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Original Research Article

Determining the relationship between obesity and its comorbidities among adult diabetic patients attending the general outpatient clinic at a tertiary health institution in South-Eastern Nigeria

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ABSTRACT

Background: Today, more than 1.1 billion adults worldwide are overweight and 312 million of them are obese. This growing prevalence of overweight and obesity had led to a propelling upsurge in cases of diabetes especially type 2. However, diabetes is a major predisposing factor of cardiovascular diseases which accounts for about 18 million death every year. This study was aimed at determining the relationship between obesity and its comorbidities among adult diabetic patients attending the GOPC at a tertiary health institution in Nigeria.
Methods: This was a cross-sectional, descriptive, and hospital-based study carried out at Federal Medical Centre, Owerri, within a four months period. Data was collected using a structured interviewer administered questionnaire and was analyzed using social package for the social sciences (SPSS) version 17 computer software, with all p values considered significant at values <0.05.
Results: A total of 216 diabetics (subjects) and 216 age, and sex matched non-diabetics (control) were studied over a period of four months. In both the study and control group their mean age was 54.70±10.59 years with females accounting for 66.9% (123) and males 43.1% (93) resulting to a male; female ratio of 1:1.3. Ninety-four (43.5%) of the diabetics were overweight, 70 (32.4%) were obese while 52 (24.1%) had normal weight. There was a statistically significant relationship between type 2 diabetes mellitus and body mass index (BMI) (p=0.000) wherein diabetics subjects tend to have higher than normal BMI.
Conclusion: This study demonstrated a significant association between type 2 diabetes mellitus (DM), BMI, physical inactivity and hypertension while dyslipidaemia did not.

Keywords: Diabetes mellitus, Obesity, Hypertension, Adults, Dyslipidaemia, Body mass index, Comorbidities

INTRODUCTION

The co-existence of type 2 diabetes mellitus (T2DM) and obesity has very important unintended consequences and effects for health, being major predisposing factors of cardiovascular diseases, which is a major cause of death every year worldwide, reducing of quality of life, and eventual reduction in life expectancy.[1-4] Obesity can have

damaging effects on the health outcome of persons with T2DM, as studies have shown that the prevalence of obesity/overweight among type 2 diabetics was over 80-90% in Nigeria and in most countries of the world.[5-8] The co-occurrence of T2DM and obesity have common comorbidities (hypertension, dyslipidaemia, and physical inactivity) and complications which are made more severe with the presence of diabetes.[9]

Clearly, comprehending the health states of individuals living with these health conditions is essential, because of the rising prevalence of diabetes in Nigeria and Sub-Saharan Africa (SSA) and also due to the recommendations of a 5% reduction in weight for persons with T2DM who have obesity or over weight by the American Diabetes Association (ADA), in order to ensure the maintenance of their optimal health.[5,10,11] However, to date there has been paucity of studies in Nigeria and SSA on the relationship between obesity using body mass index (BMI) and its comorbidities among adult type 2 diabetic patients.

Aim and objectives

In order to address these gaps in the body of knowledge, this study is aimed at determining the relationship between obesity (using BMI) and its comorbidities among adult T2DM patients attending general outpatient clinic at Federal Medical Centre, Owerri, Imo State, South- Eastern Nigeria. To achieve this aim, the study will, describe the socio-demographic characteristics of the study population; calculate their BMI and use it to determine the prevalence of overweight/obesity in this study population; to determine the relationship between T2DM and BMI in the study population and; to identify comorbidities of obesity such as hypertension, dyslipidaemia as well as physical inactivity and their relationships with T2DM among the study population.

METHODS

Study design/duration

This was a hospital based cross-sectional, descriptive study and was conducted within four months between May 2011 and August 2011.

Study setting

Federal Medical Centre, Owerri, (FMCO) where this study was carried out is the major tertiary health institution located at the center of the city and was established in 1995. The centre offers clinical services and runs residency training in family medicine, internal medicine, surgery, paediatrics, ophthalmology, otorrhinolaryngology, pathology and radio-diagnosis.

