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High-Sensitivity C-Reactive Protein as a Predictor of Cardiovascular Risk in Type 2 Diabetes Mellitus

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Abstract

Background:

Type 2 diabetes mellitus (T2DM) is associated with a significantly increased risk of cardiovascular disease (CVD). Inflammation plays a critical role in the pathogenesis of atherosclerosis, and high-sensitivity C-reactive protein (hs-CRP) is an established marker of systemic inflammation. This study aimed to assess the association between hs-CRP levels and cardiovascular risk in patients with T2DM.

Methods:

A cross-sectional study was conducted among 100 patients with T2DM attending a tertiary care hospital. hs-CRP levels were measured, and cardiovascular risk was assessed using the Framingham Risk Score. Patients were categorized into low, moderate, and high cardiovascular risk groups. Statistical analysis included ANOVA and Pearson's correlation coefficient.

Results:

Among 100 participants, 35% were categorized as high cardiovascular risk. Mean hs-CRP levels significantly increased across low (2.1 ± 0.9 mg/L), moderate (3.8 ± 1.2 mg/L), and high (6.2 ± 2.0 mg/L) risk groups ($p < 0.001$). A strong positive correlation ($r = 0.684$, $p < 0.001$) was observed between hs-CRP levels and Framingham scores.

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Conclusion:

Elevated hs-CRP levels are strongly associated with higher cardiovascular risk in T2DM patients. hs-CRP may serve as an effective adjunctive marker in cardiovascular risk prediction and management in diabetic individuals.

Keywords:

Type 2 diabetes mellitus, high-sensitivity C-reactive protein, cardiovascular risk, inflammation, Framingham score

Introduction

Type 2 diabetes mellitus (T2DM) is a globally prevalent metabolic disorder characterized by chronic hyperglycemia resulting from insulin resistance and/or impaired insulin secretion. According to the International Diabetes Federation (IDF), approximately 537 million adults were living with diabetes in 2021, and this number is projected to rise to 643 million by 2030 and 783 million by 2045, making it one of the fastest-growing health challenges worldwide [1]. A particularly alarming concern is the significantly increased risk of cardiovascular disease (CVD) in individuals with T2DM, which is the leading cause of death and disability among this population [2]. Cardiovascular complications in diabetics arise from a complex interplay of traditional risk factors such as hypertension, dyslipidemia, obesity, and poor glycemic control, along with emerging non-traditional risk markers like chronic inflammation. In recent years, inflammation has emerged as a critical link between metabolic dysregulation and atherosclerosis. Among the various inflammatory biomarkers, high-sensitivity C-reactive protein (hs-CRP) has been extensively studied due to its sensitivity, cost-effectiveness, and prognostic value. hs-CRP is a hepatic acute-phase protein produced in response to interleukin-6 and other pro-inflammatory cytokines and is regarded as a sensitive

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marker of systemic inflammation [3]. Elevated hs-CRP levels have been consistently associated with increased risk of cardiovascular events such as myocardial infarction, stroke, and sudden cardiac death. This association is observed not only in the general population but also in patients with diabetes, where the presence of chronic inflammation is more pronounced [4]. The American Heart Association (AHA) and Centers for Disease Control and Prevention (CDC) have categorized hs-CRP levels as follows: <1 mg/L (low risk), 1–3 mg/L (moderate risk), and >3 mg/L (high risk) for cardiovascular disease, indicating its clinical utility in risk stratification [5]. In diabetics, persistent hyperglycemia induces oxidative stress and endothelial dysfunction, leading to increased production of pro-inflammatory cytokines that stimulate hs-CRP production. Moreover, insulin resistance—a hallmark of T2DM—has been linked with higher hs-CRP levels, even in individuals without overt cardiovascular disease [6]. These mechanisms underline the pathophysiological basis for the potential use of hs-CRP as a marker to predict cardiovascular events in diabetics.

