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Assessment of anthropometric and biochemical parameters among type 2 diabetes mellitus adult subjects in Port-Harcourt, Nigeria

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Abstract
Background: Type 2 Diabetes mellitus (T2DM), a major cause of morbidity and mortality both in developing and developed countries, is associated with changes in biochemical and anthropometric parameters.
Materials and Methods: A cross-sectional study of 90 adult subjects consisting of 30 newly diabetic, 30 known diabetic and 30 non-diabetic subjects was done. The Ages, Body Mass Index (BMI) and Waist-Hip Ratio (WHR), were determined. Fasting blood sugar, glycated haemoglobin and fasting lipid profile were determined using standard protocols.
Results: The BMI among the study population showed that 42.7% were overweight and 35.0% obese. Among the diabetic subjects, obesity was 40.0% (newly diabetic) and 36.7% (known diabetic). Waist hip ratio was significantly ($P<0.05$) increased in diabetic subjects (0.95±0.60) compared to non-diabetics (0.92±0.11). The plasma cholesterol, triglyceride, high-density lipoprotein and low-density lipoprotein profile of non-diabetic subjects were 4.06±1.24, 1.02±0.25, 1.23±0.32, 3.08±0.06, while those of the diabetic subjects were 5.26±1.12, 1.17±0.05, 0.92±0.41, 3.90±0.60 respectively, with statistically significantly ($P<0.05$) difference. Low-density lipoprotein was significantly ($P<0.05$) higher in newly diabetics (3.13±0.78) compared to known diabetic (3.04±0.48) subjects. Fasting blood sugar was significantly ($P<0.05$) higher in diabetic (7.68±3.45) than non-diabetic (5.74±1.12) subjects. Glycated haemoglobin was significantly ($P<0.05$) lower in the known diabetic (5.98 ± 1.92) compared to the newly diabetic (7.22 ± 2.99) subjects.
Conclusion: Among adult T2DM subjects in Port Harcourt, the majority were overweight and obese, with impaired lipid and glycated haemoglobin profiles.

Keywords: diabetes mellitus, anthropometric parameters, lipid profile, glycated haemoglobin

Introduction

Diabetes mellitus defined as a metabolic and endocrine disorder of diverse etiologies is typically characterized by disturbances of carbohydrate, fat and protein metabolism leading to a state of chronic hyperglycemia resulting from defects of insulin secretion, insulin action or both. Symptoms include polyuria, polydipsia, weight loss, sometimes polyphagia and blurred vision [1].

Non-communicable diseases including Diabetes mellitus has been described as "a public health emergency in slow motion." in assuming epidemic proportions with an estimated 415 million adults affected worldwide [2].

In Africa, approximately 14.2 million adults aged 20–79 years have been diagnosed with diabetes mellitus. Mortality from the disease accounts for 2%–3% of deaths in Sub-saharan Africa [2].

An estimated prevalence of than more than 4 million cases and an alarming 2 million undiagnosed cases in Nigeria has been reported [3]. Modernization and Western lifestyle changes imbibed by Nigerians is contributing to an increase in the disease frequency and cuts across all works of life. [4]

The majority of diabetic subjects are either obese or overweight resulting from the development of insulin insensitivity and secretion with other biochemical consequences [5].

Diabetic subjects generally suffer from greater adverse metabolic effects as their visceral fat depot is a major determining factor for insulin sensitivity than similarly overweight subjects with fat stored predominantly in subcutaneous sites [6].

In Nigeria, there is a paucity of reports assessing the anthropometric and biochemical parameters of type 2 diabetic subjects in various populations, especially in Port Harcourt, Rivers State; hence, the purpose of this study.

Materials and Methods

Study Area and Population: The study was carried out in the Medical Outpatient Clinic (MOPC) and Medical Wards of the University of Port-Harcourt Teaching Hospital (UPTH), Nigeria. A total number of 90 subjects consisting of 30 newly diagnosed diabetics (diagnosed during the study period); 30 previously known diabetics (≤ 5 years duration), based on the subjects' history of onset of the DM; and 30 apparently healthy individuals (control); all within the age range of 18 to 80 years were used for this study. The sample size was determined using the 'precise prevalence of diabetes mellitus in Nigeria' formula described by Uloko *et al* [7].

The selection of diabetic subjects was initially based on the physician's provisional diagnosis and then confirmed by the fasting plasma glucose of more than 7mmol/L or 2 hour post

glucose load ≥ 11mmol/L (8) or glycated haemoglobin ≥6.5% IDF [9]. The previously known DM subjects were already on drugs such as insulin and some oral hypoglycaemic agents. The control subjects were selected from staff, students, and retirees of the University of Port Harcourt Teaching Hospital and the University of Port Harcourt respectively who are apparently healthy and non-diabetic.

