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Corelation Of The Body Mass Index (BMI), Fasting Blood Glucose And Total Cholesterol Among Adult Nigerians In Benue State University Makurd, Nigeria

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Abstract:

Background: The aim of the present investigation was to determine the relationship between obesity and diabetes using the World Health Organization criteria of body mass index (BMI), fasting blood glucose (FBG) and total cholesterol (TC) among adult Nigerians in Makurdi –Metropolis, Nigeria.

Methods: This study was a cross sectional investigation carried out among adult Nigerians population in Benue State University, Makurdi, Nigeria, and its immediate environs. The subjects include apparently healthy adult volunteers from among the University staff and students. All participants in this study accepted to venous blood withdrawal after the rationale for this study was explained to them. They all consented to take part in the investigation. The protocol was approved by Ethical Research Committee of the Benue State University Teaching Hospital Makurdi. All procedures were conducted under WHO (2020) standardized condition. A random sampling technique was adopted and the survey was carried out by a team of well trained researchers. The study tool employed was a self developed structured questionnaires designed according to the need of the present study. The questionnaire was divided into three sections (A, B, and C) which ensured systematic data collection from all the participants. The following anthropometric measurements were undertaken, (body weight, height, waist circumference, hip circumference, waist hip ratio, and calculation of body mass index as well as lipid profiles analysis). Results; showed percentage for overweight and obesity to be 38.2% and 23.9% for male and 41.3% and 24.3% for female respondents respectively The prevalence of central obesity was (27.0%) females and (2.5%) males. Hip circumference (HC) of ≥88cm for females and ≥94cm for males were regarded as central obesity. The prevalence of normoglycemia, pre–diabetes mellitus and diabetes mellitus were 43.0%, 10, 8%, 2.86% (males), and 44.1%, 12.4%.and 1.96% for female respondents respectively. The lipid profiles findings are as followings, LDL, (2.91±0.02mmol/L), HDL (2.93±0.03 mmol/L), triglycerides, (1.33±0.02 mmol/L), total cholesterol (4.98±0.03 mmol/L), and total cholesterol/HDL ratio (2.39±0.03 mmol/L) for male respondents while that of female respondents were, LDL(2.90±0.03 mmol/L), HDL (2.89±0.34 mmol/L), triglycerides (1.27±0.03 mmol/L),total cholesterol (T.C) (5.10±0.04 mmol/L) and Total cholesterol/HDL ratio (2.31±0.06 mmol/L).The study concluded that female respondents were significantly more overweight and obese compared to the male participants. (P<0.05) The study further demonstrated that females showed higher percentage of overweight and obesity tendency than the male respondents. However, it was not statistically significant (P<0.001). The male participants were significantly more diabetic than the female respondents (P<0.001) while female respondents demonstrated higher prevalence of diabetes tendency compared to male respondents.There was a statistical significant and positive association between BMI, FBG and total cholesterol as demonstrated in the study. The body mass index, waist circumference, and WHR are associated with obesity and the risk of type 2 diabetes mellitus, and hyperlipidemia. The study further confirmed that certain dietary nutritional modifications and regular, moderate physical exercise that would enhance the maintenance and achievement of ideal body weight should be given emphasis in the management of obesity and type 2 diabetes in Nigeria.

Keywords: Body mass index, Fasting blood glucose, lipid profile, total cholesterol.

I. INTRODUCTION

Obesity is a chronic metabolic disease that is rapidly becoming a major epidemic and public health challenge in Nigeria (1). The global rise of obesity among children and adults is not only common to the developed nations but is becoming a worrisome health issue in developing African countries (2,3). World Health Organization, defined obesity as

the body mass index (BMI) equal to or greater than >30kg/m^2 It is calculated as weight in kilogram (kg) divided by the squared of height in meter (m^2). (4)

