



TYPE 2 DIABETES MELLITUS; ASSOCIATION OF DYSLIPIDEMIA AND MAGNESIUM LEVELS IN TYPE 2 DIABETES MELLITUS.

1. MBBS
Senior Demonstrator
Department of Biochemistry
UM & DC Faisalabad
2. MBBS, M. Phil, FCPS, PhD
Post Doctorate
Professor of Biochemistry
Principal
UM & DC Faisalabad
3. MBBS, M Phil Physiology
Associate Professor
Department of Physiology
UM & DC Faisalabad
4. MBBS
Demonstrator
Department of Biochemistry
UM & DC Faisalabad
5. MBBS
WMO
Samnand, Gujrat
6. Student MBBS, 4th year
Sargodha Medical College,
Sargodha

Correspondence Address:

Dr Fauzia Jan
Senior Demonstrator
Department of Biochemistry
UM & DC Faisalabad
fauzia.jan@tuf.edu.pk

Article received on:

07/07/2018

Accepted for publication:

25/09/2018

Received after proof reading:

04/12/2018

Fauzia Jan¹, Muhammad Saeed², Sadaf Zia³, Rahat Rahman⁴, Sara Muzaffar⁵, Anam Waheed⁶

ABSTRACT... Developing countries like Pakistan have many sufferers of Diabetes Mellitus Type 2 still unprepared and unaware of the disastrous implications and complications of the disease. Local population must be aware about all factors that may worsen the disease or that may be monitored to keep them in a better status of health. **Objectives:** To assess the correlation between blood glucose and various parameters of lipid profile alongwith levels of Magnesium in Type 2 diabetic patients. The aim was to help in better management of patients by monitoring dyslipidemia and mineral levels in Type2 diabetics. **Study design:** Cross sectional study. **Setting:** Madinah Teaching Hospital, Faisalabad. **Period:** 6 months from July to December 2017. **Subjects and methods:** The study was executed at Madinah Teaching Hospital Faisalabad on 50 known cases of diabetes mellitus type 2 as well as 30 healthy subjects. Estimations included Fasting blood glucose, Lipid profile and Serum Magnesium. All parameters were performed by Cobas C311 analyzer. Statistical analysis was done using SPSS version 20. **Results:** There was significant positive correlation between fasting blood sugar and serum cholesterol, triglycerides and LDL while a highly significant negative correlation existed between HDL and FBS. There was negative correlation among fasting blood sugar and serum Magnesium. The control group also showed low HDL and Magnesium levels. **Conclusion:** Hypercholesterolemia, hypertriglyceridemia, high LDL is associated with type 2 diabetes mellitus along with low HDL and hypomagnesaemia. The low levels in control group may be due to heredity or dietary factors.

Key words: Diabetes Mellitus type 2, Dyslipidemia, Serum Magnesium, CETP (Cholesterol ester transfer protein).

Article Citation: Jan F, Saeed M, Zia S, Rahman R. Muzaffar S, Waheed A. Type 2 Diabetes Mellitus; Association of dyslipidemia and magnesium levels in Type 2 Diabetes Mellitus. Professional Med J 2018; 25(12):1972-1978.
DOI: 10.29309/TPMJ/18.5045

INTRODUCTION

To live a happy and healthy life is the heartiest desire of every human being. In a healthy individual all body metabolisms are working in a normal way. Any metabolic derangement affects the body in a disastrous way. Diabetes mellitus, although a very old discovered disease is still causing suffering and pain to millions. The battle is on, as the incidence is rising and expected to increase very rapidly in the coming era. In 2013, 382 million human beings suffered from diabetes and it is estimated to increase in 2035 reaching 592 million. Many of the sufferers will be belonging to developing nations.¹ A variety of metabolic disturbances due to high blood glucose level caused by impairment in role or secretion of insulin is categorized as diabetes

mellitus. The reason of insulin defectiveness may be self-destruction of pancreatic beta cells or/and no responsiveness of tissues to insulin.² The most important role of insulin is the lowering of blood glucose level. It is anabolic favoring the buildup of metabolites inside cells.³ Insulin has a vital role in metabolism of carbohydrates and lipids in certain organs like muscle and fat tissue. The synthesis and breakdown of fat in the liver and the transport of lipoproteins from liver to extra hepatic tissues is regulated by insulin.⁴

