Original Article

EPIDEMIOLOGY OF DIABETES AND IMPAIRED FASTING GLUCOSE IN A RURAL COMMUNITY OF NIGERIAN NIGER DELTA REGION

Alikor CA, Emem-Chioma PC

Department of Medicine, University of Port Harcourt Teaching Hospital, Port Harcourt.

ABSTRACT

BACKGROUND

The prevalence of diabetes mellitus is reaching epidemic rates globally. It had an estimated global incidence of 220 million in 2010. Different studies in SSA and Nigeria in particular have reported increasing prevalence of diabetes in the rural areas. This may be attributed to the rapid 'westernization' of lifestyle in the rural African community. Only few rural survey have been conducted in the Nigeria oil-rich Niger Delta region necessitating this study with the aim of determining the prevalence of diabetes and impaired fasting glucose (IFG).

METHODS

This was a cross-sectional survey involving 500 subjects aged 15 years and above in a typical rural community of Rivers State, Niger Delta region of Nigeria. A questionnaire administered by face-to-face interview was used to assess socio-demographic characteristics of the subjects. Medical history such as prior knowledge of blood sugar status and family history of diabetes were all elicited by the questionnaire. Anthropometric and blood pressure measurements were taken in a standardized manner and body mass indices (BMI) calculated as weight in kilogram divided by the square of height in meters. Venous blood glucose was measured by the glucose oxidase method. Diabetes mellitus was defined using fasting plasma glucose (FPG) $\geq$7.0 mmol/l (126 mg/dl) and individuals who were previously known to have diabetes based on history of treatment were also classified to have diabetes. Lipid profile and uric acid of patients were also checked.

RESULTS

There were 156 males and 344 females with male to female ratio of 1:2.3. The females were relatively of younger age than the males (40.62±16.6 years versus 42.84±17.8). The overall mean age was 41.32±17. The mean fasting plasma glucose among those with diabetes was 11.14±4. 00mmol/L while the mean for the subjects with impaired fasting glucose was 6.31±0.25mmol/l. The prevalence of diabetes was 2.2% with no significant gender difference (2.6% in males versus 2.0% in females; X2=0.35; p=0.84). The prevalence of Impaired fasting glucose (IFG) was 2.4% with no significant gender difference (Female 2.6% versus males 1.9%; p=0.88). The mean fasting glucose increased significantly with blood pressure (p=0.05), waist circumference (p<0.001), uric acid level (0.02), triglyceride level (<0.001) and age (p= 0.02). The correlation analyses showed that age, systolic blood pressure, waist-hip-ratio and triglycerides are positively correlated with diabetes and impaired fasting glucose in this study.

CONCLUSION

There is a low prevalence of diabetes and IFG in this rural community which may be associated to the high level of physical activity found among the study subjects in this community. However, this study confirmed that increasing age, abdominal obesity, systolic blood pressure and triglyceride level have positive relationship with the prevalence of diabetes and IFG. There is hence more need for intensified screening for diabetes, pre-diabetes and associated risk factors in order to curb or at least reduce diabetes prevalence and its attendant complications.

NigerJMed2015: 114-124

INTRODUCTION

The prevalence of diabetes mellitus is reaching epidemic rates globally. It had an estimated global incidence of 220 million in 2010[1]. According to the International Diabetes Federation, the prevalence of diabetes in Africa has been projected to rise to 18.7million in 2025[2]. This alarming increase in diabetes burden can be associated with increasing consumption of high calorie diet with little to no weight losing measures.

Corresponding Author:
Dr Alikor C.A
E-mail: alikorchizindu@yahoo.com
+2348032577372

Several studies have evaluated the prevalence of diabetes in rural and urban communities in Africa and reported higher diabetes prevalence rates in urban communities than in rural communities [3-7]. In Nigeria, the national prevalence of diabetes is 2.2% with a higher prevalence in the urban than in the rural communities [8]. The prevalence of diabetes in Port Harcourt the capital city of Rivers State, Niger delta region of Nigeria is 6.8% [9]. There are however paucity of data on the prevalence of diabetes in the rural settlement of Rivers State. The urban- rural differences could be attributed to lifestyle activities in the rural areas such as farming occupation, high consumption of vegetables and fruits.