Obesity results from a complex interaction between cultural, physiological genetic and environmental factors. Obesity is generally acknowledged to be a modifiable risk factor in the development of T2DM and various lipids abnormalities such as elevated total cholesterol, triglyceride, and lower high –density lipoprotein cholesterol levels as well as increased risks of cardiovascular diseases, stroke and certain types of cancer (5). The dyslipidaemia among the obese individuals might on one hand be due to an increased intake of food rich in saturated fatty acids and cholesterol and lack of physical activity (sedentary lifestyle). Similarly, an increased basal cholesterol synthesis and a decrease in hepatic LDL-induced inhibition of endogenous cholesterol synthesis through the activity of 3-hydroxy-3-methylglylutarate co-enzyme- A (5). In addition, subjects with established obesity have an increased lipogenesis in hepatocytes (6). This might contributes to the development of excessive fat mass and together with hyperinsulinemia which might additionally alter lipid homeostasis by promoting cholesterol synthesis.(7).

Obesity is a rapidly growing lethal disease in both the developed and developing worlds. The World Health Organization (WHO) estimated that more than 1.9 billion adults, 18 years old and above were overweight worldwide in 2019. Of these individuals, over 600 million were obese (8).

There are previous studies in other parts of Nigeria, but there is paucity of statistical data in Makurdi-Nigeria. The aim of this study therefore is to determine the molecular interrelationship between body mass index (BMI) fasting blood glucose, lipid profiles and total cholesterol among adult Nigerians.

II. MATERIALS AND METHODS.

A. STUDY DESIGN

This is a cross-sectional study conducted within the Benue State University Makurdi and its environs. The subjects are the apparently healthy University adult staff and students. The study duration for this investigation was six months and was conducted as from March, 2022 to September, 2022.Sample size was determined using the Formula $N=Z^2PQ/D^2$ (N-is sample size, Z is 1.96, P is prevalence, Q is I-P, and D is 0.05. Since the prevalence of Obesity in Nigeria is not known 5.9% was used according to Fezeu et al, 2017. This yielded a minimum sample size of 85.3. Therefore, a total of 420 participants (220 males (56%) and 200 females (35%), age range between 20 and 65 years old were studied.

All the participants provided written informed consent before questionnaire was administered. The questionnaires were divided into three sections (A, B and C). The (A) section was to obtain personal data and socio- demographic characteristics. The B- section was to obtain anthropometric indices and their social lifestyle (eating habits, smoking, alcohol consumption and level of exercise). The (C) section involves the estimation of fasting blood glucose and lipid profiles. Family history of diabetes and treatment s were noted and recorded in the questionnaire.

The protocol for this study was approved by the Benue State University Teaching Hospital Research and Ethical Committee.

a. INCLUSION AND EXCLUSION CRITERIA

Inclusion criteria are;

- ✓ Either sex
- ✓ Age between 18 years and above,
- ✓ Apparently in good health condition,
- ✓ No history of diabetes or concurrent treatment for-diabetes mellitus or obesity related disorders.

Exclusion criteria.

The following categories of persons were excluded from the study groups:

- ✓ Age below 18 years
- ✓ Pregnant and lactating mothers
- ✓ Deformed individuals
- ✓ Hypertension, diabetes mellitus and cardio-pulmonary disease, and
- ✓ Those on medications for above stated illnesses were excluded from the study.

b. ANTHROPOMETRIC MEASUREMENTS

All procedures were carried out according to WHO multinational monitoring protocol (1980s). The following measurements were carried out-weight (kg), height (m^2), mid arm circumference (cm), waist circumference (cm), hip circumference (cm), waist/hip ratio (WHR).

Body weight was measured to the nearest 0.1kg and body height to the nearest 0.1m using standard medical bathroom weighing scale (Model HD358 manufactured by Our Weigh, UK and meter rule equipment) in subjects wearing light indoor clothing without shoes, jackets and sweaters. Body mass index (BMI) was calculated as weight (kg) divided by square of height (m^2).

c. BLOOD EXPERIMENTS

After 8 hours overnight fast, participants presented in the Health Centre between 8.00 AM and 12.00 Noon. Venous blood (5mls) was collected under aseptic condition into bottle containing anticoagulant and centrifuged at 40^0C. The fasting blood glucose was estimated using digital glucometer (Accu chack). FBG=3.5-6.5mmol/l is regarded as normoglyceamic, FBG> 6.5 -6.9 mmol/l was regarded as pre-diabetes while FBG >7 .0 -11mmol/L was regarded as diabetes mellitus according to America Association of diabetes mellitus (10).

