DOI: https://doi.org/10.53350/pjmhs02023171196

ORIGINAL ARTICLE

Epidemiological Patterns and Clinical Consequences of Organophosphorus Poisoning

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ABSTRACT

Background: Organophosphates (OPs) are widely used chemicals with known harmful effects on human health, leading to Organophosphate poisoning (OPP). This study assesses the epidemiology and clinical outcomes of OPP in a developing country. The primary aim is to describe the characteristics and short-term outcomes of OP poisoning, including recovery and development of complications.

Methods: This descriptive cross-sectional study was conducted over ten months periods at DHQ Nowshehra, involving 50 adult patients with OPP repeated over a period of 10 months. Data regarding age, gender, socioeconomic status, and hospital stay was collected. Outcomes such as coma, circulatory failure, respiratory failure, and death were monitored.

Results: The study included 50 patients, predominantly young adults, with a slight male majority. Most patients recovered from poisoning effects, with a minority experiencing complications such as respiratory and circulatory failure. Mortality was recorded in 12% of cases.

Conclusion: The study highlights the significant impact of OPP, particularly among young adults in rural areas. Early hospital presentation and adequate emergency care are crucial for recovery. However, the accessibility and unregulated sale of OPs pose a continued risk, especially for intentional ingestions.

Keywords: Organophosphate Poisoning, Epidemiology, Clinical Outcomes, Developing Country, Emergency Care, Mortality.

INTRODUCTION

A class of chemicals called organophosphates (OPs) are widely used in agriculture and industry, even though they can harm human health[1]. These chemicals have carbon and phosphoric acid derivatives in their structure and can cause organophosphate poisoning (OPP) when people come into contact with them through skin, inhalation, or ingestion[2,3]. OPs block the activity of acetylcholinesterase (ACE), an enzyme that breaks down a neurotransmitter called acetylcholine. This leads to an excess of acetylcholine in the body, which can result in serious cholinergic symptoms[4]. Common OPs include parathion, dichlorvos, chlorpyrifos, azinphos-methyl, diazinon, fenitrothion, and tetrachlorvinphos[1].

Emergency hospital admissions are often caused by OPP[5]. To diagnose OPP, doctors need to consider the patient's exposure history, clinical symptoms, pesticide smell, and blood test results of cholinesterase levels. Research shows that treating OP poisoning early can improve the patient's recovery. Patients with severe mental impairment need to receive 100% oxygen and urgent breathing tube insertion, as well as drugs called atropine and oxime to counteract the effects of excess acetylcholine. If the patient has swallowed a large amount of OP and arrives within 1–2 hours after ingestion, doctors may also perform procedures to protect the airway, insert a tube through the nose into the stomach, and wash out the stomach contents[6].

Global exposure to OPs is estimated at around 3 million individuals annually, with a resulting mortality of approximately 300,000 per year. In developing nations, particularly those with less advanced healthcare systems and greater reliance on agriculture, a higher incidence of OPP is expected[7,8]. These substances are notably common agents of suicide in Sri Laka, India, Bangladesh, India, and other Asian regions[9-11].

Poisoning incidents, whether accidental or intentional, are frequent in the society, particularly among females and individuals from lower socioeconomic backgrounds[9]. The primary mechanism of major pesticides involves neurological disruption. Beyond neurotoxicity, these compounds also significantly harm the immune and endocrine systems. Adverse health effects extend to dermatological, gastrointestinal, urogenital, respiratory, musculoskeletal, and cardiac issues[5]. Despite comprehensive respiratory support, intensive care, and specific treatments like atropine and oximes, mortality rates remain high in cases of OP poisoning. OP poisoning is a serious condition that often leads to death within three days of exposure for one out of three patients who need mechanical ventilation in intensive care units[12]. This study aimed to observe and describe the clinical features and short-term outcomes of OP poisoning such as recovery, development of complications like respiratory or circulatory failure, coma, or death. The purpose was to reduce the death and disability rates related to OP poisoning, and to provide evidence-based recommendations to prevent or mitigate the adverse clinical outcomes in affected patients.

MATERIAL AND METHODS

This descriptive cross-sectional study was carried out at DHQ Nowshehra over a period of ten months, spanning from January to October, 2023. The study included 50 adult patients of varying age and gender who had experienced organophosphorus poisoning, as reported by close relatives. Sample size was calculated through WHO sample size calculator by taking 95% confidence level, 5% margin of error, 3.32 population proportion [13], and Khyber Pakhtunkhwa census 5883007. Patients with other types of poisoning were excluded from the study. Eligibility was determined based on admission through the emergency department and a diagnosis confirmed by clinical symptoms and a history of ingesting organophosphorus in the form of insecticide. Patients whose symptoms did not align with organophosphorus poisoning were excluded. For those unable to give consent, informed written consent was obtained from their attendants. The study carefully addressed patient confidentiality and the associated risks and benefits. Ethical approval has been taken from Ethical Review Board with Ref No.: ERB/DHQ/022/01 on dated 24/12/2022.

