Sokoto Journal of Medical Laboratory Science 2021; 6(4): 82 - 93

SJMLS - 6(4) - 010

Assessment of Cardiometabolic Risk Factors Among Type 2 Diabetes Mellitus Patients in Minna, North-Central Nigeria

Kester Awharentomah Digban[1], Eguagie Osareniro Osakue[2], Esther Ngozi Adejumo[2], Ayodele Adelakun[2], Oluwakemi Anike Ladipo[2] Comfort Bosede Enitan [3] and Seyi Samson Enitan [2]

Department of Medical Laboratory Science, Novena University, Ogume, Delta State, Nigeria [1], Department of Medical Laboratory Science, Babcock University, Ilishan-Remo, Nigeria [2], Department of Medical Laboratory Science, University College Hospital, Ibadan, Nigeria [3].

Author for Correspondence*: Seyi Samson Enitan, Department of Medical Laboratory Science, Babcock University, Ilishan-Remo, Nigeria /+234-806-548-3761/enitans@babcock.edu.ng/ ORCID Number: 0000-0001-5993-7920/ https://dx.doi.org/10.4314/sokjmls.v6i4.10

Abstract

Type 2 diabetes mellitus (T2DM) is a chronic metabolic disorder with economic and global health concern. The aim of this study was to assess the cardiometabolic risk factors in Type 2 diabetes mellitus patients attending General Hospital Minna, North Central, Nigeria. We recruited total of 135 subjects being 80 (57 females, 23 males) T2DM patients and 55 (38 females, 17 males) non-diabetic individuals who served as controls. A semi-structured questionnaire was used to collect socio-demographic data. Anthropometric measurements were also taken as appropriate. Blood samples were collected from subjects after 10 hours of fasting to investigate biochemical parameters for cardiometabolic risk in the test subjects and controls. Results show that T2DM patients had higher values of total cholesterol, waist circumference, SBP, DBP, TG and HDL compared to the non-diabetic controls. It was observed that 35.5% of the total population (both experimental and control subjects) were prone to cardiometabolic risk factors with 60% being T2DM patients and majority being females. A significant 48.8% of T2DM patients had well managed glycaemic levels, while 51.2% had a poorly managed glycaemic level. Findings also showed that 57.5% of T2DM patients were dyslipidaemic, 70% had abdominal obesity, while 40% had systolic hypertension. The SBP, FBS, TC, VLDL, TG and TG:HDL ratio of T2DM patients was significantly higher than controls ($p< 0.001$) while the differences in WC, DBP, LDL and HDL between T2DM and controls were not statistically significant ($p> 0.05$). On account of management among the T2DM patients, the FBS, TG and HDL values between the well managed and poorly managed patients were statistically significant ($p< 0.001$), while the WC, BP, HbA1c and HDL values were not significant ($p< 0.05$). The CMR pattern among well managed, poorly managed T2DM and controls show that the well managed had abdominal obesity with high TG:HDL ratio, while the poorly managed had systolic hypertension. Correlation of all variables with glycaemic levels show positive and highly significant in poorly managed T2DM patients. This study demonstrated that patients with type 2 DM have a higher risk for developing cardiovascular disease than non- diabetic subjects.

Key Words: *Cardiometabolic Risk Factors, Type 2 Diabetes Mellitus, Minna, North Central, Nigeria*

Introduction

Type 2 *Diabetes mellitus* (T2DM), a chronic and progressive disease characterized by elevated levels of blood glucose (WHO, 2016), remains an expanding health and economic burden to man globally, with its epidemiology closely associated with obesity. Its prevalence is on the increase and it is closely associated with a sedentary lifestyle and obesity. Several studies have been carried out in an attempt to improve its care and possibly reduce the global burden. Associated complications may involve the cardiovascular system, with a propensity towards early mortality (WHO, 2016).

The number of people with T2DM has nearly quadrupled since 1980 and the prevalence is increasing worldwide, particularly in low- and middle-income countries (WHO, 2018). Type 2 diabetes results from the interaction between a genetic predisposition and behavioural and environmental risk factors. Although the genetic basis of T2DM is yet to be fully elucidated, there

is strong evidence that such modifiable risk factors as obesity and physical inactivity are the main non-genetic determinants of the disease (Hamman, 1992).

The causes are complex, but the rise is due in part to increase in the number of people who are overweight, including an increase in obesity, and in a widespread lack of physical activity (WHO, 2018). Some further reports allege that non-communicable diseases have overtaken communicable diseases as the leading causes of morbidity and mortality in Nigeria (Ajimobi, 2017), and among the factors identified are changes in diet, cigarette smoking, alcohol consumption, and inadequate exercise.

It has been reported that T2DM has become one of the major causes of terminal diseases and premature death, mainly through the increased risk of cardiovascular diseases (CVD), and that hyperglycaemia and related changes in blood lipids (increase in triglycerides and decrease in the 'good' cholesterol HDL-c) increase a person's risk of CVD (IDF, 2006). This results from the presence of insulin resistance and atherogenic dyslipidaemia, which is characterized by reduced concentration of high-density lipoprotein (HDL)-cholesterol and elevated triglyceride levels (Anuradha *et al.*, 2012; Despres and Lemieux, 2006). Cardiovascular complications have become the predominant cause of death in diabetes mellitus patients whose risk of morbidity and mortality due to cardiovascular disease is markedly increased compared with the general population (Bachmann and Wang, 2017). Consequently, the assessment of cardiometabolic risk factors is the first and crucial step to the aim for reduction of cardiovascular risk (Kamenova, 2008). Cardiometabolic risk is the combined vascular and metabolic components of risk that may lead to a cardiovascular disease, diabetes, obesity or any combination of these (Després, 2006).

