Burden of cardiovascular disease risk factors among subjects with Type 2 Diabetes Mellitus in Southeastern Nigeria

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Abstract

Diabetes is associated with a high degree of cardiovascular morbidity and mortality. The co-existence of other cardiovascular risk factors alongside diabetes confers the cumulative risk of adverse outcomes. The prevalence of cardiovascular risk factors has been rising in sub-Saharan Africa, but their degree of co-existence with diabetes is not well known. The objective of this study was to determine the burden of cardiovascular risk factors in patients with Type 2 Diabetes Mellitus (T2DM) in a urban southeastern Nigerian population. This was a cross-sectional study consisting of consecutively recruited diabetic patients aged ≥40 years attending the diabetes clinic at Enugu State University of Science and Technology Teaching Hospital (ESUTH). Five cardiovascular risk factors were evaluated: Hypertension, overweight/obesity, cigarette smoking, physical inactivity, and poor glycemic control We studied 410 T2DM patients (31.5% male) with a mean age of 58.9 years and a mean duration of diabetes of 7.4 years. The most prevalent cardiovascular risk factor in the study was physical inactivity (69.5%), and 80.1% of respondents had 2 or more risk factors. Females had a significantly higher prevalence of physical inactivity, overweight/obesity, and poor glycemic control when compared to males (73% *vs* 62%; 73.3% *vs* 58.9%; 72.2% *vs* 60.5%, respectively). Our study has shown a high burden of cardiovascular risk factors in diabetic patients in an urban southeastern Nigerian population. Female diabetic subjects had a significantly higher prevalence of most of the cardiovascular risk factors except for smoking.

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Introduction

The global prevalence of diabetes has reached pandemic proportions. In 2017, over 450 million adults were living with diabetes worldwide, with an estimated healthcare cost of about 850 million US dollars.[1] With the ongoing successes and advancements in modern medicine, many individuals, including those with Type 2 Diabetes Mellitus (T2DM), are expected to survive into older age and will have to live with cardiovascular diseases such as coronary artery disease, heart failure, and stroke.

It is known that patients with diabetes have 2 to 4 times the risk of cardiovascular morbidity and mortality than individuals without diabetes.[2] The adverse cardiovascular consequences of diabetes are not uniform across all diabetic subjects. The risk of Cardiovascular Disease (CVD) in T2DM may be worsened by the co-existence of other cardiovascular risk factors such as obesity, physical inactivity, hypertension, and smoking.[3] The presence of multiple uncontrolled cardiovascular risk factors in T2DM patients results in a cumulative increase in the observed cardiovascular events and death.[3] It is noteworthy that cardiovascular risk factors may, in fact, precede the development of diabetes.[4] Specific strategies targeted at single or multiple CVD risk factor control in T2DM have been shown to reduce micro- and macrovascular complications as well as cardiovascular death.[3,5-8] Intensive risk factor modification also appears to be more effective than usual care in the reduction of cardiovascular events.[7,8]

Given the established role of risk factor interventions in reducing morbidity and mortality in T2DM, it is imperative to elucidate and characterize the distribution of cardiovascular risk factors in all T2DM populations. Importantly, there is a high degree of heterogeneity in the burden of cardiovascular risk factors across various geographic regions owing to differences in socioeconomic status, lifestyle, and standard of healthcare.[9]

Emerging trends in cardiovascular risk burden in sub-Saharan Africa, such as the increased prevalence of obesity and hypertension, have become a cause for public health concerns.[9] Clearly, this is likely to contribute to worse cardiovascular event outcomes in diabetic populations. More needs to be known about the epidemiologic profile of cardiovascular risk factors in T2DM in sub-Saharan Africa in general and in Nigeria in particular.

In this study, we interrogate the presence and pattern of cardiovascular risk factors in patients with T2DM in an urban southeastern Nigerian population.

Materials and Methods

Study population

This was a cross-sectional study consisting of 410 (129 male) consecutively recruited T2DM patients aged ≥40 years attending the diabetes clinic at Enugu State University of Science and Technology Teaching Hospital (ESUTH). Patients recruited into the study had previously been diagnosed with type 2 diabetes, and this was confirmed by the diabetes register of the clinic.