All participants with a history of organophosphorus poisoning received appropriate emergency care in the Accident and Emergency department. This care included removing contaminated clothing, washing the body with soap and warm water, inserting a nasogastric tube for stomach decompression and lavage, and catheterization to monitor urine output. The patients were then admitted to the ICU for further treatment according to the hospital's standard protocol for such cases. The study monitered short-term outcomes such as coma, circulatory failure, respiratory failure, and death. The data collection included variables such as age, gender,

socioeconomic status, hospital stay, and outcomes. The descriptive statistical analysis was performed on qualitative variables like socio-economic status, marital status, whether the poisoning was intentional or accidental, as well as outcomes such as coma, circulatory failure, respiratory failure, and death. Categorical variables were expressed as frequencies and percentages. Numerical variables, such as monthly income and age of patients, were calculated as mean±SD. The male to female ratio was also computed. The collected data was processed by SPSS version 25.

RESULTS

The study included 50 patients with organophosphorus poisoning. The cases constituted 29 males (58%) and 21 females (42%), with a male to female ratio of 1.38:1 for our study cohort. The patients' age range was 22-69 years, with a mean±SD of about 25.35±7.45 years. The most common age group was 22-30 years, representing 42% (21 patients), followed by the 31-36 years age group, which constituted 24% (12 patients). Moreover, 12% (6 patients) were in the 37-45 years range, 8% (4 patients) were between 45-50 years, and 14% (7 patients) were above 50 years.

Regarding marital status among these 50 cases, 66% (33 patients) were unmarried, while the remaining 34% (17 patients) were married. Geographically, the majority of patients, 64% (32 patients), were from rural areas of District Nowshehra, while 36% (18 patients) were from urban areas within the same district. An analysis of the socioeconomic background revealed that 58% (29 patients) had a monthly income of 30,000 rupees or less. In contrast, only 18% (9 patients) reported a monthly income exceeding 50,000 rupees. The route of poison ingestion was oral in all cases (100%). The predominant reason for poisoning, identified in 98% (49 cases), was a psychiatric history leading to intentional ingestion, while only one case (2%) involved accidental ingestion (Table 1).

Table 1: Demographic Features and Clinical Characteristics of Patients with Organophosphorus Poisoning (n=50)

Demographic Features	No. of Cases	Percentage
Gender:		
Male	29	58%
Female	21	42%
Age ranges:		
22-30 years	21	42%
31-36 years	12	24%
37-45 years	6	12%
45-50 years	4	8%
Above 50 years	7	14%
Marital status:		
Married	17	34%
Unmarried	33	66%
Residential status:		
Rural	32	64%
Urban	18	36%
Socioeconomic status:		
Income ≤ 30,000 per month	29	58%
Income > 50,000 per month	9	18%
Route of taking poison:		
Oral	50	100%
Reason for taking poison:		
Intentionally	49	98%
Accidentally	1	2%

As for the outcomes of these organophosphorus poisoning cases, 90% (45 patients) recovered from the poisoning effects, whereas 10% (5 patients) did not recover. Respiratory failure was observed in 12% (6 patients), while 90% (45 patients) did not experience this complication. Circulatory failure occurred in 8% (4 patients), and 94% (47 patients) did not exhibit such failure. Coma was noted in 12% (6 patients) of the cases.

Mortality was recorded in 12% (6 patients) of the cases, predominantly attributed to delayed hospital presentation. These patients, arriving from remote areas of the district, often received initial treatment at nearby hospitals or health facilities before being transferred to the study hospital (Table 2).

Table 2: Outcomes and Complications in Patients with Organophosphorus Poisoning (n=50)

Variables	No. of Cases	Percentage
Outcomes:		
Recovered	45	90%
Death	5	10%
Complications:		
Respiratory failure	6	12%
Circulatory failure	4	8%
Coma	6	12%
Mortality:		
Death	6	12%

DISCUSSION

Exposure to organophosphate compound (OP), whether via intentional, accidental, or occupational exposure or use, is a major global issue. Such exposure can cause severe symptoms such as convulsions, excessive secretions, muscle twitching, respiratory failure, and impaired consciousness, which can be diagnosed by measuring acetylcholine levels[14].

This study found that the most poisoning cases occurred predominantly among individuals aged 16-30 years. This age distribution aligns with findings from a number of studies from Pakistan, which reported a majority of cases in the 15-24 year age range[14,15]. Similar observations have been published by other researchers[16-18]. The prevalence in these younger age groups in Pakistan is particularly concerning and may be attributed to factors such as aggression, a desire for attention, expressions of distress, or motivations for revenge[19,20]. Our study observed a male predominance with a male-to-female ratio of 1.38:1, consistent with the male predominance in organophosphorus poisoning cases as reported in literature[16-18]. However, a study from Muzaffarabad reported a higher female preponderance in cases of organophosphorus poisoning[15]. However, itwas a single center based study and the results cannot be generalized onto the regional population.