Resistance to insulin is at the base of formation of dyslipidemia. The increased free fatty acids cause high triglyceride levels seen in both chylomicrons and VLDL particles. This is exchanged through CETP into HDL thus decreasing the beneficial

protection mediated by HDL particles. There is decreased quantity of high density lipoproteins accompanied by high level of small density low density lipoprotein level.⁵

The elevation in blood glucose affects many organs and tissues causing complications. A frequent problem is narrowing of blood vessels due to ischemia leading to heart attack or stroke.⁶

Some minerals have significant contributions to the normal functioning of insulin in the body. Magnesium is the most abundant positively charged ion inside the cell. It is vital for life as it is a cofactor for ATP linked enzymatic reactions, maintenance of normal functioning of mitochondria, cell membrane and channels for electrolytes and translation. Mg is recognized to play a role in enzyme function including kinases. The mechanism of insulin action is through tyrosine kinase and low magnesium impairs this activity as it is essential for this enzyme.⁷ Low level of magnesium is associated with defect in neuromuscular excitability. It also leads to low levels of potassium, calcium and phosphate thus increasing the problem. It is associated with long term complicated DM. Its low level is linked with hyperlipidemia, non-responsiveness to insulin by tissues and its high intake prevents diabetes occurrence.⁸

Dyslipidemia and magnesium levels are correlated with fasting blood glucose level in diabetic patients and their monitoring can be contributory to better management of the disease.

MATERIALS AND METHODS

The Research and Ethics / Technical Committee for The University of Faisalabad permitted to conduct this study.

Setting

The study was performed at Madinah Teaching Hospital Faisalabad with objective of finding correlation between blood glucose, lipid profile and magnesium in the local population.

Study Design and sample size

This was a cross sectional study performed

on 80 subjects at Madinah Teaching Hospital Faisalabad.

Age

Samples of age group 40 and above were selected. Fifty diagnosed diabetic patients and thirty healthy people of the same age group taken as controls.⁹

Inclusion and Exclusion Criteria

Persons having Type 2 diabetes mellitus with age 40 and above were included in the study. Patients having type 1 DM or any other serious liver, kidney or lung disease were excluded from this study.

Protocol before sampling

It was ensured that the patients who were taking any mineral supplements or cholesterol lowering drugs were also excluded. Any previous record was checked. Patients were advised to come in fasting state in the next morning.¹⁰

Evaluated Parameters:

The evaluated parameters included fasting blood sugar, lipid profile (serum total cholesterol, serum triglycerides, serum LDL, and serum HDL levels), serum magnesium. All estimations were done from clinical laboratory of Madinah Teaching hospital through Cobas C311 analyser of Roche Hitachi Company.

Fasting blood glucose estimation was done by UV test enzymatic reference method with hexokinase. Total cholesterol was done by CHOD-PAP method. HDL was performed by enzymatic photometric method. Triglycerides estimated by GPO-PAP method. Fried Wald formula was used to calculate values of LDL.⁷

Lipid profile values were according to NCEP (National Cholesterol Education Program) recommended levels.¹¹ Recommended values of cholesterol were < 200mg/dl. Borderline range was between 200-239 mg/dl while the high risk persons had more than 240mg/dl.

The goal value for triglycerides was less than 150mg/dl, highest risk was set at greater than 200mg/dl and borderline value was in between

150 and 199mg/dl.

The recommended value for HDL was equal to or greater than 60mg/dl. The borderline values were between 40-59 mg/dl and those having less than 40mg/dl were considered at high risk.

The aimed value of LDL cholesterol was less than 130mg/dl. Borderline values were between 130 -159 mg/dl and greater than 160 mg/dl was the range of high risk persons.¹² Magnesium levels with this analyzer were 1.6-2.6 mg/dl.