Acute complications of diabetes constituted a majority of diabetes-related deaths in a study done in the University of Port Harcourt teaching hospital [10]. However, the International Diabetes Federation estimates that diabetes accounts for ~ 6% of total global mortality, with 50% of diabetes-associated deaths being attributed to cardiovascular disease (CVD)[11]. Diabetes-related cardiovascular disease complications which were considered rare in Africa are on the rise and are regularly associated with classic cardiovascular risk factors [12].

Landmark studies such as the UKPDS and DCCT have demonstrated the importance of good glycaemic control in the prevention of the development and/or the progression of diabetic complications [13-14].

MATERIALS AND METHODS

This was a cross-sectional survey involving subjects 15 years and above in a typical rural community of Rivers State, Niger Delta region of Nigeria. The majority of the population in the community were involved in low-scale farming. Non-agricultural workers were mainly teachers in the primary and secondary schools in the community, and a few Local Government Council staff. Some inhabitants engaged in crafts such as welding, carpentry, block moulding. Many were also engaged in petty trading mainly limited to their farm products.

The conduct of the study fell into 3 stages I. Community mobilization which included meeting with the community Chiefs and general familiarization tour of the community. II. Staff and instrument preparation which included recruitment and training of field assistants, preparation of questionnaire and assembly and check of instruments. III. Data collection including administration of questionnaire and clinical measurement). There was an overlap between stages I and II. Stage I was useful in gaining the confidence of the leadership and people of the community and enhancing their acceptance of the research team.

A questionnaire designed to elicit demographic and social information including age, gender, occupation, educational level, cigarette smoking, alcohol consumption and level of physical activity was used. Medical history such as prior knowledge of hypertension and diabetic status and family history of hypertension and diabetes were also elicited by the questionnaire. Administration of questionnaire was by face-to-face interview by the researcher and field assistants who had been previously trained. Anthropometric and blood pressure measurements were done in a standardized manner. Participants were weighed barefooted using Hanson's weighing scale with readings taken to the nearest 0.1 kg and their heights measured without foot wear and headdress to the nearest 0.1cm.

Body mass index (BMI) was calculated as weight in kilogram divided by the square of height in meters. WHO classification of BMI was used in this study to grade BMI [15]. Under weight- < 18.5 Kg/m2 ; normal weight- 18.5 to 24.9 Kg/m2 ; overweight- 25 to 29.9 Kg/m2 ;obesity- > 30 Kg/m2 .

The uppermost border of the iliac crest and the lower border of the costal margin (rib cage) were located and the midway between these points was identified and served as the position for measuring waist circumference [16]. Waist circumference $\geq$102cm for males and $\geq$ 88cm for females was regarded as abdominal obesity [17]. Hip circumference was measured in a horizontal plane at the maximum width over the greater trochanter[16].

Auscultatory method using Mercury Sphygmomanometer and appropriately sized cuff was the method and equipment used in the measurement of blood pressure. Sitting blood pressure was measured after subject had been comfortably seated for at least five minutes and the back and arm supported, such that the middle of the cuff on the upper arm was at the level of the right atrium (the mid-point of the sternum) and the legs uncrossed [18]. The blood pressure was read to the nearest 2mmHg with the first (korotkoff phase I) and last (korotkoff phase V) sounds taken as systolic and diastolic pressure [19]. Hypertension is defined in the JNC 7 (Joint National Committee on Prevention, Evaluation, and Treatment report) criteria of blood pressure as blood pressure $\geq$140/90 mmHg or self-reported anti-hypertensive medication use [20].