Collection and Analyses of Data: A structured questionnaire was administered to obtain the demographic data and other disease-related variables: Age, Sex, Marital status, occupation, family history of Diabetes etc. Weight was measured using a mechanical weighing scale with the subject wearing only light clothing and adjusted to the nearest 0.2Kilograms, and height to the nearest 0.01 meter by stadiometer. Waist circumference was measured midway between the inferior margin of the last rib and the iliac crest and hip circumference at the widest point of the buttocks to the nearest 0.01 meter by tape measure [10]. Blood pressure and resting heart rate measurements were obtained from each subject's arm at heart level using an OMRON-M4 semi-automatic sphygmomanometer with an appropriate-sized cuff [11]. All anthropometric measurements were obtained twice and the mean recorded. Blood samples for biochemical analysis were collected and stored in fluoridated tubes and centrifuged within an hour of being withdrawn to separate plasma from red cells. Aspirated plasma aliquots were preserved at 2-8oC in refrigerators. Fasting Plasma glucose was assayed by the glucose oxidase method [12]; Glycated haemoglobin was assayed by the Boronate affinity method using the HbA1C kit (In 2it Tm system from Bio-rad) [13]. Serum Fasting cholesterol (TC mg/dl) was determined by an enzymatic colourimetric method [14], Triglycerides (TGs mg/dl) was determined by an enzymatic method, [15] High-density lipoprotein (HDL mg/dl) was also estimated by a precipitant method, [16] while Low-density lipoprotein (LDL mg/dl) and very-LDL (VLDL mg/dl) was calculated using Friedewald's formula [17]. The lipid profile of the individuals was classified based on the Adult Treatment Panel III model of the National Cholesterol Educational Program and glycemic control as per the criteria laid in 2018 by the American Diabetic Association [18].

Statistical Analyses of Data: All data were analyzed using the commercially available statistical package for social sciences (SPSS) version 26.0 analytic software. Data were expressed as mean ± standard deviations and percentages. Continuous variables were compared with the Students t-test or one-way analysis of variance (ANOVA) as considered appropriate. All tests were considered statistically significant at the P-value (<0.05).

Results

The mean age of the subjects studied was: 55.13 ±12.93 years (non-diabetic), 57.93 ±11.49 years (newly diabetic) and 54.43±9.3 years (known diabetic) respectively.

The prevalence of BMI among the study population showed that 42.7% were overweight and 35.0% were obese, while among the diabetic subjects, overweight was 40.0% (Known Diabetic) and 43.3% (New Diabetic), with 40.0% of the newly diagnosed and 36.7% of the previously known diabetic, being obese, as shown in table 1. Also, there was a statistically significant (P<0.05) difference in the Waist/Hip ratio between the known diabetic and newly diabetic subjects (Table 2).

Table 1: BMI classification of the Total Study population and the Diabetic population

BMI	Class	Known Diabeticn (%)	New Diabeticn (%)	Total Population (Non Diabetic + Diabetic)n (%)
<18.50	Underweight	0	0	0
18.5 - 24.99	Normal	7 (23.3)	5(16.7)	20 (21.3)
25.0 - 29.99	Overweight	12 (40.0)	13 (43.3)	38 (42.7)
≥30	Obese	11 (36.7)	12 (40.0)	32 (36.0)

Table 2: The Waist/Hip Circumference of the Diabetic subjects in the study population.

Parameters	Known Diabetic n=30	New Diabetic n=30	Z-test (p-value)
Waist-Hip ratio	0.92±0.11	0.95±0.60	0.04*

Values were expressed as mean ± S.D. (Standard Deviation). Significant difference at P<0.05.

Results for the biochemical parameters among the study population (table 3) shows that, among the diabetic subjects, there was a significant (P<0.05) increase in the serum level of fasting blood sugar, triglyceride, and high-density lipoprotein cholesterol, with a non-significant (P>0.05) increase in total cholesterol, when compared with the non-diabetic control subjects. However, low-density lipoprotein decreased significantly (P<0.05), when compared with the non-diabetic control subjects.

Furthermore, a comparison among the diabetic subjects (table 4) shows a significantly higher level of glycated haemoglobin (P=0.01), with a significantly lower level of LDL (P=0.01) among the newly diabetic subjects, compared to the known diabetic subjects. However, no significant difference (P>0.05) was observed in Fasting blood sugar, Total cholesterol, Triglycerides, and High-density lipoprotein cholesterol levels between subjects in the known diabetic and newly diabetic groups.

Table 3: Fasting blood sugar and lipid profile parameters of subjects in the study population

Parameters	Non Diabetic (n=30)	Diabetic population (n=60)	Z-test (p-value)
Fasting blood sugar	5.74±1.54	7.68±3.45	0.01*
Total cholesterol (mmol/1)	4.06±1.24	5.26.±1.12	0.05*
Triglycerides(mmol/l)	1.02±0.25	1.17±0.05	0.01*
High density lipoprotein cholesterol (mmol/1)	3.08±0.06	3.90±0.60	0.01*
Low density cholesterol (mmol/l)	1.23±0.32	0.92±0.41	0.01*

Values were expressed as mean ± S.D. (standard deviation). Significant different at P< 0.05.

