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ORIGINAL ARTICLE

Hematological profile alterations in suicidal organophosphorus poisoning: a comparative case control study between addicted and non-addicted individuals

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ABSTRACT

Objective: To evaluate the effects of organophosphorus (OP) poisoning on hematological parameters and compare these changes between non-addicted individuals and patients with chronic alcohol or benzodiazepine addiction.

Methods: This comparative cross-sectional study was conducted at Liaquat University Hospital, Hyderabad, Pakistan, from July to December 2024. A total of 260 male patients (20–40 years) with confirmed suicidal OP poisoning were recruited using convenience sampling. Participants were categorized into non-addicts (Group A, n=120), alcohol addicts (Group B1, n=90), and benzodiazepine addicts (Group B2, n=50). Hematological parameters were measured using an automated hematology analyzer. Comparisons among groups were performed using one-way ANOVA and the Chi-square test.

Results: Mean age was comparable across the three groups. Among 260 patients with OP, abnormal complete blood count findings were significantly more frequent in addicted than non-addicted patients' groups ($p<0.05$). Normal blood profiles were observed in 80 (66.7%) non-addicts, 40 (44.4%) alcohol addicts, and 20 (40.0%) benzodiazepine addicts, whereas hematological abnormalities were detected in 40 (33.3%), 50 (55.6%), and 30 (60.0%) patients, respectively ($p=0.001$). Hemoglobin, hematocrit, mean corpuscular volume, mean corpuscular hemoglobin, white blood cell count, and neutrophil percentage differed significantly among the study groups ($p<0.05$).

Conclusion: Chronic alcohol and benzodiazepine addiction are associated with greater hematological abnormalities in patients presenting with OP. Addicted individuals demonstrated lower hemoglobin indices and higher leukocyte and neutrophil counts, than non-addicts, suggesting that substance addiction may exacerbate the hematological effects of OP poisoning. Early hematological assessment may facilitate risk stratification and clinical management of these patients.

Keywords: Hematological parameters (MeSH); Drug Users (MeSH); Addicts, Drug (MeSH); Non-Addicts (MeSH); Substance-Related Disorders (MeSH); Poisoning (MeSH); Organophosphorus Poisoning (MeSH); Hematologic Tests (MeSH); Suicide, Attempted (MeSH); Hematologic Tests (MeSH); Blood Cell Count (MeSH).

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INTRODUCTION

Organophosphorus compounds (OPCs) are phosphate esters widely used as insecticides and pesticides worldwide.[1] Organophosphorus poisoning is a major cause of morbidity and mortality in developing countries, including Pakistan, particularly among young adults, with respiratory failure being the leading cause of death.[2] Deliberate self-poisoning with OPCs is especially common in low- and middle-income countries such as India, Sri Lanka, Bangladesh and Pakistan because of their widespread availability, low cost, and extensive agricultural use. Recent epidemiological studies have identified organophosphorus insecticides as the most frequently implicated agents in suicidal poisoning in rural agricultural communities, making them a significant public health challenge in these settings.[3]

Organophosphorus compounds (OPCs), including phosphorothioates, phosphonates, and phosphinates, are extensively used in agriculture to meet the growing global demand for food. The severity of OPC toxicity depends on several factors, including lipid solubility, route of exposure, and chemical structure. Highly lipophilic compounds persist longer in adipose tissue and systemic circulation, resulting in prolonged toxic effects.[4,5] In addition to agricultural applications, OPCs are widely used in industrial and household products such as insecticides and lice treatments. Concurrent alcohol or substance use may worsen the clinical course of organophosphorus poisoning by impairing consciousness, altering hepatic metabolism, and delaying medical care, thereby increasing disease severity and complications.[6] The toxic effects of OPCs result from inhibition of acetylcholinesterase, leading to excessive accumulation of acetylcholine at synaptic junctions and continuous stimulation of cholinergic receptors. This cholinergic crisis manifests as miosis, excessive salivation and sweating, respiratory depression, muscle fasciculations, seizures, and, in severe cases, coma and death.[7]

Organophosphorus poisoning is associated with significant hematological and biochemical alterations.

