ASSOCIATION OF DYSLIPIDAEMIA AND COMORBIDITIES WITH RISK FACTORS AMONG DIABETIC PATIENTS: A RETROSPECTIVE OBSERVATIONAL ANALYSIS.

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Abstract
Background
Diabetes mellitus (DM) is a disease marked by hyperglycemia brought on by an imbalance between the action or cooperation of insulin and its secretion.

Aim
To determine how risk variables are related to dyslipidemia and comorbidities in patients with type 2 diabetes mellitus (T2DM).

Materials and Methods
An enrolment of 65 T2DM patients was made using the electronic medical record. The link between the patients' dyslipidemia and current comorbidities and the available laboratory, clinical, and demographic data was looked for. The SPSS-23 software was used for statistical analysis.

Results
Out of the 65 T2DM patients, 19 (29.22%) were male and 46 (70.76%) were female, with a mean age of 60.12±10.49 years, according to the electronic health record. 31 (47.38%) participants had diabetes mellitus for more than ten years, and 44 (68.30%) subjects had poor glycaemic control (HbA1c > 7%). 21 (31.68%) of the participants in this study had hypertension (HTN), 22 (34.45%) had ischemic heart disease (IHD), 9 (13.84%) were obese, 2 (2.45%) had a stroke, and 53(82.76%) had dyslipidemia. Out of the 54 patients with dyslipidemia, 41 (62.44%) were receiving treatment for hypolipidemia.

Conclusion
Findings showed that comorbidities were linked to aging and that HTN, IHD, and dyslipidemia were prevalent comorbidities. The present patterns in T2DM comorbidities and symptomatology were brought to light by this investigation. All of these extremely morbid consequences of this avoidable illness can be avoided with effective management and control by early screening and encouraging patients to lead healthy lifestyles.

Recommendations
To prevent the unintended consequences of cardiovascular disorders, routine blood glucose, and blood lipid monitoring for the early identification of dyslipidemia and placing patients under medical management is recommended.

Introduction

Diabetes mellitus (DM) is a disease marked by hyperglycemia brought on by an imbalance between the action or cooperation of insulin and its secretion [1, 2]. Worldwide, type-2 diabetes mellitus (T2DM) accounts for about 90% of all instances of diabetes [3]. By 2030, it's predicted that 350 million individuals will have diabetes [4]. Regardless of other traditional risk factors, diabetes is thought to impart at least a twofold increased risk for cardiovascular diseases (CVD) [5, 6]. For several years before the onset of biochemical hyperglycemia, persons with type 2 diabetes frequently have an increased risk of cardiovascular disease. An aberrant lipid profile, or dyslipidemia, is one of the main risk factors for cardiovascular disease in diabetic patients [7]. It is primarily brought on by an increase in the flux of free fatty acids as a result of insulin resistance [8]. Because metabolic syndrome and insulin resistance reduce the inhibition of hormone-sensitive lipase in adipose tissue, they increase the portal transit of free fatty acids to the

liver, which in turn causes enhanced lipolysis [9,10]. The hormone lipoprotein lipase is then inhibited by these fatty acids, leading to an excess of triglyceride-rich lipoproteins, such as chylomicrons and very-low-density lipoprotein (VLDL), which are frequently linked to an increase in small, dense oxidized low-density lipoprotein (LDL) and a decrease in high-density lipoprotein (HDL) [11,12]. The presence of several chronic conditions in one individual as a result of one index disease is known as comorbidity, and it is frequently observed in DM. Numerous illnesses hurt a person's quality of life, and the patient is generally depressed [13]. When a person experiences several health issues, it puts a significant strain on the person, their family, and society's healthcare system. The purpose of the current study was to determine how risk factors for T2DM patients are related to dyslipidemia and comorbidities.

Materials and Methods
Study Design
An observational study was done retrospectively.