5 mls of blood was collected from each participant via the anti-cubital vein into lithium heparin bottle for the determination of fasting plasma lipids. Plasma was stored at -70^0C until analysis for triglycerides, (TG), total cholesterol (TC), and cholesterol were assayed calorimetrically. All variables were determined using enzymatic commercial kits (USA, 204321) obtained from Vinca pharmaceutics company Makurdi- Nigeria. All analyses were run in duplicate,

according to the standard protocol. Hypercholesterolemia was defined as total cholesterol >6.5mmol/L.

Definition of diagnostic criteria

A BMI>25kg/m2 was considered a positive criterion for diagnosis of overweight

A BMI> 30kg/m2 is considered as positive criterion for diagnosis of obesity.

A FBG>7.0 mmL/L is considered a positive criterion for diagnosis of T2DM according to WHO,

WHR> 0.95 (men), WHR> 0.8 (women) is a criteria by the WHO for obesity.

A GBG> 6.5 -6.9 mmol/L is considered as a positive criterion for diagnosis of pre-diabetes.

A systolic BP> 130 mmHg and a diastolic BP> 90mmHg was considered a positive criterion for diagnosis of hypertension.

A systolic BP> 125mmHg and a diastolic BP>85mmHg is considered a positive criterion for diagnosis of pr-hypertension.

A HDL <25mg/dl (men) and HDL < 39mg/dl (women) is a positive criterion by World Health Organization for diagnosis of hyperlipidemia.

d. STATISTICAL ANALYSIS

Data were presented as ±standard deviations using SPSS (version 22). Descriptive statistic and analysis of variance (ANOVA) were employed for qualitative variables and presented in the form of frequency and percentage tables. P values less than 0.05 were considered statistically significant.

III. RESULTS

Variables	Frequency	Percent
Age Group (years)		
<20	67	2.2
20-29	103	50.9
30-39	135	32.3
40-49	85	9.8
50-59	20	4.5
60 and above	10	.4
Sex		
Male	220	53.9
Female	200	46.1
Marital Status		
Married	230	54.2
Single	86	45.7
Widow	4	0.1
Religion		
Christianity	346	97.9
Islam	74	2.1
Educational Status		
None	10	0.3
Primary	54	20.9
Secondary	236	0.2
Post-Secondary	120	78.7
Occupation		
Unemployed	175	44.9
Civil Servants	210	45.5
Mechanics	31	8.7
Business	4	0.9

Table 1: Sociodemographic Characteristics of the Respondents (n=420)

The age of the respondents ranged from 18 -70 years, with a mean age of (31.1 ± 8.3) years. Majority of the respondents were male (n=1943) (53.9%) while female respondents were (n=1647) (45.7%). Marital status showed that 54.2% were married, 45.5% single, while 0.1% were widows. Majority of the respondents were Christian (98%) while 2.1% were Muslem. Majority of the respondents obtained post secondary education (78.7%), secondary education (0.2%), primary (20.9%), were uneducated (0.3%). Majority of the participants were civil servants (45.5%), unemployed (44.9%), mechanics (8.7%) and traders /business (0.9%) as shown in Table 4.1.

Variables	Frequency	Percent
Ever Smoked Cigarette		
Yes	80	12.1
No	340	87.9
Take Alcohol		
Yes	140	42.8
No	280	57.2
Number of Bottles Taken per day (n=420)		
1	294	35.0
2	80	49.0
3	28	14.6
≥4	21	1.4

Table 2: Intake of psychoactive substances

Table 2 showed the lifestyle and intake of peychoactive substances of respondents. Among those who take alcohol majority (49.0%) of them take two bottles per day, followed by one bottle (35.0%), three bottles (14.6%) and four or more bottles (1.4%). The mean number of bottles consumed by the respondents was (2 ± 1.01). 14grams of alcohol is contained in 5% beer bottle. Furthermore, about 12.1% of the respondents smoked cigarettes while majority are non smokers (87.9%) The mean number of bottle consumed by the respondents was 2 (± 1.008).