Cardiometabolic risk is diagnosed by the identification of an enhanced waist circumference (above 94cm in males and 80cm in females) accompanied by the alterations in lipid profile (HDL cholesterol below 40mg/dl in males and 50mg/dl in females, and serum triglycerides above 150mg/dl), blood pressure (BP) values above 130/85mmHg, and a fasting glucose above 100mg/dl (Alberti *et al*., 2006; Grundy *et al.,* 2005).

The prevalence of risk factors for cardiovascular disease is notably on the increase in developing nations (Oguoma *et al*., 2015). Obesity due to sedentary lifestyle and unhealthy diet, hypertension, hypertriglyceridaemia and low HDL (Oguoma *et al*., 2015) were identified risk factors among the Nigerian population. Based on the 2013 Global Burden of Disease study (Casapulla *et al*., 2017), about 90.5% of stroke burden was attributable to lifestyle-related risk factors, cluster of metabolic risk factors (high blood pressure, impaired fasting glucose, elevated total cholesterol and low glomerular infiltration) and environmental factors. Lifestyle-related risk factors and metabolic risk factors contributed to 74.2% and 72.4% stoke burden, respectively and the population attributed fraction of risk factors in low-middle-income countries increased from 1990 to 2013. Such alarming observations therefore call for periodic screening, monitoring and appraisal of data on risk factors for metabolic diseases (Chinenye *et al*., 2014). When patients have one or more risk factors and are physically inactive or smoke, the cardiometabolic risk is increased even more. In addition, when these risk factors occur in clusters, they can greatly increase the risk of CVD.

The assessment of occurrence of risk factors for cardiovascular disease has been largely studied in diabetic patients. (Formiga *et al.*, 2013; Balogun and Salako, 2011; Selby *et al.*, 2004), yet there is indication that more research is needed in different populations to further determine prevalence and more evidence-based interventions and management of T2DM. Reducing the cardiometabolic risk in T2DM patients has been shown to improve the length and quality of their life (Galaviz *et al.,* 2015). The aim of intervention in patients with cardiometabolic risk is to achieve an optimal reduction of such risk. Therefore, this study seeks to identify and assess cardiometabolic risk variables in subjects with type 2 diabetes mellitus and their contribution in predicting risk of developing cardiovascular diseases in such individuals, as this will allow better-targeted therapies for the prevention and treatment of cardiovascular disease in people with T2DM.

The elevated cardiovascular risk in individuals with T2DM is now an important public health concern given the high diabetes prevalence. However, cardiometabolic risk screening among type 2 diabetes mellitus patients in Nigeria is inadequate, even though evidence shows that there is increasing disease burden (Oguoma *et al.,* 2017; Onwuchekwa *et al*, 2009). This has, in no small measure contributed to the reduced life expectancy and quality of life of Nigerians especially those living with type 2 diabetes mellitus (Fasanmade and Dagogo-Jack, 2007). Identifying CMR variables will allow better-targeted therapies for the prevention and treatment of cardiovascular disease in people with T2DM, and also add to body of knowledge. This study assessed the cardiometabolic risk variables and their association with type 2 Diabetes mellitus (T2DM) in Niger state.

Materials and Methods

Study design

The research design used for the study was case control study design which is also descriptive.

Study area

The research was carried out at the General Hospital Minna, Niger state. Niger state is in North- central Nigeria, and has a population of 3,950,249 (Nigeria Data Portal, 2006). It is located on latitude 3.201' East and longitude 8 and 11.31' North, and covers an area of 76.363km^2. General Hospital, Minna is the major secondary healthcare institution in Minna municipality area of Niger state, located along Hospital road and Keteren Gwari, at a central area known as Mobil. It is bounded to the east, north and west by Nigeria Railway Corporation, by an area called Kwangila and by Keteren Gwari, respectively. Founded in 1962, the hospital serves as a referral centre to most private health care facilities in Niger state. The study was carried out in particular at the Diabetic Clinic of the Medical Outpatient Department of the hospital.

Sample size

A minimum of 120 samples were drawn from both diabetic and control subjects for this study. The sample size was determined using the formula:

$n = \frac{z^2pq}{d^2}$ - (Leslie Fisher's formula; Kirkwood and Robert, 2010)

Where, z = 1.96, (level of significance of 5% (1.96)

p= national prevalence

note: p + q =1

q = 1- p,

d = 5% = 0.05

Using prevalence of 8.5 % (Ogbera *et al*., 2014)

p= 8.5/100 = 0.085

1 – 0.085 = 0.915

$$\frac{1.96^2 \times 0.085 \times 0.915}{0.05^2} = 119.52$$

≈ 120 samples

Study population

All known type 2 diabetes patients attending the General Hospital, Minna, and age-matched apparently healthy control subjects were included in the study. Random sampling method was used.

Inclusion and Exclusion criteria

All type 2 diabetic patients within the age bracket 25 – 70 years and with no sign of complications were included in the study. Those who fell outside the age bracket or those with signs of cardiovascular complications were excluded. Patients who refused to grant a written informed consent to participate were also excluded from the study.

Ethical considerations

Ethical approval was obtained from the Research and Ethical Committee of the General Hospital, Minna.

