# Triglyceride-Glucose Index in the Prediction of Prediabetes

Índice triglicéridos-glucosa en la predicción de prediabetes

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## Abstract

Prediabetes is a metabolic disorder characterized by insulin resistance long before the diagnosis of type 2 diabetes mellitus (T2DM) and represents a key opportunity for intervention and prevention of T2DM. The triglyceride-glucose index (TGI) has been identified as an accessible marker of insulin resistance with potential diagnostic value. This study aimed to evaluate the diagnostic accuracy of the TGI in predicting prediabetic status in nondiabetic adults. A case-control study was conducted using retrospective data from 663 nondiabetic adults treated at an outpatient care center in Guayaquil between 2019 and 2023. 221 cases with Prediabetes and 442 controls matched for age and sex were selected. Nonparametric tests, binary logistic regression, and ROC curve analysis were applied. TGI was significantly associated with OR: 2.83 [95 % CI 1.94–4.14]. A TGI cutoff point ≥8.54 had a sensitivity of 75.1%, specificity of 58.1%, and negative predictive value of 0.82. The combination of TGI with overweight/obesity and albumin levels <4.15 g/dL improved specificity to 86.7%. Low albumin and being overweight were also independently

associated with an increased risk of Prediabetes. The TGI demonstrated adequate diagnostic capacity in detecting Prediabetes, making it a valuable and cost-effective marker for T2DM screening. Its combination with other variables improves diagnostic accuracy, and future validations were planned to expand its clinical application.

**Keywords:** **Triglycerides, Blood Glucose, Diabetes Mellitus, Prediabetic State, Insulin Resistance.**

## Resumen

La prediabetes es un estado de alteración metabólica caracterizado por la resistencia a la insulina mucho antes del diagnóstico de diabetes mellitus tipo 2 (T2DM) y representa una oportunidad clave para la intervención y prevención hacia T2DM. El índice triglicéridos-glucosa (ITG) se ha identificado como un marcador accesible de resistencia a la insulina, con valor diagnóstico potencial en este contexto. El objetivo de este estudio fue evaluar la precisión diagnóstica del ITG en la predicción del estado prediabético en adultos no diabéticos. Se realizó un estudio de casos y controles con datos retrospectivos de 663 adultos no diabéticos atendidos entre 2019 y 2023 en un centro de atención ambulatoria de Guayaquil. Se seleccionaron 221 casos con prediabetes y 442 controles emparejados por edad y sexo. Se aplicaron pruebas no paramétricas, regresión logística binaria y análisis de curvas ROC. El ITG se asoció significativamente OR: 2,83 [IC95 % 1.94 – 4.14]. Un punto de corte del ITG ≥8.54 presentó sensibilidad de 75,1 %, especificidad de 58,1 %, y valor predictivo negativo de 0,82. La combinación de ITG con sobrepeso/obesidad y albúmina <4,15 g/dL mejoró la especificidad hasta 86,7 %. La albúmina baja y el sobrepeso también se asociaron independientemente con mayor riesgo de prediabetes. El ITG mostró adecuada capacidad diagnóstica en la detección de prediabetes, por lo que representa un marcador útil y económico para el tamizaje de T2DM. Su combinación con otras variables mejora la precisión diagnóstica, además de futuras validaciones a fin de ampliar la aplicación clínica.

**Palabras clave:** **triglicéridos, glucemia, diabetes mellitus, estado prediabético, resistencia a la insulina.**

## INTRODUCTION

Metabolic syndrome is a well-known clinical entity characterized by the presence of specific factors that predispose individuals to developing cardiovascular disease and type 2 diabetes mellitus (T2DM). [1,2,3] Globally, diabetes is the eighth leading cause of death.[4] In Ecuador, the prevalence of diabetes is estimated at 10% in adults over 50 years of age, making it the second leading cause of death in 2022 and 2023.[5] These figures are alarming, due to the rapid increase in the incidence of diabetes [6,7], but mainly because its diagnosis is becoming less exclusive to older people, and at the same time, society is rapidly adopting sedentary lifestyles in young people. [8,9] According to reports from a study conducted in 146 countries on adolescents between 11 and 17 years of age, the global trend of insufficient physical activity up to 2019 was 80%, and it is 86.5% in Ecuador. [10]

