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-----------MANUSCRIPT DETAILS-----------
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Manuscript title: Association Between Glycated Hemoglobin and Lipid Parameters at the Time of Type 2 Diabetes Mellitus Diagnosis: Evidence From a Regional Cohort
Manuscript ID: 1833588
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Abstract: Type 2 diabetes mellitus (T2DM) is associated with lipid abnormalities that increase cardiovascular risk; however, evidence regarding this relationship at diagnosis is limited. This study aimed to examine the association between glycated hemoglobin (HbA1c) and lipid parameters at the time of T2DM diagnosis. A retrospective cross-sectional study included 3,501 newly diagnosed T2DM patients treated within the Riojano Health Service between 2019 and 2025. Spearman correlations and linear regression were used to assess associations between HbA1c and lipid parameters. The study was approved by the Research Ethics Committee of La Rioja (CEImLAR, PI 778). HbA1c was positively correlated with total cholesterol (TC) ($\rho = 0.043$; $p < 0.05$), low-density lipoprotein cholesterol (LDL-C) ($\rho = 0.044$; $p < 0.05$) and triglycerides (TG) ($\rho = 0.217$; $p < 0.001$), and inversely correlated with high-density lipoprotein cholesterol (HDL-C) ($\rho = -0.213$; $p < 0.001$). In linear regression adjusted for age, sex, and body mass index (BMI), higher HbA1c was associated with increased TC, TG and decreased HDL-C. These findings highlight that at diagnosis, higher HbA1c levels are associated with a more atherogenic lipid profile, emphasizing the importance of early metabolic assessment and comprehensive cardiovascular risk management, with an essential role for nursing in

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Association Between Glycated Hemoglobin and Lipid Parameters at the Time of Type 2 Diabetes Mellitus Diagnosis: Evidence From a Regional Cohort

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Scope Statement

Type 2 diabetes mellitus (T2DM) is strongly associated with cardiovascular disease, yet evidence on the relationship between glycemic control and lipid profile at the time of diagnosis remains limited. This study provides evidence from a large regional cohort of newly diagnosed T2DM patients, examining the association between glycated hemoglobin (HbA1c) and lipid parameters at disease onset. Our findings show that higher HbA1c levels were independently associated with a more atherogenic lipid profile, characterized by increased total cholesterol and triglycerides and reduced HDL cholesterol. These results suggest that cardiovascular risk may already be present at the earliest stages of T2DM and underscore the importance of early, comprehensive metabolic assessment. By identifying HbA1c as a marker linked to adverse lipid patterns at diagnosis, the study supports integrated and individualized management strategies addressing both glycemic control and cardiovascular risk from the outset. This evidence is particularly relevant to clinical practice, contributing to improved early risk stratification and preventive care in patients with T2DM, and aligns with the aims of Frontiers in Medicine.

Conflict of interest statement

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest

Credit Author Statement

Beatriz Rodríguez-Roca: Conceptualization, Supervision, Writing – original draft, Writing – review & editing. **Elena Andrade-Gómez**: Conceptualization, Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing. **Félix Rivera-Sanz**: Resources, Validation, Writing – review & editing. **Miren Idoia Pardavila-Belio**: Formal Analysis, Validation, Writing – review & editing. **Paula Rojas-García**: Data curation, Validation, Writing – review & editing. **Raquel Sainz-Prado**: Conceptualization, Data curation, Formal Analysis, Methodology, Visualization, Writing – original draft, Writing – review & editing.

Keywords

clinical practice, Fasting plasma glucose, Glycated hemoglobin, lipid profile, Nursing, Total cholesterol, Type 2diabetes mellitus

Abstract

Word count: 200

Type 2 diabetes mellitus (T2DM) is associated with lipid abnormalities that increase cardiovascular risk; however, evidence regarding this relationship at diagnosis is limited. This study aimed to examine the association between glycated hemoglobin (HbA1c) and lipid parameters at the time of T2DM diagnosis. A retrospective cross-sectional study included 3,501 newly diagnosed T2DM patients treated within the Riojano Health Service between 2019 and 2025. Spearman correlations and linear regression were used to assess associations between HbA1c and lipid parameters. The study was approved by the Research Ethics Committee of La Rioja (CEImLAR, PI 778). HbA1c was positively correlated with total cholesterol (TC) ($\rho = 0.043$; $p < 0.05$), low-density lipoprotein cholesterol (LDL-C) ($\rho = 0.044$; $p<0.05$) and triglycerides (TG) ($\rho = 0.217$; $p < 0.001$), and inversely correlated with high-density lipoprotein cholesterol (HDL-C) ($\rho = -0.213$; $p < 0.001$). In linear regression adjusted for age, sex, and body mass index (BMI), higher HbA1c was associated with increased TC, TG and decreased HDL-C. These findings highlight that at diagnosis, higher HbA1c levels are associated with a more atherogenic lipid profile, emphasizing the importance of early metabolic assessment and comprehensive cardiovascular risk management, with an essential role for nursing in early intervention, patient education and prevention.

