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Correlation of Serum Amylase and Serum Lipase Levels with Clinical Outcome in Acute Organophosphorus Poisoning

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ABSTRACT

Background: *Organophosphorus (OP) compounds, widely utilized as agricultural pesticides, are a major global cause of poisoning, particularly in developing nations. Their toxicity stems from irreversible inhibition of acetylcholinesterase, leading to excessive cholinergic stimulation and high morbidity and mortality. While plasma cholinesterase remains the diagnostic gold standard, its practical limitations highlight the need for alternative prognostic markers. This study investigates the utility of serum amylase and serum lipase in this context.*

Objectives: *The primary objective was to correlate the clinical severity of OP poisoning with serum amylase and serum lipase levels. Secondary objectives included assessing their association with complications, duration of hospital and ICU stays, and mortality rates.*

Methods: *This was a cross-sectional study conducted over 18 months at Adichuchanagiri Hospital and Research Centre. A total of 138 patients with acute OP poisoning were enrolled. The severity of poisoning was classified as mild, moderate, or severe using the Peradeniya Organophosphorus Poisoning (POP) scale. Serum amylase and lipase levels, along with other routine laboratory investigations, were measured. Statistical analysis was performed using SPSS version 26, with a p-value of < 0.05 considered significant.*

Results: *The study population was predominantly male (74.64%), with a high incidence of intentional poisoning (87.68%). Methyl parathion was the most common ingested compound (44.93%). Moderate poisoning was observed in 64.49% of patients, and severe cases in 23.19%. Statistically significant associations were found between elevated serum amylase and lipase levels and severe poisoning ($p < 0.05$), prolonged ICU stay, and higher mortality rates.*

Conclusion: *Serum amylase and serum lipase are valuable and easily accessible prognostic markers for acute OP poisoning. Their elevated levels correlate significantly with increased disease severity, prolonged hospitalization, and higher mortality. The routine estimation of these enzymes can aid in early risk stratification, facilitating timely and targeted clinical management to improve patient outcomes.*

Key words: *Organophosphorus poisoning, Serum amylase, Serum lipase, Prognostic markers, Mortality*

INTRODUCTION

Organophosphorus (OP) compounds, widely used as pesticides in agriculture, are a significant cause of poisoning globally, especially in developing nations like India, Nepal, and Bangladesh. [1] The high morbidity and mortality associated with OP poisoning are often due to a lack of awareness and delayed medical intervention. [2] The toxicity of these compounds stems from their irreversible inhibition of acetylcholinesterase, an enzyme crucial for breaking down acetylcholine at neuromuscular junctions and nerve endings. This leads to excessive cholinergic stimulation, manifesting in muscarinic, nicotinic, and central nervous system effects. [3]

While clinical scales and plasma cholinesterase levels are used to assess the severity of OP poisoning, their reliability is often limited. [4] Recent research suggests that serum amylase and serum lipase may serve as valuable prognostic markers. [5] Several studies have shown a strong correlation between elevated serum amylase levels and the severity of OP poisoning, likely a result of pancreatic injury from cholinergic overstimulation. [6] High serum amylase levels have been linked to increased rates of respiratory failure, longer ICU stays, and higher mortality. [7]

Although serum lipase is also elevated in these cases, its primary value lies in identifying patients at risk of acute pancreatitis, a known complication of OP poisoning. [8] Despite growing evidence, the routine clinical use of these enzymes remains limited, with most studies focusing predominantly on serum amylase. [9] Given the severe outcomes of OP poisoning, the early identification of high-risk patients through a combined evaluation of serum amylase and lipase could significantly improve timely intervention and patient outcomes. [10] This study aims to assess the prognostic significance of these two enzymes in acute OP poisoning, exploring their correlation with disease severity, complications, duration of hospitalization, and mortality.

AIM AND OBJECTIVES

- To establish a correlation between the clinical severity of acute OP poisoning and the initial serum amylase and serum lipase levels.
- To assess the relationship between serum amylase and serum lipase levels and key clinical outcomes, including the development of complications, the duration of hospitalization, and the necessity for ICU admission.
- To determine the mortality rate among the study population and correlate it with fluctuations in serum amylase and serum lipase levels, thereby evaluating their prognostic significance.

MATERIALS AND METHODS

This study was a cross-sectional investigation conducted over 18 months, from May 2023 to November 2024, at the Department of General Medicine, Adichuchanagiri Hospital and Research Centre in B.G. Nagara, Nagamangala Taluk, Mandya District, India. The study was approved by the Institutional Ethics Committee, and all procedures were performed in accordance with ethical guidelines. Written informed consent was obtained from all participants or their legally authorized representatives prior to their enrollment.

Study Population and Sample Size

The study population consisted of patients admitted to the hospital with a confirmed diagnosis of acute organophosphorus (OP) poisoning. The sample size was determined using the formula for cross-sectional studies, taking into account the incidence of OP poisoning in similar populations, estimated at 41% based on previous literature. The formula used for calculation was:

$n=d2[z(\alpha/2)]2Pq(D)$

Where:

- **n** = required sample size
- **P** = assumed incidence of OP poisoning (41%)
- **q** = 100 - P
- **d** = allowable error, set at 20% of the incidence (relative precision)
- **$z(\alpha/2)$** = the critical value at a 95% confidence level, which is 1.96
- **D** = Design effect, which was considered to be 1 for this study

Using this formula, the minimum required sample size was calculated to be 138 patients.

A total of 138 patients were recruited based on strict inclusion and exclusion criteria to ensure a homogenous study group.

Inclusion Criteria:

- Patients aged 18 years or older.
- Patients with a clear history of exposure to OP compounds, confirmed by self-report, a relative's account, or documentation from the referring physician.
- The presence of characteristic clinical manifestations and physical evidence of the poison compound.

Exclusion Criteria:

- Patients with a history of chronic alcoholism or other forms of hepatic dysfunction.
- Patients with known pancreatic or biliary diseases, such as gallstones or pancreatitis of a different etiology.
- Pregnant patients, as hormonal and physiological changes could affect biochemical markers.
- Patients with coagulopathies, bleeding diathesis, or those on anticoagulant therapy.
- Patients with pre-existing end-organ failure, as this could confound the assessment of poisoning-related complications.
- Patients with associated major trauma, which could independently alter laboratory values.

- Patients with a history of using drugs known to induce pancreatitis, including but not limited to azathioprine, 6-mercaptopurine, and thiazides.

Data Collection and Methodology

Data were collected using a structured proforma designed to capture comprehensive patient information. After obtaining informed consent, a detailed history was taken, including demographic details, presenting complaints, and the history of the poisoning incident. This was followed by a thorough clinical examination.

All enrolled patients underwent a standardized set of laboratory and radiological investigations upon admission. These included **Serum Lipase** and **Serum Amylase** levels, which were the primary biochemical markers of interest. Additionally, a **Complete Blood Count (CBC)**, **Arterial Blood Gases (ABG)**, and **Renal Function Tests** (Blood Urea, Serum Creatinine, and Serum Electrolytes) were performed. All patients also received an **Electrocardiogram (ECG)** and a **Chest X-ray**. Any other relevant investigations were conducted as deemed necessary by the treating physician.

