Dyslipidemic profile in Type 2 Diabetes Mellitus: A hospital-based study from Eastern Nepal

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ABSTRACT
Background
Dyslipidemia is highly prevalent in Type 2 Diabetes Mellitus (T2DM). It plays a major role in the pathogenesis for diabetic complications. This study intends to exemplify the pattern of dyslipidemia prevalent in T2DM patients attending tertiary care centre of Eastern Nepal.

Material and methods
This is a hospital based cross-sectional study conducted in the T2DM patients visiting the routine biochemistry laboratory for their routine blood investigations. 226 patients were included who fulfilled the inclusion criteria. Biochemical parameters were analyzed in routine biochemistry laboratory in cobas c311 autoanalyzer.

Results
Out of the 226 T2DM patients, 51% were female and 49% were male respectively. The mean age group was 54.15 ± 12.62 years. Mean value of, HbA1c level, total cholesterol, TG, HDL and LDL was 8.16 ± 2.59 %, 289.04 ± 47.83, 297.77 ± 119.64, 35.62 ± 12.64, 140.88 ± 40.58 respectively. HbA1c was significantly correlated with the lipid profile in T2DM patients (p < 0.05).

Conclusion
The findings from the present study depicts that the prevalence of dyslipidemia is higher in T2DM in our centre with hypertriglyceridemia being the major type of dyslipidemia in these patients. In addition, male exhibited higher rate of dyslipidemia compare to their female counterparts respectively.

Keywords
Dyslipidemia, Hypertriglyceridemia, Type 2 Diabetes Mellitus, Lipid Profile
Background
Type 2 Diabetes Mellitus (T2DM) is a group of metabolic disorders characterized by varied degrees of insulin resistance, impaired insulin secretion, and increased glucose production [1]. Globally, there is an increasing trend of cases of Diabetes Mellitus every year. The prevalence has increased from 327 million in the population of age group of 20-64 years with the estimated rise of 438 million among those aged 20-64 years in 2045 respectively [2]. It is considered as a major risk factors for the development of the atherosclerosis subsequently leading to cardiovascular disease i.e., atherosclerotic cardiovascular disease (ASCVD). Atherogenic dyslipidemia is the major cause attributed to the development of ASCVD [3]. Among the coronary artery disease, one with the common occurrence is the cardiovascular disorder and cerebrovascular accident. Hyperglycemia in T2DM for a longer period results in changes in the chemical properties of the proteins (glycosylation) especially the connective tissue proteins i.e. collagen crosslinking and matrix proteins present in the wall of arteries [4]. The major consequence of this deleterious process is the development of endothelial function ultimately resulting in atherosclerosis. There is a lack of insulin action that leads to the alteration in carbohydrate, fat and protein metabolism [5]. Relatively insulin deficiency, insulin resistance and obesity are concomitant to hypertriglycerideremia, decreased serum HDL cholesterol and intermittently associated with high serum LDL cholesterol in T2DM. T2DM is associated with dyslipidemia which is demonstrated as raised low-density lipoprotein cholesterol (LDL-C), reduced high density lipoprotein cholesterol (HDL-C) levels or increased triglyceride (TG) levels [6-9]. Increased triglyceride levels is an independent risk factor for coronary artery disease. The major concern for Dyslipidemia in T2DM is due to its utmost risk for the development of macrovascular complications affecting 10-73% of the diabetic patients [10]. Also, the expert reports from the panel on Detection, Evaluation, and Treatment of High Blood Cholesterol in Adults (Adult Treatment Panel III or ATP III) has depicted that the Diabetes Mellitus comparable to the coronary artery disease (CHD), summing it to the highest risk category [11-14]. Hence, we intended to determine the pattern of lipid profile prevalent in patients of Type II Diabetes Mellitus and to find out if there is any relationship of dyslipidemia with age, sex and obesity in Type II Diabetes Mellitus.

Material and methods
Study design and the participants
This was a hospital based comparative cross-sectional study conducted in the Department of Biochemistry at B. P. Koirala Institute of Health Sciences (BPKIHS), Dharan from June - November 2019.

Data collection
Blood was collected in serum vial and EDTA vial from the study population for lipid profile, fasting, postprandial blood glucose and HbA1c respectively. 10-12 hours of fasting was ensured in the study patients for lipid profile analysis and the blood sample was withdrawn. Serum was separated within 30 min of blood collection.

Serum Glucose estimation
Fasting blood glucose (FPG) and Postprandial blood glucose (PPG) was done by Hexokinase Method (Cobas c311 autoanalyzer) [16-17]. FPG and PPG is expressed in mg/dl. Hexokinase catalyzes the phosphorylation of glucose to glucose-6-phosphate by ATP.