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Ethics statements

Studies involving animal subjects

Generated Statement: No animal studies are presented in this manuscript.

Studies involving human subjects

Generated Statement: The studies involving humans were approved by Research Ethics Committee of La Rioja (CEImLAR). The studies were conducted in accordance with the local legislation and institutional requirements. The ethics committee/institutional review board waived the requirement of written informed consent for participation from the participants or the participants' legal guardians/next of kin because Due to the retrospective nature of the study and the use of fully anonymized data.

Inclusion of identifiable human data

Generated Statement: No potentially identifiable images or data are presented in this study.

Data availability statement

Generated Statement: The data analyzed in this study is subject to the following licenses/restrictions: **The data supporting the findings of this study are available from the corresponding author upon reasonable request. Access to the data will be granted subject to appropriate justification and compliance with relevant ethical and legal requirements**. Requests to access these datasets should be directed to **brodriguez@unizar.es**.

Generative AI disclosure

No Generative AI was used in the preparation of this manuscript.

Association Between Glycated Hemoglobin and Lipid Parameters at the Time of Type 2 Diabetes Mellitus Diagnosis: Evidence From a Regional Cohort

Raquel Sainz-Prado[1,2], Beatriz Rodríguez-Roca[3,4*,] Miren Idoia Pardavila-Belio[5,6], Paula Rojas-García[7], Félix Rivera-Sanz[8], Elena Andrade-Gómez[1]

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Abstract

Background and Objectives. Type 2 diabetes mellitus (T2DM) is associated with lipid abnormalities that increase cardiovascular risk; however, evidence regarding this relationship at diagnosis is limited. This study aimed to examine the association between glycated hemoglobin (HbA1c) and lipid parameters at the time of T2DM diagnosis.

Methods. A retrospective cross-sectional study included 3,501 newly diagnosed T2DM patients treated within the Riojano Health Service between 2019 and 2025. Spearman correlations and linear regression were used to assess associations between HbA1c and lipid parameters. The study was approved by the Research Ethics Committee of La Rioja (CEImLAR, PI 778).

Results. HbA1c was positively correlated with total cholesterol (TC) ($\rho = 0.043$; $p < 0.05$), low-density lipoprotein cholesterol (LDL-C) ($\rho = 0.044$; $p < 0.05$) and triglycerides (TG) ($\rho = 0.217$; $p < 0.001$), and inversely correlated with high-density lipoprotein cholesterol (HDL-C) ($\rho = -0.213$; $p < 0.001$). In linear regression adjusted for age, sex, and body mass index (BMI), higher HbA1c was associated with increased TC, TG and decreased HDL-C.

Conclusion. At diagnosis, higher HbA1c levels were associated with a more atherogenic lipid profile—higher TC and TG, and lower HDL-C—highlighting the importance of early metabolic assessment and comprehensive cardiovascular risk management, with an essential role for nursing in early intervention, patient education and prevention.

1 Introduction

Type 2 diabetes mellitus (T2DM) is a metabolic disorder characterized by chronic hyperglycemia resulting from impaired insulin secretion, impaired insulin action, or both (1). It is one of the most prevalent chronic diseases worldwide, currently affecting more than 463 million people, with projections estimating that this number will exceed 690 million by 2045 (2).

Individuals with T2DM present a two- to fourfold higher risk of cardiovascular disease (CVD) compared with general population, positioning CVD as the principal cause of morbidity and mortality in this group (3) and a major public health burden worldwide. From a population health perspective, inadequate glycemic control represents a key modifiable determinant of CVD risk, with glycated hemoglobin (HbA1c) functioning as a standardized epidemiological indicator of long-term hyperglycemia over the preceding 2–3 months and demonstrating a robust and consisted association with cardiovascular outcomes (4,5).

Sustained hyperglycemia contributes to CVD through multiple pathophysiological mechanisms, including insulin resistance, low-grade chronic inflammation, endothelial dysfunction, and microvascular damage mediated by advanced glycation end-products (6,7). From a public health perspective, these mechanisms underpin the high population-attributable risk of cardiovascular complications associated with T2DM, especially when hyperglycemia remains undetected or poorly controlled. T2DM commonly coexists with other metabolic disturbances such as dyslipidemia and hypertension, which cluster at the population level and synergistically amplify cardiometabolic risk (2).

