Sociodemographic and Toxicological Profiles of Poisoning Deaths in Dinajpur, Bangladesh: A Retrospective Study Based on Autopsy Records

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Abstract

Background: Poisoning is a major public health and medicolegal challenge in rural Bangladesh, yet region-specific data on fatal cases remain scarce.

Objective: To describe the sociodemographic and toxicological profiles of poisoning-related deaths autopsied at Dinajpur Medical College and identify associations between demographic factors and poison type and identify factors associated with suicidal poisoning.

Methods: This retrospective, descriptive, cross-sectional study analyzed 233 consecutive medicolegal autopsy cases of suspected or confirmed poisoning deaths from January 2021 to December 2025. Demographic, medicolegal, and toxicological data were extracted from structured autopsy records. Chi-square tests, ANOVA, Mann-Whitney U test, and binary logistic regression were applied ($\alpha = 0.05$).

Results: Mean age was 32.4 ± 15.8 years; males comprised 53.2%. Most victims were rural residents (87.1%), married (75.1%), and housewives (39.9%). Suicide was the predominant manner of death (76.8%; 95% CI: 71.0–82.0) and was significantly more common in females (92.7% vs. 62.9%; $\chi^2 = 29.235$, $p < 0.001$). Organophosphates were the leading poison (40.8%), followed by aluminium phosphide (15.5%). On logistic regression, female sex (aOR 8.21; 95% CI: 3.39–19.88) and organophosphate poisoning (aOR 34.40; 95% CI: 7.79–151.83) independently predicted suicidal deaths. Age varied significantly across poison types (ANOVA: $p < 0.001$). Cases peaked in March (14.2%). Mean toxicological report turnaround time was 30.9 ± 29.8 days (median 18 days).

Conclusion: Fatal poisonings in Dinajpur predominantly affect young rural adults, particularly housewives and farmers, and are largely suicidal in nature. Organophosphates remain the leading lethal agent. Strengthened pesticide regulation, community mental health services, and improved forensic toxicology infrastructure are urgently needed.

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Introduction

Poisoning represents a major global public health problem, causing hundreds of thousands of deaths annually.[1] The burden is disproportionately high in low- and middle-income countries (LMICs), where highly toxic substances are often easily available and inadequately regulated.[2,3] In Bangladesh, poisoning is one of the leading causes of injury-related death, frequently linked to self-harm.[4,5]

The epidemiological pattern of poisoning varies significantly across regions,[4,5] influenced by culture, socio-economic conditions, and occupation. In urban areas like Dhaka, there is a higher incidence of poisoning from pharmaceutical drugs (e.g., benzodiazepines).[6,7] Studies from agricultural regions like Rajshahi have shown a pattern dominated by agrochemical poisoning, particularly organophosphorus compounds (OPCs).[8,9]

Dinajpur district, located in northern Bangladesh, is one of the country's primary agricultural zones. The widespread use of pesticides and insecticides has become integral to modern agriculture here.[2,10,11] This easy availability of agrochemicals may create a unique profile of poisoning deaths.[2,4] A recent autopsy-based analysis of unnatural deaths in Dinajpur documented the broader medicolegal mortality pattern in this district,[12] but a focused, poison-specific toxicological and sociodemographic profile has not previously been reported. This study addresses this gap through systematic analysis of autopsy records of poisoning-related deaths to create a comprehensive demographic and toxicological profile. This study also explored the seasonal variation[13] in poisoning-related mortalities. Understanding of these patterns is crucial for developing locally relevant prevention policies.[2,3]

Methods

A retrospective descriptive cross-sectional study was conducted at the Department of Forensic Medicine, Dinajpur Medical College, from January 2021 to December 2025. All deceased individuals who underwent medicolegal autopsy where the cause of death was suspected or confirmed as poisoning were included by consecutive sampling. No a priori sample size calculation was performed as this is a census of available records. Cases were excluded if postmortem decomposition precluded cause-of-death determination or where records (postmortem report, police inquest, or chemical examiner's report) were incomplete. A structured extraction form captured age, sex, marital status, occupation, religion, residence, month and year of death, place of death, hospital referral status, manner of death, postmortem findings (cyanosis, frothy secretions, characteristic odour, visceral congestion), poison type on chemical analysis, and turnaround time for the chemical examiner's report. IBM SPSS Statistics v26.0 was used. Frequencies and percentages were computed for categorical variables; mean ± standard deviation, median, and range for continuous variables. The chi-square (χ^2) test examined associations between categorical variables; Fisher's exact test was applied where expected cell counts were < 5. The Mann–Whitney U test compared continuous variables between two independent groups. $\alpha = 0.05$ (two-tailed) throughout. Binary logistic regression analysis was performed to identify factors independently associated with suicidal poisoning deaths. Adjusted odds ratios (aORs) with 95% confidence intervals (CI) were reported. Seasons were classified per the Bangladesh Meteorological Department: spring (March–May), summer (June–August), autumn (September–November), and winter (December–February).[13]

