Section: General Medicine

Original Research Article

SERUM LIPID PROFILE IN PREDIABETICS AND DIABETICS

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ABSTRACT

Background: This study aimed to assess serum lipid profile parameters and their association with prediabetes and type 2 diabetes mellitus (T2DM) in adults attending a tertiary care hospital. The broader objective was to identify which lipid abnormalities are most strongly linked with worsening glycemic status and may therefore serve as practical clinical markers for early detection and cardiovascular risk stratification. **Materials and Methods:** This hospital-based observational cross-sectional study was conducted in the Department of Medicine, L.N. Medical College & Research Centre and associated J.K. Hospital, Bhopal, Madhya Pradesh, over 18 months. A total of 240 participants were enrolled, including 120 with prediabetes (HbA1c 5.7–6.4%) and 120 with T2DM (HbA1c >6.5%) according to ADA criteria. Patients aged above 18 years were included after written informed consent. Individuals with nephrotic syndrome, hypothyroidism, lipid-lowering therapy, alcoholism, smoking, pregnancy, hereditary dyslipidemia, and use of atypical antipsychotics were excluded. Fasting serum lipid profile parameters, including total cholesterol, triglycerides, HDL-C, LDL-C, and VLDL-C, were analyzed and compared between the two glycemic groups. **Result:** The study demonstrated a clear worsening of dyslipidemia with advancing glycemic dysregulation. Triglycerides and VLDL were consistently higher in the diabetic group than in the prediabetic group, while HDL-C was lower in patients with T2DM. Total cholesterol and LDL-C also showed an unfavorable trend in diabetes, though the association was less striking than that seen for triglycerides. The combined atherogenic pattern of high triglycerides with low HDL-C was more frequent among diabetics and also present in prediabetic individuals, suggesting that dyslipidemia begins early in the trajectory of glucose intolerance. These findings support the role of routine lipid screening in both prediabetes and T2DM. **Conclusion:** Serum lipid abnormalities, particularly elevated triglycerides, increased VLDL, and reduced HDL-C, are significantly associated with prediabetes and T2DM. The atherogenic dyslipidemic pattern becomes more pronounced as glycemic status worsens, indicating that lipid profile assessment can help identify individuals at higher metabolic and cardiovascular risk. Early detection and correction of lipid disturbances may therefore be important not only for glycemic management but also for prevention of future cardiovascular morbidity and mortality.

INTRODUCTION

Diabetes mellitus is one of the most important chronic metabolic disorders worldwide, and the burden is rising rapidly in low- and middle-income countries. Type 2 diabetes mellitus is particularly relevant because it is closely linked with obesity, insulin resistance, dyslipidemia, hypertension, and accelerated atherosclerotic cardiovascular disease. Prediabetes represents an intermediate metabolic state between normoglycemia and diabetes, and it is increasingly recognized as a stage during which vascular injury and metabolic abnormalities may already be present.

Atherogenic dyslipidemia is a well-known feature of insulin resistance and T2DM. It is typically

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characterized by elevated triglycerides, increased VLDL, reduced HDL-C, and in some patients a modest rise in total cholesterol and LDL-C. Although LDL-C may not always be markedly elevated, the qualitative changes in lipoprotein particles and the coexistence of high triglycerides and low HDL-C substantially increase cardiovascular risk. Because prediabetes is also associated with insulin resistance, similar lipid disturbances may appear before overt diabetes develops.

The clinical relevance of studying lipid abnormalities in prediabetes lies in the possibility of identifying a high-risk group at an earlier stage. Patients with prediabetes are frequently asymptomatic, and many remain undiagnosed until they develop diabetes or cardiovascular complications. If specific lipid abnormalities are shown to associate strongly with prediabetes and T2DM, routine lipid testing may provide an additional and practical tool for risk assessment in outpatient practice. This is particularly important in tertiary care settings where metabolic syndrome and cardiovascular risk factors are commonly encountered together.

Several studies have reported a positive association between dyslipidemia and diabetes, but the pattern may vary across populations depending on ethnicity, diet, body composition, and access to medical care. South Asian populations are known to have a high cardiometabolic risk at relatively lower body mass index levels, and dyslipidemia may contribute substantially to this risk. In this context, evaluating serum lipid profile parameters in prediabetic and diabetic patients can improve understanding of disease progression and help guide preventive strategies.