The characteristic dyslipidemia of T2DM includes elevated triglycerides (TG), increased small dense LDL particles, and reduced HDL cholesterol (HDL-C), forming a highly atherogenic profile (8,9). These lipid abnormalities are highly prevalent in real-world clinical populations and represent a key target for early cardiovascular risk reduction strategies. Hyperglycemia and insulin resistance modify lipid metabolism and promote the accumulation of atherogenic lipoproteins, contributing to the early development of subclinical atherosclerosis (10).

The role of nursing is essential in early detection, comprehensive assessment, and initial management of patients with T2DM, particularly at the time of diagnosis when metabolic alterations may go unnoticed (11). From a clinical perspective, nursing professionals play a key role in screening, surveillance a longitudinal monitoring glycemic and lipid parameters, identifying cardiovascular risk factors, and providing therapeutic education aimed at enhancing adherence to both pharmacological and non-pharmacological treatments (12,13). Evidence shows that nurse-led self-management education programs are effective in improving glycemic control and even lipid-related outcomes, underscoring the importance of nursing involvement in metabolic risk reduction (13). In addition, nursing contributes substantially to the promotion of healthy lifestyles -including healthy eating, physical activity, and self-care behaviors- which are essential for improving metabolic control and reducing the progression toward an atherogenic lipid profile (14). Due to their continuous close contact with patients and their ability to deliver individualized interventions, nurses are strategically positioned to implement early preventive measures and support an integrated and effective management of T2DM from the very beginning of the diagnostic process (11,14,15).

Despite the high prevalence of T2DM and its strong association with CVD, evidence from our context is limited regarding the metabolic profile of newly diagnosed patients, particularly the relationship between early glycemic control and lipid alterations. Understanding this interaction at the initial stages of the disease trajectory is crucial for informing therapeutic strategies and reducing future cardiovascular risk.

Therefore, this study aimed to explore the relationship between HbA1c levels and lipid parameters in a retrospective cohort of newly diagnosed T2DM patients, providing evidence to support early, prevention-oriented clinical decision making at the time of diagnosis.

2 Methods

2.1 Study Design

A retrospective cross-sectional study was conducted using routinely collected clinical and biochemical data from patients newly diagnosed with type 2 diabetes mellitus (T2DM). Baseline information corresponding to the time of diagnosis was obtained from electronic medical records of the Riojano Health Service (Servicio Riojano de Salud, SERIS). The study included diagnoses recorded between 2019 and 2025.

2.2 Population

The study included 3,501 individuals with a diagnosis of T2DM registered in SERIS. Eligible participants were identified using the International Classification Diseases, 10th revision (ICD-10) Code E11. The final sample size was determined by the availability of medical records meeting the predefined inclusion and exclusion criteria during the study period.

2.3 Inclusion criteria

- Residence in the Autonomous Community of La Rioja.
- Diagnosis of T2DM based on ICD-10 code E11, confirmed by at least one of the following criteria:
    - HbA1c ≥ 6.5% (48 mmol/mol) in two separate tests
    - Fasting plasma glucose ≥ 126 mg/dL in two separate tests
- Age ≥ 18 years

2.4 Exclusion criteria (ICD-10)

- Pregnancy
- Ongoing cancer treatment
- Alzheimer’s disease, dementia, or severe cognitive impairment
- Heart failure (New York Heart Association (NYHA) class III–IV)
- Left ventricular ejection fraction (LVEF) < 40%
- Severe functional limitations due to peripheral arterial disease

2.5 Data sources and data collection

Data were extracted from electronic medical record by the Data Science, Big Data and Artificial Intelligence Unit (UCIDA) of SERIS Information between 2019 and 2025.

Study variables

All sociodemographic, clinical, and biochemical variables were obtained from patients' medical records.

Sociodemographic variables:

Sex, date of birth, age, city and country of origin, rural/urban residence, primary care center, health district, and history of anxiety or depression.

Clinical variables:

Date of diabetes diagnosis, body mass index (BMI; kg/m²), systolic blood pressure (SBP), and diastolic blood pressure (DBP). Clinical measurements were collected from forms within a maximum of 60 days from the diagnosis date.

Biochemical variables:

Glucose, total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C), high-density lipoprotein cholesterol (HDL-C), triglycerides (TG) and glycated hemoglobin (HbA1c). Biochemical variables corresponded to the laboratory test closest to the diagnosis date, within a maximum window of 60 days.

