Original Article

COMPARISON OF LIPID PROFILE IN CARDIOVASCULAR DISEASE PATIENTS WITH AND WITHOUT DIABETES MELLITUS

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ABSTRACT

Background: Dyslipidaemia accounts as a major contributing factor to the severity of most prevalent non-communicable diseases such as cardiovascular diseases and diabetes mellitus. Lipid profile test is being widely used for the diagnosis of abnormal lipid levels acting as a primary diagnostic parameter. The objectives of the current study were to compare lipid profile parameters in patients of cardiovascular diseases with and without diabetes mellitus and to determine the relationship of age and gender with abnormal lipid profile parameters.

Material and Methods: A case-control study was conducted at Fatima Memorial Hospital (FMH) Lahore over a period of three months. Total of 94 subjects fulfilling the inclusion criteria were included. Total sample size was further divided into two groups of 47 individuals in each. Group A included cases (cardiovascular disease patients with diabetes mellitus) and Group B included controls (cardiovascular disease patients without diabetes mellitus). Lipid profile parameters (HDL, LDL, TAG, CHOL, VLDL and CHOL/HDL Ratio) of all individuals were determined and compared.

Results: Group A had 23(46.9%) males and 24(53.3%) females whereas, Group B had 26(53.1%) males and 21(46.7%) females. The mean age of Group A and Group B subjects was 64.87 ± 10.1, 61.1 ± 11.5 respectively. Group A had higher abnormal levels of lipid profile parameters as compared to Group B (P values < 0.05). Gender had no association with lipid profile parameters (P values > 0.05). Age had a positive significant correlation with abnormal lipid profile parameters. Group A had higher risk of developing abnormal lipid profile parameters as compared to Group B (RR >1).

Conclusion: This study concluded that elderly male and female having cardiovascular disease with diabetes mellitus presented with significantly higher abnormal lipid levels.

Keywords: Cardiovascular Diseases, Diabetes Mellitus, Dyslipidemia, Lipid Profile.

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INTRODUCTION

Cardiovascular diseases (CVDs) and Diabetes mellitus (DM) are among the most prevalent non-communicable diseases throughout the world and is prevailing in Pakistan as well.[1] CVDs include a wide range of diseases including not only heart blood vessels disease termed as coronary artery disease i.e., myocardial infarction but also cerebrovascular disease i.e., stroke, peripheral artery disease (PAD) i.e., limb diseases, and aortic atherosclerosis i.e., aneurysm.[2] DM a metabolic disorder, is being characterized by imbalanced blood glucose levels. Type-2 DM is the predominant type of diabetes characterized by body's resistance to naturally produced insulin.[3] CVDs are being

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considered the biggest killer disease causing approx. 1 in 3 deaths in the world. As per the British Heart Foundation report 2024, 523 million people are currently living with CVDs globally.[4] Global burden of disease 2019, reports that the incidence of CVD was found to be 918.18/100,000 in Pakistan.[5] Diabetes on the other hand has a rising prevalence in the world. As per the International diabetes federation (IDF) report 2021, 537 million people are living with DM and the prevalence of diabetes in Pakistan is 26.7%[6,7]. Pakistan ranks as the fifth most populous country globally thus, facing with a dual challenge of non-communicable diseases such as cardiovascular diseases and diabetes mellitus.[1,5] As per the estimate done in 2021, Type-2 DM specifically is diagnosed in 33 million living in Pakistan.[8]

A number of factors have been associated with such diseases which contribute to their severity such as obesity, tobacco use, high blood pressure, hyperglycemia, dyslipidemia, high-calorie diet, saturated fats, liquor consumption, and lack of exercise.[9] Risk for developing CVD and DM increases as the person ages. As per the AHA and IDF reports, the approximate age for developing CVDs and Type-2 DM is above 45years.[10,11] Due to the rise in unhealthy living and industrialization the younger population is at stake for developing such lethal diseases. Therefore, there is a need of proper evaluation and treatment of subjects who are at the risk.

Dyslipidemia a generalized term for abnormal or dysregulated lipid levels. Decreased high density lipoprotein (HDL) level and raised low density lipoprotein (LDL), very low-density lipoprotein (VLDL), triglycerides (TG), cholesterol (CHOL) levels and cholesterol/high density lipoprotein (CHOL/HDL) ratio are categorized as dyslipidemia.