The severity of OP poisoning was assessed using established clinical criteria and then stratified into **mild**, **moderate**, and **severe** categories. The primary objective was to correlate these clinical severity categories with the measured serum amylase and serum lipase levels. The study also aimed to analyze the relationship between these enzyme levels and key clinical outcomes, including the occurrence of complications, the duration of hospital stay, the need for Intensive Care Unit (ICU) admission, and patient mortality. This study did not involve any animal experiments.

STATISTICAL ANALYSIS

All collected data were entered into a Microsoft Excel spreadsheet and subsequently analyzed using SPSS version 26. **Descriptive statistics** were used to summarize the data. Categorical variables were presented as frequencies and percentages, while continuous variables were expressed as the mean and standard deviation.

To assess the relationships between variables, appropriate inferential statistical tests were employed. The **independent samples t-test** was used to compare the means of continuous variables between two groups. For comparisons involving more than two groups, a **one-way analysis of variance (ANOVA)** was performed. A **p-value of < 0.05** was considered to be statistically significant for all analyses.

RESULTS

Table: Age Distribution of Participants

Age	Frequency	Percentage
20–30 years	21	15.22
31–40 years	43	31.16
41–50 years	40	28.99
51–60 years	32	23.19
> 60 years	2	1.45
Total	138	100.00

The majority of participants in the study were between 31–40 years (31.16%), followed closely by those aged 41–50 years (28.99%) and 51–60 years (23.19%). A smaller proportion of participants were in the 20–30 years age group (15.22%), while only 1.45% were older than 60 years. This distribution indicates that most individuals in the study were middle-aged, with fewer younger and elderly participants.

Figure: Pie chart showing Age Distribution of Participants

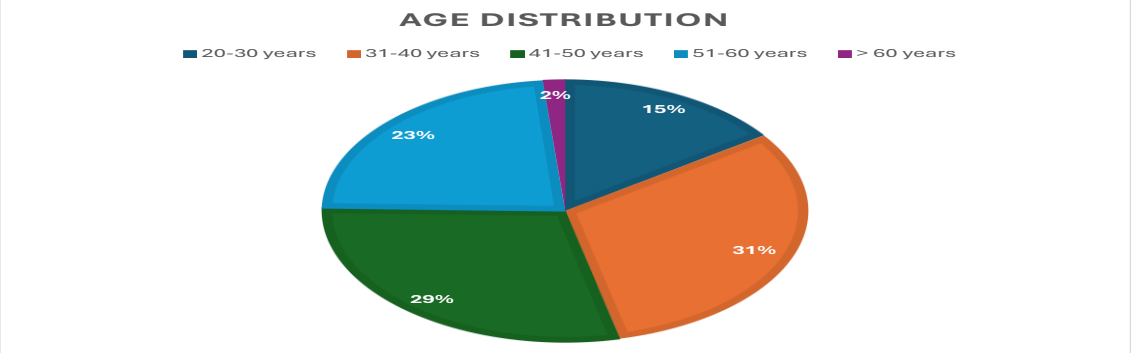

Table: Agent Consumed Among Participants

Agent Consumed	Frequency	Percentage
Methyl parathion	62	44.93
Chlorpyrifos	20	14.49
Bug killer liquid	15	10.87
Monocrotophos	15	10.87
Dichlorofos	14	10.14
Quinalphos	10	7.25
Fenthion	2	1.45

Methyl parathion was the most commonly consumed agent (44.93%), followed by chlorpyrifos (14.49%). Bug killer liquid and monocrotophos were each consumed by 10.87% of participants, while dichlorvos accounted for 10.14%. Quinalphos was used by 7.25% of cases, and fenthion was the least common agent (1.45%). This distribution highlights that methyl parathion was the predominant toxic agent in the study population.

Figure: Bar chart showing Agent Consumed Among Participants

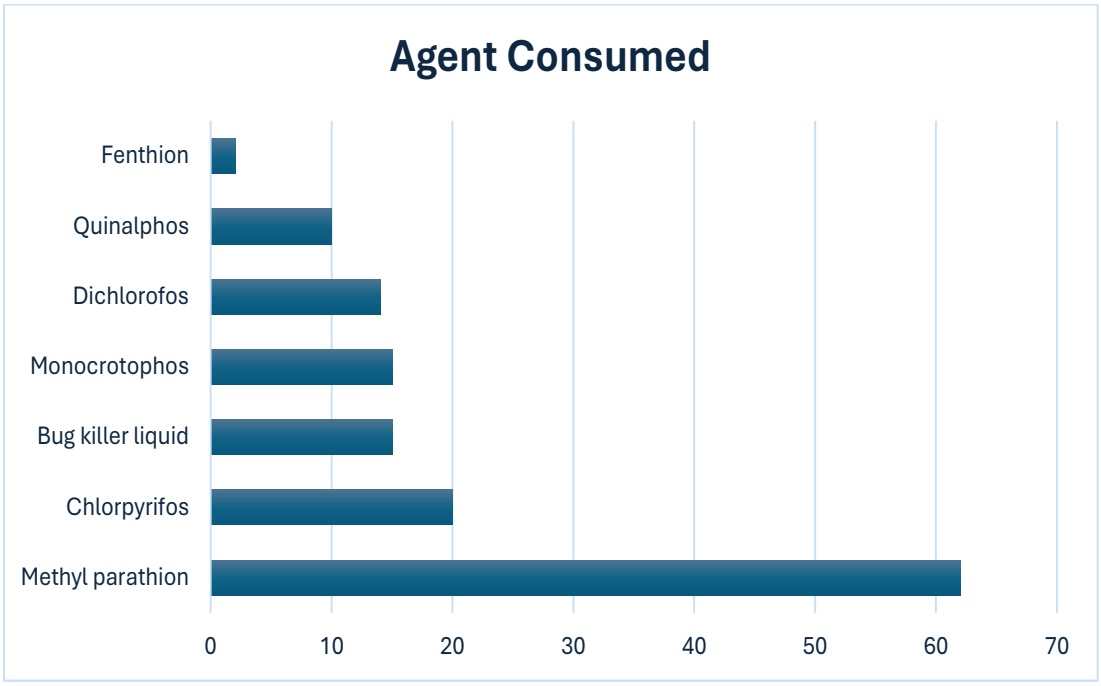

Table: Clinical Symptoms Among Participants

Symptoms	Frequency	Percentage
Vomiting	78	56.52
Miosis	83	60.14
Bradycardia	89	64.49
Increased Salivation	70	50.72
Sweating	71	51.45
Altered Sensorium	30	21.74
Tachypnoea	63	45.65
Muscle Fasciculation	42	30.43

The most frequently observed symptom was bradycardia (64.49%), followed by miosis (60.14%) and vomiting (56.52%). Increased salivation (50.72%) and sweating (51.45%) were also common. Tachypnoea was noted in 45.65% of cases, while muscle fasciculation occurred in 30.43%. Altered sensorium was observed in 21.74% of participants, indicating that neurological impairment was less frequent compared to other systemic symptoms.