Venous blood samples were obtained from study subjects using 5-ml specimen tubes containing fluoride oxalate after an 8 to 12hour fast. Plasma samples were conveyed to the Chemical department of University of Port Harcourt Teaching Hospital subsequently centrifuged for 10 minutes in a tabletop refrigerated centrifuge at 4,000 rpm. Venous blood Glucose was measured by the Glucose oxidase method [21]. Diabetes mellitus was defined using fasting plasma glucose (FPG) $\geq$7.0 mmol/l (126 mg/dl) and individuals who were previously known to have diabetes based on history of treatment were also classified to have diabetes[22]. Plasma total cholesterol and triglycerides were determined by the Colorimetric enzymatic

methods, (Randox laboratories ltd, Crumlin, Co. Antrim, United Kingdom). Plasma high density lipoprotein cholesterol (HDL cholesterol) was measured by the same enzymatic method. Low density lipoprotein (LDL cholesterol) was estimated according to the formula LDL cholesterol = total cholesterol – HDL cholesterol - triglycerides / 2.2. Uric acid was also analysed using enzymatic method.

Informed consent from the village Chiefs were obtained before starting work. Consent from each subject was also obtained for the study. Approval of the Ethics committee of the University of Port Harcourt Teaching Hospital was obtained.

Data analysis: Statistical analysis was done using Statistical Package for Social Sciences (SPSS Inc, Chicago,IL) version 17.0. Results were expressed as either mean values (standard deviation) or proportions. Comparison for statistical significance was by student's t test for Continuous variables and chi-square test for categorical variables. A correlation analysis was also done. Epi info statistical package version 3.5.1 was used for chi-square for trend analysis. A p-value of <0.05 was considered statistically significant.

RESULTS

Five hundred subjects had analyzable data. There were 156 males and 344 females with male to female ratio of 1:2.3. The females were relatively of younger age than the males (40.62±16.6 years versus 42.84±17.8). The overall mean age was 41.32±17. Farmers constituted a larger percentage (48.8%) of the study subjects and half (50.5%) of the study subjects had at least attempted secondary education or a trade training and diabetes is found to be more prevalent in this educational level (Table 1). Positive family history of diabetes was obtained in 43 subjects (8.6%). Only 2.3% of the study subjects with positive family history of diabetes had diabetes and another 2.3% had impaired fasting glucose. Most (> 85%) of the study subjects without family history of diabetes had normal glycaemia. There was high level of physical activity in this community (92.2%).

The mean BMI for diabetics was 23.50±4.93 Kg/m^2 and that for subjects with impaired fasting glucose was 20.12±2.31 Kg/m^2 while the WHR for diabetics was 0.97±0.05 and that for those with impaired fasting glucose was 0.95±0.06 Kg/m^2 (Table 3). Among those found to be diabetic in this study, 45.5% had BMI $\geq$ 25Kg/m^2 and 18.2% had high WHR. Fifty percent of subjects with impaired fasting glucose had high blood pressure, while 36.4% of diabetics had high blood pressure compared to the 19.5% found among those with normoglycaemia (X2 8.367; p=0.006).(Table 2).

The mean fasting plasma glucose among those with diabetes was 11.14±4. 00mmol/L while the mean for the subjects with impaired fasting glucose was 6.31±0.25mmol/L (Table 3). Of the 500 subjects who had their blood glucose analysed, 8 were previously diagnosed diabetic and 3 diagnosed diabetic in this study. A total of 11 participants were therefore found to have diabetes giving a crude prevalence of 2.2%.There was no significant gender difference in the prevalence of diabetes in this rural population (2.6% in males versus 2.0% in females; X^2=0.35; P=0.84). In males the highest prevalence occurred in the 40-49 age-groups, unlike the females which showed an increasing rise through the age-groups with the highest prevalence in those aged 50-59years (X^2 for trend 6.81; p <0.001).(Figure 5).

The prevalence of Impaired fasting glucose (IFG) was 2.4% with no significant gender difference (Female 2.6% versus males 1.9%; p=0.88). In males IFG showed highest prevalence in the age-group of 60 years and above, while in the females, it was highest amongst the 50-59 years age-group.(Figure 4).

