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PREVALENCE OF DEATHS CAUSED BY ZINC PHOSPHIDE POISONING IN FORENSIC CASES

Abstract. Zinc phosphide is a dark grey or black substance commonly used as a rodenticide in developing countries to protect grains and legumes. When ingested, it reacts with stomach acid to release phosphine gas, which can be absorbed through the gastrointestinal tract and lungs, leading to zinc phosphide poisoning. The results of this research will help the police and other security agencies to consider and implement the necessary measures to reduce poisonings and deaths caused by zinc phosphide, which is used for suicide, murder, and accidents.

to determine the prevalence of deaths caused by zinc phosphide poisoning in cases referred to the Kabul Forensic Medicine Centre.

This cross-sectional research was conducted using documents and registration books of forensic medicine, all cases of zinc phosphide poisoning brought to the centre from March 21, 2019, to March 20, 2020, were included and analyzed through SPSS version 26.

Out of 2176 cases of deaths due to poisoning during the given period, 583 cases (26.79%) were caused by zinc phosphide poisoning. The majority of victims were young people between the ages of 18 and 30, and zinc phosphide was found to be the second deadliest poison after alcohol. Most of these incidents were suicides and occurred among families with low-income levels and limited education. Women were more commonly affected than men.

Based on these findings, it can be concluded that zinc phosphide is a highly lethal poison that poses a significant risk to vulnerable populations in developing countries.

Key words: Zinc phosphide poisoning, Forensic medicine, Deaths, Descriptive Cross-sectional.

Introduction

Zinc phosphide (Zn_3P_2) is a dark grey or black solid substance that is widely used as a rodenticide to protect grains and legumes, especially in developing countries. It is also known by trade names such as Arrex, Ridall, Pollux, Dencarin grain, Gopha Rid, and Phosvin, and in Afghanistan, it is also known as a «mouse killer» among the people. Zinc phosphide can be purchased in the Afghan markets at a very low price in tablet and powder forms. This chemical substance is primarily absorbed through the gastrointestinal tract and respiratory system (inhalation), which can cause severe poisoning in both cases, and not absorbed through the skin. The symptoms of zinc phosphide poisoning range from abdominal pain to multi-organ failure, and if left untreated, death can occur within 24 to 48 hours after poisoning. (1)

After ingestion, zinc phosphide reacts with hydrochloric acid in the stomach, releasing phosphine gas which is easily absorbed through the gastrointestinal tract and respiratory system. Biological studies have shown that phosphine gas inhibits cytochrome oxidase C enzyme in the

mitochondria, leading to the blocking of the oxygen channel in cell membrane, causing cellular hypoxia, lack of energy, and ultimately leading to cellular death. Phosphine gas also causes protein synthesis inhibition and enzyme activity in cells, especially in the mitochondria of the heart and lungs. (2) Phosphine gas has severe effects on the cardiovascular and respiratory systems, causing cardiac arrhythmias. Electrocardiographic changes due to zinc phosphide poisoning include prolonged PR interval, ST segment changes, and complete heart block. Other symptoms of zinc phosphide poisoning include vomiting, abdominal pain, restlessness, metabolic acidosis, tachycardia, tachypnea, and hypotension. (3)

Zinc phosphide poisoning can also cause acute organs failure, especially renal and shock. Acute respiratory distress syndrome (ARDS) can also occur due to the direct effect of phosphine gas on the alveoli and their destruction, followed by severe pulmonary edema (acute lung injury). (4) Recent reports from forensic medicine indicate a significant increase in cases of poisoning, homicide, suicide, and other crimes related to the use of zinc phosphide. (5) One of the reasons for the high incidence of poisoning

and crimes related to the use of zinc phosphide is that this substance is easily available in the market and in homes and is readily accessible to all individuals, especially those who suffer from mental illnesses. (6) Individuals who are facing life problems or family violence often resort to using this substance for suicide, to escape their problems, or occasionally to commit murder by adding it to others' food. In children, accidental poisoning with zinc phosphide is also frequent due to easy access. (7)

Materials and Methods

The study is descriptive, cross-sectional, and involved collecting data in a census-like manner from the registration book and documents of the Forensic

Medicine department. The study aimed to include all cases of poisonings caused by zinc phosphide that occurred between March 21, 2019, and March 20, 2020, and were referred to the Department of Forensic Medicine Services.