The hospital has 340 bed capacity with bed occupancy rate of 90%, a large outpatient attendance of 230,948 and a staff strength of 1,795 workers in 2012.

Study population

The study population was made up of adults T2DM patients (both known and newly diagnosed diabetics) attending the GOPC of FMC Owerri. Classification of patients as type 2 diabetics was however based on clinical grounds of non-dependence on insulin for survival.

Inclusion criteria

The study included adult patients who were 18 years and above with T2DM and also those who gave their consent to participate.

Exclusion criteria

Diabetic patients less than 18 years of age, those known diabetics with a history of ketosis and/or history of insulin use for survival, those with gestational diabetes, who declined consent to participate, who had ascites or swelling of other parts of the body that might add to their true body weight, and those who were too ill to participate in the study were excluded.

Sample size determination

The sample size was determined using the best estimates of prevalence rates of obesity in diabetics from literature review of previous studies. The sample size was estimated using the formula below.[12]

$$N = (Z^2Pq)/d^2$$

Here, N=minimum sample size, Z=the standard normal deviate usually set at 1.96, which corresponds to the 95 percent confidence interval, and P=best estimates of prevalence rate from literature=83%.[5] This translates to 0.83.

$$q = 1.00 - P = (1.00 - 0.83) = 0.17$$

Also, d is the degree of accuracy desired, usually set at 0.05.

$$N = (1.96)^2 \times (0.83) \times (0.17)/(0.05)^2 = 216$$

Thus, the minimum sample size required for the study was 216 diabetic patients.

Sampling strategies

The GOPC attends to between 180 and 200 patients on average per clinic day, which translates to about 43,200 to 48,000 patients per year. An average of about 6-8 diabetics are seen in the GOPC on a daily basis with about 1-2 being newly diagnosed. This gave a total of 240 T2DM patients/month which amounted to 720 in three months (expected population). A systematic sampling method was used to achieve the sampling size of 216. To get the

sampling interval, the minimum sample size was divided by the expected population. This gave a K value of approximately 3 (sampling interval). The first patient was selected via a simple random sampling (balloting) method between the numbers 1 and 2. The first number selected for this study was 2 and that meant that the subsequent patients with numbers 5, 8, 11, n+3, n+3+3…, were selected for the study.

Data collection

A combination of structured, pre-tested, interviewer administered questionnaire, anthropometric measurement and blood samples for biochemical measurements were used for data collection.

Pre-testing of the questionnaire instrument

The questionnaire was pre-tested by the researcher on patients with similar characteristic attending the GOPC Federal Medical Centre Umuahia, which had similar status to the GOPC of FMCO. A total number of thirty diabetic patients were randomly recruited for the pretest which lasted for about five days. At the end of the pre-test activity, necessary adjustments were made on the questionnaire before carrying out the research on the proposed patients attending the GOPC of FMCO by the researcher.

Questionnaire administration

The pre-tested questionnaire that was modified from the validated WHO STEPS instrument approach to surveillance of chronic non-communicable diseases risk factors, had 6 sections.[13] The first section contained the introduction to the study and the serial numbering of the subjects, the second section had the socio-demographic data of the subjects such as age, sex occupation, highest educational status, marital status, religion, among others. The third section assessed the subjects` knowledge of the disease conditions of interest and their status while the fourth section assessed for physical inactivity as a risk factor. The fifth section was for the recording of the physical and laboratory measurements for the individual patients while the last part contained the consent form. Patients were educated on the aim and objectives of the study and their written consent obtained before the questionnaires were administered.

Data analysis

Diabetes mellitus

Diabetes mellitus was diagnosed as fasting plasma glucose ≥126 mg/dl and/or plasma glucose level ≥200 mg/dl two hours after a 75 g oral glucose load.[14] It was also taken as current use of medications for DM as prescribed by a qualified health care provider irrespective of the present plasma glucose level. A known diabetic is that patient that had been diagnosed with DM by a qualified health care professional prior to the study and thus are aware of their diabetic status. Such patients must have commenced treatment for DM. A Newly diagnosed diabetic is that patient that has just been discovered to have a plasma glucose level in the range for DM and has not commenced treatment for such.