Study Setting
The study was conducted from November 2023 to October 2024 at Jawaharlal Nehru Medical College and Hospital, Bhagalpur, Bihar, India.

Participants
There were 65 patients with the diagnosis of Type 2 Diabetes Mellitus included in the study.

Inclusion Criteria
The study covered all of the T2DM patients. Only patients on anti-diabetic medication, excluding insulin, were included, and individuals were chosen using the "American Diabetes Association (ADA) criteria (FBG ≥126 mg/dL, HbA1C≥6.5%, or RBG≥200 mg/dL)" [14].

Exclusion Criteria
Because Type 1 DM and Type 2 DM have different comorbidities and consequences, patients with Type 1 DM were excluded from the study.

Data Collection
Clinical data and pertinent investigative findings were retrieved from the hospital's central electronic health records (EHR). The following information was recorded: lipid profile, serum creatinine, HbA1c levels, age, gender, BP, weight, height, educational attainment, FBG, RBG, complications, and related issues.

Procedure
Based on their HbA1c levels, the patients were split into two groups: those with HbA1c ≤ 7 had good glycaemic control, and those with HbA1c > 7 had poor glycaemic control[15]. Dyslipidaemia was defined as "having one or more of the following: TC ≥ 5.18 mmol/L, TG ≥ 1.7 mmol/L, LDL ≥ 3.37 mmol/L, or HDL ≤ 1.04 mmol/L". The participants were further separated into dyslipidemic and normal groups[16]. The treating physician verified the MI diagnosis based on the patient's medical records. Among T2DM participants, hypertension was diagnosed using the ADA criteria, which calls for SBP ≥140 mmHg and DBP ≥90 mmHg measured across several visits [17].

Statistical Analysis
Version 23 of SPSS (Statistical Package for Social Sciences) was used to analyze the study data. For quantitative data, the mean ± SD was stated. Qualitative factors were described using frequency and percentages. Between diabetic individuals with and without dyslipidemia, the means of age, BMI, systolic and diastolic blood pressure (mm Hg), LDLc, TG, HDLc, HBA1c, serum creatinine, and random and fasting blood glucose were compared using the Student's t-test. Additionally, a logistic regression analysis was performed to determine the relationship between the variables. A significant p-value was defined as < 0.05.

Ethical considerations
The Ethics Committee gave its approval for this study. The committee waived the patient's consent because the study was retrospective, and each patient's privacy was protected. Every step was taken in compliance with global ethical norms.

Results
With a mean age of 60.12±10.49 years, this study cohort comprised 65 T2DM patients, 19 of whom were male (29.22%) and 46 of whom were female (70.76%). 31 (47.38%) participants had diabetes mellitus for more than ten years, and 44 (68.30%) subjects had poor glycaemic control (HbA1c > 7%). 21(31.68%) of the participants in this study had hypertension (HTN), 22 (34.45%) had ischemic heart disease (IHD), 9 (13.84%) were obese, 2(2.45%) had a stroke, and 53 (82.76%) had dyslipidemia. 41 (62.44%) of the 54 dyslipidemic patients were receiving hypolipidemic medication. The lipid profile, which includes HDLc, LDLc, TC, and TG, showed a highly significant difference (p-value <0.001) when research variables were compared based on dyslipidemia versus normal lipid levels, but many other factors, such as age, blood pressure, and serum creatinine, did not change significantly. Subjects with dyslipidemia had significantly increased RBG, HBA1c, and FBG (Table 1). Patients' comorbidities and risk variables were analyzed using logistic regression, which showed that comorbidities were significantly correlated with age groups 60–69 and 70–79. Similarly, when controlling for other variables, the strong correlation between comorbidities and the length of diabetes >10 years vanished. There was no significant correlation seen between comorbidities and females, blood pressure, HbA1c >7, dyslipidemia, or hypolipidemic therapy (Table 2).

