis [25-27]. Implementing robust surveillance systems to track poisoning trends and identify high-risk regions can enable targeted interventions, ensuring that prevention efforts are data-driven and directed where they are most needed. Real-time monitoring of pesticide poisoning cases could also help policymakers adapt regulations and intervention strategies effectively.

It is important to note that paraquat herbicide has recently been abused for homicidal purposes in India on multiple occasions, further strengthening the argument for its ban in the country [28-30]. Sadly, a male child (aged 18 months) who was criminally poisoned to death with paraquat was also part of the study population in our research.

This study has some limitations. The exact percentage of consumed compounds/lethal substances (formulations) is unavailable, and the toxicological analysis is only qualitative. Also, since data extraction was performed manually, there may be minor errors in substance categorization.

Conclusion

This toxicoepidemiology study of fatal poisonings in the Visakhapatnam region during the year 2023 revealed the widespread abuse of paraquat, a herbicide, for committing suicide. Furthermore, pesticide poisoning is no longer limited to rural areas; it is becoming a common means of suicide in urban areas and among individuals from non-agrarian backgrounds. Middle-aged males were the most common victims of poisoning, and the decedents ingested several highly hazardous pesticides to take away their lives. This raises concerns about the availability of such substances in the market since restricting their access is a modifiable risk factor for preventing suicide.

Statements and Declarations

Conflicts of interest

The authors declare that they do not have conflict of interest.

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Ethical considerations

All ethical concerns should be addressed by the authors.

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