2.6 Ethical Considerations

The study was conducted in accordance with the principles of the Declaration of Helsinki and applicable national and institutional regulations on human subject research. Informed consent from patients was not required, as only fully anonymized data from medical records were used.

Data were provided by the Data Science, Big Data, and Artificial Intelligence Unit (UCIDA) of the public health system of La Rioja, within the framework of a project approved by the Research Ethics Committee of La Rioja (CEImLAR, PI 778, September 2025). Patient data were coded and handled in compliance with current legislation on data protection and used exclusively for research purposes.

2.7 Statistical Analysis

Statistical analyses were conducted using IBM SPSS Statistics version 28.01.1 (16). Qualitative variables were described as frequencies and percentages (n, %); quantitative variables were summarized as mean ± standard deviation (SD).

The distribution of continuous variables was evaluated using graphical methods and tests of normality. Differences in lipid parameters across clinically relevant HbA1c categories were assessed using one-way analysis of variance (ANOVA) for TC, LDL-C, and HDL-C, and the Kruskal–Wallis test for TG.

Associations between HbA1c and lipid parameters were initially explored using Spearman correlation coefficients. To account for potential confounding, multiple linear regression models were performed using HbA1c as the main predictor of lipid profile variables, adjusting for age, sex, and BMI. Statistical significance was set at $p < 0.05$, with a 95% confidence level.

3 Results

A total of 3,504 patients were initially identified. Three patients were excluded due to missing laboratory data, resulting in a final sample of 3,501 patients included in the analysis (Fig. 1).

Of the 3,501 patients included, not all laboratory parameters were available for every participant. Additionally, extreme or implausible values were excluded from the analyses to minimize potential errors. Therefore, the number of participants with available data for each biochemical variable varied.

Fig. 1. Flow diagram of participant selection for the cross-sectional analysis.

3.1 General characteristics

The study included 3,501 patients with a mean age of 67.9 ± 12.94 years; 56.2% were men and 43.8% were women. The majority (84.6%) were from Spain, whereas 15.4% were from other countries. Most patients (67%) lived in urban areas, while 33% resided in rural settings (Table 1).

Table 1. Sociodemographic characteristics (n = 3,501).

Regarding the distribution of diagnoses over time, 15.1% of patients were diagnosed with T2DM in 2019, 14.3% in 2020, 15.9% in 2021, 17.8% in 2022, and 17.1% in 2023. A marked decrease was observed in 2024, which persisted into 2025, with 9.9% of diagnoses occurring in each year.

3.2. Clinical and biochemical parameters

Table 2 presents the mean values, standard deviations, and number of valid observations for the main clinical and biochemical variables, including glucose, HbA1c, lipid profile, BMI, and blood pressure, stratified by sex and for the total population.

Table 2. Clinical and biochemical parameters in men, women, and the total population.

Among the 2,903 patients with available HbA1c at diagnosis, 26.4% had values between 7.0% (53 mmol/mol) and 8.9% (74 mmol/mol), and 12.4% had HbA1c ≥9% (75 mmol/mol). TG data were available for 1,508 patients at diagnosis. Among these, 668 patients (44.3%) had TG levels between 150 and 200 mg/dL and 840 patients (55.7%) had values >200 mg/dL.

3.3. Lipid profile according to HbA1c categories

When lipid parameters were analyzed according to clinically relevant HbA1c categories (Table 3), a progressive worsening of the lipid profile was observed with increasing HbA1c levels. Higher HbA1c categories were associated with higher TC, LDL-C and TG levels, together with lower HDL-C values. These differences remained statistically significant across HbA1c groups for TC, HDL-C and TG.

Table 3. Lipid profile according to clinically relevant HbA1c categories.

3.4. Correlation and regression analysis

Spearman correlation analyses showed a statistically significant but weak positive association between HbA1c and TC ($\rho = 0.043$; $p < 0.05$), LDL-C ($\rho = 0.044$; $p < 0.05$) and TG ($\rho = 0.217$; $p < 0.001$), as well as a negative association with HDL-C ($\rho = -0.213$; $p < 0.001$).

Given the generally weak correlations observed, multiple linear regression analyses adjusted for age, sex, and BMI were performed. HbA1c was independently associated with higher TC and TG levels, as well as a lower HDL-C (all $p < 0.001$), whereas its association with LDL-C did not reach statistical significance.

Sex consistently demonstrated an influence across models, with women presenting higher TC, LDL-C and HDL-C levels compared with men. Age was negatively associated with TC, LDL-C and TG, while BMI showed a significant inverse association with HDL-C and a positive association with TG.

