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A study of Fasting and Postprandial Lipid Profile in Type 2 Diabetes Mellitus: A Comparative Study

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Abstract:

Background:
Type 2 diabetes mellitus (T2DM) is a common metabolic disorder in Pakistan. It is often associated with dyslipidemia, which increases cardiovascular risk. Routine practice mainly focuses on fasting lipid levels, while postprandial lipid changes are less explored, despite their clinical relevance.

Objective:
To compare fasting and postprandial lipid profiles in patients with type 2 diabetes mellitus and non-diabetic controls, and to assess the significance of postprandial lipid abnormalities.

Methods:
This comparative study was conducted at Avicenna Medical College Hospital, Lahore. A total of 200 participants were enrolled, including 100 known T2DM patients and 100 non-diabetic controls, aged 30–50 years. Fasting and six-hour postprandial blood samples were analyzed for total cholesterol, triglycerides, HDL-C, LDL-C, and VLDL. Glycemic parameters included fasting blood sugar and HbA1c. Statistical analysis was performed using t-tests and repeated measures ANOVA, with $p < 0.05$ considered significant.

Results:
Patients with T2DM showed significantly higher fasting and postprandial triglycerides, LDL-C, VLDL, and lower HDL-C compared to controls ($p < 0.0001$). Postprandial triglyceride and VLDL levels were markedly elevated in diabetic patients compared to their fasting values, while total cholesterol and LDL-C showed relative reduction after meals. Poor glycemic control was associated with more pronounced lipid abnormalities.

Conclusion:
Type 2 diabetes mellitus is associated with significant fasting and postprandial dyslipidemia. Postprandial lipid assessment reveals additional atherogenic risk not evident in fasting samples alone. Routine evaluation of postprandial lipid profiles should be considered for better cardiovascular risk assessment in patients with T2DM.

Keywords:
Type 2 diabetes mellitus; Dyslipidemia; Fasting lipid profile; Postprandial lipid profile; Triglycerides; Cardiovascular risk; HbA1c

Introduction: Type 2 Diabetes Mellitus (T2DM) is a chronic metabolic disorder. It is characterized by elevated blood glucose levels resulting from insulin resistance and/or insufficient insulin secretion. It may lead to disturbances in the metabolism of Lipid, carbohydrates, and protein.[1] This pervasive condition, affecting millions of humans globally. It is a major risk factor for various microvascular and macrovascular complications, significantly impacting patient morbidity and mortality.[2] Type 2 diabetes, also known as Non-Insulin Dependent Diabetes Mellitus (NIDDM), is becoming increasingly prevalent among South Asian populations, particularly in emerging countries like Pakistan and India.[3] High BMI, top body fat percentage, upper body adiposity, genetic predisposition, insulin resistance, and vulnerability to environmental factors all contribute to the rising occurrence.[4]

Among these complications, dyslipidemia, particularly the alterations in lipid profiles, plays a pivotal role in accelerating atherosclerotic processes, especially in the postprandial state.[5] The increased prevalence of cardiovascular disease in Type 2 Diabetes Mellitus (T2DM) is largely attributed to a prolonged and exaggerated postprandial dysmetabolism, primarily characterized by hyperglycemia and hypertriglyceridemia, which consequently induces endothelial dysfunction.[6] Current clinical practice predominantly relies on fasting lipid profiles for diagnosing and managing dyslipidemia. However, recent research suggests that a random lipid profile, which correlates significantly with the fasting lipid profile, might be a reliable alternative for patients with Type 2 Diabetes Mellitus.[7] Despite this, the postprandial lipid profile, representing the physiological response to a meal, offers a more dynamic and potentially more accurate assessment of an individual's cardiovascular risk, often revealing abnormalities not evident in a fasting state.[6] This disparity underscores the importance of a comprehensive evaluation of both fasting and postprandial lipid parameters to fully capture the atherogenic potential in individuals with Type 2 Diabetes Mellitus.[8] Specifically, postprandial triglycerides and the triglyceride/HDL-cholesterol ratio have been shown to correlate more strongly with HbA1c in diabetic patients compared to fasting measurements, suggesting their utility in assessing glycemic control and cardiovascular risk.[8] However, a significant proportion of diabetic individuals exhibit normal fasting lipid profiles but demonstrate considerable postprandial lipid abnormalities, thereby masking their true cardiovascular risk.[5] Hence, we conducted the present study to compare the fasting and random lipid profile among Pakistani subjects with T2DM, irrespective of their glucose-lowering or lipid-lowering treatment.

Material and Methods:

The present study was conducted in the department of General Medicine, Avicenna Medical College, Hospital, Lahore. A tertiary health care center. The study was approved by ethical research committee in 2025-26. The study was initiated with 100 cases (type 2 Diabetic mellites patients) and 100 controls (non-diabetic mellites patients). Gender wise equally distributed. As per procedure, verbal consent is taken by the patients in prescribed formats before their participation in study.