The mean fasting glucose increased significantly with blood pressure (p=0.05), waist circumference (p<0.001), uric acid level (0.02), triglyceride level (<0.001) and age (p= 0.02) (Table 4). The correlation analyses show that age, systolic blood pressure, waist-hip-ratio and triglycerides are positively correlated with diabetes and impaired fasting glucose in this study.(Table 6)

Table 1.Socio-demographic characteristics of Subjects with Diabetes Mellitus and Impaired Fasting Glucose

Characteristics	No (%) Normal	No (%) with Diabetes Mellitus	No (%) with Impaired Fasting Glucose	p-value
Occupation				
Farmer	233(48.8)	7(63.6)	11(91.7)	0.01
Government worker	38(8.0)	1(9.1)	0(0.0)	
Student	95(19.9)	1(9.1)	0(0.0)	
Traders and others	111(23.3)	2(18.2)	1(8.3)	
Educational status				
No education	27(5.7)	0(0.0)	2(16.7)	
Primary education	161(33.8)	4(36.4)	8(66.6)	0.02
Secondary education/Trade certificate	241(50.5)	5(45.4)	2(16.7)	
Tertiary education	48(10.0)	2(18.2)	0(0.0)	
Alcohol consumption				
Yes (current + stopped)	208(43.6)	3(27.3)	6(50.0)	0.89
No	268(56.4)	8(72.7)	6(50.0)	
Quantity of alcohol consumed				
<7-14 units/week	165(79.3)	3(100)	6(100)	
14-21 units/week	32(15.4)	0(0.0)	0(0.0)	0.24
>21 units/week	11(5.3)	0(0.0)	0(0.0)	
Cigarette smoking				
Yes(current + stopped)	33(6.9)	1(9.1)	0(0.0)	
No	444(93.1)	10(90.9)	12(0.0)	0.77

TABLE 2. ARTHROPOMETRIC INDICES/ BLOOD PRESSURE STATUS OF SUBJECTS WITH DIABETES MELLITUS AND IMPAIRED FASTING GLUCOSE

Parameter	No (%) Normal glycaemia	No (%) with Diabetes Mellitus	No (%) with Impaired Fasting Glucose	p-value
BMI				
Underweight	58(12.2)	2(18.1)	2(16.7)	0.52
Normal	331(69.4)	4(36.4)	10(83.3)	
Overweight	76(15.9)	4(36.4)	0(0.0)	
Obesity	12(2.5)	1(9.1)	0(0.0)	
Waist circumference by NCEP				
High	14(2.9)	3(27.3)	0(0.0)	0.006
Normal	463(87.1)	8(76.7)	12(100)	
Waist-Hip-Ratio				
High	73(15.3)	2(18.2)	2(16.7)	0.86
Normal	404(84.6)	9(81.8)	10(83.3)	
Blood pressure				
High(hypertension)	93(19.5)	4(36.4)	6(50)	0.006
Normal	384(80.5)	7(63.6)	6(50)	

TABLE 3. MEAN AND STANDARD DEVIATION OF PARAMETERS OF SUBJECTS WITH DIABETES MELLITUS AND IMPAIRED FASTING GLUCOSE

PARAMETER	NORMAL FASTING GLUCOSE	DIABETES MELLITUS	IMPAIRED FASTING GLUCOSE
BMI(kg/m^2)	22.02±3.61	23.50±4.93	20.12±2.31
Waist circumference(cm)	71.67±10.06	68.82±15.16	73.33±7.99
Hip circumference (cm)	76.50±9.93	70.82±15.84	77.33±7.81
Waist-hip-ratio	0.94±0.06	0.97±0.05	0.95±0.06
Systolic blood pressure(mmHg)	120.01±21.76	130.73±15.21	132.00±26.38
Diastolic blood pressure(mmHg)	74.00±12.91	74.36±7.15	73.83±10.53
Blood glucose (mmol/L)	4.38±0.65	11.14±4.00	6.31±0.25

TABLE 4. CHANGES IN MEAN FASTING BLOOD GLUCOSE WITH DIFFERENT VARIABLES

VARIABLE	FASTING BLOOD GLUCOSE (mmol/l)	P value
Blood pressure (mmHg)		
High	4.84	
Normal	4.52	0.05
Waist circumference (cm)		
High	6.20	
Normal	4.53	<0.001
Uric acid (mmol/l)		
High	4.91	
Normal	4.51	0.02
Triglycerides (mmol/l)		
High	5.45	
Normal	4.52	<0.001
Age (years)		
15-29	4.28	
30-39	4.47	
40-49	4.80	
50-59	4.91	
60-69	4.67	
= 70	4.64	0.02

