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Linking Diabetes and Dyslipidemia: Hospital-Based Evidence from Haryana

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ABSTRACT

Diabetes mellitus is frequently accompanied by dyslipidemia, a major risk factor for cardiovascular complications. This hospital-based cross-sectional study from Faridabad, Haryana, examined 947 patients with type 2 diabetes mellitus (T2DM) to assess the prevalence and patterns of dyslipidemia. The findings revealed a higher occurrence of lipid abnormalities in urban populations compared to rural groups. Low HDL-C, elevated LDL-C, and hypertriglyceridemia were the most common abnormalities, with notable gender-specific differences. These results underscore the importance of early lipid screening, lifestyle interventions, and effective management strategies to reduce long-term complications in T2DM patients.

INTRODUCTION

As a metabolic condition that often predisposes to cardiovascular diseases (CVD), diabetes mellitus (DM) is one of the main causes of morbidity and death for individuals with both type 1 and type 2 diabetes mellitus (T1DM and T2DM). Cardiovascular events in T1DM are reduced when glycaemic management is good. Intensive glycaemic management does not, however, prevent the development of CVD in T2DM patients. 1. In addition to insulin resistance and deficiency, people with type 2 diabetes frequently have dyslipidemia, or abnormalities in serum lipids, which is a disease known as metabolic syndrome.

Low-density lipoprotein (LDL) cholesterol is mildly affected, triglyceride levels rise, and high-density lipoprotein (HDL) cholesterol falls in diabetes-related dyslipidemia. Two The pathophysiology of dyslipidemia includes an excess of very low-density lipoproteins (VLDL) produced by the liver, which raises serum triglyceride levels. Diabetic dyslipidemia raises the risk of coronary heart disease (CHD) in diabetic individuals by causing dysregulation of triglyceride and serum cholesterol levels, which is linked to atherosclerotic cardiovascular disease (ASCVD). 3

1.1. Risk factors for diabetes-related dyslipidemia

Dyslipidemia is a significant modifiable risk factor for cardiovascular disease, atherosclerosis, stroke, and type 2 diabetes 4, 5. However, in recent years, the risk of dyslipidemia has increased due to more urbanization, socioeconomic development, and changes in lifestyle. Additionally, the American Diabetes Association and the American Association of Clinical Endocrinologists (AACE) have identified a number of significant risk factors for atherosclerosis and dyslipidemia in diabetes that fall into four categories.

Table 1 Classification of Risk Factors in Dyslipidemia

Category	Risk Factors
Non-modifiable factors	Age (≥45 years in men, ≥55 years in women), Gender (male > female pre-menopause), Family history of premature cardiovascular disease (CVD), Genetic disorders (e.g., familial hypercholesterolemia)
Modifiable lifestyle factors	Unhealthy diet (high saturated fat, trans fats, refined carbs), Physical inactivity, Obesity and central adiposity, Excessive alcohol consumption, Smoking and tobacco use
Medical/Metabolic factors	Type 2 diabetes mellitus, Hypertension, Metabolic syndrome, Chronic kidney disease, Hypothyroidism, Liver disease, Polycystic ovary syndrome (PCOS)
Drug-induced factors	Thiazide diuretics, Beta-blockers (non-selective), Corticosteroids, Oral contraceptives, Antiretroviral therapy, Retinoids, Immunosuppressants (e.g., cyclosporine)

LIPIDS'S ROLE

Epidemiological studies have demonstrated that elevated LDL-C and non-HDL-C levels and lower HDL-C levels are linked to an

increased risk of ASCVD in individuals with diabetes, just as they are in non-diabetic populations. LDL-C levels were the best indicator of coronary artery disease in the UKPDS cohort. Although it is widely acknowledged that high LDL-C and non-HDL-C levels contribute to atherosclerosis and ASCVD, HDL-C's function remains unclear. Low HDL-C levels as a cause of atherosclerosis have not been supported by genetic research or investigations of medications that increase HDL-C. Instead, it is now believed that HDL function is linked to the risk of atherosclerosis, and that this is not exactly correlated with HDL-C levels. Elevated blood triglyceride (TG) levels in diabetic patients are also linked to a higher risk of ASCVD. Regarding TG, it is unclear if it is a contributing cause to ASCVD or if the increase in TG is a sign of other abnormalities. The idea that high TG levels are a causative factor in atherosclerosis has been supported by recent Mendelian randomization studies.

Lipid Abnormalities in Patients with Diabetes

In patients with type 1 diabetes mellitus (T1DM) who maintain good glycemic control, lipid levels are generally comparable to those of the non-diabetic population, though some studies report slightly elevated HDL-C. Conversely, patients with type 2 diabetes mellitus (T2DM) often present with lipid abnormalities even under good glycemic control. Around 30–60% of individuals with T2DM develop dyslipidemia, commonly showing raised triglycerides (TG), increased VLDL and IDL, and reduced HDL-C. While LDL-C levels may not differ significantly, there is often a predominance of small, dense LDL particles, which are highly atherogenic. This, combined with elevated VLDL and IDL, results in higher apolipoprotein B levels. Additionally, postprandial triglyceride spikes are exaggerated in T2DM, further increasing ASCVD risk.

These lipid disturbances resemble those seen in obesity and metabolic syndrome, both strongly associated with insulin resistance. Since most T2DM patients are overweight or obese, the presence of high TG, small dense LDL, and low HDL-C is common, even with reasonable glycemic control. Obesity also promotes systemic inflammation, and with rising obesity among T1DM patients, dyslipidemia is expected to increase in this group as well.

Studies indicate that HDL in both T1DM and T2DM patients has impaired antioxidant and anti-inflammatory capacity, and its cholesterol efflux ability is diminished. Thus, HDL-C concentration alone may not accurately represent cardiovascular risk, as HDL functionality is compromised in diabetes.

Poor glycemic control worsens dyslipidemia by raising TG, VLDL, and IDL while lowering HDL-C, and may modestly increase LDL-C, primarily in the small dense subfraction. Optimizing glycemic control therefore provides additional benefits by improving lipid profiles.