Figure: Bar chart showing Clinical Symptoms Among Participants

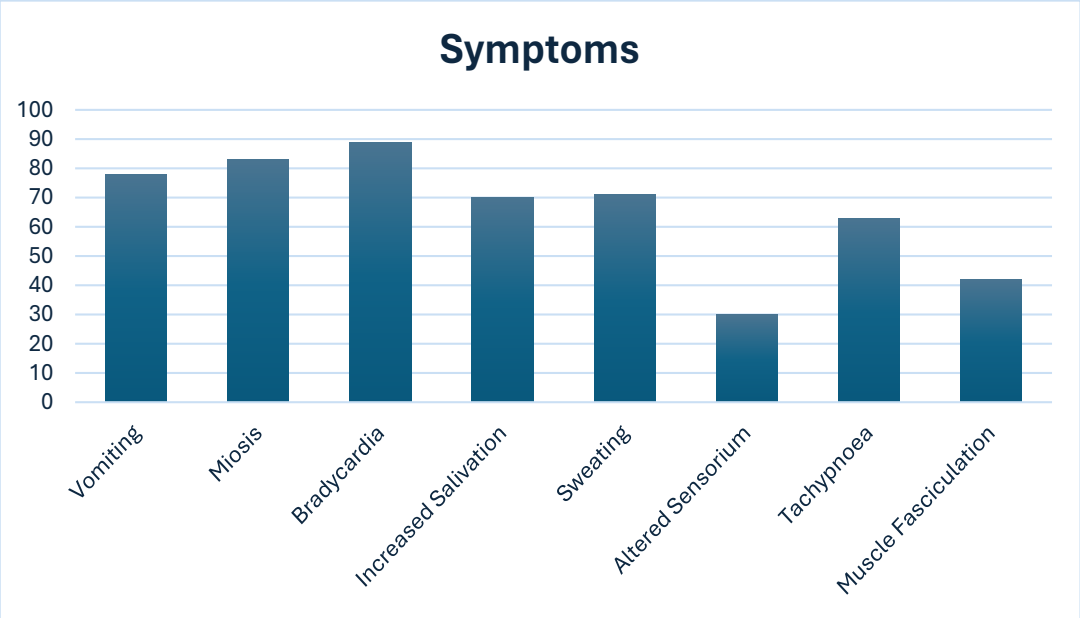

Table: Severity of Poisoning Among Participants

POP Status	Frequency	Percentage
Mild	17	12.32
Moderate	89	64.49
Severe	32	23.19

The majority of participants (64.49%) experienced moderate poisoning, while 23.19% had severe poisoning. Mild cases accounted for 12.32% of the study population. This distribution indicates that most cases fell within the moderate severity range, with a significant proportion experiencing severe effects.

Figure: Bar chart showing Severity of Poisoning Among Participants

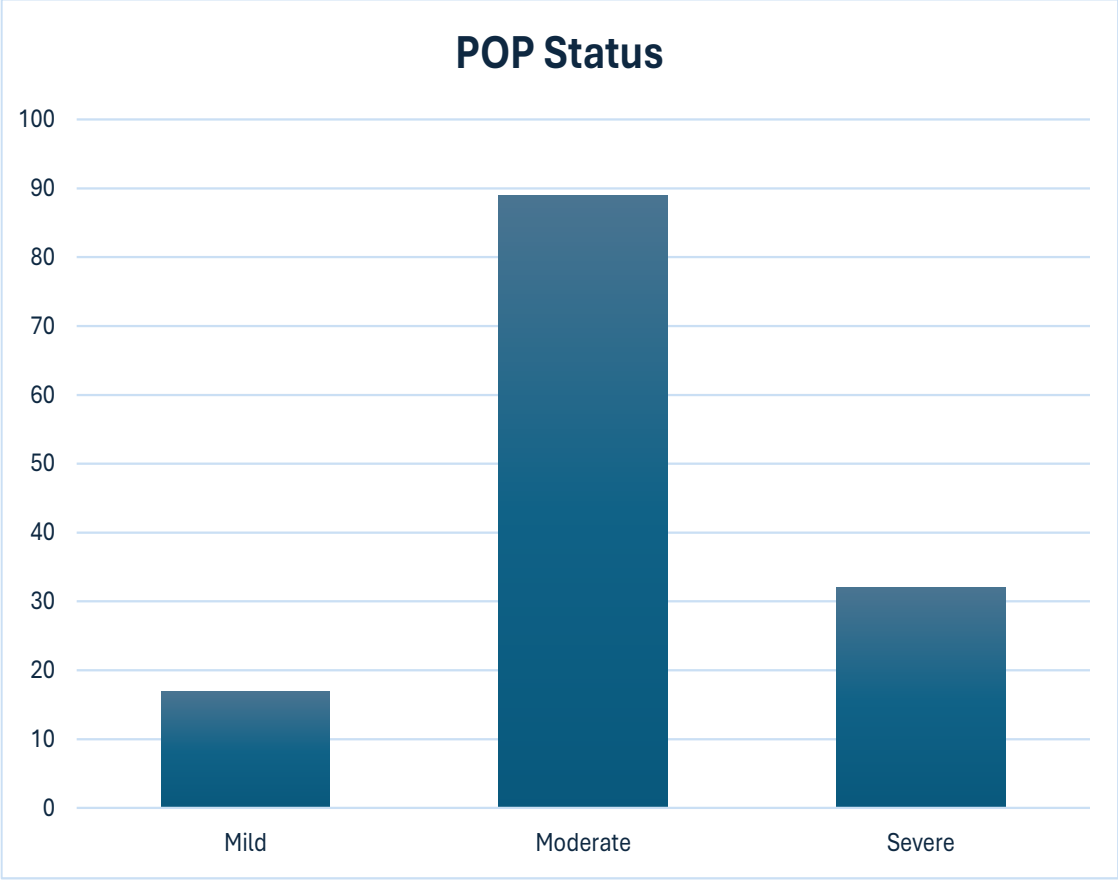

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Table: Laboratory Parameters Among Participants

Lab Parameters	Mean	SD
Haemoglobin	12.43	1.21
WBC (*100)	105.22	24.94
Platelets (*1000)	197.92	21.29
S. Lipase	344.91	176.58
S. Amylase	144.94	102.65

The mean hemoglobin level was 12.43 ± 1.21 g/dL, while the mean WBC count was 10,522 ± 2,494 cells/mm³. Platelet levels averaged 197.92 ± 21.29 × 10³/mm³. Serum lipase had a mean value of 344.91 ± 176.58 U/L, and serum amylase was 144.94 ± 102.65 U/L. These findings indicate variations in hematological and biochemical parameters, with notable elevations in serum lipase and amylase levels.

