

## Exploring the Link between Insulin Resistance (HOMA-IR) and Carotid Intima-Media Thickness in Type 2 Diabetes

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### Abstract

**Background:** Insulin resistance plays a central role in type 2 diabetes mellitus (T2DM) and may accelerate the development of atherosclerosis. Carotid intima-media thickness (CCAIM) is a simple ultrasound marker of vascular changes. This study investigates whether insulin resistance, measured using the Homeostasis Model Assessment (HOMA-IR), is associated with increased carotid intima-media thickness in patients with T2DM. **Methods:** Patients with T2DM underwent assessment of fasting blood sugar (FBS), fasting serum insulin, HbA<sub>1c</sub>, and CCAIM. HOMA-IR was calculated as:  $\text{HOMA-IR} = (\text{FBS (mg/dL)} \times \text{Serum Insulin } (\mu\text{IU/mL})) / 405$ . The correlation between HOMA-IR and CCAIM was tested using Pearson correlation analysis. **Results:** HOMA-IR values showed a strong positive correlation with CCAIM ( $r = 0.77$ ,  $p = 2.2 \times 10^{-11}$ ). The scatter plot confirmed that patients with higher carotid wall thickness consistently had elevated HOMA-IR. **Conclusion:** Insulin resistance is closely associated with early vascular changes in Indian patients with T2DM. Combined assessment of HOMA-IR and CCAIM may improve early cardiovascular risk detection.

**Keywords:** HOMA-IR, Insulin Resistance, Carotid Intima-Media Thickness, Type 2 Diabetes, Atherosclerosis

### Introduction

Type 2 diabetes mellitus (T2DM) has emerged as one of the most pressing health concerns of our time, particularly in India, which now carries one of the highest global burdens of the disease. The complications of T2DM extend far beyond elevated blood glucose, with cardiovascular disease accounting for much of the associated morbidity and mortality.

Ultrasound-based measurement of carotid intima-media thickness (CCAIM) offers a convenient and reliable marker for early vascular changes linked to atherosclerosis. Increased carotid wall thickness reflects cumulative vascular injury and has been considered a predictor of adverse outcomes such as myocardial infarction and stroke<sup>2</sup>.

Insulin resistance is a critical factor in the progression of T2DM and its vascular complications. The Homeostasis Model Assessment of Insulin Resistance (HOMA-IR) provides a practical and economical way to estimate insulin resistance, making it useful in both research and clinical practice<sup>1,3</sup>. While international studies have demonstrated a consistent relationship between HOMA-IR and vascular abnormalities, evidence from Indian populations remains limited<sup>4</sup>.

This study therefore examines whether HOMA-IR correlates with CCAIM in Indian patients with T2DM, aiming to provide insight into early predictors of cardiovascular risk.

## Methods

This cross-sectional study was conducted among patients with type 2 diabetes.

- Clinical measurements: fasting blood sugar, serum insulin, and HbA<sub>1c</sub> were measured using standard laboratory techniques.
- HOMA-IR formula:  $\text{HOMA-IR} = (\text{FBS (mg/dL)} \times \text{Serum Insulin } (\mu\text{IU/mL})) / 405$ .
- Carotid intima-media thickness (CCAIM): measured at the common carotid artery using high-resolution B-mode ultrasonography.

Statistical analysis: Pearson's correlation coefficient was applied to assess the association between HOMA-IR and CCAIM. A scatter plot with regression line was generated to visually demonstrate the relationship.

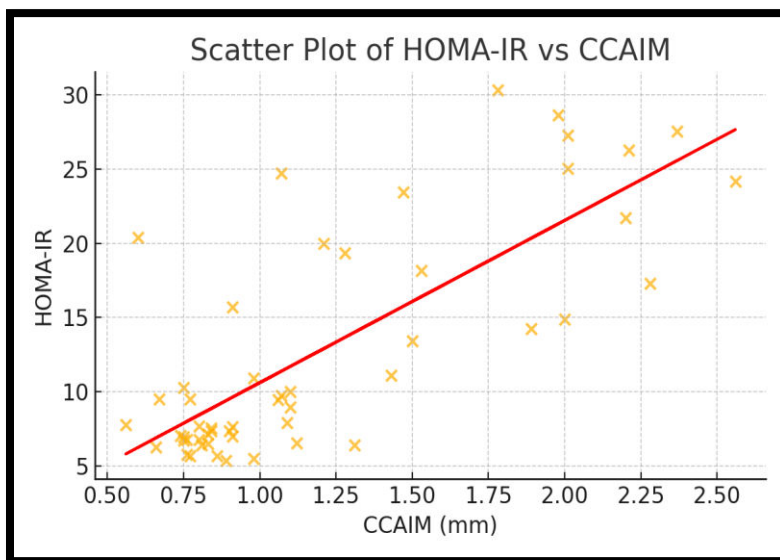
## Results

Patients with higher HOMA-IR consistently demonstrated increased carotid wall thickness.

- Correlation coefficient (r): 0.77
- p-value:  $2.2 \times 10^{-11}$  (highly significant)

This indicates a strong positive correlation between HOMA-IR and CCAIM.

Figure 1. Scatter plot of HOMA-IR vs CCAIM with regression line  
The plot revealed a clear linear trend, with greater insulin resistance associated with thicker carotid intima-media layers.



## Discussion

The present study demonstrates a clear link between insulin resistance and early carotid vascular changes in Indian patients with T2DM. Insulin resistance not only disrupts glucose regulation but also appears to drive direct structural changes within the vascular system.

Comparison with existing research: International evidence supports this relationship. Lorenz et al. showed that carotid IMT predicts cardiovascular events<sup>2</sup>, while Bonora et al. confirmed that HOMA-IR mirrors clamp-derived measures of insulin sensitivity<sup>3</sup>. Matthews et al. established HOMA as a validated tool for assessing insulin resistance<sup>1</sup>. Our findings echo these results in an Indian setting, where local data remain scarce<sup>4</sup>.

Possible mechanisms: Insulin resistance contributes to hyperinsulinemia, endothelial dysfunction, oxidative stress, and smooth muscle proliferation, all of which accelerate arterial thickening. This pathophysiological link explains the strong correlation observed in our study.

### **Clinical implications:**

- HOMA-IR is inexpensive, simple, and feasible for routine clinical use<sup>1,3</sup>.
- Carotid ultrasound adds structural information on early atherosclerotic changes<sup>2</sup>.
- Together, these tools may help identify patients at high cardiovascular risk before overt disease develops.

Limitations: The cross-sectional design limits causal inference. The single-center setting and moderate sample size restrict generalisability. Advanced vascular imaging (e.g., plaque morphology) was not included.

Future directions: Larger, prospective multicentric studies are needed to validate whether HOMA-IR can predict progression of carotid thickening and cardiovascular events in Indian patients<sup>4</sup>.

### **Conclusion**

Insulin resistance, assessed by HOMA-IR, is strongly and significantly correlated with carotid intima-media thickness in patients with T2DM. The combined use of biochemical and imaging markers may improve early cardiovascular risk detection and allow preventive measures before overt complications occur.

### **References:**

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