ejpmr, 2016,3(2), 340-347

SJIF Impact Factor 2.026

EUROPEAN JOURNAL OF PHARMACEUTICAL AND MEDICAL RESEARCH

www.ejpmr.com

Research Article

ISSN 3294-3211

EJPMR

PATTERN OF DYSLIPIDAEMIA IN PATIENTS WITH TYPE 2 DIABETES MELLITUS IN FUJAIRAH, UNITED ARAB EMIRATES

Mouza Alsaadi*[1], Sundus Qassim[1], Farah Hamad[2] and Zakia Metwali[3]

[1]Clinical Pharmacy and Pharmacy Practice Department, Pharmacy College, Ajman University of Science and Technology Network, Ajman, United Arab Emirates.

[2] Department of Pharmaceutics, Pharmacy College, Ajman University of Science and Technology Network, Ajman, United Arab Emirates.

[3]Pharmacology and Microbiology Department Pharmacy College, Ajman University of Science and Technology Network, Ajman, United Arab Emirates.

***Correspondence for Author: Mouza Alsaadi**

Clinical Pharmacy and Pharmacy Practice Department Pharmacy College, Ajman University of Science and Technology Network, Ajman, United Arab Emirates.

Article Received on 17/12/2015 **Article Revised on 08/01/2016** **Article Accepted on 29/01/2016**

ABSTRACT

A retrospective cross-sectional study was conducted based on the available biochemical data of patients who attended the endocrine clinic of Fujairah hospital, in Al Fujairah between June 2013 and June 2015. The aim of the study was to detect the pattern of lipid abnormalities in patients with type 2 diabetic mellitus (T2DM) and to observe the association between glycemic control and serum lipid profile. The majority (72%) of T2DM patients in the current study did not sustain a good glycemic control. Low level of high-density lipoprotein cholesterol (HDL-C) was the most common pattern of dyslipidaemia observed in diabetic patients (55%) followed by elevated triglycerides (TG) level (29%). There was no significant difference between males and females in lipid levels except for HDL-C in which females had higher levels compared to males (P=0.050), indicating a certain degree of gender influence on lipid levels. TG showed significant negative correlation with the age while total cholesterol (TC) and low-density lipoprotein cholesterol (LDL-C) demonstrated significant positive correlation with fasting blood sugar (FBS) and glycated hemoglobin (HbA1c). Consequently, identification and treatment of dyslipidaemia together with tight glycemic control should be maintained in order to minimize the cardiovascular disease (CVD) risk among T2DM patients.

KEYWORDS: Dyslipidaemia, Type 2 Diabetic Mellitus, Lipid Profile, Glycemic Control.

INTRODUCTION

The lipid abnormalities are common in diabetic mellitus (DM) because insulin resistance or deficiency affects key enzymes and pathways in lipid metabolism.[1] 70% to 97% of adults with type 2 diabetes have one or more lipid abnormalities.[2] The pattern of lipid profile in T2DM is called diabetic dyslipidaemia or atherogenic dyslipidaemia.[3] Diabetic dyslipidaemia is characterized by elevated triglycerides (TG) level, low high-density lipoprotein cholesterol (HDL-C) level and the presence of smaller and denser low-density lipoprotein cholesterol (sdLDL-C) particles.[4,5] Besides, abnormality in the level of each of the major lipids has been independently related with increased risk of cardiovascular disease (CVD).[6]

The previous study has been documented that, for every 1% reduction in low-density lipoprotein cholesterol (LDL-C) levels there an equivalent reduction in cardiovascular events.[7] It is well documented that a high HDL-C level is cardioprotective [8] and low HDL-C levels are widespread in type 2 diabetes patients, and this appears to be associated to the increased mortality and morbidity in coronary heart disease (CHD).[9] Additionally, low HDL-C levels are commonly escorted by elevated TG levels[10], and the combination appears to be the most severe combination for hastening vascular damage. The main step in the direction of reducing the risk of CVD-related with diabetes is detection and treatment of dyslipidaemia.[11] According to the American Diabetes Association (ADA), LDL-C lowering is the first priority, lowering triglyceride level is the second priority and raising levels of HDL-C is the third priority. [12]