STATISTICAL ANALYSIS

All results obtained were saved and arranged followed by statistical analysis. Data was statistically analyzed by using SPSS version 20. Correlation of both cases and controls was found out. This was followed by comparison between controls and type 2 diabetics using ANOVA. Results were considered significant if $p < 0.001$.¹³

RESULTS

Biochemical parameters

Correlation of lipid profile with blood sugar was calculated as shown in the table

Comparison between fasting blood sugar and FBS (X1) and Cholesterol(X2), Triglycerides (X3), HDL (X4), serum LDL(X5) in diabetic Type 2 group

	CHOL mg/dl	TAG mg/dl	HDL mg/dl	LDL mg/dl
	X2	X3	X4	X5
r	0.843	0.853	-0.763	0.822
N	50	50	50	50
P <0.001	0.000	0.000	0.000	0.000

Table-I. Correlation between FBS and lipid profile in diabetic type 2 group
r = correlation, N = number of diabetic patients

Correlation between FBS (X1) and lipid profile was also calculated in controls (N= 30)

Comparison between fasting blood sugar and

serum cholesterol, TAG, HDL, LDL in healthy control group

	CHOL mg/dl	TAG mg/dl	HDL mg/dl	LDL mg/dl
	X2	X3	X4	X5
R	0.094	0.130	- 0.048	0.112
N	30	30	30	30
p <0.001	0.620	0.493	0.802	0.555

Table-II. Correlations between FBS and lipid profile in control group
r =correlation, N =number of controls

Graphs showing relationship between fasting blood sugar and serum cholesterol, serum TAG, LDL and HDL in diabetic type 2 group

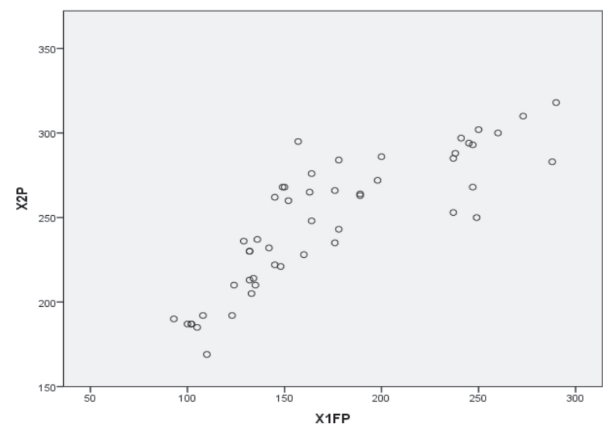


Fig .1 Graph between FBS and serum total cholesterol in diabetic group
X1FP = Fasting blood sugar in mg/dl
X2P = Serum cholesterol level in mg/dl

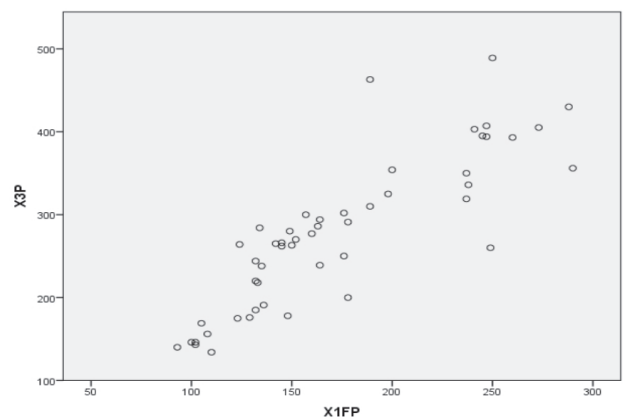


Fig-2. Graph between FBS and Serum Triglycerides in type 2 diabetic group
X1FP = Fasting blood sugar in mg/dl
X3P = Serum TAG in mg/dl

