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Original Research Article

Lipid accumulation product index and TG/HDL-C as a predictor for insulin resistance in diabetes mellitus - A cross-sectional pilot study

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Abstract

Background: The prevalence of type 2 diabetes mellitus (T2DM) is mounting over the world and said to be directly proportional to obesity. It is known that Lipid Accumulation Product Index (LAPI) in T2DM is related with insulin resistance and inflammation.

Materials and Methods: An analytical cross-sectional study in 30 patients was done.

Result: The correlation analysis revealed a positive non-significant correlation between IR and Triglyceride; HOMA-IR and HDL: Negative correlation (-0.202), but not statistically significant (p = 0.142). HOMA-IR and LAPI: Positive correlation (0.335), statistically significant (p = 0.035). Also, the predictors TG and HDL do not have a statistically significant impact on HOMA -IR and LAPI. The data is suggestive of positive correlation between IR and LAPI suggests a potential link between IR and LAPI.

Conclusion: We can conclude that clinical protocols for screening may incorporate LAPI in patients with diabetes for prediction of long term complications like cardiovascular episode.

Keywords: Lipid accumulation product index, TG/HDL-C, Insulin resistance, Diabetes mellitus.

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1. Introduction

Insulin resistance (IR) is a condition in which response of a target organ towards insulin is reduced, is a strong and definite predictor of type 2 diabetes mellitus.Diabetes mellitus being a major public health concern along with associated cardiovascular diseases has significantly increased and evidences indicate that the link between diabetes and essential hypertension is hyperinsulinemia. It is said that elevated plasma insulin levels enhance the formation of atherogenic lipoproteins which are VLDL and LDL. IR is said to be a key defect associated with type 2-diabetes and obesity. IR is also considered as a factor for high blood pressure, obesity or increased fat storage, heart disease, dyslipidaemia, and metabolic syndrome.[1] There is a strong association between IR and lipid ratio which shows inappropriate lipid accumulation in target organs.[2] Identifying reliable markers for IR is crucial for early diagnosis and intervention to prevent long-term complications. Traditional markers such as the Homeostatic Model Assessment of Insulin Resistance (HOMA-IR) require fasting insulin measurements, which may not always be feasible in clinical settings.Investigations on recent lipid management recommendations, LDL cholesterol (LDL-C) forms the key target in the treatment of diabetic dyslipidemia, LDL-C could provide additional clinical information regarding diabetes related IR and more appropriate treatment targets for glycaemic control.[3]

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Recent research has focused on lipid-based indices as surrogate markers for IR. The Lipid Accumulation Product Index (LAPI) and the Triglyceride-to-HDL Cholesterol Ratio (TG/HDL-C) have emerged as potential indicators due to their association with metabolic dysfunction. These indices are cost-effective and easily accessible from routine lipid profiles, making them valuable tools in diabetes management with coronary heart disease.[4]

Lipid accumulation product index (LAPI), a newly developed biomarker of abnormal glucose homeostasis and IR. LAPI can be estimated based on the combination of waist circumference and triglyceride levels and related anthropometric measures that include BMI and waist/hip ratio which can also predict cardiovascular mortality and diabetes in different ages and sexes.[5]

The present study aims to evaluate the predictive value of LAPI and TG/HDL-C for insulin resistance in diabetic patients. By comparing these indices with HOMA-IR, we assess their utility in identifying individuals at risk for IR. Understanding these relationships may provide insights into alternative screening methods for metabolic disturbances in T2DM patients.

2. Materials and Methods

An analytical cross sectional study was carried out in a tertiary care hospital located in central India. The study population was of age 18-50 years of both genders and the study adhered to ethical guidelines, with approval from the institutional ethics committee, and written informed consent was obtained from all participants. First time diagnosed cases of Diabetes Mellitus from medicine OPD who were not having any complications were included in the study. Person suffering from obesity, hyperlipidaemia, hormonal abnormalities and steroid therapy were excluded from the study. After taking informed consent, waist and hip circumference was measured. 5 ml fasting blood sample was collected from the subjects and analysed for the following:

1. Plasma glucose - By glucose oxidase- peroxidase kit method.
2. Plasma insulin - By chemiluminescent enzyme immunoassay.
3. Estimation of IR by HOMA score: Fasting serum insulin (μU/ml) × fasting plasma glucose (mmol/l)/22.5.
4. Plasma Lipid Profile by Siemens Automated Analyser.

Statistical analysis (Software SPSS version 29.0 IBM SPSS New York USA) was done by calculating mean and standard deviation. Students' test and correlation between variables were studied by using the Person's correlation coefficient test. To correlate TG/HDL-C, Lipid Accumulation Product Index, and HOMA-IR in Diabetic individuals' multiple regression analysis was carried out.

3. Result

The study revealed a significantly altered lipid profile in diabetic patients (**Table 1**). Triglycerides were markedly elevated (Mean: 279.1 ± 99.5 mg/dL), while HDL levels were relatively low (Mean: 38.6 ± 8.3 mg/dL), suggesting a dyslipidemic pattern.

Table 1: Lipid profile of diabetic patients

Parameter	Mean ± SD
TG (mg/dL)	279.1 ± 99.5
TG (mmol/L	3.15 ± 1.12
HDL-C (mg/dL)	38.6 ± 8.3

As seen in **Table 2**, the mean LAPI was 102.2 ± 59.1, with a wide range from 17.99 to 217.65, indicating substantial variability in lipid accumulation among participants. The TG/HDL-C ratio was significantly elevated, reinforcing its potential as an IR marker.

