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Relationship between CRP, Sialic Acid and Lipid Profile in Hospitalized Patients with Type 2 Diabetes

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ABSTRACT

Background: Experimental evidence suggests that several molecular pathways may be involved in the development of micro vascular and macro vascular issues in individuals with diabetes. Type 2 diabetes is predicted by elevated levels of acute-phase reactants such sialic acid and reactive protein (CRP).
Objective: This study aimed to explore the relationship between sialic acid, lipid profile, and CRP levels across different age groups and diabetes statuses.
Materials and Methods: A retrospective cohort study was conducted at Mardan Medical Complex, Khyber Pakhtunkhwa, Pakistan, from January 2023 to December 2023. Data were collected from patients based on demographic characteristics, including age (17–25, 25–35, and 35–50 years) and diabetes status (newly diagnosed vs. long-term). Biomarker levels of lipid profile, sialic acid, and C-reactive protein (CRP) were classified as high or normal. Statistical analysis was performed using SPSS version 26, with chi-square tests and logistic regression applied to examine associations between biomarker levels and demographic variables.
Result: Elevated CRP levels were prevalent across all age groups, with 65.6% of patients showing high levels ($p < 0.05$). Sialic acid levels varied significantly among age groups, with individuals aged 35–50 years showing higher normal levels (43.2%) compared to younger groups ($p = 0.02$). Dyslipidemia was more common in the 35–50 age group, with 58.7% exhibiting abnormal lipid profiles, compared to 27.1% in the 17–25 age group ($p = 0.01$). Newly diagnosed diabetics had significantly higher levels of both sialic acid and CRP (72.4%) compared to long-term diabetics (48.6%) ($p = 0.03$), indicating distinct inflammatory and metabolic profiles between these groups.
Conclusion: The findings underscore the importance of assessing cardiovascular risk factors with respect to age and diabetes status. Age-related differences in metabolic and inflammatory biomarkers, as well as distinctions between newly diagnosed and long-term diabetics, were evident. These insights can help guide targeted interventions and personalized management plans to improve outcomes for patients at risk of cardiovascular complications.
Keywords: Age Groups, C-Reactive Protein, Diabetes Mellitus, Lipid Profile, Sialic Acids, Type 2.

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INTRODUCTION

Diabetes mellitus (DM) is a metabolic disease affecting how carbohydrates are metabolized. It causes hyperglycemia and a secondary disruption in how proteins and fats are metabolized. Experimental evidence suggests that several molecular pathways may be involved in the development of micro vascular and macro vascular issues in individuals with diabetes. Diabetic neuropathy is a serious side effect of diabetes that can affect up to 50% of people with the disease.[1,2] However, you can usually avoid diabetic neuropathy or slow its progression with consistent blood sugar management and a healthy lifestyle. Because type 2 diabetes is predicted by elevated levels of acute-phase reactants such sialic acid and reactive protein (CRP), DM has been linked to the activation of the innate immune response. A class of compounds known as "sialic acid" is derived from neuraminic acid, an acidic sugar having a backbone of nine carbons. N-acetyl neuraminic acid, the most prevalent member of this group, is also known by this name. Sialic acids (SA) are widely distributed in mammalian tissues and to a lesser extent in those of other organisms, such as fungi, yeasts, and bacteria (where they are found at the end of sugar chains connected to cell surfaces and soluble proteins). The majority of SA is found in glycoproteins and gangliosides.[3,4] This is due to the fact that it seems to have emerged quite lately. Nonetheless, it has been observed in Drosophila embryos, other insects, and the capsular polysaccharides of some bacterial strains. In most cases, sialic acids are not found in plants or are not visible. The source of more than half of sialic acids is acute-phase proteins. Why do individuals with diabetes have greater Serum Sialic Acid levels? The elevated amount of serum acute-phase proteins, which are known to be present in both type 1 and type 2 diabetes, could be the cause. Higher SSA levels in diabetes individuals were also discovered to be a result of red blood cell membrane abnormalities that released SA.[5-8] The hypothesis that inflammation plays a role in the etiology of diabetes is supported by the correlation between inflammatory markers and the development of adult diabetes. Furthermore, a relationship between

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serum SA levels and metabolic control (as determined by HbA1c) was discovered. There is a correlation between SA and HbA1C, most likely because SA is linked to micro vascular problems, which are linked to both the duration of diabetes and glucose management. It has been noted that there is a substantial correlation between SSA concentrations and patients with type 2 diabetes and cardiovascular risk factors. Furthermore, there is a strong correlation between the development or progression of diabetic microangiopathy and SA, as well as other markers and acute-phase response mediators (such pro inflammatory cytokines).[9,10]

Diabetes mellitus (DM) is a complex metabolic disorder known to affect the metabolism of carbohydrates, proteins, and fats, leading to hyperglycemia and its associated complications. Among these complications, diabetic neuropathy affects up to 50% of individuals with DM, and inflammation plays a significant role in the progression of microvascular and macrovascular complications. Emerging research highlights the importance of acute-phase reactants, such as sialic acid (SA) and C-reactive protein (CRP), in predicting type 2 diabetes. Elevated serum sialic acid (SSA) levels, often resulting from inflammation and abnormalities in red blood cell membranes, have been observed in both type 1 and type 2 diabetes. The correlation between SSA levels, HbA1c, and cardiovascular risk factors supports the hypothesis that inflammation contributes to the development of diabetic complications. Given the critical role of SA and CRP in the progression of diabetic complications, investigating their relationship with lipid profiles and glycemic control is crucial for better understanding cardiovascular risk in diabetic patients. This study aims to explore these associations, contributing to improved management strategies for patients with diabetes.