The present study was therefore designed to assess serum lipid profile parameters and their association with prediabetes and T2DM among adults attending a tertiary care hospital in Bhopal. The study also aimed to determine the type of lipid component acting as a risk factor and to explore its relevance to cardiovascular morbidity and mortality in the two glycemic states.

MATERIALS AND METHODS

Study design: This was a hospital-based observational cross-sectional study conducted in the Department of Medicine, L.N. Medical College & Research Centre and associated J.K. Hospital, Bhopal, Madhya Pradesh. The study duration was 18 months and included planning, recruitment and data collection, followed by statistical analysis and report writing.

Study population: The study universe consisted of all patients above 18 years of age attending the Department of Medicine during the study period. A total of 240 participants were enrolled, of whom 120 were prediabetic and 120 had T2DM. The prediabetic group included patients with HbA1c between 5.7% and 6.4%, while the diabetic group included those with HbA1c above 6.5%, as per American Diabetes Association criteria.

Eligibility criteria: Inclusion criteria were age above 18 years and fulfillment of the HbA1c criteria for prediabetes or T2DM. Exclusion criteria included nephrotic syndrome, hypothyroidism, current lipid-lowering therapy, alcoholism, smoking, pregnancy, hereditary dyslipidemia, and use of atypical antipsychotic drugs such as clozapine and olanzapine. These exclusions were applied to reduce confounding influences on serum lipid values.

Data collection: Demographic and clinical details were collected using a structured case record form. Venous blood samples were obtained after an overnight fast. Serum lipid profile parameters assessed included total cholesterol, triglycerides, HDL-C, LDL-C, and VLDL-C. HbA1c was used to classify participants into the study groups. Laboratory estimation was performed using standard hospital protocols.

RESULTS

The results of this study showed a consistent and clinically relevant association between serum lipid disturbances and glycemic status. Compared with the prediabetic group, patients with T2DM had higher mean total cholesterol, triglycerides, LDL-C, and VLDL-C, while HDL-C was lower. Among all lipid parameters, triglycerides and VLDL-C showed the most obvious rise in the diabetic group, suggesting that hypertriglyceridemia is a prominent biochemical feature of worsening glucose intolerance.

The proportion of participants with abnormal lipid values was also greater in T2DM than in prediabetes. Low HDL-C was common in both groups, but it was more frequent among diabetics, indicating a shift toward a more atherogenic profile as disease severity increased. The combined pattern of high triglycerides with low HDL-C was particularly important because it was observed more often in the diabetic group and reflects insulin resistance and elevated cardiovascular risk.

Total cholesterol and LDL-C were also higher in T2DM, but their association was less pronounced than that of triglycerides and HDL-C. This pattern is consistent with the concept of diabetic dyslipidemia, where triglyceride-rich lipoproteins and reduced HDL-C are the dominant abnormalities. The observation that lipid abnormalities were already present in prediabetes suggests that metabolic derangement begins before overt diabetes is diagnosed.

Overall, the data support the view that lipid profile parameters can serve as practical markers of cardiometabolic risk in patients with prediabetes and T2DM. Among these parameters, triglycerides, VLDL-C, and HDL-C appear to be the most informative for identifying the atherogenic burden.

Statistical Analysis: Data were entered in Microsoft Excel and analyzed using appropriate statistical

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software. Continuous variables were expressed as mean and standard deviation or median and interquartile range, depending on distribution. Categorical variables were expressed as frequency and percentage. Comparison between prediabetes and T2DM groups was performed using the Student t test or Mann-Whitney U test for continuous variables and the chi-square test for categorical variables. A p value of less than 0.05 was considered statistically significant. For the manuscript, tables were formatted to highlight the direction and magnitude of lipid abnormalities across the two glycemic categories.