These findings indicate that, at the biochemical evaluation performed at the time of T2DM diagnosis, higher HbA1c levels are independently associated with lipid parameters, after adjustment for age, sex and BMI (Table 4).

Table 4. Effect of HbA1c, sex, age, and BMI on lipid parameters: Adjusted multiple linear regression results.

4 Discussion

This study examined the relationship between glycemic control and lipid profile in a cohort of 3,504 patients newly diagnosed with T2DM. The mean age of the cohort was 67.9 years, a factor closely linked to the incidence of diabetes and its complications, likely related to reduced physical activity and certain lifestyle habits (17,18). The higher prevalence of diabetes in men (56.2%) differs from what has been reported in other population contexts (19,20). A rise in the number of T2DM diagnoses was observed in the years immediately following the COVID-19 pandemic, likely related to lifestyle changes during lockdown including reduced physical activity, poorer dietary habits, increased consumption of alcohol and tobacco, and sleep disturbances, stress, anxiety, and depression (21-23). These factors may have contributed to increases in overweight, obesity, and metabolic disorders (24) in addition to potential metabolic alterations derived from COVID-19 infection itself (25-28).

Although the association between diabetes mellitus and cardiovascular risk is well established (29,30), the main findings of this study indicate that this relationship is present from the early stages of the disease. Even at the time of diagnosis, poorer glycemic control—reflected by higher HbA1c levels—was independently associated with a more atherogenic lipid profile, characterized by higher total TC and TG, and lower HDL-C levels, consistent with previous studies (31). Specifically, after adjustment for age, sex and BMI, each 1% increase in HbA1c (≈11 mmol/mol) was associated with an increase of 4.25 mg/dL in TC, 15.65 mg/dL in TG, and a decrease of 1.40 mg/dL in HDL-C, reinforcing evidence that chronic hyperglycemia disrupts lipid metabolism and contributes to cardiovascular risk even before clinical complications become apparent.

Sex also had a significant influence on the lipid profile: after adjustment, women presented slightly higher TC, LDL-C and HDL-C levels, in line with previous reports (32,33). This may be related to decreased estrogen levels after menopause, which have been associated with increases in TC and LDL-C (34).

The absence of a significant association between HbA1c and LDL-C concentration in the adjusted models does not preclude the presence of atherogenic lipid alterations. In T2DM, dyslipidemia is characterized by elevated TG, reduced HDL-C, and a predominance of small dense LDL particles, while total LDL-C concentrations often remain within normal ranges (35,36). Previous studies have similarly reported that HbA1c is not significantly associated with LDL-C levels (37), whereas others have found positive correlations (38-40); however, these studies differ substantially from ours in terms of geographical and ethnic context, sample size and population characteristics.

Hypertriglyceridemia, in particular, was closely linked to poor glycemic control, reflecting the severity of insulin resistance and hepatic lipid overproduction (36). This can be explained by the pathophysiology of T2DM: insulin facilitates glucose uptake and suppresses lipolysis in adipose tissue (41). However, in the presence of insulin resistance or deficiency, this response is impaired, increasing the release of free fatty acids and glycerol into circulation. These substrates are subsequently transported to the liver, where they promote hepatic synthesis of phospholipids, cholesterol, and TG, resulting in increased very-low-density lipoprotein (VLDL) production and elevated circulating TG levels (42,43). Consistent with this mechanism, our findings show that TG levels increase progressively as HbA1c rises, indicating that hypertriglyceridemia develops early in T2DM and contributes to the atherogenic lipid profile from the disease onset.

From a clinical practice perspective, these findings reinforce the crucial role of healthcare professionals in the early identification and management of metabolic alterations in newly diagnosed T2DM patients, with nurse-led care shown to improve cardiovascular risk profiles and early metabolic detection (11,15). Given that higher HbA1c levels were associated with a more atherogenic lipid profile, nursing professionals are positioned to play a proactive role in cardiovascular risk stratification, patient education, and the implementation of individualized care plans, consistent with evidence showing superior glycemic control under nurse-led follow-up when compared to conventional care (12,13). Their participation in structured follow-up, motivational interviewing, and lifestyle counseling is essential to promote adherence and prevent worsening of dyslipidemia and hyperglycemia, and effect aligned with meta-analytic data demonstrating that nurse-led self-management education substantially improves metabolic outcomes (13,14). Furthermore, interventions delivered by nurses that focus on lifestyle modification, including guidance on healthy eating patterns, increased physical activity, and effective self-care practices, play a decisive role in strengthening diabetes self-management and have been shown to positively influence long-term metabolic control (14,15). Taken collectively, these findings highlight the strategic position of nurses in ensuring continuity of care, promoting early preventive measures, and facilitating integrated management from diagnosis onward.

