Scientific Research Publishing

Journal of Diabetes Mellitus, 2018, 8, 131-144
http://www.scirp.org/journal/jdm
ISSN Online: 2160-5858
ISSN Print: 2160-5831

Diabetes and Pre-Diabetes among Adults in an Urban Slum in South East Nigeria

Birinus Adikaibe Ezeala-Adikaibe[1,2*], Nkeiruka Mbadiwe[1], Celestine Okwara[1], Obinna Onodugo[1], Chinwe Onyekonwu[1], Uchenna Ijoma[1], Oluchi Stella Ekenze[1], Casmir Orjioke[2], Peter Chime[2], Eddy Aneke[1], Chidimma Brenda Nwatu[1], Ekenechukwu Young[1], Obumneme Anyim[2]

[1]Department of Medicine, University of Nigeria Teaching Hospital, Enugu, Nigeria
[2]Department of Medicine, Enugu State University Teaching Hospital, Enugu, Nigeria
Email: *birinusadikaibe@gmail.com

How to cite this paper: Ezeala-Adikaibe, B.A., Mbadiwe, N., Okwara, C., Onodugo, O., Onyekonwu, C., Ijoma, U., Ekenze, O.S., Orjioke, C., Chime, P., Aneke, E., Nwatu, C.B., Young, E. and Anyim, O. (2018) Diabetes and Pre-Diabetes among Adults in an Urban Slum in South East Nigeria. *Journal of Diabetes Mellitus*, **8**, 131-144.
https://doi.org/10.4236/jdm.2018.84013

Received: September 7, 2018
Accepted: October 20, 2018
Published: October 23, 2018

Abstract

Background: Despite the rising prevalence of diabetes in Nigeria and sub-Saharan Africa, few studies have assessed the prevalence of prediabetes and diabetes in people with low socioeconomic status or urban slums. **Methods:** Using the WHO STEP-wise approach to surveillance of noncommunicable diseases, we estimated the prevalence of diabetes and prediabetes among adults 20 years and older living in two urban slums in Enugu south east Nigeria. Diabetes was defined as previous history of diabetes, use of hypoglycemic agents and fasting blood glucose within the diabetes range on two occasions during the survey period. Study duration was 5 months. **Results:** Out of the 811 individuals invited to the clinic, 605 (74.6%) participants had their fasting blood glucose measured based on the study protocol. The prevalence of diabetes and prediabetes in the population was 11.7% (95% CI; 9.2 - 14.3) and 7.6% (95% CI; 5.0 - 9.7) respectively. About 54.9% were newly detected and 28.1% of them had normal control. The prevalence of diabetes peaked at 55 - 64 years. The odds ratio for diabetes was significantly higher in participants ≥ 45 years (1.033, 95% CI; 1.208 - 3.420), participants with hypertension (0.442, 95% CI; 0.257 - 0.762) and stroke (1.638, 95% CI; 0.459 - 5.848). **Conclusion:** There is a relatively high prevalence of diabetes among adults in two urban slums in Enugu. Public health educational measures promoting prevention and early detection of diabetes should be encouraged. Efforts should be made to educate the populace on the need for early detection and treatment.

Keywords

Diabetes, Nigeria, Obesity, Prediabetes, Epidemiology, Urban Dwellers

1. Introduction

Diabetes is rising in sub-Saharan Africa (SSA) [1]-[6] and presents a critical public health challenge and an important target for public health education. The World Health Organization (WHO) estimated that the prevalence of diabetes in the African Region is 8.7% and 8.5% in males and females respectively. The prevalence of diabetes in Africa varies between countries with rural-urban gradients and Northern African having a higher prevalence [7] [8] [9] [10]. In Nigeria, this varies from 0.65% in rural Mangu (North) to 11% in urban Lagos (South) [6] [8] [9]. The highest WHO prevalence estimate of diabetes (17.3%) in SSA is among males in Equatorial Guinean and the lowest (5%) in Burundi [3]. However, this estimate included a wide age-range of participants and therefore does not provide information on people living in urban slums who may have higher risk of the disorder [11] [12] [13].

Most type 2 diabetes patients go through a "pre-diabetes" phase for several years [14] [15]. Early detection and treatment of diabetes in the pre-diabetic stage is not only cost-effective, but reduces morbidity and presents an affordable model for care in resource poor countries. In Uganda, the prevalence of prediabetes was estimated to be 8.6% (95% CI 7.3 - 10.2) using WHO criteria and 20.2% (95% CI 17.5 - 22.9) with American Diabetes Association (ADA) criteria [10].

Low socioeconomic status has been associated with both incidence and mortality in diabetes [16] [17] and most slum dwellers fall into this group [18]. Poor nutrition and lack of access to standard medical care predispose these individuals to high rates of diabetes and pre-diabetes [16] [17] [19]. Little is known about the prevalence of diabetes in people with low socio-economic status in Nigeria. Though a number of studies provide data about diabetes and prediabetes in SSA [6] [8] [9], none has focused on special populations such as urban slum dwellers. Without prevalence data, it is difficult to justify targeted screening for high risk persons, the percentage of the population requiring long-term care and the cost treatment will remain unclear. The aim of the present study was to estimate the prevalence of diabetes and prediabetes among people aged 20 years and above (determined by fasting plasma glucose, FPG) in two urban slums.