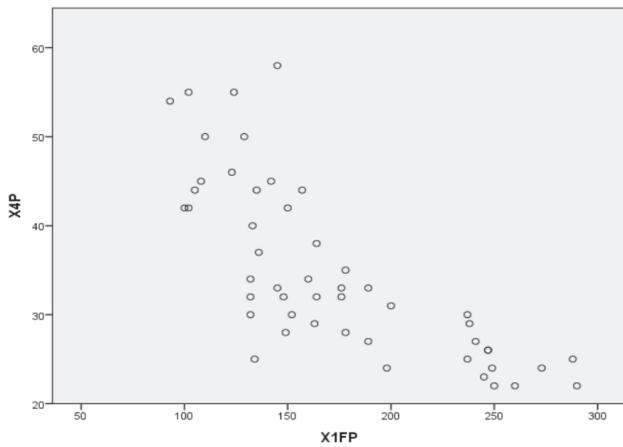


Fig-3. Graph between FBS and serum HDL in diabetic group

XFP = Fasting blood sugar in mg/dl
X4P = Serum HDL level in mg/dl

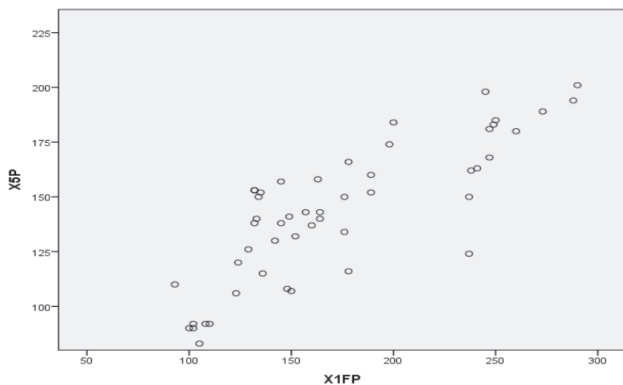


Fig-4. Graph between FBS and serum LDL in type 2 diabetic group

X1FP=Fasting Blood Sugar in mg/dl
X5P = Serum LDL level in mg/dl

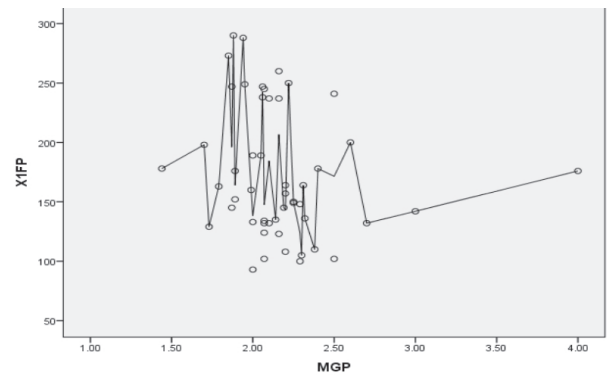


Fig-5. Graph between FBS with serum magnesium in diabetics type 2

X1FP = Fasting blood sugar in diabetic type 2 patients
MGP = Serum magnesium in diabetic type 2 group

R	-0.0421
N	30
p<0.001	0.021

Table-III. Comparison between fasting blood sugar and serum magnesium in control group

r = correlation, N = number of controls

r	-0.168
N	50
p<0.001	0.243

Table-IV. Comparison between fasting blood sugar and serum magnesium in diabetic Type 2 group

r = correlation, N = number of diabetics

Descriptive analysis for biochemical parameters in control and diabetes mellitus type2 patients

Correlation between Fasting Blood Sugar (X1) and magnesium (X6)

	FBS(mg/dl)	Chol(mg/dl)	TAG(mg/dl)	HDL(mg/dl)	LDL (mg/dl)	Mg(mg/dl)
Mean ±SD	88.17± 10.544	168.90± 44.103	139.03± 74.564	37.43± 9.529	105.43± 35.321	2.1363± .22093
Range	57-104	96-287	322-73	57-16	200-51	2.57-1.60
Variance	111.178	1945.059	5559.826	90.806	1247.564	.049

Table-V. Analysis for biochemical parameters in healthy control group

FBS: fasting blood sugar, Chol: Cholesterol TAG: triacylglycerol
HDL: High density lipoprotein LDL: low density lipoprotein Mg: magnesium
Control group in which N = 30