BMI	Total		Male		Female	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Normal Weight	220	37.7	110	32.2	90	35.5
Overweight	150	39.8	80	38.2	70	41.1
Obesity	50	24.1	30	23.9	40	24.3
Total	**420**	**100.0**	**220**	**100.0**	**200**	**100.0**

Table 3: Prevalence of Obesity by Sex among Respondents using Body Mass Index (BMI)

Table 3 Showed that the body mass index, distribution of obesity, overweight, normal weight and underweight among the females was similar to that of males. Overall, prevalence of obesity was 24.1%, while overweight, normal weight and underweight was 39.8%, 37.75% and 2.4% respectively. The percentage for overweight and obesity was 38.2% and 23.9% for male and 41.3% and 24.3% for female respondents respectively. Females showed higher percentage of overweight and obesity tendency than the male respondents but however, it was not statistically significant (P<0.001).

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BMI	Total		Male		Female	
	Freq.	Percent	Freq.	Percent	Freq.	Percent
Underweight	18	2.4	12	2..4	20	2.4
Normal Weight	231	37.7	106	32.2	90	35.5
Overweight	160	39.8	80	38.2	60	41.1
Obesity	21	24.1	22	23.9	17	24.3
Total	**420**	**100.0**	**220**	**100.0**	**200**	**100.0**

Table 4: Prevalence of Obesity by Sex among Respondents using Body Mass Index (BMI)

Table 4. showed that the body mass index, distribution of obesity, overweight, normal weight and underweight among the females was similar to that of males.. Overall, prevalence of obesity was 24.1%, while overweight, normal weight and underweight was 39.8%, 37.75% and 2.4% respectively. The percentage for overweight and obesity was 38.2% and 23.9% for male and 41.3% and 24.3% for female respondents respectively. Females showed higher percentage of overweight and obesity tendency than the male respondents but however, it was not statistically significant (P<0.001

Waist Circumference (Cm)	Male (Ref: ≥102cm) number	percentage	Female (Ref: ≥88cm) number	Percentage
Normal	172	97.5	151	73.0
Central Obesity	48	2.5	49	27.0
Total	**220**	**100.0**	**200**	**100.0**

Table 5: Prevalence of central obesity by Sex among Respondents using waist circumference

Table 5 showed the waist circumference (WC) among the respondents.The cut-off for male and female varies. Waist Circumference of ≥88cm and ≥102cm was considered as central obesity for females and males respectively. The prevalence of central obesity was higher among the females (27.0%) as compared to the males (2.5%).

FBS (mmol/l)	Total		Male		Female	
	No	Percent	No	Percent	No	Percent
Normal (3.5-6.5)	210	62.9	85	62.9	94	62.8
Pre-*Diabetes mellitus* (6.6-6.9)	123	34.7	79	34.2	85	35.3
Diabetes mellitus (≥7.0)	87	2.4	56	2.9	31	1.9
Total	**420**	**100.0**	**220**	**100.0**	**200**	**100.0**

Table 6: Prevalence of Type 2 Diabetes mellitus based on Fasting Blood Sugar (FBS)

Table 6 above showed prevalence of normoglycaemia, pre–diabetes and diabetes mellitus in the population to be 62.94%, 34.20%, 2.86% (males), and 62.79%, 35.25%.and 1.96% for female respondents respectively. These results illustrated that females have higher tendency of pre-*diabetes mellitus* than male respondents. However male respondents are significantly more *diabetes mellitus* (P<0.001)

