The Bioscan
AN INTERNATIONAL QUARTERLY JOURNAL OF LIFE SCIENCES
19(2): S.I (1), 943-947, 2024 www.thebioscan.com

Dyslipidemia Patterns among Type 2 Diabetes Patients: Evidence from a Hospital-Based Study in Faridabad, Haryana

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DOI: 10.63001/tbs.2024.v19.i02.S.I(1).pp943-947

KEYWORDS
Type 2 Diabetes Mellitus (T2DM), Dyslipidemia, Cardiovascular Risk, Urban-Rural Differences, Prevalence
Received on:

18-05-2024

Accepted on:

15-06-2024

Published on:

21-07-2024

ABSTRACT

Dyslipidemia is a common metabolic abnormality in patients with type 2 diabetes mellitus (T2DM) and a major contributor to cardiovascular risk. This cross-sectional study, conducted at a multispecialty hospital in Faridabad, Haryana, evaluated 947 patients with T2DM from urban and rural populations to determine the prevalence and patterns of dyslipidemia. Results revealed a higher burden of dyslipidemia in urban patients, with low HDL-C, high LDL-C, and elevated triglycerides being the most frequent abnormalities. Gender differences showed men with higher triglycerides and women with relatively higher HDL-C. The findings highlight the need for early screening, lifestyle modification, and targeted interventions to reduce cardiovascular complications in T2DM.

INTRODUCTION

Diabetes is a metabolic disorder marked by defects in insulin secretion and function of insulin, which leads to long-term harm, organ failure, and dysfunction1. Diabetes arises from multiple pathological mechanisms, such as insulin resistance and autoimmune death of pancreatic ß-cells, which impair the metabolism of proteins, fats, and carbohydrates due to insufficient insulin. Insufficient insulin secretion or reduced tissue responses can lead to deficient insulin action.These abnormalities frequently overlap in the same patient, making it difficult to identify which one causes hyperglycemia2-3. Long-term consequences from diabetes include peripheral and autonomic neuropathy, nephropathy, eyesight loss, hypertension, increased risk of cardiovascular and cerebrovascular disorders, and changes in lipoprotein metabolism4.

Increased fatty acid flow, increased hepatic triglyceride synthesis, decreased triglyceride clearance, and disruptions to processes such apoprotein formation and cholesteryl ester action are all consequences of insulin resistance in T2DM2-5. Intracellular hormone-sensitive lipase is activated by T2DM, which raises hepatic triglyceride synthesis and production. Triglyceride removal is determined by lipoprotein lipase, which is found on the vascular endothelium. It is downregulated in insulin resistance or insufficiency, which leads to postprandial lipemia (Figure 1)2-5.

Etiology

Diabetes is categorized into two major types: type-I, type-II:

T1DM (Type I Diabetics): It is a form of the disease known as autoimmune destruction of beta cells in the pancreas that produce insulin, leading to a complete lack of insulin. This condition is typically observed in children and teenagers. Ninety percent of cases of T1DM occur in adults and are a kind of autoimmune diabetes that results from the death of pancreatic beta cells. There is a strong genetic susceptibility to the major histocompatibility complex (MHC) and human leukocyte antigens (HLA). Because type I diabetes is caused by a complete lack of insulin secretion, it can be recognized by genetic markers and autoimmune pathologic processes2.

T2DM: Ninety percent of cases of diabetes are caused by T2DM, a disease that results in insulin resistance. Usually it is observed in those over the age of 45. Obesity, physical inactivity, and diets high in calories are making it more common in kids, teens, and young adults. Insulin resistance in liver, muscle, and fat cells as well as insufficient pancreatic insulin synthesis is the main causes of T2DM. Due to a combination of insufficient insulin secretory response and resistance to insulin action, T2DM can result in hyperglycemia that is asymptomatic and does not cause any clinical signs. There are two forms of Type II diabetes:

Predominantly insulin resistance with relative insulin deficiency, and predominantly an insulin secretory defect with insulin resistance.

