Gender Differences in the Effect of Diabetes Mellitus in Serum Lipid of Diabetics Attending Plateau State Specialist Hospital

Luka Carrol Dumkat[1], Agi Peace Josephine[1], Egwuindu Josephine Chika[1], Istifanus Gurumtet[1*] and Comfort Japhet Philip[2]

[1]Department of Biochemistry, Faculty of Medical Science, University of Jos, P.M.B 2084, Jos, Nigeria.
[2]National Biotechnology Development Agency, Umaru Yar'adua Way, Lugbe, Abuja, Nigeria.

Authors' contributions:

This work was carried out in collaboration between all authors. 'Author A' designed the study, performed the statistical analysis, wrote the protocol, and wrote the first draft of the manuscript. 'Author B' and 'Author C' managed the analyses of the study. 'Author C' managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJMAH/2018/45360
Editor(s):
(1)
(2)
Reviewers:
(1)
(2)
(3)
(4)
Complete Peer review History:

Original Research Article

Received 20YY
Accepted 20YY
Published 20YY

ABSTRACT

Background: Diabetes is an increasing health concern globally with several complications (including coronary heart disease) and diverse contributing factors. Diabetes has been proven to affect both male and females nevertheless, the attendant dyslipidemia is suspected to be common among females than males.

Objectives: This study is aimed at evaluating the effect of gender on the serum lipid profile of diabetics.

Methods: One hundred and eighty six (186) diabetics comprising 86 males and 100 female diabetics of all groups, attending plateau state specialist hospital Jos were admitted as subjects in this study. While 50 control samples were collected from apparently healthy

**Corresponding author: E-mail: gurumtetistifanus@yahoo.com;*

non-diabetics. The BMI and Blood pressure of the subjects was determined on the site of sample collection, while the blood samples were analyzed in the laboratory using a fully automated biochemistry analyzer. The parameters assayed include; Total cholesterol, High density lipoproteins, Low density lipoproteins, Triglycerides and Fasting blood glucose.

Results: Results generated revealed a significant (p = .05) variation in the total cholesterol, Low Density Lipoprotein and Blood pressure values of male and female diabetics while triglycerides values varied significantly (p = 0.05) between diabetics and controls subjects of both sexes accordingly. The results further revealed that female diabetics above 60yrs had higher total cholesterol (5.5±1.5mmol/L), Triglycerides (1.6±1.4mmol/L), LDL (2.9±1.5 mmol/L) and Systolic blood pressure (15.58±2.19×10mmHg) values, and the lowest HDL (1.9±0.3mmol/L) value when compared to the values gotten from the other age groups. While those between the ages of 21-40yrs had the lowest Total cholesterol (4.2±0.8mmol/L), Triglycerides (1.3±0.9mmol/L), LDL (1.5±1.0mmol/L), BMI (25.2±5.7 Kg/m^2) and Systolic blood pressure (13.4±2.29×10mmHg) values.

Conclusion: This study unveils the possibility of the female diabetics being more prone to dyslipidemia than the male gender thus exposing the females to increased risk of coronary heart disease. Although, both males and females alike are exposed to the metabolic syndrome, the female diabetic is especially prone to this syndrome. This may be due to the physiologic make-up of the female and their body changes during pregnancy.

Keywords: Gender; Diabetes mellitus; dyslipidemia.

1. INTRODUCTION

Disorder of serum lipids is a very common finding in diabetic patients and is the major predisposing factor to the morbidity and mortality arising from cardiovascular diseases [1]. According to the National Cholesterol Education Programme-Adult Treatment Panel III (NCEP-ATP III) and the International Diabetes Federation (IDF) definitions, diabetic dyslipidemia is defined by the presence of high serum total cholesterol, high serum triglyceride, high LDL-Cand low serum HDL in type 2 diabetic patients [2, 3]. Low levels of HDL-C are often associated with raised TG levels (e.g. in familial combined hyperlipidaemia (FCH) and in dyslipidaemia in type 2 diabetes). The typical pattern of dyslipidemia present in type 2 diabetic patients is a raised triglyceride level and low HDL cholesterol. Other associated findings may include increase in LDL particle number, small dense LDL, and apolipoprotein B [4]. Patients with diabetic dyslipidemia have lipid particles that are more artherogenic than in the general population and even are at slightly increased risk of cardiovascular morbidity and mortality (Goldberg, 2001) [5]. Diabetic patients have a tendency of increased transport of large amounts of fatty acids to the liver which are then reassembled into triglycerides and secreted in VLDL, defective insulin action and hyperglycaemia could lead to these lipoproteins abnormalities.