Age	N	Sex	BMI (Kg/M^2) ±SEM	FBG (mmol/L) ±SEM	LDL Mmol/L	HDL Mmol/L	TRIGLY Mmol/L	TOTAL CHOLESTROL Mmol/L	TOTAL CH/HDL RATIO
20-29	60	M	26.05±0.19	6.7±0.07	2.47±0.05	2.76±0.06	1.20±0.03	5.60±0.07	2.53±0.08
30-39	50	M	26.73±0.13	6.7±0.05	3.03±0.04	2.94±0.05	1.4±0.04	4.81±0.05	2.15±0.06
40-49	46	M	26.60±0.15	6.7±0.05	2.88±0.04	2.94±0.05	1.34±0.03	4.92±0.06	2.27±0.07
50-59	42	M	26.81±0.22	6.5±0.07	3.84±0.07	2.91±0.07	1.20±0.05	4.87±0.09	2.08±0.07
60-69	18	M	26.75±0.31	6.8±0.11	3.25±0.10	3.06±0.11	1.41±0.07	5.15±0.13	2.29±0.15
≥70	6	M	26.63±0.56	6.5±0.18	3.25±0.22	3.20±0.26	1.50±0.14	5.0±0.29	2.26±0.29
TOTAL	220.		26.62±0.08	6.7±0.03	2.91±0.02	2.93±0.03	1.33±0.02	4.98±0.03	2.39±0.03

Table 7: Percentage distribution of mean values of BMI, FBG and lipid profiles for males participants

Table 7 shows mean values of BMI,FBG and lipid profiles to be as follows BMI(26.9±0.1), FBG (6.7±0.4), LDL, (2.91±0.02mmol/L), HDL (2.93±0.03 mmol/L), triglycerides, (1.33±0.02 mmol/L), total cholesterol (4.98±0.03 mmol/L), and total cholesterol/HDL ratio (2.39±0.03 mmol/L) for male subjects.

Age	N	Sex	BMI (Kg/M^2) ±SEM	FBG (mmol/L) ±SEM	LDL	HDL	TRIGLY	TOTAL CHOLESTROL	TOTALCH/HDL RATIO
20-29	55	F	25.8±0.3	6.5±0.08	2.53±0.07	2.76±0.07	0.93±0.03	5.78±0.09	2.51±0.10
30-39	50	F	26.5±0.2	6.6±0.08	2.91±0.08	2.73±0.08	1.36±0.05	5.23±0.09	2.53±0.11
40-49	40	F	27.0±0.2	6.8±0.06	2.92±0.06	2.95±0.06	1.33±0.04	4.97±0.08	2.20±0.08
50-59	30	F	27.4±0.3	6.6±0.09	3.10±0.08	3.07±0.09	1.36±0.06	4.88±0.11	2.21±0.20
60-69	20	F	27.7±0.4	6.7±0.12	2.88±0.11	2.77±0.12	1.10±0.09	4.64 ±0.16	2.24±0.16
≥70	5	F	26.3±0.8	8.1±0.3	3.79±0.48	4.97±0.3	1.13±0.13	5.7 ±0.27	1.21±0.12
TOTAL	200	F	26.9±0.1	6.7±0.4	2.90±0.03	2.89±0.34	1.27±0.03	5.10±0.04	2.31±0.06

Table 8: Percentage distribution of mean values of lipid profiles for females participants

Table 8 shows mean value distribution of BMI,FBG and lipid profiles to be as follows, BMI (26.9±0.1),FBG(6.7±0.4), LDL (2.90±0.03 mmol/L), HDL (2.89±0.34 mmol/L), triglycerides (1.27±0.03 mmol/L), T.C (5.10±0.04 mmol/L) and Total cholesterol/HDL ratio (2.31±0.06 mmol/L) respectively for females participants.

Variables	Combined population Mean±SD	male Mean ± SD	Female Mean ± SD	T	P-value
LDL cholesterol (mmol/L)	2.90 ± 1.28	2.91 ± 1.29	2.90 ± 0.27	0.17	0.867
HDL cholesterol (mmol/L)	2.94 ± 1.62	2.93 ± 1.76	2.89 ± 0.32	1.50	0.133
Triglycerides (mmol/L)	1.31 ± 0.96	1.33 ± 0.97	1.27 ± 0.03	2.10	**0.036**
Total cholesterol (mmol/L)	5.03 ± 1.64	4.98 ± 1.62	5.10 ± 0.04	2.22	**0.027**

Table 9: Comparison of lipid profiles between males and females subjects

Table 9 showed the mean values of LDL, HDL, triglycerides and total cholesterols to be 2.90 ± 1.28 mmol/L,, 2.94 ± 1.62, mmol/L 1.31 ± 0.96, mmol/L, 5.03 ± 1.64mmol/L for the combined population. There was siginificant different (P<0.01) between the males and females subjects.