Ethical considerations

Ethical approval was obtained from the Ethical Review Committee (ERC), Dinajpur Medical College [Ref: DjMC/2025/2110 Date: 23.09.2025]. All cases were assigned anonymized identifiers; no personal identifiers were retained in the analysis dataset.

Results

Sociodemographic profile

Among 233 medicolegal autopsy cases involving suspected or confirmed poisoning, the mean age was 32.4 ± 15.8 years (median 30; range 1–95). The 21–30-year age group was the largest cohort (27.9%). The sex-stratified age distribution is shown in Figure 1. Males comprised 53.2% of cases (124/233; 95% CI: 46.6–59.6) and were significantly older than females (mean 35.2 ± 16.6 vs. 29.3 ± 14.4 years; Mann–Whitney U, $p = 0.002$). The majority were married (75.1%), rural residents (87.1%), and Muslim (70.8%). Housewives (39.9%) and farmers (21.5%) were the most common occupational groups. [Table I]

Medicolegal characteristics

Suicide constituted the majority (179/233, 76.8%; 95% CI: 71.0–82.0), followed by accident (7.7%, n = 18). Deaths predominantly occurred in hospitals (67.4%, n = 157); 68.2% had been referred to hospitals prior to death (n = 159). The most prevalent autopsy findings were visceral congestion (86.3%), cyanosis (79.4%), frothy secretions (51.5%), and characteristic odor (40.3%). Organophosphates were the most frequently identified poisoning agents (95/233, 40.8%; 95% CI: 34.5–47.3), followed by aluminium phosphide (15.5%) and organochlorides (12.0%). [Table II] Females showed a non-significant trend toward higher odds of organophosphate poisoning (OR 1.39; 95% CI: 0.81–2.38)

Age variation across poison types

There was a statistically significant difference in age across poisoning types (ANOVA: $F(7,225) = 5.415$, $p < 0.001$). [Figure 2]

Temporal distribution of poisoning cases

Spring was the peak season (n = 73, 31.3%), followed by autumn (n = 58, 24.9%), summer (n = 52, 22.3%), and winter (n = 50, 21.5%). March was the single highest-volume month (n = 33, 14.2%). Organophosphate poisoning was the leading agent in all four seasons, with an absolute peak in spring, coinciding with pre-harvest agricultural activity.

Association between sex and manner of death

Cross-tabulation of sex and manner of death revealed a statistically significant association ($\chi^2 = 29.235$, df = 3, $p < 0.001$). Suicide was the predominant manner of death in both sexes but was markedly more common among females (92.7% vs 62.9%). Accidental poisoning was substantially more frequent in males (12.9% vs 1.8%). Homicide was rare overall (0.9%), recorded exclusively in males (n = 2), while no female homicide case was identified. Undetermined manner of death accounted for 22.6% of male cases but only 5.5% of female cases.

Binary logistic regression analysis was performed to identify factors independently associated with suicidal poisoning deaths. Female sex and organophosphate poisoning were independently associated with significantly higher odds of suicidal poisoning. Female victims had over eight-fold higher odds of suicidal poisoning compared to males (adjusted OR [aOR] 8.21, 95% CI: 3.39–19.88; $p < 0.001$). Organophosphate poisoning was also strongly associated with suicidal deaths (aOR 34.40, 95% CI: 7.79–151.83; $p < 0.001$). Increasing age showed a weak inverse association with suicidal poisoning (aOR 0.98 per year increase, 95%

CI: 0.95–1.00; p = 0.049). Rural residence and marital status were not statistically significant. [Table III]

Turnaround time of toxicological reports

Among 233 cases, the mean time delay between requisition and receipt of toxicological reports was 30.93 ± 29.77 days, with a median of 18 days (IQR: 12–44 days). The delay ranged from 3 to 201 days.