Dyslipidemia, particularly secondary dyslipidemia is strongly associated with the comorbidities such as CVDs and DM. Dyslipidemia is a hallmark for the development of atherosclerotic plaque in vessels which causes the vessels narrowing and hinders the blood flow and ultimately leads to CVDs. Type-2 DM characterized by insulin resistance and insufficient insulin production causes increased free fatty acid in blood impairing use of lipoprotein which deposits in vessels and forms atheroma and ultimately leads to CVDs.[12] Consequently, DM has been recognized as a significant determinant for CVDs.[13]

Lipid profile a medical laboratory blood test determines different levels of lipid in blood. It analyses high density lipoprotein known as good cholesterol, low density lipoprotein and very low-density lipoprotein known as bad cholesterol, TG, CHOL and CHOL/HDL ratio. HDL, LDL, VLDL, CHOL levels and CHOL/HDL ratio are the hallmark for atherosclerotic changes in vessels leading to coronary artery disease. TGs levels act as an indicator for metabolic disease such as DB. Raised levels of LDL, VLDL, TGs, CHOL, CHOL/HDL ratio and low level of HDL are an indicator of dyslipidemia in CVDs and DM patients. Thus, lipid panel test is a strong diagnostic test for patients presenting with symptoms of cardiovascular diseases and diabetes mellitus.[14]

The objectives of the current study were to compare lipid profile parameters in patients of cardiovascular diseases with and without diabetes mellitus and to determine the relationship of age and gender with abnormal lipid profile parameters. The widespread occurrence of CVDs and DM provoked a thought for the determination of lipid profile role in assessing the severity and risk of these conditions in affected patients. Therefore, the findings of this study will assist clinicians in the effective management and timely treatment of patients who are at the risk of developing dyslipidemia. Additionally, this study will raise awareness among individuals about the severe risks associated with elevated lipid levels and the importance of maintaining a healthy lifestyle to mitigate these hazards.

MATERIAL AND METHODS

A case-control study constituting of 94 subjects was conducted at Indoor and Outdoor departments of Fatima Memorial Hospital (FMH) Lahore from May 2024 to July 2024. 94 subjects

were divided into two groups of 47 individuals in each. Group A subjects consisted of CVDs and DM (cases). Group B subjects consisted of CVDs without DM (controls). Non-randomized purposive sampling technique was used to collect the sample fulfilling the criteria. This study included subjects of both genders, aged 40 to 80 years, with cardiovascular diseases, including both diabetic and non-diabetic individuals. This study excluded subjects with renal failure, cardiac arrest, or stroke.

Data collection was initiated after taking approval from Institutional review Board (IRB) of FMH with a Reference No.FMH-04/03/2024-IRB-1364. Informed consents duly signed by patients, were obtained before blood sampling.

Demographic factors and disease history of patients were recorded using a proforma. After 9-12hr of fasting, venous blood samples were taken in the morning and analyzed for lipid profile parameters (HDL, LDL, VLDL, Triglyceride, CHOL, and CHOL/HDL Ratio). HDL level < 40mg/dL in males and < 50mg/dL in females was taken as abnormal or raised. LDL level > 100mg/dL, VLDL > 50mg/dL, TG level > 150 mg/dL, CHOL level >200 mg/dL, and CHOL/HDL Ratio > 5 were taken as abnormal or raised. Lipid profile parameters (HDL, LDL, VLDL, Triglyceride, CHOL, and CHOL/HDL Ratio) of all individuals were determined by automated ROCHE Cobas Analyzer using enzymatic method (spectrophotometry technique).[15,16]

All the data collected was entered into SPSS version 26 and subjected to statistical analysis.
The continuous variables were expressed as mean ± SD and categorical data as frequency zand percentage. The mean of lipid profile variables HDL, LDL, VLDL, TG, CHOL and CHOL/HDL ratio were compared using independent t-test among two groups. Pearson correlation and chi-square test was used to determine the relationship of age and gender with lipid profile variables. Relative Risk (RR) was used to find the risk. p value < 0.05 was deemed to be statistically significant.