Table 1: Study Variable Comparison Based on Normal Lipid Values and Dyslipidaemia

Variable	Normal(N=11)	Dyslipidaemia(N=54)	p-value
BMI (kg/m^2)	30.69±6.29	32.19 ± 6.49	0.11
Age(years)	59.82±10.49	60.11±10.59	0.84
Diastolic BP (mmHg)	70.89±11.29	72.99±12.79	0.26
Systolic BP (mmHG)	136.59±25.79	138.69±24.69	0.58
LDL (mmol/l)	2.09±0.29	3.29+0.79	<0.001
HDL (mmol/l)	1.29±0.25	0.98±0.30	<0.001
TG (mmol/l)	1.29±0.29	2.30±1.09	<0.001
Cholestrol (mmol/l)	3.50±0.29	5.09±1.09	<0.001
HbA1c (%)	6.79±1.59	8.19±1.89	<0.001
Serum Creatinine(μmol/L)	68.59±26.59	67.09±21.89	0.644
RBG (mmol/l)	9.59±3.39	11.29±4.29	0.0049
FBG (mmol/l)	7.29±1.89	8.09±2.69	0.034

Table 2: Analysing Risk Factors and Comorbidities in Diabetic Patients Using Logistic Regression

Variables	Odds Ratio (95% CI)	p-value	Adjusted Odds Ratio (95% CI)	p-value
Gender				
Female	1.059 (0.55–2.01)	0.849	0.69 (0.269–1.839)	0.459
Male	1		1	
Age Group				
<40 years	1		1	
40-49 years	3.239 (0.869–12.059)	0.079	2.849 (0.589–13.649)	0.190
50-59 years	2.419 (0.749–7.809)	0.139	2.539 (0.59–10.639)	0.203
60-69 years	7.329 (2.019–26.659)	0.0019	8.349 (1.589–43.969)	0.0119
70-79 years	20.139 (3.379-120.22)	0.001	16.969 (2.049–140.19)	0.009
80+ years	5.139 (0.809–32.769)	0.0829	3.849 (0.459–32.109)	0.211
Blood Pressure				
Diastolic BP	1.019 (0.989–1.039)	0.272	1.009 (0.979–1.039)	0.3979
Systolic BP	1.0001 (0.98–1.01)	0.591	1.01 (0.98–1.01)	0.896
HbA1c				
≥7	1.27 (0.67–2.40)	0.445	1.19 (0.59–2.40)	0.599
≤7	1		1	
DM duration				
>10 years	9.93 (0.51–1.72)	0.851	0.81 (0.38–1.69)	0.586
≤10 years	1		1	
Comorbidities				
Yes	1.16 (0.54–2.51)	0.679	1.35 (0.58–3.10)	0.473
No	1		1	

Discussion

Globally, T2DM sufferers anticipate several crippling and potentially fatal consequences [18]. The primary causes of these consequences are inadequate diabetes management and the chronic nature of the condition. Due to the involvement of several organs, comorbidity—the simultaneous existence of two or more complications—produces devastating health repercussions [19]. The main elements in improving control of this potentially lethal condition are patient education and commitment to appropriate therapy.

The fundamental mechanism of type 2 diabetes is believed to be the body's growing insulin resistance. Numerous dyslipidaemias are caused by this process, which also causes numerous disturbances in lipid metabolism.19. Patients with Type II diabetes were included in the current investigation. According to the overall age group with T2DM, nearly all of the patients (95.39%) were over 40, with roughly 61.01% falling into the 50–69 age range. According to this research, diabetic patients in the 60–69 and 70–79 age groups had 7.329- and 20.139 times higher probabilities of having comorbidities, respectively, than those in the age group under 40. Even after controlling for additional risk factors, this OR remained substantial. There isn't a good reason why this age group's OR value is so high. However, the weakening of all other bodily systems with age and the likelihood of developing comorbidities could be the cause of this connection.