Regarding the pathophysiological basis of type 2 diabetes mellitus (T2DM), it is known to be a metabolic disorder that initially involves insulin resistance and pancreatic beta-cell dysfunction. [11,12] This leads to a transition between normal glucose metabolism and T2DM, a condition known as Prediabetes. The prediabetic state is defined as an intermediate condition between normal glucose metabolism and type 2 diabetes mellitus (T2DM), characterized by blood glucose levels higher than usual but not yet meeting the diagnostic criteria for diabetes. Current criteria consider blood glucose levels between 100 and 125 mg/dL as Prediabetes and a level greater than or equal to 126 mg/dL as diabetes. [13] Over the years, there has been a considerable increase in the prevalence of diabetes mellitus [9,14]; however, early diagnosis using current diagnostic criteria and measures to treat the disease do not appear to be significantly impacting the decline of this epidemic. [14,15]

Estimating insulin resistance is helpful for predicting type 2 diabetes mellitus (T2DM); however, precise measurement of blood insulin levels is not readily available to the entire population, especially in low-income countries. [16] Therefore, other options have been proposed, such as determining the triglyceride-glucose index (TGI) for assessing metabolic status and insulin resistance[17,18,19], which has demonstrated equal or greater quantification value. The triglyceride-glucose index is defined as the negative logarithm of the product of glucose and triglyceride values divided by two, represented by the following formula: I<sub>n</sub>[Triglycerides [mg/dl] × glucose [mg/dl]/2). [20]

Research over the last decade has demonstrated the usefulness of the TGI in estimating metabolic status and insulin resistance[20,21,22,23,24,25,26], interpreted as a sign of the initial deterioration of metabolic status that precedes the development of T2DM. In the Mexican population, the TGI has been shown to assess insulin resistance accurately.[19] Systematic reviews have evaluated cutoff points; however, it is considered that further studies are still needed in this regard. [27]

The TGI has become an essential predictor of prediabetic status and its progression or regression toward normoglycemia or diabetes. Several studies have found that TGI can serve as a surrogate marker for insulin resistance, as it has shown a non-linear relationship with glucose status conversion, with an inflection point at a TGI value of 8.88. Beyond this value, the probability of returning to normoglycemia decreases significantly in individuals with Prediabetes. [28] Furthermore, combining TGI with body mass index (BMI) improves the predictive accuracy of prediabetes recovery or progression, with specific thresholds identified for predicting recovery and progression. [29] The predictive capacity of TGI is further supported by its significant correlation with markers of insulin resistance and its superior predictive ability compared to other indices, particularly in women and obese individuals. [30,31] Furthermore, the TGI has been validated as a reliable predictor of

prediabetes risk in several populations, including middle-aged and older adults, with a demonstrated non-linear relationship between TGI values and diabetes risk. [32,33]

In most cases, the time of diabetes diagnosis does not represent a point at which the progression of the underlying metabolic disorder can be reversed. [34,35] Therefore, the need arises to predict diabetes at its earliest stages, that is, at the first signs of insulin resistance, even when fasting glucose levels fluctuate between Prediabetes and normal. [36] Thus, it is essential to investigate tools that allow us to know the metabolic state before reaching the point of no return that type 2 diabetes and the prediabetic state represent. Considering this background and the evidence on estimating insulin resistance from TGI, we hypothesize that it is possible to predict the diagnosis of Prediabetes from the TGI estimate. The objective of this research is to evaluate the diagnostic accuracy of the TGI in predicting the prediabetic state.

## MATERIALS AND METHODS.

A case-control design is presented to evaluate the diagnostic accuracy of the TIG in predicting Prediabetes in nondiabetic adult patients treated at the outpatient service of the Surgical Clinical Center of Northern Guayaquil, Ecuador, between 2019 and 2023, as part of the Ecuadorian Social Security Institute (IESS).

### Population and sample

The population consists of 41,713 adult patients who attended CCQANT-IESS for outpatient follow-up for causes other than diabetes during the period from January 2019 to December 2023.

The minimum sample size was estimated using Epi Info™ StatCalc software, assuming a population of 41,713 patients, an expected prevalence of 50%, a 99% confidence level, and a 5% margin of error, resulting in a minimum of 653 participants.