RESULTS

The present study included 94 subjects, with 47 participants in each of the two groups, Group A and Group B. Group A had 23(46.9%) males and 24(53.3%) females whereas, Group B had 26(53.1%) males and 21(46.7%) females. The mean age of Group A and B subjects was 64.87 ± 10.1 and 61.1 ± 11.5 respectively.
Mean ± SD for each of the lipid profile parameters in both Group A and Group B were calculated separately. The p values were found to be significant (p < 0.05) (Table. 1).

Table 1: Comparison of lipid profile parameters among group A and group B

LIPID PROFILE	Group A (CVD & DIABETICS)	Group B (CVD & NON-DIABETICS)	p Value
HDL	39.87 ± 11.14	46.38 ± 13.96	
Male	36.78 ± 9.54	43.19 ± 15.24	0.014
Female	42.83 ± 11.93	50.33 ± 11.32	
LDL	127.68 ± 30.62	111.04 ± 39.90	
Male	123.83 ± 32.52	114.73 ± 42.08	0.026
Female	131.38 ± 28.8	106. 38 ± 37.52	
VLDL	71.96 ± 28.33	58.68 ± 27.70	
Male	68.87 ± 28.05	59.65 ± 26.60	0.024
Female	74.92 ± 28.89	57.48 ± 29.63.	
TG	234.40 ± 111.94	188.77 ± 81.66	
Male	224.48 ± 118.02	193.04 ± 82.51	0.029
Female	243.92 ± 113.61	183.48 ± 82.32	
CHOL	255.60 ± 71.05	224.45 ± 59.91	
Male	243.17 ± 67.97.	227. 54 ± 45.36	0.024
Female	267.50 ± 73.31	220.62 ± 75.22	
CHOL/HDL Ratio	7.17 ± 3.28	5.72 ± 3.28	0.036
Male	7.31 ± 3.52	6.39 ± 3.63	
Female	7.03 ± 3.10	4.89 ± 2.64	

CVD; cardiovascular diseases, HDL; high density lipoprotein, LDL; low density lipoprotein, VLDL; Very low-density lipoprotein, TG; triglyceride, CHOL; cholesterol, CHOL/HDL Ratio: cholesterol/high density lipoprotein ratio.

Table 2: Abnormal distribution of Lipid Profile parameters in Group A and B according to Gender

LIPID PROFILE PARAMETERS	Group A (CVD & DIABETICS)		Group B (CVD & NON - DIABETICS)	
	Male (N=23)	Female (N=24)	Male (N=26)	Female (N=21)
HDL	14 (45.2%)	17 (54.8%)	11 (57.9%)	8 (42.1%)
LDL	17 (44.7%)	21 (55.3%)	16 (57.1%)	12 (42.9%)
VLDL	19 (47.5%)	21 (52.5%)	17 (54.8%)	14 (45.2%)
TG	18 (46.2%)	21 (53.8%)	17 (56.7%)	13 (43.3%)
CHOL	20 (48.8%)	21 (51.2%)	19 (57.6%)	14 (42.4%)
CHOL/ HDL Ratio	17 (45.9%)	20 (54.1%)	13 (65.0%)	7 (35.0%)

Gender had no association with abnormal lipid profile parameters HDL (p=0.66), LDL (p=0.52), VLDL (p=0.62), TG (p=0.65), CHOL (p=0.83), CHOL/HDL (p=0.90). Lipid profile parameters such as LDL, VLDL, TG, CHOL, CHOL/HDL have a direct relationship with the degree of abnormality except HDL which has an inverse relationship the abnormality. Age had a positive significant correlation with all lipid profile parameters HDL (p=0.004), LDL, VLDL, TG, CHOL, CHOL/HDL (p=0.000) The Pearson correlation value of -2.94 doesn't represents negative correlation of HDL with age as it's already been described above that HDL has an inverse relationship with abnormality. Thus, -2.94 represents a positive correlation with age like all other factors (Table. 3).

Table 3: Correlation between age with lipid profile parameters.

Lipid Profile Parameters	Pearson Correlation value	p- value
HDL	-2.94	0.004
LDL	0.471	0.000
VLDL	0.468	0.000
TG	0.352	0.000
CHOL	0.582	0.000
CHOL/HDL Ratio	0.374	0.000

Group A subjects had high risk of developing abnormal lipid levels (RR>1) (Table. 4).