In both type-1 diabetes (insulin dependent diabetes (IDDM)) and type-2 diabetes (non-insulin dependent diabetes (NIDDM)), morbidity and mortality from cardiovascular disease is greatly increased. It has also been estimated that up to 80% of the 200 million people with diabetes globally will die of cardiovascular diseases, thus putting metabolic syndrome and diabetes mellitus ahead of HIV/AIDS in terms of morbidity and mortality [6].

Control of hyperglycaemia and associated lipid abnormalities are very well identified as modifiable risk factors among patients with type II diabetes and are also very important primary Preventive measures for coronary artery disease. It has been reported that type 2 DM increases the risk of CHD more markedly in women than in men [7].

Hyperglycaemia and hypertension are the two key factors relevant to increased risk of progression of Diabetic kidney disease (DKD) [8]. DKD is the major cause of end-stage renal disease worldwide; therefore, clarification of the mechanisms and identification of the risk factors associated with DKD are urgently required. Dyslipidaemia has also been implicated in the pathogenesis of DKD. Experimental studies have clarified that altered lipid metabolism and an excessive amount of lipid deposits in the kidney play an important role in the exacerbation of diabetic kidney disease [9]. However, the effects

of lipid abnormalities on the progression of DKD in humans remain conflicting [10].

Gender differences in the association between serum lipid parameters and renal function decline have been recently reported in the general population. In women, higher cholesterol-to-HDL cholesterol ratio was associated with a rapid decline in renal function. In contrast, lower cholesterol-to-HDL cholesterol ratio was shown to be a predictor of renal function decline in men [11]. Interestingly, a cross-sectional study of male patients with type-2 diabetes mellitus (T2DM) showed that lipid abnormalities were associated with decreased glomerular filtration rate (GFR) [12]; however, this association was not observed in female patients with T2DM in another study [10]. Taken together, these findings may suggest that there are differences in gender in the association of serum lipid abnormalities with the pathogenesis of DKD.

2. MATERIALS AND METHODS

Some of the materials used for this study include; Digital weighing scale, Glucometer and strips (one touch ultra), 5ml capacity plain vacutainer tubes, Needles and syringes, Cotton wool, Methylated spirit, Tourniquette, Digital blood pressure meter, Biochemistry autoanalyser (Landwind LWC400), Centrifuge, etc.

2.1 Ethical Clearance

An ethical clearance was applied for and obtained from the ethical committee of the Plateau State Specialist Hospital.

2.2 Sampling and Sample Area

The sample population used for this study were, male and female diabetic patients attending Plateau State Specialist Hospital, Jos, Plateau State, Nigeria. Only diabetic patients and control (non-diabetic) subjects, who gave their consent, were sampled for this study. Information concerning their age, sex, marital status and anti-hyperglycemic medication status were also obtained using a researcher administered questionnaire.

2.3 Sample Size

The proposed sample size for this study was derived from the IFAS table of statistics [13]. Calculated from the formula; $n_0 = Z^2PQ \div e^2$

Where; $\mathbf{n_0}$ is the expected sample size, Z^2 is the abscissa of the normal curve that cuts off an area α at the tails (1 – α equals the desired confidence level, e.g., 95%), e is the desired level of precision, P is the estimated proportion of an attribute that is present in the population, Q is 1-P, while, The value for Z is found in statistical tables which contains the area under the normal curve [14].

The sample size was estimated to be 200 diabetic patients (100 males and 100 females) and 50 control samples (25 males and 25 females) making a total of 250 samples.

2.4 BMI Determination

Weight was measured using a weighing scale and recorded in kilograms (Kg). Their corresponding Basal metabolic indexes (BMI) were then calculated using the formula by "AdolpheQuetelet (1796–1874)" [15]. BMI (kg/M^2) = Mass (kg) ÷ Height $(M)^2$.

2.5 Sample Collection, Preparation

Approximately 2.5ml fasting whole blood samples was collected into sample containers containing fluoride oxalate, using standard asceptic techniques. The whole blood sample was then allowed to clot; thereafter it was spun in a centrifuge at 3000rpm for 5mins to separate the serum from the cellular constituent.

2.6 Sample Transport and Storage

The obtained whole blood of each patient was properly labeled and packaged for onward transport to the site of separation, storage and laboratory analysis. The samples were stored frozen in a refrigerator pending analysis.