Table 4: Fasting blood sugar, glycated haemoglobin, and lipid profile among Diabetic subjects in the study population

Parameters	Known Diabetic n=30	Newly Diabetic n=30	Z-test (p-value)
Fasting blood sugar (mmol/l)	7.37±3.58	7.54±3.38	0.85
Glycated Haemoglobin (%)	5.98±1.92	7.22±2.99	0.01*
Total cholesterol (mmol/l)	5.07±1.29	5.04±1.16	0.6
Triglycerides(mmol/l)	1.48±0.55	1.50±0.46	0.17
High density lipoprotein cholesterol(mmol/1)	0.98±0.16	0.97±0.21	0.12
Low density lipoprotein cholesterol (mmol/l)	3.13±0.78	3.04±0.48	0.01*

Values were expressed as mean ± S.D. (Standard deviation); Significance difference at P<0.05.

Discussion

In the study, most of the diabetic subjects belonged to the overweight and obese category (BMI > 30 kg/m2) as shown in table 1. A multicenter and population-based study has also reported high BMI and impaired lipid profile in subjects with diagnosed T2DM [19].

Different categories of obesity and being overweight, as measured by BMI, has been established as an independent risk factor for type 2 diabetes and metabolic syndrome. A vast majority of type 2 diabetic patients are overweight, and obesity undoubtedly plays a major role in the development of the disease and may be the cause of the reduction in BMI of our non-diabetic population compared with the diabetic population.

There is a close relationship linking BMI and risk of developing T2DM, with the relative risk of T2DM increasing progressively with BMI. For one kilogram of weight accumulated or lost annually over 10 years, there is a 49% increase or 33% reduction in the risk of developing T2DM in the subsequent 10 years [20]. Several risk factors responsible for the increasing incidence of T2DM in developing countries include unhealthy eating habits (consumption of fat-laden and high energy-dense foods) coupled with almost sedentary activity due to the availability of alternative modes of transportation, advanced age and modernization [21]. Thus, the risk of the development of obesity is increased with urbanization. Obesity increases the risk of DM 7-fold when compared to normal-weight [22]. Increased waist-hip ratio is a significant risk factor for the development of T2DM [23]. Comparing the waist-hip circumference among the diabetic and the non-diabetic population, showed a higher value among the newly diabetic population compared with the non-diabetic individuals and the previously known diabetic subjects (as shown in Table 2). Schmidt *et al* have shown that the waist-hip ratio is known to predispose to the development of diabetes mellitus and can also worsen preexisting or untreated diabetes. This in turn increases the risk of cardiovascular disease, especially when associated with high levels of triglycerides [24]. The result obtained from this study also showed significantly (P<0.05) higher mean plasma glucose in diabetic subjects compared to the non-diabetics. This satisfies the American Diabetes Association definition of Diabetes Mellitus, as a metabolic and endocrine disorder of diverse etiologies, typically, characterized by disturbances of carbohydrate, fat and protein metabolism leading to a state of chronic hyperglycemia resulting from defects of insulin secretion, insulin action or both [1]. The fasting blood glucose was most elevated among the newly diabetic individuals compared with other subjects. This suggests that blood glucose was better controlled in the known diabetic individuals who are compliant with their medications together with lifestyle modification. The higher level of glycated haemoglobin (HbA1c) observed among the newly diagnosed diabetic subjects could be due to impaired glucose homeostasis, decreasing sensitivity of peripheral tissues due to the hormonal effects of insulin and the fact that they are drug-naive with no formal diabetic education on lifestyle modification and treatment. This result agrees with the report of Pearl [25]. The abnormal haemoglobin A1c (HbA1c) observed among diabetic subjects predicts a time-integrated marker of glycemic control and predicts the risk of coronary heart disease [26].

In this present study, Total Cholesterol, Triglycerides and high-density lipoproteins increased, whereas low-density lipoprotein cholesterol levels among diabetics as compared to controls. This pattern of lipid profile in diabetics is well documented and agrees with previous reports [27].

The high total cholesterol levels observed in the diabetic population compared with the non-diabetic subjects may have resulted from increased lipolysis resulting in excess production of fatty acids. These large quantities of extra fatty acids in the liver are converted into cholesterol along with triglycerides and are discharged into the circulation as lipoproteins; Very Low-Density Lipoproteins (VLDL) and Low-Density Lipoproteins (LDL). Most of the LDL-cholesterol receptors found on the hepatic cell surface increase intracellular cholesterol accumulation due to increased synthesis and reduce the uptake of cholesterol by the LDL receptors thereby potentiating plasma LDL concentration. This in turn leads to either a decreased clearance of VLDL–cholesterol and LDL–cholesterol from the circulation or increased production of VLDL- cholesterol in the liver, leading to an increase in the plasma VLDL and LDL concentrations [28].

Conclusion

The results of the present study suggest that subjects diagnosed with T2DM have an increased abnormality in both anthropometric and biochemical parameters. Understanding these risk factors can help further prevent the development of T2DM and provide better strategies for combating the disease.

Ethical Approvals for this study were obtained from the Research and Ethics Committees of the University of Port Harcourt (UPH/CEREMAD/REC/MM78/018), and the University of Port Harcourt Teaching Hospital (UPTH/ADM/90/S.II/VOL.XI/1189), respectively. Also, verbal and written consent to participate in the study were obtained from all the subjects.

Disclosures: Nothing to disclose

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