Table 4: Risk estimation of Group A having abnormal lipid profile values.

LIPID PROFILE PARAMETERS	GROUP A (CVD & DIABETICS)
HDL	1.63
LDL	1.35
VLDL	1.29
TG	1.30
CHOL	1.24
CHOL/HDL Ratio	1.85

DISCUSSION

Dyslipidemia is a key contributor to the severity of many common non-communicable diseases, including cardiovascular diseases and diabetes mellitus leading to high morbidity and mortality. Dyslipidemia is a broad term for abnormal or deranged lipid levels in the blood. It constitutes of low HDL, high LDL, VLDL, TG, CHOL and CHOL/HDL ratio defined as mixed dyslipidemia.

Elevated lipids in the blood deposits in the vessels increasing the intima media thickness, forming atherosclerotic plaques leading to narrowing and blockage of blood vessels compromising the blood flow through the body and progressing to CVDs. DM on the other hand is caused by a combination of insulin resistance, where the cells of the body do not effectively utilize insulin due to various underlying factors and inadequate insulin production by the pancreas which results from the gradual loss of pancreatic islet function or cell count. This change in lipid levels is associated to a higher risk of both macrovascular (peripheral vascular disease, cerebrovascular disease, ischemic heart disease) and microvascular (retinopathy, nephropathy, neuropathy) complications in individuals with diabetes.[17]

DM is a major contributing factor for the development of CVDs however, as per the recent study CVDs can also contribute to the development of DM specifically in patients with abnormal lipid levels such as mixed dyslipidemia[18]. Thus, deranged lipid levels are deemed as risk factors for such lethal diseases.

Lipid profile assessment is the base line diagnostic tool for determining the risk and severity of CVDs and DM as it provides the key information about the levels of different types of fats in the blood. An accurate and timely evaluation of dysregulated lipid levels is essential for delivering optimal patient care.

In current study, patients with CVDs and DM were compared to those with cardiovascular diseases but without diabetes mellitus. To the best of our knowledge this in an only study which included a broad range of cardiovascular diseases while, previous researches focused only on specific heart conditions without encompassing cardiovascular diseases as a whole. This highlighted the need for research that encompasses all types of CVDs to more effectively compare lipid profiles between diabetic and non-diabetic patients with CVDs.

This study included 94 subjects aged between 40-80 years. Total subjects were divided into two groups of 47 in each having nearly equal ratio of male to female. Group A had CVD &DM and Group B had CVD-Non-DM subjects.

In this study HDL in Group A and B was 39.87 ± 11.14 and 46.38 ± 13.96. LDL in Group A and B was 127.68 ± 30.62 and 111.04 ± 39.90. TG in Group A and B was 234.40 ± 111.94 and 188.77 ± 81.66. CHOL in Group A B was 255.60 ± 71.05 and 224.45 ± 59.91.

HDL was found abnormal in 31 (62.0%), 19 (38.0%) subjects of Group A and B. LDL was found abnormal in 38(57.6%), 28(42.4%) subjects of Group A and B. TG was found abnormal in 39(56.5%), 30(43.5%) subjects of Group A and B. CHOL was found abnormal in 41(55.4%), 14(42.4%) subjects of Group A and B.

A study was conducted to compare lipid profile in ischemic heart disease patients with and without diabetes found that HDL in diabetics and non-diabetics with IHD was 43.17±14.042 mg/ dL and 45.98±16.142 mg/dL. LDL in diabetics and non-diabetics was 103.31±37.397 mg/ dL, 85.84±28.344 mg/dL. TG in diabetics and non-diabetics with IHD was 159.14±56.139 mg/dL, 124.43±50.341 mg/dL. CHOL in diabetics and non-diabetics with IHD was 175.86±41.410 mg/ dL, 156.64±25.756 mg/ dL. The results were comparable to our study (P value < 0.05). Abnormal lipid profile parameters HDL, LDL, triglyceride and cholesterol was found in

61(46.92%) 46 (35.38%) 68 (52.30%) and 50 (38.46%) individuals respectively.[19]