2. Methods

2.1. Setting

Using a purposive sampling method, we selected 2 isolated urban settlements (Agu-Abor and Ugbodogwu) in Enugu, the capital of Enugu State, south east Nigeria. The two settlements have an estimated adult population of 7000 - 9000 individuals (based on church and local records). The total area occupied by both settlements is approximately 2.5 - 5 km^2 and are located about 1 - 2.5 km from the nearest state-owned teaching hospital. The two settlements were selected purposively because of their relatively isolated location. The inhabitants of Agu-Abor were surveyed over a 4-week period (August 12-September 9, 2013), while Ugbodogwu inhabitants were surveyed between November 25 and De-

cember 21, 2013. This study was approved by the ethics committee of the University of Nigeria Teaching Hospital Ituku/Ozalla, P M B 01129 Enugu. No NHREC/05/01/2008B-FWA00002458-1RB00002323. Date of approval 28th July 2013.

2.2. Study Design

A cross-sectional descriptive study was done to survey the adult population living in both localities. In order to facilitate the participation of the populace, sensitization meetings in the community which included both religious and elected leaders. Community-wide awareness announcements were carried out in churches and by town criers followed by sensitization meeting(s) on selected days. Following community entry, all participants who came out for the survey were interviewed by teams of research assistants. Using the WHO STEPS instrument [20] data on selected socio-demographic characteristics and lifestyle behaviors including, physical activity was collected. Inclusion criteria were all consecutive consenting adults 20 years and above, while the exclusion criteria were refusal to participate. Pregnant women, patients on steroids and individuals who could not be weighed or have their heights were interviewed but their data were not included in the final analysis. Clinical assessment of the participants was carried out in a field clinic. Data on weight, height, blood pressure, fasting blood glucose as well as past medical history were collected at this phase of the study. Only data on behavioral and physical measurements were collected. Biochemical measurements (excluding fasting blood glucose) were not done.

Fasting blood glucose (FBG) was measured using a glucometer (Fine test premium, Infobia co Ltd., Dongan-gu. South Korea) after an overnight fast. Fine test coding strips contains glucose oxidase and potassium ferricyanide and displays results between 0.6 - 33.3 mmol/L with a coefficient of variation of <10%. Accuracy of the results obtained from the Fine test meter compared with Hitachi glucose auto analyzer 747 and showed a system accuracy within ±0.8 mmol/L of 100%. Fine test control solution was used to check and test strips to make sure they are properly working. Participants with fasting blood glucose within normal range on two consecutive measurements (measured 2 - 5 days apart) were considered as having normal blood glucose [14]. If blood glucose was abnormal in two occasions it was categorized as prediabetes or diabetes. Subjects with one abnormal glucose levels were referred for glucose tolerance test in teaching hospital and were not included in the study.

Blood pressure was measured after 5 - 10 minutes rest in a sitting position and was measured thrice by means of mercury sphygmomanometer according to the guidelines of the European Society of Hypertension [21]. The measurements were done by one of the investigators or a doctor not below the rank of a registrar who was trained for the study from the department of medicine, UNTH using mercury sphygmomanometers and stethoscopes. All blood pressure measurements were obtained from the non-dominant arm. Systolic blood pressure (SBP) and diastolic blood pressures (DBP) were taken at the first and fifth Korotkoff sounds, respectively. The mean of 3 consecutive blood pressure meas-

urements was documented. Weight was measured using a standard bathroom scale in kilograms (nearest 0.5 kg). Scales were calibrated and recalibrated on daily basis by re-adjusting their pointers to zero. At the beginning of the study, scales were compared with standard scales used in the hospital. Bathroom scales were used because of cost and availability. Height was measured in centimetres using a straight centimetre ruler with the patient standing erect on a flat surface. Body mass index (BMI) was calculated as weight (Kg) divided by squared height (m^2) and categorized as underweight < 18.5 kg/m^2, normal weight 18.5 - 24.9 kg/m^2, Overweight 25 - 29.9 kg/m^2, Obese ≥ 30 kg/m^2. Obesity was defined as BMI ≥ 30mg/m^2 based on WHO criteria [22]. Patients with impaired fasting blood glucose were subsequently referred to the state hospital for follow-up.

Classification of diabetes and prediabetes was based on the WHO criteria [23].

FBG < 6.1, mmol/L, n(%)-normal range

FBG 6.1 - <7, mmol/L, n(%)-Prediabetes range

FBG ≥ 7, mmol/L, n(%)-Diabetes range

Definition of diabetes included two categories:

1) Previous diabetes and/or use of hypoglycemic agents;
2) FBG within the diabetic range on two occasions during the survey period.

Awareness was assessed based on past medical history of diabetes diagnosed by a health professional. Normal blood glucose control was defined as normal FBG measurements in individuals taking hypoglycemic agents at the time of survey. Individuals with systolic blood pressure (SBP) of ≥140 mmHg and/or diastolic blood pressure (DBP) of ≥90 mmHg, past medical history of hypertension and/or use of anti-hypertensive drugs were considered as having hypertension. Stroke was defined as a clinical syndrome of rapidly progressive symptoms and signs of focal or global neurological deficit lasting more than one hour of which there is no apparent cause other than vascular origin, and/or past medical history stroke diagnosed by a qualified personnel (doctors). Current tobacco use was defined as the use of any form of tobacco in the past 4 weeks. Alcohol use and quantity was defined as (mean quantity) the consumption of any alcoholic beverage in a week. The safe limit of alcohol was defined based on WHO guidelines of 21 units for men and 14 units for women per week [24].

Artisans were defined as skilled manual laborers. Level of education was the individual's highest educational (formal) attainment based on the Nigerian school system.