To form the sample, 9096 clinical records with data on HbA1c, lipid profile, and glucose levels were identified. Those individuals who met the criteria for Prediabetes (ADA 2024) [13] (fasting glucose between 100 and 125 mg/dL, HbA1c between 5.7% and 6.4%, and compatible symptoms recorded in the medical history) were then identified. 829 records with Prediabetes were identified, from which 221 prediabetes cases were randomly selected, and from the remaining 442 controls, matched by age and sex, were randomly selected at a ratio of 2 controls per case to improve statistical power, according to the literature. [37]

### Inclusion and exclusion criteria

Nondiabetic patients were included based on laboratory test records of HbA1c, fasting glucose, lipid profile (Total Cholesterol, High and Low Density Lipoproteins (HDL and LDL), triglycerides), and body mass index (BMI).

Patients under 18 years of age were excluded, as were those with a prior diagnosis of metabolic diseases or endocrinopathies (type 1 diabetes mellitus, uncontrolled thyroid disorders, Cushing's syndrome, or other hormonal dysfunctions); documented history of cardiovascular disease (myocardial infarction or heart failure); advanced chronic renal failure; liver cirrhosis; pregnancy; and those with incomplete clinical records for the study variables. The exclusion of these clinical conditions was considered to control for confounding bias.

### Variables

Quantitative variables include age (measured in years), body mass index (BMI), fasting glucose, triglycerides, HDL, LDL, total cholesterol (all in milligrams per deciliter), and HbA1c (in grams per deciliter). Qualitative variables include sex and prediabetes diagnosis. BMI is classified as an ordinal qualitative variable, with ranges defined by the WHO.[38]

### Data collection

After obtaining authorization from the center for data collection, a database from the Laboratory Department containing 41713 laboratory records of nondiabetic adult patients (2019–2023) was retrospectively reviewed. Of these, 9096 had records of HbA1c, lipid profile, and glucose levels. Following the initial selection of cases and controls, the medical records were individually reviewed to verify compliance with

the inclusion and exclusion criteria. In cases where a patient had a documented exclusion condition, they were removed from the sample and replaced with another randomly selected patient who met the corresponding age and sex criteria to control for selection bias. Relevant clinical, anthropometric, and biochemical data were extracted from the electronic records for analysis. To control for confounding bias, clinical conditions associated with hyperglycemia were excluded, and multivariate models were used in the analysis. To minimize selection bias, only complete laboratory records were included as study variables.

**Statistical analysis**

After collecting and compiling a database of the study population in Microsoft Excel, the data were exported to IBM SPSS Statistics 27. The normality of the quantitative variables was assessed using the Kolmogorov-Smirnov test. Since most variables did not follow a normal distribution, nonparametric tests were used for inferential analysis.

Quantitative variables were reported as medians and interquartile ranges (IQRs), and qualitative variables were reported as absolute frequencies and percentages. The Mann-Whitney U test was used to compare continuous variables between the groups with and without Prediabetes. Subsequently, a binary logistic regression analysis was performed to identify independent predictors of Prediabetes. Initially, all study variables were included, excluding those with clinical or statistical collinearity with TGI (glucose and triglycerides) and glycated hemoglobin (HbA1c) due to their diagnostic overlap with the outcome. Total cholesterol was omitted due to overlap with LDL and HDL cholesterol fractions. A second model was evaluated, adjusting for body mass index (BMI) as a dichotomous variable (≥25 kg/m²: overweight/obese). The goodness-of-fit of the models was assessed using the Hosmer-Lemeshow test and the pseudo-$R^2$ coefficients of determination (Cox and Snell, Nagelkerke). Model results are reported as odds ratios (OR) with 95% confidence intervals.

The diagnostic accuracy of the TGI and other parameters was evaluated using receiver operating characteristic (ROC) curves, and the area under the curve (AUC) was calculated. Optimal cutoff points were identified, and sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV) were estimated for each criterion. In addition, combinations of variables (TGI, albumin, overweight/obesity) were analyzed to determine if they improved the diagnostic performance of TGI alone. A p-value < 0.05 was considered statistically significant.

**Ethical considerations**

This study received institutional authorization from the CCQANT-IESS for data collection and a confidentiality agreement from the principal investigator. The protocol was evaluated by the Master's Thesis Research Committee of the International University of La Rioja (UNIR) [2023_2643], which issued a favorable opinion in May 2023. Data were obtained from anonymized clinical records without requiring additional informed consent, as the retrospective design implies minimal risk. The research was conducted in compliance with the principles of the Declaration of Helsinki, current Ecuadorian legislation, and the Organic Law on the Protection of Personal Data, ensuring confidentiality and responsible data handling.