	FBS(mg/dl)	Chol(mg/dl)	TAG(mg/dl)	HDL(mg/dl)	LDL(mg/dl)	Mg(mg/dl)
Mean± SD	173.10± 55.167	247.46± 39.215	276.82± 90.778	34.76± 9.899	143.00± 31.373	2.1646± .37412
Range	290-93	318-169	489-134	58-22	201-83	4.00-1.4
Variance	3043.439	1537.804	8240.681	97.982	984.286	.140

Table-VI. Analysis for biochemical parameters in type 2 diabetic group
Patients of Diabetes Mellitus type 2 in which N=50

Of the total 80 samples, 46 had cholesterol level more than 200mg/dl (58%). Among the diabetic patients, 40 out of 50 (80%) and in the controls 6 out of 30 (20%) had cholesterol above 200mg/dl. Of the very high risk group with cholesterol level more than 240 mg/dl.

There were 28 diabetic patients (56%) and 5 controls (16%). In the borderline category with level of cholesterol between 200 and 239, there was 1 control (2%) and 12 diabetics (24%).

Considering HDL, 34 out of 50 had very low values (68%), 13 showed borderline results (26%) Total 47 out of 50 (94%) had significantly deranged HDL levels. In the controls 20 out of 30 had low HDL levels (66%) 6 out of 30 (20%) had borderline low values between 40-59 mg/dl.

LDL values showed 13 at high risk (26%), 21 in the borderline category (42%) so total 34 out of 50 (68%) had elevated LDL levels. In the controls only 2 had high LDL level (6%).

DISCUSSION

Diabetes mellitus is a clinical condition which involves all body systems. The latest management includes self-education of patient, concentration at his nutritional status, avoiding smoking, regular follow ups with doctor and regular evaluation of levels of glucose and lipids. The goal of this research work was to take into account every factor that may be playing a vital role in progression of diabetes with reference to other lipid parameters along with minerals.⁶

Various studies have shown the association of hyperglycemia with deranged lipoprotein levels as a consequence of the metabolic derangement found in this syndrome. This exposes the patients

to suffer from ischemic heart disease and maybe life threatening. Several studies^{11,14} found almost eighty percent of patients of Type 2 DM suffering from lipid disorders which is quite similar to the current research. There is different percentage of all lipid levels but all are disturbed to some extent emphasizing on the definite presence of derangement. There may difference in body mass index or some hereditary base behind the results. A very high number of diabetics had hypercholesterolemia as compared to controls also described by.^{11,14-15}

Triglycerides are considered as a separate risk factor for causing complexities of diabetes mellitus. Triacylglycerol were also significantly raised and linked with type 2 diabetic subjects as determined by.^{12,14,16,17}

Low HDL are a common pattern of abnormality seen in diabetics type 2 .High density lipoprotein take up excess cholesterol from tissues and return it to liver. They have beneficial effect in preventing deposition of lipid inside vessel wall and inhibiting narrowing of vessels. Thus a high level is a strength for the body as described by.^{14,18,19}

It was documented in the extensive studies^{14,17,20,21} that both the quantity of low density lipoprotein particles is increased and their morphology is distorted in diabetes subjects putting them at risk of morbidity and mortality.

Sajjan & Shamsuddin⁷ in their study on serum magnesium and hyperlipidemia in noninsulin dependent diabetes mellitus stated results similar to this study with negative correlation among blood sugar and magnesium levels. Strong relation between low magnesium and

diabetes mellitus was shown by^{8,13,22,23} in their studies. The causes may be dietary insufficiency, increased excretion of magnesium from the body or drug intake. Gröber., et al.²⁴ in their study on magnesium, document its common sources in diet as aqua, green vegetables, legumes and dry fruits. The important roles of magnesium include a coenzyme in various chemical reactions including translation, transmission of signals and nerve and muscle conduction, glucose homeostasis and regulation of hypertension. The energy dependent transport of K⁺ and Ca⁺⁺ also requires magnesium. It is stored in bones and helps in formation of bones.

Magnesium is an important coenzyme of many enzymes involved in carbohydrate metabolism.¹⁰ Moreover it is also cofactor for tyrosine kinase which mediates signal transduction of insulin.¹³ The metabolic disturbance in diabetes mellitus type 2 also leads to a disturbance in magnesium level.