Instrument validation and reliability

A structured questionnaire was administered to each participant to obtain biodata as well as sociodemographic and medical information. The instrument was tested and found to be capable of yielding similar results when subjected to similar conditions at different times, and therefore was confirmed reliable. Confidentiality was also ensured during the administering of the assessment material (Questionnaires). Participants were identified by numbers and initials of their names, and their documents were not provided to any third party without written or oral permission from the participants. Only members of the investigating team and

authorized individuals under the law (Clinician and Ethics Review Board members) had access to study participants' identities and documents.

Anthropometric measurements
Waist circumference was measured at the midpoint between the lower margin of the least palpable rib and the top of the iliac crest, using a stretch-resistant tape, and the subject standing with feet close together, arms at the side and body weight evenly distributed. The measurements were taken at the end of a normal expiration with the subject relaxed.

Blood pressure measurements
Systolic blood pressure (SBP) and Diastolic blood pressure (DBP) were measured by trained nurses using a manual sphygmomanometer (Welch Allyn DS66, Skaneateles Falls, New York) with an appropriate cuff size. Subjects were seated with their backs and feet supported for at least 5 minutes before blood pressure was measured. The appearance of the first sound was used to define systolic blood pressure, and the disappearance of sound used to define diastolic blood pressure. Measurements were repeated two additional times, with a 1-2 minutes interval between each reading, and then the average of the measurements was used for data analysis.

Specimen collection
After a period of 10 – 12 hours overnight fast by the subjects, blood samples were aseptically drawn from a palpable vein using a sterile syringe and needle with minimal stasis, and about 5 milliliters (ml) of blood was collected and 2 ml of this was dispensed into a fluoride oxalate bottle, well mixed and properly labeled for fasting blood glucose and glycated haemoglobin levels. The remainder of the blood was dispensed into a plain bottle, retracted and centrifuged to harvest the serum for lipid profile.

Laboratory analysis
Fasting Blood Glucose, HDL-cholesterol, Total cholesterol and Triglyceride were measured using the enzymatic colorimetric method and read spectrophotometrically with the aid of VS 10 clinical chemistry semi-auto analyzer (Vitro Scient, Cairo, Egypt), while following manufacturers' instructions. The LDL and VLDL cholesterols were calculated using the "Friedewald's" formula.

Statistical analysis
Data obtained in this study were subjected to quantitative analysis using the descriptive and inferential statistics with SPSS version 18.0. Descriptive statistics for continuous variables were presented as mean ± standard error of mean (SEM) or standard deviation (S.D), where indicated. Student's test was used for statistical comparisons between groups. Pearson's correlations were looked into to measure the associations between FBS, HbA1C and other variables.

Results
This study assessed the cardiometabolic risk factors in type 2 *Diabetes mellitus* patients. A total of 135 subjects participated, out of which 80 (57 females, 23 males) were type 2 diabetic patients and 55 (38 females, 17 males) were non-diabetic control. A higher prevalence of increased total cholesterol, waist circumference values, SBP, DBP, TG, HDL were observed in T2DM subjects compared to non-diabetic control (52% vs 11%; 70% vs 60%; 40% vs 18%; 49% vs 27%; 91% vs 54%; 67% vs 36% respectively). A total of 48 T2DM patients (35.5% of total population; 60% of all T2DM) had at least two cardiometabolic risk factors while 13 non-diabetic control subjects (23.6% of total population; 9.6% of control) had same. There were more females than males in each case, 39 out of 48 T2DM (81.3%) and 10 out of 13(76.9%) control subjects. Out of the 80 T2DM, 39(48.8%) had well managed glycemic levels while 41 (51.2%) had poorly managed glycemic levels. A total of 46 (57.5%) T2DM patients had dyslipidaemia, 56 (70%) had abdominal obesity and 32 (40%) had systolic hypertension.

Table 1 shows some clinical and biochemical characteristics of T2DM subjects and controls. The mean blood pressure of T2DM was 132.1 ± 2.2 mmHg systolic and 83.4 ± 1.3 mmHg diastolic. The SBP was significantly higher than that of the control (124.5 ± 1.6 mmHg; $p<0.001$) while DBP was higher but not significantly than that of the control (80.6 ± 1.1; $p>0.05$). There were significant differences ($p< 0.001$) between FBS (7.9 ± 0.4 vs 5.2± 0.1 mmol/l), TC (6.20 ± 0.16 vs 5.03 ± 0.16 mmol/l), VLDL (1.42 ± 0.07 vs 0.87 ± 0.05 mmol/l), TG (2.92 ± 0.16 vs 1.87 ± 0.09 mmol/l) and TG: HDL (2.99 ± 0.22 vs 1.49 ± 0.09) of the T2DM subjects and controls respectively, but no significant difference was observed between WC (91.2±1.2 vs 88.2

±1.3cm), HDL (1.14±0.07 vs 1.34 ± 0.04 mmol/l), LDL (3.65 ± 0.16 vs 2.84±0.18 mmol/l) at p>0.05.

Table 2 shows the comparison between clinical and biochemical parameters of well managed and poorly managed T2DM patients. There was significant decrease (p<0.001) in the FBS levels of well managed T2DM (5.28 ± 0.15 mmol/l) when compared to those of the poorly managed (10.56 ± 0.48 mmol/l). Also, TG:HDL ratio of poorly managed T2DM was significantly higher than that of the well managed T2DM (3.47 ± 0.36 vs 2.48 ± 0.22; p<0.001). There were no significant differences in the duration of DM, WC, BP, lipids and HbA1c levels although these were higher in the poorly managed T2DM. HDL cholesterol was higher in the well managed than in the poorly managed (1.25±0.13vs 1.02 ±0.04mmol/l; p>0.05), but this difference was not statistically significant.

