



# Assessment of tobacco and substance use among patients with aluminum phosphide poisoning: A register-based study

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## ABSTRACT

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Aluminum phosphide (AIP) poisoning is a major public health concern in several low- and middle-income countries due to its high fatality rate and widespread availability. While its clinical toxicity is well-documented, limited research exists on behavioral risk factors such as tobacco and illicit drug use among affected individuals. This study aimed to assess the prevalence of tobacco and substance use among patients with AIP poisoning and explore its associations with demographic characteristics, clinical outcomes, and mortality. A descriptive cross-sectional study was conducted at Razi Hospital in northern Iran between March 2018 and March 2022. Data from 481 AIP poisoning cases were retrospectively analyzed using structured questionnaires, medical records, and interviews. Sociodemographic variables, substance use history, and clinical outcomes were assessed. Of the 481 patients, 29.7% (n = 143) reported tobacco or illicit substance use. Substance use was significantly more prevalent among males (92.3%), individuals aged 21–40, the self-employed, singles, and those with economic hardship or concurrent alcohol consumption ( $P < 0.05$ ). Although not statistically significant ( $P = 0.132$ ), mortality was higher among substance users (46.2%) compared to non-users (38.8%). Tobacco and illicit drug use are common among AIP poisoning patients and are strongly associated with specific sociodemographic factors. Although causality could not be established, substance use may contribute to poorer clinical outcomes. These findings underscore the importance of integrating behavioral screening into AIP poisoning management and highlight the need for targeted prevention strategies in high-risk populations.

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## 1. Introduction

Aluminum phosphide (AIP), commonly used as a fumigant and pesticide in many developing countries, poses a significant public health challenge due to its high toxicity and ease of accessibility [1]. Upon ingestion, AIP reacts with moisture and gastric acid to release phosphine gas, causing severe cardiotoxicity, metabolic acidosis, hypotension, respiratory distress, and multi-organ failure [2]. Mortality varies significantly across different regions and is influenced by factors such as geographic location and the quality of medical care available. In Iran, a major center for AIP poisoning, a hospital-based retrospective review found 471 admissions over seven years (2000–2007), with a case fatality rate of 31%. The majority were young adults engaging in intentional self-harm, although mortality was closely linked to biochemical parameters such as arterial pH [3]. Similarly, in a 2023 study from Saudi Arabia, the mortality rate for aluminum phosphide poisoning was reported at 56%, with significant predictors including young age, delayed medical intervention, and accidental exposure during household fumigation [4].

Concurrently, epidemiological evidence underscores a strong link between substance use disorders and suicidal behavior. A forensic toxicology analysis in Tehran (2011–2015) revealed that individuals with a history of drug use were more likely to attempt suicide, often via pesticide ingestion. Notably, over 80% of positive toxicology screens from suicide deaths featured phosphine as the primary agent [5].

Despite their frequent co-occurrence, the literature reveals a gap, as systematic investigations into tobacco and illicit substance use among patients with AIP poisoning remain limited. Most existing studies emphasize clinical toxicology without delving into behavioral risk profiles. Yet, substance use may play multifaceted roles: it could increase impulsivity, delay timely medical care, modify metabolic responses, or contribute to worse clinical outcomes [6].

In this context, the present study aimed to evaluate the prevalence of tobacco and illicit drug use among patients with aluminum phosphide poisoning through a register-based analysis. We also explore associations between tobacco and illicit drug use patterns and clinical severity, outcomes, and demographic factors. By examining these behavioral contributors, this work addresses a critical knowledge gap and has the potential to enhance risk stratification, clinical management, and targeted prevention strategies in high-incidence regions.