Serum Cholesterol estimation
Serum Cholesterol was done by enzymatic, colorimetric method [18] in cobas c311 autoanalyzer.

Serum Triglycerides estimation
Serum triglycerides estimation was done by enzymatic colorimetric test [19] in cobas c311 autoanalyzer.

HbA1c estimation
HbA1c was done by turbidimetric inhibition immunoassay (TINIA) method in Cobas c311 Autoanalyzer [16]. The range for HbA1c was taken as 4.5–6.3%.

Inclusion criteria
Patients diagnosed with Type 2 Diabetes Mellitus and aged 18-55 years. All newly diagnosed and follow-up cases of T2DM visiting the laboratory for their blood investigations was included in the study.

Exclusion Criteria
Pregnant females, patients diagnosed of Type 1 Diabetes Mellitus and patients taking drugs like corticosteroids and other systemic diseases were excluded from the study.
Sample size calculation
Two hundred and twenty-six patients and one hundred thirteen apparently healthy controls were enrolled from routine clinical biochemistry laboratory at B.P. Koirala Institute of Health Sciences. Sample size was calculated based on a similar study done in eastern Nepal in 2009 by Regmi et al [15] which reported the prevalence of dyslipidemia in T2DM to be 63.8%.

Sampling technique
Diabetic patients were recruited from clinical laboratory services (Department of Biochemistry) by convenient sampling technique and the biochemical parameters was assessed in Department of Biochemistry, BPKIHS.

Data management and statistical analysis
Data was collected and entered using Microsoft Excel™ and analyzed using Statistical Package of Social science (SPSS) version 11.5 (Chicago Inc). Data was expressed in terms of figure, percentage, mean and standard deviation. Chi-square test was used to compare the categorical terms of figure, percentage, mean and standard deviation. Ethical committee approval
Ethical clearance was obtained from the Departmental Ethical clearance was obtained from the Departmental Ethical committee approval

Results
The study population included 226 patients diagnosed with T2DM and 113 healthy controls. Demographic data and glycemic status of the T2DM and healthy controls has been depicted in Table 1.

Table 1: Demographic profile and glycemic status in the study population

| Variables         | Case       | Control    | p value  |
|-------------------|------------|------------|----------|
| Age (years)       | 54.15 ± 12.62 | 45.5 ± 10.4 | 0.01*    |
| Gender (M/F)      | 110/116    | 55/58      | -        |
| Fasting Blood Glucose (mg/dl) | 176.83 ± 82.26 | 91.25 ± 22.34 | < 0.001* |
| Post-Prandial Blood Glucose (mg/dl) | 278.79 ± 140.35 | 128.54 ± 37.45 | < 0.001* |
| HbA1c (%)         | 8.16 ± 2.59 | 4.4 ± 1.2  | < 0.001* |

*p < 0.05, statistically significant

Serum total cholesterol, Triglycerides, LDL was found to be significantly higher and HDL was significantly lower in the Type 2 DM patients compared to the healthy controls (Table 2).

Table 2: Lipid Profile in the study population

| Lipid Profile                | Type 2 DM | Control | p value |
|------------------------------|-----------|---------|---------|
| Total Cholesterol (mg/dl)    | 289.04 ± 47.83 | 145.20 ± 45.40 | < 0.001* |
| Triglycerides (mg/dl)        | 297.77 ± 119.64 | 115.55 ± 38.77 | < 0.001* |
| High Density Lipoprotein (mg/dl) | 35.62 ± 12.64 | 50.55 ± 18.79 | < 0.05* |
| Low-Density Lipoprotein (mg/dl) | 140.88 ± 40.58 | 90.45 ± 23.55 | < 0.04* |

*p value < 0.05, statistically significant

Comparison of glycemic and lipid parameters between male and female revealed that only HDL was found to be significantly higher in female compared to male type 2 DM patients (Table 3).

Table 3: Comparison of Lipid Profile parameters and Glycemic status in male and female patients

| Variables              | Male       | Female     | p value |
|------------------------|------------|------------|---------|
| FPG (mg/dl)            | 184.44 ± 157.16 | 169.35 ± 121.60 | 0.16    |
| PPG (mg/dl)            | 288.22 ± 8.22 ± 2.73 | 269.53 ± 8.11 ± 2.46 | 0.31    |
| HbA1c (%)              | 8.11 ± 2.46 ± 1.26 | 121.60 ± 168.87 ± 10.63 | 0.76    |
| TC (mg/dl)             | 192.28 ± 9.22 ± 2.73 | 186.65 ± 186.65 ± 39.61 | 0.38    |
| HDL (mg/dl)            | 43.96 ± 4.22 ± 1.04 | 11.45 ± 47.17 ± 13.47 | 0.04*    |
| LDL (mg/dl)            | 114.16 ± 11.45 ± 1.04 | 46.94 ± 107.66 ± 33.07 | 0.23    |
| TG (mg/dl)             | 206.15 ± 119.64 ± 2.73 | 189.53 ± 107.66 ± 33.07 | 0.29    |

Comparison of glycemic and lipid parameters between male and female revealed that only HDL was found to be significantly higher in female compared to male type 2 DM patients (Table 3).