Hypertension

Hypertension was defined as blood pressure ≥140 mmHg systolic and/or ≥90 mmHg diastolic in tandem with JNC 7 report on prevention, evaluation and treatment of high blood pressure in adults aged 18 years and above.[15] It was also taken as the current use of antihypertensive drugs as prescribed by a qualified health care provider.[15]

Nutritional status based on BMI

The BMI was calculated by dividing the measured weight in kilograms (kg) by the height in meters (m) squared, that is weight (kg)/height (m^2). Patients were categorized using the 4 BMI categories <18.5,18.5-24.9, 25.0-29.9 and ≥30 kg/m^2) which corresponds to underweight, normal weight, overweight and obesity respectively.[16]

Lipid profile

The value of low density lipoprotein cholesterol (LDL-C) was calculated by using the formula, 4 LDL (mg/dl) =TC–TG/5–HDL values greater than 200 mg/dl for serum total cholesterol, 150 mg/dl for triglyceride, 100 mg/dl for LDL–cholesterol and less than 40 mg/dl for HDL–cholesterol was considered as abnormal for each of the lipid parameters.[17] Respondents would be classified in this study as either dyslipidaemic or non-dyslipidaemic.

Physical activity

This was assessed as adequate or inadequate physical activity following the American Diabetic Association recommendation of engaging in an activity that causes continuous sweating for a minimum of 30 minutes in a day, 5 times in a week, levels of activity below this were considered inadequate physical activity while level at or above this was judged adequate for the purpose of this study.[18,19]

The results generated were entered into a computer statistical package for the social sciences (SPSS) version 17. Relevant means and standard deviations were calculated alongside appropriate frequencies. Findings were presented in frequency tables and charts such as pie and bar charts.

Chi square tests were conducted to determine the association between T2DM and potential risk factors. Multivariate logistic regression was used to compute odds ratios (ORs) and their 95% confidence intervals (CIs) to ascertain the independence of the risk factors. All p values were considered significant at<0.05.

RESULTS

Table 1 shows the distribution of the subjects based on sex and age. The greater proportion of the subjects were females 123 (56.9%) for both the diabetic (study group) and the non-diabetic (control) groups. Males had a proportion of 93 (43.1%) in both groups. The male to female ratio was 1:1.3. The proportion of diabetic subjects was observed to increase with advancing age from 1.4% in the age group ≤30 years, through 25.9% in age group 41-50 years to 36.6% in age group >60 years. The mean age of the group was 54.70±10.59 years. A similar pattern was observed in the age matched control group with a mean age of 54.70±10.59 years.

Table 1: Distribution of the subjects based on sex and age.

Variables	Diabetic, N (%)	Non-diabetic, N (%)
Male	93 (43.1)	93 (43.1)
Female	123 (56.9)	123 (56.9)
Total	216 (100)	

Figure 1 show the distribution of the subjects based on the educational status. In the diabetic (study) group, majority of the respondents had post-secondary level of education 70 (32.4%) followed by secondary level 62 (28.7%) and then primary level 51 (23.6%). The least proportion of subjects had no formal education 33 (15.3%). A similar pattern was observed in the control group with majority also in the post-secondary 72 (33.3%), followed by secondary 64 (29.6%) and then primary 60 (27.8%). The least proportion was also in the `no formal` group of subjects.

Table 2 shows the distribution of the subjects based on their occupation. Majority of the respondents were self-employed (34.3%, 39.8%) for both the diabetic and the control groups respectively. This was closely followed by the unemployed group (31.0%, 27.8%) while the least proportion of subjects were non-government employees (8.3%, 8.8%) for diabetic and control groups respectively.

Table 2: Distribution of subjects based on occupation.