## 2. Materials and Methods

### 2.1 Study design and participants

This descriptive cross-sectional study was conducted on patients diagnosed with AIP poisoning between March 2018 and March 2022, who were admitted to the

poisoning ward of Razi Hospital, located in Guilan Province, northern Iran. As a regional referral center for poisoning cases, Razi Hospital serves as a primary site for such admissions. The study protocol received ethical approval from the Ethics Committee of Guilan University of Medical Sciences (IR.GUMS.REC.1401.542) and adhered to the principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants. In instances where individuals were unable to provide written consent, verbal consent was obtained and documented in the presence of a witness. For adult patients with cognitive impairments, informed consent was secured from a parent, legal guardian, or designated representative.

### 2.2 Inclusion criteria and data collection

Inclusion criteria comprised patients with a verified history of tobacco use and substance abuse who had attempted suicide by ingesting AIP, with diabetic ketoacidosis ruled out. Patients who had consumed herbal AIP pills (marketed as 'Banan') were excluded. Patient data were entered into the Disease Registration System by trained personnel for routine daily monitoring throughout hospitalization. Data collection was structured into two components. The first component covered demographic details such as age, sex, residence, and medical history. The second component encompassed clinical and laboratory findings. Data were collected using structured questionnaires, which were completed based on diagnostic test results, clinical assessments, and interviews conducted with the patients and their family members [7]. Information was gathered from hospital records as well as direct interactions with patients and their families, facilitated by qualified healthcare professionals.

### 2.3 Statistical analysis

The collected data were coded and entered into SPSS software version 22 (IBM Corp., Armonk, NY). Quantitative variables were described using mean and standard deviation, while qualitative variables were presented as frequencies and percentages. The Chi-square test, Fisher's exact test, and the Mann-Whitney U test were employed for statistical analysis. A significance level of  $P < 0.05$  was considered for all tests.

## 3. Results

Over a four-year period, a total of 481 cases of AIP poisoning were recorded. Among these, 283 cases (58.8%) involved males and 198 cases (41.2%) involved females. The mean age of the patients was  $38.18 \pm 16.19$  years, with an age range of 14 to 97 years. Of the 481 cases, 143 individuals (29.7%) had a documented history of tobacco or substance abuse. Among the 143 cigarette/substance-using patients, the most common

age group was 21–30 years (32.9%), followed by 31–40 years (30.8%). The majority of these individuals were male (92.3%), with only 7.7% being female. The mean age of substance users was  $38.14 \pm 16.03$  years, ranging from 15 to 89 years. 70.6% were self-employed, while smaller proportions, were housewives (6.3%), students (3.5%), farmers (2.8%), and others (16.1%). In terms of education, 50.3% had a high school diploma, 23.8% had completed middle school, and 10.5% were illiterate. Most were married (62.2%), and 84.6% resided in urban areas. Regarding economic status, 38.5% reported income lower than expenses, while 61.5% had income equal to expenses. 21.7% had a history of alcohol use; 9.1% had underlying medical conditions, and 17.5% had a diagnosed psychiatric illness. Notably, 12.6% had a prior history of suicide attempts. The full results of the demographic characteristics of individuals with a history of substance use who poisoned with ALP are presented in Table 1.

Substance use was significantly associated with several demographic and clinical variables (Table 2). A significantly higher prevalence of substance use was observed among males ( $P < 0.001$ ). Self-employment was significantly more common among substance users ( $P < 0.001$ ). Substance use was more prevalent among single individuals ( $P < 0.001$ ). Individuals with income lower than their expenses had a higher prevalence of substance use ( $P = 0.002$ ). A strong association was found between alcohol consumption and substance use ( $P < 0.001$ ). No significant associations were observed between substance use and age ( $P = 0.97$ ), educational level ( $P = 0.086$ ), residence ( $P = 0.871$ ), or history of mental illness in the patient or family. Outcomes differed between substance users and non-users, although not significantly ( $P = 0.132$ ). Among substance users, the mortality rate was 46.2%, while it was 38.8% among non-users.