Regarding lipoprotein(a) [Lp(a)], levels are usually within the normal range in both T1DM and T2DM, though studies show mixed findings, with some reporting increases or decreases. However, the onset of microalbuminuria or renal disease is associated with elevated Lp(a). Interestingly, low Lp(a) levels are linked to a greater risk of developing T2DM, with one large case-control study showing that patients in the lowest 10% of Lp(a) levels had higher diabetes risk.

STUDY DESIGN: It is a cross sectional, observational study.
STUDY AREA: Department of lab Service, Metro heart institute hospital, Faridabad, Haryana.
STUDY PERIOD: 2022 -2023
SAMPLE SIZE: 947 Patients. TIME FRAME: 2021 -2023
SELECTION CRITERIA OF PATIENTS INCLUSION CRITERIA:

A. Patients with 10-90 year of age.
B. Known case of type II DM.
C. Newly diagnosed case of type II diabetes diagnosed as open criteria of American diabetes association.

1. Fasting plasma glucose level higher than 126 mg/dl or
2. Plasma glucose levels exceeding 200 mg/dl at 2 hours in the 75 g oral glucose tolerance test or
3. Symptoms of diabetes and random plasma glucose >200 mg/dl
4. HbA1c>6.5%.

EXCLUSION CRITERIA

A. Metabolic complications – diabetic ketoacidosis, hyperglycemic hyperosmolar syndrome.
B. Acute illnesses –acute myocardial infarction cerebrovascular disease, acute infections.
C. Hypothyroidism.
D. Liver disordered
E. Renal disease
F. Patients on beta blocker, diuretics, thiazides.

Glucose

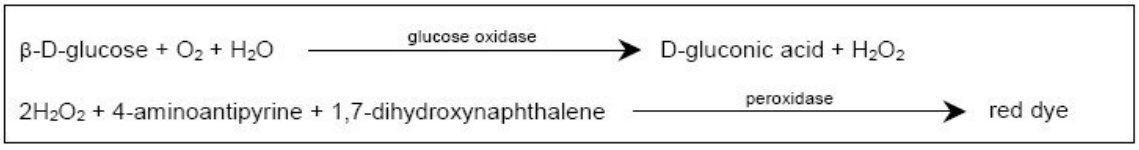
Purpose of examination:

Glucose is a primary cellular energy source. Fasting plasma glucose concentrations and tolerance to a dose of glucose are used to establish the diagnosis of diabetes mellitus and disorders of carbohydrate metabolism. The Glucose assay based on GOD – POD method based on Dry Slide Technology in VITROS 5600 Integrated system is an in vitro diagnostic test intended for the quantitative determination of glucose in human serum, plasma, urine, and cerebrospinal fluid.

Test Condition:

Test Type	VITROS System®	Approximate Incubation Time	Temperature	Wavelength	Reaction Sample Volume
Colorimetric	XT 7600	5 minutes	37 °C (98.6 °F)	540 nm	2.7 µL

Reaction sequence:



Performance characteristics:

Performance characteristics of Glucose parameter has been verified and documented in Operation/Performance Qualification Procedures.

Analytical Measurement range: The assay has measurement range of 10 to 700 mg/dL. Analytical Sensitivity: Lower limit of detection is 10 mg/dL.

Linearity: The assay is linear for Glucose concentration from 20 to 625 mg/dL in serum; 20 to 650 mg/dL in urine and CSF samples.

Type of Sample:

1. Serum
2. Plasma (Sodium Fluoride or Heparin (Lithium or Sodium)
3. Urine
4. CSF

Sample Storage and Stability:
Serum / Plasma:

Storage	Temperature	Stability
Room Temperature	18–28 °C (64–82 °F)	≤ 24 hours
Refrigerated	2–8 °C (36–46 °F)	≤ 7 days
Frozen	≤ -18 °C (≤ 0 °F)	≤ 6 months

Urine specimen:

Storage	Temperature	Stability
Room Temperature	18–28 °C (64–82 °F)	≤ 24 hours
Refrigerated	2–8 °C (36–46 °F)	≤ 3 days
Frozen	≤ -18 °C (≤ 0 °F)	≤ 28 days

CSF:

Storage	Temperature	Stability
Refrigerated	2–8 °C (36–46 °F)	≤ 7 days
Frozen	≤ -18 °C (≤ 0 °F)	≤ 6 months

Patient Preparation:

- Normal procedures for collecting and storing serum, plasma, urine and cerebrospinal fluid may be used for samples to be analyzed by this method.
- For fasting blood glucose, blood sample shall be collected after minimum of 8 hrs. fast.
- For postprandial blood glucose, blood samples shall be collected after 2 hrs. of meal. Type of container and additives:
- Serum: Serum separator tube (SST)
- Plasma: Sodium Fluoride / Potassium oxalate / Lithium Heparin / Sodium Heparin tubes
- Urine: Clean and dry container
- CSF: Sterile container

Required Equipment and Reagents:
Equipment: VITROS XT 7600 Integrated system, Centrifuge, Refrigerator, Freezer, Micropipettes, VITROS sample cups and Versa tips
Reagent:

- VITROS Glucose Slides cartridge
- VITROS Cal Kit 1
- Assayed Chemistry Control
- 7% BSA or FS Diluents Pack 2
- Reagent grade water or FS Diluents Pack 3

Reagent storage, handling and stability:

Reagent	***Storage Condition***	***Reagent status***	***Stability***
Glucose Cartridge	- 18°C (Freezer)	Unopened	Until Expiration date
	2 - 8°C (Refrigeration)	Unopened	≤ 4 months
	On board (in VITROS system)	Opened	≤ 1 week
VITROS Cal Kit 1	- 18°C (Freezer)	Unopened	Until Expiration date
	2 - 8°C (Refrigeration)	Reconstitute d	≤24 hours if tightly stoppered
FS Diluent Pack 2	2 - 8°C (Refrigeration)	Unopened	Until Expiration date
	On board (in VITROS system)	Opened	≤ 8 weeks
FS Diluent Pack	2 - 8°C (Refrigeration)	Unopened	Until Expiration date

- ✧ VITROS Glucose cartridges are received in wrapped condition in alu foil pouch.
- ✧ Remove the slide cartridges from storage.
- ✧ Warm the wrapped cartridge at room temperature for 30 minutes when taken from the
- ✧ refrigerator or 60 minutes from the freezer.
- ✧ Unwrap and load the cartridge into the slide supply 2.
- ✧ Get the cartridge acclimatized in the VITROS system environment for about 5 min. before put in use.
- ✧ Load FS Diluents Pack 2 and Pack 3 in Reagent supply 3 in VITROS XT 7600 system.