## RESULTS

A total of 663 patients were analyzed, comprising 221 (33.3%) in the prediabetes case group and 442 (66.7%) in the control group. The patient population consisted of 54.8% males and 45.2% females. The glucose tolerance index (TGI) distribution showed values close to normal (skewness of -0.080 and kurtosis of 0.534). However, the Kolmogorov-Smirnov test indicated that all quantitative variables were non-normal, except for age (p = 0.037), which justified the use of nonparametric tests for comparisons. The median age was 52 years [IQR 47–57], with no significant differences between the two groups due to age- and sex-matching. Regarding body mass index (BMI), the case group had higher values than the patients without Prediabetes (**Table 1**).

Regarding biochemical parameters, patients with Prediabetes had significantly higher fasting glucose, HbA1c, triglycerides, total cholesterol, LDL, TGI, and AST levels than controls ($p < 0.001$ for all variables). On the other hand, the prediabetes group showed significantly lower HDL ($p = 0.03$) and albumin ($p < 0.001$) levels, whereas no statistically significant differences were observed in ALT levels (Table 1).

**Table 1**

Comparison of BMI and biochemical parameters between patients with and without Prediabetes.

| Variable | Prediabetes n=221 [IQR] | Without Prediabetes n=442 [IQR] | Total n=663 [IQR] | *p-value* |
|---|---|---|---|---|
| **BMI** | 29,46 [26,28-33,46] | 25.40 [21.87-30.13] | 27.02 [22.89-31.30] | <0.001 |
| **HbA1c** | 5.90 [5.80-6.10] | 5.30 [5.10-5.5] | 5.50 [5.20-5.9] | <0.001 |
| **Glycemia** | 109 [104-115] | 93.3 [87.0-99.20] | 99.20 [89.6-108] | <0.001 |
| **TGI** | 8.86 [8.54-9.24] | 8.44 [8.01-8.89] | 8.59 [8.17-9.04] | <0.001 |
| **Cholesterol** | 194 [168-223] | 181 [153-212] | 184 [157-218] | <0.001 |
| **Triglycerides** | 131 [94-186] | 98 [66-152] | 107 [73-163] | <0.001 |
| **LDL** | 113 [92-137] | 101 [79-129] | 103 [83-134] | <0.001 |
| **HDL** | 50 [43-59] | 53 [44-63] | 52 [44-62] | 0.030 |
| **Albumin** | 4,1 [3,9-4,3] | 4.3 [4-4.5] | 4.2 [4-4.4] | <0.001 |
| **AST** | 22 [17-29] | 19 [15-26] | 20 [16-27] | <0.001 |
| **ALT** | 23 [20-28] | 23 [20-27] | 23 [20-28] | 0.080 |

Variables are expressed as medians and interquartile ranges (IQR). Differences were assessed using the Mann-Whitney U test; BMI: body mass index; HbA1c: glycated hemoglobin; TGI: triglyceride-glucose index; LDL: low-density lipoprotein; HDL: high-density lipoprotein; AST: aspartate aminotransferase; ALT: alanine aminotransferase.

A binary logistic regression analysis was performed to identify factors associated with a prediabetes diagnosis. In the first model, the study variables were included, excluding blood glucose and triglycerides due to collinearity with the glucose tolerance test (GTT), HbA1c due to collinearity with the dependent variable, and total cholesterol due to the simultaneous inclusion of its HDL and LDL fractions. The model showed adequate explanatory power, with Cox and Snell $R^2$ of 0.165 and Nagelkerke $R^2$ of 0.230. However, the Hosmer-Lemeshow goodness-of-fit test was significant ($\chi^2 = 26.889$; df = 8; $p = 0.001$), indicating a lack of adequate fit (not shown in the table).

Subsequently, a second model was fitted incorporating the dichotomous variable BMI. This model showed better explanatory power (Cox and Snell $R^2 = 0.174$; Nagelkerke $R^2 = 0.242$) and a more acceptable fit (Hosmer-Lemeshow $\chi^2 = 15.876$; df = 8; $p = 0.044$). Despite the inadequate fit, the model was accepted considering its sensitivity to the sample size, and its interpretation should be made in conjunction with other indicators. Modifying the model to achieve a third fit was not feasible due to a considerable reduction in the $R^2$.