Table 1: Baseline profile of study participants

Variable	Prediabetes (n=120)	T2DM (n=120)
Age, years	46.2 ± 9.8	52.8 ± 10.4
Male sex, n (%)	64 (53.3)	66 (55.0)
BMI, kg/m²	25.4 ± 3.1	27.1 ± 3.4
HbA1c, %	6.1 ± 0.2	8.2 ± 1.1

Table 2: Mean serum lipid profile in the two groups

Parameter	Prediabetes	T2DM
Total cholesterol (mg/dL)	184.6 ± 28.4	196.8 ± 31.7
Triglycerides (mg/dL)	146.2 ± 36.9	188.5 ± 44.6
HDL-C (mg/dL)	44.8 ± 6.7	39.2 ± 5.8
LDL-C (mg/dL)	108.3 ± 24.2	118.6 ± 27.1
VLDL-C (mg/dL)	29.2 ± 7.4	37.7 ± 8.9

Table 3: lipid abnormalities among participants

Abnormality	Prediabetes n (%)	T2DM n (%)
High total cholesterol	32 (26.7)	49 (40.8)
High triglycerides	54 (45.0)	81 (67.5)
Low HDL-C	58 (48.3)	76 (63.3)
High LDL-C	28 (23.3)	40 (33.3)
High VLDL-C	41 (34.2)	68 (56.7)

Table 4: Comparison of atherogenic pattern

Pattern	Prediabetes n (%)	T2DM n (%)
Isolated hypertriglyceridemia	26 (21.7)	28 (23.3)
Isolated low HDL-C	20 (16.7)	16 (13.3)
Combined high TG and low HDL-C	38 (31.7)	59 (49.2)

Table 5: Association of lipid profile with glycemic category

Parameter	Association
Triglycerides	Strong positive association with T2DM
VLDL-C	Positive association with T2DM and prediabetes
HDL-C	Negative association with worsening glycemic status
LDL-C	Mild positive association

Table 6: Cardiometabolic interpretation

Lipid marker	Clinical implication
High triglycerides	Increased insulin resistance and vascular risk
Low HDL-C	Reduced anti-atherogenic protection
High VLDL-C	Increased remnant particle burden
Combined TG/HDL abnormality	Highest atherogenic concern

DISCUSSION

Our study demonstrated that dyslipidemia worsens progressively from prediabetes to type 2 diabetes mellitus, with triglycerides and VLDL-C rising and HDL-C falling most consistently across the two groups. This overall pattern aligns closely with the classic description of diabetic dyslipidemia, which is characterized by hypertriglyceridemia, low HDL-C, and an atherogenic lipoprotein profile. The main contribution of our work is that these abnormalities were already evident in prediabetes, supporting the view that metabolic derangement begins before overt diabetes is established.[1-5]

The most prominent finding in our study was the strong rise in triglycerides in the diabetic group compared with the prediabetic group. This is consistent with Bhowmik et al., who observed significant linear trends in high triglycerides with increasing glucose intolerance and reported that both prediabetes and diabetes were associated with hypertriglyceridemia in a rural Bangladeshi population. Jasim et al. also found that triglycerides were significantly higher in prediabetes and diabetes than in normoglycemic subjects, reinforcing the idea that triglycerides are among the earliest and most useful biochemical markers of worsening glycemic status.[1-3]

Our data also showed that HDL-C was reduced in both groups, with a more marked fall in the diabetic

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cohort. This mirrors the findings of Bhowmik et al., who reported low HDL-C in more than 90% of participants across glucose categories and found a significant association between low HDL-C and both prediabetes and diabetes. Similarly, Jasim et al. observed that the triglyceride/HDL ratio rose significantly in prediabetes and diabetes, indirectly confirming that a reduction in HDL-C accompanies the metabolic transition toward diabetes. These converging findings suggest that HDL-C is not merely a passive marker but part of the broader insulin-resistant phenotype.[1-3]

The elevation of VLDL-C in our diabetic patients is another important observation. Jasim et al. reported a similar pattern, with higher VLDL levels in both prediabetic and diabetic groups compared with normoglycemic individuals. This fits well with the accepted pathophysiology of diabetic dyslipidemia, where increased hepatic production and reduced catabolism of triglyceride-rich lipoproteins lead to VLDL accumulation. The consistency of this pattern across studies strengthens the argument that VLDL-C can serve as an additional marker of metabolic disturbance, especially when interpreted alongside triglycerides and HDL-C.[1-5]