Results and Discussion

According to the results, between March 21, 2019, and March 20, 2020, the Department of Forensic Medicine received a total of 2176 poisoning cases. Out of these, 583 cases (26.79%) were attributed to zinc phosphide, while the remaining 1593 cases (73.3%) were caused by other forms of poisoning such as alcohol, carbon monoxide, methane gas, and organophosphates. Figure 1 illustrates the analysis of these cases.

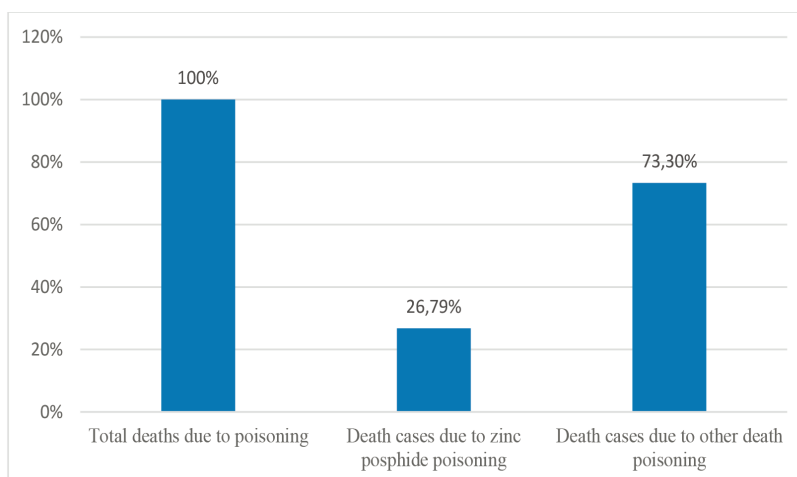


Figure 1 – Percentage of deaths due to zinc phosphide poisoning and other poisons

Regarding gender, the data showed that out of the 583 cases of death caused by zinc phosphide poisoning during the specified time frame, the majority of cases

(395 cases or 67.75%) were among women, while 188 cases (32.25%) were among men. Figure 2 presents a graphical representation of these findings.

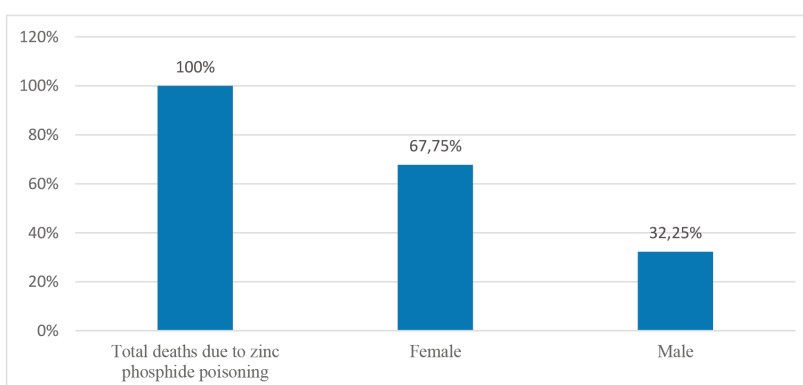


Figure 2 – Percentage of deaths due to zinc phosphide poisoning concerning gender

The study found that the highest number of deaths resulting from zinc phosphide poisoning occurred among young individuals aged between

18 and 30 years (59.02%), while the lowest number of fatalities was recorded among children (3.08%). These findings are illustrated in Figure 3.