Exposure to OPCs has been reported to reduce hemoglobin and mean corpuscular hemoglobin concentration while increasing leukocyte counts. In addition, elevated serum alanine aminotransferase, aspartate aminotransferase, and gamma-glutamyl transferase levels indicate hepatocellular injury following poisoning.[8,9] Previous studies have demonstrated that OP is associated with reduced hemoglobin and mean corpuscular volume, leukocytosis, and elevated liver enzyme levels.[10,11] Concurrent use of substances such as alcohol, benzodiazepines, and opioids may further increase morbidity and mortality by potentiating central nervous system and respiratory depression.[12] Chronic alcohol use is also associated with bone marrow suppression, folate and vitamin B_{12} deficiencies, and disturbances in hematological and biochemical parameters. Khan M, et al., demonstrated significant hematological and biochemical abnormalities among individuals chronically exposed to alcohol and other toxic substances, while Farooqui WA, et al., reported that biochemical derangements were associated with poorer clinical outcomes in acute organophosphorus poisoning.[13,14] However, studies comparing hematological and biochemical changes between addicted and non-addicted patients with organophosphorus poisoning are scarce. Therefore, the present study was undertaken to compare these parameters between the two groups and evaluate the impact of substance addiction on the clinical manifestations of organophosphorus poisoning.

METHODS

This was 6-month duration of study conducted in settings of Liaquat University Hospital, Hyderabad, Pakistan from 01-07-2024 up to 31-12-2024. Ethical approval was obtained from the Ethical Review Committee of the Department of Physiology, University of Sindh, Jamshoro (Reference No. DRGS/3359; October 10, 2023). This study formed part of the principal investigator's PhD research in Physiology.

The sample size of this study was calculated using the single proportion formula by assuming the 95% confidence interval, 5% margin of error, and expected proportion of 16.7% based on previous study of Hanif S, et al.[15] To improve the statistical precision and power of study, recruitment was not only restricted to the minimum calculated sample size but instead all eligible consecutive patients presenting during the study and fulfilled the criteria of inclusion were enrolled that results in a final sample size of 260 participants A convenient sampling technique was applied to recruit the eligible patient presenting with suicidal organophosphorus poisoning during the period of this study.

All participants were categorized into two groups according to their addiction status. Group A includes 120 male patients within the age range of 20-40 years with no previous history of alcohol consumption who presented to the emergency department with suicidal organophosphorus poisoning. Group B included 140 males who also presented in the emergency department with suicidal organophosphorus poisoning with a positive history of chronic addiction, and based on the type of addiction use, they were further divided into 2 subgroups: B1 (n=90) were alcoholics and B2 (n=50) were addicted to benzodiazepines. Comparative analysis of hematological and biochemical parameters was performed between both groups to evaluate the impact of alcohol and Benzodiazipine addiction on organophosphorus poisoning outcomes.

Male patients aged 20-40 years presenting to the emergency department with confirmed suicidal organophosphorus poisoning were included in the study. Participants were enrolled irrespective of their addiction status and were subsequently categorized into study groups according to the type of addiction.

Individuals with known chronic systemic illnesses, including chronic liver disease, chronic kidney disease, hematological disorders, malignancy, a history of major surgery or major trauma, or any condition likely to influence hematological or biochemical parameters, were excluded to minimize potential confounding.

Under aseptic conditions, 10 ml of venous blood was collected from each participant. Three (3) ml of blood was transferred into an EDTA anticoagulant tube for hematological analysis, while the remaining sample was placed in a plain gel tube for other biochemical investigations. Hematological parameters, including hemoglobin level, total leukocyte count, and MCH concentration, were analyzed using an automated hematology analyzer. Biochemical parameters that include alanine aminotransferase (ALT), aspartate aminotransferase (AST), gamma-glutamyl transferase (GGT), and lipid profile were analyzed using an automated chemistry analyzer in the hospital diagnostic laboratory according to standard laboratory protocols.

Data analysis was performed using GraphPad Prism version 9. Categorical variables were presented as frequencies and percentages, whereas continuous variables were expressed as mean±standard deviation. The Chi-square test was applied for comparison of categorical variables, while the independent sample t-test was used for comparison of continuous variables between Group A and Group B. A p-value of less than 0.05 was considered statistically significant.

RESULTS

Table I demonstrates the demographic characteristics of the study participants. The mean age was comparable among non-addicts, alcohol addicts, and benzodiazepine addicts presenting with organophosphorus (OP) poisoning. Overall, the largest proportion of participants belonged to the 26-30 year age group (86/260; 33.1%), followed by the 20-25 year age group (83/260; 31.9%). Approximately two-thirds (169/260; 65.0%) of the participants were aged 20-30 years. Body mass index was relatively higher among addicted participants compared to non-addicts. Unemployment and rural residence were more frequently observed among addicted participants.