Total cholesterol and LDL-C were also higher in our diabetic group, but the changes were less striking than those seen for triglycerides and HDL-C. This pattern is in keeping with Mooradian's review, which emphasized that the dominant lipid abnormalities in type 2 diabetes are elevated triglycerides and low HDL-C, while total cholesterol and LDL-C may be variable or only modestly abnormal. Wu and Parhofer similarly noted that the principal lipid phenotype in diabetes is not isolated LDL elevation but a combined dyslipidemic state dominated by triglyceride-rich lipoproteins and HDL abnormalities. Our results therefore reinforce the concept that attention should not be limited to LDL-C alone when evaluating metabolic risk.[1,4,5]

The frequent presence of combined hypertriglyceridemia and low HDL-C in our study is especially noteworthy. This atherogenic combination was more common in the diabetic group, but it was already evident in prediabetic patients, indicating that cardiovascular risk may begin early in the glycemic continuum. Bhowmik et al. reported that participants with both high triglycerides and low HDL-C had substantially higher odds of prediabetes and diabetes. Jasim et al. also identified triglyceride/HDL-related indices as promising markers to distinguish prediabetes from normoglycemia. Together, these findings support the use of combined lipid abnormalities rather than isolated lipid values for risk stratification.[1-3]

Our study adds clinical relevance by showing that dyslipidemia is not confined to established diabetes but is already present in prediabetes. This is consistent with Jasim et al., who specifically evaluated lipid profile parameters for predicting prediabetes and found meaningful increases in triglycerides, VLDL, and triglyceride/HDL ratio in the prediabetic group. Bhowmik et al. likewise concluded that lipid assessment is warranted not only in diabetes but also in prediabetes. In practical terms, our findings support earlier screening and intervention during the prediabetic stage rather than waiting until diabetes develops.[1-3]

The pathophysiological explanation for our findings is strongly supported by the literature on insulin resistance. Increased free fatty acid flux promotes hepatic triglyceride synthesis and VLDL overproduction, while cholesteryl ester transfer and altered lipoprotein remodeling contribute to low HDL-C and small dense LDL particles. Hirano's review further explains that this process is a core feature of diabetic dyslipidemia and is closely tied to the metabolic consequences of insulin resistance. Our data fit this model well, because the most abnormal parameters in our cohort were those most directly linked to triglyceride-rich lipoprotein metabolism.[4-6]

The stronger dyslipidemic pattern in diabetes than in prediabetes in our study suggests a stepwise deterioration in lipid metabolism with worsening glycemic control. This pattern is similar to the gradient reported by Bhowmik et al., who observed increasing lipid abnormalities across normoglycemia, prediabetes, and diabetes. It is also consistent with Jasim et al., who found progressively unfavorable triglyceride-related indices from normoglycemia to prediabetes and diabetes. Such a gradient supports the idea that glycemic worsening and lipid derangement are biologically linked rather than independent events.[1-3]

Our findings also have cardiovascular implications, because the lipid pattern observed here is associated with higher atherogenic burden. Huang et al. showed that prediabetes itself is associated with increased risk of cardiovascular disease and all-cause mortality, meaning that risk begins before overt diabetes in many patients. Lee et al. further demonstrated that triglyceride and HDL-C dyslipidemia carries coronary and stroke risk across glycemic dysregulation states. In that context, the abnormalities in our prediabetic patients should not be viewed as mild laboratory deviations but as signals of early vascular risk.[1,7,8]

The present results are also consistent with large epidemiologic evidence linking triglycerides to future diabetes risk. Tirosh et al. found that changes in triglyceride levels over time predicted incident type 2 diabetes in young men, suggesting that triglycerides are not only a consequence of diabetes but may also participate in its development. This reciprocal relationship is important because it supports our observation that dyslipidemia appears before or alongside diabetes rather than after it alone. Thus, triglycerides may function as both a marker and a mediator of metabolic progression.[9]

The atherogenic profile in our patients is further supported by the broader cardiovascular literature. Yusuf et al. reported that cardiovascular risk is substantial across low-, middle-, and high-income

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countries, emphasizing the need to identify modifiable metabolic risk factors early. Nichols et al. showed that hypertriglyceridemic patients with statin-controlled LDL still have increased cardiovascular risk, underscoring the fact that LDL-C control alone may not eliminate residual risk when triglycerides remain elevated. This is particularly relevant to our study, where triglycerides and HDL-C were more informative than LDL-C.[10,11]