Occupation	Diabetics, N (%)	Non-diabetics, N (%)
Government employee	57 (26.4)	51 (23.6)
Non-government employee	18 (8.3)	19 (8.8)
Self employed	74 (34.3)	86 (39.8)
Unemployed	67 (31.0)	60 (27.8)
Total	216 (100.0)	216 (100.0)

Figures 2 and 3 above show the distribution of diabetic and control groups respectively based on their marital status. Majority of the respondents in the diabetic group that had never gotten married was 205 (95%) while 11 (5%) were single. In the control group, a similar pattern was observed with majority being ever married 181 (84%) while 35 (16%) were single.

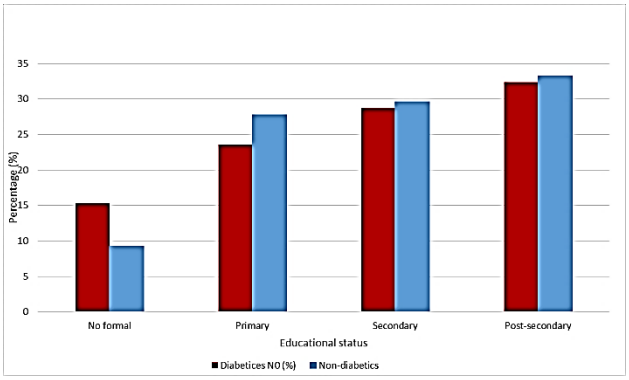

Figure 1: Distribution of subjects based on educational status.

Table 3 shows the distribution of the subjects based on their BMI (prevalence of the various BMI groups in the study population).

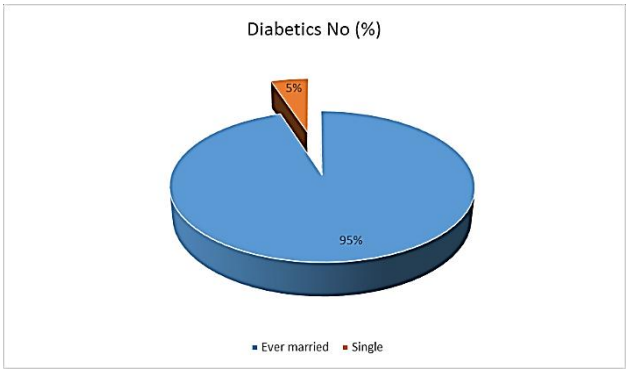

Figure 2: Distribution of diabetic subjects based on their marital status.

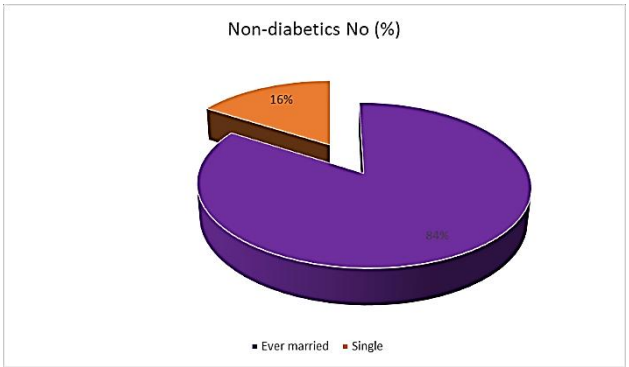

Figure 3: Distribution of the non-diabetic subjects based on marital status.

Among the diabetic study group, the proportion of subjects with higher-than-normal BMI was greater than the proportion with normal BMI. It increased from 24.1% in those with normal BMI to the highest proportion 43.5% in

the overweight subjects. The prevalence of obesity in this group was 32.4%. This shows that diabetic subjects tend to have a higher-than-normal BMI.

On the contrary among the non-diabetic subjects, the proportion of the subjects decreased as the BMI increased from 56.0% in those with normal BMI through 39.4% in the overweight category to 4.6% in the obese group. This showed that the non-diabetic subjects tend to have normal or lower BMI than their diabetic counterpart. The difference observed in these groups was statistically significant, χ^2=72.025, df=2, p value=0.000 showing a tendency for higher-than-normal BMI among diabetics.

Table 3: Distribution of subjects based on BMI (prevalence of various BMI).