2.7 Sample Analysis

Analytical run on samples collected was carried out in Dee Medical Center Bukuru, using the LWC400 fully automated Biochemistry analyser, a product of LandwindShenzeng China. The functionality of this analyser is based on the following principles; Ion Selective Electrode, Absorption Photometry and Micro Volumetric Assays.

The following analytes were assayed for in the samples collected; Fasting blood Glucose and Fasting lipid Profile which includes; Total Cholesterol, Triglycerides, High Density Lipoproteins and Low Density Lipoproteins.

Glucose Estimation was enzymatic (Glucose Oxidase/Peroxidase) endpoint method. Total Cholesterol Estimation was enzymatic, CHOD-PAP Single reagent method. High Density Lipoprotein (HDL) was direct CHOD-PAP double reagent method. Triglyceride was by GPO-PAP Single reagent method. Low density Lipoprotein was by direct method 2 reagents.

3. RESULTS AND DISCUSSION

3.1 Results

3.2 Discussion

The results of this study as discussed herein, reveals certain facts that could be relevant to patient care and medical practice generally, especially in the management of Diabetes mellitus. The results as shown in Table 1 shows that female diabetics above 60yrs had higher total cholesterol (5.5±1.5mmol/L), Triglycerides (1.6±1.4mmol/L), LDL (2.9±1.5 mmol/L) and Systolic blood pressure (15.58±2.19×10mmHg) values, they also had the lowest HDL (1.9±0.3mmol/L) value when compared to the other age groups. This is similar to findings from studies carried out by Hanai and Halbesma [11]. Their study which was carried among male and female type 2 diabetics greater than 64 years of age revealed that, in women, there was higher TC-to-HDL ratio which was associated with rapid decline in renal function as compared in males. In contrast, lower TC-to-HDL ratio was shown to be a predictor of renal function decline in men. Interestingly, a cross-sectional study of male patients with type 2 diabetes mellitus (T2DM) showed that lipid abnormalities were associated with decreased glomerular filtration rate (GFR); however, this association was not observed in female patients with T2DM in another study [10].
Taken together, these findings may suggest that there are differences in gender in the association of serum lipid abnormalities with the pathogenesis of Diabetic Kidney Disease.

Furthermore, results of this study as shown in Table 6 reveals that, out of the total number of diabetics sampled (186), 171 had fasting blood glucose levels higher than normal. 96 (56.1%) being females while 75 (43.9%) were males. Also, a greater percentage of females had raised TC 27 (77.1%), TG 27 (57.5%), LDL 40 (76.9%) and BMI 40 (81.6%) relative to the male subjects who had TC 8 (22.9%), TG20 (42.5%), LDL 12 (23.1%) and BMI 9 (18.4%). This in tandem with the study carried out by Yasir [16] among type 2 diabetics in Abbotabad, Pakistan. Their study revealed that, the female gender had a higher percentage of raised serum Total Cholesterol, Low Density Lipoproteins and Triglycerides but lowered levels of HDL compared to the male gender. However, Hypertriglyceridemia was the most common component of diabetic dyslipidemia in their study. This could be linked to several factors which include; the effect of insulin therapy and other antihyperglycemic drug therapy the patient is being administered [17]. Another study in Pakistan also showed hypertriglyceridemia to be the most common component of diabetic Dyslipidemia [18].

Data generated from previous studies on dyslipidemia revealed that the female gender is more prone to coronary heart disease consequent upon findings that, Females have high frequency of low HDL cholesterol and high LDL cholesterol, which is an important risk factor for Coronary Heart Diseases [1].

The results of this study further reveals that a greater percentage of the female diabetics are Obese. This is synonymous with findings made by Awosan [19]. This could be related to the fact that, African women are largely prone to obesity as such, have a high prevalence of metabolic syndrome which includes dyslipidemia, consequent upon the fact that the dietary constituent of the average Nigerian largely comprises staple carbohydrate and fats (unsaturated fatty acids Triglycerides and harmful Cholesterols eg. LDL-C). Also, cultural practices and religious beliefs relegate the African woman to a sedentary life style. They are less likely to be allowed to engage in outdoor leisure exercises, even if there are facilities for moderate physical activities where they live [19].

The body physiology of the females especially during and after pregnancy is an indispensable factor contributing to the common obesity among females. Thus this lifestyle further exposes them to the deleterious consequence of accumulated lipids.