Table 3 shows the CMR pattern in T2DM subjects and controls. Among the three groups of well managed T2DM, poorly managed T2DM and control, 18 (46.2%), 28 (68.3%) and 7(12.7%) respectively had high TG:HDL ratio, 28(71.8%), 28(68.3%) and 33(60%) respectively had abdominal obesity, while 13 (33.3%), 19(46.3%) and 10 (18.2%) respectively had systolic hypertension.

Correlations between other variables and glycaemic indices of cardiometabolic T2DM patients are shown in Table 4. There were positive and significant (p<0.05) correlations between FBS vs HbA1C (r= 0.926), Duration of DM vs TG: HDL (r=0.286) and WC vs SBP (r=0.313) respectively. There were also positive correlations between FBS and WC, TG: HDL, SBP, Age and Duration of DM (r= 0.249, 0.206, 0.092, 0.069,0.127; p> 0.05) and between WC and TG: HDL ®= 0.128).

Table 5 is a correlation analysis of FBS and HbA1C with CMR variables in poorly managed cardiometabolic T2DM patients. FBS correlated significantly with WC (r=0.410; p< 0.05), and positively but not significantly with HbA1C (r= 0.030; p>0.05). TG: HDL and SBP were positively correlated with HbA1C (r=0.254, 0.109; p>0.05), SBP correlated significantly with TG: HDL (r= 0.498; p<0.05).

Table 1: Some Biochemical and clinical characteristics of T2DM and Controls

	T2DM Patients		Control Subjects			
Variables	**N**	**Mean ± S.E.M**	**N**	**Mean ± S.E.M**	**t-value**	**p-value**
SBP (mmHg)	80	132.13±2.23	55	124.55±1.62	3.03	P<0.001
DBP (mmHg)	80	83.38±1.31	55	80.64±1.06	1.51	P>0.05
WC (cm)	80	91.15±1.15	55	88.18±1.28	1.69	P>0.05
FBS (mmol/l)	80	7.99±0.39	55	5.19±0.13	5.74	P<0.001
TC (mmol/l)	80	6.20±0.16	55	5.03±0.16	4.91	P<0.001
HDL (mmol/l)	80	1.14±0.07	55	1.34±0.04	1.66	P>0.05
LDL (mmol/l)	80	3.65±0.16	55	2.84±0.18	1.26	P>0.05
VLDL (mmol/l)	80	1.42±0.07	55	0.87±005	5.7	P<0.001
TG (mmol/l)	80	2.92±0.16	55	1.87±0.09	4.95	P<0.001
TG: HDL	80	2.99±0.22	55	1.49±0.09	5.39	P<0.001
HBA1C (%)	10	6.84±0.43	NA	NA		

N= number of subjects, T2DM= Type 2 Diabetes mellitus, S.E.M= Standard error of mean, NA= Not applicable, SBP and DBP= Systolic and Diastolic blood pressures, WC= Waist circumference, FBS= fasting blood sugar, TC=total cholesterol, HDL= High density lipoprotein, LDL and VLDL= low and very low-density lipoproteins, TG= Triglycerides, TG:HDL ratio= Triglyceride: Ratio, HBA1C= Glycated haemoglobin.

Table 2: Clinical and Biochemical parameters (Mean ± S.E.M) of Well-managed vs Poorly managed T2DM

	Well Managed T2DM (N= 39) Mean± S.E.M	Poorly Managed T2DM (N = 41) Mean± S.E.M	t-value	p-value
Age (yrs)	53.31 ± 1.485	53.98±1.433		
SBP (mmHg)	130.51±2.772	133.6± 3.4	0.684	p>0.05
DBP (mmHg)	81.79±1.79	84.88±1.89	1.17	p>0.05
Duration of DM (yrs)	5.33±0.60	5.76± 0.50	0.53	p>0.05
WC (cm)	89.3±1.34	92.83±1.82	1.49	p>0.05
FBS (mmol/l)	5.28±0.15	10.56±0.481	0.13	p<0.001
TC (mmol/l)	6.29±0.25	6.13±0.21	0.48	p>0.05
HDL (mmol/l)	1.25±0.13	1.02 ± 0.04	1.68	p>0.05
LDL (mmol/l)	3.72±0.25	3.58± 0.21	0.41	p>0.05
VLDL (mmol/l)	1.32±0.09	1.52±0.10	1.42	p>0.05
TG (mmol/l)	2.71±0.21	3.13± 0.25	1.29	p>0.05
TG:HDL ratio	2.48±0.22	3.47±0.36	2.29	p<0.001
HBA1C (%)	35.90±0.25	77.24±0.55	1.41	p>0.05

N= Number of subjects, T2DM= Type 2 Diabetes mellitus, S.E.M= Standard error of mean, SBP and DBP= Systolic and Diastolic blood pressures, WC= Waist circumference, FBS= fasting blood sugar, TC=total cholesterol, HDL= High density lipoprotein, LDL and VLDL= low and very low-density lipoproteins, TG= Triglycerides, TG:HDL ratio= Triglyceride:HDL ratio, HBA1C= Glycated haemoglobin.