It is well recognized that diabetic dyslipidaemia patients have an excess risk of cardiovascular morbidity and mortality because the lipid particles in these patients are more atherogenic than in general population.[13] Moreover, the lipid abnormality associated with type 2 diabetes increases with increase in duration of diabetes.[14-19] For that reason, there is an urgent need for screening and management of dyslipidaemia in diabetics

in order to reduce morbidity and mortality from coronary artery disease (CAD).[15] The incidence of dyslipidaemia differs depending on the population studied, geographic location and socioeconomic development.[20,21] Additionally, ethnic-specific strategies and guidelines on risk estimation and prevention of CVD due to dyslipidaemia are essential as a result of ethnic-specific patterns of lipid profile in type 2 diabetics despite their glucose levels.[22] A previous study in the United Arab Emirates (UAE) showed that 31% of diabetic patients suffered from dyslipidaemia, 35% from hypertension and 14% from coronary artery disease.[23] Evidence reported that cardiovascular disease in the UAE is one of the highest age-standardized death rates in the world.[24] As a result of an increase in CVD in UAE, the purpose of current study was to detect the pattern of lipid abnormalities in patients with T2DM and to observe the association between glycemic control and serum lipid profile in type 2 diabetic patients. Moreover, there are no studies found to evaluate the pattern of lipid abnormalities in T2DM patients in the UAE so the current study considers the first cross-sectional analysis to be carried out in the country.

METHODOLOGY

This study was conducted at the endocrine clinic of Fujairah hospital, in Al Fujairah. A total of 100 adult type 2 diabetic patients attending the endocrine clinic between June 2013 and June 2015 were reviewed. Data collection was supervised by the physician conducting the DM clinic. Demographic, anthropometric data and biochemical investigations were collected from the patients' medical records. Duration of diabetes, blood pressure, associated chronic condition and different treatment regimens were documented. The biochemical investigations included: detecting the levels of serum fasting blood sugar (FBS), glycated hemoglobin (HbA1c), serum total cholesterol (TC), LDL-C, serum HDL-C and serum TG. Dyslipidaemia was defined by the presence of one or more than one abnormal amount of lipids.[56] The ADA standard of medical care for patients with DM was used to define desirable levels of HbA1c and serum lipids.[57]

Male and female who aged ≥ 20 years with the history of type 2 diabetes and dyslipidaemia were included in the study. Type 1 diabetic patients, pregnant women, patients with acquired immune deficiency syndrome (AIDS), patients with cancer and patients with missing clinical data were excluded from the study.

Statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS) software version 20.0. Descriptive analysis was used to analyse the socio-demographic data. The descriptive statistics included mean, median, frequency and standard deviation. Mann-Whitney test was used to compare quantitative data in groups. Pearson correlation test was used to study the correlations between lipid fractions and other clinical characteristics. All data was expressed as the mean and standard deviation and a P value ≤0.05 was considered as significant.

RESULTS

Table 1: Socio-demographic data of all participants

Variable group	Sub-variable group	Frequency	
		Number of Patients (N)	Percentage (%)
Gender	Male	26	26 %
	Female	74	74 %
Nationality	Local	90	90 %
	Non-local	10	10 %
Status	Single	3	3 %
	Married	96	96 %
	Divorced	1	1 %
Hypertension	No	27	27 %
	Yes	73	73 %
Thyroid Problem	No thyroid problem	87	87 %
	Hypothyroidism	12	12 %
	hyperthyroidism	1	1 %
Heart Disease	No	90	90 %
	Yes	10	10 %
Kidney Disease	No	95	95 %
	Yes	5	5 %
Respiratory Disease	No	98	98 %
	Yes	2	2 %
Other Chronic Disease	No	62	62 %
	Yes	38	38 %

Table 2: Medication history of all participants

Variable group	Sub-variable group	Frequency	
		Number of Patients (N)	Percentage (%)
Lipid Lowering Agent	Statin	96	96 %
	Statin and Ezetimibe	4	4 %
Anti-diabetic Agent	Oral hypoglycemic agent	64	64 %
	Oral hypoglycemic + Insulin	34	34 %
	Insulin only	2	2 %
Antihypertensive Agent	No	27	27 %
	Yes	73	73 %
Diuretic	No	64	64 %
	Thiazide diuretic	25	25 %
	Loop diuretic	4	4 %
	Aldosterone antagonist	1	1 %
	Amiloride with thiazide	4	4 %
	Triamterene with thiazide	1	1 %
	Loop diuretic and aldosterone antagonist	1	1 %
Other medications	No	22	22 %
	Yes	78	78 %