**Table 1.** Demographic, social, and clinical characteristics of individuals with cigarette/substance use admitted with ALP poisoning

Variable	Category	Frequency	Percentage (%)
Year of admission (March to March)	2018-2019	31	21.7
	2019-2020	50	35.0
	2020-2021	42	29.4
	2021-2022	20	14.0
Gender	Male	132	92.3
	Female	11	7.7
Age distribution (years)	< 20	8	5.6
	21–30	47	32.9
	31–40	44	30.8
	41–50	19	13.3
	51–60	10	7.0
	61–70	7	4.9
Age (Mean $\pm$ SD, min–max)		$38.14 \pm 16.03$ (15–89)	
Occupation	Self-employed	101	70.6
	Housewife	9	6.3
	Student	5	3.5
	Farmer	4	2.8
	Employee/Retired	1	0.7
	Other	23	16.1
Education level	Illiterate	15	10.5
	Primary School	12	8.4
	Middle School	34	23.8
	High School Diploma	72	50.3
Marital status	Academic education	10	7.0
	Single	50	35.0
	Married	89	62.2
Residence	Divorced	4	2.8
	Rural	22	15.4
Income status	Urban	121	84.6
	Less than expenses	55	38.5
Alcohol use	Equal to expenses	88	61.5
	Yes	31	21.7
Chronic illness	No	112	78.3
	Present	13	9.1
Psychiatric illness History	Absent	130	90.9
	Present	25	17.5
Family history of psych. illness	Absent	118	82.5
	Present	5	3.5
History of suicide attempts	Absent	138	96.5
	Yes	18	12.6
Outcome of ALP poisoning	No	125	87.4
	Death	66	46.2
	Recovery	77	53.8

**Table 2.** Association between individual, social, and clinical factors and cigarette/substance use among AIP poisoning patients

Variable	Used Substances (n, %)	Did Not Use Substances (n, %)	P-value
<b>Year of Admission (March to March)</b>			
2018-2019	31 (21.7%)	129 (38.2%)	<0.001
2019-2020	50 (35%)	67 (19.8%)	
2020-2021	42 (29.4%)	59 (17.5%)	
2021-2022	20 (14%)	83 (24.6%)	
<b>Gender</b>			
Male	132 (92.3%)	151 (44.7%)	<0.001
Female	11 (7.7%)	187 (55.3%)	
<b>Age Group</b>			
< 20	8 (5.6%)	41 (12.1%)	0.18
21-30	47 (32.9%)	84 (24.9%)	
31-40	44 (30.8%)	89 (26.3%)	
41-50	19 (13.3%)	61 (18%)	
51-60	10 (7%)	23 (6.8%)	
61-70	7 (4.9%)	20 (5.9%)	
> 70	8 (5.6%)	20 (5.9%)	
<b>Mean Age ± SD</b>	38.14 ± 16.03	38.2 ± 16.28	0.97
<b>Occupation</b>			
Self-employed	101 (70.6%)	115 (34%)	<0.001
Employee/Retired	1 (0.7%)	4 (1.2%)	
Student	5 (3.5%)	21 (6.2%)	
Housewife	9 (6.3%)	166 (49.1%)	
Farmer	4 (2.8%)	6 (1.8%)	
Other	23 (16.1%)	26 (7.7%)	
<b>Education Level</b>			
Illiterate	15 (10.5%)	23 (6.8%)	0.086
Primary	12 (8.4%)	14 (4.1%)	
Middle School	34 (23.8%)	93 (27.5%)	
High School Diploma	72 (50.3%)	194 (57.4%)	
Academic education	10 (7%)	14 (4.1%)	
<b>Marital Status</b>			
Single	50 (35%)	61 (18%)	<0.001
Married	89 (62.2%)	270 (79.9%)	
Divorced	4 (2.8%)	7 (2.1%)	
<b>Residence</b>			
Rural	22 (15.4%)	54 (16%)	0.871
Urban	121 (84.6%)	284 (84%)	
<b>Income</b>			
Less than expenses	55 (39.3%)	80 (23.7%)	0.002
Equal to expenses	88 (60.7%)	257 (76%)	
More than expenses	0 (0.0%)	1 (0.3%)	
<b>Alcohol Use</b>			
Yes	31 (21.7%)	6 (1.8%)	<0.001
No	112 (78.3%)	332 (98.2%)	
<b>Chronic Illness</b>			
Yes	13 (9.1%)	33 (9.8%)	0.819
No	130 (90.9%)	305 (90.2%)	
<b>Psychiatric Illness</b>			
Yes	25 (17.5%)	45 (13.3%)	0.236
No	118 (82.5%)	293 (86.7%)	
<b>Family Psychiatric History</b>			
Yes	5 (3.5%)	8 (2.4%)	0.458
No	138 (96.5%)	330 (97.6%)	
<b>Suicide History</b>			
Yes	18 (12.6%)	30 (8.9%)	0.214
No	125 (87.4%)	308 (91.1%)	
<b>Treatment Outcome</b>			
Death	66 (46.2%)	131 (38.8%)	0.132
Recovery	77 (53.8%)	207 (61.2%)	