Prevalence of Type II Diabetes mellitus and dyslipidemia in rural and urban patients from Faridabad, India.

Diabetes mellitus is non-communicable, chronic, epidemic disease[63-67]. Patients with Type II Diabetes Mellitus (T2DM) experience increase in insulin resistance and a decrease in normal insulin production from the pancreas[67-69]. T2DM is the primary etiology of 95% of diabetes patients[70-71]. The most risk factors for T2DM are hyperglycemia, dyslipidemia, stroke, and cardiovascular illnesses among many additional risks[72-73]. An imbalance between insulin secretion and action leads to hyperglycemia. In low- and middle-income countries such as India, reports of T2DM and dyslipidemia occurrences and prevalence are most common[69-70]. T2DM is the seventh most common cause of mortality worldwide, with comparable rates for men and women[69-70].

Dyslipidemia, an aberrant lipid profile, is common in patients diagnosed with T2DM[72-73]. Insulin resistance is associated with dyslipidemia through elevated fatty acid flux. Insulin resistance and metabolic syndrome cause the liver to create an excessive amount of free fatty acids. These fatty acids induce overproduction of lipoproteins high in triglycerides to be produced, which raises LDL levels while lowering HDL[72-73]. Lipid imbalances, including high triglycerides (TG), decreased HDL, elevated TC, and elevated LDL are associated with the prevalence of dyslipidemia in patients with T2DM. Several investigations have demonstrated that insulin resistance plays a significant role in the onset of type II diabetes[74].

Pre-diabetic symptoms, such as impaired fasting glucose and/or impaired glucose tolerance are present in majority of patients. These symptoms appear before the full- blown diabetic symptoms. Pre-diabetes can be prevented from progressing further by altering one's lifestyle and controlling insulin levels[75]. The primary lifestyle factors associated with T2DM are obesity, inactivity, diet, stress and urbanization[75-77]. Sugar- filled beverages are also believed to play a central role in prevalence of T2DM. Moreover, monounsaturated and polyunsaturated lipids reduce the incidence of type II diabetes, while trans and saturated fats increase it[73, 74].

Diabetes mellitus is diagnosed with a test for the glucose levels in the blood. The World Health Organization offers two standard tests for T2DM[75]. The first is the glycated hemoglobin level, which should be at least 6.5, and the second is the fasting plasma glucose level. People with impaired glucose tolerance had plasma levels between 140 and 200 mg/dL. Individuals with impaired fasting glucose are those whose blood glucose levels fall between 110 and 125 mg/dL. Compared to fasting glucose, the estimate of glycated hemoglobin is a more accurate way to predict the risk of cardiovascular disease associated with T2DM[76-77].

Furthermore, as India becomes more urbanized, people's lifestyles change, which alters the country's disease prevalence[76-78]. The aim of this study was to assess the prevalence of dyslipidemia and type II diabetes mellitus patients from Faridabad, Haryana, India, both in urban and rural areas. The aim of this study was to ascertain the prevalence of T2DM and dyslipidemia amongst genders in Faridabad, India and to establish other risk factors that may be connected to these conditions.

4.1.1 Methodology

Research design: The Laboratory Services, Metro Heart Institute with multispecialty Faridabad (Haryana) was the site of this descriptive study. Data from patients visiting the diabetes clinic were collected in August and September of 2023 with approval from the local Institutional Ethical Committee of Metro Heart Institute with multispecialty Faridabad, Haryana, India.

Population under investigation: Total of 947 patients from urban and rural area of Faridabad (Haryana, India) was included in investigation to determine the prevalence of type II Diabetes mellitus (T2DM) and dyslipidemia in patients. Out of 947 patients 590 were from urban area and 357 from rural area. The study comprised both males and females.

Procedure: The study incorporated patient data such as gender and demographic data (urban versus rural). The following measurements were included: The levels of fasting blood sugar (mg/dl), total cholesterol (mg/dl), triglycerides (mg/dl), high-density lipoprotein (mg/dl), low-density lipoprotein (mg/dl), and glycosylated hemoglobin-
HBA1C (%). All patients were instructed to fast for at least 12 hours overnight, and 5ml of venous blood was drawn before breakfast to assess fasting blood glucose and serum lipid profile. After drawing blood from the patients, 3ml was transferred into serum tubes for lipid analysis and 2ml was placed into sodium fluoride tubes for blood glucose measurement.

Materials: Patient data was collected from the Laboratory Services, Metro Heart Institute with multispecialty Faridabad (Haryana). If the patient's fasting blood sugar was >126 mg/dL, they were diagnosed with type-II diabetes mellitus (T2DM); if it was < 100 mg/dL, they were classified as non-diabetic. If value were between 100-125 mg/dL condition is pre-diabetic for T2DM. If the patient had HBA1C > 6.5% they were classified as diabetic, HBA1C between 5.7-6.4 % considered pre-diabetic. While, HBA1C < 5.7% was indicative of controlled type-II diabetes.

Dyslipidemia: Dyslipidemia was defined as the existence of one or more of the following lipid abnormalities: total cholesterol level >200 mg/dl, triglyceride level > 150 mg/dl, low-density lipoprotein >100 mg/dl, or high-density lipoprotein <40 mg/dl in males or < 50 mg/dl in and females. Patients whose HDL was >60 mg/dL were considered as normal. A total cholesterol <200mg/dL was regarded as normal, 200-239 mg/dL as borderline and >240 mg/dL as high. Similarly, triglyceride <150mg/dL were regarded as normal, those between 150-199 mg/dL as borderline and those >200 mg/dL as high. Low-density lipoprotein >160-190 mg/dL was considered as extremely high. Patients diagnosed with dyslipidemia were further divided into three categories: isolated single-parameter dyslipidemia, combined-parameter dyslipidemia (two abnormal lipid parameters) and mixed-parameter dyslipidemia (three abnormal lipid parameters).