Table 3: Basic demographic and anthropometric features of all patients

N=100	Range	Mean ± SD
Age (years)	(21.00 - 84.0)	(57.4 ± 11.3)
HbA1c (%)	(5.6 - 16.0)	(8.3 ± 2.0)
FBS (mmol/L)	(3.3 - 23.3)	(9.1 ± 8.5)

N= number of patients, SD= standard Deviation

Table 4: Mean lipid levels for overall 100 patients

N=100	All Mean ± SD
TC (mmol/L)	(3.9 ± 0.9)
TG (mmol/L)	(1.6 ± 0.8)
HDL-C (mmol/L)	(1.2 ± 0.3)
LDL-C (mmol/L)	(1.9 ± 0.87)

Table 5: Classification of the patients according to lipid profile disturbance

Lipid type		All patients		Female		Male	
		N	%	N	%	N	%
TC	Normal	92	92 %	69	93 %	23	88.5 %
	High	8	8 %	5	6.8 %	3	11.5 %
TG	Normal	71	71 %	51	68.9%	20	76.9 %
	High	29	29 %	23	31.1 %	6	23.1 %
LDL-C	Normal	84	84 %	64	86.5 %	20	76.9 %
	High	16	16 %	10	13.5 %	6	23.1 %
HDL-C	Normal	45	45 %	29	39.2 %	16	61.5 %
	Low	55	55 %	45	60.8 %	10	38.5 %

*Normal value indicates TC level less than 6.2 mmol/l, TG less than 1.7 mmol/l, LDL-C less than 2.6 mmol/l and HDL-C more than 1.0 mmol/l in males and more than 1.3 mmol/l in females.

Table 6: Pattern of dyslipidaemia in studied patients according to their glycemic status.

Lipid level		HbA1C <7 (28 patients)		HbA1c≥7% (72 patients)	
		N	%	N	%
TC	Normal	26	92.9 %	66	91.7 %
	High	2	7.1 %	6	8.3 %
TG	Normal	19	67.9 %	52	72.2 %
	High	9	32.1 %	20	27.8 %
LDL-C	Normal	25	89.3 %	59	81.9 %
	High	3	10.7 %	13	18.1 %

HDL-C	Normal	14	50 %	31	43.1 %
	Low	14	50 %	41	56.9 %

*Normal value indicates TC level less than 6.2 mmol/l, TG less than 1.7 mmol/l, LDL-C less than 2.6 mmol/l and HDL-C more than 1.0 mmol/l in males and more than 1.3 mmol/l in females.

Table 7: Correlations between lipid profile and demographic, anthropometric and other clinical characteristics

Source	TC		TG		HDL-C		LDL-C	
	P value	Pearson Correlation	P value	Pearson Correlation	P value	Pearson Correlation	P value	Pearson Correlation
Age (years)	0.459	-0.075-	0.030	- 0.217	0.868	0.17	0.966	-0.004-
Gender	0.299	0.105	0.815	0.024	0.008	0.265	0.887	0.014
Type of lipid therapy	0.439	-0.078-	0.780	-0.028-	0.861	0.018	0.418	-0.082-
FBS (mmol/L)	0.003	0.296	0.225	0.122	0.246	0.117	0.026	0.222
HbA1c (%)	0.017	0.238	0.847	0.020	0.214	0.125	0.049	0.197

Table 8: Gender differences in term of lipid profile.

N=100	Male Mean ± SD	Female Mean ± SD	*P* value
TC (mmol/L)	(3.7 ± 1.0)	(3.9 ± 0.9)	0.442
TG (mmol/L)	(1.6 ± 0.8)	(1.6 ± 0.8)	0.441
HDL-C (mmol/L)	(1.1 ± 0.3)	(1.3 ± 0.3)	0.050
LDL-C (mmol/L)	(1.9 ± 1.0)	(1.9 ± 0.8)	0.255

DISCUSSION

There were 100 patients in this study out of which 74% of the patients were female and 26% were male. Seventy-three percent of total patients had hypertension, which represented the highest of the total co-morbidities observed in our patients. Hypertension is around twice as common in patients with diabetes compared to those without diabetes.[25,26] Medication history of the patients indicates that all patients were using statin as lipid lowering agent and only 4% of them were using ezetimibe as an additional treatment. All participants were using anti-diabetic agents; 64% were using an oral hypoglycaemic agent and 34% were using oral hypoglycaemic together with insulin (Table 2).