TABLE 5. OVERALL PREVALENCE OF DIABETES MELLITUS AND IMPAIRED FASTING GLUCOSE BY AGE GROUP AND GENDER

	Number	DIABETES MELLITUS Number(%)	IMPAIRED FASTING GLUCOSE Number(%)	P value
MALES				
<30 years	49	1(2.0)	0(0.0)	0.46
30-39 years	20	0(0.0)	0(0.0)	
40-49 years	32	2(6.3)	1(3.1)	
50-59 years	20	0(0.0)	0(0.0)	
60-69 years	20	1(5.0)	1(5.0)	
>70 years	15	0(0.0)	1(6.7)	
Total prevalence for males	156	4(2.6)	3(1.9)	

FEMALES				
<30 years	111	0(0.0)	0(0.0)	0.01
30-39 years	50	1(2.0)	1(2.0)	
40-49 years	72	3(4.2)	1(1.4)	
50 59 years	53	3(5.7)	5(9.4)	
60-69 years	37	0(0.0)	1(2.7)	
>70 years	21	0(0.0)	1(4.8)	
Total prevalence for females	344	7(2.0)	9(2.6)	
Overall prevalence for both gender	500	11(2.2)	12(2.4)	

TABLE 6: Pearson and Spearman' rho correlation analysis

Variable	Correlation coefficient	P value
Age	1.44	0.002
Weight	-0.003	0.96
Systolic blood pressure	0.97	0.004
Diastolic blood pressure	0.024	0.60
BMI	0.043	0.36
Waist circumference	-0.086	0.06
Waist-Hip-Ratio	120	0.009
Total cholesterol	-0.031	0.50
Triglyceride	181	<0.001
High Density Lipoprotein	-0.078	0.09
Low Density Lipoprotein	-0.054	0.25
Uric acid	0.078	0.10

DISCUSSION

In this study, the low crude prevalence of diabetes (2.2%) is similar to 2.6% that was reported by Okesina et al in a study in rural Maiduguri, the Nigeria national crude prevalence of 2.2% and the International Diabetic Federation estimated prevalence of 2.8% for type 2 DM in Africa [23,8,24]. It is however lower than 4.4% reported by Ejim et al from a rural community in Enugu, 4% reported in rural Guinea, and 4.8% in rural South African community [25-26,7]. The higher prevalence rates in these comparative studies may be related to the fact that whereas the present study recruited participants from 15 years of age and above, these other comparative studies recruited only middle aged and elderly people; ages at which increased prevalence of diabetes is known [27]. There were also higher prevalence rates reported in urban studies done in Port Harcourt, Nigeria 6.8% [9] Lagos, Nigeria 7.2% [9], Katsina, Nigeria 5.3%[28], North west Australia 6.0% [29], and Hong Kong 8.4%[30]. All of these studies were in industrialised cities which may account for the comparatively higher diabetic prevalence as industrialisation and westernisation have been found to predispose to higher diabetes prevalence [31].

The prevalence of impaired fasting glucose in this study was 2.4% which is comparable to the 2.5% reported by Dahiru et al in a community study in Northern Nigeria and 2.9% reported by Oyegbade et.al in Ile-Ife, South-West Nigeria but much lower than the 15% reported by Ogbu et.al in Enugu, South-East Nigeria [32-34]. This higher prevalence reported by Ogbu et.al could be related to the fact that it was a hospital based study among hypertensive patients who were aged 35years and above unlike the present study which is a cross sectional rural community study involving subjects 15years and above. Prevalence of pre-diabetes increases with increasing age. Motala et.al reported a lower prevalence of 1.5% in a study in a rural South Africa community [35]. These further buttresses the fact that impaired fasting glucose is lower in the rural setting than in the urban settlement and may be related to dietary and other lifestyle factors.

There was no significant difference in gender distribution of diabetes in this study unlike what was reported in some other studies were males had higher prevalence than female [9, 25]. Contrary to the findings of Ogbu et.al and Motala et.al, impaired fasting glucose had no significant gender differences. It was also observed that those in the younger age-group of less than 30 years had very low prevalence of diabetes and IFG. The high prevalence rates of diabetes in the middle aged particularly in the females compare to other age groups may also be part of metabolic syndrome prevalent in this age-group.