CONCLUSIONS

In this study the lipid level disturbance and the mineral levels of magnesium were evaluated. Eighty subjects were enrolled in the study after taking complete history. They were divided into a diabetic group of 50 samples and the control group of the same age group but having no serious health problem. The subjects included in the study showed a definite correlation with fasting blood sugar. Hyperglycemia was strongly positively correlated with high levels of cholesterol, triglycerides and LDL. There was negative correlation of FBS among HDL and serum Mg. Cholesterol, TAG and LDL showed statistical significance as compared to controls. Magnesium and HDL were both significantly lower in controls as well as diabetics. The dietary sources of both of these were perhaps deficient in the diets of local population.

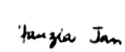
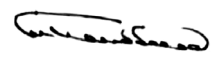



Copyright© 25 Sep, 2018.

REFERENCES

- Guariguata L., Whiting D, Beagley H, Linnenkamp U, Shaw J, **Global estimates of diabetes prevalence for 2013 and projections for 2035. Diabetes Research and Clinical Practice.** 2014. Volume 103, Issue 2 Pages 137–149.
- Fox C, Golden S, Anderson C, Bray G, Burkel, Boer, Deedwania P, Eckel R, Ershow A, Fradkin J, Inzucchi S, Kosiborod M, Nelson R, Patel M, Pignone M., Quinn L, Schauer P, Selvin E, Vafiadis D. **Update on Prevention of Cardiovascular Disease in Adults With Type 2 Diabetes Mellitus in Light of Recent Evidence: A Scientific Statement From the American Heart Association and the American Diabetes Association.** *Diabetes Care.* 2015;38(9), 1777–1803.
- Qaid M., Abdelrahman M. **Role of insulin and other related hormones in energy metabolism—A review.** *Cogent Food & Agriculture.* 2016.2: 1267691.
- Han C., We F, He F, Liu D, Wan H, Liu H, Li L, Xu H, Du X. **The Regulation of Lipid Deposition by Insulin in Goose Liver Cells Is Mediated by the PI3K/AKT-mTOR Signaling Pathway.** *PLoS ONE.* 2015. 10(5).
- Tangvarasittichai S. **Oxidative stress, insulin resistance, dyslipidemia and type 2 diabetes mellitus.** *World J Diabetes.* 2015. 6(3): 456-480.
- American Diabetes Association Foundations of Care and Comprehensive Medical Evaluation.** *Diabetes Care.* 2016.39 (Suppl. 1).
- Sajjan N, Shamsuddin M. **A study of serum magnesium and dyslipidemia in type 2 diabetes mellitus patients.** *International Journal of Clinical Biochemistry and Research.* 2016 ;3(1): 36-41.
- Liamis G, Liberopoulos E, Barkas F, Elisaf, M. **Diabetes mellitus and electrolyte disorders.** *World Journal of Clinical Cases W J C C.* 2014. 2(10): 488-496.
- Mishra S, Padmanaban P, Deepti G, Sarkar G, Toora S. **Serum Magnesium and Dyslipidemia in Type-2 Diabetes Mellitus.** *Biomedical Research.* 2012.23 (2): 295-300.
- Malek A, Mia A, Shaha S, Azad A. **Study of serum levels of Zinc and Magnesium in Type 2 Diabetic subjects.** *Asian Journal of Pharmacy and Pharmacology.* 2016. 2(4): 81-84.
- Ultra K, Devrajani B, Shah S, Devrajani T, Das T, Raza S, Naseem. **Lipid Profile of Patients with Diabetes mellitus (A Multidisciplinary Study).** *World Applied Sciences Journal.* 2011.12 (9): 1382-1384.
- Roy S, Shah P. **Lipid Profile In Diabetes Mellitus.** *National Journal of Integrated Research in Medicine.* 2016. Vol. 7(4).
- Kaur J, Singh T. **Estimation of serum magnesium and zinc levels in type-2 diabetes mellitus.** *Int. J. Bioassays.* 2015. 4 (01).3654-365.
- Bali K, Vij A. **Pattern of dyslipidemia in Type 2**