Statistical analysis : Descriptive analysis including mean, percentage distribution, range and standard deviations was performed on fasting blood sugar (mg/dl), total cholesterol (mg/dl), triglyceride (mg/dl), high-density lipoprotein (mg/dl), low-density lipoprotein (mg/dl) and hemoglobin HBA1C (%) in both males and females as well as on rural versus urban patients. A P-value of <0.05 were considered statistically significant. The statistical package for social sciences (SPSS version 14; IBM SPSS, Inc., Chicago, IL, USA) was used to analyze the collected data.

4.1.2 Results

Demographic distribution of patients: This study included 947 patients diagnosed for fasting blood sugar, glycosylated hemoglobin levels, total cholesterol, total triglyceride, high-density lipoprotein (HDL) and low-density lipoprotein (LDL) to examine Type II Diabetes mellitus (T2DM) and dyslipidemia from urban and rural populations (Table 1). Out of 947 studied patients, 590 belonged to urban and 357 to rural population. Number of females underwent diagnosis from both rural and urban population was lesser than males. There were 231 (39.15%) and 122 (34.17%) females from urban and rural areas, respectively. In contrast, there were significantly more males in this study, 235 (65.82%) from rural and 359 (60.84%) from urban (Table 1). HBA1C (%) analysis was performed on 69 females and 85 males from urban area and 9 females and 27 males from rural population.

Comparison of urban versus rural patients: The mean values of diagnosis for fasting glucose level, glycosylated hemoglobin levels

and lipid profile from rural versus urban populations were illustrated in Table 2. Patients in urban population had significantly (P- values: <0.001) higher fasting blood sugar (Urban: 124.24 mg/dL; Rural: 98.64 mg/dL), HBA1C (Urban: 7.09; Rural: 6.04) and total triglycerides (Urban: 169.64 mg/dL; Rural: 139.61 mg/dL) than patients in rural areas. Patients in urban areas had slightly higher total cholesterol than those in rural areas (P-values: <0.05). Nonetheless, patients in urban and rural areas had almost similar and non-significant mean values for HDL (P=0.12ns) and LDL (P=0.23ns; Table 2).

Gender comparison: The gender-specific profiles of fasting glucose levels, glycosylated hemoglobin levels, and lipid profiles were shown in Table 3 and Figure 3. There was lack of difference amongst gender for fasting blood sugar levels of both urban (females: 125.79 mg/dL; males: 123.24 mg/dL; P-value: 0.40 ns) and rural patients (females: 99.37 mg/dL; males: 98.26 mg/dL; P-value=0.35 ns). Likewise; HBA1C levels were similar for males and females from both urban and rural patients. There was lack of gender-specific differences in total cholesterol (mg/dL) between rural and urban patients(Table 3). Males' triglyceride levels were significantly higher (P-value <0.001) than females' in both rural (males: 146.02 mg/dL, females: 127.26 mg/dL) and urban patients (males: 183.45 mg/dL, females: 148.42 mg/dL). HDL were higher in females than males in both rural (Males: 43.26mg/dL Females: 51.49mg/dL) and urban patients (Males: 41.97mg/dL Females: 49.82mg/dL). LDL was non-significant in males and females as well as urban and rural patients (Table 3; Figure 3).

Risk Profile: T2DM diagnoses were more common in urban (36.27%) compared to rural (6.16%; Table 4). Patients in both urban areas (24.40%) and rural areas (25.49%) had nearly identical pre-diabetic conditions. In addition, the percentage of non-diabetic patients was higher in rural (68.34%) compared to urban areas (39.32%). HBA1C value ranged from 6.53-11.38% in rural population and 6.57-14% in urban patients. Overall, patients with higher cholesterol levels were found in 6.16% of rural and 9.83% of urban patients (Table 4). Higher cholesterol level ranged from 240-424 mg/dL in rural patient and 240-367 mg/dL in urban patients. Patients with high triglycerides (>200mg/dL) were higher in urban (27.11%) than rural (14.56%). Percentage patient with low HDL (<40mg/dL in males and <50mg/dL in females) were almost equal in rural (45.09%) and urban (49.50%) patients. Urban patients (6.77%) had a slightly higher percentage of high- LDL (>160mg/dL) than rural (5.04%) patients (Table 4).

Statistically significant differences were observed amongst diabetic and non-diabetic patients in males and females from urban and rural population (P-value <0.001; Table 5; Figure 4). A comparison of gender revealed that patients in urban areas (males 78.88%; females 84.05%) had a higher HBA1C risk profile than patients in rural areas (males 48.17%; females 44.44%). Hypercholesterolemia was more prevalent in urban (males: 34.26%; females: 32.03%) than rural (males: 25.10%; females: 25.40%). Hypertriglyceridemia was also more in urban (males 54.31%; females 40.69%) than rural (males 39.57%; Females 26.22 %) patients. Males had more hypertriglyceridemia than females in both urban and rural area. High number of patients from both rural and urban (>75%) had low-HDL values. Patients with >100mg/dL LDL were more in males of urban (males 61.01%; females 48.48%) than rural (males 53.61%; females 52.45%) patients (Table 5).

Table 6 illustrates the significant levels of normal and risk levels of various variables and their mean. This table demonstrated that that the mean value of the non-diabetic patients was not significantly influenced by gender or demographics (rural versus urban). Patients with T2DM had significantly higher mean values in urban areas (males: 145.03mg/dL; females: 150.86mg/dL) compared to rural areas (males: 118.82mg/dL; females: 121.64mg/dL).The HBA1C means of patients in rural and urban areas did not differ from each other (Table 6). In terms of hypercholesterolemia the mean were (>200mg/dL) non-significant in both rural and urban patients. In both urban (males: 245.03; females: 211.13) and rural patients (males: 211.33; females: 194.25) male patients had higher levels of hypertriglyceridemia than female patients. The mean values, showed a significant difference (P-value <0.05) between the urban and the rural patients. Females at risk had higher HDL values than males (females: 46.50; males: 40.57). Rural patients had higher mean LDL values than urban patients (P-value: <0.05; Table 6).