Non-insulin-dependent diabetes: Ninety to 90-95 percent of people with diabetes have this type of diabetes. Commonly it is referred to as type II diabetes or adult-onset diabetes. It typically

involves insulin resistance and relative deficiency, without insulin treatment. Without insulin therapy, it usually entails relative deficit and insulin resistance.

Dyslipidemia-associated with T2DM

Dyslipidemia, or an aberrant lipid profile, is a significant public health concern, particularly in low-income countries like India, where patterns of hypercholesterolemia and hypertriglyceridemia have almost doubled since 20006. Research indicates that a number of variables, including age, inadequate physical activity, blood pressure, fasting glucose, BMI, dietary habits, smoking, and changes in lifestyle, are linked to the rising incidence of dyslipidemia in people with T2DM.Non-communicable diseases such as cardiovascular diseases are common in developing nations, and dyslipidemia plays a major role in the development of CVD, T2DM, and atherosclerosis. It would be beneficial to assess the prevalence and pattern of dyslipidemia as well as the risk factors associated with it among patients with type II diabetes in order to help achieve the desired control of lipid parameters and to lessen the incidence, prevalence, and complications of diabetic dyslipidemia.

Dyslipidemia, which is defined as aberrant lipid profiles brought on by insulin resistance, is one the risk factor for T2DM. Atherogenic lipoprotein phenotype, another name for dyslipidaemia, is a major metabolic risk factor. It is characterized by increased triglycerides, low high density lipoprotein, and normal to slightly raise in low density lipoprotein7-8. T2DM is characterized by hypertriglyceridemia, decreased HDL cholesterol, and elevated LDL particles, with dyslipidemia playing a major role. Though its specific etiology is uncertain, insulin resistance is the main cause of diabetes dyslipidemia, which leads to increased free fatty acid flow. When combined with dyslipidemia, elevated HBA1C increases the risk of cardiovascular disease (CVD) in diabetics by 18% for every one percentage increase in absolute HBA1C6.

Gender and age-specific patterns of dyslipidemia differ, and obesity and hypertension are independent risk factors. There may be a reciprocal relationship between dyslipidemia and T2DM, as glycated hemoglobin and lipid profile parameters are substantially associated in T2DM patients. In order to lessen the risk of CVD, clinicians should strive to treat hyperglycemia, hyperlipidemia, and hyperglycemia by medication and lifestyle changes. For diabetic patients, this means lowering blood pressure and cholesterol objectives. The following are risk factors for T2DM: age, gender, diabetes, hypertension, tobacco use, excessive alcohol intake, sedentary lifestyle, and poor diet. Patients with T2DM have higher cardiovascular disease risk factors due to metabolic syndromes such as dyslipidemia, hyperglycemia, and hypertension, which result in elevated blood pressure, aberrant cholesterol levels, and elevated glucose levels6. The frequency of dyslipidemia is rising worldwide, especially in developing nations like Bangladesh, India, Ethiopia, Kenya, and Sri Lanka. It also considerably cardiovascular risk for diabetic patients, with 70–80% of them dying from cardiovascular disease9-12.

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, 2023 with approval from the local Institutional Ethical Committee of Metro Heart Institute with multispecialty Faridabad, Haryana, India.