Year-wise trend (2021–2025)

There was a surge from 2023 to 2024 (+105.4%)—from 37 to 76 cases. Cases remain high in 2025 (71 cases). [Figure 3]

Table I: Sociodemographic profile of victims (n = 233)

Variable	Category	n	%
Age group (years)			
	≤ 20	60	25.8
	21–30	65	27.9
	31–40	48	20.6
	41–50	36	15.5
	51–60	12	5.2
	> 60	12	5.2
Sex			
	Male	124	53.2
	Female	109	46.8
Marital status			
	Married	175	75.1
	Unmarried	52	22.3
	Widowed/Divorced/Separated	6	2.6
Occupation			
	Housewife	93	39.9
	Farmer	50	21.5
	Student	30	12.9
	Laborer	26	11.2
	Business	12	5.2
	Service	10	4.3
	Others	3	1.3
	Unknown	9	3.9
Religion			
	Muslim	165	70.8
	Sanatan	64	27.5
	Christian	4	1.7
Area of residence			
	Rural	203	87.1
	Urban	30	12.9

Table II: Medicolegal characteristics of poisoning-related autopsy cases (n = 233)

Variables	Category	n	%
Manner of death			
	Suicide	179	76.8
	Accident	18	7.7
	Undetermined	34	14.6
	Homicide	2	0.9
Place of death			
	Hospital	157	67.4
	Home	44	18.9
	Outside	32	13.7
Hospital referral prior to death			
	Yes	159	68.2
	No	74	31.8
Postmortem signs			
	Visceral congestion	201	86.3
	Cyanosis	185	79.4
	Frothy secretions	120	51.5
	Characteristic odour	94	40.3
Poison Type			
	Organophosphates	95	40.8
	Aluminium phosphide	36	15.5
	Organochlorides	28	12.0
	Zinc phosphide	12	5.2
	Benzodiazepines	6	2.6
	Alcohol	6	2.6
	Others	6	2.6
	No poison detected	44	18.9

Table III. Binary logistic regression analysis of factors associated with suicidal poisoning deaths

Variable	Adjusted OR	95% CI	*p*
Female sex	8.21	3.39–19.88	<0.001
Age (per year increase)	0.98	0.95–1.00	0.049
Rural residence	0.77	0.24–2.49	0.665
Married	0.96	0.39–2.37	0.934
Organophosphate poisoning	34.40	7.79–151.83	<0.001

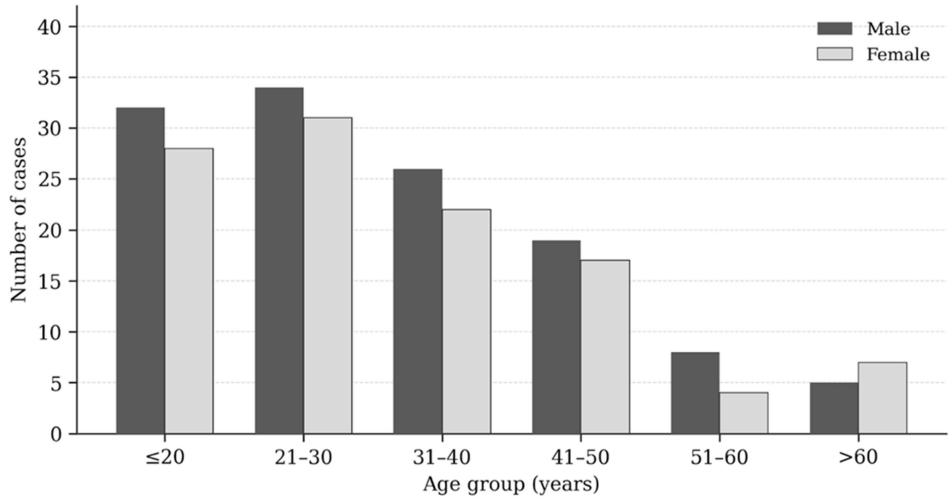

Figure 1: Age-group distribution of poisoning deaths stratified by sex (n = 233).