The basic demographic and anthropometric features of all patients (Table 3) showed that the mean age for patients was 57.4 + 11.3 years. Our results have shown that the majority (72%) of the T2DM patients did not sustain a good glycaemic control; where the mean levels of HbA1c and FBS were 8.3 % and 9.1 mmol/l respectively. These findings are consistent with previous studies in Malaysia [27] and in Saudi Arabia.[28] This result suggests more attention by healthcare providers in following the optimal guidelines to achieve the desired glycemic control. In addition, there is critical need to ensure patient compliance to medication and healthy lifestyle to avoid poor glycemic control.

In the present study the mean levels of TC, TG, HDL-C and LDL-C were (3.9 mmol/L, 1.6 mmol/L, 1.2 mmol/L and 1.9 mmol/L), respectively (Table 4). Compared with other previous studies, our findings were lower than those in Malaysia [26] and in Brazil.[29] In Malaysia, the mean levels of TC, TG, HDL-C and LDL-C were 4.68 mmol/L, 1.70mmol/L, 1.19 mmol/L and 2.71 mmol/L respectively. While in Brazil, the mean levels of TC, TG, HDL-C and LDL-C were 4.81 mmol/L, 1.68 mmol/L, 1.24 mmol/L and 2.78 mmol/L respectively.

The results of the present study showed that the most common lipid abnormality was reduced HDL-C (55%) followed by hypertriglyceridemia (29 %) (Table 5). This is the common trend in the majority of type-2 DM patients, in view of the fact that, diabetic dyslipidaemia is usually reflected as a decreased level of HDL-C and elevated TG with a prevalence of small, dense LDL-C particles along with relatively normal LDL-C levels [30]. Findings consistent with our results were also found in the previous study conducted in Nepal [31], southern India [32] and another recent study conducted in Mangalore, India.[33] Additionally, a study conducted in Ghana [34] showed that the highest number of diabetics (50.4%) had HDL-C dyslipidaemia. Likewise, in a study conducted in Sudan [35] on type 2 diabetes patients, the authors found statistically significant higher TG levels and low HDL-C levels in diabetic patients as compared to healthy controls. These differences may be explained by different lifestyle, occupation and level of education among diabetic patients.[36]

In the present study, the HDL-C levels below 1.3 mmol/l were present in 60.8 % of the female and below 1.0 mmol/l in 38.5 % of the male. This finding is in agreement with the previous studies which showed that reduced HDL-C were more common in females than males.[37, 38, 39, 40] Additionally, previous studies indicated that dyslipidaemia was more marked in women than men. [41, 42] Different levels of sex hormones particularly estrogens and androgens in women versus men most likely account for these differences.[43, 44]

The pattern of dyslipidaemia in the studied patients according to their glycaemic status (Table 6) indicated that about 72% of them were poor glycaemic control

(HbA1c≥7%). Of these 56.9 %, 27.8 %, 18.1 % and 8.3 % had HDL-C, TG, LDL-C and TC out of target levels respectively. Whereas, 28% of patients were good glycaemic control and 50 %, 32.1%, 10.7 % and 7.1 % of them had HDL-C, TG, LDL-C, and TC out of target levels respectively.