Figure: Bar chart showing Laboratory Parameters Among Participants

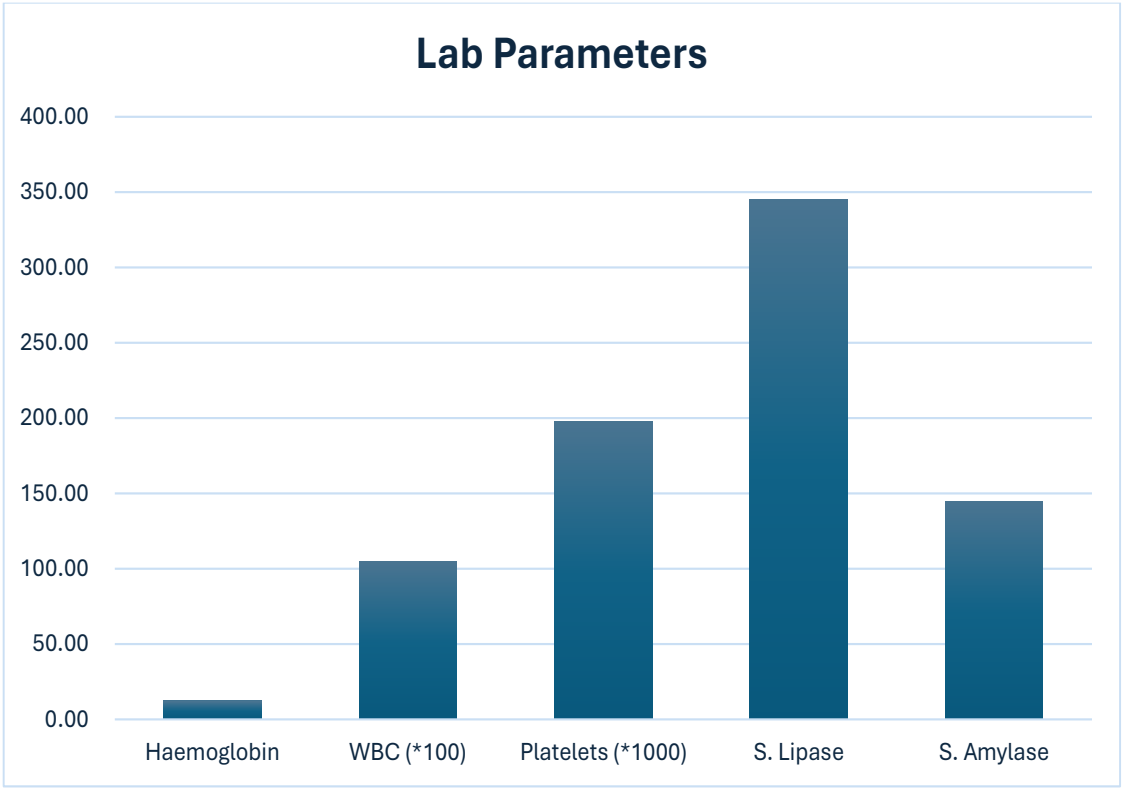

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Table: Requirement for Ventilatory Support

Ventilatory Support	Frequency	Percentage
Yes	32	23.19
No	109	78.99

A majority of participants (78.99%) did not require ventilatory support, while 23.19% needed mechanical ventilation. This indicates that while most cases were managed without respiratory assistance, a significant proportion experienced severe toxicity necessitating ventilatory support.

Figure: Pie chart showing Requirement for Ventilatory Support

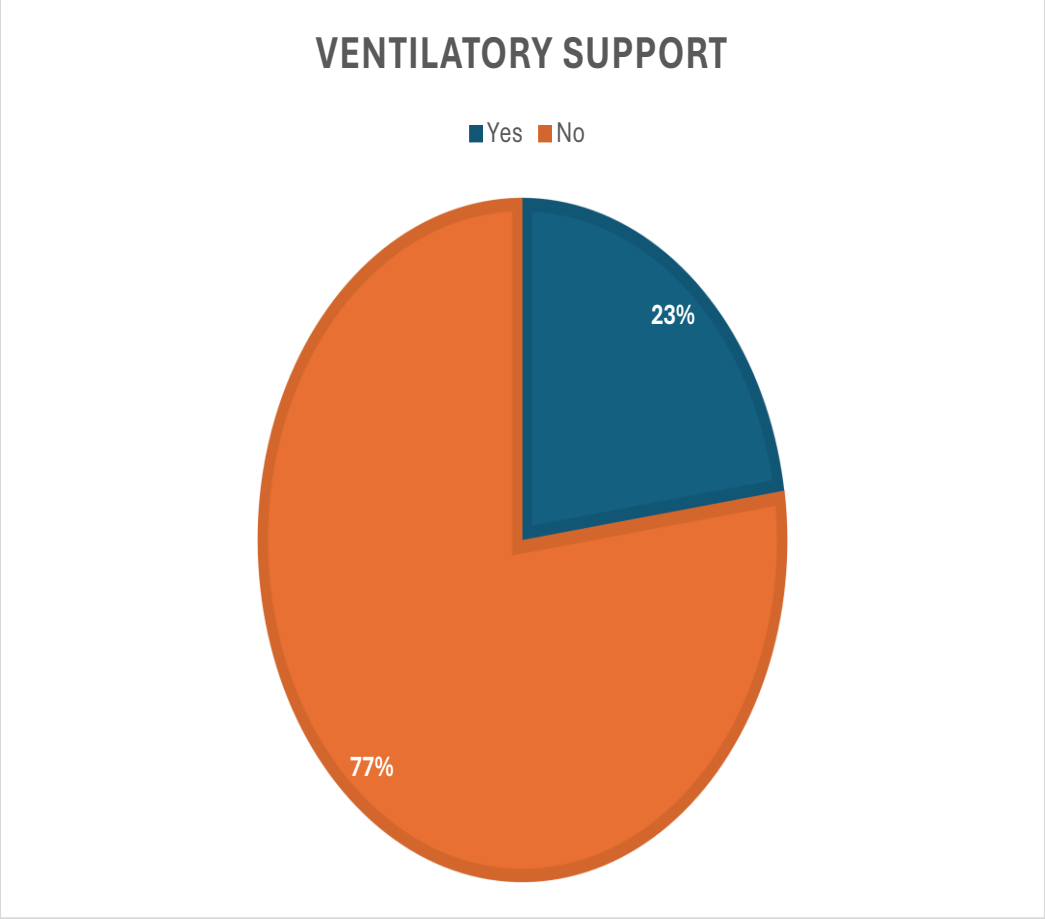

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Table: Outcome of Participants

Outcome	Frequency	Percentage
Death	21	15.22
Survived	117	84.78

The majority of participants (84.78%) survived, while 15.22% unfortunately succumbed to the condition. This suggests that most individuals in the study managed to recover, though a notable proportion experienced fatal outcomes.