Table 3: Pattern of CMR in T2DM patients and controls

CMR variables	Managed T2DM N=39			Poorly Managed T2D N=41			Control N=55		
	M	F	%	M	F	%	M	F	%
TG: HDL	6	12	46.2	5	23	68.3	2	5	12.7
↑WC (cm)	8	20	71.8	1	27	68.3	5	28	60
↑ SBP(mmHg)	2	11	33.3	4	15	46.3	5	5	18.2
↑ FBS (mmol/l)			NA	8	33	100			NA
HbA1c (%)			NA	2	5	100			NA

N= number of subjects, ↑ = Increase in value above normal for subjects, NA= Not applicable.

Table 4: Pearson's Correlation of Glycaemic indices and CMR variables in T2DM patients.

Variables	N	r-value	t-value	p-value	Remark
FBS vs WC	48	0.249	0.089	p>0.05	NS
FBS vs TG: HDL	48	0.206	0.160	p>0.05	NS
FBS vs HbA1c	5	0.926	0.024	p<0.05	S
FBS vs SBP	48	0.092	0.533	p>0.05	NS
FBS vs Age	48	0.069	0.642	p>0.05	NS
FBS vs Duration DM	48	0.127	0.389	p>0.05	NS
Duration vs TG: HDL	48	0.286	0.049	p<0.05	S
WC vs SBP	48	0.313	0.030	p<0.05	S
WC vs TG: HDL	48	0.128	0.388	p>0.05	NS

N= number of subjects, S= significant, NS=non-significant

Table 5: Correlation Analysis of FBS, HbA1c and CMR variables in poorly managed cardiometabolic T2DM patients

Variables	N	r-value	t-value	p-value	Remark
FBS vs WC	28	0.410	0.030	p<0.05	S
FBS vs TG: HDL	28	-0.305	0.114	p>0.05	NS
FBS vs HbA1c	7	0.030	0.950	p>0.05	NS
FBS vs SBP	19	-0.027	0.912	p>0.05	NS
HbA1c vs WC	7	-0.626	0.133	p>0.05	NS
HbA1c vs TG: HDL	7	0.254	0.582	p>0.05	NS
HbA1c vs SBP	7	0.109	0.817	p>0.05	NS
SBP vs TG: HDL	19	0.498	0.030	p<0.05	S

Discussion

The results obtained in the present study showed that the percentage prevalence of cardiometabolic risk factors were significantly higher in T2DM patients than in control subjects. This agrees with the results of previous studies similarly carried out in different environments on T2DM subjects (Gregory 2017; Formiga *et al.,* 2013 Balogun and Salako, 2011). The findings from this present study are consistent with previous report by Garry (2007). Even though there were a few variations in the values of percentage prevalence reported by the author, the values were still higher in T2DM patients than in control subjects.

A higher prevalence of cardiometabolic risk factor was found in female participants (36.3%) when compared to the males (8.9%) in the present study. This finding is similar to other reports of higher prevalence in females than males (Gómez-Ambrosi *et al*., 2014; Hatunic *et al.,* 2005). There was a high prevalence (70%) of obesity among T2DM patients in the present study. This is similar to a prevalence of 69.2% reported by Hillier and Pedula (2003) in Asia. Previous reports (Jaffiol, 2011; Huxley *et al*., 2010; Johnson *et al.,* 2009) indicated a higher prevalence of obesity in T2DM patients using the using the waist circumference cut off values recommended by IDF ($\geq$ 80cm for females; $\geq$ 94cm for males from Europe and Africa). However, Kaptoge, (2011) reported a prevalence of 75% which is higher than that obtained in the present study. The association between abdominal obesity and elevated cardiometabolic risk has been suggested to be in part related to the direct release of free fatty acids (FFA) into the portal vein (Bachmann and Wang, 2017). The

importance of abdominal obesity, as a modifiable root cause of a cluster of metabolic abnormalities increasing the risk of CVD, is also emphasized in published guidelines (Mbanya *et al.,* 2015). The health threat posed by abdominal obesity, as measured by high waist circumference, is largely due to an excess of intra-abdominal adiposity or visceral fat, which is also a risk factor for Type 2 diabetes and CVD.

A causal connection has been suggested between abdominal obesity and the presence of the majority of previously established cardiometabolic risk factors (Mbanya *et al.,* 2015). This report corresponds with the present finding that abdominal obesity measured by the waist circumference correlated positively and significantly with the glycaemic level of the poorly managed T2DM, and with the systolic blood pressure of all T2DM patients.

The high prevalence of hypertension (50%) observed in the present study is by far lower than the 80% reported by Sawar *et al*. (2010) in two separate studies on T2DM, and 78% reported by Olarewaju (2017). However, the hypertensive rates among T2DM were higher than rates reported for the control subjects in several studies (WHO, 2012). This further confirms that hypertension and obesity increase the risk of cardiovascular complications of T2DM (Zimmet *et al*., 2016).