Sample size was calculated using the Taro Yamane formula [25], $N = N/1 + N(e)^2$. Where: n = required sample size, e^2 = error limit and N = estimated adult population in both settlements.

N = estimated population of the community (9000), e = 0.05.

N = 9000/9000 × 0.0025 = 9000/22.5 = 400. With an expected 10% attrition rate, a minimum of 440 individuals will be screened.

2.3. Statistical Methods

For database management and statistical analyses, we used the SPSS version 20

(IBM Corporation, New York, USA). Data were presented in tables. Age standardization was done using the WHO standard population distribution and Enugu East (EE) 2006 population data [26] [27]. For continuous variables, mean values and 95% confidence intervals were calculated. Prevalence of diabetes and prediabetes were expressed as percentages and confidence interval calculated. Mean values were compared using the independent t-test and the Mann-Whitney U test where applicable. In all, p values of <0.05 was regarded as statistically significant. The confidence level was kept at 95%.

3. Results

3.1. General Characteristics of the Sample Population

Out of the 811 individuals invited to the clinic, 605 (74.6%) participants (414 women (68.4%) and 191 (31.6%) men $p < 0.01$) had their fasting blood glucose measured based on the study protocol. The male to female ratio of those screened was 0.5:1. The distribution of the participants showed that 444 (54.7%) came from Ugbodogwu while 367 (45.3%) were from Aguabor. The participants' age ranged from 20 to 90 years, averaging 44.5 (43.3 - 45.8) years. Males were older than females by about a decade (mean age: 51.1 vs 41.5 years, $p < 0.01$). The age distribution and other characteristics of the participants are shown in Table 1. Females were shorter but weighed the same as males. Most participants were artisans/business men or women and had at least a secondary school education (51.6%). Current alcohol (males 160 (83.8%), females 306 (73.9%). $P < 0.01$) and tobacco (males 73 (38.2%), females 61 (14.7%). $P < 0.01$) use were more prevalent in males than females.

3.2. Blood Glucose Measurement and Body Mass Index

Fasting blood glucose ($p < 0.01$; skewness, 3.5; kurtosis, 21.6) and body mass index ($P < 0.01$; skewness, 0.9; kurtosis, 0.9) were skewed to the right. Twenty-four (4%) subjects were underweight, 285 (47.1%) had normal BMI while 296 (48.9%) were either overweight or obese. The mean body mass index (BMI) was 25 kg/m^2 higher in females (26.7 kg/m^2) than males (24 kg/m^2) $P < 0.01$. The mean fasting glucose level was similar in males and females. $P = 0.98$ (Table 1).

3.3. Blood Pressure, Medical History and Metabolic Risk Factors

The mean blood pressure of the participants was 133.7 mmHg (95% CI, 131.7 - 135.9) systolic and 83.4 mmHg (95% CI, 82.4 - 84.7) diastolic. Systolic blood pressure was significantly higher in males than in females. $P = 0.01$. Past medical history of hypertension, previous diabetes and stroke was documented in 23%, 5.3% and 2.8% of the population sample respectively. The overall prevalence of hypertension (newly diagnosed and previous cases) was (52.2%) 316/605 (Table 1).

3.4. Prevalence of Diabetes and Prediabetes

The overall prevalence of diabetes and prediabetes in the population was 71

(11.7%), (95% CI; 9.2 - 14.3) and 7.6% (95% CI; 5.5 - 9.7); similar in males and females P = 0.21 and 0.25 respectively. More than half of all the cases of diabetes (39/71 (54.9%) were newly detected (65.9% in females and 37% in males, p = 0.02). Out of the remaining 32 (45.1%) who were aware of having diabetes 28.1% had normal fasting serum glucose at the time of the study. Control was almost similar in males and females P = 0.06. The highest prevalence of diabetes was in females 60 years and above (17.2%, 95% CI, 7.5 - 26.7) (Table 2). Prevalence of diabetes varied widely with BMI and was most prevalent in those with BMI category of 25 - 29.9 kg/m^2. The sex distribution of diabetes and BMI showed that it was most prevalent in males with BMI ≥ 30 kg/m^2. Individuals with previous history of stroke also showed a very high prevalence, however their number was small.

The highest prevalence of prediabetes was in males 40 - 49 years (95% CI, 16.7%, 3.4 - 30). The prevalence of prediabetes was similar in all sub-groups compared. It however increased with increasing BMI reaching 10.2% in those with a BMI of 30 kg/m^2 and above (Table 3). The Enugu East Age adjusted prevalence of diabetes was 9.8% and the WHO population adjusted prevalence was 11%. The age specific rates adjusted for the two populations are shown in Table 4. The odds ratio of diabetes in different groups is shown in Table 5. It was significantly higher in subjects ≥ 45 years, hypertensives, stroke patients and those with sedentary lifestyles.

Table 1. Characteristics of participants.