Informed consent was obtained from each participant. Ethical approval was obtained from the ethics committee ESUTH, Enugu, Nigeria.

Demographic, clinical and biochemical parameters

Demographic information such as age, gender, duration of diabetes, age at diagnosis, smoking status, and level of physical activity was collected using a pre-tested structured questionnaire administered by trained research assistants.

Blood pressure was measured in a sitting position with an Accoson mercury sphygmomanometer using the standard technique.[10]

Weight in kilograms and height in meters were obtained from the weighing scale and stadiometer, respectively.

Body Mass Index (BMI) was calculated by dividing weight in kilograms by the square of height in meters (kg/m^2).

Waist circumference was measured in centimeters using an inelastic measuring tape at the highest point of the iliac crest, parallel to the ground and with the patient in expiration.

One milliliter of venous blood was collected in an Ethylenediaminetetracetic Acid (EDTA) bottle and used for the determination of Glycated Hemoglobin (HbA1c).

Risk factor definitions and thresholds

Five risk factors: hypertension, overweight/obesity, cigarette smoking, physical inactivity and poor glycemic control were evaluated. Hypertension was defined as either systolic blood pressures greater than or equal to 140 mmHg and/or diastolic blood pressures greater than or equal to 90 mmHg,[11] a positive history of hypertension or use of antihypertensive medications.

Being overweight was defined as a BMI >25 but <30 kg/m^2 while obesity was defined as a BMI of 30 kg/m^2 or greater.[12]

Poor glycemic control was defined as Glycated Hemoglobin (HbA1c) >7.0%.[13]

Physical inactivity was defined as engaging in less than 30 minutes of moderate-intensity activity (such as brisk walking, jogging or swimming, *etc*.) per day and/or exercising less than 5 days a week.[14]

Cigarette smoking status was dichotomized into non-smokers and smokers (including current smokers and smokers that had quit within the past 6 months).

Abdominal obesity was defined as a waist circumference of ≥102 cm in men and ≥88 cm in women.[15]

Statistical analysis

Sociodemographic characteristics and cardiovascular risk factors were presented as means ± standard deviation or proportions. Comparisons between groups were made using the Chi-squared test for categorical variables and the Student *t*-test for continuous variables. P<0.05 was considered statistically significant. Data obtained were entered and analyzed using the Statistical Package for Social Sciences (SPSS) version 21.0 software 9 (IBM-SPSS, IBM Corporation, Armonk, NY, USA).

Results

Study population

We studied 410 T2DM patients (31.5% male) with a mean age of 58.9±SD years and a mean duration of diabetes of 7.4 ± SD years. A greater proportion of the patients (61.7%) were in the middle age group (45-64 years).

Females had a significantly higher obesity index than males (BMI 28.7±5.7 *vs* 25.8±4.2 kg/m^2; p<0.001) as well as significantly wider waist circumference (98.4±12.6 *vs* 89.7±15 cm; p<0.001). Table 1 shows the baseline characteristics of the study population stratified by gender.

Prevalence of cardiovascular risk factors

The most prevalent cardiovascular risk factor in the study was physical inactivity (69.5%), closely followed by overweight/obesity combined (68.7%) and poor glycemic control (68.5%). Hypertension (62.4%) was next in prevalence, while cigarette

Table 1. Baseline characteristics of the study population stratified by gender.

Variable	Total (N=410)	Male (N=129)	Female (N=281)	p
Age (years)	58.9±8.7	59.5±10.1	58.0±8.0	0.116
<45	26 (6.3)	12 (9.3)	14 (5.0)	
45–64	253 (61.7)	68 (52.7)	185 (65.8)	0.027
≥65	131 (32.0)	49 (38.0)	82 (29.2)	
Body Mass Index (kg/m^2)	27.7±5.4	25.8±4.2	28.7±5.7	<0.001
Waist circumference (cm)	95.7±14.2	89.7±15.7	98.4±12.6	<0.001
Duration of diabetes (years)	7.4±5.9	7.8±5.8	7.2±6.0	0.377
Glycated Hemoglobin (%)	8.4±2.1	8.3±2.1	8.5±2.0	0.416

smoking was the least encountered cardiovascular risk factor (13.9%) (Figure 1).