The correlation between lipid profile and demographic, anthropometric and other clinical characteristics was investigated using Pearson correlation test (Table 7). Our results showed that TC and LDL-C were positively correlated with FBS and HbA1c. This significant correlation suggesting that poor glycemic control showed to be directly associated with hypercholesterolemia and elevated LDL-C level. Likewise, Blebil et al. [27] and Chowta et al. [46] found that TC, LDL-C and TG were significantly positive correlated with FBS and HbA1c. Additionally, Chan et al. [47] and Ladeia et al. [48] showed that TC, LDL-C and TG were significantly correlated with HbA1c. A study by Mullugeta et al. [49] found that TG and TC were significantly correlated with HbA1c. On the other hand, certain studies reported no significant correlation between serum HbA1c and serum lipid parameters.[50, 32]

Additionally, in this study, TG was negatively correlated with the age, suggesting that older patients in our study were more compliant to treatment than younger patients. While Elnasri and Ahmed [35] found statistically significant association between TG and increase age. Also, Ali, et al. [45] reported that dyslipidaemia in both genders increases with age. On the other hand, Nadeem et al. [51] reported that no significant correlation between age and dyslipidaemia. The previous study shows that after the sixth decade triglyceride levels decreased as a result of increased rate of catabolism and lower food intake and absorption.[52]

Mann-Whitney test was conducted to compare lipid profile between males and females (Table 8). There was no significant difference between males and females in lipid levels except for HDL-C in which females had higher level compared to males, indicating a certain degree of gender influence on lipid levels in our participants. Our results agreed with a previous study.[27] In contrast to our findings, it was reported that females have higher LDL-C compared to males.[39, 53, 54] On the other hand, a number of studies have shown that no significant correlation exists between gender and dyslipidaemia.[34, 55]

CONCLUSION

Low HDL level was the most common pattern of dyslipidaemia observed in our patients followed by elevated TG level. Serum HDL-C was higher in a diabetic female in comparison to males, indicating gender influence on lipid levels in diabetics. TC and LDL-C correlate positively with FBS and HbA1c, suggesting that poor glycaemic control showed to be directly associated with hypercholesterolemia and elevated LDL-C level. Therefore good glycaemic control can prevent progression of lipid abnormalities in diabetic patients. The majority of the T2DM patients in our study do not sustain a good glycaemic control. Consequently, identification and treatment of dyslipidaemia together with tight glycaemic control should be maintained in order to minimize the CVD risk among T2DM patients.

LIMITATION OF THE STUDY

This study was a retrospectively collected data from a routine clinic and not a prospectively collected data. A similar group of patients without diabetes was not available in the current health system to allow comparison with subjects in this study. Moreover, variables such as duration of disease, BMI and cigarette smoking which modify the lipid profile were not available in the hospital electronic records. Medications that can modify lipid levels like beta blockers and diuretics were not considered. Additionally, patients used multi-vitamin supplementation or patients with hepatic, renal or metabolic bone disorders which may affect the carbohydrate and lipid metabolism in diabetes were not excluded from this study. Finally, this study was based on population from one hospital.

RECOMMENDATIONS

Early management of dyslipidaemia and improvement of glycemic control are helpful in reducing the incidence of CVD among T2DM patients. The awareness of diabetic patients about their high risk of having dyslipidaemia complications and the importance of having routine screening for their lipids profile should be maintained and implement by developing effective strategies by healthcare providers and decision makers in the country. Improving medication adherence among type 2 diabetes patients is essential to achieve good glycemic control.

ACKNOWLEDGEMENT

The authors would like to thank Dr. Mohammed Naman and all the staff in Endocrine Clinic of Fujairah Hospital in Al-Fujairah for their kind cooperation in data collection during the course of this study.

REFERENCES

1. Taskinen MR. Diabetic dyslipidemia. Atherosclerosis Supplements, 2002; 3(1): 47-51.
2. Fagot-Campagna AN, Rolka DB, Beckles GL, Gregg EW, Narayan KM. Prevalence of lipid abnormalities, awareness, and treatment in US adults with diabetes. Diabetes, 2000; 49(5): A78-9.
3. Smith JW, Marcus FI, Serokman R, Multicenter Postinfarction Research Group. Prognosis of patients with diabetes mellitus after acute myocardial infarction. The American journal of cardiology, 1984; 54(7): 718-21.
4. Mooradian AD. Dyslipidemia in type 2 diabetes mellitus. Nature clinical practice endocrinology & metabolism, 2009; 5(3):150-9.

