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Original Research Article

Relationship between metabolic parameters and lifestyle factors in type 2 diabetes mellitus: a retrospective analysis

Muzammil Mohammed[1]*, Riyaz Mohammed[2], Mudassir Mohammed[3], Mushtaq Mohammed[3]

[1]Department of Medicine, Shadan Institute of Medical Sciences, Hyderabad, Telangana, India
[2]Department of Medicine, MNR Medical College, Sangareddy, Telangana, India
[3]Department of Computer Science and Engineering, Muffakham Jah College of Engineering and Technology (MJCET), Jubliee Hills, Hyderabad, Telangana, India

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***Correspondence:**
Dr. Muzammil Mohammed,
E-mail: muzammilesani@gmail.com

ABSTRACT

Background: This study examined the correlation between metabolic biomarkers (e.g., fasting blood sugar, HbA1C, cholesterol, creatinine) and lifestyle factors (e.g., smoking, body weight, blood pressure) in pre-diabetes and diabetes patients. We wanted to find patterns that may affect metabolic disorders and cardiovascular disease (CVD) in these populations.
Methods: A medical outpatient department patient and laboratory data was used in a retrospective cross-sectional study. FBS, PPBS, HbA1C, lipid profiles, creatinine levels, urine microalbumin, blood pressure, BMI, and risk factors like smoking were analysed using t-tests, ANOVA, and multivariate regression.
Results: The study found significant lipid abnormalities in diabetic individuals. Patients with diabetes had an average triglyceride level of 286.6 mg/dl. Low HDL levels (averaging 36.3±5.8 mg/dl) were also observed. We also had high LDL levels, which increase the risk of cardiovascular disease. The highest triglyceride (305.80 mg/dl) and VLDL (61.16 mg/dl) levels were found in participants aged 60-70. AIP, a key CVD risk marker, was high in older diabetics (0.80), indicating a strong link between age, dyslipidemia, and cardiovascular risk. Furthermore, smoking worsened these lipid irregularities. Males had higher triglycerides than females (p=0.036), but fasting blood sugar, HbA1C, and LDL did not differ.
Conclusions: Research shows a high prevalence of dyslipidemia in diabetics, characterized by elevated triglycerides, low HDL, and high LDL, all linked to increased CVD risk. Early detection and treatment of lipid issues are crucial, particularly for older adults and smokers, who are more prone to atherosclerotic events.

Keywords: Age-related metabolic changes, Atherogenic index of plasma, Cardiovascular disease risk, Diabetic dyslipidemia, Gender differences, Glycemic control

INTRODUCTION

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder associated with significant morbidity and mortality, largely driven by cardiovascular disease (CVD). The interplay between hyperglycemia, dyslipidemia, and lifestyle factors accelerates the development of atherosclerosis and end-organ damage. This retrospective analysis was designed to evaluate the relationships between key metabolic biomarkers- including fasting blood sugar (FBS), HbA1C, lipid profiles, and creatinine- and lifestyle determinants such as smoking status, body weight, and blood pressure in individuals diagnosed with diabetes. By analyzing clinical and laboratory data from 600 patients, we aimed to identify critical patterns that contribute to metabolic dysregulation and heightened

cardiovascular risk.[1] The study highlights the prevalence of diabetic dyslipidemia, characterized by elevated triglycerides and reduced HDL cholesterol, and introduces the atherogenic index of plasma (AIP) as a valuable predictor of cardiovascular events. Additionally, the impact of smoking on worsening lipid parameters and the influence of age and gender on metabolic outcomes are examined. Understanding these associations is essential for developing targeted interventions, improving glycemic control, and reducing the long-term cardiovascular burden in the diabetic population.[1,2]

METHODS

A retrospective analysis of clinical and laboratory data collected from SIMS Medical OPD of sample size of 1000 patients from April 2024 to June 2024. Data from participants regarding FBS, PPBS, HBA1C, lipid profiles, creatinine, urine microalbumin, blood pressure BMI and risk factors like smoking were also taken into consideration. These data were analysed using t-tests, ANOVA, and multivariate regression were applied to assess the associations between metabolic variables and demographic/lifestyle factors.

Inclusion criteria

Participants included in this study should meet the following criteria: Age: adults aged between 18 years - 90 years. Availability of key health metrics: participants with complete data for core health parameters, including fasting blood sugar, HbA1C, cholesterol levels, creatinine, blood pressure, and smoking status. Health checkup: participants who had undergone clinical evaluation and laboratory testing within last 3 months.