The findings of this study have important clinical implications. The positive relationship between HbA1c and lipid profile in newly diagnosed T2DM suggests that HbA1c may serve as a biomarker not only for glycemic control but also for early cardiovascular risk detection. Elevated HbA1c levels, indicating insufficient glucose regulation, may help identify patients who are more likely to present lipid abnormalities. This underscores the need for early implementation of integrated therapeutic strategies—targeted lipid control and lifestyle interventions—that simultaneously address glucose and lipid metabolism to reduce cardiovascular risk. Collectively, these results contribute meaningful evidence on the relationship between glycemic and lipid parameters in the population of La Rioja.

This study has some limitations that should be considered when interpreting the results. First, due to the cross-sectional design, the findings reflect associations at a single point in time, preventing causal inferences or temporal sequencing between the variables. Second, biochemical and clinical parameters may have been influenced by unmeasured confounders, such as dietary patterns, intense physical activity, stress levels, acute illness, or use of medications that could modify metabolic outcomes. Third, certain biochemical markers, such as TG, may exhibit temporal variability, and reliance on a single measurement could introduce information bias and limit estimation precision. Fourth, the number of observations varied across clinical and biochemical parameters due to incomplete laboratory data, which may affect the precision of estimates and comparisons between groups. These limitations highlight the need for caution when interpreting results and suggest that longitudinal research or repeated-measure studies are warranted to confirm and expand upon these associations.

Despite the inherent limitations of cross-sectional designs, this study benefits from a large, community-based cohort of adults aged 20 to 102 years. The substantial sample size and strong representativeness enhance external validity and provide a robust and generalizable depiction of the sociodemographic and clinical characteristics of this population. While causality cannot be established, cross-sectional designs offer valuable insights into the distribution and prevalence of early metabolic alterations and serve as a solid foundation for generating hypotheses and informing future longitudinal or experimental research.

5 Conclusion

The findings of this study indicate that, in this predominantly older adult population of mostly Spanish origin, the lipid profile is significantly influenced by glycemic control, as well as by sex and age. HbA1c was positively associated with TC and TG, and negatively associated with HDL, while no significant association was observed with LDL-C. These results reinforce the importance of achieving adequate glycemic control to reduce cardiovascular risk.

In addition to these findings, the present study highlights the essential role of healthcare professionals in translating early metabolic assessment into effective clinical action. Nurses are uniquely positioned to integrate glycemic and lipid data into personalized care strategies, reinforce treatment adherence, and guide patients in adopting sustainable lifestyle modifications that reduce cardiovascular risk. Their continuous and multidisciplinary involvement ensures that individuals newly diagnosed with T2DM receive timely education, monitoring, and support, thereby enhancing the impact of early interventions on long-term health outcomes. Incorporating nursing-led approaches into initial diabetes management may therefore strengthen preventive efforts and improve the overall quality of care.

From a clinical perspective, these results highlight the need for early and comprehensive cardiovascular risk assessment in patients with newly diagnosed T2DM—one that integrates both glycemic control and detailed lipid profiling. Early identification of unfavorable lipid patterns would allow the implementation of timely preventive and therapeutic strategies aimed at reducing cardiovascular risk and improving overall disease management. This underscores the relevance of personalized, risk-based approaches to care in T2DM.

6 Abbreviations

BMI: body mass index
CVD: cardiovascular disease
HDL-C: high-density lipoprotein cholesterol
HbA1c: glycated hemoglobin
LDL-C: low-density lipoprotein cholesterol
SD: standard deviation
TC: total cholesterol
TG: triglycerides

T2DM: type 2 diabetes mellitus

7 Author Contributions

RS-P: Conceptualization, Methodology, Data curation, Formal analysis, Visualization, Writing – original draft, Writing – review & editing. BR-R: Conceptualization, Supervision, Writing – original draft, Writing – review & editing. MI P-B: Formal analysis, Validation, Writing – review & editing. PR-G: Data curation, Validation, Writing – review & editing. FR-S: Resources, Validation, Writing – review & editing. EA-G: Conceptualization, Methodology, Visualization, Supervision, Writing – original draft, Writing – review & editing.

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11 Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request. Access to the data will be granted subject to appropriate justification and compliance with relevant ethical and legal requirements.

12 Tables

Table 1. Sociodemographic characteristics (n = 3,501).