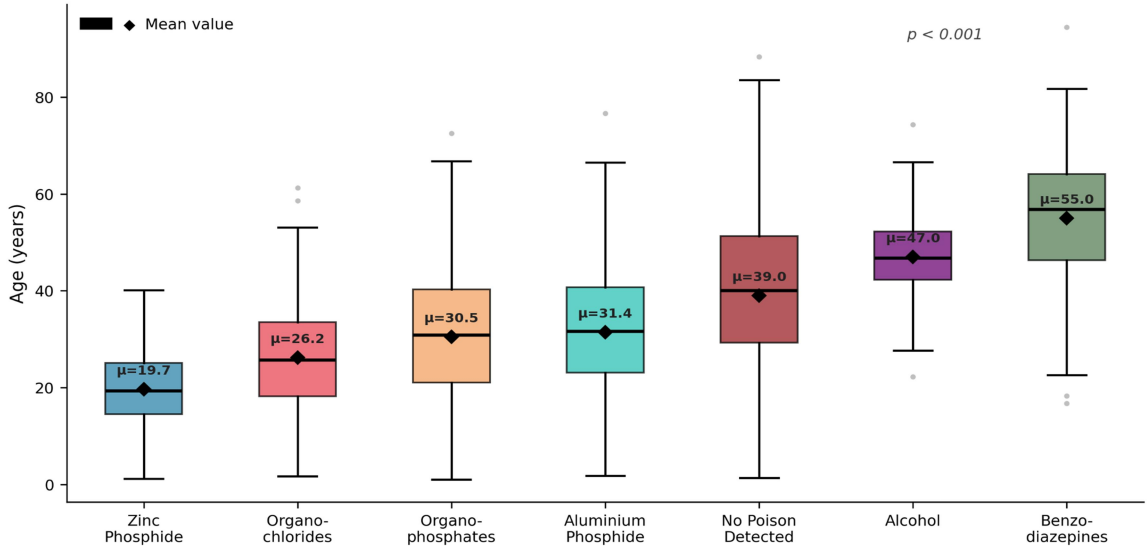

Figure 2: Distribution of age across different poisoning agents.

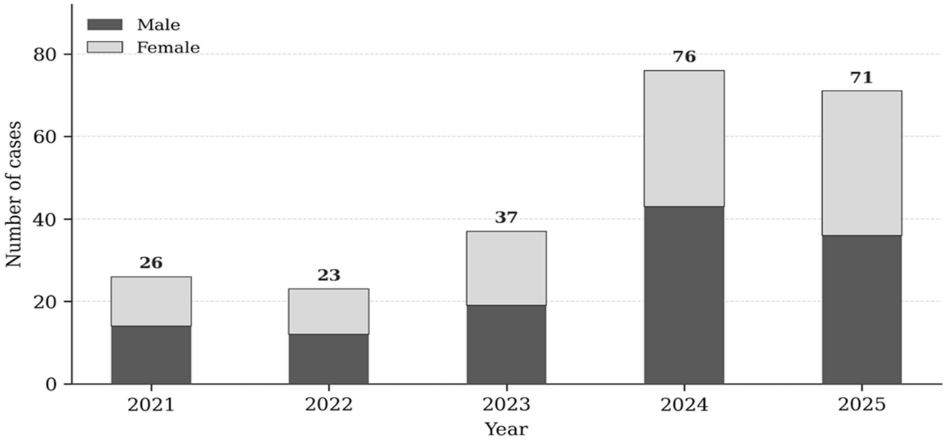

Figure 3: Year-wise distribution of poisoning-related autopsy cases stratified by sex (n = 233). Total annual count is shown above each bar.

Discussion

This retrospective study of 233 medicolegal autopsy cases from Dinajpur Medical College provides a toxicological and sociodemographic profile of fatal poisoning from this primarily agricultural district of northern Bangladesh.