Inclusion criteria:

- Know case of type 2 DM in the past 5 years and on hypoglycemic medicine
- Age between 30-50 years

Exclusion Criteria:

Type 2 DM Patients with chronic illness like: Hypertension, Chronic Renal Disease, Chronic Liver Disease, Stroke, Malignancy, Neuropathy

In present study the following parameters were measured: Fasting Blood Sugar (FBS), HbA1C, Total Cholesterol (TC), Triglycerides (TG), High Density Lipoprotein Cholesterol (HDL-C), Very-low-density lipoprotein cholesterol (VLDL), Low-density lipoprotein cholesterol (LDL).

Data for the proposed study was collected in a pretested proforma, which included various parameters like age, sex, occupation, etc. Detailed history and physical examination of all the cases and controls were done. Fasting and postprandial lipid levels were estimated in all the cases and controls. Blood was collected from patients after an overnight (12hour) fast and six hours postprandial (after a standard meal) for lipid profile measurements.

The GOD-POD method was used to assess fasting blood sugar, and the direct enzymatic assay method using ion exchange chromatography (Crest A Coral Clinical System, USA)[9] was used to estimate HbA1c. The CHOD-PAP method was used to measure serum total cholesterol,[10] the GPO-Trinder method to measure triglycerides, and the Phosphotungstic acid method to measure HDL cholesterol.[9], [11] Friedewald's equation14,18 can be used to determine the values of very-low-density lipoprotein cholesterol (VLDL) and low-density lipoproteins(LDL):

• Total cholesterol - HDL cholesterol + triglycerides/5 is LDL cholesterol.

• Triglycerides/5 = VLDL-C.[12]

Statistical Analysis:

Graph Pad Prism v3.0's tools have been used to statistically analyze a number of the parameters specified in the study protocol. To ascertain statistical significance ($P < 0.05$) Between fasting and post-prandial lipid profiles, the Newman-Keuls Multiple Comparison Test and repeated measured ANOVA were utilized. For correlation testing, the Spearman coefficient was employed. Additionally, all tests were two-tailed, and a P value of less than 0.05 was deemed statistically significant.

Results:

The study had 200 participants who met the inclusion and exclusion criteria were included in the study. We divide the participant into 2 groups: a) known type 2 DM patients b) non-diabetic mellites patients. They appeared to be in good health. 23 of the individuals were not allowed to participate in the trial because their fasting blood glucose levels fell within the range of diabetes. Out of the total 200 members, 117 (58.5%) were women and 83 (41.5%) were men. Participants in the study ranged in age from Thirty to Fifty years. The average age of the males and females was 37.98 ± 10.51 and 36.4 ± 10.11 years, respectively.

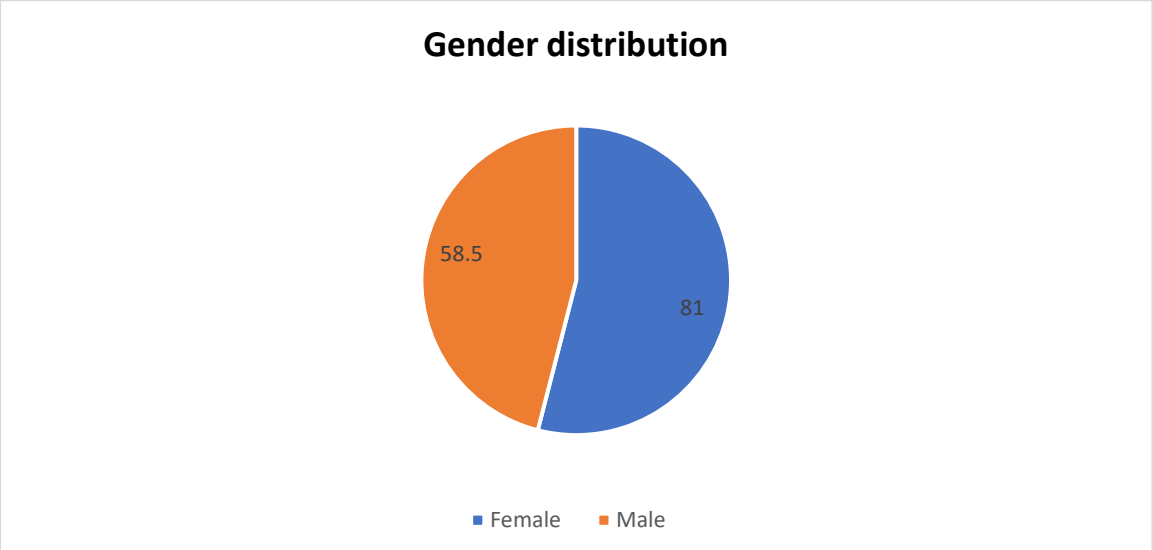

Fig 1: Gender distribution of the study population

Age (Years)	**Cases (type 2 Diabetic) (n=100)**		**Controls (Non-Diabetic) (n=100)**	
	Male (42)	**Female (58)**	**Male (41)**	**Female (59)**
30- 35	04	07	04	20
36-40	10	17	08	10
41-45	11	11	17	17
46-50	17	23	12	12
Total	42	58	41	59
Mean ± SD	12.5 ± 6.14		12.5 ± 5.29	