The incidence of many outcomes of T2DM complications such as cardiovascular disease, is directly associated with the degree of hyperglycaemia as measured by the plasma glucose or the HbA1c level, a measure of the mean blood glucose level during the previous 2 to 3 months. A prevalence of 30% high HbA1c values (>7.0%) was seen among T2DM, and is an indication of poorly managed diabetes in the present study. An increase of 1% in the HbA1c level has been associated with an increase of 18% in the risk of a cardiovascular event (Wendland *et al*., 2012), and an increase of 12-14 % in the risk of death (Yau *et al*., 2018). Therefore, well controlled glycaemic levels targeting FBS $\leq$ 7.2 mmol/l and HbA1c $\leq$ 7.0% is expected to reduce cardiometabolic risk. This was confirmed in a study by Seidell (2010) in which a reduction of cardiovascular causes of death was observed in T2DM from 2.6% to 1.8%, and rate of non-fatal myocardial infarction from 4.6% to 3.6%. Findings from the present study agrees with the report because when the prevalence of cardiometabolic risk factors in well managed T2DM were compared with those in poorly managed T2DM, they were lower (HbA1c: 30% vs 70%; TG:HDL: 46.2% vs 68.3%; SBP: 33.3% vs 46.3%). There are evidences that good management of glycaemic levels, and control of other risk factors such as hypertension and dyslipidaemia in T2DM patients play a major role in reduction of cardiometabolic risk (Umuerri and Obasohan, 2013). They also reported that intensive glycaemic control alone does not have a major impact in reducing cardiovascular disease in patients with T2DM, because dyslipidaemia (↑ TG, ↓ HDL, ↑ LDL) may persist even with good glycaemic control. This corresponds with the findings of the present study in which the TG:HDL ratio of well managed T2DM was still higher than those of the control subjects (46.2% vs 12.7%) although they were lower than those of the poorly managed (68.3%). But worthy of note is the finding that poor glycemic control increases TG levels and decreases HDL cholesterol levels that is ↑ TG: HDL in diabetes. Other lipids such as VLDL IDL, small dense LDL are also increased in poorly managed T2DM (Umuerri and Obasohan, 2013).

The high prevalence of low HDL cholesterol (67%) observed in T2DM patients further confirms the works done by previous researchers (Ambady *et al*., 2007; Despres and Lemieux, 2006) that HDL cholesterol reduces in T2DM patients. Studies have demonstrated the association between high waist circumference and an increased probability of finding metabolic abnormalities, including elevated blood pressure, dysglycaemia and low HDL-cholesterol, in addition to hypertriglyceridaemia in T2DM (Vazquez, *et al., 20*07).

Findings on high prevalence of TG among T2DM patients is similar to those from previous clinical studies by Ren *et al.* (2016) and Vazquez *et al.* (2007) in which they found increased plasma triglyceride levels were associated with T2DM,

which contributed to cardiovascular diseases. The most common dyslipidaemia in individuals with T2DM is increased triglyceride (TG) levels. A prevalence of 91% obtained in the present study confirms this fact when compared with those of other lipids in this study, though it is higher than those reported (77.5%) in previous studies (Vazquez *et al*., 2007). Although the dyslipidaemias in T2DM, particularly hypertriglyceridaemia, are exacerbated by poor glycaemic control, lipid abnormalities cannot be explained merely by hyperglycaemia (Oputa and Chinenye, 2015). Various researches have shown that individuals with impaired glucose regulation and recent-onset T2DM share a similar high prevalence of dyslipidemias with individuals with long-standing diabetes. Lipoprotein lipase (LPL) plays a central role in TG metabolism, and if defective, could predispose to hypertriglyceridemia (Ren *et al*., 2016).

The positive and significant correlation of the duration of T2DM with TG:HDL ratio ($r= 0.286$; $p<0.05$) and with glycaemic level ($r= 0.127$; $p>0.05$) agree with previous findings by Steinarsson *et al*. (2018) who reported that individuals who develop type 2 diabetes at a younger age are more frequently obese, display a more adverse lipid profile, have higher HbA1c and a faster deterioration in glycaemic control compared with individuals who develop diabetes later in life.

Studies have shown that improvements in glycaemic control can markedly lower serum triglyceride levels and may increase serum HDL levels. The present study further confirms this fact from the lower TG prevalence value seen in the well managed T2DM than in poorly managed T2DM (38.7% vs 43.7 %), respectively.

Conclusion

This study has demonstrated that patients with type 2 DM have a higher risk for developing cardiovascular disease than non- diabetic subjects. Hypertriglyceridaemia and reduced HDL-cholesterol (as used for the TG: HDL ratio), abdominal obesity and systolic hypertension have been identified as the major cardiometabolic risk factors in patients with T2DM in Minna. Also, there was a significant reduction in the overall cardiometabolic risk factors in well managed T2DM than in the poorly managed ones. FBS was associated with HbA1c, and with WC in type 2 DM, while duration of T2DM was associated with high TG: HDL ratios.

Limitations of the study

Insulin resistance and C-reactive protein were not estimated in this study in order to reduce costs; however, these would not have affected the outcome of the study objectives.

Recommendations

We recommend that further research on the subject matter using a larger sample size, and also the inclusion of analysis of insulin resistance and C-Reactive proteins in the study to determine it effects in T2DM patients as cardiometabolic risk factors.

Acknowledgments

The cooperation of the Nurses at the Primary Healthcare Centre in data and sample collection is appreciated.

Disclosure of conflict of interest

All authors declare no form of conflict of interest in this study.

Funding

This research work was self-sponsored. No funding was received from any funding agency.

Authors' contributions

This work was carried out in collaboration among all authors. Authors KAD designed the study, wrote the protocol and the first draft of the manuscript. Authors EOO and ENA managed the analyses of the study. Authors AA, OAL, CBE and SSE managed the literature searches. Authors EOO and AA performed the statistical analysis. All authors read and approved the final manuscript.

References

Ajimobi, K. (2017). Hypertension Prevalence in Nigeria is about 30 - 45%. Business Day. *https://businessday.ng/health/article/hypertension-prevalence-nigeria-30-45-experts/*

Alberti, G., Zimmet, P. and Shaw, J. (2006). Type 2 diabetes in the young: the evolving epidemic. The International Diabetes Federation Consensus Workshop. *Diabetes Care;* **27**: 1798–1811.