Table II demonstrates significant differences in several hematological

Table I: Demographic characteristics of study participants

Variables		Group A (n=120) [Mean±SD / n (%)]	Group B 1 (n=90) [Mean±SD / n (%)]	Group B 2 Poisoning (n=50) [Mean±SD / n (%)]
Age (years)	Mean±SD	29.19±7.73	29.70±7.63	28.94±6.81
	20-25 years	45 (37.5%)	24 (26.7%)	14 (28.0%)
	26-30 years	38 (31.7%)	32 (35.6%)	16 (32.0%)
	31-35 years	22 (18.3%)	20 (22.2%)	12 (24.0%)
	36-40 years	15 (12.5%)	14 (15.5%)	8 (16.0%)
Body Mass Index (kg/m^2)		23.5 ± 2.1	24.9 ± 2.8	24.1 ± 2.3
Employment Status	Employed	62 (51.7%)	34 (37.8%)	20 (40.0%)
	Unemployed	58 (48.3%)	56 (62.2%)	30 (60.0%)
Residential Status	Urban	72 (60.0%)	38 (42.2%)	26 (52.0%)
	Rural	48 (40.0%)	52 (57.8%)	24 (48.0%)
Marital Status	Married	73 (60.8%)	66 (73.3%)	38 (76.0%)
	Unmarried	47 (39.2%)	24 (26.7%)	12 (24.0%)

Table II: Comparative analysis of hematological parameters among study groups

Parameters	Group A (n=120) [Mean±SD]	Group B 1 (n=90) [Mean±SD]	Group B 2 (n=50) [Mean±SD]	p-value
Hemoglobin (g/dL)	11.46±1.41	10.27±0.76	10.47±0.88	<0.001
Hematocrit (%)	42.45±4.85	37.54±4.85	41.21±4.74	<0.001
Red Blood Cells (×10^6/μL)	4.31±0.70	4.42±0.45	4.33±0.76	0.45
Mean Corpuscular Volume (fL)	82.76±9.63	74.54±10.25	80.49±11.08	<0.001
Mean Corpuscular Hemoglobin (pg)	29.47±4.99	27.50±5.65	29.04±2.29	0.01
Mean Corpuscular Hemoglobin Concentration (g/dL)	30.71±1.05	31.70±3.77	31.00±0.45	0.01
White Blood Cells (×10^3/μL)	10.41±2.26	11.85±2.36	13.66±2.23	<0.001
Neutrophils (%)	72.00±7.07	81.78±6.52	81.23±4.55	<0.001
Platelets (×10^3/μL)	290.2±28.27	292.4±16.68	291.6±20.11	0.77
Erythrocyte Sedimentation Rate (mm/hr)	22.74±7.28	23.86±11.46	21.44±0.97	0.36

One-way ANOVA was used for comparison of continuous variables among the three groups.

Table III: Comparison of complete blood profile findings among study groups

Complete Blood Profile Findings	Group A [n=120 (%)]	Group B 1 [n=90 (%)]	Group B 2 [n=50 (%)]	p-value
Normal Blood Profile	80 (66.7%)	40 (44.4%)	20 (40.0%)	<0.001
Abnormal Blood Profile	40 (33.3%)	50 (55.6%)	30 (60.0%)	

Chi-square test was applied for comparison of categorical variables.

parameters among study groups. Hemoglobin and hematocrit levels were significantly lower among alcohol addicts and benzodiazepine addicts compared to non-addicts. Mean corpuscular volume and mean corpuscular hemoglobin also showed statistically significant differences among groups. White blood cell count and neutrophil percentage were significantly elevated in addicted participants compared to non-addicts. Platelet count and erythrocyte sedimentation rate did not demonstrate statistically significant differences.

Abnormal complete blood profile findings were observed more frequently among addicted participants compared to non-addicted participants. Normal blood profile findings were present in 66.7% of non-addicts, whereas abnormal findings were more common among alcohol addicts and benzodiazepine addicts. Statistically significant differences were observed among the study groups (p=<0.001) [Table III].

Any deviation from the normal laboratory reference range in hemoglobin level, total leukocyte count, hematocrit, or erythrocyte indices was considered as an abnormal blood profile.

Figure 1 shows that among non-addict participants, 80 had normal CP parameter values, while 40 showed

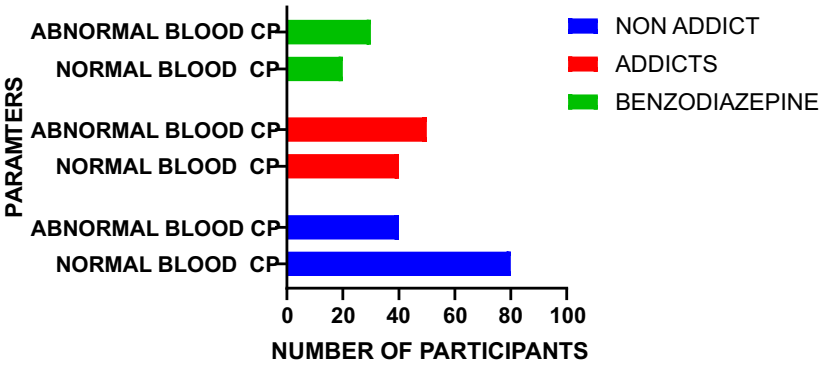

Figure 1: Addiction-related changes in complete blood profile among organophosphorus poisoning cases

abnormalities. In the addict group, around 40 individuals had normal results, and 50 showed abnormal CP findings. In the case of benzodiazepine users, 20 had unaltered CP, while 30 showed abnormal values. The p-value of <0.001 reflects a statistically significant difference in CP outcomes among the groups.