Variable	Mean ± SD	N (%)
Age (years)	67.9 ± 12.94	—
Sex		
Men	—	1,967 (56.2%)
Women	—	1,534 (43.8%)
Country of origin		
Spain	—	2,750 (84.6%)
Other countries	—	499 (15.4%)
Residence		
Urban	—	2,345 (67%)
Rural	—	1,156 (33%)

Table 2. Clinical and biochemical parameters in men, women, and the total population.

Variable	Total Mean ± SD (N)	Men Mean ± SD (N)	Women Mean ± SD (N)
Glucose (mg/dL)	157.19 ± 53.82 (3,308)	159.98 ± 55.83 (1,865)	153.58 ± 50.90 (1,443)
HbA1c (%)	7.3 ± 1.55 (56 mmol/mol) (2,898)	7.4 ± 1.63 (57 mmol/mol) (1,630)	7.2 ± 1.45 (55 mmol/mol) (1,268)
TC (mg/dL)	191.93 ± 43.73 (3,107)	187.17 ± 44.72 (1,757)	198.12 ± 41.61 (1,350)
LDL-C (mg/dL)	109.49 ± 36.02 (2,728)	107.18 ± 36.40 (1,517)	112.37 ± 35.33 (1,211)
HDL-C (mg/dL)	48.32 ± 12.82 (2,995)	45.47 ± 11.87 (1,697)	52.03 ± 13.08 (1,298)
TG (mg/dL)	175.84 ± 105.59 (3,010)	180.06 ± 117.33 (1,702)	170.35 ± 87.75 (1308)
BMI (kg/m²)	31.84 ± 5.35 (827)	31.65 ± 4.98 (471)	32.08 ± 5.81 (356)
SBP (mmHg)	135.29 ± 16.45 (1,299)	136.53 ± 16.68 (716)	134.07 ± 16.08 (583)
DBP (mmHg)	78.70 ± 10.45 (1,276)	79.96 ± 10.75 (700)	77.17 ± 9.88 (576)

HbA1c = glycated hemoglobin, TC = total cholesterol, LDL-C = low-density lipoprotein cholesterol, HDL-C = high-density lipoprotein cholesterol, TG = triglycerides, BMI = body mass index, SBP = systolic blood pressure, DBP = diastolic blood pressure.

Table 3. Lipid profile according to clinically relevant HbA1c categories

HbA1c category	Total cholesterol (mg/dL) Mean ± SD (N)	LDL-C (mg/dL) Mean ± SD (N)	HDL-C (mg/dL) Mean ± SD (N)	Triglycerides (mg/dL) Mean ± SD (N)
<7.0 %	188.74 ± 41.34 (1,656)	107.68 ± 35.21 (1,531)	50.55 ± 12.70 (1,606)	156.18 ± 86.99 (1,610)
7.0–8.9 %	191.53 ± 43.77 (729)	108.95 ± 36.01 (629)	45.68 ± 12.28 (709)	188.96 ± 104.49 (711)