Ingestion of OP in suicide attempts poses a major challenge, particularly in developing countries like Pakistan. This issue is exacerbated by the widespread availability of pesticides, largely due to extensive agricultural use and over-the-counter sales [20]. Suicidal attempts account for a significant proportion of OP poisoning cases, ranging from 40% to 80% in certain countries[21, 22].Our study reveals that 98% of the cases were intentional suicides, with accidental poisoning constituting only 2%. These findings are consistent with other studies, where the majority of cases were attributed to suicidal poisoning, varying from at least 50% to as high as 97.3%[18, 22, 23].

Deliberate self-poisoning (DSP) remains a critical health issue globally, particularly in developing countries. In the Pakistani context, it is the most common method of DSP among adolescents and young adults. Notably, young married females constitute a significant proportion of individuals attempting DSP[15,20].

In this research, organophosphorus (OP) intoxication predominantly impacted young, unmarried males, all of whom attempted suicide. A study from Muzaffarabad, Azad Jammu & Kashmir, Pakistan showed that more unmarried females tried to attempt suicide by ingesting OP compounds, compared to males[15]. This contrasts with other studies where the majority of patients were married, with married females showing a higher tendency towards self-harm than their male counterparts[22-24]. These differences highlight the unique aspects of our study compared to previous research.

Our study also found that factors like illiteracy and poverty play significant roles in driving individuals towards suicide. The majority of our cases were from the lower middle class and had limited educational backgrounds, predominantly with no education or only primary level education. These findings align with other studies which report similar findings[25-27].

Organophosphorus compounds, widely utilized in agricultural pest control, have become a significant source of both intentional and accidental poisoning. These incidents are particularly prevalent in rural areas of developing countries, where access to these substances is relatively unregulated. In agrarian nations like Pakistan, the combination of pesticide toxicity and inadequate medical services contributes to high case fatality rates[15]. Urban regions report fewer cases of self-poisoning with pesticides, a trend also observed in our study where the majority of cases originated from rural areas of the district. The accessibility of these pesticides in rural settings appears to be a key factor in cases of intentional poisoning[20].

Severe exposure to organophosphorus compounds can lead to critical symptoms such as slurred speech, convulsions, coma, and respiratory depression. Acute fatalities are often due to respiratory failure or cardiovascular collapse, while deaths may result from respiratory failure and complications related to aspiration and extended ventilation. In our study, recovery was recorded in 90% of cases, while fatalities occurred in 10%. Notably, respiratory failure was observed in 10% of patients, circulatory failure in 6%, and coma in 10% of cases. Mechanical ventilation plays a crucial role in treating severe cases. Among the 10% of patients who did not survive, 4% could potentially have been saved with the availability of more, or operational, mechanical ventilators in our hospital's ICU at the time of their admission.

During the hospital admission of one patient, two ventilators in the ICU were inoperative, while the others were already in use. For another patient's admission, all ICU ventilators were occupied. The short-term outcomes from our study showed that 93% of patients with organophosphorus poisoning fully recovered, 1.1% left the ICU against medical advice, and 5% succumbed to the condition. Our findings are consistent with various other studies[1 28].

our study provided a comprehensive insight into the epidemiology and clinical outcomes of organophosphorus poisoning (OPP) in context of a developing country. The predominance of young adults, particularly males, in the cohort underscores a demographic vulnerability that warrants targeted interventions. Moreover, the high percentage of cases resulting from intentional ingestion reflects underlying psychosocial issues, such as mental health challenges and socioeconomic pressures, that need addressing. The relatively high recovery rate in this study highlights the effectiveness of prompt and adequate medical intervention, yet the mortality rate, primarily due to delayed hospital presentation, calls for improved public awareness and accessibility to emergency healthcare services. The small sample size of 50 patients may limit the generalizability of the findings to the broader population. As a cross-sectional study, it captures only a snapshot in time and cannot establish causality. The study primarily focuses on a single medical center, which may not reflect the varied healthcare settings across different regions.

CONCLUSION

This study underscores the significant health burden of OPP, especially in rural areas of developing countries. Key findings indicate that OPP predominantly affects young adults, with a slight male majority, and is primarily a result of intentional ingestions. The critical role of early hospital presentation and comprehensive emergency care in improving clinical outcomes is evident. These findings should inform public health strategies aimed at reducing the incidence of OPP through education, better regulation of organophosphate sales, and enhanced accessibility to mental health resources.

The study provides valuable epidemiological data on OPP in a developing country setting, filling a gap in the current literature. It encompasses a wide age range, offering insights into demographic-specific vulnerabilities. The comprehensive tracking of clinical outcomes, including recovery, complications, and mortality, adds depth to the study.

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This article may be cited as: Sheikh JS, Ubaid R, Alam S, Mohammad P, Munib M, Khan Y: Epidemiological Patterns and Clinical Consequences of Organophosphorus Poisoning. Pak J Med Health Sci, 2023;18(11): 96-99.