Table 4: Pattern of Dyslipidemia in male and female patients with Type 2 Diabetes Mellitus

| Abnormal serum lipid values | Mean ± S.D. | Male | Female | p value |
|-----------------------------|-------------|------|--------|---------|
| Total Cholesterol (> 200 mg/dl) | 337.62 ± 3.77 | 106 (51%) | 96 (42%) | 0.43    |
| Triglycerides (> 150 mg/dl)  | 367.54 ± 10.63 | 120 (53%) | 100 (44%) | 0.51    |
| LDL (> 100 mg/dl)            | 168.87 ± 2.87 | 98 (43%) | 78 (34%) | 0.34    |
| HDL (< 40 mg/dl)             | 34.67 ± 0.43 | 79 (35%) | 59 (26%) | 0.15    |

Lipid profile of the study population reveals that dyslipidemia was prevalent in 51% of the male and 42% of the female. Pattern of dyslipidemia between male and female patients showed that though dyslipidemia was highly prevalent in both of the gender, but the difference was insignificant (Table 4).

Discussion
Dyslipidemia is one of the focal concerns in patients with T2DM, as it is the major risk factor related to further complications of T2DM [22]. Studies have shown that atherogenic dyslipidemia due to insulin resistance is exaggerated by the hyperglycemic state and lipotoxicity; all of these factors collectively lead to increased threat to cardiovascular system [23].
The present study intended to evaluate the pattern of lipid profile with the HbA1c level depicting profile and its correlation with HBA1c in T2DM patients. The findings revealed that HbA1c which represents the long-term glycemic control was significantly correlated with HDL-Cholesterol levels. While there was no significant correlation with other parameters of lipid profile (TC, LDL and TG). This finding was in accordance with the study reported by Sapkota et al [29] who had reported significant correlation between HbA1c and lipid profile parameters. There is an established fact for the direct association of long-standing hyperglycemia and T2DM complicated with severe dyslipidemia consequently leading to cardiovascular events. The presence of these risk factors upsurges 2-4-fold of increased menace for the development of coronary heart disease and other cardiovascular events respectively. In addition, current treatment protocols target to prioritize the patients with poor glycemic control to achieve near normal to sub normal blood glucose levels in a prospect to prevent the progression of dyslipidemia and further events related to it [23]. Subsequently, our study reports a high prevalence of increased total cholesterol, raised triglycerides, high LDL-C and low HDL-C levels in patients with poor glycemic control as shown by increased HbA1c levels which are well known risk factors for cardiovascular diseases. Insulin, the hormone for glucose homeostasis regulates the apolipoprotein production in liver and modulates the enzymatic activity of lipoprotein lipase and Cholesterol ester transport protein. Hence, insulin resistance or decreased insulin action collectively leads to dyslipidemia in Diabetes mellitus [30]. Adversely, insulin deficiency reduces the activity of hepatic lipase and several steps in the production of biologically active LpL may be altered in Diabetic patients [31].

The type of lipid abnormalities is variable in T2DM patients ranging from dyslipidemia to isolated lipid parameter abnormality [27]. The present study demonstrated a higher rate of dyslipidemia in T2DM i.e., 51% of T2DM patients has dyslipidemia. This was slightly lower compared to the other studies reported from other part of the country [25-27]. Our research findings illustrated that T2DM patients had significantly higher level of triglycerides (TG) level, increased total cholesterol and LDL-Cholesterol and lower HDL level which was in line with the similar studies [25-27]. Uncontrolled state of T2DM characterized by hyperglycemia and insulin resistance is the major causative factor contributing for dyslipidemia [27,32-34]. Among the lipid parameters, isolated hypertriglyceridemia was the most common in T2DM patients. Similar findings were reported by other studies as well [25,35-38].