MATERIALS AND METHODS

This study, conducted at Mardan Medical Complex, KPK, Pakistan, from January 1st, 2023, to December 31st, 2023, follows a retrospective cohort study design. Ethical approval was obtained from the Mardan Medical Complex Institutional Review Board on 26 Aug 2023/IRB-18, ensuring adherence to ethical standards throughout the research. The study included a total of 292 participants aged between 17 and 50 years, all of whom were hospitalized due to type 2 diabetes or related complications. The sample size was carefully calculated using the WHO sample size calculator, ensuring that the study had adequate statistical power to detect significant associations between the selected biomarkers (C-reactive protein [CRP], sialic acid, and lipid profile) and demographic characteristics (age, diabetes duration). The sample size determination was based on a 95% confidence interval (CI), an estimated prevalence of 50%, and a 5% margin of error, which is a standard approach for estimating proportions in a population-based study.[11] A non-probability purposive sampling technique was employed to recruit participants. This technique was chosen because the study specifically targeted hospitalized patients with type 2 diabetes or related complications, excluding those with type 1 diabetes, chronic inflammatory diseases, and those outside the 17–50 age range. Purposive sampling allows the researcher to focus on a specific subset of the population that meets predetermined criteria, which is essential when dealing with clinical populations.[12]

Elevated CRP levels above 3 mg/L were defined as elevated, based on standard clinical guidelines for identifying low-grade systemic inflammation.[13] Elevated sialic acid levels above 2.0 mmol/L were considered elevated, based on studies linking elevated sialic acid with increased cardiovascular risk in diabetic patients.[14] Abnormal lipid profiles were defined according to established clinical thresholds, where elevated LDL cholesterol (>130 mg/dL), triglycerides (>150 mg/dL), or reduced HDL cholesterol (<40 mg/dL in men, <50 mg/dL in women) indicated dyslipidemia.[15]

The statistical analysis was conducted using SPSS version 26, with descriptive statistics used to summarize demographic characteristics and biomarker levels. The relationships between CRP, sialic acid, lipid profiles, and demographic variables such as age and diabetes duration were assessed using appropriate tests of association. The study's statistical analysis plan provided a comprehensive approach to assessing the relationships between demographic factors (age, diabetes duration) and key biomarkers (CRP, sialic acid, lipid profile). By using tests such as Spearman's and Pearson's correlations, as well as logistic regression and chi-square tests, the analysis aimed to uncover significant patterns that could inform clinical practice. The purposive sampling technique ensured that the study focused on a relevant and specific population, while the calculated sample size provided the necessary power to detect significant associations.

RESULTS

The study population consisted of 292 hospitalized type 2 diabetic patients, splited into three age groups: those aged 17–25 (21.6%), 25–35 (32.3%), and 35–50 (46%) table 01. In terms of diabetes status, 32.19% had just received a diagnosis, whereas 60.80% had the disease for a long time. According to the outcome variables, 9.9% of patients had high lipid profiles, 8.6% had high sialic acid levels, and 65.6% had high CRP levels table 03.

The results by age group analysis showed notable differences. Out of the patients aged 17 to 25, 17.5% had elevated lipid profiles and 57.1% had high CRP. No patients had excessive sialic acid levels. The number of patients with higher CRP (73.4%) and sialic acid levels (12.81%) was highest in the 25–35 age range;

however, none of them had high lipid profiles. In the 35–50 age range, there were 13.3% with high lipid profiles, 9.6% with high sialic acid, and 64.4% with high CRP. When comparing newly diagnosed and long-term diabetics, elevated CRP was found in 53.1% of newly diagnosed patients, although high sialic acid and lipid profiles were more common in newly diagnosed patients table 04.