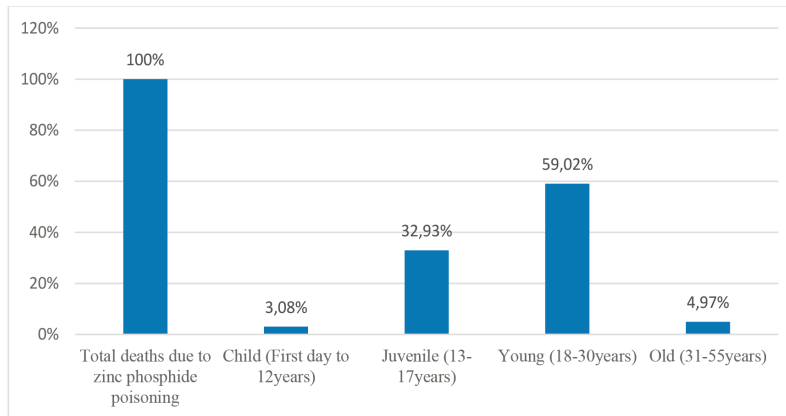


Figure 3 – Percentage of Deaths due to Zinc Phosphide Poisoning in Term of Age

Regarding the type of toxic substances involved, the study revealed that alcohol (38.02%) was the most lethal,

followed by zinc phosphide (26.79%) which ranked second. Figure 4 displays a visual representation of these data.

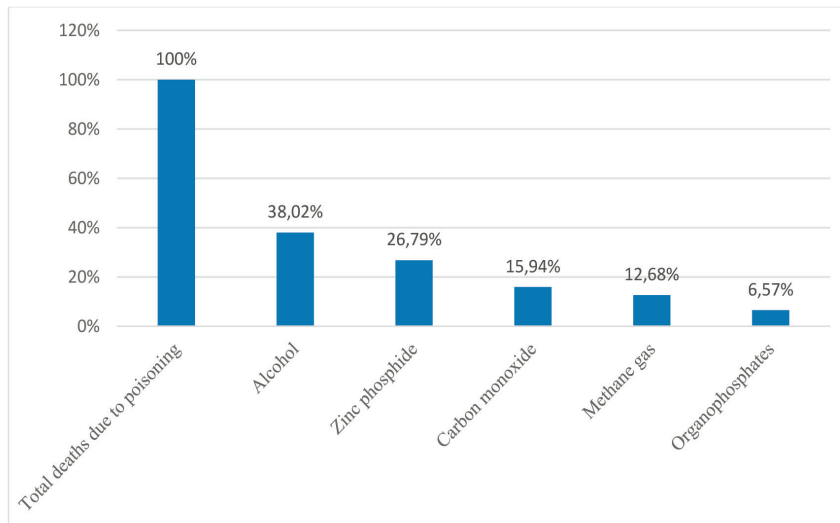


Figure 4 – Percentage of deaths due to various types of toxic materials

The data indicates that suicide was the primary motive and cause of poisoning leading to death in the majority of the cases. The cases were recorded

particularly among families with low income level and limited education. These findings are clearly depicted in Figures 5, 6, and 7.

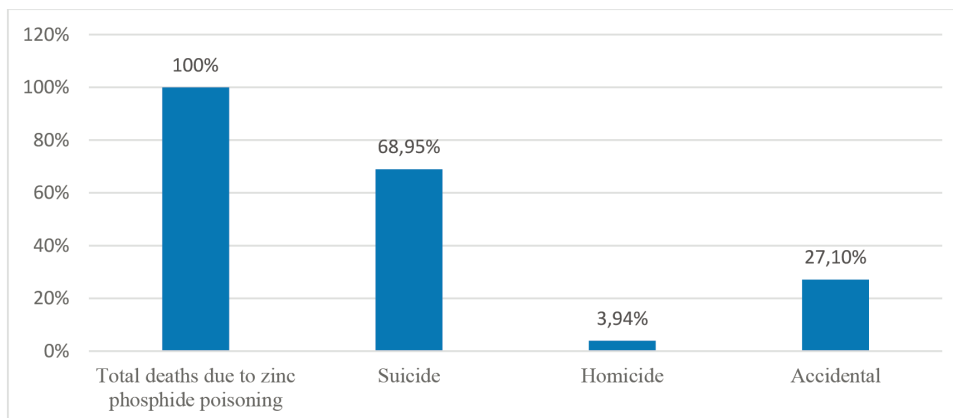


Figure 5 – Percentage of deaths due to zinc phosphide poisoning in relation of cause