Al Shaer et al compared lipid profile in type-2 diabetes mellitus subjects with and without CADs. HDL in Non-CAD and CAD group was 1.98 ± 0.07, 1.82 ± 0.09. (p value > 0.05). LDL in Non-CAD and CAD group was 126.82 ± 12.91, 156.17 ± 17.9. TG in Non-CAD and CAD group was 5.21 ± 1.8, 12.46 ± 2.1. (p value < 0.05). The findings were concerned to our study with (P value < 0.05), however, HDL of this showed insignificant difference among two groups. [20]

In another study lipid parameters in diabetic and non-diabetic atherosclerotic patients were compared. Diabetic atherosclerotic individuals had low level of HDL in comparison to non-diabetic atherosclerotic and normal control individuals. Diabetic atherosclerotic individuals had high level of LDL, VLDL, TG, CHOL and CHOL/HDL in comparison to non-diabetic atherosclerotic and normal control individuals.[21] These results were comparable to current study.

Few previously published studies have been conducted on comparison of lipid profile between diabetic and non-diabetic subjects. They reported dyslipidemia in diabetics as compared to non-diabetics. This finding is in the support of pathophysiological mechanism of diabetics having abnormal lipid levels.[22,23]

In this research a positive significant correlation of age with all lipid profile parameters was found. This finding was consistent with other studies[19,21]. Gender found no significant association with either of the abnormal lipid levels. This was found contrary to other article findings as they showed female and male association with abnormal lipid levels.[19,20, 21] Our finding suggests that both male and female are equally affected by these highly morbid and mortal diseases.

Overall, the findings of this study provide an insight to the alarming lipid levels in cardiovascular diseases patients with diabetes mellitus. A significant but not highly significant difference in lipid levels has been observed in present study among both groups particularly CHOL/HDL ratio which has been reported a better parameter to for the identification of dyslipidemia is less significant among both groups with p-value 0.03.[9,18,21] These results suspect the development of diabetes in near future in control group and increases chances of more adverse form of cardiovascular diseases. Moreover, both elderly male and female have been found to be equally affected by such lethal diseases. Therefore, this suggests a need of appropriate lipid management in both genders particularly of aged individuals.

CONCLUSION

The current study concludes that CVD patients with DM presented with mixed dyslipidaemia having significantly higher levels of LDL, VLDL, CHOL, CHOL/HDL ratio and low level of HDL as compared to CVD patients without DM. These findings highlight the need for proactive management in such cases.

CONFLICT OF INTEREST

None

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None

AUTHOR'S CONTRIBUTIONS

SS: Conception and drafting of the work
AI: Proof reading
SK: Data interpretation
SDH: Revision of work
MNY: Revising of work critically for important intellectual content
SS: Data collection

REFERENCES

1. Kazmi T, Nagi MLF, Razzaq S, Hussnain S, Shahid N, Athar U. Burden of noncommunicable diseases in Pakistan. East Mediterr Health J. 2022;28(11):798–804. doi: 10.26719/emhj.22.083
2. Lopez EO, Ballard BD, Jan A. Cardiovascular disease. In: StatPearls [Internet].StatPearls Publishing;2023Aug 22.