Age and sex profile

The mean age of poisoning victims in our series, 32.4 ± 15.8 years, with a median of 30 years, confirms that fatal poisonings in Dinajpur disproportionately affect individuals in the prime of their productive lives. This finding is broadly consistent with studies from Bangladesh and South Asia, where young adults aged 21–40 years constitute the largest affected cohort.[14-16] The right-skewed age distribution with an early-adulthood peak likely reflects the convergence of high psychological stress, impulsive behaviour, and ready access to toxic agrochemicals. Similar pattern has been described in similar agricultural communities.[17-19]

A slight male predominance (53.2% vs. 46.8%) is consistent with national and regional data from Bangladesh.[20,21] The sex difference in mean age was statistically significant: male victims were nearly six years older on average than female victims (35.2 ± 16.6 years vs. 29.3 ± 14.4 years; p = 0.002). This finding is likely a reflection of the vulnerability of young women in rural Bangladeshi households, as they are exposed to early marriage, domestic stress, and limited autonomy. These factors are well-recognized contributors to suicidal behaviour among women in South Asia.[22-24]

Sociodemographic characteristics

The majority of victims (87.1%) were from rural areas, and most were married (75.1%). These findings collectively underscore the rural character of the poisoning burden in Dinajpur. Rural populations in Bangladesh face a dual disadvantage: they live in closer proximity to toxic agrochemicals, and they often lack adequate access to mental health services and timely emergency medical care.[25,26]

Regarding occupational profile, housewives constituted the single largest group (39.9%), followed by farmers (21.5%) and students (12.9%). The predominance of housewives among poisoning victims has been reported in other studies from Bangladesh and India and reflects the various structural vulnerabilities, e.g., social isolation, financial dependence,

domestic conflict, and limited legal recourse.[16,27] The significant representation of farmers is almost certainly a product of easy occupational access to highly toxic agrochemicals, a consistent pattern across South and Southeast Asia.[15,17,28] The proportion of student victims (12.9%) is also noteworthy and merits targeted mental health interventions within educational institutions.

Manner of death

Suicide was by far the most common manner of death, accounting for 76.8% of cases, which is consistent with national-level data and comparable regional studies.[14,29,30] Accidental poisoning accounted for 7.7%, and homicide was rare (0.9%). A substantial proportion of cases (14.6%) had an undetermined manner of death. This likely reflects real-world medicolegal challenges in establishing intent.

The sex-based difference in manner of death was one of the most striking findings in this study ($\chi^2 = 29.235$, $p < 0.001$). Suicidal deaths were dramatically more common among females (92.7%) than males (62.9%), while accidental deaths were far more frequent in males (12.9% vs. 1.8%). This pattern has been documented in other low- and middle-income country (LMIC) contexts: women tend to choose poisoning as the method of suicide more often than men, in part because firearms and other violent methods are less accessible to them and in part because agrochemicals are readily available within the domestic environment.[22-24] The higher rate of accidental poisoning in males reflects occupational exposure, particularly among the farmer subgroup, and is consistent with the known risks of unprotected pesticide exposure.[16,27]

Toxicological agents

Organophosphate compounds (OPCs) were identified as the leading cause of fatal poisoning, (40.8% of cases)—a finding that places Dinajpur firmly within the pan-South Asian epidemiological pattern of OPC-dominated rural poisoning mortality.[14,29,30] OPCs are widely used in rice and vegetable cultivation throughout Bangladesh's northern districts, and their unrestricted availability in local markets makes them the toxicological "weapon of convenience" in both suicidal and accidental contexts.[15,28] This finding has direct clinical implications: hospitals in Dinajpur, especially at the Upazila level, should ensure stocking of the primary antidotes for OPC poisoning.[31]

Aluminium phosphide (AlP) was the second most common agent (15.5%), followed by organochlorides (12.0%). AlP—commonly used as a grain fumigant in Bangladesh—is of particular concern because it has no specific antidote and is associated with extremely high fatality rates.[32-34] Its presence as the second leading agent in our series underscores an urgent need for regulatory restriction of its over-the-counter availability. Organochlorides, though largely banned or restricted in many countries, continue to circulate in rural Bangladesh.[25]

Zinc phosphide (5.2%) and benzodiazepines (2.6%) were also detected, and their age associations were clinically interesting. Younger victims (mean age 19.7 years) were more commonly associated with zinc phosphide, while older victims (mean age 55.0 years) were associated with benzodiazepines (ANOVA: $F(7,225) = 5.415$, $p < 0.001$). This association may reflect its particular availability in and around rural homes and its attractiveness as an impulsive means in adolescent and young-adult crisis situations. The relative prevalence of benzodiazepines among older victims may indicate either greater access to prescription medications with age or may reflect a more

deliberate, premeditated pattern of self-harm.[35-37]