Prevalence of dyslipidemia: There were 19.04% patients in rural and 9.15% in urban area without dyslipidaemia. The prevalence of dyslipidaemia (defined as having at least one abnormal lipid fraction) was 80.96% in rural patients and 90.85% in urban patients (Table 7).In 12.60% of rural and 5.08% of urban areas; high LDL dyslipidemia was the most prevalent form of isolated dyslipidemia. The percentage of patients with isolated dyslipidemia (high TG, low HDL, and high LDL) was 29.13% in urban areas and 34.44% in rural. Patients with combined dyslipidemia (two abnormal lipid fractions) are more common in urban areas (26.7%) than in rural areas (23.24%). Patients with mixed dyslipidemia (three abnormal lipid fractions) were also more prevalent in urban (18.46%) than in rural (16.52%) population (Table 7).

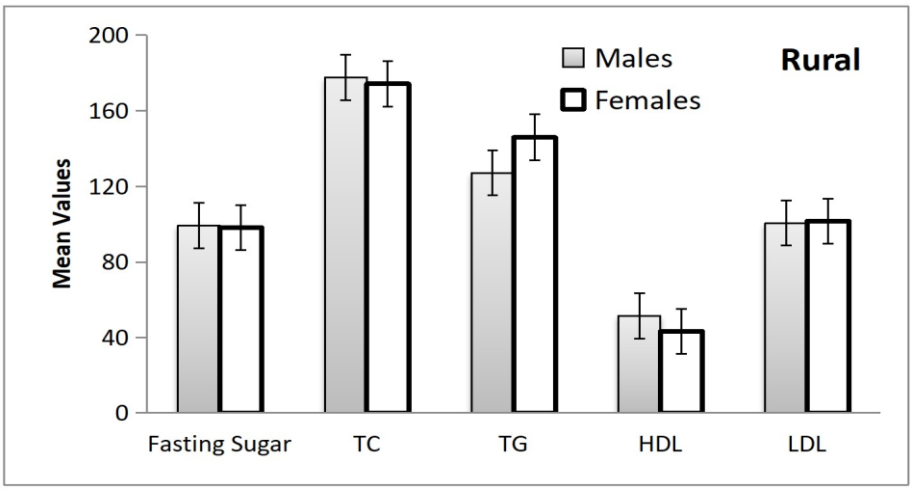
Table 1: Demographic (urban versus rural) distribution of patients for analyzing T2DM and dyslipidemia (n=947)

Total Patients	***Rural***		***Urban***	
	Count	***%***	***Count***	***%***
Total Patients	357	37.69%	590	62.30%
Gender				
Females	122	34.17%	231	39.15%
Males	235	65.82%	359	60.84%

Table 2: Comparison of fasting blood sugar, glycosylated hemoglobin levels and lipid profile in rural versus urban patients for analyzing T2DM and dyslipidemia.

Variables	***Rural***		***Urban***		
	Mean	***SD***	***Mean***	***SD***	***P-Value***
Fasting blood Sugar (mg/dL)	98.64	25.64	124.24	47.70	<0.001
HBA1C	6.04	1.24	7.09	1.84	<0.001
Total cholesterol (mg/dL)	175.33	42.91	180.58	44.53	<0.05
Total triglyceride (mg/dL)	139.61	63.79	169.64	90.82	<0.001
High-density lipoprotein(mg/dL)	46.07	12.44	45.04	12.74	012ns
Low-density lipoprotein (mg/dL)	101.34	35.34	100.84	36.91	0.23ns

ns=non-significant



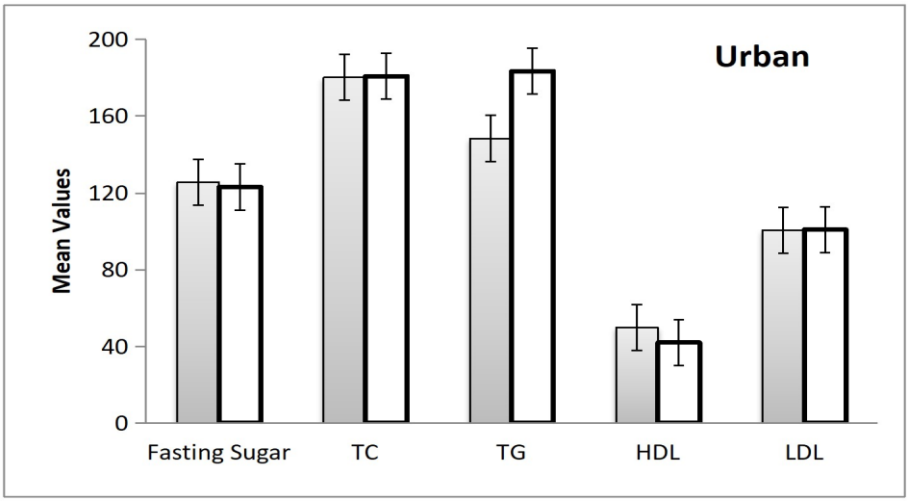


Figure 3: Comparison of fasting blood sugar and lipid profile amongst gender in rural versus urban patients. TC total cholesterol, TG triglycerides, HDL high-density lipoprotein, LDL low-density lipoprotein

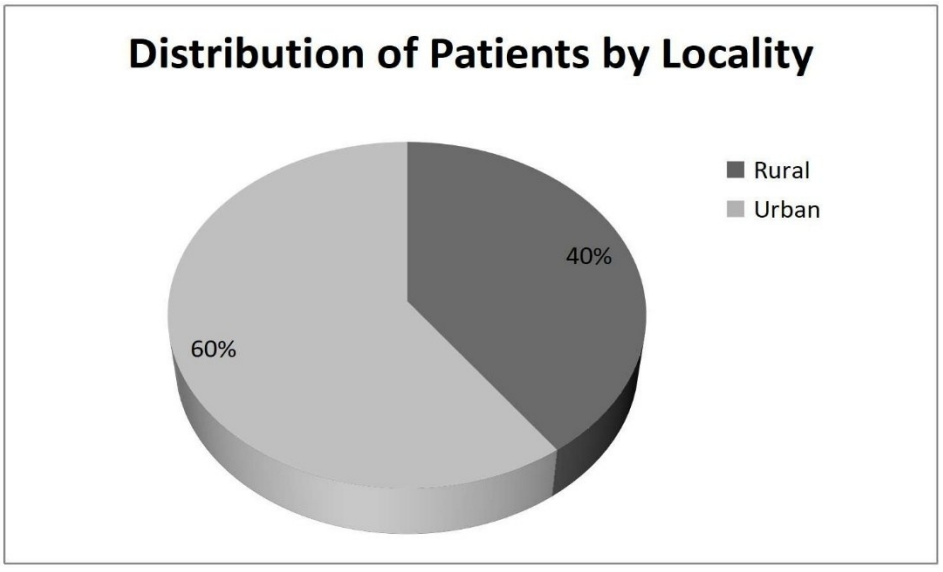


Figure 4. Distribution of patients in accordance with localities. Prevalence of dyslipidemia among type II diabetes patients was 60% in urban region and 40% in patients from rural region.