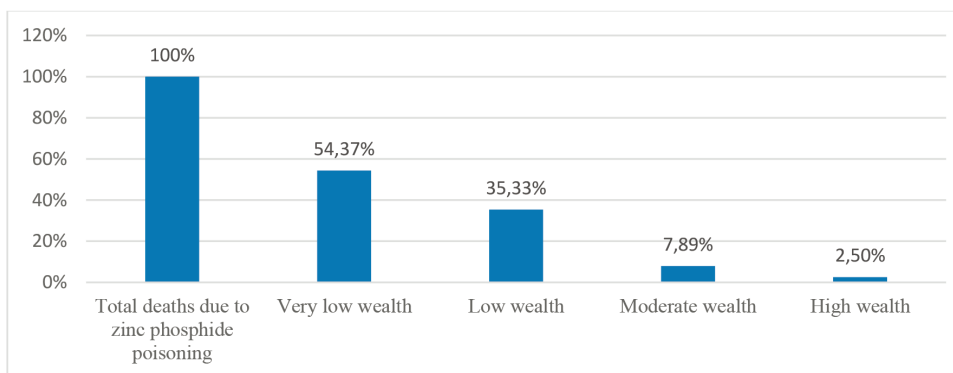


Figure 6 – Percentage of deaths due to zinc phosphide poisoning in relation of victim's economy status

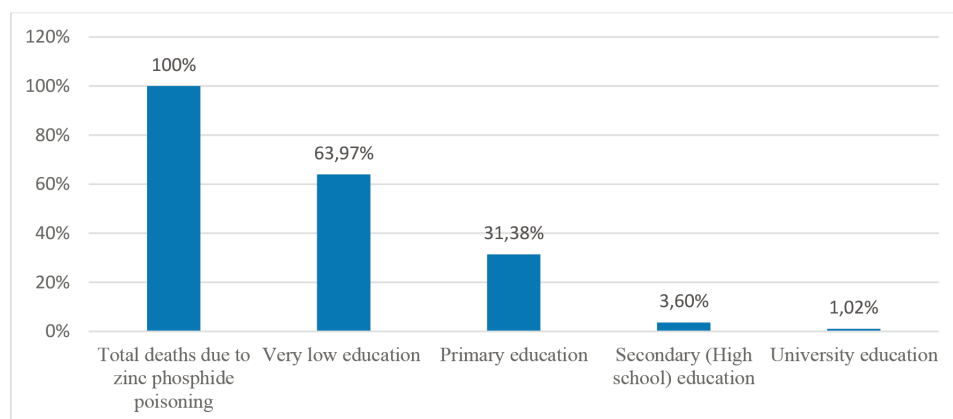


Figure 7 – Percentage of deaths due to zinc phosphide poisoning in relation of victim's education

The aim of this study is to investigate the prevalence of deaths caused by zinc phosphide poisoning, focusing on gender, age, and level of education.(8) Additionally, the study seeks to compare the number of fatalities resulting from zinc phosphide poisoning to other forms of fatal poisoning, such as carbon monoxide poisoning, methane gas poisoning, organophosphate poisoning,

and alcohol poisoning.(9) The research also aims to identify the social stratification of groups with the highest incidence of deaths due to zinc phosphide poisoning, and to determine the motive and cause of death (murder, suicide, or accidental death) in all cases of poisoning fatalities.(6)

The study discovered that the occurrence of deaths caused by zinc phosphide poisoning was 26.79%,

with a higher number of fatalities among women (67.75%) than men. The majority of these deaths occurred among young individuals aged between 18 to 30 years old. The study also revealed that most of the victims belonged to a low-income group (poor) with very limited education (mostly illiterate), and the primary cause of death was suicide, which was more common among women.(10)