Exclusion criteria

Participants were excluded if they met any of the following criteria: incomplete or missing data: individuals with missing values for key variables such as fasting blood sugar, HbA1C, cholesterol, or creatinine were excluded. Age: individuals below 18 years of age and more than 90 years. Pregnancy: pregnant individuals were excluded due to the physiological changes in metabolic parameters that occur during pregnancy. Outliers: any extreme outliers in key measurements (e.g., blood sugar levels, cholesterol) that were deemed biologically implausible or due to measurement errors were excluded from the analysis. Advanced cancers, chronic liver disease, renal failure, CVA was excluded.

Based on the criteria only 600 patients' data was accepted for the study.

RESULTS

The demographic data collected for this study were analyzed as follows: The gender distribution indicated that 34% of the participants were male and 66% were female.

Table 1: Demographic characteristics.

Characteristics	N	Percentage
Total Participants	978	100
Male	333	34
Female	645	66
Mean age (SD)	56 years	(±13.7)
Age range	18-90 years	

Participants' ages ranged from 18 to 90 years, with an average age of 56 years (SD±13.7). The mean fasting blood sugar (FBS) level was recorded at 139.9 mg/dl (SD±26.4), while the average post-prandial blood sugar (PPBS) was 303.5 mg/dl (SD±65.5). Additionally, the mean HbA1C level was 7.2% (SD±1.3).

Table 2: Blood glucose levels.

Metric	Mean±SD	Normal Range (mg/dl)
Fasting blood sugar (FBS)	139.9±26.4	<100
Post-lunch blood sugar (PPBS)	303.5±65.5	<140
HbA1C (%)	7.2±1.3	<5.7

In terms of lipid profile parameters, the study found the following values: total cholesterol averaged 197.8 mg/dl (SD±42.2), triglycerides were at 286.6 mg/dl (SD±89.4), HDL measured 36.3 mg/dl (SD±5.8), and LDL averaged 102.7 mg/dl (SD±48.3). The renal parameter assessed was serum creatinine, which had a mean value of 0.91 mg/dl (SD±0.25), while the average urine microalbumin level was 26.7 mg/dl (SD±3.9).

Blood pressure readings showed a mean systolic blood pressure of 123.1 mmHg (SD±7.6) and a mean diastolic blood pressure of 78.3 mmHg (SD±6.1). Additional information on smoking status revealed that only 5% of participants were smokers, while 95% were non-smokers.

The demographic composition of the participants, with a focus on the middle-aged to elderly demographic, is presented in Table 1. The total sample size for this study comprised 978 individuals, of which 34% were male and 66% were female. The average age of the participants was 56 years, with a standard deviation of 13.7, and the ages ranged from 18 to 90 years.

Table 2 presents data indicating that fasting blood sugar levels (139.9 mg/dl), post-prandial blood sugar levels (303.5 mg/dl), and HbA1C (7.2%) are all significantly elevated compared to normal ranges, suggesting inadequate glycaemic control and an associated risk. Table 3 outlines lipid profiles, revealing increased triglyceride levels (286.6 mg/dl) and VLDL levels (52.9 mg/dl), while HDL levels are below the recommended threshold (36.3 mg/dl), which may heighten cardiovascular risk. Total cholesterol levels are within a

near-normal range (197.8 mg/dl), whereas LDL levels are marginally elevated (102.7 mg/dl).

The Table 4 outlines the lipid profiles of smokers compared to non-smokers. It shows that smokers have slightly higher levels of total cholesterol (224.9 mg/dl versus 217.1 mg/dl), triglycerides (260.6 mg/dl versus 254.4 mg/dl), LDL (132.1 mg/dl versus 126.2 mg/dl), and VLDL (52.1 mg/dl versus 50.9 mg/dl) in comparison to non-smokers. These results indicate a heightened cardiovascular risk linked to smoking. A bar graph depicting the lipid parameters of smokers and non-smokers would effectively highlight these differences.

Table 3: Lipid profile.

Lipid parameters	Mean±SD	Normal range (mg/dl)
Total cholesterol (T CHOL)	197.8±42.2	<200
Triglycerides (TGL)	286.6±89.4	<150
HDL (good cholesterol)	36.3±5.8	>40 (men); >50 (women)
LDL (bad cholesterol)	102.7±48.3	<100
VLDL	52.9±12.7	10-30

Table 4: Smokers versus non smokers.

Lipid parameter	Smokers	Non-smokers	Normal range (mg/dl)
Total cholesterol (T CHOL)	224.9±35.6	217.1±39.4	<200
Triglycerides (TGL)	260.6±80.4	254.4±75.6	<150
HDL	40.74±3.5	40.00±3.6	>40 (men); >50 (women)
LDL	132.1±41.7	126.2±42.6	<100
VLDL	52.1±9.2	50.9±10.1	10-30

Table 5: Gender-based t-tests for metabolic parameters.