BMI category	Diabetics, N (%)	Non-diabetics, N (%)
Normal	52 (24.1)	121 (56.0)
Overweight	94 (43.5)	85 (39.4)
Obese	70 (32.4)	10 (4.6)
Total	216 (100.0)	216 (100.0)

Table 4 depicts the association between dyslipidaemia and obesity (high BMI) in the diabetic subjects. It shows that 91.4% of obese diabetic subjects had dyslipidaemia compared to 82.2% recorded among the non-obese subjects.

This showed that the obese subjects tend to be more dyslipidaemic than the non-obese. This observed association, however, was not statistically significant χ^2=3.199, df=1, p value=0.074.

Table 4: Association between dyslipidaemia and Obesity (High BMI) in the study group.

BMI category	Normal lipid level, N (%)	Dyslipidae-mia, N (%)	Total, N (%)
Obese	6 (8.6)	64 (91.4)	70 (100.0)
Non-obese	26 (17.8)	120 (82.2)	146 (100.0)
Total	32	184	216

Table 5 shows the association between hypertension and obesity in the diabetic subjects. It is observed that 64.3% of obese subjects had hypertension. This was higher than the 45.2% recorded among the non-obese subjects. This showed that the obese subjects have a higher tendency to be hypertensive than their non-obese counterpart. This observed association/difference between obesity and hypertension was statistically significant χ^2=6.895, df=1, p value=0.009.

Table 6 above showed the association between physical activity and obesity (high BMI) in the diabetic subjects. It can be seen that 82.9% of the obese diabetic subjects had inadequate physical activity.

This proportion was greater than the 42.5% recorded in the non-obese group. This showed that the obese subjects tend to have higher inadequate physical activity compared to their non-obese counterpart. This observed difference/association between obesity and inadequate physical activity in this study group was statistically significant χ^2=11.526, df=1, p value=0.001.

Table 5: Association between hypertension and Obesity (high BMI) in the study group.

BMI category	Normal (non-hypertensive), N (%)	Hyperte-nsive, N (%)	Total
Obese	25 (35.7)	45 (64.3)	70 (100)
Non-obese	80 (54.8)	66 (45.2)	146 (100)
Total	105	111	216

Table 6: Association between physical activity and Obesity (high BMI) in the study group.

BMI category	Adequate activity, N (%)	Inadequate activity, N (%)	Total
Obese	12 (17.1)	58 (82.9)	70 (100)
Non-obese	84 (57.5)	62 (42.5)	146 (100)
Total	96	120	216

Table 7 showed the multivariate logistic regression analysis of the associated co-morbidities/risk factors of obesity in the diabetic study group.

Three associated variables which are serum lipid status, physical activity and hypertension status were subjected to logistic regression to determine their independence as risk factor/co-morbidities of obesity among the diabetic subjects.

Table 7: Multivariate regression analysis of co-morbidities/risk factor of obesity (high BMI) in diabetic subjects.

Variables	(OR)	95% CI	P value
Serum lipid status			
Normal	1.0	0.03–29.41	0.997
Dyslipidaemia	3.12		
Physical activity			
Adequate	1.0	3.07–27.48	<0.001
Inadequate	9.19		
Hypertension			
No	1.0	2.02–76.43	0.008
Yes	24.61		

Inadequate physical activity (OR=9.19, 95% CI=3.07-27.48, p≤0.001) and hypertension (OR=24.61, CI=2.02-

76.43, p=0.008) were independently associated with obesity (high BMI) in the study group. Dyslipidaemia was not associated with obesity (OR=3.12, 95% CI=0.03-29.41, p=0.997).