In a study conducted by Kanchan T, Menezes RG. Suicidal poisoning in Southern India, it was demonstrated that out of 57 cases of zinc phosphide poisoning, the majority of cases (33 cases, 57.9%) were among females, and the highest incidence of zinc phosphide poisoning occurred among individuals aged between 20 to 40 years old (36%). The highest incidence of these poisonings was observed among married individuals (72%).(11) The primary motive for zinc phosphide poisoning was suicide (35.61%). Among toxic substances (alcohol, organophosphates, sedatives, carbon monoxide), zinc phosphide was the third substance responsible for the highest number of poisoning cases and fatalities (8 cases, 14%). These findings are similar to the study's results, which showed that 67.75% of deaths occurred among women.(12)

In another comprehensive retrospective study conducted at the Department of Forensic Medicine and Toxicology, Faculty of Medicine, Menoufia University in Bangladesh, the researchers examined 399 cases of zinc phosphide poisoning (rodenticide) over a period of three years, from June 2016 to July 2018. The study found that the highest incidence of zinc phosphide poisoning occurred among individuals over 18 years old (46.8%) and the majority of these poisonings were due to suicide (92.2%). In most of these cases, the individuals had used zinc phosphide in powder form.(13)

In research conducted by Rajeshwar Sambhaji Pate, Mohit Vijay Rojekar, and Rohankumar Ohanrakumar Hire at the Rajiv Gandhi Medical College in Maharashtra, India, published in the international journal Forensic Medicine and Toxicology, 318 cases of zinc phosphide poisoning (rodenticide) resulting in death were investigated . The study found that the majority of zinc phosphide poisoning victims were male (64.2%) aged between 20 to 30 years old (31.7%). The highest incidence of these poisonings occurred among farmers (145 cases, 45.6%). The majority of these poisonings were due to suicide (282 cases, 88.68%), and these suicides occurred predominantly in rural areas (189 cases, 59.43%). Among other toxic substances (alcohol, carbon monoxide, methane gas, organophosphates, and others), zinc phosphide was the leading cause of poisoning (15.4%).(14)

In another study involving over 70 autopsies at the Department of Forensic Medicine at Rajshree Medical Research Institute, it was found that the majority of zinc phosphide poisoning (rodenticide) cases resulting in death occurred among males (75.7%). The highest incidence of these poisonings was observed in the age range of 25 to 35 years old (45.7%) followed by the age range of 35 to 45 years old (28.5%).(9)

Upon comparing the results of this study with the literature, it is observed that zinc phosphide poisoning deaths occur more frequently in females and in young people between the ages of 18 to 30 than in males and other age groups. This finding is consistent with the research conducted by Chaudhary Ritesh, Rai Bijendra Kumar, Poudel Masum, Yadov Ashok Kumar et al. in Dharan, Nepal. In terms of the type of toxic substance, zinc phosphide was the second most deadly poison after alcohol, which caused poisoning and deaths in the community. This fact is fully consistent with the research conducted by Chaudhary Ritesh, Rai Bijendra Kumar, Poudel Masum, Yadov Ashok Kumar et al. in Dharan, Nepal and is similar to other literature. This study found that the motivation and cause of most zinc phosphide poisoning deaths were suicide, which is consistent with the research mentioned in the literature.(15)

The other research showed that 88.68% of deaths due to zinc phosphide poisoning were a consequence of suicide, and 58.81% of the victims of this poisoning were people with low income levels, which is consistent with the results of this study. (11) It was also observed in this research that the casualties of zinc phosphide poisoning were mostly women with very low levels of education (or mostly illiterate), for which no investigation or research has been conducted in previous literature.(2)

Conclusion

Based our research and literature data, it can be concluded that zinc phosphide is a highly lethal poison that poses a significant risk to vulnerable populations in developing countries due to easy access, and wide spreading among poor people. The following recommendations can reduce risk of poisoning and prevent casualties.

Recommendation

1. Implementation of strict control measures to limit easy free access to sales of zinc phosphide.
2. Raising awareness and enlightening the public through mass communication channels about the

religious laws and issues of suicide in the perspective of Islam.

3. Educate parents in safety measures to prevent children's poisoning and importance of keeping chemicals out of the reach of children.

4. Establishing an institution to address youth problems, so that young people (especially women) can solve their problems by referring to this institution and do not have to resort to suicide by consuming zinc phosphide due to the intensity of their problems.

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