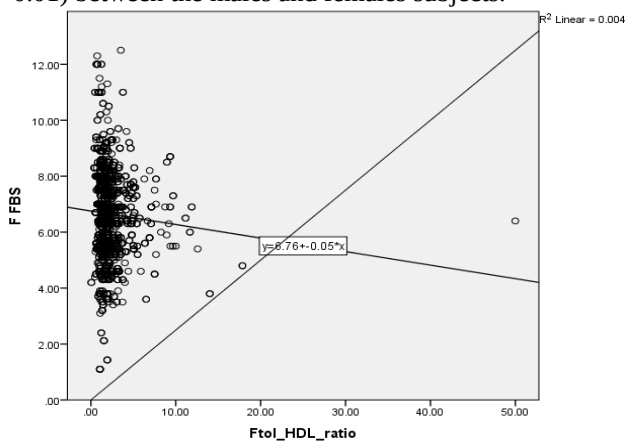

*Figure 1: Scatter graph showed significant and negative relation between FBS and Total/HDL cholesterol ratio (Y=76+0.06*X)*

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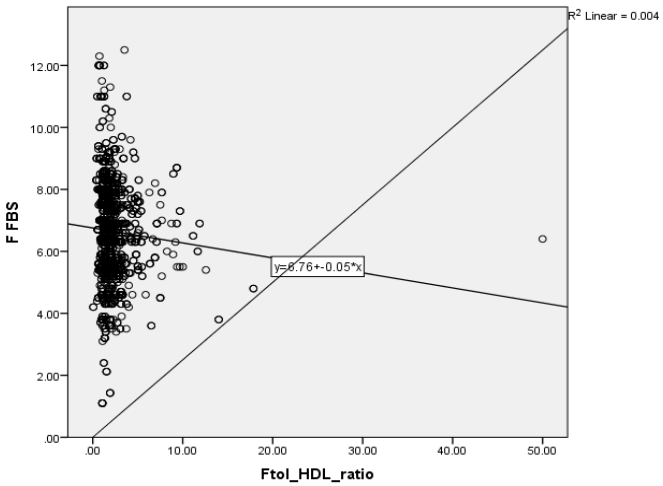

*Figure 2: Scattergraph showing negative significant distribution between FBS and Total cholesterol/HDL ratio (y=6.76+0.05*x)*

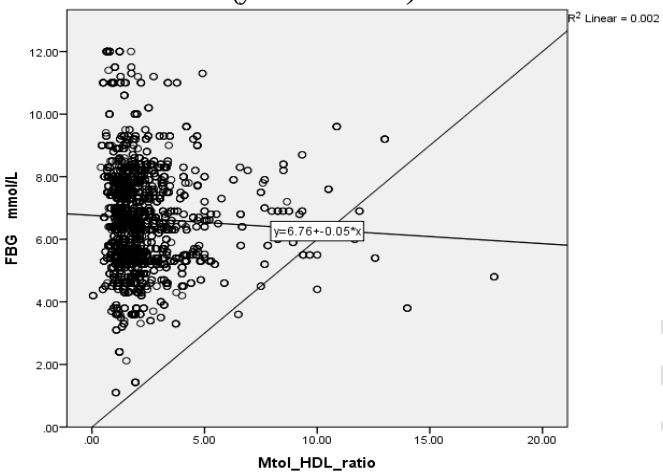

*Figure 3: Scattergraph showed negative significant relation between FBG and total cholesterol/HDL for male participants. (y=6.76+0.05*x)*