Ambady, R., Chamukuttan, S., Annasami, Y., Narayanasam, M. and Venkat N. (2007). Insulin Resistance and Clustering of Cardiometabolic Risk Factors in Urban Teenagers in Southern India. *Diabetes Care;* **30:**1828–1833.

Anuradha, R., Hemaachandran, S. and RumaDutta. (2012). Waist circumference measurement: A simple method for assessing the abdominal obesity. *Journal of Clinical and Diagnostic Research;* **6(9)**: 1510- 1513.

Bachmann, K.N. and Wang, T.J. (2017). Biomarkers of cardiovascular disease: contributions to risk prediction in individuals with diabetes. *Diabetologia;* **61**:987–995**.**

Balogun, W.O. and Salako, B.L. (2011). Co-occurrence of Diabetes and Hypertension: Pattern and Factors Associated with order of Diagnosis among Nigerians. *Ann of Postgraduate Medicine*; **9**(2):89–93.

Casapulla, S.L., Cheryl, A.H., Gabriela, R.M., Darlene, B., Mario, J.G., Edgar, W.R., Masato, N. and Jay, H.S. (2017). Cardiometabolic risk factors, metabolic syndrome and pre-diabetes in adolescents in the Sierra region of Ecuador. *Diabetologia Metabolic Syndrome*; **9**:24.

Chinenye, S., Oputa, R.N. and Oko-Jaja, R. I. (2014). Diabetes and related diseases in Nigeria: Need for improved primary care in rural communities. *Research Journal of Health Science;* **2(2)**: 99-107.

Després, J. (2006). Abdominal obesity: the most prevalent cause of the metabolic syndrome and related cardiometabolic risk. *European Heart Journal Supplements*, **8(B)**: B4–B12, https://doi.org/10.1093/eurheartj/sul002.

Despres, J.P. and Lemieux, I. (2006). Abdominal obesity and metabolic syndrome. *Nature*; **444**:881–887.

Fasanmade, O.A. and Dagogo-Jack, S. (2007). Diabetes Care in Nigeria. *Ann Global Health*; **81**(6):821–829.

Formiga, F., Ferrer, A., Sanz, H., Marengoni, A., Alburquerque, J., Pujol, R. (2013). Octabaix study: Patterns of comorbidity and multimorbidity in the oldest old: the Octabaix study. *European Journal of Internal Medicine*; **24**(1):40–44.

Galaviz, K.I., Narayan, K.M.V., Lobelo, F. and Weber, M.B. (2015). Lifestyle and the Prevention of Type 2 Diabetes: A Status Report. *American Journal of Lifestyle Medicine;* **12**(1): 4-20.

Garry, X.S. (2007). Lipid Disorders in diabetes mellitus and current. management *Current Pharmaceutical Analysis;* **3**: 17-24.

Gómez-Ambrosi, J. Catalán, V., Rodríguez, A., Andrada, P., Ramírez, B., Ibáñez, P., Vila, N., Romero, S., Margall, M. A., Gil, M. J., Moncada, R., Valentí, V., Silva, C., Salvador, J. **and** Frühbeck, G. (2014). Increased cardiometabolic risk factors and inflammation in adipose tissue in obese subjects classified as metabolically health. *Diabetes Care*; **37**: 2813- 2821.

Gregory, R. (2017) CVD causes One-third of deaths worldwide: Study examines global burden of CVD from 1990 to 2015. Accessed online.

Grundy, S.M., Cleeman, J.I. and Daniels, S.R. (2005). Diagnosis and management of the metabolic syndrome: An American Heart Association/National Heart, Lung, and Blood Institute Scientific Statement. *Circulation*; **112**: 2735–2752.

Hamman, R.F. (1992) Genetic and environmental determinants of non-insulin-dependent diabetes mellitus (NIDDM). *Diabetes Metabolism Review*; **8:** 287-338.

Hatunic, M., Burns, N. and Finucane, F. (2005). Contrasting clinical and cardiovascular risk status between early and later onset type 2 diabetes. *Diabetes Vascular Diseases Research*; **2**: 73-75.

Hillier, T.A. and Pedula, K.L. (2003) Complications in Young Adults with Early-Onset Type 2 Diabetes: Losing the Relative Protection of Youth. *Diabetes Care*, **26**: 2999-3005.

Huxley, R., Mendis, S. and Zheleznyakov, E. (2010). Body mass index, waist circumference and waist- hip ratio as predictors of cardiovascular risk- a review of the literature. *European Journal of Clinical Nutrition*; **64**(1):16-22.

International Diabetes Federation (IDF) (2006).

IDF Diabetes Atlas, 6th edition, Brussels.

Jaffiol, C. (2011). The burden of diabetes in Africa: A major public health problem. *Bulletin of Academic Natural Medicine*; **195**: 1239- 1253.

Johnson, S.C., Mendis, S. and Mathers, C.D. (2009). Global variation in stroke burden and mortality: Estimates from monitoring, surveillance and modelling. *Lancet Neurology*; **8**: 345-354.

Kamenova, P. (2008). Prevalence and Characteristics of Cardiometabolic Risk Factors in Patients with Type 2 Diabetes Mellitus. *Endocrinologia;* **13:** 3.

Kaptoge, S. (2011). Diabetes mellitus, fasting glucose and risk of cardiovascular disease. Emerging risk factors collaboration, SRK S. New *England Journal of Medicine*; **346**:829-841.

