



ASSESSMENT OF SERUM ALKALINE PHOSPHATASE IN PATIENTS DIAGNOSED WITH METABOLIC SYNDROME

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Abstract

Introduction: Metabolic syndrome (MetS) is a cluster of interrelated metabolic abnormalities, including central obesity, elevated blood pressure, hyperglycaemia, and dyslipidaemia. Together, these conditions substantially increase the risk of developing cardiovascular disease and type 2 diabetes mellitus. Serum alkaline phosphatase (ALP), an enzyme primarily derived from the liver and bones, is commonly assessed as part of routine liver function testing. However, emerging evidence indicates that elevated ALP levels may also be associated with metabolic disturbances and an increased risk of cardiovascular complications.

Methods: This study included 80 individuals aged 18–50 years. They were divided into two groups. Group 1 (40 patients) had MetS based on ATP III guidelines. Group 2 (40 healthy volunteers) were matched by age and gender. Blood samples were collected from all participants, and serum ALP levels were measured using standard laboratory methods. The difference between the two groups was analyzed using an unpaired t-test.

Results: People with metabolic syndrome had higher ALP levels (124.15 ± 61.47 U/L) compared to the healthy group (88.97 ± 24.69 U/L). This difference was statistically significant ($p < 0.05$).

Conclusion: Serum ALP levels were elevated in individuals with metabolic syndrome, indicating a potential association between ALP and underlying metabolic alterations as well as increased health risks. Further research is required to clarify the mechanisms responsible for the rise in ALP levels in these patients.

Keywords: Metabolic syndrome (MetS), Serum alkaline phosphatase (ALP), Cardiometabolic risk, Biomarker, Insulin resistance, Inflammation

INTRODUCTION:

Metabolic syndrome (MetS) is increasing rapidly across the world, emerging as a major public health concern. This rise is primarily attributed to rapid urbanization, increased consumption of high-calorie

processed foods, reduced physical activity and the growing prevalence of obesity, all of which are closely linked to modern sedentary lifestyles.¹

MetS consists of a cluster of interrelated metabolic abnormalities that together elevate the risk of cardiovascular disease, type 2 diabetes mellitus and premature mortality. The principal components of MetS include insulin resistance, central obesity, elevated blood pressure, dyslipidaemia and chronic low-grade inflammation. These factors do not occur in isolation; rather, they interact in a complex manner, creating a harmful metabolic environment that predisposes individuals to long-term complications.^{2,3}

The global prevalence of MetS shows considerable variation, ranging from less than 10% to over 80%, depending on factors such as geographic region, demographic characteristics and the diagnostic criteria applied. In India, several population-based studies report a prevalence of 10–30%, with rates notably higher in urban settings compared to rural areas. Furthermore, the likelihood of developing MetS increases significantly with age, with particularly high rates observed among individuals above 50 years.⁴⁻⁶

Chronic inflammation, oxidative stress and hormonal imbalance play central and interconnected roles in the development of MetS. Persistent low-grade inflammation contributes to insulin resistance, alters lipid metabolism and promotes endothelial dysfunction, all of which accelerate the progression of metabolic abnormalities. Oxidative stress further aggravates this process by damaging cellular components, impairing insulin signalling and increasing the risk of vascular injury. In addition, disturbances in hormonal regulation such as altered levels of adipokines, cortisol and thyroid hormones affect appetite control, fat distribution, glucose homeostasis and energy expenditure. Together, these mechanisms create a cycle of metabolic disruption that drives the onset and progression of MetS.^{7,8}

Serum alkaline phosphatase (ALP) is an important enzyme predominantly present in the bone, liver and intestine, where it plays a key role in various metabolic and physiological processes. Elevated ALP levels are traditionally associated with liver or bone disorders; however, recent evidence suggests that its significance extends far beyond these organs. Several studies have demonstrated that higher ALP concentrations are linked to an increased risk of mortality in the general population. This association has also been observed in patients with cardiovascular conditions, including those with established heart disease.⁹

Additionally, elevated ALP has shown a strong relationship with poor outcomes in individuals with chronic kidney disease, both in early stages and in patients undergoing long-term hemodialysis.¹⁰⁻¹⁴ Beyond metabolic and renal disorders, raised ALP levels have been reported in various malignancies, such as metastatic neuroendocrine tumours¹⁵, metastatic prostate cancer¹⁶ and advanced renal cell carcinoma¹⁷, where it often serves as a marker of disease burden and progression. These findings suggest that ALP may reflect broader systemic alterations related to inflammation, oxidative stress, vascular calcification and tumour activity, making it a potentially valuable biomarker across diverse clinical settings. Some studies also report higher ALP levels in people with MetS.^{18,19}

Considering the emerging evidence linking ALP with metabolic disturbances and cardiometabolic risk, the present study aims to compare serum ALP levels in individuals with MetS and healthy controls to better understand its potential role as a metabolic biomarker.

MATERIALS AND METHODS:

The present study was conducted at the Department of Biochemistry in collaboration with the Department of Medicine. Metabolic syndrome is diagnosed as defined by the Adult Treatment Panel (ATP) III criteria. Patients clinically diagnosed cases of MetS have been included in the study.