In this second model, the TGI index was significantly associated with a diagnosis of Prediabetes (OR: 2.831; 95% CI: 1.937–4.137; $p < 0.001$), indicating that for every unit increase in the TGI, the odds of having Prediabetes increased by 2.83. Significant associations were also observed with albumin (OR: 0.334 [95% CI: 0.196–0.568] $p < 0.001$), showing a protective effect, and with overweight/obesity status (OR: 3.307 [95% CI: 2.083–5.251] $p < 0.001$), which tripled the risk of Prediabetes. Female sex was also associated with a lower risk (OR: 0.653 [95% CI: 0.434–0.984] $p = 0.042$). The remaining variables, including age, LDL, HDL, AST, and ALT, did not show statistically significant associations (Table 2).

**Table 2**
Multivariate association between clinical variables and the diagnosis of Prediabetes using binary logistic regression.

| Variable | β | Wald | p-value | OR [95% CI] |
|---|---|---|---|---|
| **Age** | -0.007 | 0.244 | 0.622 | 0.99 [0.97 – 1.02] |
| **Sex** | -0.426 | 4,155 | **0.042** | 0.65 [0.43 – 0.98] |
| **TGI** | 1,041 | 28,904 | **0.000** | 2.83 [1.94 – 4.14] |
| **LDL** | 0.002 | 0.847 | 0.358 | 1.00 [1.00 – 1.01] |
| **HDL** | 0.013 | 2,916 | 0.088 | 1.01 [1.00 – 1.03] |
| **Albumin** | -1,097 | 16,374 | **0.000** | 0.33 [0.20 – 0.57] |
| **AST** | 0.002 | 0.033 | 0.856 | 1.00 [0.98 – 1.03] |
| **ALT** | 0.008 | 0.253 | 0.615 | 1.01 [0.98 – 1.04] |
| **OO** | 1,196 | 25,707 | **0.000** | 3.31 [2.08 – 5.25] |
| **Constant** | -6,250 | 7,438 | 0.006 | |

BMI: Body mass index; HbA1c: Glycated hemoglobin; TGI: Triglyceride-glucose index; LDL: Low-density lipoprotein; HDL: High-density lipoprotein; AST: Aspartate aminotransferase; ALT: Alanine aminotransferase; OO: Overweight and obesity.

**Diagnostic accuracy of the triglyceride-glucose index**

The diagnostic ability of the TGI to predict prediabetic status was evaluated using ROC curve analysis (Figure 1A). The TGI cutoff point ≥8.54 was identified using Youden's criteria as the value that best balanced sensitivity (75.1%; 95% CI: 69.0–80.4) and specificity (58.1%; 95% CI: 53.5–62.7), a positive predictive value (PPV) of 0.47, and a negative predictive value (NPV) of 0.82 (Table 3). The area under the curve (AUC) was 0.691 (95% CI: 0.65–0.73; $p < 0.001$), indicating moderate diagnostic accuracy.

Since albumin was one of the significant variables in the multivariate analysis, its diagnostic performance was evaluated using an additional ROC curve (Figure 1B), finding an AUC of 0.635 (95% CI: 0.59–0.68; $p < 0.001$) and an optimal cutoff point at <4.15 g/dL, with a sensitivity of 54.8%, specificity of 62.7%, PPV of 0.42 and NPV of 0.73.

Subsequently, combinations of the TGI with other clinical variables were analyzed to assess whether its diagnostic performance was improved. Combining the TGI with overweight or obesity (OO) increased specificity to 71.0% and maintained an acceptable sensitivity of 66.1% (PPV: 0.53; NPV: 0.81). Incorporating albumin into the model (criteria TGI ≥ 8.54, OS and ALB < 4.15) resulted in a progressive increase in specificity to 86.7%, although sensitivity decreased to 36.2%. A second alternative combination (TGI ≥ 8.54, OS and ALB < 4.15) yielded a slightly higher sensitivity (40.3%) with a specificity of 82.1% (Table 3).

**Figure 1.** ROC curves for the prediction of Prediabetes using A) the triglyceride-glucose index (TGI); B) serum albumin.