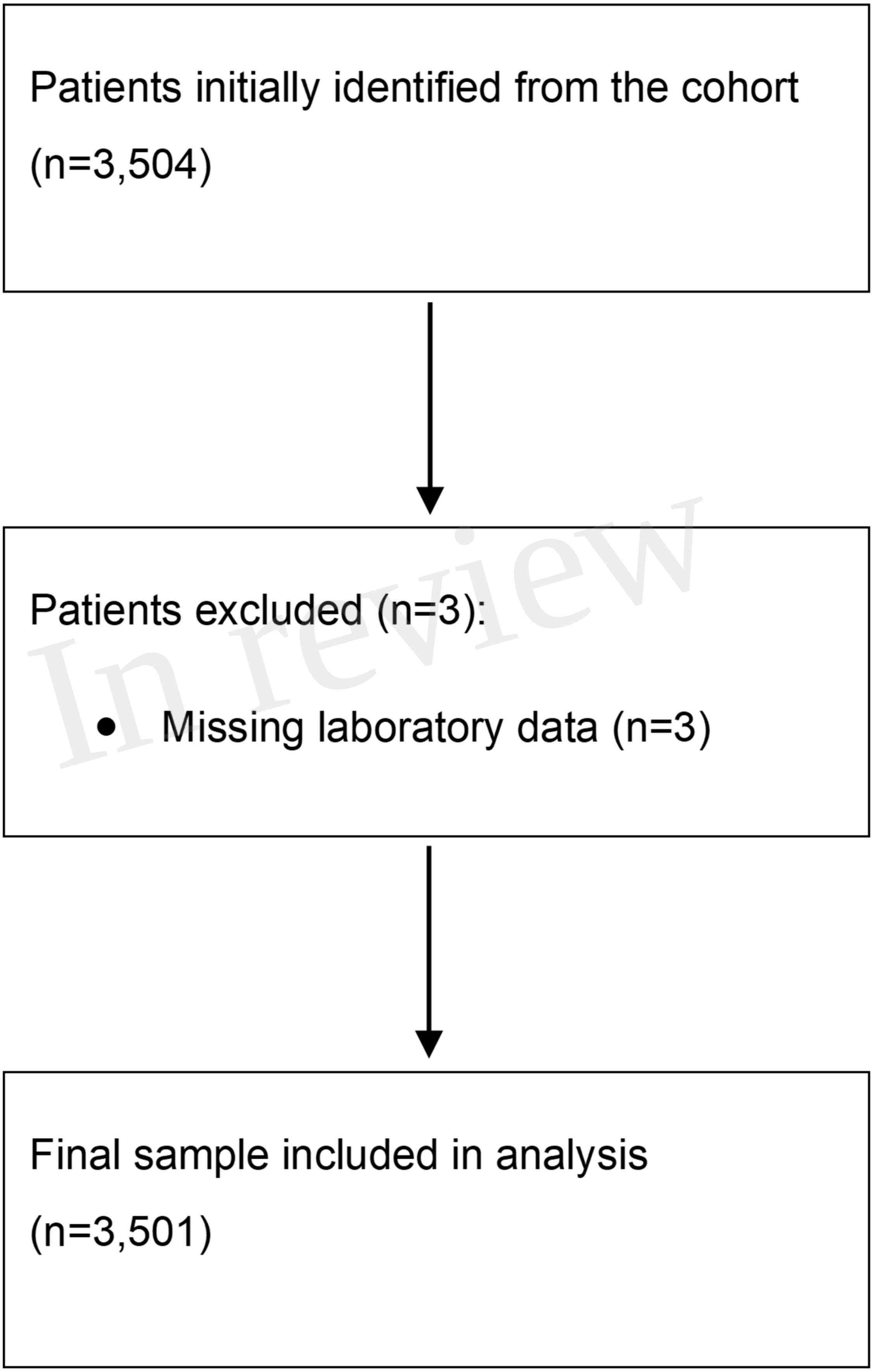
HbA1c category	Total cholesterol (mg/dL) Mean ± SD (N)	LDL-C (mg/dL) Mean ± SD (N)	HDL-C (mg/dL) Mean ± SD (N)	Triglycerides (mg/dL) Mean ± SD (N)
≥9.0%	204.30 ± 47.52 (351)	116.49 ± 37.64 (269)	42.63 ± 11.08 (342)	230.70 ± 139.71 (335)
p-value	<0.001	0,264	<0.001	<0.001

Differences across HbA1c categories were tested with one-way ANOVA for total cholesterol, LDL and HDL cholesterol, and the Kruskal–Wallis test for TG.

Table 4. Effect of HbA1c, sex, age, and BMI on lipid parameters: Adjusted multiple linear regression results.

Dependent Variable	R^2	Predictor	B	p
TC	0.106	HbA1c	4.25	<0.001
		Sex	19.76	<0.001
		Age	–0.55	<0.001
		BMI	-0.49	0.119
LDL-C	0.057	HbA1c	1.67	0.080
		Sex	10.47	<0.001
		Age	–0.54	<0.001
		BMI	–0.41	0.139
HDL-C	0.120	HbA1c	–1.40	<0.001
		Sex	6.07	<0.001
		Age	0.06	0.090
		BMI	–0.22	0.018
TG	0.116	HbA1c	15.65	<0.001
		Sex	8.28	0.264
		Age	–1.011	0.001
		BMI	1.535	0.034

B = unstandardized coefficient; p-values in bold indicate statistical significance ($p < 0.05$). Sex coded as 0 = male, 1 = female.


Patients initially identified from the cohort
(n=3,504)
Patients excluded (n=3):
• Missing laboratory data (n=3)
Final sample included in analysis
(n=3,501)

[07 July 2026]

Reviewer confirmation

To whom it may concern,

We are pleased to confirm that Yenny Yenny acted as a reviewer for the Family Medicine and Primary Care specialty section in Frontiers in Medicine.

Yenny Yenny was selected for this role by peers based on their expertise in the field and has played an important role in our collaborative peer-review process.

Please feel free to contact the editorial office at medicine@frontiersin.org if you have any questions about the reviewer role.

Best regards,

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