Variable	t-statistic	P value	Interpretation
FBS	1.056	0.291	No significant difference
Triglycerides (TGL)	-2.105	0.036	Significant difference; males higher TGL
LDL	-0.007	0.994	No significant difference

Table 6: Lipid parameters.

Lipid parameters	Lipid parameters	Lipid parameters
Triglycerides (TGL)	286.6±89.4	<150
HDL (good cholesterol)	36.3±5.8	>40 (men); >50 (women)
Atherogenic index of plasma (AIP)	0.897 (calculated)	

The correlation analysis derived from the statistical examination of the data indicates a weak association between fasting blood sugar (FBS) and postprandial blood sugar (PPBS), with a correlation coefficient of r=0.02. Furthermore, the analysis revealed no significant correlations between the majority of metabolic parameters and age.

In the analysis conducted through t-tests to assess gender differences, a significant disparity was identified in triglyceride levels between males and females (p=0.036), with males exhibiting higher triglyceride levels. However, no significant gender differences were observed for other parameters, including FBS, HbA1C, LDL, or blood pressure (Table 5).

The atherogenic index of plasma (AIP) does not have a fixed “normal range” like lipid levels, but it is generally interpreted as follows: AIP<0.11: low risk of cardiovascular disease (CVD), AIP between 0.11 and 0.24: Intermediate or moderate risk of CVD, AIP>0.24: high risk of CVD.

These thresholds are commonly used in research and clinical practice to assess cardiovascular risk based on the balance between triglycerides and HDL cholesterol levels. A higher AIP indicates a higher risk of developing atherosclerosis and other cardiovascular conditions.

DISCUSSION

Dyslipidemia is closely linked to cardiovascular disease (CVD), especially in individuals with impaired glycemic control. Numerous studies, including those by Goldberg et al and Mooradian, have confirmed the unique lipid profile associated with diabetic dyslipidemia, which is marked by elevated triglyceride levels, decreased HDL cholesterol, and the presence of small dense LDL particles. In the present study, diabetic participants exhibited average

triglyceride levels of 254.49 mg/dl and HDL levels of 40.05 mg/dl.[1-3]

Additionally, the research highlights the importance of the atherogenic index of plasma (AIP), which reflects the ratio of triglycerides to HDL and is a vital predictor of cardiovascular events.[4] According to Dobiasova et al, AIP values above 0.24 are associated with an increased risk of atherosclerosis. In this study, all participants had AIP values significantly exceeding this critical level, indicating that the entire group is at a heightened risk for CVD. Notably, the AIP values for diabetic individuals aged 60-70 years were particularly concerning, averaging around 0.80, primarily due to high triglyceride levels (305.80 mg/dl) and low HDL levels (36.60 mg/dl). This combination greatly increases the risk of atherosclerotic events in this age group.[5,6]

Age significantly heightens the risks linked to dyslipidemia. Research conducted by Abbott et al and Grundy et al indicates that the severity of dyslipidemia increases with advancing age, particularly among individuals with diabetes. Our findings corroborate this trend, as participants within the 60-70-year age bracket demonstrated the highest levels of triglycerides (305.80 mg/dl) and VLDL (61.16 mg/dl), suggesting an elevated risk for atherosclerosis in older adults.[7-9]

It is imperative to address cardiovascular risk in diabetic individuals. The alarming rate of abnormal lipid profiles, observed in 96.5% of participants, underscores the necessity for immediate intervention.[10] As suggested by Collins et al, the implementation of lipid-lowering therapies, such as statins, in conjunction with lifestyle changes, should be prioritized. Consistent monitoring of triglycerides, LDL, and HDL levels is vital for effective dyslipidemia management in these populations.[11,12] Furthermore, smoking, a recognized contributor to cardiovascular disease, exacerbates dyslipidemia.[13,14] Our study revealed that smokers exhibited higher levels of total cholesterol, triglycerides, and LDL compared to their non-smoking counterparts, aligning with the findings of Bakhru and Erlinger and Law et al. In light of these findings, promoting smoking cessation should be a central focus in strategies aimed at reducing risk among diabetic populations.[15]

This research is a retrospective analysis of data from a small pool, and the only criteria that were used were specific inclusion and exclusion criteria. In order to acquire comprehensive information regarding the numerous health risks and complications, a large pool of data and a randomised control trial would be of great assistance in providing information that is both superior and refined.

CONCLUSION

This study highlights several significant metabolic issues, such as hyperglycemia, dyslipidemia, and early indicators of kidney damage. It emphasizes the importance of focused interventions, especially in managing lipids and implementing lifestyle changes, to reduce cardiovascular risks. Future research should concentrate on lifestyle modifications and interventions that consider gender differences.

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