DISCUSSION

Socio-demographic characteristics of the study population

This study has shown that there is a relationship between T2DM and the BMI of adult diabetic patients who were seen at the general out-patient clinic of Federal Medical Centre Owerri. In this group of people, it was observed that the proportion of subjects with higher-than-normal BMI was greater than the proportion with normal BMI. This was more pronounced in the diabetic subjects who tended to have a higher-than-normal BMI as against the control group (χ^2=72.025, p=0.000) (this debunked the earlier stated null hypothesis which said that there was no relationship between diabetes mellitus and BMI among the study group). This finding was in keeping with many previous studies which have reported association between high body mass index and T2DM in men and women.[20,21] The study done by Hart et al also found that the odds ratio for diabetes mellitus was higher in the overweight than in the normal group and highest in the obese group.[22] Compared with the normal weight group age – adjusted, the odds ratio for overweight and obese men were 2.73 (95% CI 2.05-3.64) and 7.26 (95% CI 5.26-10.04) respectively.[22]

There is a higher prevalence of diabetes among females compared to males. Although it is known that females have a better health seeking behavior than their male counterparts in our environment, Nigeria, our study however, showed there was a higher prevalence of diabetics among females compared to males. Similar trends have also been reported in some other studies in Nigeria, Saudi Arabia, United States of America, Nepal, Ghana, and Iran.[23-29] In addition, females tend to be more obese than men as have been found in various studies thereby having a higher risk of developing diabetes than men.[5,23-25] This tendency for women to be more obese than men have been attributed to some factors such as the socio-cultural background, differences in the energy density of diets consumed, variations in physical activity and genetic differences.[23,24]

The proportion of diabetic subjects was observed to increase with advancing age. This agrees with studies which have shown increasing age to be an independent risk factor in the development of diabetes mellitus.[5,24,25,30] T2DM has been considered a disease of middle age and the elderly. This could be due to the fact that obesity increases with advancing age as lifestyle changes (more with physical activities) and metabolic activities diminishes thereby predisposing the elderly to diabetes mellitus.[25] This result obtained in our study was in contrast to the finding observed in Kano North-west Nigeria, which showed no significant relationship between aging and obesity.[31]

Majority of the diabetic respondents had post-secondary level of education (32.4%) followed by the secondary level (28.7%) and then primary level (23.6%). The least proportion of subjects had no formal education. This may be due to westernization of lifestyle, reduced physical activities, more sedentary habits and consumption of high energy, high fat diets commonly seen among the educated and high socioeconomic class in Nigeria. The above finding is similar to other studies done in Nigeria and most developing countries.[32] However, globally it has been shown that the prevalence of diabetes was lower among the educated and the high socioeconomic class because they have access to healthy food, better health seeking behavior and engaged in regular physical activities.[25,26]

Majority of the respondents in the study group had never been married with a proportion of 95.0%. This was in keeping with the finding in Ibadan, Nigeria, by Fadupin et al which reported higher prevalence rate of diabetes and obesity amongst the married subjects.[5] Other studies also supported this finding.[25,33,34] This was probably due to the socio-cultural belief of perceiving obesity as evidence of beauty, good husband care and a general dietary habit of married people` (increased portion during meals) in the study area. Furthermore, married women are likely to be multiparous which is associated with high risk of obesity.[5]

Prevalence of BMI groups among the subjects

Majority of the study group belonged to the overweight (BMI) category with a prevalence rate of 43.5% followed by those in the obese category with a prevalence rate of 32.4%. This higher preponderance of overweight category as compared to the obese group could be due to the fact that this study recruited both newly diagnosed and known diabetics who were already on treatment. Frequent hospital visits which might have afforded the known diabetics some regular counselling sessions on lifestyle modifications for weight reduction might be responsible for this finding. In addition, the use of such anti diabetic agents such as metformin (first line treatment in the management of diabetes) could have also contributed by causing weight loss, thus tipping a lot of the respondents from the obese category into the overweight category.[35]