Our results are also aligned with work on triglyceride-based indices such as TG/HDL ratio and related insulin resistance markers. Dobiášová and Frohlich proposed the log(TG/HDL-C) ratio as an atherogenic index correlated with lipoprotein particle size. González-Chávez et al. reported that a high triglyceride/HDL-C ratio is associated with insulin resistance, while Babic et al. found that TG/HDL ratio and triglyceride-glucose index can predict glycemic control in type 2 diabetes. These studies support the clinical interpretation of our findings, because the combined TG-HDL abnormality reflects deeper metabolic dysfunction than either component alone.[5,12-15]

The current study is also consistent with the American Diabetes Association's emphasis on comprehensive risk assessment in diabetes care. Although the ADA document cited here is a summary of revisions rather than a lipid-specific guideline, it reflects the broader principle that diabetes management should incorporate cardiovascular risk evaluation and routine laboratory monitoring. Our findings support that philosophy by showing that lipid abnormalities are common in both prediabetes and diabetes and can help identify patients who may need earlier preventive attention. In this sense, lipid screening is useful not only diagnostically but also prognostically.[1,16]

One distinction between our study and some community-based studies is the clinical setting and population structure. Bhowmik et al. studied a large rural Bangladeshi sample, whereas our work was hospital-based and therefore likely captured patients with a somewhat higher burden of comorbidity or clinical concern. Despite these differences, the direction of association was similar, which strengthens generalizability across settings. The consistency suggests that the lipid abnormalities are not an artifact of one region or one population but a common feature of dysglycemia.[1,2]

Another important comparison is with studies that focused on predictive performance rather than prevalence alone. Jasim et al. emphasized the predictive value of triglyceride-related indices, while our study highlights the actual distribution of dyslipidemia across prediabetes and diabetes. Together, these approaches are complementary: one identifies biomarkers that may forecast risk, and the other shows the burden of abnormal lipids once dysglycemia is present. This makes our findings useful both for clinical screening and for understanding disease progression.[1,3,5]

Finally, our study supports the broader literature showing that prediabetes is a clinically meaningful state rather than a benign precursor. The lipid abnormalities observed in our prediabetic patients suggest that vascular and metabolic injury may already be underway, which is consistent with the cardiovascular risk described in meta-analyses and cohort studies. In summary, our findings agree with and extend prior work by showing that triglycerides, VLDL-C, and HDL-C are the most informative lipid markers across the spectrum from prediabetes to diabetes.[1-8]

CONCLUSION

This study highlights a strong association between serum lipid profile abnormalities and both prediabetes and type 2 diabetes mellitus. The findings show that the dyslipidemic pattern becomes progressively worse from prediabetes to overt diabetes, with higher triglycerides, higher VLDL-C, and lower HDL-C being the most prominent abnormalities. These changes are important because they reflect insulin resistance, metabolic stress, and a greater likelihood of future cardiovascular events.The clinical implication of these results is that lipid screening should not be restricted to patients with established diabetes alone. Individuals with prediabetes also demonstrate a significant burden of atherogenic lipid abnormalities, and early detection may help in risk reduction before overt diabetes develops. In routine practice, a lipid profile can therefore provide information that complements glycemic testing and helps identify patients who need more aggressive lifestyle intervention, monitoring, and possibly pharmacologic treatment.

The combined abnormality of raised triglycerides and reduced HDL-C deserves special attention. This pattern is strongly linked with atherogenic risk and is widely considered a marker of insulin resistance. In the present context, it appears to be more useful than isolated changes in total cholesterol or LDL-C for recognizing metabolic risk in both prediabetes and T2DM.The study also supports the broader concept that prediabetes is not a benign state. It is already associated with measurable metabolic derangement and likely precedes vascular complications. Therefore, early intervention at the prediabetic stage may reduce progression to diabetes and may also lower the future burden of cardiovascular disease.

In conclusion, serum lipid profile assessment is an essential part of evaluating patients with prediabetes and T2DM. Triglycerides, VLDL-C, and HDL-C are the most relevant markers in this setting, and their routine evaluation can strengthen both preventive and therapeutic decision-making.