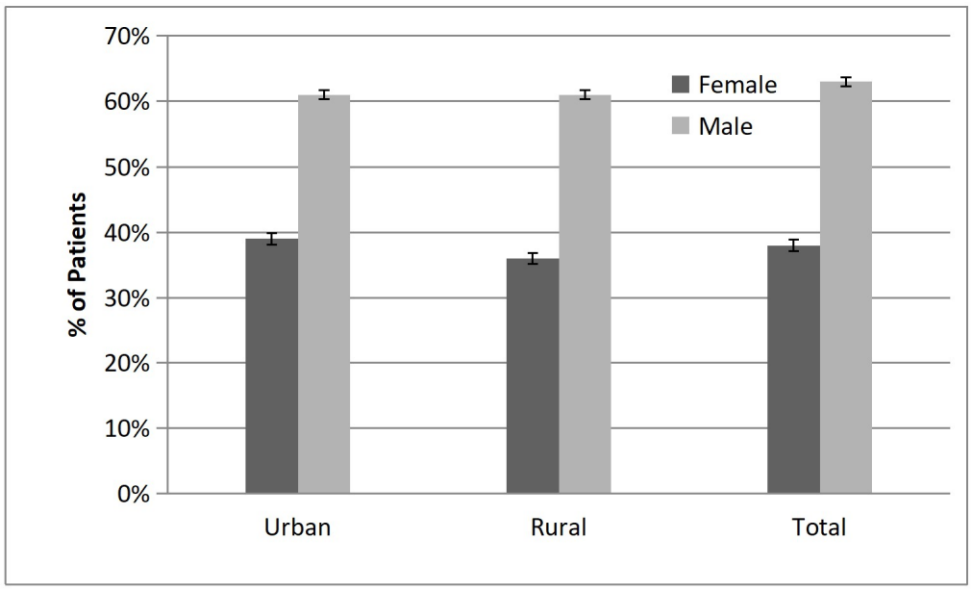


Figure 5. Demographic distribution of patients according to gender.

Table 3: Comparison of genders (Mean±SD) for fasting blood sugar, glycosylated hemoglobin levels and lipid profile in rural versus urban patients for analyzing T2DM and dyslipidemia.

Variables	***Rural***			***Urban***		
	Females	***Males***	***P-value s***	***Females***	***Males***	***P-value s***
Fasting blood Sugar (mg/dL)	99.37±25.14	98.26±25.94	0.35ns	125.79±49.22	123.24±46.74	0.40ns
HBA1C	6.12±0.98	6.01±1.33	0.81ns	7.04±1.62	7.14±2.01	0.58ns
Total cholesterol (mg/dL)	177.62±40.31	174.14±44.23	0.46ns	180.17±43.77	180.85±45.07	0.86ns
Triglyceride (mg/dL)	127.26±49.95	146.02±69.13	<0.001	148.42±69.57	183.45±100.01	<0.001
High-density lipoprotein(mg/ dL)	51.49±11.76	43.26±11.86	<0.001	49.82±12.85	41.97±11.70	<0.001
Low-density lipoprotein (mg/dL)	100.67±34.19	101.67±35.99	0.82ns	100.66±37.26	100.96±36.73	0.15ns

ns=non-significant

Table 4: Demographic profile of patients for fasting blood sugar, glycosylated hemoglobin levels and lipid profile to study dyslipidemia and T2DM (N=number of patients in %)

Variables		*Rural*				*Urban*			
		N (%)	*Rang e*	*Mean*	*SD*	*N (%)*	*Rang e*	*Mean*	*SD*
Fasting blood sugar (mg/dL)	Normal(<100 mg/dL)	68.34	45-99	88.88	8.01	39.32	66-99	88.71	6.40
	Prediabetic (100-125 mg/dL)	25.49		107.15	7.30	24.40		111.05	7.95
	Diabetes (>126 mg/dL)	6.16	126-349	171.86	55.91	36.27	129-526	171.63	49.57
HBA1C	Normal (<5.7 %)	52.78	4.85-5.68	5.37	0.24	18.83	4.9-5.69	5.35	0.22
	Prediabetic (5.7 - 6.4 %)	27.77		5.88	0.24	31.16		6.03	0.20
	Diabetes (>6.5%)	19.44	6.53-11.38	8.05	1.60	50.01	6.57-14	8.42	1.78
Total cholesterol (mg/dL)	Normal (< 200 mg/dL)	74.78	58-199	157.35	29.11	66.61	76-200	155.57	27.83
	Borderline (200 -239 mg/dL)	19.04		216.48	11.19	23.55		217.44	11.61
	High (>240 mg/dL)	6.16	240-424	256.40	62.10	9.83	240-367	261.74	22.65
Triglyceride (mg/dL)	Normal (<150 mg/dL)	64.98	50-148	103.12	25.05	50.33	47-149	107.05	26.08
	Borderline (150-199 mg/dL)	20.44		171.69	15.09	21.86		170.78	14.46
	High (>200 mg/dL)	14.56	202-406	255.61	60.47	27.11	200-765	285.01	90.49
High-density lipoprotein	Normal (>60 mg/dL)	14.56	60-91	67.75	7.98	12.71	60-95	68.89	8.34

(mg/dL)	Low (<40 mg/dL/ <50mg/dL)*	45.09	15-49	36.37	6.63	49.50	15-50	36.18	6.96
Low-density lipoprotei n (mg/dL)	Normal(<100 mg/dL)	47.33	16.2-99.8	72.63	19.14	48.30	9.4-100	70.87	19.77
	Borderline high (100 to 160 mg/dL)	47.61		121.48	16.02	44.91		123.90	16.47
	High(>160-190 mg/dL)	5.04	160.4 293.4	180.68	33.79	6.77	160-586	184.29	68.91

*Females <50(mg/dL); Males <40(mg/dL)

Table 5: Prevalence rates (% of patients) of studied characteristics in rural versus urban patients for analyzing T2DM and dyslipidemia.