5. American Diabetes Association. Standards of medical care in diabetes--2012. Diabetes care, 2012; 35: S11-63.
6. Krauss RM. Lipids and lipoproteins in patients with type 2 diabetes. Diabetes care, 2004; 27(6): 1496-504.
7. Sacks FM. The role of high-density lipoprotein (HDL) cholesterol in the prevention and treatment of coronary heart disease: expert group recommendations. The American journal of cardiology, 2002; 90(2): 139-43.
8. Lemieux I, Lamarche B, Couillard C, Pascot A, Cantin B, Bergeron J, Dagenais GR, Despres JP. Total cholesterol/HDL cholesterol ratio vs LDL cholesterol/HDL cholesterol ratio as indices of ischemic heart disease risk in men: the Quebec Cardiovascular Study. Archives of internal medicine, 2001; 161(22): 2685-92.
9. Witztum JL, Mahoney EM, Branks MJ, Fisher M, Elam R, Steinberg D. Nonenzymatic glucosylation of low-density lipoprotein alters its biologic activity. Diabetes, 1982; 31(4): 283-91.
10. Lamarche B, Despres JP, Moorjani S, Cantin B, Dagenais GR, Lupien PJ. Triglycerides and HDL-cholesterol as risk factors for ischemic heart disease. Results from the Quebec cardiovascular study. Atherosclerosis, 1996; 119(2): 235-45.
11. Pyorala K, Pedersen TR, Kjekshus J, Faergeman O, Olsson AG, Thorgeirsson G. Cholesterol lowering with simvastatin improves prognosis of diabetic patients with coronary heart disease: a subgroup analysis of the Scandinavian Simvastatin Survival Study (4S). Diabetes care, 1997; 20(4): 614-20.
12. Robins SJ, Collins D, Wittes JT, Papademetriou V, Deedwania PC, Schaefer EJ, McNamara JR, Kashyap ML, Hershman JM, Wexler LF, Rubins HB. Relation of gemfibrozil treatment and lipid levels with major coronary events: VA-HIT: a randomized controlled trial. Jama, 2001; 285(12): 1585-91.
13. Goldberg IJ. Clinical review 124: Diabetic dyslipidemia: causes and consequences. The Journal of clinical endocrinology and metabolism, 2001; 86(3): 965-71.
14. Sultana R. Impact of duration of type 2 diabetes mellitus on lipid profile. Gomal journal of medical sciences, 2010; 8(1): 57-9.
15. Mahajan V, Shende S, Narkhede H, Chakole S, Lokhande M, Mahajan VV. Short Communication "Effect of duration on lipid profile in type 2 diabetes mellitus.". Current Research in Medicine and Medical Sciences, 2013; 3(1): 6-8.
16. Shabana S, Sasisekhar TV. Effect of gender, age and duration on dyslipidemia in type 2 diabetes mellitus. International Journal of Current Research and Review, 2013; 5(6): 104-13.
17. Parmar D, Vidja K, Ghugare B. Impact of duration of diabetes and age: on lipid profile and glycaemic control in type 2 diabetic patients. Journal of International Medical Research, 2013; 2(1): 69-72.
18. Singh G, Kumar A. Impact of Chronicity on Lipid Profile of Type 2 Diabetics. Journal of Exercise Science and Physiotherapy, 2013; 9(1): 46-50.
19. Naheed T, Khan A, Masood G, Yunus BB, Chaudry MA. Dyslipidemias in type II diabetes mellitus patients in a teaching hospital of Lahore, Pakistan. Pakistan Journal of Medical Sciences, 2003; 19(4): 283-6.
20. WOOD PD, STERN MP, SILVERS A, REAVEN GM, VON DER GROEBEN JO. Prevalence of plasma lipoprotein abnormalities in a free-living population of the Central Valley, California. Circulation, 1972; 45(1): 114-26.
21. Berrios X, Koponen T, Huiguang T, Khaltaev N, Puska P, Nissinen A. Distribution and prevalence of major risk factors of noncommunicable diseases in selected countries: the WHO Inter-Health Programme. Bulletin of the World Health Organization, 1997; 75(2): 99-108.
22. Singh G, Kumar AK. A study of lipid profile in type 2 diabetic punjabi population. Journal of Exercise Science and Physiotherapy, 2012; 8(1): 7-10.
23. Al-Maskari F, El-Sadig M, Norman JN. The prevalence of macrovascular complications among diabetic patients in the United Arab Emirates. Cardiovasc Diabetol, 2007; 6(1): 24-30.
24. Loney T, Aw TC, Handysides DG, Ali R, Blair I, Grivna M, Shah SM, Sheek-Hussein M, El-Sadig M, Sharif AA, El-Obaid Y. An analysis of the health status of the United Arab Emirates: the 'Big 4'public health issues. Global health action, 2013; 6: 1-8.
25. Epstein M, Sowers JR. Diabetes mellitus and hypertension. Hypertension, 1992 May 1; 19(5): 403-18.
26. Sowers JR, Epstein M. Diabetes mellitus and associated hypertension, vascular disease, and nephropathy an update. Hypertension, 1995; 26(6): 869-79.
27. Blebil AQ, Hassan Y, Dujaili JA, Aziz NA. Pattern of dyslipidemia in type 2 diabetic patients in the state of Penang, Malaysia. International Journal of Pharmacy and Pharmaceutical Sciences, 2012; 4(1): 305-8.
28. Habib SS. Frequency distribution of atherogenic dyslipidemia in Saudi type 2 diabetic patients. Pak J Physiol, 2006; 2(2): 20-3.
29. Souza LJ, Souto Filho JT, Souza TF, Reis AF, Gicovate Neto C, Bastos DA, Côrtes VA, Chalita FE, Teixeira CL. Prevalence of dyslipidemia and risk factors in Campos dos Goytacazes, in the Brazilian state of Rio de Janeiro. Arquivos brasileiros de cardiologia, 2003 Sep; 81(3): 257-64.
30. Peters AL. Clinical relevance of non-HDL cholesterol in patients with diabetes. Clinical Diabetes, 2008; 26(1): 3-7.
31. Shrewastwa MK, Thanpari C, Yadav NK, Mittal RK. Dyslipidemia in Type-2 Diabetes Mellitus Patients in Western of Nepal: A Hospital Based Study. Bali Medical Journal, 2013; 2(2): 46-50.