Number of cardiovascular risk factors

Of our study population, almost 98% had at least one risk factor. Seventeen point six percent had only one risk factor, 42.4% had two risk factors, 33.4% had three risk factors, 4.1% had four risk factors, and only 0.2% had all five of the risk factors we evaluated. Eighty point one percent of the study population had 2 or more co-existing risk factors (Figure 2).

Stratification of cardiovascular risk factors by gender

While only 13.9% of our study population smoked, the prevalence of smoking in males was significantly more than it was in females (33.3% *vs* 5.0%; p<0.001).

Females had a significantly higher prevalence of physical inactivity, overweight/obesity, and poor glycemic control when compared to males (73% *vs* 62%; 73.3% *vs* 58.9%; 72.2% *vs* 60.5%, respectively).

The prevalence of hypertension was higher in females than in males (64.4% *vs* 58.1%), but this was not statistically significant.

The mean number of cardiovascular risk factors per patient in both males and females was comparable (2.2±0.9 *vs* 2.2±0.8; p=0.673)

Table 2 shows gender differences in cardiovascular disease risk factors in the study population

Discussion

The prevalence of diabetes in Nigeria has been rising over the past few decades as it has in other parts of sub-Saharan Africa.[16,17] T2DM results in excessive cardiovascular morbidity and mortality with a burden that tends to accrue partly due to the presence of co-existing cardiovascular risk factors.[2,3] The profile of cardiovascular risk factors in T2DM patients in Nigeria has not been well studied. In this study we determined the presence and pattern of cardiovascular risk factors in patients with T2DM in an urban southeastern Nigerian population. We further provide recommendations that we believe will help inform health policy as it concerns the management of diabetes in Nigeria.

In this study, a high burden of cardiovascular risk factors was found, with almost 98% of study participants having at least one cardiovascular risk factor in addition to T2DM. Also, 80.1% of participants had two or more cardiovascular risk factors (*i.e.* multiple risk factors). Only a very small proportion of study participants had all five cardiovascular risk factors. A comparably high CVD risk factor burden was observed by Mokta J. and colleagues[18] in T2DM patients in a rural Indian population. Agede and Zheng[19] also made similar findings in an urban population in the United States. Furthermore, CVD risk burden has been found to be significantly higher in diabetic than non-diabetic populations.[20] The high CVD burden found in our study, as in others may not be unexpected. There exists a complex interrelationship among several cardiovascular risk factors for example, physical inactivity may contribute to obesity which may, in turn, promote the development of hypertension, insulin resistance and, ultimately, T2DM. The tendency for cardiovascular risk factors to cluster in individuals has been well established and the term metabolic syndrome or Raeven's syndrome has been used.[20]

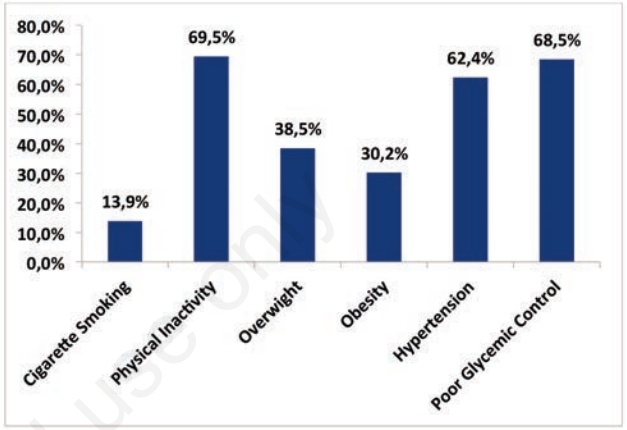

Figure 1. Prevalence of cardiovascular disease risk factors in the study population of subjects with Type 2 Diabetes Mellitus.