Characteristic	Female	Male	Total	P-value
Anthropometrics				
n (%)	414 (68.4)	191 (31.6)	605 (100)	<0.01
Age, years, (mean 95% CI)	41.5 (40.2 - 42.9)	51.1 (48.7 - 53.5)	44.5 (43.3 - 45.8)	<0.01
Height, cm (mean 95% CI)	158.2 (157.5 - 159)	165.3 (164.2 - 166.5)	160.5 (159.8 - 161.1)	<0.01
Weight, kg (mean 95% CI)	66.9 (65.2 - 68.6)	65.6 (63.8 - 67.4)	66.5 (65.2 - 67.8)	0.38
Body mass index, kg/m^2 (mean 95% CI)	26.7 (26.1 - 27.3)	24.0 (23.4 - 24.6)	25.8 (25 - 4 - 26.3)	0.01
Age group				
20 - 29 *n (%)*	104 (25.1)	35 (18.3)	139 (23)	<0.01
30 - 39 n (%)	88 (21.3)	13 (6.8)	101 (16.7))	
40 - 49 n (%)	92 (22.2)	30 (15.7)	122 (20.2)	
50 - 59n (%)	72 (17.4)	41 (21.5)	113 (18.7)	
≥60 n (%)	58 (14)	72 (37.7)	130 (21.5)	
Level of Education				
None/Primary, n (%)	196 (47.3)	97 (50.8)	293 (48.4)	
Secondary and above, n (%)	218 (52.7)	94 (49.2)	312 (51.6)	0.43
Blood pressure				
Systolic pressure, mm Hg (mean 95% CI)	132 (129.3 - 134.6)	137.8 (134.3 - 141.3)	133.7 (131.7 - 135.9)	0.01
Diastolic pressure, mm Hg (mean 95% CI)	83.1 (81.5 - 84.7)	84.0 (81.7 - 86.2)	83.4 (82.4 - 84.7)	0.51

Continued

BMI group				
<18.5, n (%)	**15 (3.6)**	**9 (4.7)**	**24 (4)**	**0.52**
18.5 - 24.9, n (%)	172 (41.5)	113 (59.2)	285 (47.1)	**<0.01**
25 - 29.9, n (%)	124 (30)	54 (28.3)	178 (29.4)	**0.67**
≥30, n (%) blood	103 (24.9)	15 (7.9)	**118 (19.5)**	**<0.01**
Glucose, mmol/L (mean 95% CI)	**5.4 (93.7 - 99.3)**	**5.4 (92.2 - 101)**	**5.4 (94.2 - 98.9)**	
<6.1, mmol/L, n (%)	**346 (83.6)**	**151 (79.1)**	**497 (82.1)**	**0.98**
6.1 - <7, mmol/L, n (%)	**30 (7.2)**	**23 (12)**	**53 (8.8)**	
≥7, mmol/L, n (%)	**38 (9.2)**	**17 (8.9)**	**55 (9.1)**	
Lifestyle				
Current tobacco use, n (%)	**61 (14.7)**	**73 (38.2)**	**134 (22.1)**	**<0.01**
Current alcohol use, n (%)	**306 (73.9)**	**160 (83.8)**	**466 (77)**	**<0.01**
Quantity of alcohol (mean units/week)	**0.04 (0.03 - 0.04)**	**0.06 (0.05 - 0.07)**	**0.73 (0.66 - 0.81)**	**<0.01**
Medical History of				
Hypertension n (%)	**93 (22.5)**	**46 (24.1)**	**139 (23)**	**0.66**
Diabetes n (%)	**15 (3.6)**	**17 (8.9)**	**32 (5.3)**	**<0.01**
Stroke n (%)	**10 (2.4)**	**7 (3.7)**	**17 (2.8)**	**0.39**

P-values are for the sex differences. Peripheral systolic and diastolic blood pressure were the average of 3 consecutive measurements.

Table 2. Prevalence of diabetes.

Characteristic	Total N (%, 95 CI)	Males N (%, 95%, CI)	Females N (%, 95%, CI)	P-value
-	-	-	-	-
Diabetes				
Overall prevalence	**71 (11.7, 9.1 - 14.3)**	**27 (14.1, 9.2 - 19.1)**	**44 (10.6, 7.6 - 13.6)**	**0.22**
***Detected**	**39 (54.9)**	**10 (37)**	**29 (65.9)**	**0.02**
Not Aware				
†Controlled	**32 (45.1)**	**17 (63)**	**15 (34.1)**	**0.02**
Prevalence of diabetes in different groups	**9 (28.1)**	**5 (29.4)**	**4 (26.7)**	**0.06**
Age group				
20 - 29	8 (5.8, 1.9 - 9.7)	**5 (14.3, 2.7 - 25.9)**	**3 (2.9, −0.3 - 6.1)**	**0.02****
30 - 39	11 (10.9, 4.8 - 17)	**1 (7.7, −6.8 - 22.2)**	**10 (11.4, 4.8 - 18)**	**0.69**
40 - 49	16 (13.1, 7.1 - 19.1)	**4 (13.3, 1.1 - 25.4)**	**12 (13, 6.1 - 19.9)**	**0.97**
50 - 59	15 (13.3, 7 - 19.6)	**6 (14.6, 3.8 - 25.4)**	**9 (12.5, 4.9 - 20.1)**	**0.75**
≥60	21 (16.2, 9.9 - 14.3)	**11 (15.3, 7 - 23.6)**	**10 (17.2,7.5 - 26.9)**	**0.76**
BMI category				
<18.5	-	-	-	-
18.5 - 24.9	24 (8.4, 5.2 - 11.6)	**12 (10.6, 4.9 - 16.3)**	**12 (7, 3.2 - 10.9)**	**0.28**
25 - 29.9	34 (19.1, 13.3 - 24.9)	**10 (18.5, 8.2 - 28.9)**	**24 (19.4, 12.4 - 26.3)**	**0.9**
≥30	13 (11, 5.4 - 16.7)	**5 (33.3, 9.4 - 57.2)**	**8 (7.8, 2.6 - 12.9)**	**<0.01**
Medical History	-	-	-	-
Stroke	3 (17.6, −0.5 - 35.8)	**1 (14.3, −11.6 - 40.2)**	**2 (20, −4 - 44.8)**	**0.1****
Hypertension	27 (8.5, 5.5 - 11.6)	**9 (9.9, 3.8 - 16)**	**18 (8, 4.5 - 11.5)**	**0.34**

*percentage of overall prevalence of hypertension, β previous history of diabetes. **Fisher's exact test, †Controlled percentage of Aware with fasting blood glucose within normal range during the survey, P-values for sex differences.