- Diabetes Mellitus in Punjab.** International Journal of Research in Medical Sciences. 2016. 4(3)809-812. DOI: <http://dx.doi.org/10.18203/2320-6012.ijrms20160523> .
15. Bhutto G, Lokesh R, Shah S, Afroze H, Ghouse P, Abhilash D. **Association between lipid profile and silent coronary artery disease in south Indian patients with type 2 diabetes mellitus.** International Journal of Advances in Medicine. 2017. 4(1). doi: <http://dx.doi.org/10.18203/2349-3933.ijam20164020>.
 16. Sacks M , Hermans M , Fioretto P, Davis T , Horton E, Wanner C, Al-Rubeaan K, Aronson R, Barzon I, Bishop L, Bonora E, Bunnag P, Chuang L, Deerochanawong C, Goldenberg R, Harshfield B, Hernández B, Botein S, Itoh H , Jia W, Jiang Y , Kadowaki T , Laranjo N, LeiterL, Miwa T , Odawara M , Ohashi K , Ohno A , Pan C , Pan J , Pedro-Botet J , Reiner Z, Rotella C, Simo R , Tanaka M, Tedeschi-Reiner Z, Twum-Barima D, Ppini G, Carey V. **Association Between Plasma Triglycerides and High-Density Lipoprotein Cholesterol and Microvascular Kidney Disease and Retinopathy in Type 2 Diabetes Mellitus.** A Global Case–Control Study in 13 Countries .Circulation.2014.129:999-1008.
 17. Tenenbaum A , Fisman E. **Fibrates are an essential part of modern anti-dyslipidemic arsenal: spotlight on atherogenic dyslipidemia and residual risk reduction.** Tenenbaum and Fisman Cardiovascular Diabetology.2012. 11:125.
 18. Vergès B. **Pathophysiology of diabetic dyslipidaemia: where are we?.** Diabetologia.2015. Volume 58 Issue 5, pp 886–899.
 19. Linthout S, Spillmann F , Schultheiss H. Tschöpe C.(2010) **High-Density Lipoprotein at the Interface of Type 2 Diabetes Mellitus And Cardiovascular Disorders.** Current Pharmaceutical Design. 2010. Vol. 16, No. 131504-1516.
 20. Bays H. **Lowering low-density lipoprotein cholesterol levels in patients with type 2 diabetes mellitus.** International Journal of General Medicine .2014. 7:355-64. doi: 10.2147/IJGM.S65148.
 21. Khan N, Venkatachalam V, Al-akhali K , Alavudeen S , Dhanapal C, Ansari S, (2014). **Therapeutic Management of Hypertension and Hyperlipidemia in Type 2 Diabetes Mellitus Patients in Southwestern Region of Saudi Arabia: A Pharmacist Perspective.** Asian J Pharm Clin Res. 2014.Vol 7 (5), 241-245.
 22. Yahya H, Yahya K , Saqib A. **Minerals and type 2 diabetes mellitus _level of zinc, magnesium and chromium in diabetic and non-diabetic population.** JUMDC. 2011. Vol.2 Issue 1,pg 34-38.
 23. Motamedi P, Dehghani N, Kiani F, Torkamaneh S, Nasri H. **Magnesium and lipids in diabetes mellitus.** Journal of Parathyroid Disease.2014 .2(2),73–74
 24. Gröber U, Schmidt J, Kisters K. **Magnesium in Prevention and Therapy.** Nutrients. 2015. vol.7. 8199-8226.

AUTHORSHIP AND CONTRIBUTION DECLARATION

Sr. #	Author-s Full Name	Contribution to the paper	Author=s Signature
1	Fauzia Jan	Performed experimental & research work.	
2	Muhammad Saeed	Conceived the idea & supervised the research.	
3	Sadaf Zia	Proof reading & correction of manuscript.	
4	Rahat Rahman	Assisted in experimentation & data collection.	
5	Sara Muzaffar	Proof reading & formatting.	
6	Anam Waheed	Literature review & Proof Reading.	