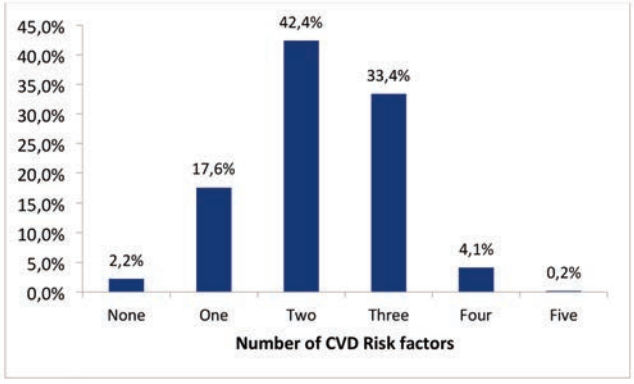

Figure 2. Cardiovascular disease risk factor burden per patient in the study population of subjects with Type 2 Diabetes Mellitus.

Table 2. Gender differences in cardiovascular disease risk factors in the study population.

Variable	Male (N=129)	Female (N=281)	p
Cigarette smoking	43 (33.3)	14 (5.0)	<0.001
Physical inactivity	80 (62.0)	205 (73.0)	0.025
Overweight/obesity	76 (58.9)	206 (73.3)	0.003
Hypertension	75 (58.1)	181 (64.4)	0.223
Poor glycemic control	78 (60.5)	203 (72.2)	0.017
Number of CVD risk factors*	2.2±0.9	2.2±0.8	0.673

CVD, Cardiovascular Disease. *Data are in mean ± SD.

Modification or control of these CVD risk factors in T2DM has been shown to reduce its micro- and macrovascular complications as well as associated cardiovascular death.[3,5-8] In particular, intensive as well as simultaneous multiple risk factor modification in diabetes has been shown to provide improvement in cardiovascular morbidity and mortality.[5-8,21] These observations present an opportunity to mitigate the adverse CVD outcomes seen in T2DM.

The Centers for Disease Control and Prevention (CDC) reports that 64.8% of diabetic patients have comorbid hypertension, and this is closely mirrored in our study, which showed a prevalence of 62.4%.[22] The high prevalence of hypertension in our study population is of serious concern because its co-existence with diabetes increases the incidence of cardiovascular morbidity and mortality.[23] Although the threshold of hypertension was set at systolic Blood Pressure (BP) ≥140 mmHg and/or diastolic BP ≥90 mmHg, in order to make it comparable to other studies, the recommended BP threshold for diabetic patients with additional cardiovascular risk factors is systolic BP ≥130 mmHg and/or diastolic BP ≥80 mmHg.[24] Persistent efforts should be made towards aggressive BP control in diabetic patients. Every physician/healthcare provider contact should be considered an opportunity to measure blood pressure, counsel the patient and adjust treatment if required.

Considered together, overweight and obesity were the second most prevalent cardiovascular risk factor in our study. This study and others have shown a high prevalence of overweight/obesity in diabetic subjects.[22,27] The twin epidemics of diabetes and obesity are so intricately linked that the term "diabesity" has been used.[27] For T2DM to occur, both peripheral insulin resistance and some degree of pancreatic β-cell dysfunction have to be present.[28] In obese individuals, adipose tissues release adiponectin, leptin, Non-Esterified Fatty Acids (NEFAs), pro-inflammatory cytokines and glycerol which promote insulin resistance.[29,30] This also appears to be worse in those that accumulate fat centrally and can be quantified indirectly using waist circumference.[29,31,32] We found a significantly higher prevalence of overweight/obesity defined by BMI (a general obesity index) in females than in males. Furthermore, the average waist circumference (a central obesity index) in women was significantly higher than in males (despite a lower reference cut off point in the former). This gender disparity in both central and peripheral obesity, particularly in black women, has been previously reported.[32,33] In the African context, Ojofeitimi *et al*.[34] have previously reported that obesity is culturally acceptable where it is considered a sign of affluence. Women are also more likely to gain weight during pregnancy and this may not be fully shed after delivery. In addition, changes in diet, physical activity and sleep, all consequences of urbanization, are also likely to be drivers of this epidemic in our population. A lot needs to be done at the policy, healthcare and individual levels. For example, a significant tax on sugary soft drinks could be an effective tool to discourage their consumption. Similarly, provision of open spaces and parks will afford children and adults the opportunity for exercise that is dearly needed to stem the dangerous acceleration towards society-wide obesity. It should be noted that weight is not the only determinant of diabetes. Asians, who generally have lower BMI than other ethnic groups, have a higher prevalence of diabetes than caucasians.[35]