Figure: Pie chart showing Outcome of Participants

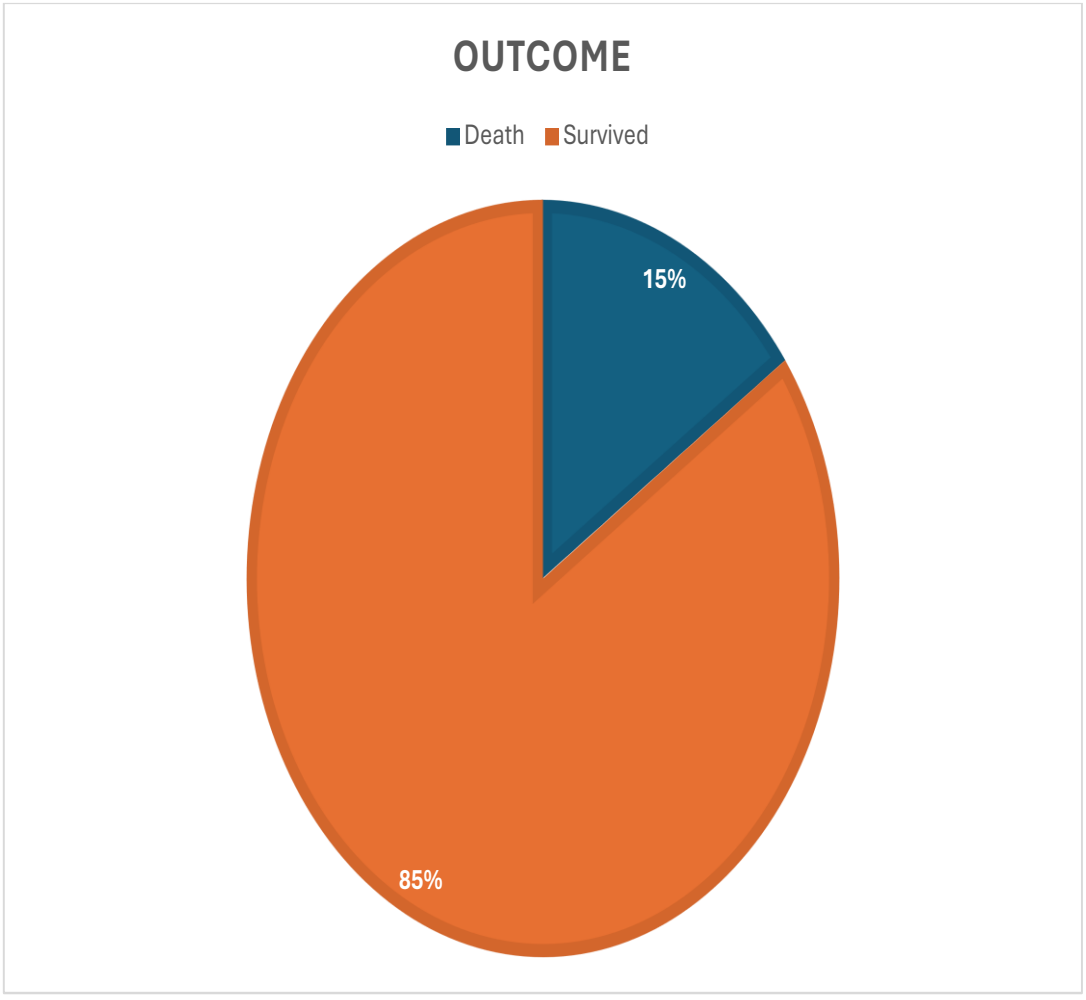

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Table: Association Between Serum Amylase Levels and Outcome

S. Amylase	Outcome	
	Death	Survived
Mean	290.48	118.82
SD	155.76	59.92
p-value	< 0.0001	

Participants who died had a significantly higher mean serum amylase level (290.48 ± 155.76 U/L) compared to those who survived (118.82 ± 59.92 U/L). The p-value of < 0.0001 indicates a statistically significant association between elevated serum amylase levels and mortality. This suggests that higher amylase levels may be a predictor of poor outcomes in this population.

Figure: Bar chart showing Association Between Serum Amylase Levels and Outcome

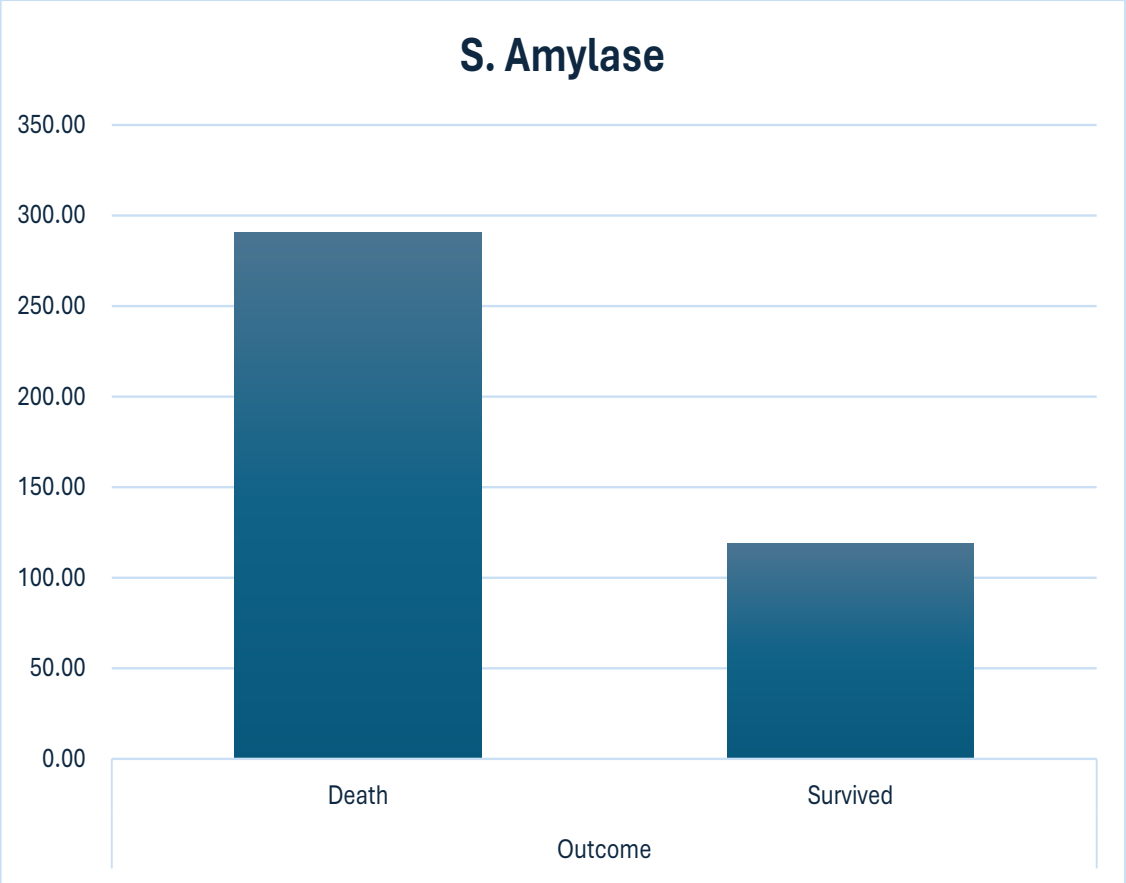

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Table: Association Between Serum Lipase Levels and Outcome

S. Lipase	Outcome	
	Death	Survived
Mean	625.48	294.55
SD	187.01	117.62
p-value	< 0.0001	

Participants who died had a significantly higher mean serum lipase level (625.48 ± 187.01 U/L) compared to those who survived (294.55 ± 117.62 U/L). The p-value of < 0.0001 indicates a statistically significant relationship between elevated serum lipase levels and mortality. This suggests that higher serum lipase levels are associated with a worse prognosis in this population.