The prevalence of adult diabetics attending the GOPC of FMC Owerri that had higher than normal BMI (overweight and obese) was 75.9% while 24.1% had normal BMI. The finding that most adults with diagnosed diabetes are either overweight or obese was consistent with the results of the NHANES III study. NHANES III observed that a significant portion of adults with type 2 diabetes were overweight or obese. This aligned with the broader understanding that obesity and being overweight are major risk factors for developing type 2 diabetes.[6,35] In addition, the SHIELD study also revealed that increase in BMI was generally associated with a significant increase in

prevalence of diabetes mellitus.[36,37] However, for both studies, the majority of adults with diabetes mellitus were obese (59% for the SHIELD study, and 51% for the NHANES study). Those overweight and obese accounted for 87% and 82% for the respective studies thus agreeing with the findings of this study. Faeh et al in Keneya reported that the proportion of diabetics that could be attributed to overweight was 60.1% and for obesity as 25.0%.[38] The study of Fadupin et al in Ibadan Nigeria also revealed that 83% of the diabetics were either overweight or obese.[5]

Co-morbidities/risk factor of obesity in the study group

It was also observed that 64.3% of obese diabetic subjects had hypertension as against 45.2% recorded among the non-obese subjects. This implied that the obese subjects had a higher tendency to be hypertensive than their non-obese counterparts. However, a statistically significant association between obesity and hypertension was found among the diabetic patients. This led to the conclusion that there may be a growing number of obese and hypertensive diabetics, and this suggest greater effort to be put towards combating the present trend of cultural and dietary changes in many African communities which tend to produce more overweight, hypertensive and diabetic problems.[39] These findings highlight the burden of hypertension among the study population and corroborate the report that the prevalence of hypertension is on the increase in Nigeria.[40]

In Nigeria, non-communicable diseases such as diabetes mellitus, obesity and hypertension have overtaken communicable diseases as the leading causes of morbidity and mortality.[41,42] While this study found no statistically significant link between obesity and dyslipidemia, it did observe a higher prevalence of dyslipidemia (91.4%) in obese diabetic individuals compared to their non-obese counterparts (82.2%). This suggests a tendency for obese individuals with diabetes to experience dyslipidemia more frequently, despite the lack of a strong, statistically proven correlation in this specific study. However, result from Sheth et al showed in their study that there was a significant direct relationship between obesity and dyslipidaemia among T2DM patients which was different from what was obtained in this study.[43]

Among the obese diabetics, 82.9% had inadequate physical activity as against the 42.5% of non-obese diabetics who did not have adequate physical activity. This study demonstrated a statistically significant association between physical inactivity and obesity in the diabetic subjects (p=0.001), suggesting that participants' weight status did influence their physical activity level or their barriers to being physically active. This was different from results obtained by Mynarski et al and Enyew et al who reported a lack of significant associations between physical activity and BMI of T2DM patients.[44,45]

Implication of the study

The findings of this study have significant implications for early screening and diagnosis of T2DM and obesity. This would reduce missed opportunity for counseling patients on lifestyle modification, educate them on co-morbidities, advise on adherence to medication intake, follow-up visits and treatment plan of the family physician. Also, the study will be relevant for the development of interventions and policies aimed at addressing obesity and T2DM in Nigeria and SSA.

Limitations

The study was hospital based as only patients who presented to the clinic were recruited. This may not have been a true representation of what may be obtained in the larger community. Random sampling is the ultimate goal of most cross-sectional studies; however, it was not possible to adopt. It was not possible to adopt this technique in this study because of the anticipated low patient flow given the time limits for the study. Few local studies, literatures, randomized and meta-analysis data were available for referencing in our environment.

CONCLUSION

This study demonstrated a relationship between T2DM and the BMI of adult diabetic subjects in an African community with a tendency of having a higher-than-normal BMI among the study group. Hypertension was noted as a significant co-morbidity while physical inactivity was a significant associated risk factor for obesity in the study group.

Recommendations

Routine anthropometric measurements should be done for every diabetic patient presenting to the GOPCs, to enable Family physicians discover those with high BMI and subsequently educate them on lifestyle measures to reduce weight and avert further complications. There is the need to closely monitor the blood pressure in T2DM patients and ensure strict blood pressure control. Family physicians should educate and counsel their patients on the need for regular and adequate physical activity. A planned proactive follow up of diabetic patients is necessary. Those with primary co-morbidities should be targeted for risk reduction therapy and appropriate management.

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