32. Jayarama N, Reddy M, Lakshmaiah V. Prevalence and pattern of dyslipidemia in type 2 diabetes mellitus patients in a rural tertiary care centre, southern India. Glob J Med Public Health. 2012; 1: 24-8.
33. Pasha SW, Faseeh KM, Maryam Z, Thunga MV. The Pattern of dyslipidemia among type 2 Diabetes Mellitus patients of Mangalore. Indian Journal of Basic and Applied Medical Research, 2015; 4(2): 254-7.
34. Tagoe DN, Amo-Kodieh P. Type 2 diabetes mellitus influences lipid profile of diabetic patients. Scholars Research Library Annals of Biological Research [internet]. 2013; 4(6): 88-92.
35. Elnasri HA, Ahmed AM. Patterns of lipid changes among type 2 diabetes patients in Sudan. Eastern Mediterranean Health Journal, 2008; 14(2): 314-24.
36. Ogbera AO, Fasanmade OA, Chinenye S, Akinlade A. Characterization of lipid parameters in diabetes mellitus–a Nigerian report. International archives of medicine, 2009; 2(1): 19-25.
37. Mohamed E, Mohamed M, Rashid FA. Dyslipidaemic pattern of patients with type 2 diabetes mellitus. The Malaysian journal of medical sciences: MJMS, 2004; 11(1):44-51.
38. Singh DP, Shah JY, Singh P, Jain S. Evaluation of dyslipidemia in type 2 diabetes mellitus. Asian Journal of Medical Sciences, 2015; 6(6): 16-9.
39. Rathod GB, PragneshParmar SR, Parikh A. Study of Dyslipidemic Pattern and Glycosylated Hemoglobin Status in Diabetic Patients. Endocrinol Diabetes, 2015; 1(1), 1-3.
40. Cook CB, Erdman DM, Ryan GJ, Greenlund KJ, Giles WH, Gallina DL, El-Kebbi IM, Ziemer DC, Ernst KL, Dunbar VG, Phillips LS. The pattern of dyslipidemia among urban African-Americans with type 2 diabetes. Diabetes care, 2000; 23(3): 319-24.
41. Siddiqui SA, Khatoon AB, Iffat S, Sherwani MK, Bashir S, Hussain R. Prevalence of dyslipidemia in Patients with type-2 diabetes mellitus. Pak J Med Res, 2011; 50(1): 29-33.
42. Wang ZH, Wang LH, Li YC, Zhang M, Hu N, Wang LM. [Current status of diabetes, hypertension and dyslipidemia among older Chinese adults in 2010]. Zhonghua yu fang yi xue za zhi [Chinese journal of preventive medicine], 2012; 46(10): 922-6.
43. Li Z, McNamara JR, Fruchart JC, Luc G, Bard JM, Ordovas JM, Wilson PW, Schaefer EJ. Effects of gender and menopausal status on plasma lipoprotein subspecies and particle sizes. Journal of lipid research. 1996; 37(9): 1886-96.
44. Tremollieres FA, Pouilles JM, Cauneille C, Ribot C. Coronary heart disease risk factors and menopause: a study in 1684 French women. Atherosclerosis, 1999; 142(2): 415-23.
45. Ali F, Jamil H, Anwar SS, Wajid N. Characterization of lipid parameters in diabetic and non-diabetic atherosclerotic patients. Journal of geriatric cardiology: JGC, 2015; 12(1): 37-43.