From an Indian perspective, the situation is particularly concerning. India is home to the second-largest diabetic population in the world, with over 77 million adults affected as per recent estimates [1]. Studies from various parts of India have demonstrated a strong association between elevated hs-CRP levels and cardiovascular risk in T2DM patients, reinforcing the relevance of incorporating inflammatory markers into routine risk assessment in clinical practice. For instance, Gupta et al. in a hospital-based study in North India observed significantly elevated hs-CRP levels among diabetic patients compared to non-diabetic controls and found a positive correlation with other risk factors such as BMI, waist circumference, and lipid profile [7]. Given this background, the present study aims to investigate the association between hs-CRP levels and cardiovascular risk among individuals with type 2 diabetes mellitus. This would help in understanding the prognostic utility of hs-

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CRP in Indian diabetic populations and provide a foundation for targeted preventive strategies in primary care settings.

Aim:

To assess the association between high-sensitivity C-reactive protein (hs-CRP) levels and cardiovascular risk in patients with type 2 diabetes mellitus.

Objectives: To determine the correlation between hs-CRP levels and cardiovascular risk among type 2 diabetics.

Methodology

Study Design:

A hospital-based cross-sectional study.

Study Population:

Patients with type 2 diabetes mellitus attending the outpatient and inpatient departments during the study period.

Sampling Method:

Simple random sampling.

Inclusion Criteria:

- Adults aged 30–70 years.
- Diagnosed cases of type 2 diabetes mellitus (as per ADA criteria).
- Willing to give written informed consent.

Exclusion Criteria:

- Patients with acute or chronic infections.

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- History of cardiovascular events (e.g., myocardial infarction, stroke).
- Chronic inflammatory or autoimmune diseases.
- Pregnant women.
- Those on corticosteroids or immunosuppressive therapy.

Data Collection Procedure:

Each participant underwent:

- Detailed clinical history and physical examination.
- Anthropometric measurements: height, weight, BMI, waist circumference.
- Blood pressure recording.

Investigations:

- Fasting blood sugar, HbA1c.
- Lipid profile (Total cholesterol, LDL, HDL, Triglycerides).
- hs-CRP (measured using high-sensitivity CRP assay method such as ELISA or immunoturbidimetry).

Cardiovascular Risk Assessment:

- Cardiovascular risk was calculated using the Framingham Risk Score.
- Participants were categorized into low (<10%), moderate (10–20%), and high (>20%) risk groups based on 10-year CVD risk.

Statistical Analysis:

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- Data were analyzed using SPSS. Descriptive statistics: Mean, standard deviation, frequencies, and percentages. Inferential statistics: Correlation between hs-CRP and cardiovascular risk using Pearson or Spearman correlation coefficient. Comparison of hs-CRP levels across risk groups using ANOVA or Chi-square test. A p-value <0.05 was considered statistically significant.

Results

Table 1: Baseline Characteristics of the Study Population (n = 100)

Variable	Mean ± SD / n (%)
Age (years)	55.6 ± 8.7
Gender	Male: 58 (58%), Female: 42 (42%)
Duration of Diabetes (years)	8.3 ± 4.1
BMI (kg/m²)	27.8 ± 3.2
Systolic BP (mmHg)	136.4 ± 14.7
Diastolic BP (mmHg)	84.1 ± 8.6
HbA1c (%)	8.2 ± 1.1

Interpretation:

The average age of participants was around 56 years, with a slight male predominance. Most participants were overweight with suboptimal glycemic control, indicating a population at elevated cardiometabolic risk.

Table 2: Distribution of Study Participants by Cardiovascular Risk Categories (Framingham Risk Score)

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Cardiovascular Risk Category	Frequency (n)	Percentage (%)
Low Risk (<10%)	28	28%
Moderate Risk (10–20%)	37	37%
High Risk (>20%)	35	35%

Interpretation:

A significant proportion of the diabetic patients (35%) were found to have a high cardiovascular risk, emphasizing the need for early risk stratification in clinical settings.

Table 3: Mean hs-CRP Levels Across Cardiovascular Risk Groups

Cardiovascular Risk Group	Mean hs-CRP (mg/L) ± SD	Statistical Test
Low Risk	2.1 ± 0.9	
Moderate Risk	3.8 ± 1.2	One-way ANOVA
High Risk	6.2 ± 2.0	**p < 0.001**

Interpretation:

There was a statistically significant increase in hs-CRP levels with increasing cardiovascular risk category ($p < 0.001$), indicating a strong association between systemic inflammation and cardiovascular risk in T2DM patients.