The Nigerian National survey on Non-communicable disease [8] established a positive association between family history of diabetes and the risk of having diabetes. This buttressed the fact that children of diabetic parents had increased lifetime risk of developing diabetes. However in this study there was no significant relationship between diabetes prevalence and family history of diabetes similar to the findings by Levitt et.al [36].

Alcohol consumption was found to be negatively associated with diabetes mellitus in this study. This may be related to the fact that only 5.3% of those who took alcohol were involved in heavy alcohol consumption. Heavy alcohol consumption has been positively associated with development of diabetes while moderate alcohol consumption is said to reduce the risk of diabetes by enhancing the sensitivity to insulin [8,37]. Cigarette smoking which is a major modifiable risk factor for cardiovascular diseases has been found to be high among diabetics [38-40]. In this study however there was no significant relationship between cigarette smoking and diabetes. This may be because all of the subjects with positive history of cigarette smoking smoked less than 10 cigarettes a day. Those who smoke more than 20 cigarettes a day almost double their risk of developing diabetes, when compared with non-smokers. Tobacco leads to insulin resistance.

According to the Non-communicable Disease survey in Nigeria, the prevalence of type 2 diabetes was reported to rise with increasing age which is similar to the findings in this study were age was positively associated with the risk of diabetes with peak prevalence found in the middle age group [8]. It is however important to note that the diabetes prevalence in the elderly age-group of 70 years and above was 0%. The reason for this may be partly because this age-group constituted only 7.2% of the sample size.

Abdominal obesity is associated with an excessive depot of triglycerides and other lipid products which contribute to both insulin resistance and beta-cell dysfunction thereby leading to abnormal glucose homeostasis.41Waist-Hip-Ratio significantly showed a positive association with diabetes and IFG prevalence in this study unlike generalised obesity with no significant relationship similar to findings in previous studies.[42-43]

Systolic pressure was also found to be positively associated with the prevalence of diabetes and impaired fasting glucose in this study similar to the findings by previous authors.[44-45] Similarly a positive relationship between blood glucose and triglyceride level was also found in this study which is in agreement with the work done by previous authors. [46-47] Triglyceride and other lipid products contribute to both insulin resistance and beta-cell dysfunction thereby leading to abnormal glucose homeostasis.

CONCLUSION

There is a low prevalence of diabetes and IFG in this rural community which may be associated to the high level of physical activity found among the study subjects in this community. However, this study confirmed that increasing age, abdominal obesity, systolic blood pressure and triglyceride level have positive relationship with the prevalence of diabetes and IFG. There is hence more need for intensified screening for diabetes, prediabetes and associated risk factors in order to curb or at least reduce diabetes prevalence and its attendant complications.

REFERENCES

1 Amos AF, McCarthy DJ, Zimmet P. The rising global burden of diabetes and its complications: Estimates and projections to the year 2010. Diabetes Medicine 1997; 14:51-55.

2 International Diabetes Federation: DiabetesAtlas. 3rd ed. Brussels, International Diabetes Federation, 2006

3 Mbanya JC, NgogangJ, Salah JN, Minkoulou E, Balkau B. Prevalence ofNIDDM and impaired glucose tolerance in a rural and urban population in Cameroon. Diabetologia 1997; 40:824–829.

4 Mbanya JC, Cruickshank JK, Forrester T, Balkan B, Ngogang JY, Riste L, et al. Standardized comparison of glucose intolerance in west African-origin populations of rural and urban Cameroon, Jamaica, and Caribbean migrants to Britain. Diab Care 1999; 22:434–440.

5 Herman WH, Ali MA, Aubert RE, Engelgau MM, Kenny SJ, Gunter EW, et al.Diabetes mellitus in Egypt: risk factors and prevalence. Diab Med 1995;12:1126–1131.

6 Elbagir MN, Eltom MA, Elmahadi EMA, Kadam IMS, Berne C. A populationbasedstudy of the prevalence of diabetes and impaired glucose tolerance inadults in northern Sudan. Diab Care 1996; 19:1126–1128.