Figure: Bar chart showing Association Between Serum Lipase Levels and Outcome

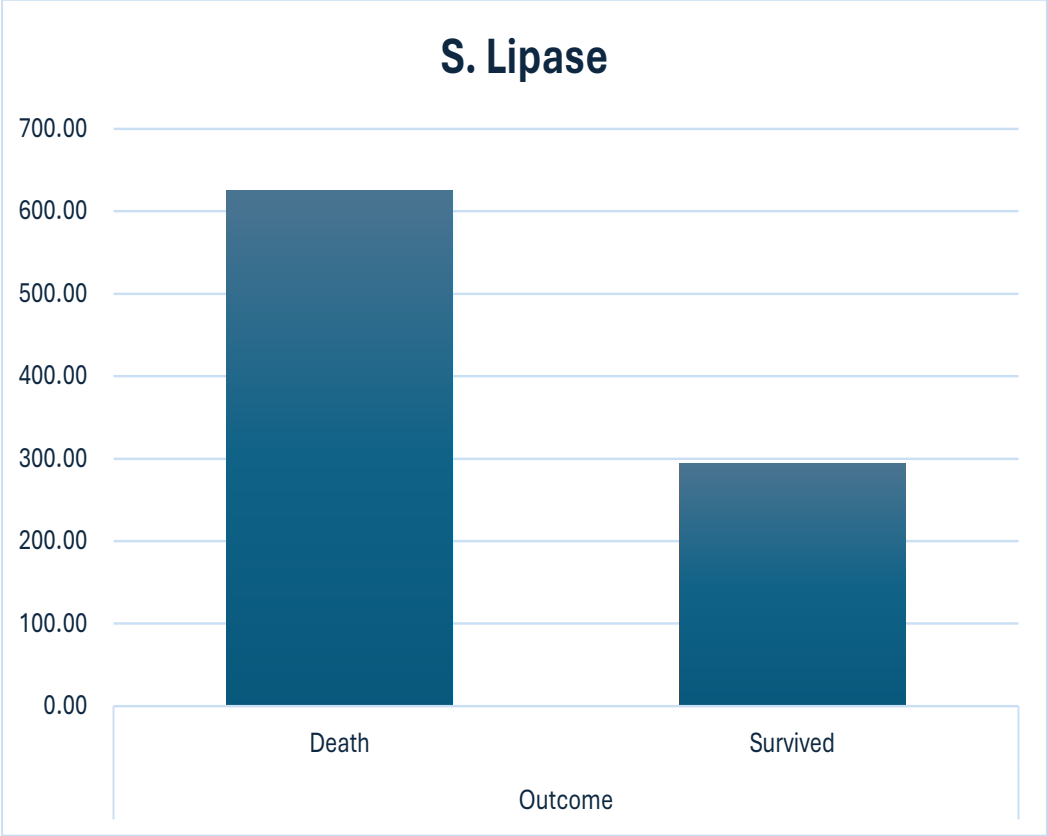

Table: Association Between Serum Amylase Levels and Ventilatory Support

S. Amylase	Ventilatory Support	
	Yes	No
Mean	265.34	108.59
SD	137.29	48.27
p-value	< 0.0001	

Participants who required ventilatory support had a significantly higher mean serum amylase level (265.34 ± 137.29 U/L) compared to those who did not require ventilatory support (108.59 ± 48.27 U/L). The p-value of < 0.0001 indicates a statistically significant association between elevated serum amylase levels and the need for ventilatory support. This suggests that higher serum amylase levels may be an indicator of more severe toxicity, requiring respiratory assistance.

Figure: Bar chart showing Association Between Serum Amylase Levels and Ventilatory Support

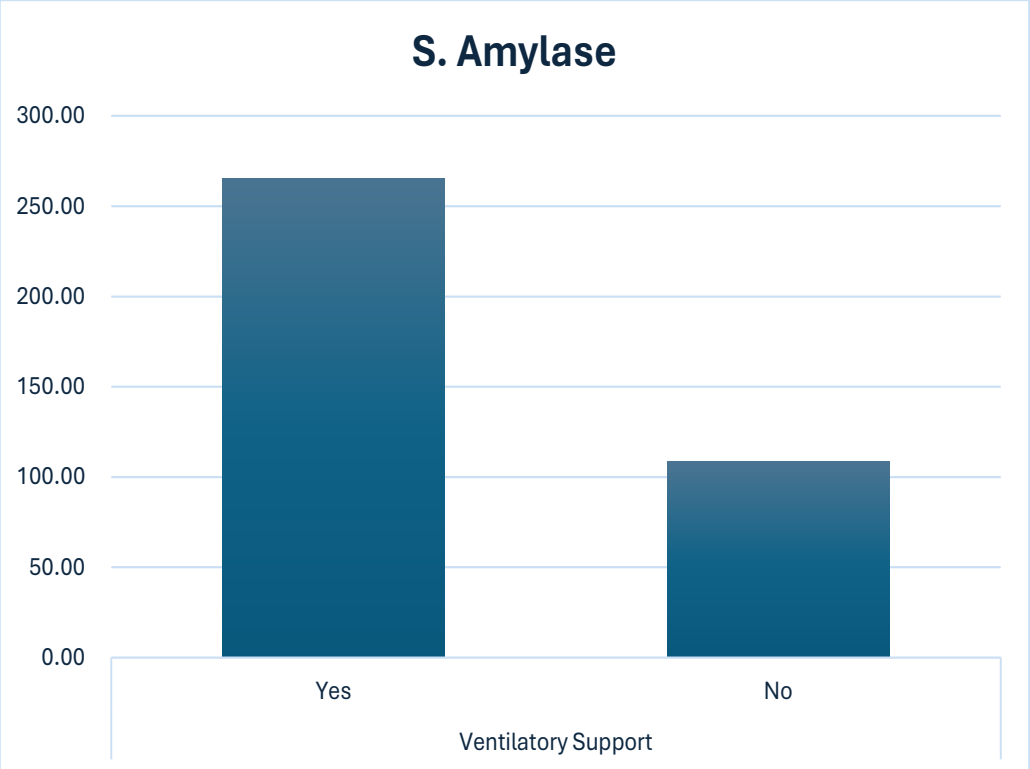

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Table: Association Between Serum Lipase Levels and Ventilatory Support

S. Lipase	Ventilatory Support	
	Yes	No
Mean	574.69	275.54
SD	174.50	103.19
p-value	< 0.0001	

Participants who required ventilatory support had a significantly higher mean serum lipase level (574.69 ± 174.50 U/L) compared to those who did not require ventilatory support (275.54 ± 103.19 U/L). The p-value of < 0.0001 indicates a statistically significant relationship between elevated serum lipase levels and the need for ventilatory support. This suggests that higher serum lipase levels may be associated with more severe cases requiring respiratory intervention.

