



Original Article

Epidemiology of Fatal Poisonings from Organophosphorus Compounds in Rangpur District, Bangladesh

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Abstract

Background: Organophosphorus compound (OPC) poisoning represents a significant public health issue in low- and middle-income countries. Globally, the WHO estimates three million annual cases of pesticide poisoning, resulting in 220,000 deaths, predominantly in international settings. In Bangladesh, OPCs are frequently used for suicide in rural areas due to their affordability, toxicity, and accessibility.

Objective: This study aimed to determine the prevalence, incidence by age and sex, and marital status of victims in cases of fatal organophosphorus poisoning in Rangpur District.

Methods: This retrospective study analyzed all medicolegal autopsies conducted between October 2005 and January 2007 at the mortuary of Rangpur Medical College based on the history and preliminary findings of the deceased.

Results: Of the 282 medicolegal autopsies performed during the study period, 60 (21%) resulted from organophosphorus poisoning. Females accounted for the majority of victims (31, 52%) compared to males (29, 48%). The highest prevalence of organophosphorus poisoning occurred in the Mithapukur area (17, 28%), with the age group 21-30 years showing the highest incidence (38%). Acute poisoning was more prevalent among married individuals (80%) compared to unmarried individuals (20%).

Conclusion: Organophosphorus poisoning remains a significant healthcare challenge in Bangladesh. Enhanced awareness, restricted availability, and preventive measures are crucial for reducing mortality and morbidity associated with OPC poisoning.

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Introduction

Bangladesh, a developing country in South Asia, relies heavily on agriculture to sustain its rural population. As

agricultural practices have modernized, pesticides have become integral for crop cultivation. These chemicals are

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readily available over the counter in village shops but unfortunately also serve as a common method for suicide attempts and, less frequently, accidental poisonings¹. Pesticides encompass a range of substances including insecticides, herbicides, acaricides, fungicides, and rodenticides, each tailored to combat specific types of pests². By 2013, Bangladesh had approved a staggering 2,894 different types of pesticides³, with organophosphate compounds emerging as the most commonly implicated in poisoning cases⁴⁻⁶.

The history of organophosphates dates back to the 19th century when they were initially synthesized as chemical curiosities. German chemist Gerhard Schrader began researching them as insecticides in 1920, leading to the development of nerve agents like Tabun, stockpiled by the German Armed Forces by 1939. Simultaneously, DDT (Dichloro-diphenyl-trichloroethane) was covertly imported from German chemical industries by the Allies, significantly reducing morbidity from arthropod-borne diseases and halting a typhus epidemic in Naples in 1944. However, the indiscriminate use of DDT also led to ecological concerns, causing a decline in bird populations and contaminating marine species as toxic food sources for humans. Consequently, organochlorine pesticides like DDT gradually gave way to organophosphorus compounds.

Today, organophosphates find diverse applications ranging from military nerve agents to agricultural and domestic uses such as fly strips, wood preservatives, and treatments for human arthropod infestations like malathion^{9,10}. These compounds, however, pose significant risks to human health, accounting for over 80% of pesticide-related hospitalizations due to their rapid degradation in air and light, facilitating exposure through inhalation, ingestion, or skin contact.

Organophosphorus poisoning occurs through the inhibition of the enzyme cholinesterase, leading to the accumulation of acetylcholine and symptoms associated with excessive cholinergic activity. Fatalities result from respiratory muscle paralysis, respiratory failure, or severe bronchoconstriction.

Cases of poisoning can occur in various contexts—accidental, homicidal, suicidal, or self-inflicted. In rural Bangladesh, organophosphorus compounds are commonly used for suicide due to their accessibility as insecticides, contrasting with their infrequent use in urban areas¹². Similarly, in India, pesticide ingestion is the second most common method of suicide (40.5%) after hanging (49%)¹³. Accidental poisonings can affect children, the mentally impaired, intoxicated individuals, manufacturers, packers, sprayers, and users, as well as occur through the contamination of food grains and consumption of contaminated fruits and vegetables¹⁴.

Homicidal poisonings with organophosphates are rare due to their detectable odor and early onset of symptoms. However, in developing countries where public awareness and diagnostic resources are limited, such incidents may occur more frequently.

Globally, acute poisoning remains a significant medical and social issue, influenced by factors such as pesticide availability, socioeconomic conditions, and educational levels. In Bangladesh, acute poisoning contributes significantly to mortality and morbidity rates, echoing trends observed across the developing world.

Studies by the World Health Organization (WHO) and others underscore the lethal impact of organophosphorus pesticides in self-attempted deaths across developing nations.

Materials and Methods

This retrospective study was conducted at Rangpur Medical College between October 2005 and January 2007. A total of 282 autopsies were performed by Assistant Professor Dr. Md. Abdus Samad, Head of the Department of Forensic Medicine, Rangpur Medical College, during this period. Among these cases, 60 individuals (21%) died due to organophosphorus compound (OPC) poisoning. The study focused on meticulously analyzing these 60 cases, taking into account various parameters including preliminary data of the deceased, medical history, location of incident, and post-mortem findings. All data for this study was extracted from the department's register book.

Observations and Results

After collecting and observing the data, statistical analysis was conducted using SPSS software version 16.0, and the findings were presented through tables and charts.

The study identified 60 cases of organophosphorus compound (OPC) poisoning deaths out of a total of 282 autopsies, resulting in an incidence rate of 21% (Table-1).

Table-1: Incidence of OPC poisoning deaths

Total number of autopsies	282
Number of OPC poisoning deaths	60
Percentage	21%

The majority of victims were female, comprising 31 cases (52%), while males accounted for 29 cases (48%) (Table-2). The male-to-female ratio was found to be approximately 1:1.07.