3. Sapra A, Bhandari P. Diabetes. StatPearls-NCBI Bookshelf [Internet]. 2023.
4. Nedkoff L, Briffa T, Zemedikun D, Herrington S, Wright FL. Global Trends in Atherosclerotic Cardiovascular Disease. Clin Ther. 2023;45:1087–91.
5. Samad Z, Hanif B. Cardiovascular Diseases in Pakistan: Imagining a Postpandemic, Postconflict Future. Circulation. 2023 Apr 25;147(17):1261-3. doi: 10.1161/Circulationaha.122.059122
6. Magliano DJ, Boyko EJ, Balkau B, Barengo N, Barr E, Basit A, et al. IDF Diabetes Atlas 2021. International Diabetes Federation; 2021.
7. Azeem S, Khan U, Liaquat A. The increasing rate of diabetes in Pakistan: A silent killer. Ann Med Surg. 2022;79:103901. doi: 10.1016/j.amsu.2022.103901
8. Hasan SU, Siddiqui MR. Epidemiology of diabetes mellitus in Pakistan: a systematic review protocol. BMJ Open. 2024;14(3):e 079513. doi: 10.1136/bmjopen-2023-079513
9. Sone H, Nakagami T, Nishimura R, Tajima N, MEGA Study Group. Comparison of lipid parameters to predict cardiovascular events in Japanese mild-to-moderate hypercholesterolemic patients with and without type 2 diabetes: subanalysis of the MEGA study. Diabetes Res Clin Pract. 2016;113:14-22. doi: 10.1016/j.diabres.2015.12.00210
10. Rodgers JL, Jones J, Bolleddu SI, Vanthenapalli S, Rodgers LE, Shah K, et al. Cardiovascular risks associated with gender and aging. J Cardiovasc Dev Dis. 2019 Apr 27;6(2):19. doi: 10.3390/jcdd6020019
11. Goyal R, Singhal M, Jialal I. Type 2 diabetes. StatPearls [Internet]. 2023 Jun 23. Available from: (link unavailable)
12. Warraich HJ, Rana JS. Dyslipidemia in diabetes mellitus and cardiovascular disease. Cardiovasc Endocrinol Metab. 2017 Mar 1;6(1):27-32. doi: 10.1097/XCE.0000000000000120
13. Antwi-Baffour S, Kyeremeh R, Boateng SO, Annison L, Seidu MA. Haematological parameters and lipid profile abnormalities among patients with Type-2 diabetes mellitus in Ghana. Lipids Health Dis. 2018 Dec;17(1):1-9. doi: 10.1186/s12944-018-0926-y
14. Pappan N, Awosika AO, Rehman A. Dyslipidemia. In: StatPearls [Internet]. StatPearls Publishing; 2024 Mar 4.
15. Li B, Kumar A, Finlay C, van Drimmelen M, Barnes E, Southby S, et al. Verification of point-of-care analysers for C-reactive protein, lipid studies and glycated haemoglobin. Pathology. 2023 Dec 1;55(7):989-99.
16. Bowling JL, Katayev A. An Evaluation of the Roche Cobas c 111. doi: 10.1309/LM6T8D1LKQXVNCAC
17. Alidrisi HA, Al-Ibadi AA, Al-Saidi JS, Alsawad MA, Jameel AA, Al-Shati AW. Comparative Analysis of Glycemic and Lipid Profiles in Newly Diagnosed Males and Females With Type 2 Diabetes Mellitus. Cureus. 2023 Dec;15(12). doi: 10.7759/cureus.50101
18. Peng J, Zhao F, Yang X, Pan X, Xin J, Wu M, et al. Association between dyslipidemia and risk of type 2 diabetes mellitus in middle-aged and older Chinese adults: a secondary analysis of a nationwide cohort. BMJ Open. 2021 May 1;11(5):e042821. doi: 10.1136/bmjopen-2020-042821
19. Anwar A, Devi G, Hospita C, Hanif A. Comparison of lipid profile in diabetic and non-diabetic patients with ischemic heart disease. 2017. doi: 10.18203/2349-3933.ijam20175169
20. Al-Shaer MH, Elzaky MM, Farag ES, Saad MO. Correlation between Coronary Artery Diseases and Dyslipidemia in Type 2 Diabetic Patients. Egypt J Hosp Med. 2021 Oct 1;85(2):3578-82. doi: 10.21608/ejhm.2021.201964.
21. Ali F, Jamil H, Anwar SS, Wajid N. Characterization of lipid parameters in diabetic and non-diabetic atherosclerotic

patients. J Geriatr Cardiol (JGC). 2015 Jan;12(1):37.
doi: 10.11909/j.issn.1671-5411.2015.01.005

22. Shirazi T, Sikandar R. Lipids levels comparison of diabetic and non-diabetic individuals: a retrospective study at a secondary care hospital. Pak J Rehabil. 2024 Jul 6;13(2):145-52.

23. Khan HU, Khan I, Khan AA, Rahman AU, Khan Z, Khan RU. Lipid Profile In type 2 Diabetics versus non-diabetic controls in adult population of district Bannu, Pakistan. Glob J Med Sci (GJMS). 2022 Mar 27;20(1):17-23.
doi: 10.46903/gjms/20.01.1015.