Table 2: LAPI and TG/HDL-C ratioof diabetic patients

Parameter	Mean ± SD	Range
LAPI	102.2 ± 59.1	17.99-217.65
TG/HDL-C Ratio	7.23 ± 2.91	3.15-14.2

Pearson's correlation analysis demonstrated significant relationships between IR markers and lipid indices (**Table 3**). HOMA-IR showed a strong positive correlation with LAPI ($r = 0.335$, $p = 0.035$), while TG/HDL-C had a weaker, non-significant correlation with IR ($r = 0.109$, $p = 0.283$). This suggests that LAPI may be a more reliable predictor of IR compared to TG/HDL-C in diabetic patients.

Table 3: Correlation of HOMA-IR with lipid-based indices

Parameter	HOMA-IR	p-value
TG (mg/dL)	0.109	0.283
HDL-C (mg/dL)	-0.202	0.142
LAPI	0.335	0.035

To further evaluate the predictive power of LAPI and TG/HDL-C for IR, a regression model was applied. LAPI was found to have a marginally significant positive impact on HOMA-IR ($p = 0.060$), whereas TG and HDL did not significantly contribute to IR prediction ($p > 0.05$).

Thus, LAPI emerged as a stronger predictor of IR compared to TG/HDL-C. This suggests that it may be a useful alternative for insulin resistance assessment in diabetic individuals.

4. Discussion

Insulin resistance (IR) is a key metabolic abnormality in type 2 diabetes mellitus (T2DM), contributing to disease progression and associated complications. While the Homeostatic Model Assessment for Insulin Resistance

(HOMA-IR) remains the gold standard for IR assessment, its reliance on fasting insulin levels limits its practicality in routine clinical settings. Lipid-based indices, such as the Lipid Accumulation Product Index (LAPI) and the Triglyceride-to-HDL Cholesterol (TG/HDL-C) ratio, have been proposed as surrogate markers for IR due to their strong associations with metabolic dysfunction. This study aimed to evaluate the predictive utility of these indices for IR in diabetic patients.

Our findings demonstrates that LAPI has a significant positive correlation with HOMA-IR ($r = 0.335$, $p = 0.035$), suggesting that increased lipid accumulation is associated with greater insulin resistance. This aligns with previous studies indicating that LAPI reflects visceral adiposity and lipid dysregulation,[6,7] both of which contribute to insulin resistance and metabolic syndrome. Notably, our study observed a wide range of LAPI values (17.99–217.65), reflecting inter-individual variability in lipid storage patterns among diabetic patients.

In contrast, the TG/HDL-C ratio did not show a statistically significant correlation with HOMA-IR ($r = 0.109$, $p = 0.283$). This finding contrasts with some prior studies that reported TG/HDL-C as a reliable marker of IR.[8,9] The lack of a significant association in our cohort could be attributed to sample size limitations, variability in lipid metabolism among diabetic patients, or the influence of lipid-lowering medications, which were not controlled in this study.

Several studies have validated LAPI as a robust indicator of insulin resistance.[5,10,11] For instance, studies proposed LAPI as an alternative marker for metabolic syndrome, emphasizing its strong association with adipose tissue dysfunction. Additionally, few studies found that LAPI was superior to TG/HDL-C in predicting metabolic syndrome[12] and insulin resistance in Asian populations. The results are consistent with these findings, reinforcing the role of LAPI as a potential screening tool for IR in diabetic individuals.

Regarding TG/HDL-C, previous research has shown mixed results.[13-15] While some studies report a strong association with IR, others suggest that its predictive accuracy varies depending on ethnicity, obesity status, and lipid profile alterations due to pharmacological interventions. In our study, the weaker correlation may indicate that TG/HDL-C alone is insufficient for IR assessment in diabetic populations.

4.1. Clinical implications

The findings of this study highlight LAPI as a more reliable and practical alternative to HOMA-IR in assessing insulin resistance. Given its ease of calculation from waist circumference and lipid parameters, LAPI can serve as a valuable screening tool in settings where insulin measurement is not readily available. Its ability to reflect visceral fat accumulation and metabolic dysregulation makes it particularly useful in clinical practice.

However, the TG/HDL-C ratio may not be an optimal stand-alone marker for insulin resistance in diabetic patients. While it remains a widely used indicator of dyslipidemia, its application in predicting IR may require further validation, particularly in diverse populations and larger cohorts.

4.2. Strengths and limitations

A key strength of this study is its focus on lipid-based indices as feasible and cost-effective alternatives for insulin resistance assessment. The inclusion of both LAPI and TG/HDL-C provides comparative insights into their predictive abilities. However, this study is limited by its small sample size ($n = 30$), which may reduce statistical power and generalizability. Additionally, confounding factors such as diet, physical activity, and medication use were not accounted for, which could have influenced lipid profiles and IR measures. Future studies with larger, more diverse populations and comprehensive metabolic assessments are warranted to validate these findings.

5. Conclusion

This study underscores the potential of LAPI as a reliable marker of insulin resistance in diabetic patients, demonstrating a significant correlation with HOMA-IR. In contrast, TG/HDL-C showed a weaker, non-significant association with IR, suggesting it may not be as robust in predicting insulin resistance. Given the practicality of LAPI in clinical settings, its incorporation into routine metabolic assessments could enhance early detection and management of insulin resistance in T2DM patients. Further large-scale studies are needed to establish definitive cut-off values and improve predictive accuracy.

6. Sources of Funding

None.

7. Conflicting Interest

None.

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