Table-1: age and Gender distribution of cases and control subjects

Variables	**Controls (n=100)**	**Cases (n=100)**
Family history of Diabetes (yes/no)	32/68	54/46
Occupation		
Farmer	12	08
Housewife	32	48
Labourer	27	09
other	18	35

Table-2: Demographic data of the cases and control subjects

Parameters	**Cases (type 2 Diabetic) (n=100) Mean ± SD**	**Controls (Non-Diabetic) (n=100) Mean ± SD**	**t-test**
FBS	146.78 ± 48.92	85.32 ±7.34	11.03
HbA1c	8.98 ±1.23	4.82 ±1.23	19.33
TC	198.43 ±16.32	184.40 ±45.23	20.39
TG	184.32 ±14.67	147.39 ±13.65	
HDL-C	39.98 ±9.37	52.49 ±7.16	15.42
VLDL	35.43 ±3.20	30.46 ±1.98	15.99
LDL	176.42 ±36.37	83.19 ± 26.37	48.22

< 0.0001* = extremely statistically significant.

Table-3: Comparison of fasting lipid profile among the cases and control subjects.

Parameters	**Cases (type 2 Diabetic) (n=100) Mean ± SD**	**Controls (Non-Diabetic) (n=100) Mean ± SD**	**t-test**
PBS	216.78 ± 36.92	168.32 ±6.33	12.67
TC	158.98 ±14.67	214.82 ±15.20	20.12
TG	208.43 ±17.34	174.30 ±48.21	18.35
HDL-C	40.58 ±10.77	53.19 ±17.26	17.32
VLDL	36.53 ±3.72	29.96 ±1.83	13.79
LDL	166.42 ±16.39	99.10 ± 36.54	46.42

< 0.0001* = extremely statistically significant.

Table-4: Comparison of Postprandial lipid profile among the cases and control subject

Parameters	**Fasting Mean ± SD**	**Postprandial Mean ± SD**
TC	198.43 ±16.32	158.98 ±14.67
TG	184.32 ±14.67	208.43 ±17.34
HDL-C	39.98 ±9.37	40.58 ±10.77
VLDL	35.43 ±3.20	36.53 ±3.72
LDL	176.42 ±36.37	166.42 ±16.39

Table-5: Comparison of fasting and postprandial lipid profile of type 2 diabetes mellitus

Discussion:

The present study evaluated the demographic characteristics, glycemic status, and lipid profile abnormalities among patients with type 2 diabetes mellitus (T2DM) in comparison with non-diabetic controls. The findings demonstrate significant metabolic differences between the two groups, reinforcing the well-established association between T2DM and dyslipidemia. The elevated fasting blood glucose, total cholesterol, low-density lipoprotein cholesterol, and triglycerides, coupled with diminished high-density lipoprotein cholesterol levels in type 2 diabetic patients compared to controls, strongly align with prior research highlighting the pervasive nature of dyslipidemia in this population.[13], [14] This observation is further supported by findings that demonstrate significantly higher levels of total cholesterol, triglycerides, and LDL in Type 2 Diabetes Mellitus patients, while HDL levels are markedly lower when compared to control groups.[15]

The prevalence of dyslipidemia among individuals with Type 2 Diabetes Mellitus is notably high, with some studies reporting rates as elevated as 224 out of 355 cases, and frequently more pronounced in males than females[11]. This study further supports the notion that dyslipidemia is a common complication of Type 2 Diabetes Mellitus, with specific lipid abnormalities manifesting differently between genders.[16] Further investigation into the underlying mechanisms driving these gender-specific differences in dyslipidemia within the context of Type 2 Diabetes Mellitus could provide valuable insights into targeted therapeutic strategies.[6] The correlation between HbA1c and lipid profiles further emphasizes the interconnectedness of glycemic control and lipid metabolism in Type 2 Diabetes Mellitus.[17] The poor glycemic control often exacerbates dyslipidemia.[18] In this study, females constituted a higher proportion of participants (58.5%) compared to males (41.5%). A similar female predominance has been reported in several regional and South Asian studies, which

may be attributed to lifestyle factors, hormonal influences, and healthcare-seeking behavior among women in this age group. The mean age of participants ranged from the third to fifth decade of life, consistent with the age at which T2DM commonly manifests in developing countries, including Pakistan.[17] where early-onset diabetes is increasingly reported due to sedentary lifestyle and dietary transitions. This age distribution aligns with epidemiological data reported by the International Diabetes Federation (IDF), which highlights a growing burden of T2DM among younger adults in South Asia.[7]