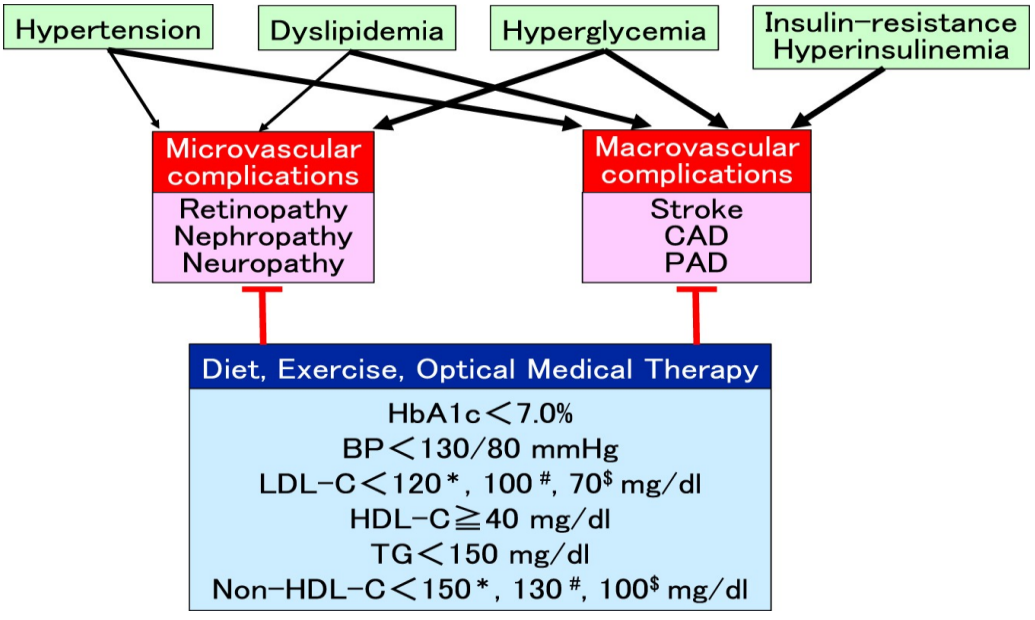
Population under investigation: Total of 947 patients from urban and rural area of Faridabad Haryana was included in investigation to determine the prevalence of type-II Diabetes mellitus (T2DM) and dyslipidemia in patients. Out of 947 patients 590 were from urban and 357 from rural area. The study comprised both males and females as per their age group including younger (>30), middle and elderly (>71). Furthermore, data from younger (<45) and older (>45) age groups was also analyzed.

Dyslipidemia: TC level >200 mg/dl, TG > 150 mg/dl, LDL >100 mg/dl, or HDL <40 mg/dl in males or < 50 mg/dl in and females. Patients whose HDL was >60 mg/dL were considered as normal. A TC <200mg/dL was regarded as normal. Similarly, TG <150mg/dL were regarded as normal and LDL >160-190 mg/dL was considered as extremely high.

Statistical analysis : Descriptive analysis including mean, percentage distribution and standard deviations was performed on fasting blood sugar (mg/dl), TC (mg/dl), TG (mg/dl), HDL (mg/dl), LDL (mg/dl) in both males and females as well as on rural versus urban patients. The statistical package for social sciences (SPSS version 14; IBM SPSS, Inc., Chicago, IL, USA) was used to analyze the collected data.

Hyperglycemia

Hyperglycemia, a metabolic disease brought on by abnormalities in either insulin secretion, insulin action, or both is characterized T2DM. The risk of T2DM is further increased by other lifestyle choices such as using tobacco, abusing alcohol, living a sedentary lifestyle, and eating an unhealthy diet that results in obesity. Chronic hyperglycemia can harm organ systems and result in potentially fatal consequences including macro- and microvascular disorders [13]. Obesity, hypertension and T2DM have been recognized as risk factors for dyslipidemia. There can be a mutual link between T2DM and dyslipidemia. Certain studies have demonstrated a substantial correlation between glycated hemoglobin (HBA1C) and lipid profile measures in patients with T2DM2,[13].