Table 1— Adult Treatment Panel (ATP) III criteria

Central Obesity	WC Male: ≥ 102 cm Female: ≥ 88 cm
FBS	≥ 100 mg/dL or Rx
$\uparrow$ TG	≥ 150 mg/dL or Rx
$\downarrow$ HDL-C	Male: < 40 mg/dL Females: < 50 mg/dL
$\uparrow$ BP	Diastolic ≥ 130 and/or systolic ≥ 85 mmHg or Rx
Other	
Diagnosed as MetS, If	≥ 3 criteria

The study population will include 80 subjects of age group between 18-50 years and will be divided into two group. Group 1 (cases, n=40): Patients clinically diagnosed cases of MetS. Group 2 (controls, n=40): Healthy, age and gender matched volunteers. For each patient, blood samples have been collected on same days.

Exclusion criteria

1. Patients with any known chronic disease affecting diagnosis and subjects on drugs for any such disease such as chronic liver disease, parathyroid disease, chronic kidney disease, metabolic bone disease.
2. Patients taking drugs like statins and fibrates which can alter serum lipid profile.
3. Patients on Vitamin D supplementation.

After detailed history, informed consent was obtained. Weight and height of the patient was measured. Weight of the patient was measured using standard and calibrated weighing scale with least difference of 5 grams. Height was measured using a standard and calibrated stadiometer. Body mass index was calculated using the following standard formula: BMI= weight /height² (kg/m²).

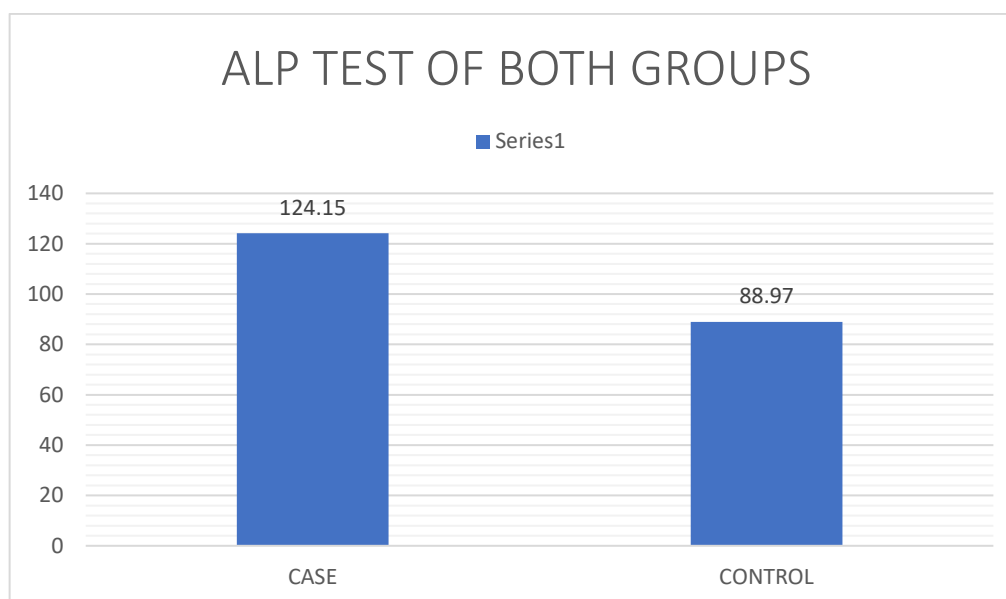
SPECIMEN COLLECTED: After overnight fasting for 8 hr, six mL of venous blood will be collected from antecubital vein following all aseptic measures (4mL in red vacuum tube and 2 mL in grey vacuum tube). For routine biochemical investigation, serum sample will be analysed on the autoanalyzer using standard methods.

Statistical Analysis: The statistical analysis of the collected data was carried out using Statistical Package for Social Sciences (SPSS) version 20.0 for Windows. Laboratory test results were summarized as mean $\pm$ standard deviation. Comparisons between the study groups were conducted using the Student's t test, and the frequencies of abnormal results were analyzed using the chi-square (χ^2) test. A 95% confidence interval (CI) was considered, and the data were compiled and analyzed using appropriate statistical methods.

RESULTS AND DISCUSSION:

TABLE 2: ALP TEST OF BOTH GROUPS

		Cases	Controls	P Value
ALP (U/L)	Mean $\pm$ SD	124.15 $\pm$ 61.47	88.97 $\pm$ 24.69	0.001
	Range	11 – 413	45 – 140	



The mean ALP levels in cases were 124.15 ± 61.47 U/L and in controls were 88.97 ± 24.69 U/L. On the basis of unpaired t-test, the difference between the groups for AST was statistically significant ($p < 0.05$).

CONCLUSION:

Serum alkaline phosphatase levels were significantly higher in metabolic syndrome patients compared with healthy controls. Although this association is evident, metabolic syndrome alone does not explain the increased mortality risk linked to elevated ALP levels. Further studies with larger sample sizes are required to validate these findings and clarify the underlying mechanisms.

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