Kirkwood, J and Robert, H (2010). The UFAW handbook on the care and management of laboratory and other research animals. Wiley-Blackwall, pp. 29 ISBN 1-4051-7523-0.

Mbanya, V., Hussain, A. and Kengne, A.P. (2015). Application and applicability of non-invasive risk models for predicting undiagnosed prevalent diabetes in Africa: A systematic literature search. *Primary Care Diabetes*; **9(5)**: 317- 329.

Nigeria Data Portal (2006). Nigeria - Population Census. https://nigeria.opendataforafrica.org/ifpbxbd/state- population-2006.

Ogbera, A. O., Chinenye, S. and Onyekwere, A. (2014) Prognostic indices of diabetes mortality. *Ethnicity and Diseases*; **17**: 721–725.

Oguoma, V.M., Nwose, E.U., Ulasi, I.I., Akintunde, A. A., Chukwukelu, E. E., Bwititi, P. T., Richards, R. S. & Skinner, T. C. (2017). Cardiovascular disease risk factors in a Nigerian population with impaired fasting blood glucose level and diabetes mellitus. *BMC Public Health* **17,** 36.

Oguoma, V.M., Nwose, E.U., Skinner, T. C., Digban, K.A., Onyia, I. C and Richards, R.S. (2015). Prevalence of Cardiovascular disease risk factors among a Nigerian Adult Population: relationship with income level and accessibility to CVD risks screening. *BMC Public Health;* **15**:397.

Olarewaju, S. (2017). 3 out of every 10 Nigerian have a cardiovascular disease. *HealthfactNg.* Accessed online.

Onwuchekwa, A.C., Onwuchekwa, R.C and, Asekomeh, E.G. (2009). Stroke in young Nigerian adults. *Journal of Vascular Nurs*ing; **27(4)**:98–102.

Oputa, R.N. and Chinenye, S. (2015). Diabetes in Nigeria: A translational medicine approach. *African Journal of Diabetes Medicine*; **23**:1.

Ren, X., Chen, Z, Zheng, S., Han, T., Li, Y. and Liu, W. (2016) Association between Triglyceride to HDL-C Ratio (TG/HDL-C) and Insulin Resistance in Chinese Patients with Newly Diagnosed Type 2 Diabetes. *PLoS ONE;* **11(4)**: e0154345.

Sawar, N., Gao, P., Seshasai, S.R., Gobin, R., Kaptoge, S and Di- Angelantonio, E. (2010). Emerging risk factors collaboration diabetes mellitus, fasting blood glucose concentration, and risk of vascular disease: a collaborative meta -analysis of 102 prospective studies. *Lancet;* **375** (9733): 2215- 2222.

Selby, J.V., Peng, T., Karter, A.J., Alexander, M., Sidney, S., Lian, J., Arnold, A. and Pettitt, D. (2004). High Rates of Co-occurrence of Hypertension, Elevated Low-density Lipoprotein Cholesterol, and Diabetes mellitus in a Large Managed Care Population. *American Journal of Management Care*; **10**(2):163–170.

Steinarsson A.O., Rawshani A., Gudbjörnsdottir S., Franzén S., Svensson A.M., Sattar N. (2018). Short-term progression of cardiometabolic risk factors in relation to age at type 2 diabetes diagnosis: a longitudinal observational study of 100,606 individuals from the Swedish National Diabetes Register. *Diabetologia*. **61**(3): 599-606.

Umuerri, E.M. and Obasohan, A.O. (2013). Lower extremity peripheral artery disease: prevalence and risk factors among adult Nigerians with diabetes mellitus. *West African Journal of Medicine;* **32:** 200- 205.

Vazquez, G., Duval, S., Jacobs, D.R Jr. and Silventoinen, K. (2007). Comparison of body mass index, waist circumference and waist/ hip ratio in predicting incident

diabetes: a meta- analysis. *Epidemiologic Reviews*; **2(9)**: 115-128.

Wendland, E.M., Torloni, M.R., Falavigna, M., Trujillo, J., Dode, M.A and Campos, M.A., Duncan, B.B. and Schmidt, M.I. (2012). Gestational diabetes and pregnancy outcomes- a systematic review of the world health organization (WHO) and the international association of diabetes in pregnancy study groups (IADPSG) diagnostic criteria. *BMC Pregnancy Childbirth*; **12**: 23.

World Health Organization (WHO) *(2016). Global Report on Diabetes.* WHO Library Cataloguing -in- Publication Data. https :// www.who. int/publications/i/item /9789241565257.

World Health Organization (WHO) (2018). Waist Circumference and Waist–Hip Ratio: Report of a WHO Expert Consultation Geneva. https: // www. who .int / publications /i/ item /9789241501491.

World Health Organization (WHO) (2021). Cardiovascular Diseases. Geneva. *https://www.who.int/news-room/fact-sheets/detail/cardiovascular-diseases-(cvds).*

Zimmet, P., Alberti, G., Magliano, D.J. and Benett, P., (2016). Diabetes mellitus statistics on prevalence and mortality: facts and fallacies. *Nature Review Endocrinology*; **12**: 616-622.

Citation: Kester Awharentomah Digban, Eguagie Osareniro Osakue, Esther Ngozi Adejumo, Ayodele Adelakun, Oluwakemi Anike Ladipo, Comfort Bosede Enitan and Seyi Samson Enitan. Assessment of Cardiometabolic Risk Factors Among Type 2 Diabetes Mellitus Patients in Minna, North-Central Nigeria. ***Sokoto Journal of Medical Laboratory Science; 6(4): 82-93.***