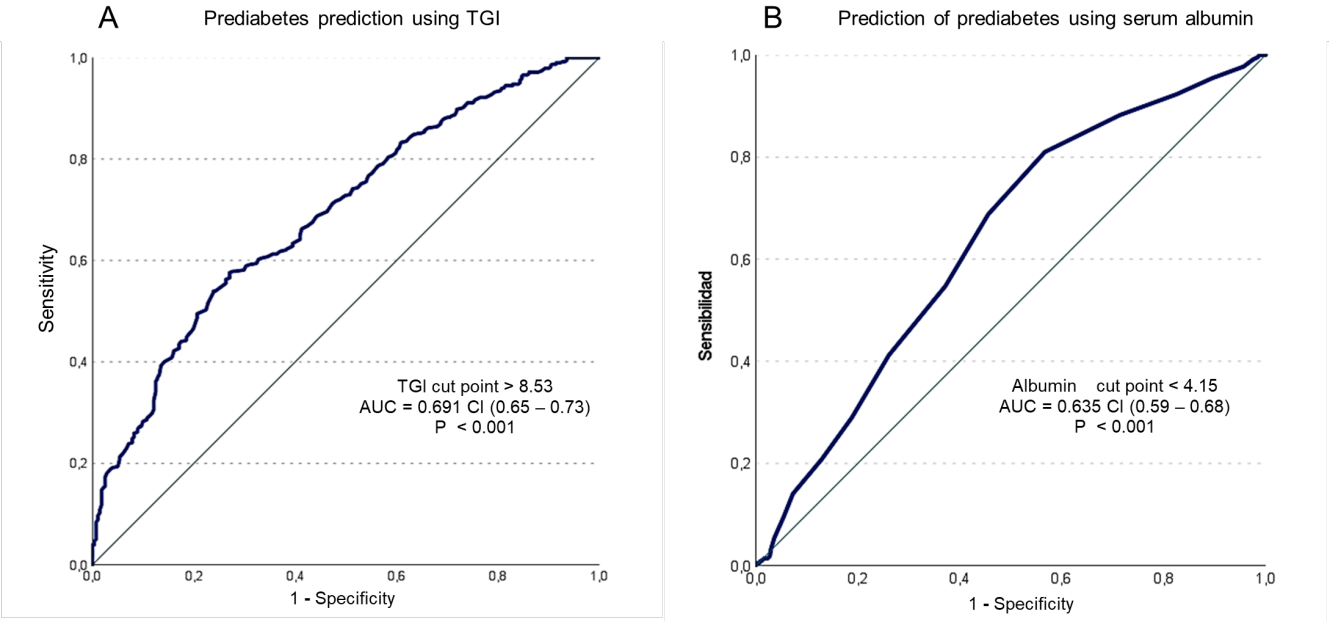


**Table 3**

Diagnostic accuracy of the triglyceride-glucose index (TGI) alone and combined with albumin and overweight/obesity for the detection of Prediabetes

| Criterion | VP | FP | FN | VN | S | AND | VPP | VPN |
|---|---|---|---|---|---|---|---|---|
| TGI >=8.54 | 166 | 185 | 55 | 257 | 75.1% | 58.1% | 0.47 | 0.82 |
| ALB <4.15 | 121 | 165 | 100 | 277 | 54.8% | 62.7% | 0.42 | 0.73 |
| TGI+OO | 146 | 128 | 75 | 314 | 66.1% | 71.0% | 0.53 | 0.81 |
| TGI+ALB+OO | 80 | 59 | 141 | 383 | 36.2% | 86.7% | 0.58 | 0.73 |
| TGI+ALB+OO | 89 | 79 | 132 | 363 | 40.3% | 82.1% | 0.53 | 0.73 |

VP: True positives; FP: False positives; FN: False negatives; TN: True negatives; S: Sensitivity; E: Specificity; PPV: Positive predictive value; NPV: Negative predictive value; TGI: Triglyceride-glucose index; OO: Overweight and obesity; ALB: Albumin.

## DISCUSSION

The results demonstrated that an TGI ≥ 8.54 shows moderate utility as a marker for the early detection of type 2 diabetes mellitus (T2DM). These findings are consistent with previous studies by Zhang and Zeng in a cross-sectional analysis of more than 25,000 US adults using NHANES data, which found a non-linear relationship between TGI and the prevalence of Prediabetes and diabetes, observing a progressive increase in risk starting from an TGI > 8.00 in men and > 9.00 in women. [39] This behavior suggests that the risk threshold for TGI may vary according to population characteristics, justifying the need for local studies such as the present one.

In a prospective cohort study in China, [31] reported that a one-standard-deviation increase in TGI was associated with a 1.38-fold increased risk of Prediabetes. Furthermore, they found that the TGI had better diagnostic performance than other non-insulin-based markers, such as the triglyceride/HDL ratio or obesity, with an AUC of 0.60 [31], a value comparable to that observed in this study.