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Additionally, as diabetic people age, diabetes problems often manifest. Additionally, a correlation between the length of the DM and dyslipidemia was discovered. It can be explained by the fact that insulin resistance rises with the length of time that type 2 diabetes persists, which in turn affects the metabolism of fats and carbohydrates. HTN, IHD, and different degrees of dyslipidaemias were found to be comorbid conditions. When HTN and ICH (intracerebral brain hemorrhage) coexist, Hussain et al. discovered negative prognostic consequences on diabetics [21]. The majority of the obese patients in this study had comorbidities of HTN, Stroke, and IHD in varied amounts, and their HbA1c levels were higher than 7, indicating comparatively poor control of their diabetes. The patients had a high prevalence of MI, related dyslipidaemias, and cerebrovascular accidents (CVA). Otherwise, there exists a strong correlation between CVA and hypertension and diabetes. High morbidity and death were linked to these concurrent T2DM illnesses, according to a multicentre investigation [22]. The occurrence of comorbidities in older patients was also found to be growing, and there is a positive correlation between comorbidity and age, as has been noted in numerous other investigations [23,24,25]. Long-term hyperglycemia is mostly linked to microvascular problems affecting end artery organs, such as retinopathy, nephropathies, and selected neuropathies, particularly in poorly managed type 2 diabetes. Long-term T2DM and hypertension are linked to nephropathy, with a frequency of up to 60% in patients with hypertension and a greater prevalence of retinopathy in normotensive individuals with long-term T2DM [26]. Several significant variables in the sample were compared. The groups' results on the lipid profile series tests (HDLc, LDLc, TC, and TG) differed significantly. The dyslipidemic subjects exhibited significantly elevated HbA1c, FBG, and RBG levels. One likely explanation for these variations is the individuals' abnormal lipid and carbohydrate metabolism. Fung et al. have noted a variety of data indicating that type 2 diabetes is a metabolically complicated condition [27]. The main element in better care and the prevention of numerous morbidities is the provision of improved medical treatment and awareness campaigns for people with chronic conditions like type 2 diabetes. Nonetheless, a significant effort to raise public awareness of the value of good lifestyle choices and regular exercise is also required to stop this terrible but perhaps avoidable illness [28].

Conclusion
Comorbidities increased with age, and the most common ones were dyslipidemia, IHD, and hypertension. The present patterns in T2DM comorbidities and symptoms have been noted by this investigation. Preventing all of these extremely serious side effects of this avoidable illness can be greatly aided by effective management and control by early screening and encouraging patients to lead healthy lifestyles.

Limitations
A small sample population that was included in the study is one of its shortcomings. Data was obtained from the electronic health records and were not directly exposed to the patients, as is the case with all retrospective research. Many topics were left unaddressed, such as the management-related issues that older diabetics experience and their food and exercise patterns.

Recommendations
To prevent the unintended consequences of cardiovascular disorders, routine blood glucose, and blood lipid monitoring for the early identification of dyslipidemia and placing patients under medical management is recommended.

Data Availability
Data is available upon request.

Author contributions
All authors contributed to the design of the research. PBM and BB collected and analyzed the data. RPJ wrote the manuscript. PBM and BB edited the paper. All authors read and approved the paper.

List of abbreviations
DM- Diabetes mellitus
T2DM- type 2 diabetes mellitus
HTN- hypertension
IHD- ischemic heart disease
CVD- cardiovascular diseases
VLDL- very-low-density lipoprotein
LDL- low-density lipoprotein
HDL- high-density lipoprotein
ADA- American Diabetes Association
FBG- fasting blood glucose
RBG- random blood glucose
EHR- electronic health records
BP- blood pressure
SPSS- Statistical Package for Social Sciences
BMI- Body mass index
TG- triglycerides
ICH- intracerebral brain hemorrhage
CVA- cerebrovascular accidents
MI- myocardial infarction
TC- Total cholesterol

Conflict of interest
The authors have no conflicting interests to declare.

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