Table 3. Prevalence and distribution of prediabetes in the sample population.

Characteristic	Total N (%, 95% CI)	Males N (%, 95%, CI)	Females N (%, 95%, CI)	P-value
Prediabetes	**46 (7.6, 5.5 - 9.7)**	**18 (9.4, 5.2 - 13.6)**	**28 (6.8, 4.3 - 9.2)**	**0.25**
Prevalence of Prediabetes				
Age group				
20 - 29	9 (6.5, 2.4 - 10.5)	**2 (5.7, −2 - 13.8)**	**7 (6.7, 1.8 - 11.5)**	**0.83**
30 - 39	3 (3,6, −0.3 - 6.3)	**−5 (16.7, 3.4 - 30)**	**3 (3.4, −0.4 - 7.2)**	**1***
40 - 49	13 (10.7, 5.2 - 16.2)	**3 (7.3, −0.7 - 15.3)**	**8 (8.7, 2.9 - 14.4)**	**0.22**
50 - 59	11 (9.7, 4.2 - 15.2)	**8 (11.1, 3.8 - 13.5)**	**8 (11.1, 3.8 - 18.3)**	**0.51**
≥60	**10 (7.7, 3.1 - 12.3)**		**2 (3.4, −1.3 - 8.1)**	**0.25**
BMI category				
<18.5	-	**-**	**-**	**-**
18.5 - 24.9	20 (7, 4.1 - 10)	**12 (10.6, 4.9 - 16.3)**	**8 (4.7, 1.5 - 7.8)**	**0.05**
25 - 29.9	14 (7.9, 3.9 - 11.8)	**5 (9.3, 1.5 - 17)**	**9 (7.3, 2.7 - 11.8)**	**0.65**
≥30	12 (10.2, 4.7 - 15.6)	**1 (6.7, −6 - 19.3)**	**11 (10.7, 4.7 - 16.6)**	**1**
Medical History	-	**-**	**-**	**-**
Stroke	5 (29.4, 7.6 - 51.1)	**2 (28.6, −4.9 - 62)**	**3 (30, 1.6 - 58.4)**	**0.95**
Hypertension	18 (5.7, 3.1 - 8.3)	**7 (7.7, 2.2 - 13.2)**	**11 (4.9, 2.1 - 7.7)**	**0.33**

*Fisher's exact test.

Table 4. Age adjusted prevalence of diabetes based on Enugu East 2006 population and WHO standard population.

	Enugu East weighted population	Enugu East adjusted population	Expected number of cases	Adjusted Prevalence (%)	WHO weighted population	WHO adjusted population	WHO expected cases	Adjusted prevalence (%)
<20	0.48	-	-	**-**	**0.35**	-	-	-
20 - 44	0.37	224	17	**7.5**	**0.38**	230	19	8.3
45 - 54	0.08	48	7	**14.5**	**0.11**	67	10	14.9
55 - 64	0.04	24	4	**16.7**	**0.08**	48	8	16.7
≥65	0.03	18	3	**16.7**	**0.08**	48	7	14.6
Total	1.0	315	31	9.8	1.0	392	43	11.0

Table 5. Odds ratio for diabetes.

Disease	Odds ratio	95% CI	P = value
Males	**0.384**	0.829 - 2.313	
Females	0.722	0.432 - 1.207	0.21
≥45 years	2.033	1.208 - 3.420	**0.01***
Obesity	0.916	0.484 - 1.1734	0.79
Hypertension	0.442	0.257 - 0.762	**<0.01***
History of stroke	1.639	0.459 - 5.848	**<0.01***

*significant P-values.

4. Discussion

Diabetes in SSA presents a critical public health challenge. Current estimates on

the prevalence of diabetes in the continent included a wide age-range of participants and therefore do not provide information on people living in urban slums who may have higher risk of the disorder [11] [12] [13]. The prevalence of diabetes and prediabetes in this study were 11.7% and 7.6% respectively. Out of 71 cases of diabetes, 54.9% were newly diagnosed, 45.1% were aware of their condition and 28.1% of those aware were controlled. Prevalence rates similar to the index study have been reported in urban Kenya [17], Zimbabwe [28] and some parts of North Africa [18] [29]. In the WHO African region, the estimated prevalence of diabetes (percentage of the population aged 18 years and above with FBG ≥7 mmol/L) is 8.7% in males and 8.5% in females [3]. This figure ranges from 5% in Rwanda to 17.3% in Equatorial Guinea. Overall in the continent, the prevalence of diabetes is higher in males [3].

The prevalence of diabetes in our report is almost 1.3 times higher than the WHO regional estimate for Africa (8.7%) and 1.2 times higher than IDF regional estimate for Africa (9.7%) [2] [3]. The high prevalence of diabetes in this study may be related to urbanization, high prevalence of obesity and hypertension and low socioeconomic class of the participants. Urbanization is associated with changes in lifestyle that lead to physical inactivity, an unhealthful diet, and obesity, all of which have been implicated as contributing factors in the development of diabetes [14] [30] [31].