Table 1. Results of female diabetic subjects of various age groups

Age groups (years)	TC (mmol/L)	TG (mmol/L)	HDL (mmol/L)	LDL (mmol/L)	BMI (Kg/m^2)	GLU (mmol/L)	BP (SYS) (×10mmHg)	BP (DIA) (×10mmHg)
0-20	-	-	-	-	-	-	-	-
21-40	4.2±0.8	1.3±0.9	2.1±0.2	1.5±1.0	25.2±5.7	14.2±6.9	13.4±2.29	8.98±1.25
41-60	5.1±1.4	1.5±0.8	2.0±0.2	2.6±1.4	29.9±6.2	9.9±4.7	14.87±2.2	8.93±1.3
>60	5.5±1.5	1.6±1.4	1.9±0.3	2.9±1.5	28.8±5.2	12±6.3	15.58±2.19	8.73±1.54

TC- Total cholesterol, TG- Triglycerides, HDL- High Density Lipoprotein, LDL- Low Density Lipoprotein, BMI- Body Mass Index, GLU- Fasting Blood Glucose, BP (SYS)- Systolic Blood Pressure, BP (DIA)- Diastolic Blood Pressure

Table 2. Results of the female control subjects of various age groups

Age groups (years)	TC (mmol/L)	TG (mmol/L)	HDL (mmol/L)	LDL (mmol/L)	BMI (Kg/m^2)	GLU (mmol/L)	BP (SYS) (×10mmHg)	BP (DIA) (×10mmHg)
0-20	4.3 ±1.3	0.9 ±0.3	2.0 ±0.2	2.1 ±1.2	21.8±1.7	5.1±0.4	11.3±0.31	7.44±0.33
21-40	4.1±0.9	0.7±0.3	1.9±0.2	1.9±1.0	24.7±5.9	5.1±0.5	11.8±0.76	7.78±0.75
41-60	4.9±1.5	1.4±0.7	2.1±0.1	2.2±1.3	30.7±6.0	5.6±0.2	12.24±0.9	7.4±0.64
41-60	4.1±0.2	1.3±0.6	2.2±0.2	1.3±0.7	28±6.7	5.1±0.3	14.1±1.85	7.2±1.13

TC- Total cholesterol, TG- Triglycerides, HDL- High Density Lipoprotein, LDL- Low Density Lipoprotein, BMI- Body Mass Index, GLU- Fasting Blood Glucose, BP (SYS)- Systolic Blood Pressure, BP (DIA)- Diastolic Blood Pressure

Table 3. Results of male test subjects of various age groups

Age groups	TC (mmol/L)	TG (mmol/L)	HDL (mmol/L)	LDL (mmol/L)	BMI (Kg/m^2)	GLU (mmol/L)	BP (SYS) (×10mmHg)	BP (DIA) (×10mmHg)
0-20	4.3	2.0	2.4	1	15	28	13.5	9.3
21-40	4.0±0.83	1.2±0.38	2.1±0.16	1.3±0.78	21.2±3.12	17±6.5	13.4±9.24	9.4±8.51
41-60	4.4±1.17	1.3±0.64	2.1±0.16	1.8±1.29	25.7±3.18	10±6.1	15.4±2.52	9.11±1.38
>60	4.3±1.14	1.5±1.14	2.1±0.26	1.6±1.27	25.5±4.46	9.4±4.28	15.9±2.93	9.13±1.24

TC- Total cholesterol, TG- Triglycerides, HDL- High Density Lipoprotein, LDL- Low Density Lipoprotein, BMI- Body Mass Index, GLU- Fasting Blood Glucose, BP (SYS)- Systolic Blood Pressure, BP (DIA)- Diastolic Blood Pressure

Table 4. Results of male control subjects of various age groups

Age groups (yrs)	TC (mmol/L)	TG (mmol/L)	HDL (mmol/L)	LDL (mmol/L)	BMI (Kg/m^2)	GLU (mmol/L)	BP (SYS) (×10mmHg)	BP (DIA) (×10mmHg)
0-20	4.5±1.2	1.0±0.4	2.0±0.1	2.0±1.1	19.6±2.3	5.3±0.5	11.4±4.3	8.17±6.1
21-40	5.1±1.6	1.1±0.3	1.9±0.21	2.7±1.7	23.7±3.6	5.1±0.3	12.34±9.7	8.16±6.1
41-60	4.3±0.8	1.2±0.6	2.0±0.1	1.7±0.8	26.4±4.0	5.3±0.6	12.3±4.8	7.8±8.3
>60	4.4±1.6	0.8±0.4	2.2±0.4	1.9±1.5	21.2±1.5	5.2±0.4	12.98±0.4	8.65±3.9