Figure: Bar chart showing Association Between Serum Lipase Levels and Ventilatory Support

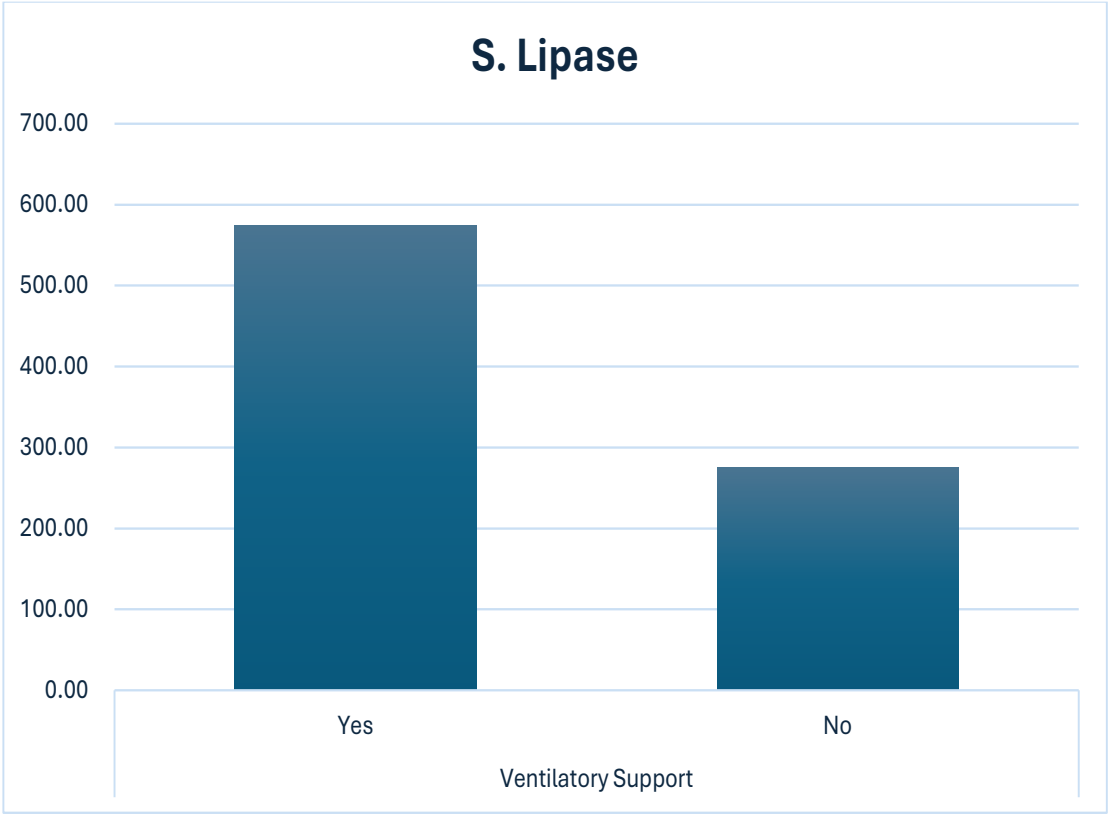

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Table: Association Between Serum Amylase Levels and Severity of Poisoning (POP Status)

S. Amylase	POP Status		
	Mild	Moderate	Severe
Mean	96.71	126.15	222.84
SD	45.97	68.06	152.15
p-value	< 0.0001		

Participants with severe poisoning had a significantly higher mean serum amylase level (222.84 ± 152.15 U/L) compared to those with moderate (126.15 ± 68.06 U/L) and mild poisoning (96.71 ± 45.97 U/L). The p-value of < 0.0001 indicates a statistically significant association between increased serum amylase levels and the severity of poisoning. This suggests that higher serum amylase levels are linked to more severe cases of poisoning.

Figure: Bar chart showing Association Between Serum Amylase Levels and Severity of Poisoning (POP Status)