### Table 5: Pearson’s correlation correlating the level of HbA1c with lipid profile

| Parameters | HbA1c | TC  | TG  | HDL | LDL |
|------------|-------|-----|-----|-----|-----|
| HbA1c      | -     | 0.64*| 0.43*| -0.56**| 0.50*|
| TC         | 0.64* | -   | 0.29**| -0.19*| 0.91**|
| TG         | 0.43  | -0.02| -0.001| -0.40**| 0.16* |
| HDL        | 0.02  | -0.002| -0.001| -0.092 |
| LDL        | <0.001| 0.004| 0.001| 0.17  |
|            | 0.50* | 0.91**| 0.16*| 0.092 |
|            | 0.03  | <0.001| <0.01| 0.17  |

**p< 0.001; *p<0.05, statistically significant**

Pearson’s correlation for correlating the lipid profile parameters with the marker for glycemic control (HbA1c) demonstrated that TC, TG and HDL was significantly correlated with HbA1c, while there was a negative correlation between HDL and HbA1c (p<0.05) (Table 5).

The present study depicted that dyslipidemia is highly prevalent in the T2DM patients of Eastern Nepal. The finding was in accordance with the study done in other parts of Nepal [24-25]. Associated co-morbidities specifically dyslipidemia and hypertension in T2DM increases the 2-4-fold risk for the development for coronary artery disease compared to non-diabetic patients [26-27].

Our study depicted female preponderance in T2DM with 51% of female with T2DM. But, in contrast male patients showed higher prevalence of dyslipidemia i.e., 66% of male showed dyslipidemia. This is in accordance with the studies reported by Pandeyya et al [25] and Shrestha et al [26] who reported the prevalence of dyslipidemia in 59% and 85% of males in the study population respectively. Studies have depicted that glycation of proteins tends to be higher in the male patients compared to their female counterparts. The reason postulated for this could be due to the presence of some physiological state like pregnancy or metabolic conditions like obesity rather than sex specific genetic tendency [27]. The mean age in the present study is 54.15 ± 12.62 years which exhibits the presence of T2DM in older population. This is in accordance with the studies published by WHO 1998. Mean BMI (28.5± 4.7) was higher in the T2DM patients which was in accordance to the study reported by Pokharel et al [24], Pandeyya et al [25] respectively. Higher BMI which is directly associated with the abdominal obesity is recognized as one of the risk factors for metabolic risk factors, incident cardiovascular events and increased mortality respectively. There is the direct risk which is linked with the presence of visceral adipose tissue (VAT) that can lead to insulin resistance, dyslipidemia and hypertension [27].

The present study intended to evaluate the pattern of lipid profile and its correlation with HBA1c in T2DM patients. Assessment of lipid profile with the HbA1c level depicts that there was no significant difference in the lipid profile parameters in male and females. Few factors predispose females for high risk of development of dyslipidemia like the effect of sex hormones on body fat distribution leading to the differences in altered lipoproteins metabolism [28].
Conclusion
The present study finding depicts that dyslipidemia is highly prevalent in T2DM. The coexistence of dyslipidemia in T2DM encompasses for increased cardiovascular risk. Hence, the indication of lifestyle modification and lipid lowering therapy as a prophylaxis for cardiovascular disease in T2DM is done by continuous monitoring of lipid profile and glycemic status in T2DM patients.

Limitation and future scope of the study
This was a hospital based cross-sectional study reported from a single setting done in a limited sample size. Additional markers of inflammation like hs-CRP, IL-6 could not be incorporated in the present study due to resource constraints. A large multi centric cohort study could be conducted in future taking the baseline variables like FPG, PP, HbA1c, Lipid profile and Apolipoproteins in Type 2 Diabetes Mellitus.

Relevance of the study
This study will be a baseline study for the further larger study if conducted in the similar setting. Also, the present study shows the status of common co-morbidity i.e., Dyslipidemia associated with Type 2 Diabetes Mellitus patients of Eastern Nepal.

Abbreviations
ATP- Adult Treatment Panel Guidelines, CHD-Coronary Artery Disease, HDL- High Density Lipoprotein, LDL- Low Density Lipoprotein T2DM: Type 2 Diabetes Mellitus, TC- Total Cholesterol TG- Triglycerides

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Authors’ contribution
a. Study planning: BKLD, AN
b. Data collection: NP, MFA, KA, SP, AN
c. Data analysis/ interpretation: NP, MFA, KA, SP, AN
d. Manuscript writing: BKLD, NP, AN
e. Manuscript revision: BKLD, AN
f. Final approval: BKLD, NP, MFA, KA, SP, AN
g. Agreement to be accountable for all aspects of the work: BKLD, NP, MFA, KA, SP, AN

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Availability of data and materials
The data generated and analyzed during the study are not publicly available due to the restriction in disclosure of the patient’s details including identification but can be made available by the author on rational request.

Competing interests
None declared.

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