More than two-thirds of our study participants were physically inactive, which appears higher than the prevalence of 34% reported by the CDC. This may be due to the specific definition of physical inactivity adopted in this study.[8,22] Diabetic subjects are less likely to meet guideline recommendations for physical activity than people without diabetes.[36] In our study, the proportion of females who were physically inactive was significantly higher than males. This may partly be explained by the fact that a higher proportion of our study participants were middle-aged, a group in which males are more likely to engage in physically tasking activities as part of daily living. Sedentary behaviors are also becoming the societal norm as people spend many hours in front of screens such as televisions, phones and computers. There is also wider availability of automobile transport, particularly in the urban setting of our study. Physical inactivity has been associated with the development of non-communicable diseases such as diabetes, hypertension, coronary artery disease, and stroke.[37,38] As discussed for obesity, physical inactivity should be tackled at the policy level, such as the promotion of school sports, the creation of open spaces and parks. Health education strategies should also be improved.

The majority of our study population had poor glycemic control, and this was worse in females compared to males. These findings are consistent with other studies done in Nigeria and other countries that have shown a high prevalence of poor glycemic control in diabetic patients.[22,39-43] Poor glycemic control has been associated with a greater degree of diabetic complications, particularly microvascular complications such as retinopathy, nephropathy and neuropathy.[8,44] Factors associated with poor glycemic control have been identified and include lower income level, lack of health insurance, obesity, inappropriate diet, inadequate diabetes knowledge and low adherence to antidiabetic medications.[39-41] Gender differences in the phenotype and clinical course of diabetes may be due to influences of biology, culture, lifestyle, environment, and socioeconomic status.[45] These factors probably interact in a complex manner, for example, in our study, females were more likely to be obese and physically inactive. Also, in our environment, females are more likely to be socioeconomically deprived than males. These factors may have contributed to a greater tendency for poorer glycemic control in females. In addition, females with Gestational Diabetes (GDM) have a significantly increased risk of developing diabetes.[46]

Smoking is associated with an increased risk of developing T2DM in both males and females.[47] It was the least encountered cardiovascular risk factor in our study population. About a third of male subjects were smokers, and this was significantly more than in females. This disparity is not surprising as smoking among Nigerian women is culturally anathema. However, the prevalence of smoking among male diabetic subjects is a matter of concern. The adverse effects of smoking on cardiovascular health have been well documented.[48] The combined effect of smoking and diabetes can accelerate and worsen atherosclerotic cardiovascular disease.[47,49] It has been said that quitting cigarette smoking is the single most important contribution that a person can make to their cardiovascular health.[50] Aggressive smoking cessation campaigns should be undertaken to discourage smoking in both diabetic and non-diabetic populations.

In conclusion, our study has shown a high burden of cardiovascular risk factors in diabetic patients in an urban southeastern Nigerian population. Female diabetic subjects had a significantly higher prevalence of most of the cardiovascular risk factors except for smoking.

Our study has some limitations. Firstly, we did not measure serum lipids and were, therefore, unable to assess dyslipidemia which is an important cardiovascular risk factor. This was due to financial constraints as the study was funded solely by the investigators. Secondly, data on physical activity was based on self-report and their accuracy cannot be guaranteed.

Conclusions

Diabetic health education, which can be led by trained personnel such as nurses, pharmacists, and dieticians, must be improved. Greater emphasis should be placed on physician-driven counseling and they, in turn, should receive formal training on counseling techniques.

Specific attention should be given to the female diabetic patient. This should entail sociocultural reorientation where necessary. The period of pregnancy provides a unique opportunity for screening and detection of gestational diabetes. Follow-up of GDM patients should link seamlessly with dedicated diabetic clinics.

At the policy level, school sports programs should be revitalized. Open parks and spaces should be provided to promote exercise. Unhealthy commodities such as junk food, sugary drinks and cigarettes should be taxed in such a way as to discourage their abuse.

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