The present study revealed that the prevalence of diabetes was similar in men and women, which is consistent with findings of previous studies [8] [9]. Worldwide, diabetes occurs equally in men and women, but is slightly higher in men under 60 years of age and in women at older age [2] [3] [23]. Our results also demonstrated that the prevalence of diabetes increased with age for both genders, though the increase was more consistent in males. The higher prevalence in males may be due to smaller number of males who participated in the study which may likely overestimate the true prevalence. The peak age of diabetes in women was 55 - 64 years a decade younger than in males. Hormonal factors, postmenopausal weight gain, and a different risk profile might account for an earlier peak of diabetes in females compared with males [23].

Similar to the present study, in developing countries the majority of people with diabetes are in the 45 - 64-year age range [5]. This study also revealed a high prevalence of diabetes among individuals < 45 years (8.1%), who are overweight (19.1%) and those with a self-reported history of stroke (17.6%). These findings reinforces the growing burden of noncommunicable disorders in the low income countries [3] [32] as well as the relationship between diabetes and body mass index and the role of diabetes in the etiology of stroke [16] [23].

Newly diagnosed diabetes defined as the percentage of people with diabetes who were detected for the first time during the survey was (54.9%) more in females than males. Data from international diabetes federation in 2013 suggests that currently Nigeria has the greatest number of people living with diabetes (1.997.8 million) with only about 225,000 (21.4%) being aware of their condition [6]. Earlier studies in Nigeria and SSA have reported varying proportions of

newly diagnosed diabetes in community based surveys with rural communities reaching as high as 100% [6] [8] [16] [17] [33]. Some reasons for late diagnosis of diabetes in this report may include paucity of symptoms early in the disease, poverty as well as attributing the ailment to myths [6]. Diabetes is largely asymptomatic [34] at onset and in order to increase awareness, there is need to screen all adults when they get in contact with health system at all levels. It has been reported that it will cost about 2 - 4 Dollars to screen subjects for diabetes [32]. This cost is modest and within the reach of most African States. Early detection and prophylaxis are undoubtedly the only ways out for Africa in this epidemic. High level of awareness in males has previously been reported [34]. Several reasons have also been proffered for this. These includes: higher socioeconomic status of men, cultural norms and educational status. Furthermore, because older people are more likely to be at home during the day and hence attend the screening program.

Prediabetes identifies patients at risk of diabetes. The conversion rate from prediabetes to diabetes changes with population characteristics and the criteria used to define prediabetes [35] [36]. In general, epidemiological studies indicate that ~25% of subjects with prediabetes progress to type 2 diabetes in 5 years, whereas about ~50% remain prediabetic and ~25% revert to normal [36]. Given the burden of type 2 diabetes and its complications [6] on fragile health infrastructure in SSA, attention should be directed towards identifying these at-risk individuals to allow for better management of scarce resources. In Uganda [10], the prevalence of pre-diabetes was 8.6% (95% CI 7.3 - 10.2) using WHO criteria and 20.2% (95% CI 17.5 - 22.9) similar to 7.6% and 19.7% in the current study. The rise in prediabetes has been shown to be closely linked to obesity and possibly even to weight gain within the normal BMI range as also demonstrated in the index study. Other reasons for such a high prevalence may be due to the selection of older, subjects with more risk factors for type 2 diabetes.

Mean SBP was significantly higher in males than females similar to a previous report [37] [38]. The prevalence of hypertension and obesity has been previously reported and similar to other reports [37] [38] [39]. Associations between diabetes and age, stroke, SBP, DBP and BMI have also been reported [37] [38] [39]. The odds ratio for diabetes was statistically significant from 45 years and above, in subjects with hypertension and stroke. Our study adds to these previous reports and presents target areas for public health education and primary prophylaxis of diabetes.

Strengths of the study. This is the first study in south east Nigeria to study the prevalence of diabetes in a slum. In addition, we estimated of disorders linked to diabetes such as hypertension obesity and stroke in the population.

5. Limitations

This study has some limitations. The glucometer is not the most appropriate instrument for the diagnosis of diabetes mellitus. A laboratory method would have

been most appropriate. We collected data on past medical history directly from the participants without any supporting medical records hence cases like gestational diabetes may be omitted. The low response rate to the invitation for screening (5% - 10%) may also affect the overall result. The present study did not discriminate between types 1 and 2 diabetes. Notwithstanding these shortcomings, our results suggest that diabetes and pre-diabetes are common among poor urban slums in Enugu and can be useful in formulating local health policies, at least for the age groups studied.

6. Conclusion

There is a relatively high prevalence of diabetes among adults in an Enugu slum. Public health educational measures promoting prevention and early detection of diabetes should be encouraged. Efforts should be made to educate the populace on the need for early detection and treatment.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

References

[1] Mbanya, J.C., Motala, A.A., Sobngwi, E., Assah, F.K. and Enoru, S.T. (2010) Diabetes in Sub-Saharan Africa. *The Lancet*, **375**, 2254-2266. https://doi.org/10.1016/S0140-6736(10)60550-8

[2] IDF Diabetes Atlas. (2013) Sixth Edition, International Diabetes Federation. http://www.idf.org/diabetesatlas

[3] Noncommunicable Diseases Country Profiles. (2011) World Health Organization.

[4] Shaw, J.E., Sicree, R.A. and Zimmet, P.Z. (2009) Global Estimates of the Prevalence of Diabetes for 2010 and 2030. *Diabetes Research in Clinical Practice*, **87**, 2009-2014.