46. Chowta MN, Adhikari P, Rajeshwari S, Chowta NK, Shenoy AK, Ramapuram JT, Rao S. Gender Differences of Lipid profile in type 2 Diabetes Mellitus. Journal of Medical Science & Clinical Ressearch, 2012; 2(2): 25-33.
47. Chan WB, Tong PC, Chow CC, So WY, Ng MC, Ma RC, Osaki R, Cockram CS, Chan JC. Triglyceride predicts cardiovascular mortality and its relationship with glycaemia and obesity in Chinese type 2 diabetic patients. Diabetes/metabolism research and reviews, 2005; 21(2): 183-8.
48. Ladeia AM, Adan L, Couto-Silva AC, Hiltner Â, Guimarães AC. Lipid profile correlates with glycemic control in young patients with type 1 diabetes mellitus. Preventive cardiology, 2006; 9(2):82-8.
49. Mullugeta Y, Chawla R, Kebede T, Worku Y. Dyslipidemia associated with poor glycemic control in type 2 diabetes mellitus and the protective effect of metformin supplementation. Indian Journal of Clinical Biochemistry, 2012; 27(4): 363-9.
50. Sert M, Morgul G, Tetiker BT. Diabetic dyslipidemia is a well-known issue, but what about lipoprotein a levels in Type 2 diabetics. Int J Diab & Metab, 2010; 18: 81-7.
51. Nadeem A, Mumtaz S, Naveed AK, Aslam M, Siddiqui A, Lodhi GM. Pattern of dyslipidaemia and impact of increasing age and duration of type 2 diabetes mellitus on dyslipidaemia, insulin levels and insulin resistance. JPMA. The Journal of the Pakistan Medical Association, 2015; 65(9): 928-32.
52. Boshtam M, Rafiei M, Sarraf-Zadegan N. Obesity and its association with other cardiovascular risk factors in Isfahan population: Isfahan CVD risk factor survey. Atherosclerosis, 1997; 1: 7-11.
53. Ambachew H, Shimelis T, Lemma K. Dyslipidemia among diabetic patients in Southern Ethiopia: Cross-sectional study. Journal of Diabetes and Endocrinology, 2015; 6(4):19-24.
54. Dixit AK, Dey R, Suresh A, Chaudhuri S, Panda AK, Mitra A, Hazra J. The prevalence of dyslipidemia in patients with diabetes mellitus of ayurveda Hospital. Journal of Diabetes & Metabolic Disorders, 2014; 13(1):58-63.
55. Habib SS, Aslam M, Hameed W. Gender differences in Lipids and Lipoprotein (A) profiles in healthy individuals and patients with type 2 Diabetes Mellitus. Pak J Physiol, 2005; 1(1-2): 2-6.
56. Lukshmy H, Sudheera J, Thilak W, Shalika P, Kotapola I. Genetic association between insulin resistance and total cholesterol in type 2 diabetes mellitus-A preliminary observation. Online Journal of Health and Allied Sciences, 2005; 4(1): 1-4.
57. Haffner SM. American diabetes association. Dyslipidemia management in adults with diabetes. Diabetes Care, 2004; 27(1): 68-71.