Notably, no toxicological agent was detected in 18.9% of cases. This figure deserves careful attention. It may reflect genuine cases where the substance was fully metabolized before viscera collection or where the suspected poison was not among the panels routinely tested by the Chemical Examiner's laboratory. The high proportion of undetected agents highlights the need for expanded analytical panels and closer collaboration between autopsy examiners and the forensic chemical laboratory.[14,28]

Sex-based differences in poison type

On univariate analysis, females showed a non-significant trend toward a higher proportion of organophosphate poisoning compared to males (OR 1.39, 95% CI: 0.81–2.38). Although this association did not reach statistical significance, the direction of the trend is biologically and socially plausible: as housewives, female victims would have ready access to pesticides stored within the household for domestic and agricultural use. The domestically stored pesticide thus becomes the most readily available and impulsively accessible means of self-harm for women in distress.[16,27] This calls for community-level storage safety interventions—e.g., locked pesticide storage boxes and community safe-storage programmes. Such interventions have shown promise in reducing both accidental and suicidal pesticide poisoning in similar settings in Sri Lanka and India.[38,39] The multivariable model demonstrated that female sex was independently associated with markedly higher odds of suicidal poisoning.[12]

Seasonal and temporal patterns

Monthly distribution of cases revealed a pronounced peak in March (14.2%), with secondary peaks in May and September. March in northern Bangladesh corresponds to the late harvest period, when pesticide application is at its peak and stocks are most accessible within homes and fields. This seasonal availability hypothesis is supported by agrochemical sales data in similar agricultural regions.[40] Secondary peaks in May and September may correspond to the early summer and late monsoon cropping seasons. The relative plateau of around 18 cases per month during autumn and early winter (October–December) suggests that the post-harvest period carries a lower but still persistent risk.

The year-wise trend over the study period (2021–2025) revealed a dramatic surge in cases between 2023 and 2024, with a 105.4% increase (37 to 76 cases). Cases remained high in 2025 (n = 71). This trend warrants cautious interpretation. Increased case referral to Dinajpur Medical College Hospital, improved record-keeping, or expanded catchment area could partially explain the rise. This highlights an urgent need for epidemiological surveillance and public health response. The sustained high case burden in 2025 suggests that the surge is not simply a transient artifact.[41,42]

Turnaround time for toxicological reports

A mean turnaround time of 30.9 ± 29.8 days (median 18 days; range 3–201 days) for the receipt of chemical examiner's reports represents a major systemic concern. While a median of 18 days may be acceptable for finalizing the cause-of-death opinion in autopsy records, the extreme right tail—with some cases exceeding 100 days and one reaching 201 days - has serious medicolegal implications. Prolonged delays in toxicological reporting can hamper police investigations, delay judicial proceedings, and deny families timely closure.[14] These delays are not unique to Dinajpur; similar challenges have been reported across forensic toxicology

laboratories in Bangladesh and other LMICs. Where chronic understaffing, inadequate reagent supply, and centralization of analytical services contribute to backlogs.[42]

Limitations

As a single-centre retrospective study, cases from outside Dinajpur Medical College are not captured, likely underestimating district-level mortality. The retrospective design precluded collection of psychosocial contextual data relevant to suicide research. Without reliable population-denominator figures stratified by age, sex, and sub-district, it was not possible to calculate incidence rates or mortality rates per 100,000 population. The study is restricted entirely to fatal poisoning cases. Non-fatal poisonings are not captured. The toxicological findings in this study are contingent on the scope of the routine analytical panel used by the Regional Chemical Examiner's laboratory. The low 2021–2022 counts (26, 23) may reflect incomplete early-period record capture.

Conclusion

The findings of this study converge on several actionable recommendations. First, regulatory restriction of highly toxic pesticides through tighter point-of-sale controls, and mandatory registration of purchasers should be prioritized by the relevant national authorities.[25,30,43] Second, community-level safe pesticide storage interventions should be piloted. Third, given the disproportionate burden among young women and housewives, targeted mental health screening and community mental health support programmes are urgently needed. Fourth, the turnaround time for toxicological reporting must be reduced through investment in regional laboratory infrastructure and workforce. Finally, this study should serve as a call for a national registry of poisoning-related autopsy data, enabling longitudinal trend monitoring and evidence-based national prevention policy.[14]

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