Table 4: Correlation Between hs-CRP and Cardiovascular Risk Score

Variable Pair	Correlation Coefficient (r)	p-value
hs-CRP vs Framingham Score	0.684 (Positive Correlation)	<0.001

Interpretation:

There was a strong positive correlation ($r = 0.684$) between hs-CRP levels and Framingham

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cardiovascular risk scores. The association was statistically significant ($p < 0.001$), suggesting that as hs-CRP increases, the calculated risk of cardiovascular events also rises.

Discussion

The present study aimed to evaluate the association between high-sensitivity C-reactive protein (hs-CRP) levels and cardiovascular risk in patients with type 2 diabetes mellitus (T2DM). Our findings revealed that a significant proportion (35%) of the diabetic subjects were in the high cardiovascular risk category, and hs-CRP levels increased progressively across low, moderate, and high cardiovascular risk groups. A strong positive correlation was found between hs-CRP levels and Framingham risk scores ($r = 0.684$, $p < 0.001$), indicating a direct association between systemic inflammation and cardiovascular risk in this population. These results are in concordance with previous studies suggesting that hs-CRP, an inflammatory biomarker, plays a crucial role in the pathogenesis of atherosclerosis, especially in patients with T2DM [8]. Diabetes induces a chronic low-grade inflammatory state due to persistent hyperglycemia, insulin resistance, and oxidative stress, all of which contribute to elevated hs-CRP levels [9]. Several mechanisms have been proposed, including activation of nuclear factor-kappa B (NF-κB), increased cytokine release, and endothelial dysfunction, which lead to vascular inflammation and plaque instability [10]. Ridker et al. first reported that hs-CRP is a stronger predictor of cardiovascular events than LDL cholesterol in apparently healthy individuals, and its predictive value has since been confirmed in diabetic cohorts as well [11]. Our study reinforces these findings in the Indian context, where the burden of both diabetes and premature cardiovascular disease is high. Indian studies have

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also shown similar results—Gupta et al. observed significantly higher hs-CRP levels in diabetics with cardiovascular risk factors such as obesity, dyslipidemia, and hypertension [12]. The mean hs-CRP values in our high-risk group were above 6 mg/L, aligning with other research showing that levels above 3 mg/L are independently associated with a higher incidence of cardiovascular events [13]. According to guidelines from the American Heart Association and Centers for Disease Control and Prevention, hs-CRP can be classified as a useful adjunct marker to conventional cardiovascular risk scoring systems, including Framingham [14]. Moreover, our results highlight the potential of incorporating hs-CRP testing into routine risk stratification in diabetics, especially in resource-limited settings where early identification of high-risk individuals could guide timely interventions. In a study by Pradhan et al., hs-CRP was shown to predict not only cardiovascular events but also the development of diabetes, reinforcing its role as a dual-purpose biomarker [15]. Furthermore, Indian researchers such as Rajendran et al. emphasized the predictive value of hs-CRP in diabetic patients for both microvascular and macrovascular complications, advocating its inclusion in regular diabetic monitoring [16].

In summary, our study supports the growing body of evidence that hs-CRP is a valuable marker for assessing cardiovascular risk in T2DM patients. Its inclusion alongside standard risk scores may enhance risk prediction and facilitate personalized treatment strategies. However, further multicentric longitudinal studies are required to confirm causality and to determine if hs-CRP-lowering interventions translate into improved clinical outcomes.

Conclusion

This study demonstrated a significant positive association between high-sensitivity C-reactive protein (hs-CRP) levels and cardiovascular risk in patients with type 2 diabetes mellitus. hs-

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CRP levels increased progressively with higher cardiovascular risk categories, and a strong correlation was observed between hs-CRP and Framingham risk scores. These findings suggest that hs-CRP is a useful inflammatory biomarker that can enhance cardiovascular risk stratification in diabetic patients. Incorporating hs-CRP into routine clinical assessment may help identify high-risk individuals early and guide timely preventive interventions. Further large-scale, longitudinal studies are recommended to validate these findings and assess the impact of hs-CRP-targeted interventions on clinical outcomes.

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