Table-2: Incidence of sex

Sex	Number of cases	Percentage
Male	29	48%
Female	31	52%
Total	60	100%

According to age groups, the highest incidence of poisoning occurred among individuals aged 21-30 years (38%), with a gradual decrease observed in older age groups (Table-3).

Table-3: Incidence of age

Age group(yrs)	Number of cases	Percentage
11-20	19	32%
21-30	23	38%
31-40	09	15%
41-50	07	12%
51-60	02	03%
Total	60	100%

Figure 1 illustrates the distribution of OPC poisoning cases according to marital status, showing that 80% of victims were married and 20% were unmarried.

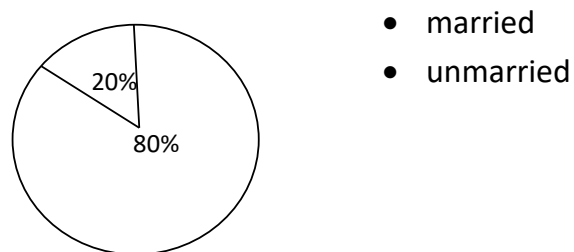


Figure-1: Incidence of OPC poisoning according to marital status

Table-4 presents the prevalence of OPC poisoning across different Upazilas (sub-districts) of Rangpur district, with Mithapukur having the highest prevalence at 28%. The study noted a higher prevalence of cases originating from rural areas.

Table-4: Prevalence of OPC poisoning

Area	Number of cases	Percentage
Mithapukur	17	28%
Pirganj	12	20%
Pirgacha	10	17%
Badarganj	07	12%
Rangpur Sadar	05	08%
Kaunia	04	07%
Gangachara	03	05%
Taraganj	02	03%
Total	60	100%

These findings underscore the regional distribution and demographic patterns of OPC poisoning cases in the study area, emphasizing the predominance of this health issue among specific population groups and geographical locations.

Discussion

In Bangladesh, poisoning constitutes a significant public health issue, causing approximately 2000 deaths annually¹⁷. Organophosphate pesticides are among the leading causes of poisoning worldwide, with annual incidences varying between 3-10% among agricultural workers in different countries¹⁸. Studies have reported a mortality rate of 16.4% from acute poisoning, predominantly attributed to organophosphorus compounds. Self-poisoning, particularly with pesticides, accounts for over 60% of deaths in rural Asia, surpassing other forms of self-harm like hanging¹⁹⁻²¹. Recent surveys in Bangladesh indicate that 14% of deaths among women aged 10-50 years are due to self-poisoning, with pesticides being the primary agents²². This issue is particularly severe in Sri Lanka, where pesticides are the leading cause of hospital deaths across rural districts^{23,24}. The widespread availability of highly toxic pesticides used

in agriculture has made them a well-known method of choice for self-harm, recognized by healthcare professionals and public health authorities globally²⁵⁻²⁷. The International Agency for Research on Cancer (IARC) has highlighted the potential increased cancer risks associated with organophosphates²⁸. Prenatal exposure to these pesticides has also been linked to impaired fetal growth and development, while their harmful effects include mental disturbances, infertility, gastrointestinal disorders, and organ failures such as liver and kidney failure. Unlike Western countries where vegetables are routinely checked for Maximum Residual Limits (MRL) of insecticides, such practices are not consistently followed in Bangladesh.

Previous studies have documented varying incidences of OPC poisoning over time, suggesting potential improvements in social awareness and consciousness as contributing factors to declining mortality rates²⁹⁻³¹. Gender disparities in poisoning cases have been observed, with some studies showing a predominance of males, contrasting with findings from the Rangpur district study where females were more prominently affected³²⁻³⁴. Similarly, young adults aged 21-30 years were found to be the most affected group in our study, consistent with findings from another research in Bangladesh and neighboring regions³³⁻³⁶.

The geographical distribution of OPC poisoning cases within Rangpur district highlights Mithapukur Upazila as a significant hotspot, reflecting broader rural-urban disparities in pesticide-related self-harm incidents³⁷. Factors contributing to these incidents include socio-economic challenges such as poverty, unemployment, familial discord, and personal crises, which often precipitate suicidal behaviors involving agricultural chemicals. Mental illnesses or chronic health conditions may also play a role as underlying factors in poisoning incidents.

Mitigating the incidence and severity of OPC poisoning requires multifaceted approaches including restricting access to highly toxic pesticides, implementing stricter regulations, enhancing chemical identification capabilities in medical settings, providing more effective treatment options, and intensifying public awareness and education campaigns. These measures collectively aim to reduce the fatality and impact of OPC poisoning incidents in Bangladesh and similar agricultural-based economies.

Conclusion

Organophosphorus poisoning poses a significant public health challenge in countries like Bangladesh, impacting not only health but also socio-economic aspects and cultural practices. There is an urgent imperative to prioritize prevention strategies against poisoning. A coordinated and comprehensive approach is crucial to achieve meaningful outcomes. Swift identification and aggressive management of acute intoxications are imperative to reduce the severity and fatality associated with these highly hazardous substances.

Moving forward, the Ministry of Agriculture in developing nations, particularly Bangladesh, should focus on optimizing and monitoring the use of organophosphorus compounds as pesticides. Encouraging farmers to adopt natural alternatives over chemical pesticides could further mitigate the risks associated with pesticide poisoning. These measures are essential to safeguard public health, promote sustainable agricultural practices, and mitigate the adverse impacts of pesticide exposure on both human health and the environment.

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