[5] Hall, V., Thomson, W.T., Henriksen, O. and Lohse, N. (2011) Diabetes in Sub-Saharan Africa 1999-2011: Epidemiology and Public Health Implications. A Systematic Review. *BMC Public Health*, **11**, 564. https://doi.org/10.1186/1471-2458-11-564 http://www.biomedcentral.com/1471-2458/11/564

[6] Chinenye, S. and Young, E. (2011) State of Diabetes Care in Nigeria: A Review. *Nigeria Health Journal*, **11**, 101-109.

[7] Bos, M. and Agyemang, C. (2013) Prevalence and Complications of Diabetes Mellitus in Northern Africa, a Systematic Review. *BMC Public Health*, **13**, 387. https://doi.org/10.1186/1471-2458-13-387

[8] Ejike, C.E.C.C., Uka, N.K. and Nwachukwu, S.O. (2015) Diabetes and Prediabetes in Adult Nigerians: Prevalence, and Correlations of Blood Glucose Concentrations with Measures of Obesity. *African Journal of Biochemistry Research*, **9**, 55-60.

[9] Akinjinmi, A.A., Adeyooye, O.A., Akingbade, O.A. and Okerentugba, P.O. (2014) Prevalence of Diabetes Mellitus in Abeokuta, Ogun State. *Resarcher*, **6**, 73-75.

[10] Mayega, R.W., Guwatudde, D., Makumbi, F., Nakwagala, F.N., Peterson, S., Tomson, G. and Ostenson, C. (2013) Diabetes and Pre-Diabetes among Persons Aged 35 to 60 Years in Eastern Uganda: Prevalence and Associated Factors. *PLoS ONE*, **8**,

e72554. https://doi.org/10.1371/journal.pone.0072554

[11] Rabi, D.M., Edwards, A.L., Southern, A.D., Svenson, L.W., Sargious, P.M., Norton, P., Larsen, E.T. and Ghali, W.T. (2006) Association of Socio-Economic Status with Diabetes Prevalence and Utilization of Diabetes Care Services. *BMC Health Services Research*, **6**, 124. https://doi.org/10.1186/1472-6963-6-124

[12] Krishnan, S., Cozier, Y.C., Rosenburg, L. and Palmer, J. (2010) Socioeconomic Status and Incidence of Type 2 Diabetes: Results from the Black Women's Health Study. *American Journal of Epidemiology*, **171**, 564-570. https://doi.org/10.1093/aje/kwp443

[13] Saydah, S. and Lochner, K. (2010) Socioeconomic Status and Risk of Diabetes-Related Mortality in the U.S. *Public Health Reports*, **125**, 377-388. https://doi.org/10.1177/003335491012500306

[14] Dall, T.M., Narayan, K.M.V., Gillespie, K.B., Gallo, P.D., Blanchard, T.D., Solcan, M., O'Grady, M. and Quick, W.W. (2014) Detecting Type 2 Diabetes and Prediabetes among Asymptomatic Adults in the United States: Modeling American Diabetes Association versus US Preventive Services Task Force Diabetes Screening Guidelines. *Population Health Metrics*, **12**, 12. https://doi.org/10.1186/1478-7954-12-12

[15] Forouhi, N.G., Luan, J., Hennings, S. and Wareham, N.J. (2007) Incidence of Type 2 Diabetes in England and Its Association with Baseline Impaired Fasting Glucose: The Ely Study 1990-2000. *Diabetic Medicine*, **24**, 200-207. https://doi.org/10.1111/j.1464-5491.2007.02068.x

[16] Balde, N.M., Diallo, I., Balde, M.D., Barry, I.S., Kaba, L., Diallo, M.M., Kake, A., Bah, D., Barry, M.M., Sangare-Bah, B. and Maugendre, D. (2007) Diabetes and Impaired Fasting Glucose in Rural and Urban Populations in Futa Jallon (Guinea): Prevalence and Associated Risk Factors. *Diabetes & Metabolism*, **33**, 114-120. https://doi.org/10.1016/j.diabet.2006.10.001

[17] Christensen, D.L., Friis, H., Mwaniki, D.L., Kilonzo, B., Tetens, I., Boit, M.K., Omondi, B., Kaduka, L. and Borch-Johnson, K. (2009) Prevalence of Glucose Intolerance and Associated Risk Factors in Rural and Urban Populations of Different Ethnic Groups in Kenya. *Diabetes Research Clinical Practice*, **84**, 303-310. https://doi.org/10.1016/j.diabres.2009.03.007

[18] Malek, R., Balatech, F., Laouamri, S., Hamdi-Cherif, M., Touabli, A., Bendib, W., Nechadi, A., Mekideche, F.Z. and Hanat, S. (2001) Prevalence of Type 2 Diabetes Mellitus and Glucose Intolerance in the Setif Area (Algeria). *Diabetes and Metabolism*, **27**, 164-171.

[19] Blakely, T., Hales, S. and Woodward, A. (2004) Poverty: Assessing the Distribution of Health Risks by Socioeconomic Position at National and Local Levels. World Health Organization, Geneva.

[20] WHO (2005) WHO STEP Wise Approach to Chronic Disease Risk Factor Surveillance (STEPS). WHO, Geneva, Switzerland.

[21] O'Brien, E., Asmar, R., Beilin, L., Imai, Y., Mancia, G., Mengden, T., Meyers, M., Palatini, P., Parati, G., Pickering, T., Redon, J., Staessen, J., Stergiou, G. and Verdecchia, P. (2005) On Behalf of the European Society of Hypertension Working Group on Blood Pressure Monitoring. Practice Guidelines of the European Society of Hypertension for Clinic, Ambulatory and Self Blood Pressure Measurement. *Journal of Hypertension*, **23**, 697-701. https://doi.org/10.1097/01.hjh.0000163132.84890.c4

[22] World Health Organization (2000) Obesity: Preventing and Managing the Global

Epidemic.