Variables	***Rural***		***Urban***	
	Males (%)	***Females (%)***	***Males (%)***	***Females (%)***
Type-II Diabetic mellitus				
No(<100 mg/dL)	67.65	69.67	38.44	40.69
Yes (>100 mg/dL)	32.34	30.32	61.55	59.30
P-Values	<0.001	<0.001	<0.001	<0.001
HBA1C				
No (<5.7 %)	51.85	55.55	21.17	15.94
Yes (>5.7 %)	48.17	44.44	78.88	84.05
P-Values	<0.05	<0.001	<0.001	<0.001
Hypercholesterolemia				
No(< 200 mg/dL)	74.89	74.49	65.73	67.96
Yes (> 200 mg/dL)	25.10	25.40	34.26	32.03
P-Values	<0.001	<0.001	<0.001	<0.001
Hypertriglyceridemia				
No(<150 mg/dL)	60.42	73.77	44.56	59.30
Yes (>150 mg/dL)	39.57	26.22	54.31	40.69
P-Values	<0.001	<0.001	<0.001	<0.001

Low HDL				
No(>60 mg/dL)	9.78	21.80	7.52	21.64
Yes (<60 mg/dL)	90.12	76.22	92.47	78.35
P-Values	<0.001	<0.001	<0.001	<0.001
High LDL				
No(<100 mg/dL)	47.65	47.54	37.32	51.51
Yes (>100 mg/dL)	53.61	52.45	61.01	48.48
P-Values	<0.001	<0.001	<0.001	<0.001

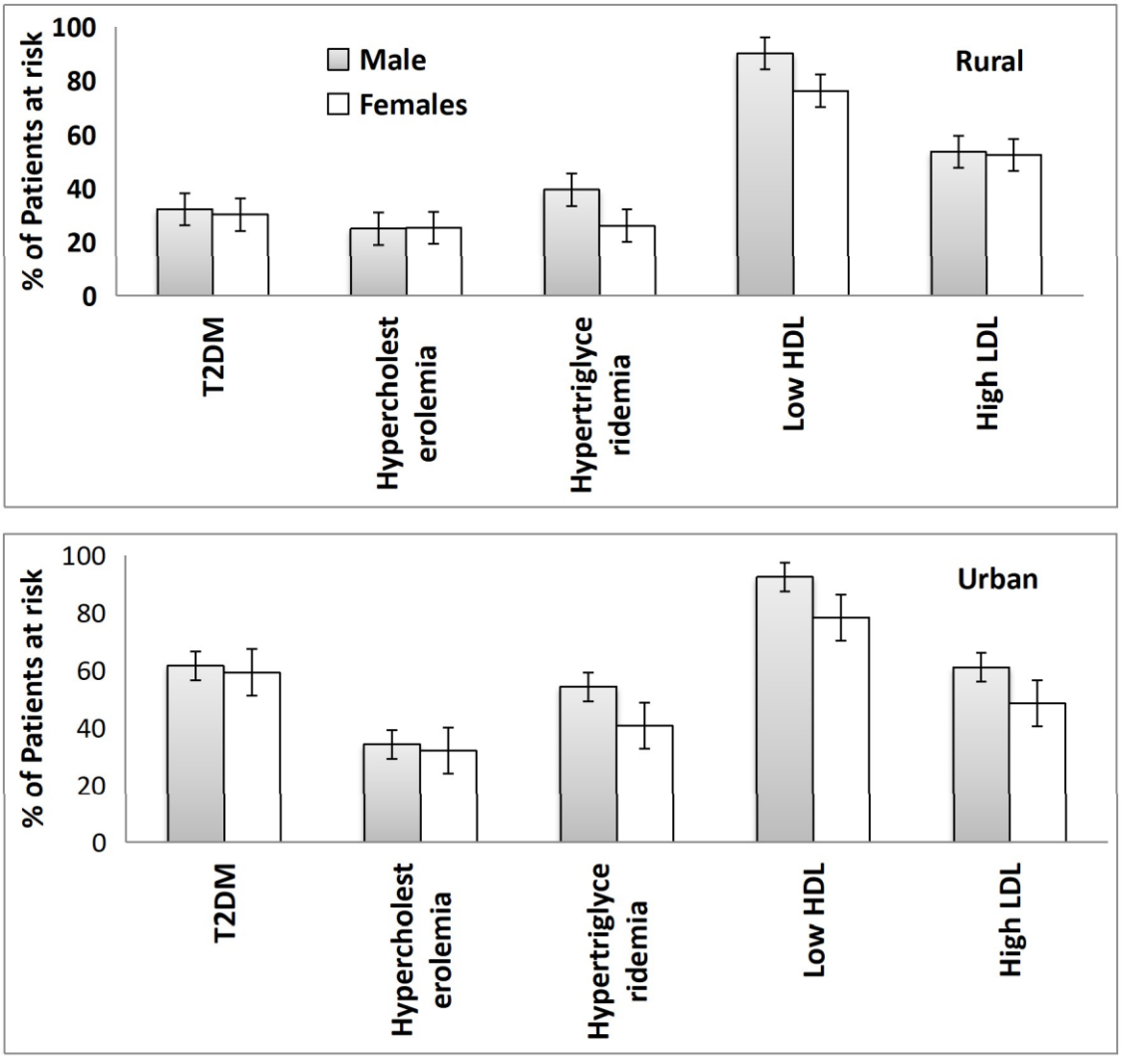


Figure 6: Comparison of genders based on risk profile (%) for fasting blood sugar, glycosylated hemoglobin levels and lipid profile in rural versus urban patients. T2DM: type-II Diabetic mellitus, HDL high-density lipoprotein, LDL low-density lipoprotein.

Table 6: Mean values of studied characteristics in rural versus urban patients for analyzing T2DM and dyslipidemia.