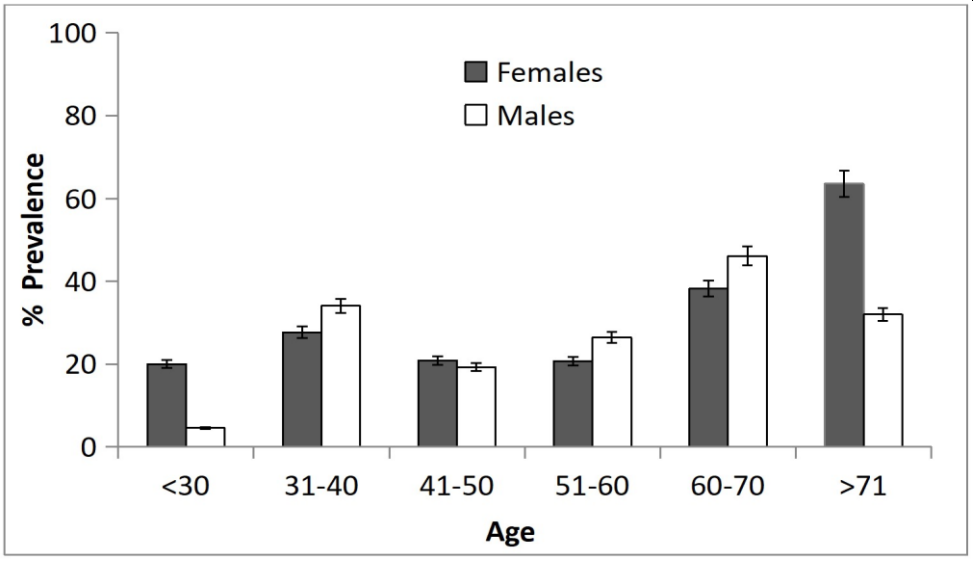
Source: Miyata, M. Intensive lipid-lowering therapy in high-risk diabetic patients. *Hypertens Res* 44: 1676–1677 (2021). https://doi.org/10.1038/s41440-021-00773-4.

High-risk populations, such as those with T2DM, still lack a dyslipidemia diagnosis and treatment plan. The main factor causing the lipid changes associated with diabetes acid reflux due to insulin resistance is an increase in free fatty acids. The primary objective of the clinician ought to be the management of lifestyle-related dyslipidemia and hyperglycemia, as well as the mitigation of cardiovascular disease risk. Dyslipidemia is a key risk factor for cardiovascular disease, and T2DM is a metabolic illness characterized by hyperglycemia due to insulin abnormalities, commonly accompanied by aberrant lipoprotein metabolism [1,3].

Results

Table 1: Prevalence rates (%) of dyslipidemia in patients diagnosed with T2DM from Faridabad, Haryana.

Rural	***Females***			***Males***		
Age	**<45**	**>45**	**Overall**	**<45**	**>45**	**Overall**
Hypercholesterolemia (mg/dL)	0%	20%	16.66%	29.41%	26.31%	27.07%
Hypertriglyceridemia (mg/dL)	0%	13.33%	11.11%	58.52%	33.33%	39.18%
Low high-density lipoprotein(mg/dL)	100%	76.66%	80.55%	70.58%	38.59%	45.94%
High low-density lipoprotein(mg/dL)	83.33%	30.00%	38.88%	70.58%	52.63%	56.75%
Urban	**Females**			**Males**		
Age	**<45**	**>45**	**Overall**	**<45**	**>45**	**Overall**
Hypercholesterolemia (mg/dL)	38.88%	32.20%	33.08%	47.72%	27.52%	31.53%
Hypertriglyceridemia (mg/dL)	44.44%	44.91%	44.85%	65.90%	38.76%	44.14%
Low high-density lipoprotein(mg/dL)	55.55%	61.86%	61.09%	50.00%	50.56%	50.45%
High low-density lipoprotein(mg/dL)	50.01%	43.22%	44.11%	65.90%	44.94%	49.09%