TC- Total cholesterol, TG- Triglycerides, HDL- High Density Lipoprotein, LDL- Low Density Lipoprotein, BMI- Body Mass Index, GLU- Fasting Blood Glucose, BP (SYS)- Systolic Blood Pressure, BP (DIA)- Diastolic Blood Pressure

Table 5. Results of students't-test comparing parameters assayed among diabetics and control groups of male and female subjects

Test & control	TC (mmol/L)	TG (mmol/L)	HDL (mmol/L)	LDL (mmol/L)	BMI (Kg/m^2)	GLU (mmol/L)	BP (SYS) (×10mmHg)	BP (DIA) (×10mmHg)
FT vs FC	0.0046 (P<0.05)*	0.0006 (P<0.05)**	0.2689 (P>0.05)	0.024 (P<0.05)	0.017 (P<0.05)	6.3 (P>0.05)	1.24 (P>0.05)	8.83 (P>0.05)
MT vs MC	0.111 (P>0.05)	0.0046 (P<0.05)*	0.0435 (P<0.05)	0.039 (P<0.05)	0.0294 (P<0.05)	2 (P>0.05)	1.68 (P>0.05)	1.12 (P>0.05)
FT vs MT	0.005 (P<0.05)*	0.2305 (P>0.05)	0.1064 (P>0.05)	0.0032 (P<0.05)*	6.621 (P>0.05)	0.187 (P>0.05)	0.035 (P<0.05)	0.261 (P>0.05)
MC vs FC	0.115 (P>0.05)	0.282 (P>0.05)	0.477 (P>0.05)	0.158 (P>0.05)	0.062 (P>0.05)	0.32 (P>0.05)	0.22 (P>0.05)	0.004 (P<0.05)*

TC- Total cholesterol, TG- Triglycerides, HDL- High Density Lipoprotein, LDL- Low Density Lipoprotein, BMI- Body Mass Index, GLU- Fasting Blood Glucose, BP (SYS)- Systolic Blood Pressure, BP (DIA)- Diastolic Blood Pressure, FT- Female test subjects, MT- Male test subjects, MC- Male control subjects, FC- Female control subject

Table 6. Table showing the percentage number of diabetics sampled with raised values (above normal range) of parameters measured, according to gender

Gender	↑TCN(%)	↑TGN(%)	↑HDLN(%)	↑LDLN(%)	↑BMIN(%)	↑GLUN(%)	↑SYST BP N(%)	↑DIAS BP N(%)
Female (N=100)	27 (77.1%)	27 (57.5%)	100 (53.8%)	40 (76.9%)	40 (81.6%)	96 (56.1%)	77 (53.1%)	53 (48.3%)
Male (N=86	8 (22.9%)	20 (42.5%)	86 (46.2%)	12 (23.1%)	9 (18.4%)	75 (43.9%)	68 (46.9%)	57 (51.7%)
Total (N=186)	**35**	**47**	**186**	**52**	**49**	**171**	**145**	**110**

TC- Total cholesterol, TG- Triglycerides, HDL- High Density Lipoprotein, LDL- Low Density Lipoprotein, BMI- Body Mass Index, GLU- Fasting Blood Glucose, BP (SYS)- Systolic Blood Pressure, BP (DIA)- Diastolic Blood Pressure, ↑ - increased value, N number of subjects, % - percentage

This study also shows that diabetics are largely prone to metabolic syndrome as seen in Table 5 using the NCEP ATPIII definition. This affects both male and female gender. Nevertheless, a greater percentage of the female diabetic subjects sampled had hypertension compared to the male diabetics also greater percentage of the female diabetics were Obese with a BMI > 30Kg/m^2. This is similar to studies carried out by, Awosan [20], although their study was not among diabetics it revealed that males and females were prone to metabolic syndrome depending on the definition criteria used and the particular parameter considered.

4. CONCLUSION

The variation of gender in evaluating the serum lipid levels of diabetics is significant. This study unveils the possibility of the female diabetics being more prone to dyslipidemia than the male gender thus exposing the females to increased risk of coronary heart disease. Although, both males and females alike are exposed to metabolic syndrome, the female diabetic is especially prone to this syndrome. This may be due to the physiologic make-up of the female and their body changes during pregnancy. Nevertheless, this is largely owed to behavioural, cultural and religious practices.