#### 4. Discussion

In this register-based analysis of AIP poisoning among 481 patients over four years, nearly 30% had a documented history of tobacco or illicit drug use. This prevalence significantly exceeds the rates documented in general populations experiencing acute intoxication,

such as the 22% tobacco and 12% illicit drug use reported among Dutch adolescents hospitalized for acute alcohol intoxication, thereby highlighting a markedly elevated of high-risk behaviors within the study population [8]. The present study identified significant correlations between tobacco or illicit drug

use and several sociodemographic factors, including male gender, self-employment, single marital status, economic hardship, and concurrent alcohol consumption. These associations are in line with previous studies, which has demonstrated that adolescent substance use is more prevalent among individuals from non-traditional family backgrounds and those with lower socioeconomic status [9-11]. Furthermore, the observed co-occurrence of alcohol, tobacco, and illicit drug use in our sample reflects a pattern of polysubstance involvement frequently reported in adolescent populations [12-14], suggesting the persistence of shared psychosocial risk factors into adulthood. These findings support the notion that similar behavioral and environmental vulnerabilities may underlie suicide attempts involving pesticide ingestion in adults with a history of substance use.

Although our results did not reach statistical significance, the observed mortality rate was higher among substance users compared to non-users. High mortality aligns with previous studies report fatality rates ranging from 30–100% and emphasize mortality predictors such as metabolic acidosis, refractory shock, and delayed care [15, 16].

Substance use may compound clinical outcomes through multiple mechanisms: direct toxic effects on cardiovascular and metabolic systems, impaired immune response, and delayed presentation to care factors known to exacerbate AIP toxicity [17, 18].

Our findings support the idea that comprehensive risk assessment in AIP poisoning should incorporate screening for tobacco and illicit drug use. Comparable to poly-substance screening protocols in intoxicated adolescents, early detection of such behaviors may inform prognostic stratification and facilitate behavioral interventions alongside toxicological treatment. Behavioral risk profiles can guide preventive strategies in high-incidence regions. Public health interventions should emphasize safe fungicide handling, and mental health support to successfully reduced unintentional exposure and suicide rates from AIP [19, 20].

This investigation is subject to several limitations typically observed in retrospective, hospital-based studies. Data completeness rely on medical records and patient or proxy reports. Additionally, due to our study design, the relationship between substance use and clinical outcomes cannot be definitively established.

Our study reveals a substantial prevalence of tobacco and illicit drug use among patients with AIP poisoning, with strong associations to demographic and behavioral risk factors. Although not statistically significant, the observed trend towards increased mortality suggests substance use may worsen clinical outcomes. These findings advocate for integrated toxicological and behavioral risk assessments in AIP poisoning management and highlight opportunities for preventative public health strategies targeting vulnerable populations.