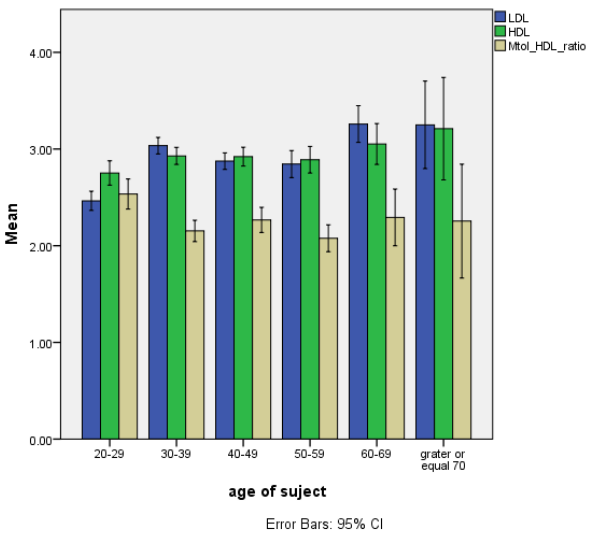

Figure 4: Error Bars showing mean values of total cholesterol and HDL based on age. The ratio of total cholesterol and HDL is significant with advancing age.(P<0.05)

IV. DISCUSSION

The results of this study demonstrated that obesity is the major risk factor for the development of diabetes Mellitus and is associated with high lipid profiles primarily due to dietary habits, lifestyles, and environmental factors. These findings are in consonant with previous studies conducted in other part of the globe (17, 18).

This study also demonstrated that females are more obese, with higher body mass index, Hip and waist circumference, compared to male subjects. The finding is in agreement with the report obtained by Ahmed and colleagues (19.20). The reasons for high incidence of obesity witnessed among female participants in this investigation was attributed to poor dietary habits and lack of physical activity. This observation was also in conformity with the study of Bakari et al,(2016) carried out among adult population in Zaria. He further concluded that females have higher body mass index than the males counterparts because of their sedentary lifestyles and high consumption of carbohydrate rich diets. However these reports are in contrasts to the report conducted in South Africa by Case et al.; (2016). He reported that males are more obese than their female subjects.

The study also showed that the lifestyle and psychoactive substances of the respondents are associated with body mass index. (BMI), fasting blood glucose (FBG), and hyperlipdemia. High dietary and alcohol consumption induces an increased in body weight and body mass (11),. Many studies demonstrated that alcohol stimulates appetite (12), causing a higher food intake along with alcohol consumption. High energy intake from alcohol was positively associated with intramuscular adipose tissue in older participants especially in women. The changed in lifestyle habits (sedentary) with an increased alcohol intake in both sexes may be one of the most important risk factors for the obesity epidemic observed in the present study. This finding is in accordance with previous studied, which showed that frequent alcohol consumption was associated with a less healthy diet (15).The studied populations are adapting rapidly to western dietary lifestyle instead of their traditional eating habits (16.17).

Smoking cigarette is postulated to be associated with increased body mass and fasting blood sugar (16). Smoking cessation, however, lead to great changes in endocrine and metabolic balance which may explain the increased body mass index in non-smokers (17). The body fat composition tends to increase with advancing age among the respondents. The body mass index was observed to differ among the age range of the respondents but was highest among the elderly respondents. This study was in consonant with the investigation carried out in Northern Nigeria among adult population by Adamu (18, 19). His research demonstrated a positive association between age and overweight/obesity among the participants. The distribution of body mass index (BMI) was observed to be higher in female than male subjects. The main reason could be attributed to physical in activities and dietary lifestyle. These findings are in agreement with study done by Amusa (20) among adults population in Northern Nigeria,

The respondents engagement in physical exercise showed that majority of the respondents did not engaged in exercise on

a daily basis (exercise that last for at least 30 minutes daily) (19). The results of this study is similar to the investigation carried out by Onifade and colleagues (19) among adult population in Western Nigeria. They demonstrated that most people, not only in Nigeria but most developing African countries, do not engage in enough physical activity. This can be attributable to variety of labour saving devices and gargets in most homes and the overuse of cars, meaning that most people use-up much less energy compared to past generation.(20) The amount of dietary intake and physical excise are predictive of body weight (BW), and hip and waist circumference (22).