REFERENCES

1. Bhowmik B, Siddiquee T, Mujumder A, Afsana F, Ahmed T, Mdala IA, et al. Serum lipid profile and its association with

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diabetes and prediabetes in a rural Bangladeshi population. Int J Environ Res Public Health. 2018;15(9):1944.
2. Jasim OH, Mahmood MM, Ad'hiah AH. Significance of lipid profile parameters in predicting pre-diabetes. Arch Razi Inst. 2022;77(1):277-284.
3. Mooradian AD. Dyslipidemia in type 2 diabetes mellitus. Nat Clin Pract Endocrinol Metab. 2009;5(3):150-159.
4. Wu L, Parhofer KG. Diabetic dyslipidemia. Metabolism. 2014;63(12):1469-1479.
5. Hirano T. Pathophysiology of diabetic dyslipidemia. J Atheroscler Thromb. 2018;25(9):771-782.
6. American Diabetes Association. Standards of medical care in diabetes-2016: Summary of revisions. Diabetes Care. 2016;39(Suppl 1):S4-S5.
7. Huang Y, Cai X, Mai W, Li M, Hu Y. Association between prediabetes and risk of cardiovascular disease and all cause mortality: systematic review and meta-analysis. BMJ. 2016;355:i5953.
8. Lee JS, Chang PY, Zhang Y, Kizer JR, Best LG, Howard BV. Triglyceride and HDL-C dyslipidemia and risks of coronary heart disease and ischemic stroke by glycemic dysregulation status: the Strong Heart Study. Diabetes Care. 2017;40(4):529-537.
9. Tirosh A, Shai I, Bitzur R, Kochba I, Tekes-Manova D, Israeli E, et al. Changes in triglyceride levels over time and risk of type 2 diabetes in young men. Diabetes Care. 2008;31(10):2032-2037.
10. Yusuf S, Rangarajan S, Teo K, Islam S, Li W, Liu L, et al. Cardiovascular risk and events in 17 low-, middle-, and high-income countries. N Engl J Med. 2014;371(9):818-827.
11. Alexopoulos AS, Qamar A, Hutchins K, Crowley MJ, Batch BC, Guyton JR. Triglycerides: emerging targets in diabetes care? Curr Diab Rep. 2019;19(4):13.
12. Nichols GA, Philip S, Reynolds K, Granowitz CB, Fazio S. Increased cardiovascular risk in hypertriglyceridemic patients with statin-controlled LDL cholesterol. J Clin Endocrinol Metab. 2018;103(8):3019-3027.
13. Dobiášová M, Frohlich J. The plasma parameter log(TG/HDL-C) as an atherogenic index: correlation with lipoprotein particle size and esterification rate in apoB-depleted plasma. Clin Biochem. 2001;34(7):583-588.
14. González-Chávez A, Simental-Mendía LE, Elizondo-Argueta S. Elevated triglycerides/HDL-cholesterol ratio associated with insulin resistance. Cir Cir. 2011;79(2):126-131.
15. Babic N, Valjevac A, Zaciragic A, Avdagic A, Zukic S, Hasic S. The triglyceride/HDL ratio and triglyceride glucose index as predictors of glycemic control in patients with type 2 diabetes mellitus. Med Arch. 2019;73(3):163-168.
16. Lim J, Kim J, Koo SH, Kwon GC. Comparison of triglyceride glucose index and related parameters to predict insulin resistance in Korean adults. PLoS One. 2019;14(3):e0212963.
17. Chen Z, Hu H, Chen M, Luo X, Yao W, Liang Q, et al. Association of triglyceride to high-density lipoprotein cholesterol ratio and incident diabetes mellitus: a secondary retrospective analysis based on a Chinese cohort study. Lipids Health Dis. 2020;19(1):33.
18. Rijkelijkhuizen JM, Nijpels G, Heine RJ, Bouter LM, Stehouwer CD, Dekker JM. High risk of cardiovascular mortality in individuals with impaired fasting glucose is explained by conversion to diabetes: the Hoorn study. Diabetes Care. 2007;30(2):332-336.
19. Guerrero-Romero F, Simental-Mendía LE, González-Ortiz M, Martínez-Abundis E, Ramos-Zavala MG, Hernández-González SO, et al. The product of triglycerides and glucose, a simple measure of insulin sensitivity. J Clin Endocrinol Metab. 2010;95(7):3347-3351.
20. Sadeghi E, et al. Association of lipid profile with type 2 diabetes in first-degree relatives of patients with diabetes. Please verify the final journal citation before submission.

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