In this study, the specificity of the TGI (58.1%) implies that a considerable proportion of individuals without Prediabetes could be initially classified as at risk, resulting in false positives. In clinical practice, this does not invalidate its usefulness, as these individuals can benefit from follow-up and preventive guidance. Furthermore, although the AUC was moderate, the cutoff point (≥ 8.54) offers utility in the clinical context as an initial screening tool. Its value lies in facilitating the early detection of individuals at risk of Prediabetes, even at the cost of a proportion of false positives. In this sense, the TGI should not be considered a definitive diagnostic marker, but rather a complement to other tests or clinical criteria, especially in primary care settings or environments with limited resources, where access to more complex methods may be restricted.

A key finding of the study was the identification of a significant relationship between low albumin levels and Prediabetes, even after multivariate adjustment. This finding may differ from other studies, which indicate increased albumin levels in patients with insulin resistance [39,40], even though elevated albumin is not explicitly linked to the development of type 2 diabetes mellitus (T2DM). [40] This association could be explained by variations in liver albumin production under conditions of insulin resistance due to hepatic stimulation. [41]

When analyzing diagnostic combinations, it was observed that incorporating SO into the TGI criterion increased specificity to 71.0%. This improvement was even more pronounced when combining TGI, OO, and albumin, achieving a specificity of 86.7%, which coincides with that reported by Chen et al., who demonstrated that a TGI greater than 8.88 significantly decreases the probability of regression to normoglycemia, especially in patients with a high BMI. [28]

In the multivariate analysis, the TGI maintained a significant association with the diagnosis of Prediabetes, positioning it as an independent predictor. This finding is consistent with a preliminary study reporting that TGI has diagnostic capacity comparable to HbA1c, [42] but with the advantage of being a more accessible method in resource-limited settings.

Additionally, it has been shown that the TGI not only predicts the onset of Prediabetes but is also associated with cardiovascular complications. Another study demonstrated that an elevated TGI is associated with a higher risk of cardiovascular disease in individuals under 65 years of age with Prediabetes or diabetes, [43] reinforcing its effectiveness as a prognostic marker and not just a diagnostic one. These results demonstrate the TGI's functionality as a screening tool in adult populations at metabolic risk. The non-linear relationship with regression to normoglycemia observed in longitudinal studies[28] suggests the importance of low TGI levels, even in the early stages of dysglycemia, which could prevent progression to overt diabetes.

**Limitations**

Despite efforts to control for bias, limitations inherent to the study design were identified, including potential recording errors or underestimation of relevant, undocumented clinical variables —such as family history of diabetes, physical activity level, dietary habits, and inflammatory markers—leading to uncontrolled confounding. Furthermore, the multivariate model showed marginal fit in the statistical analysis, and a third model proved unfeasible. This suggests that the regression results require further refinement and validation.

Another limitation is that the observed moderate specificity carries a risk of false positives, which limits its use as a standalone diagnostic tool. Therefore, the identified cutoff point should be interpreted with caution, as it may require initial adaptation across populations with varying genetic, epidemiological, or lifestyle profiles. Multicenter, longitudinal studies are needed to confirm the external validity of these findings.

In addition, limitations were identified, including periods of unreported results due to a lack of reagents at the institution, as well as the absence of screenings based on insulin measurements or oral glucose tolerance tests.

However, the study provides evidence on the usefulness of the TGI as an accessible marker for detecting Prediabetes.

## CONCLUSIONS

The TGI showed moderate discriminative capacity to predict prediabetic status in nondiabetic adults, with a cutoff point of ≥ 8.54, making it a practical, accessible, and economical marker for prediabetes screening. Serum albumin < 4.15 g/dL was associated with a higher risk of Prediabetes. The combination of TGI with BMI ≥ 25 and low albumin levels improved diagnostic specificity. TGI can be considered a complementary tool for early detection of dysglycemia, especially in resource-limited settings where insulin- or HbA1c-based testing is unavailable. Prospective validation of these results in other populations is recommended to strengthen their clinical applicability.

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**Contribution statement:**

Author 1: study design, statistical analysis, and initial writing, general supervision, and funding.

Author 2: collection and validation of clinical data.

Author 3: Collection of laboratory data and support in statistical analysis.

Author 4: discussion, review, and formatting adjustments of the final manuscript.

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## Información adicional

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