[23] Powers, A.C. (2005) Diabetes Mellitus. In: Kasper, D.L., Fauci, A.S., Longo, D.L., Braunwald, E., Hauser, S.L. and Jameson, J.L., Eds., *Harrison's Principles of Internal Medicine*, 16th Edition, McGraw-Hill, New York, 2152-2180.

[24] World Health Organization. (2018) Global Status Report on Alcohol and Health 2018.

[25] Yamane, T. (1967) Statistics: An Introductory Analysis. 2nd Edition, Harper and Row, New York.

[26] Ahmad, O.B., Boschi-Pinto, C., Lopez, A.D., Murray, C.J.L., Lozano, R. and Inoue, M. (2001) Age Standardization of Rates: A New WHO Standard. World Health Organization.

[27] (2006) Federal Republic of Nigeria 2006 Population and Housing Census. Population Distribution by Age and Sex (State and Local Government Area). National Population Commission, Abuja, Nigeria.

[28] MOH (2005) National Survey: Zimbabwe Non-Communicable Disease Risk Factors (ZiNCoDs). Preliminary Report. Ministry of Health and Child Welfare, Zimbabwe.

[29] Ben Romdhane, H., Ben Ali, S., Aissi, W., Traissac, P., Aounallah-Skhiri, H., Bougatef, S., Marie, B., Delpeuchm, F. and Achour N. (2014) Prevalence of Diabetes in Northern African Countries: The Case of Tunisia. *BMC Public Health*, **14**, 86. https://doi.org/10.1186/1471-2458-14-86

[30] Guize, L., Jaffiol, C., Gueniot, M., Bringer, J., Tramoni, M., Thomas, F., Pannier, B., Bean, K. and Jego, B. (2008) Diabetes and Socioeconomic Deprivation: A Study in a Large French Population. *Bulletin de l'Academienationale de Medicine*, **192**, 1707-1723.

[31] Sims, M., Diez Roux, A.V., Boykin, S., Sarpong, D., Gebreab, S.Y., Wyatt, S.B., Hickson, D., Payton, M., Ekunwe, L. and Taylor, H.A. (2011) The Socioeconomic Gradient of Diabetes Prevalence, Awareness, Treatment, and Control among African Americans in the Jackson Heart Study. *Annals of Epidemiology*, **21**, 892-898. https://doi.org/10.1016/j.annepidem.2011.05.006

[32] Sobngwi, E., Mbanya, J.C., Unwin, N.C., Kengne, A.P., Fezeu, L., Minkoulou, E.M., Aspray, T.J. and Alberti, K.G. (2002) Physical Activity and Its Relationship with Obesity, Hypertension and Diabetes in Urban and Rural Cameroon. *International Journal of Obesity*, **26**, 1009-1016. https://doi.org/10.1038/sj.ijo.0802008

[33] Mathenge, W., Foster, A. and Kuper, H. (2010) Urbanization, Ethnicity and Cardiovascular Risk in a Population in Transition in Nakuru, Kenya: A Population-Based Survey. *BMC Public Health*, **10**, 569. https://doi.org/10.1186/1471-2458-10-569

[34] Uche, O.E. (2017) Factors Affecting Health Seeking Behaviour among Rural Dwellers in Nigeria and Its Implication on Rural Livelihood. *European Journal of Social Sciences Studies*, **2**, 2. https://www.oapub.org/soc/

[35] Nathan, D.M., Davidson, M.B., De Fronzo, R.A., Heine, R.J., Henry, R.R., Pratley, R. and Zinman, B. (2007) American Diabetes Association. Impaired Fasting Glucose and Impaired Glucose Tolerance: Implications for Care. *Diabetes Care*, **30**, 753-759. https://doi.org/10.2337/dc07-9920

[36] Larson, H., Lindgarde, F., Berglund, G. and Ahren, B. (2004) Prediction of Diabetes Using ADA or WHO Criteria in Postmenopausal Women: A 10 Year Follow-Up Study. *Diabetologia*, **43**, 1224-1228.

[37] Ezeala-Adikaibe, B.A., Orjioke, C., Ekenze, O.S., Ijoma, U., Onodugo, O., Okudo, G., Okwara, C., Chime, P., Mbadiwe, N., Eddy, A., Onyekonwu, C., Onyebueke, G., Ulasi, I. and Mbah, A.U. (2015) Population-Based Prevalence of High Blood Pres-

sure among Adults in an Urban Slum in Enugu, South East Nigeria. *Journal of Human Hypertension*, **30**, 285-291. https://doi.org/10.1038/jhh.2015.49

[38] Ulasi, I.I., Ijoma, C.K., Onwubere, B.J., Arodiwe, E., Onodugo, O. and Okafor, C. (2011) High Prevalence and Low Awareness of Hypertension in a Market Population in Enugu, Nigeria. *International Journal of Hypertension*, **2011**, Article ID: 869675.

[39] Okafor, C.I., Gezawa, I.D., Sabir, A.A., Raimi, T.H. and Enang, O. (2014) Obesity, Overweight, and Underweight among Urban Nigerians. *Nigerian Journal of Clinical Practice*, **17**, 743-749. https://doi.org/10.4103/1119-3077.144389