Variables	Rural		Urban		
	Male	Females	Male	Females	
Type-II Diabetic mellitus					P-Values
No(<100 mg/dL)	88.44	89.68	88.36	89.24	0.95ns
Yes (>100 mg/dL)	118.82	121.64	145.03	150.86	<0.001
P-Values	<0.001	<0.001	<0.001	<0.001	
HBA1C					
No (<5.7 %)	5.31	5.54	5.35	5.35	0.28ns
Yes (>5.7 %)	6.75	6.85	7.62	7.36	0.48ns
P-Values	<0.001	<0.001	<0.001	<0.001	
Hypercholesterolemia					
No(< 200 mg/dL)	156.26	159.45	155.45	155.75	0.36ns
Yes (> 200 mg/dL)	227.49	230.96	229.59	231.97	0.54ns
P-Values	<0.001	<0.001	<0.001	<0.001	
Hypertriglyceridemia					
No(<150 mg/dL)	103.25	103.44	108.37	105.39	0.48ns
Yes (>150 mg/dL)	211.33	194.25	245.05	211.13	<0.05
P-Values	<0.001	<0.001	<0.001	<0.001	
Low HDL					
No(>60 mg/dL)	68.08	67.48	69.74	68.08	0.39ns
Yes (<60 mg/dL)	40.57	46.50	39.71	44.78	0.12ns
P-Values	<0.001	<0.001	<0.001	<0.001	
High LDL					
No(<100 mg/dL)	71.93	73.40	83.36	85.49	<0.05
Yes (>100 mg/dL)	128.68	125.39	117.51	116.77	<0.05
P-Values	<0.001	<0.001	<0.001	<0.001	

Table 7: Demographic distribution of dyslipidemia amongst the studied patients

Variables	Rural	Urban

	Females	Males	Total	Females	Males	Total
No dyslipidaemia	23 (18.85%)	45(19.14 %)	68(19.04 %)	4(1.73%)	50(13.92 %)	54(9.15%)
Isolated dyslipidaemia						
High TG (mg/dL)	1 (0.81%)	18(7.65%)	19(5.32%)	0	21(5.84%)	21(3.55%)
Low HDL (mg/dL)	24(19.67 %)	35 (14.89%)	59(16.52 %)	80(34.63 %)	41(11.42 %)	121(20.50 %)
High LDL (mg/dL)	16(13.11 %)	29(12.34 %)	45(12.60 %)	2 (0.87 %)	28(7.79%)	30(5.08%)
Combined dyslipidaemia						
High LDL+ Low HDL	13(10.65 %)	10(4.25%)	23(6.44%)	29 (12.55%)	19(5.29%)	48(8.13%)
High TG + Low HDL	6(4.91%)	12(5.10%)	18(5.04%)	32(13.85 %)	52(14.48 %)	84(14.23%)
High TG+ High LDL	0	9(3.82%)	9(2.52%)	0	10(2.78%)	10(1.69%)
High TC+ High LDL	12(9.83%)	19(8.08%)	31(8.68%)	0	14 (3.89%)	14(2.37%)
High TC+ High TG	0	2 (0.85%)	2(0.56%)	0	0	0
High TC+ Low HDL	0	0	0	3 (1.29%)	4(1.11%)	7(1.18%)
Mixed dyslipidaemia						
High TG+ Low HDL+ High LDL	12(9.83%)	18(7.65%)	30(8.40%)	15 (6.49%)	20(5.57%)	35(5.93%)
High TG +High TC+ High LDL	6(4.91%)	18(7.65%)	24(6.72%)	1 (0.43%)	38(10.58 %)	39(6.61%)
High TC+ High LDL+Low HDL	1(0.81%)	1(0.42%)	2(0.56%)	19 (8.22%)	6(167%)	25(4.23%)
High TC+ High TG+Low HDL	0	3(1.27%)	3(0.84%)	1 (0.43%)	9(2.56%)	10(1.69%)
High TG + Low HDL + High LDL+ High TC	8 (6.55%)	16(6.81%)	24(6.72%)	45 (19.48%)	47(13.09 %)	92(15.59%)

TC total cholesterol, TG triglycerides, HDL high-density lipoprotein, LDL low-density lipoprotein.

Diabetes is a chronic metabolic disorder that affects the synthesis of insulin. Two major types of diabetes are Type I and type II. Type I Diabetes results from autoimmune disease due to destruction of insulin-producing beta cells in the pancreas' islets. While, type II insulin (T2DM) is caused by insulin resistance in muscle, fat and liver cells. Insulin resistance in T2DM leads higher triglyceride biosynthesis, decreased triglyceride and increased fatty acid flux. The various risk factors associated with T2DM includes dyslipidemia, hyperglycemia and cardio vascular diseases. T2DM, a chronic non-communicable disease, affects around 463 million people worldwide suffer from this disease and by 2040, that figure is predicted to increase to 640 million.

The most common types of T2DM diagnostic tests are (i) FPG (fasting plasma glucose) ≥126 mg/dl assays (ii) The OGTT, or oral glucose tolerance test 2-h plasma glucose ≥200 mg/dl (iii) HBA1C (glycated hemoglobin) ≥6.5%. Due to their sedentary lifestyles and over nutrition, urban patients typically experience higher rates of T2DM than rural ones. A healthy lifestyle that includes eating low-fat, high-fiber meals, exercising moderately too vigorously, decreasing weight, and avoiding prolonged inactivity is key to preventing T2DM. In nations like India, with the use of epidemiological data diabetes prevention initiatives can more effectively target high-risk people.

Type-II-Diabetes mellitus (T2DM) is a chronic endocrine disease linked to elevated blood sugar levels and dyslipidemia. This study focused on prevalence of T2DM and dyslipidemia in urban-rural location of Faridabad. A retrospective cross-sectional study was gender, blood analysis (fasting glucose level, HBA1C) and lipid profile-triglycerides (TG), high density lipoprotein (HDL), low density lipoprotein (LDL) and total cholesterol (TC). This study included 590 urban and 357 rural patients having >60% males. Prevalence of T2DM (urban: 36.27%; rural: 6.16%) and dyslipidemia (urban: 90.85%; rural: 80.96%) was more in urban than rural patients.

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