DISCUSSION

This study demonstrates that there are significant changes observed in the blood parameters of patients who ingest the OPC, and their drastic effects are further enhanced in the case of positive addictive substance use. It shows that the blood CP of 40 patients who were non-addicts had low haemoglobin, haematocrit, and MCV, and there was also a rise in WBC count as well as neutrophil count in comparison with 80 participants who were non-addicts. This shows that these changes were more pronounced in patients who were addicted, as addiction worsens the outcome of OPC in individuals.

There are groups of researchers that support these results' findings. Mahmoud E, et al., found that in organophosphorus poisoning, the haematological parameters are disturbed significantly; the WBC count is raised with a p-value of < 0.001.[16] Chandana G, et al., also show that RBC count is decreased in organophosphorus poisoning, and it is more profound in addicted individuals in comparison to non-addicts, with a p-value of 0.02.[17] Chauhan A, et al., in their study on marine ecosystem organisms, also found that the level of Hb, RBC, Hct, and MCHC decreases, while the level of ↑ WBC, MCV, and MCH rises significantly after exposure to OPC; their p-value <0.05 shows that their relation to haematological parameters is statistically significant.[18] Javeres LJ, et al., also show that levels of total count of WBC were significantly elevated in individuals with organophosphorus poisoning, and these changes were more pronounced in addicts compared to individuals who were non-addicts.[19] Alizadeh A, et al., further showed that in organophosphorus poisoning, the levels of RBC cholinesterase were lower in addicts than in non-addicts, with a significant P value of 0.008.[20] Yu G, et al., in a study of 50 participants, found that the abnormal neutrophil count was higher in addicts with organophosphorus poisoning than in non-addicts, with a significant p-value of 0.004.[21] Behera A, et al., conducted their study on 110 participants of organophosphorus poisoning and found that blood indices were significantly altered in addicts compared to non-addicts, with a significant P value of < 0.001.[22] But contrary to this, Sobolev VE, et al., demonstrate that OPC toxicity causes kidney damage but no significant effect on blood.[23] Kalász H, et al.,[24] and Samarghandian S, et al.,[25] conducted their research on the rats. They found that the blood profile was consistently unaltered in all, which further supports no interaction with addiction compounds.

These findings have important clinical implications for emergency and critical care practice. Hematological abnormalities, particularly leukocytosis and anemia, may help identify patients at increased risk of complications and poor outcomes. Early assessment of addiction status, combined with routine hematological evaluation, may facilitate timely risk stratification, closer monitoring, and appropriate supportive management.

This study has several limitations. First, it was conducted at a single tertiary care center with a relatively small sample size, which may limit the generalizability of the findings. Second, only male participants were included to minimize gender-related confounding, limiting the applicability of the results to females. Third, the use of convenience sampling may have introduced selection bias. Finally, inflammatory biomarkers and serum cholinesterase levels were not evaluated, which may have provided additional insights into disease severity and prognosis. Future multicenter studies with larger, more diverse populations and comprehensive biomarker assessment are warranted to validate and extend these findings.

CONCLUSION

Organophosphorus poisoning is associated with significant hematological alterations, which are more pronounced in patients with chronic alcohol or benzodiazepine addiction. Addicted individuals demonstrated lower hemoglobin and hematocrit levels and higher leukocyte and neutrophil counts than non-addicted patients, suggesting that substance addiction may exacerbate the hematological effects of organophosphorus poisoning. These findings highlight the importance of obtaining an addiction history and performing routine hematological assessment for risk stratification and clinical management. Further multicenter prospective studies involving larger and more diverse populations, with evaluation of serum cholinesterase, inflammatory and oxidative stress biomarkers, and long-term clinical outcomes, are needed to validate these findings and better understand the underlying pathophysiological mechanisms.

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AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

SFD: Conception and study design, acquisition, analysis and interpretation of data, drafting the manuscript, approval of the final version to be published

JW: Acquisition, analysis and interpretation of data, critical review, approval of the final version to be published

Authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICT OF INTEREST

Authors declared no conflict of interest, whether financial or otherwise, that could influence the integrity, objectivity, or validity of their research work.

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DATA SHARING STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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