A notable finding of this study was the significantly higher prevalence of a positive family history of diabetes among cases compared to controls (54% vs. 32%). This observation underscores the strong genetic predisposition associated with T2DM, which has been well documented in previous studies.[19] Familial clustering of diabetes reflects the interaction of genetic susceptibility with shared environmental and lifestyle factors, such as dietary habits and physical inactivity.[20]

Regarding glycemic parameters, fasting blood sugar (FBS), postprandial blood sugar (PBS), and HbA1c levels were markedly elevated in diabetic patients compared to non-diabetic controls, with extremely high statistical significance ($p < 0.0001$). HbA1c values among cases indicated poor glycemic control, which is a critical factor contributing to the development of microvascular and macrovascular complications. These findings are consistent with ADA guidelines, which identify HbA1c as a reliable marker for long-term glycemic control and cardiovascular risk assessment.[2], [21]

The lipid profile analysis revealed significant dyslipidemia in patients with T2DM. Diabetic subjects exhibited higher levels of total cholesterol (TC), triglycerides (TG), LDL-C, and VLDL, along with significantly lower HDL-C levels, in both fasting and postprandial states. This pattern of dyslipidemia commonly referred to as “diabetic dyslipidemia” is characterized by elevated triglycerides, reduced HDL-C, and increased small dense LDL particles, all of which contribute to accelerated atherosclerosis.[4], [22]

Postprandial lipid levels were particularly deranged among diabetic patients, highlighting the importance of assessing postprandial metabolism in addition to fasting measurements. Postprandial hypertriglyceridemia has been shown to be an independent risk factor for cardiovascular disease and is more pronounced in individuals with insulin resistance. The observed rise in TG and VLDL levels after meals in diabetic patients supports existing evidence that postprandial lipid abnormalities play a crucial role in endothelial dysfunction and cardiovascular risk.[12], [23]

A cross-sectional study conducted in Peshawar reported that over 90% of T2DM patients exhibited dyslipidemia, with particularly high rates of low HDL-C. The elevated triglycerides, patterns that mirror the significant derangements observed in our diabetic cohort.[17] Similarly, research from Lahore observed dyslipidemia in approximately 96% of diabetic subjects. They identified strong associations with poor glycemic control, obesity, and smoking, find out how lifestyle and metabolic factors compound cardiovascular risk in Pakistani patients.[15] A study in Islamabad also highlighted that more than half of newly diagnosed diabetic patients had hypertriglyceridemia and low HDL-C, emphasising that lipid abnormalities are evident early in the diabetic course. These consistent findings across diverse geographic and clinical settings within Pakistan align with our observations of significantly higher total cholesterol, triglycerides, LDL-C, and VLDL levels alongside reduced HDL-C in

diabetic individuals, underscoring the robust pattern of dyslipidemia in South Asian T2DM populations and the urgent need for integrated lipid and glycemic management strategies to reduce cardiovascular complications.[24], [25]

Interestingly, when fasting and postprandial lipid profiles were compared within the diabetic group, triglyceride and VLDL levels showed an increase in the postprandial state, whereas TC and LDL-C levels demonstrated a relative reduction. This shift reflects altered lipid handling due to insulin deficiency or resistance, impaired lipoprotein lipase activity, and increased hepatic VLDL production. Similar trends have been reported in previous studies evaluating lipid metabolism in T2DM patients.[8], [15], [16]

Overall, the findings of this study reinforce the strong association between T2DM and atherogenic dyslipidemia, emphasizing the need for routine lipid monitoring in both fasting and postprandial states.[26] Early identification and aggressive management of lipid abnormalities, along with optimal glycemic control, are essential to reduce cardiovascular morbidity and mortality among patients with type 2 diabetes mellitus. Moreover, the data presented herein corroborate the established understanding that hyperlipidemia, characterized by elevated triglycerides and reduced high-density lipoprotein cholesterol, is frequently intertwined with insulin resistance in Type 2 Diabetes Mellitus patients. [4], [10], [14]These findings highlight the critical need for comprehensive lipid management strategies in individuals with Type 2 Diabetes Mellitus to mitigate the heightened risk of cardiovascular complications associated with dyslipidemia. [3]

Conclusion:

The study found that type 2 diabetes patients had a considerably higher postprandial lipid profile compared to their fasting lipid profile. So, we propose to include assessing the risk of cardio-vascular diseases in type 2 diabetes patients, postprandial lipid profiles should be estimated alongside fasting lipid profiles.

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