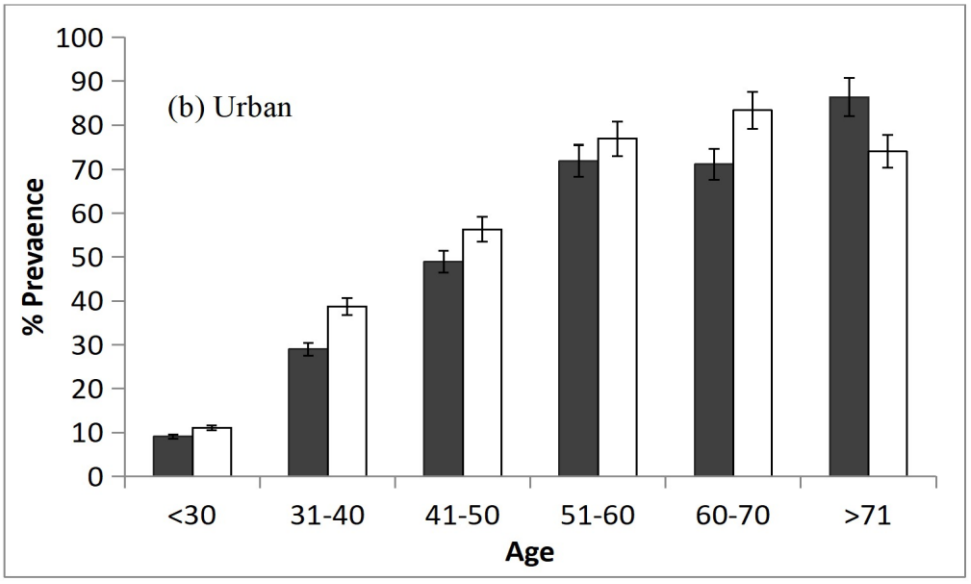


Figure 7: Age specific prevalence of type-II diabetic mellitus in patients from urban and rural area.

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

Demographic distribution of patients

Urbanization influences lifestyle and socio-economic status of people compared to rural population. Urbanization has several detrimental impacts, including enhanced consumption of sugar and fats, obesity, cardiovascular disease and T2DM79,80-84. Studies indicated that persons who relocate from rural to urban regions are typically less active than those who remain in rural areas80,82. India's fast urbanization in recent years has led to a rise in the prevalence of many diseases in urban areas. Understanding the incidence of T2DM and dyslipidemia in India's rural and urban populations is therefore important. The current study examined the prevalence of pre-diabetes, diabetes, and dyslipidemia in patients from both urban and rural areas of Faridabad, India. The majority of patients diagnosed in this study came from urban areas (n = 590) as opposed to rural ones (n = 357). Regarding gender, men from both urban and rural populations made up the majority of diagnosed patients compared to women (Table 1). T2DM diagnoses were significantly more common in urban population (36.27%) than rural (6.16%) population (Table 4). Urban patients exhibited greater fasting blood sugar, HBA1C, total cholesterol, and triglycerides than rural patients (Table 2). The disparities in T2DM and dyslipidemia between patients in urban and rural locations can be attributed to a variety of factors, including living conditions, economic level, awareness, eating habits, and lifestyle85.

Gender comparison

Recent research indicates that men are diagnosed with T2DM at a higher rate than women86. Therefore, understanding gender differences in T2DM, pre-diabetes, and dyslipidemia prevalence is essential to understanding public health strategies. In this study, fewer than 40% of female participants in both urban and rural areas received a diagnosis, compared to more than 60% of male participants (Table 1). This could be the result of gender discrimination or a lack of knowledge about women's health and wellbeing. Interestingly, in patients from urban or rural locations, changes in any of the following parameters—total cholesterol, LDL, HBA1C, or fasting blood sugar levels— were not influenced by gender. However, men's TG levels were significantly greater than women's in individuals in both rural and urban areas (Table 3). In both rural and urban areas females mean HDL was higher than males (Table 3). These differences can be explained by varying hormone effects and levels of physical exercise86,87.

Risk Profile

Adults living in urban area were significantly more likely to have dyslipidemia and T2DM than those in rural areas71,73,75. In comparison to their rural counterparts, urban patients had greater mean values for TC, TG, HBA1C, and fasting blood sugar (Table 4). Table 4 shows that a greater proportion of patients from urban areas had higher fasting blood sugar (Urban: 36.27%; Rural: 6.16%), HBA1C (Urban: 50.01%; Rural: 19.44 %), triglycerides (Urban: 27.11%; Rural: 14.56 %), and total cholesterol (Urban: 9.83%; Rural: 6.16 %) than patients from rural population. In summary, patients in urban areas were higher likelihood of developing dyslipidemia and T2DM than patients in rural.

Additionally, a comparison of genders showed that patients in urban areas had higher risk profiles than those in rural areas fasting blood glucose (Urban: males 61.55%; females 59.30%; males 32.34%; females 30.32%) and HBA1C (Urban: males 78.88%; females 84.05%; Rural: males 48.17%; females 44.44%) than rural population (Table 5).