## Authors' contributions

Supervision, Conceptualization and Methodology: HM, HI, MR; Data collection, Analysis and Interpretation: AH, HH, AB, HI; Writing draft and Editing: AH, AB, MR. All authors have read and approved the final manuscript.

## Conflict of interest

No potential conflict of interest was reported by the authors.

## Ethical declarations

The study protocol received ethical approval from the Ethics Committee of Guilan University of Medical Sciences (IR.GUMS.REC.1401.542) and adhered to the principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants. In instances where individuals were unable to provide written consent, verbal consent was obtained and documented in the presence of a witness. For adult patients with cognitive impairments, informed consent was secured from a parent, legal guardian, or designated representative.

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## References

- Hadi N, Asfandiyar, Saleem A, Ashraf, Rumman, Ullah Z, et al. Electrocardiographic Patterns as Predictors of Mortality in Aluminum Phosphide Poisoning: A Retrospective Cohort Single-Center Study. *Cureus*. 2025;17(4):e81713. DOI: [10.7759/cureus.81713](https://doi.org/10.7759/cureus.81713) PMID: 40235690
- Gurjar M, Baronia AK, Azim A, Sharma K. Managing aluminum phosphide poisonings. *J Emerg Trauma Shock*. 2011;4(3):378-84. DOI: [10.4103/0974-2700.83868](https://doi.org/10.4103/0974-2700.83868) PMID: 21887030
- Shadnia S, Sasanian G, Allami P, Hosseini A, Ranjbar A, Amini-Shirazi N, et al. A retrospective 7-years study of aluminum phosphide poisoning in Tehran: opportunities for prevention. *Hum Exp Toxicol*. 2009;28(4):209-13. DOI: [10.1177/0960327108097194](https://doi.org/10.1177/0960327108097194) PMID: 19734272
- Alnasser S, Hussain SM, Kirdi TS, Ahmed A. Aluminum phosphide poisoning in Saudi Arabia over a nine-year period. *Ann Saudi Med*. 2018;38(4):277-283. DOI: [10.5144/0256-4947.2018.277](https://doi.org/10.5144/0256-4947.2018.277) PMID: 30078026
- Kordrostami R, Akhgari M, Ameri M, Ghadipasha M, Aghakhani K. Forensic toxicology analysis of self-poisoning suicidal deaths in Tehran, Iran; trends between 2011-2015. *Daru*. 2017;25(1):15. DOI: [10.1186/s40199-017-0181-1](https://doi.org/10.1186/s40199-017-0181-1) PMID: 28610598
- Kozak K, Lucatch AM, Lowe DJE, Balodis IM, MacKillop J, George TP. The neurobiology of impulsivity and substance use disorders: implications for treatment. *Ann N Y Acad Sci*. 2019;1451(1):71-91. DOI: [10.1111/nyas.13977](https://doi.org/10.1111/nyas.13977) PMID: 30291624
- Kojidi HM, Attarchi M, Rahbar-Taramsari M, Badsar A, Faraji N, Rastak Y, et al. Aluminum Phosphide Poisoning in the North of Iran: A Register-based Research. *Curr Drug Saf*. 2023;18(3):323-334. DOI: [10.2174/1574886317666220627112353](https://doi.org/10.2174/1574886317666220627112353) PMID: 35761489