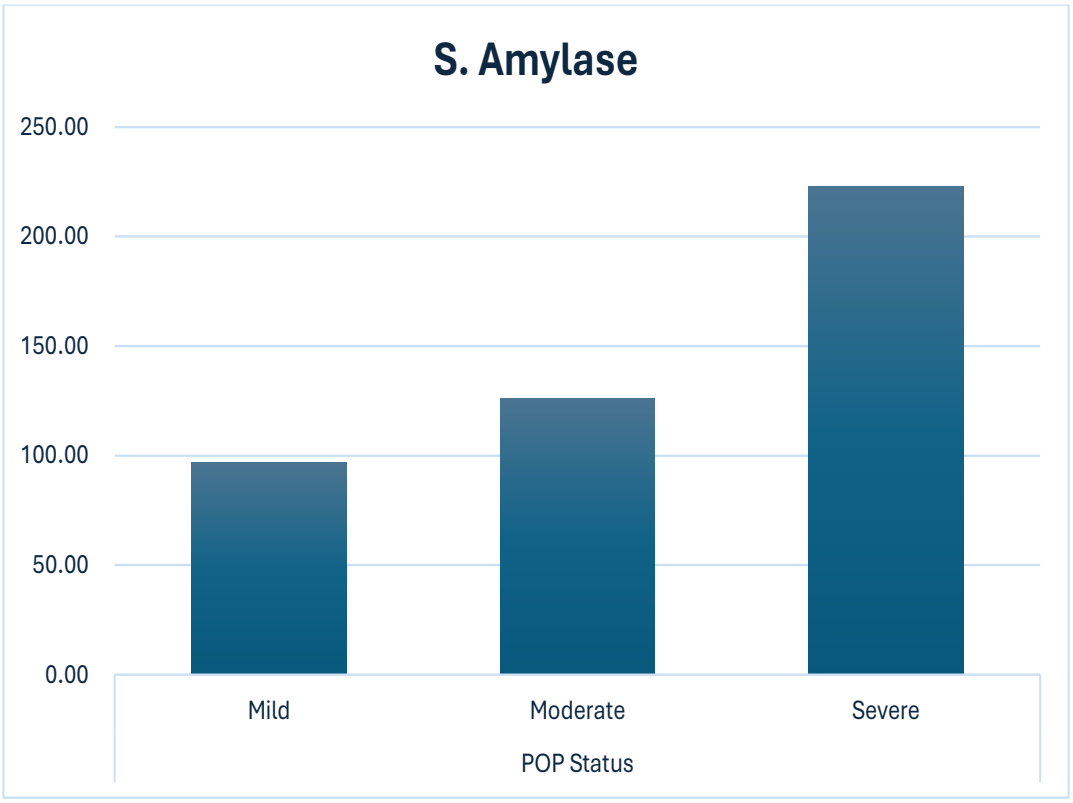
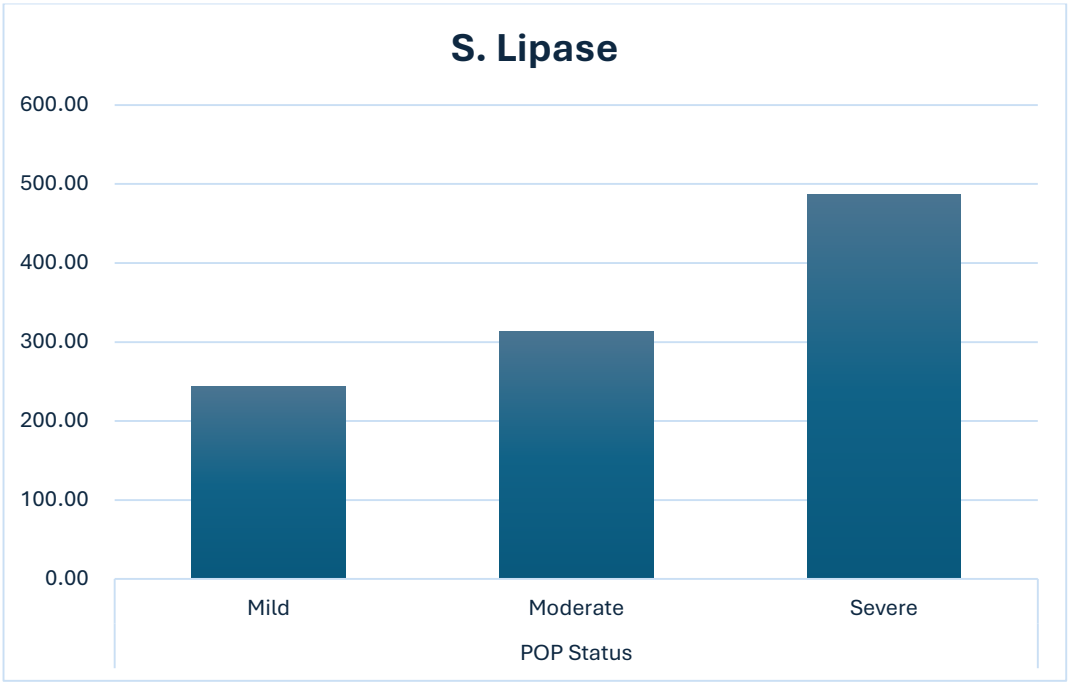


Table: Association Between Serum Lipase Levels and Severity of Poisoning (POP Status)

S. Lipase	POP Status		
	Mild	Moderate	Severe
Mean	243.76	313.18	486.88
SD	98.04	133.57	226.60
p-value	< 0.0001		

Participants with severe poisoning had a significantly higher mean serum lipase level (486.88 ± 226.60 U/L) compared to those with moderate (313.18 ± 133.57 U/L) and mild poisoning (243.76 ± 98.04 U/L). The p-value of < 0.0001 indicates a statistically significant relationship between elevated serum lipase levels and the severity of poisoning. This suggests that higher serum lipase levels are associated with more severe cases of poisoning.

Figure: Bar chart showing Association Between Serum Lipase Levels and Severity of Poisoning (POP Status)



DISCUSSION

This study aimed to evaluate the prognostic significance of serum amylase and serum lipase in acute organophosphorus compound (OPC) poisoning, a common medical emergency in developing nations. Our findings underscore the critical utility of these enzymes as reliable biomarkers for disease severity and patient outcomes.

The demographic analysis revealed a **predominance of middle-aged individuals (31-40 years)**, consistent with other studies in the region. This trend suggests that this age group may be particularly vulnerable to poisoning incidents, likely due to a combination of occupational exposure and psychosocial factors. Furthermore, the **male predominance (74.64%)** observed in our cohort aligns with several other studies,

though some literature reports a more balanced gender distribution or even female predominance, suggesting that gender-based differences may vary by region and cultural context.

Clinically, **bradycardia (64.49%), miosis (60.14%), and vomiting (56.52%)** were the most frequent symptoms. The high prevalence of **moderate (64.49%) and severe (23.19%) poisoning** in our cohort, as classified by the Peradeniya Organophosphorus Poisoning (POP) scale, highlights the critical nature of cases presenting to tertiary care centers. This contrasts with some studies that report a higher incidence of mild cases, likely reflecting variations in the time to presentation and the quantity of poison consumed.

Our laboratory findings demonstrated a significant elevation in both **serum lipase (mean 344.91 ± 176.58 U/L) and serum amylase (mean 144.94 ± 102.65 U/L)**. The hyperamylasemia and hyperlipasemia observed are likely due to the direct cholinergic stimulation of the pancreas by OP compounds, which can lead to pancreatic injury or acute pancreatitis.

A key finding of this study is the strong and statistically significant association between elevated serum enzyme levels and poor patient outcomes. The mean serum amylase and lipase levels were **markedly higher in non-survivors (amylase: 290.48 ± 155.76 U/L; lipase: 625.48 ± 187.01 U/L)** compared to survivors, with a p-value of <0.0001, confirming their prognostic value. These results are consistent with similar findings in the literature, which have also reported higher mean enzyme levels in deceased patients.

Furthermore, our data show that increasing enzyme levels are directly correlated with poisoning severity. Patients with severe poisoning had **significantly higher mean serum amylase (222.84 ± 152.15 U/L) and lipase (486.88 ± 226.60 U/L)** compared to those with moderate or mild poisoning ($p < 0.0001$). This confirms that these enzymes can serve as objective biomarkers for assessing disease severity.

The need for ventilatory support, a crucial indicator of severe respiratory compromise, was also strongly associated with elevated enzyme levels. Patients requiring mechanical ventilation had **significantly higher mean serum amylase (265.34 ± 137.29 U/L) and lipase (574.69 ± 174.50 U/L)**, further reinforcing their utility in identifying high-risk patients. Our findings are in agreement with other studies that have highlighted the predictive value of elevated amylase for respiratory support requirements.

CONCLUSION

The study highlights the concerning prevalence of intentional poisoning. Clinical manifestations suggest that early identification of severe cases is crucial and serum amylase levels and serum lipase levels are a reliable indicator of organophosphorus intoxication because they allow for early detection of the condition's severity and the identification of people who are most likely to experience its complications. The high mortality rate among those with elevated enzyme levels indicates that targeted early interventions, including intensive monitoring and timely ventilatory support, could significantly improve patient outcomes. Strengthening mental health support systems, implementing preventive strategies, and ensuring rapid medical response are essential to reducing poisoning-related morbidity and mortality.

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