CONSENT

As per international standard, patient's consent has been collected and preserved by the authors.

ETHICAL CLEARANCE

An ethical clearance was applied for and obtained from the ethical committee of the Plateau State Specialist Hospital.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Syed Yasir Hussain Gilani, Saima Bibi, Nazir Ahmed, Syed Raza Ali Shah. Gender differences of dyslipidemia in type 2 diabetics. *Journal of ayub medical college Abbottabad,* 2010 volume 22 page 3.
2. Berner A, Zirie M, Musallam M, Khader YS, Al-Hamaq AO. Prevalence of metabolic syndrome according to Adult Treatment Panel III and International Diabetes Federation criteria: a populationbased study. *Journal of Metabolic Syndrome and Related Disorders* 2009, 7(3): 221-229.
3. Grundy SM, Cleeman JI, Merz CN, Brewer HB Jr, Clark LT, Hunninghake DB. Implications of recent clinical trials for the National Cholesterol Education Program Adult Treatment Panel III guidelines. *Circulation,* 2004, 110(2):227–39.
4. Eckel, RH. Diabetic Dyslipidemia and Cardiovascular Risk. *Curr Diabetes Rep;* 2008, 8:421–3.
5. Goldberg IJ. Clinical review 124: Diabetic Dyslipidemia: Causes and Consequences. *Journal of Clinical Endocrinology and Metabolism;* 2001: 86:965–71.
6. IDF, World-wide definition of the metabolic syndrome. International Diabetes Federation 2013:. Available at: http://www.idf.org/metabolicsyndrome
7. Barrett-Connor E, Giardina EG, Gitt AK, Gudat U, Steinberg HO, Tshoepe D. Women and heart disease: the role of diabetes and hyperglycemia. *Archives of Internal Medicine*; 2004:164:934–42.
8. Retnakaran R, Cull CA, Thorne KI et al. Risk factors for renal dysfunction in type 2 diabetes. Diabetes 2006; 55: 1832–1839
9. Wang Z, Jiang T, Li J *et al*. Regulation of renal lipid metabolism, lipid accumulation, and glomerulosclerosis in FVBdb/db mice with type 2 diabetes. *JournalofDiabetes* 2005:54: 2328–2335
10. Lin J, Hu FB, Mantzoros C, Curhan GC. Lipid and inflammatory biomarkers and kidney function decline in type 2 diabetes. Diabetologia; 2010:53: 263–267
11. Halbesma N, Brantsma AH, Bakkar SJL. Gender differences in predictors of the decline of renal function in the general population. Kidney International; 2008:74: 505–512
12. Lin J, Hu FB, Rimm EB *et al.* The association of serum lipids and inflammatory biomarker with renal function in men with type II diabetes mellitus. *Kidney International*; (2006): 69: 336–342
13. Glenn D. Israel, determining sample sze. Program Evaluation and Organizational Development ($PEOD_6$) 2013:. http://edis.ifas.ufl.edu

14. Cochran, W. G. *Sampling Techniques*, 2nd Edition., New York; John Wiley and Sons, Inc 1963.
15. Eknoyan, Garabed. "AdolpheQuetelet (1796–1874)—the average man and indices of obesity". *Journal of Nephrology Dialysis Transplantation.* 2007:**23** (1): 47–51.
16. Yasir Syed Hussain Gilani, Saima Bibi, Nazir Ahmed, Syed Raza Ali Shah. Gender differences of dyslipidemia in type 2 diabetics. J Ayub Med Coll Abbottabad 2010;22 (3).
17. Buse JB, Tan MH, Prince MJ, Erickson PP. The effects of oral anti-hyperglycaemic medications on serum lipid profiles in patients with type 2 diabetes. Diabetes Obesity and Metabolism .*Journal of Pharmacology and therapeutics.* 2004 :6(2):133-56.
18. Khan SR, Ayub N, Nawab S, Shamsi TS. Triglyceride profile in dyslipidaemia of type 2 diabetes mellitus. J CollPhysicians Surg Pak; 2008:18:270–3.
19. Awosan, K.J., Ibrahim, M.T.O., Arisegi, S.A., Ejimadu, S.P., Erhiano, E.E., Aderahman, A.T. Prevalence of metabolic syndrome and its components among civil servants in a metropolitan city in Northern Nigeria. *Global Advanced Research Journal of Medicine and Medical Sciences.* 2013:Vol. 2(11) 238-246.