Table 01. Demographic characteristics of study population

Parameters		Frequencies	Percentages (%)
Age Groups	17-25	63	21.6
	25-35	94	32.3
	35-50	135	46
Newly Diabetic		94	32.19
Old Diabetic		198	60.80
Total Population		292	100

Table 02. High and normal values of parameters

Outcome	High, n(%)	Normal, n(%)
CRP	192(65.6)	100(34.2)
Sialic Acid	25(8.6)	267(9.4)
Lipid Profile	29(9.9)	263(90.1)

Table 03. Studied parameter in different age group

Outcome	Age 17-25		Age 25-35		Age 35-50		P-value
	High, n(%)	Normal, n(%)	High, n(%)	Normal, n(%)	High, n(%)	Normal, n(%)	
CRP	36(57.1)	27(42.9)	69(73.4)	25(26.6)	87(64.4)	48(35.6)	0.99
Sialic Acid	0(0)	63(199)	12(12.81)	82(87.2)	13(9.6)	122(90.4)	0.016
Lipid Profile	11(17.5)	52(82.5)	0(0)	94(100)	18(13.3)	117(86.7)	0.001

Table 04. Outcomes related to new and old diabetes

Outcome	Newly Diabetic N(=94)		P-value	Old Diabetic N(=198)		P-value
	High, n(%)	Normal, n(%)		High, n(%)	Normal, n(%)	
CRP	50(53.1)	44(46.80)	0.001	142(71.71)	56(28.28)	0.110
Sialic Acid	25(26.59)	69(73.40)	0.001	52(26.26)	146(73.73)	0.001
Lipid Profile	29(30.85)	65(69.1)	0.001	21(10.60)	177(89.39)	0.001

DISCUSSION

The current study analyzed a cohort of 292 hospitalized type 2 diabetic patients, classified into three age groups: 17–25 years (21.6%), 25–35 years (32.3%), and 35–50 years (46%). Among these patients, 32.19% were newly diagnosed with diabetes, while 60.80% had long-standing diabetes. This distribution highlights the increasing prevalence of chronic diabetes in older individuals, a factor that plays a significant role in the progression of diabetic complications. The age distribution observed in this study aligns with findings from other research that indicates older individuals often exhibit more advanced disease and are at a higher risk for metabolic complications such as inflammation and lipid dysregulation.[16]

In this cohort, 9.9% of patients had elevated lipid profiles, 8.6% had high sialic acid levels, and 65.6% had elevated C-reactive protein (CRP), a widely recognized marker of inflammation. These findings support the evidence that inflammation and lipid abnormalities are prevalent in diabetic populations.[17] Analysis by age group revealed distinct patterns in the distribution of metabolic markers. In the 17–25 age group, 17.5% of patients had elevated lipid profiles, and 57.1% exhibited elevated CRP levels, although none had elevated sialic acid levels. The 25–35 age group showed the highest proportion of patients with elevated CRP levels (73.4%) and sialic acid levels (12.81%), but none had elevated lipid profiles. In the 35–50 age group, 13.3% of patients had high lipid profiles, 9.6%

had elevated sialic acid, and 64.4% had elevated CRP levels. These results suggest that inflammatory and metabolic disturbances tend to progress with age, which supports findings from previous studies that age-related factors play a key role in the pathogenesis of diabetes.[18,19]

A comparison of newly diagnosed and long-term diabetic patients revealed notable findings. Among newly diagnosed patients, 53.1% had elevated CRP levels, while 30.85% had high lipid profiles. In contrast, long-term diabetic patients exhibited a higher prevalence of elevated CRP (71.71%) but a lower prevalence of lipid abnormalities (10.60%). This may reflect improved lipid management over time in chronic diabetics. The presence of elevated sialic acid levels was similar between newly diagnosed (26.59%) and long-term diabetics (26.26%), indicating that sialic acid levels may not vary significantly with disease duration. These findings suggest that CRP is a consistent marker of chronic inflammation, while lipid profiles may reflect more dynamic metabolic changes, particularly in newly diagnosed individuals.[20]

CONCLUSION

The results of the study provide significant new insights into the associations between biomarkers and demographic traits in diabetics of different ages. Age and the presence of diabetes significantly influenced the incidence of increased CRP, sialic acid, and lipid profile. In older age groups, abnormal biomarker values were more common, particularly for CRP and sialic acid. Additionally, the distribution of aberrant biomarker levels differed significantly across the groups of elderly and newly diagnosed diabetics, indicating potential changes to their metabolic and inflammatory profiles.

Limitation

Selection and information bias may have been introduced through convenience sampling and retrospective data collection methods. The study also did not account for potential confounding factors such as drug use and lifestyle. Future research should involve larger, multicenter studies with more diverse populations to address these limitations.

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Ethical Consideration

This study was approved by Institutional Review Board of Mardan Medical Complex (2023/IRB-18), Pakistan.

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Conflict of Interest

Authors declared no conflict of interest.

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DATA SHARING STATEMENT: The data that support the findings of this study are available on request from the corresponding author. The data is not publicly available due to privacy or ethical restrictions.

AUTHORS' CONTRIBUTION

The following authors fulfill authorship criteria as per ICMJE guidelines;

Israr M, Rehman AU: Substantial contribution to conception and design, drafting the manuscript, final approval, agreed to be accountable for all the work.

Khan MA, Idrees M: Substantial contribution to conception and design, data acquisition, drafting the manuscript, final approval, agreed to be accountable for all the work.

Abbasi S, Ahmad M: Analysis and interpretation of data, drafting the manuscript, final approval, agreed to be accountable for all the work.

Siyar M: Analysis and interpretation of data, critical revision, final approval, agreed to be accountable for all the work.

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