The findings of this study also demonstrated a closed association between obesity and T2DM.The likelihood of T2DM are closely linked with increased body mass index. The prevalence of T2DM was higher in male than female subjects However, the females demonstrated a greater pre-diabetes tendency than male subjects. These findings are similar to studies conducted at Uyo (22.23). However these findings are in contrast to the research carried out in South Africa (24) and India (26). They observed higher prevalence of diabetes mellitus among females. The main reasons were attributed to lack of physical activity, poor dietary habits and socio-environmental factors.

In this study WC was found to have statistically significant positive correlation with FBG. Obesity is rapidly becoming an important health issues all over the world. (23,24). It is associated with increased risk of cardiovascular diseases and T"DM (25.26)

The study also demonstrated a positive and significant correlation between elevated fasting blood glucose and cholesterol concentration among the respondent.

This study showed that cholesterol increased with advancing age in both male and female subjects. The study further demonstrated that males have statistically significant higher total cholesterol than females. However both males and females showed strong negative and significant correlation between body mass index (BMI) and total cholesterol. Similarly, these results are in lined with several previous studies which have found that overweight and obese males cholesterol increased by age substantially in the BMI category of <25kg/m^2 on the other hand, the age –related rise in total cholesterol in females was steeper and of similar intensity to BMI (23, 24). This may be caused by oestrogen deficiency in advance age women (postmenopausal). It has been extensively demonstrated that menopause is highly associated with abnormal lipid profiles (27).

This investigation is in conformity with other documented reports which demonstrated more increased in total cholesterol in males than female of the same age category. The increase in total cholesterol with advances age had a remarkably different pattern according to gender and BMI (26).

The incidence of premature death due to obesity and hyperlipidemia remains a major health public challenges in Nigeria in recent times. Moreover, elevated blood cholesterol is still an important risk factor for cardiovascular diseases, hypertension and stroke (27.28). Available reports also showed that the increase in total cholesterol with age is different for men and women. The above results stated that the total cholesterol level rises as the body mass index rises. However, in the previous studies there are widespread opinions that the reduction of BMI among older person will automatically lead to a decrease in cholesterol level. A reduction in body mass index, control of fasting blood glucose through dietary modification and increased physical activity will critically lead to a decrease in total cholesterol concentration and subsequent reduction in premature death in Nigeria (29,30). This study also demonstrated a significant relationship between smoking, alcohol, level of exercise and total plasma cholesterol for both male and female participants'. Cigarette and alcohol are modifiable risk factors for obesity and hyperlipidemia. There is currently no consensus on the mechanism coupling glucose metabolism in the amplification of insulin secretion, although several theories have been proposed (31). One cardinal mechanism, relates to the regulation by glucose of endogenous lipid signaling in the beta-cells. According to the mechanism proposed by Randie (32). Increased FFA levels increased mitochondria acetyl Co –A-COA ratios which in turn inhibit pyruvate dehydrogenase activity and increased citrate levels which again inhibit phosphofructokinase activity. This process leads to increased glucose 6-phosphate concentration which allosterically inhibits hexokinase thus reducing glucose transport phosphoraylation activity and glucose stimulated insulin secretion (32.33,34).

This study further throws more light on the complex interaction between dietary, socio-cultural, and lifestyles predisposition to obesity, type 2 Diabetes mellitus, and hyperlipidemia and the need for health education on good dietary habits and physical activity in the management of obesity related diabetes mellitus.

A. CONCLUSION AND RECOMMENDATION

This study has extensively investigated the relationship between body mass index, fasting blood glucose and total cholesterols among adult Nigerians and provided valuable insights that could help to improve individual health and prolong life expectancy. There was a significant negative relationship between body mass index, blood glucose concentration and total cholesterol. Obesity, diabetes and hyperlipidemia are risk factors for the current increased in the development of hypertension, sudden heart failure and premature death in Nigeria. There is therefore the need to promote the quality of health education programs among the people in Nigeria and world over, by promoting modification of lifestyles- healthy eating habit, reduction in cigarrete smoking and alcohol consumption and encourage physical activity.

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