8. de Veld L, Wolberink IM, van Hoof JJ, van der Lely N. The role of tobacco smoking and illicit drug use in adolescent acute alcohol intoxication. *BMC Pediatr.* 2021;21(1):233. DOI: [10.1186/s12887-021-02710-3](https://doi.org/10.1186/s12887-021-02710-3) PMID: 34001049
9. Hemovich V, Lac A, Crano WD. Understanding early-onset drug and alcohol outcomes among youth: the role of family structure, social factors, and interpersonal perceptions of use. *Psychol Health Med.* 2011;16(3):249-67. DOI: [10.1080/13548506.2010.532560](https://doi.org/10.1080/13548506.2010.532560) PMID: 21491334
10. Aschengrau A, Grippo A, Winter MR. Influence of Family and Community Socioeconomic Status on the Risk of Adolescent Drug Use. *Subst Use Misuse.* 2021;56(5):577-587. DOI: [10.1080/10826084.2021.1883660](https://doi.org/10.1080/10826084.2021.1883660) PMID: 33719860
11. Patrick ME, Wightman P, Schoeni RF, Schulenberg JE. Socioeconomic status and substance use among young adults: a comparison across constructs and drugs. *J Stud Alcohol Drugs.* 2012;73(5):772-82. DOI: [10.15288/jsad.2012.73.772](https://doi.org/10.15288/jsad.2012.73.772) PMID: 22846241
12. Rodzlan Hasani WS, Saminathan TA, Ab Majid NL, Miaw Yn JL, Mat Rifin H, Abd Hamid HA, et al. Polysubstance use among adolescents in Malaysia: Findings from the National Health and Morbidity Survey 2017. *PLoS One.* 2021;16(1):e0245593. DOI: [10.1371/journal.pone.0245593](https://doi.org/10.1371/journal.pone.0245593) PMID: 33476329
13. Black N, Noghrehchi F, Yuen WS, Aiken A, Clare PJ, Chan G, et al. Transitions to polysubstance use: Prospective cohort study of adolescents in Australia. *Addiction.* 2024;119(6):1100-1110. DOI: [10.1111/add.16468](https://doi.org/10.1111/add.16468) PMID: 38499496
14. Moss HB, Chen CM, Yi HY. Early adolescent patterns of alcohol, cigarettes, and marijuana polysubstance use and young adult substance use outcomes in a nationally representative sample. *Drug Alcohol Depend.* 2014;136:51-62. DOI: [10.1016/j.drugalcdep.2013.12.011](https://doi.org/10.1016/j.drugalcdep.2013.12.011) PMID: 24434016
15. Farahani MV, Soroosh D, Marashi SM. Thoughts on the current management of acute aluminum phosphide toxicity and proposals for therapy: An Evidence-based review. *Indian J Crit Care Med.* 2016;20(12):724-730. DOI: [10.4103/0972-5229.195712](https://doi.org/10.4103/0972-5229.195712) PMID: 28149031
16. Moghadamnia AA. An update on toxicology of aluminum phosphide. *Daru.* 2012;20(1):25. DOI: [10.1186/2008-2231-20-25](https://doi.org/10.1186/2008-2231-20-25) PMID: 23351193
17. Mladěnka P, Applová L, Patočka J, Costa VM, Remiao F, Pourová J, et al. Comprehensive review of cardiovascular toxicity of drugs and related agents. *Med Res Rev.* 2018;38(4):1332-1403. DOI: [10.1002/med.21476](https://doi.org/10.1002/med.21476) PMID: 29315692
18. Volkow ND, Blanco C. Substance use disorders: a comprehensive update of classification, epidemiology, neurobiology, clinical aspects, treatment and prevention. *World Psychiatry.* 2023;22(2):203-229. DOI: [10.1002/wps.21073](https://doi.org/10.1002/wps.21073) PMID: 37159360
19. Halladay J, Woock R, El-Khechen H, Munn C, MacKillop J, Amlung M, et al. Patterns of substance use among adolescents: A systematic review. *Drug Alcohol Depend.* 2020;216:108222. DOI: [10.1016/j.drugalcdep.2020.108222](https://doi.org/10.1016/j.drugalcdep.2020.108222) PMID: 32971420
20. Nada MAA, Elfeky AKEE, Darweesh HAM, Mohamed FKI, Sharif LS, Kandil FS, et al. Correction: The effect of educational programs on parents' knowledge, behavior, and practices regarding aluminum phosphide poisoning and its first-aid measures. *BMC Pediatr.* 2025;25(1):51. DOI: [10.1186/s12887-025-05404-2](https://doi.org/10.1186/s12887-025-05404-2) PMID: 39838344