Humans have two types of lipoprotein: HDL and LDL, whereas triglycerides are stored as excess fat in the body. Patients with elevated low-density lipoprotein (LDL) risk atherosclerosis, myocardial infarction, and stroke. HDL, on the other hand, regarded as healthy cholesterol and can help prevent heart attack and stroke to some extent. HDL carries LDL from arteries back to the liver, where it is processed and eliminated from the body[6,7]. Patients in urban areas were more likely than those in rural areas to have hypercholesterolemia (Urban: males: 34.26%; females: 32.03%; Rural: 25.10%; females: 25.40%) and hypertriglyceridemia (Urban: males: 54.31%; females: 40.69%; Rural: 39.57 %; females: 26.22%; Table 5). Dyslipidemia and other T2DM risk factors are produced when hypertriglyceridemia is paired with either high LDL or low HDL6, 7. Table 5 shows that most of the study's participants are from urban area, have hypertriglyceridemia, low-HDL (>75%), and high- LDL (>50%) levels. Males had higher levels of hypertriglyceridemia than females, but there was no gender difference in hypercholesterolemia (Table 5). Low-HDL (>75%) and high-LDL (>50%) values were present in a large proportion of patients from both urban and rural areas (Table 5).

According to this study, dyslipidemia affected 90.85% of patients in the urban area and 80.96% of patients in the rural area (Table 6). In both males and females, the most prevalent patterns of dyslipidemia were (high LDL and low HDL) and (High TG and Low HDL). Isolated dyslipidemia, such as elevated LDL, was more common in rural areas (Rural: 12.60%; Urban: 5.08%). Conversely, mixed dyslipidemia—defined as having three or more aberrant lipid fractions—was more prevalent in urban areas. 18.46% of patients in the urban population had three abnormal lipid fractions, whereas 15.59% had four abnormal lipid fractions. Table 6 shows that 16.52% of the rural population had three abnormal lipid fractions and 6.72% had four abnormal lipid fractions. Numerous earlier studies reported the prevalence of dyslipidemia concurred with these findings. These differences in T2DM and

dyslipidemia prevalence and patterns may be due to lifestyle, genetics, and socioeconomic development74,75,76.

Limitations and Future Scope

The study had several limitations, including not measuring variables like sleep period, depression, and dyslipidemia caused due to secondary drugs. There were limited female and rural participants in the study due to lack of awareness about disease progression. Furthermore this study did not consider the proportion of diabetic patients as migrants, potentially causing bias in rural-urban diabetes prevalence.

According to this study, the prevalence of dyslipidemia and T2DM in adult Indians varied significantly between urban and rural population. The current study found association between prevalence of type II diabetes and dyslipidemia with urban versus rural lifestyle. According to these results, patients from urban population may have greater levels of total cholesterol, total triglycerides, HBA1C, and fasting blood glucose. The percentage of non-diabetic patients was higher in rural areas compared to urban areas.

CONCLUSION

The present study highlights a high prevalence of dyslipidemia among patients with type 2 diabetes mellitus (T2DM), with significant differences between urban and rural populations. Urban patients exhibited markedly higher levels of fasting blood glucose, HbA1c, total cholesterol, triglycerides, and mixed dyslipidemia compared to their rural counterparts, reflecting the influence of lifestyle and socio-economic factors. Low HDL and elevated LDL were the most common lipid abnormalities, underscoring their central role in diabetic dyslipidemia. Gender-wise, males showed a higher prevalence of hypertriglyceridemia, while females tended to have higher HDL values, though overall dyslipidemia was widespread in both sexes.

These findings emphasize that dyslipidemia remains a major modifiable risk factor for cardiovascular complications in T2DM patients. Early screening, lifestyle modifications, and appropriate pharmacological interventions are crucial to prevent the progression of cardiovascular disease. Public health strategies should particularly target urban populations and raise awareness among rural communities and women, where underdiagnosis and limited healthcare access remain challenges. Strengthening preventive measures and tailored management programs could substantially reduce the dual burden of diabetes and dyslipidemia in India.

Acknowledgement

I am grateful to my guide for the cooperation throughout the paper.

Conflict of interest

No conflict of interest were found.

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