7 Mollentze WF, Moore AJ, Steyn AF, Joubert G, Steyn K, Oosthuizen GM,Weich DJV. Coronary heart disease risk factors in a rural and urban OrangeFree State black population. S Afr Med J 1995; 85:90–96.

8 Non-Communicable Diseases (NCD) in Nigeria - final report of a national survey Federal Ministry of Health - National Expert Committee on NCD; 1997.

9 Nyenwe EA, Odia OJ, Ihekwaba AE, Ojule A, Babatunde S.Type 2 Diabetes in adult Nigerians: a study of its prevalence and risk factors in Port Harcourt, Nigeria. Diabetes Res Clin Pract 2003; 62: 177-185.

10 Unachukwu C. N, Uchenna D. I, Young E. E ; Mortality among diabetic in-patients in the Niger-Delta Region of Nigeria. Paper accepted for publication by African Journal of Endocrinology and Metabolism.

11 International Diabetes Federation: Diabetes prevalence August 2008.

12 André Pascal Kengne, Albert G.B. Amoah, Jean-Claude Mbanya, Cardiovascular Complications of Diabetes Mellitus in Sub-Saharan Africa (Circulation. 2005;112:3592-3601.)

13 UK Prospective Diabetes Study (UKPDS) Group. Intensive blood glucose control with sulphonyl ureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). Lancet 1998; 352: 837-853.

14 Diabetes Control and Complications Trial (DCCT) Research Group. The relationship of glycaemic exposure (HbA1c) to the risk of development and progression of retinopathy in the diabetes control and complications trial. Diabetes 1995; 44: 968-983

15 Jackson, R, Lawes, CM, Bennett, DA. Treatment with drugs to lower blood pressure and blood cholesterol based on an individual's absolute cardiovascular risk. Lancet 2005; 365:434.

16 Chobanian, AV, Bakris, GL, Black, HR, Cushman, WC. The Seventh Report of the Joint National Committee on Prevention, Detection, Evaluation, and Treatment of High Blood Pressure: The JNC 7 Report. JAMA 2003; 289:2560-72.

17 Intensive blood-glucose control with sulphonylureas or insulin compared with conventional treatment and risk of complications in patients with type 2 diabetes (UKPDS 33). UK Prospective Diabetes Study (UKPDS) Group. Lancet 1998; 352:837.

18 Anand SS. Using ethnicity as a classification variable in health researchperpetuating the myth of biological determinism, serving socio-political agendas, or making valuable contributions to medical sciences? EthnHealth. 1999; 4:241–244.

19 Menotti A, Keys A, Kromhout D. Inter-cohort differences in coronary heart disease mortality in the 25-year follow-up of the Seven Countries study. Eur J Epidemiol. 1993; 9:527–536.

20 Omran AR. The epidemiologic transition: a theory of the epidemiology of Population change. Millbank Memorial Fund Q. 1971; 49:509–538. 25.

21 Trinder P. Determination of blood glucose using 4 –aminophenazone as oxygen acceptor. J Clin. Path 1969; 22:246.

22 WHO: Definition, Diagnosis and Classification of Diabetes Mellitus and it's Complications. Part 1, WHO,Geneva, 1999

23 Okesina AB, Oparinde DP, Akindoyin KA, Erasmus RT. Prevalence of some risk factors of coronary heart disease in a rural Nigerian population. East Afr Med J 1999; 76:212-6.

24 Gill G, Mbanya JC, Ramaiya K, Tesfaye S: A sub-Saharan African perspective of diabetes. Diabetologia 2009, 52(1):8-16.

25 Ejim E. C., Okafor C. I., Emehe A., Mbah A. U., Onyia U., Egwuonwu T., Akabueze J., and Onwubere B. J., Prevalence of Cardiovascular Risk Factors in theMiddle-Aged and Elderly Population of a Nigerian Rural Community Journal of Tropical Medicine Volume 2011, Article ID 308687, 6 pages doi:10.1155/2011/308687 Accepted 10 february 2011

26 Baldé NMDI, Baldé MD, Barry IS, Kaba L, Diallo MM, Kaké A, Camara A, Bah D, Barry MM, Sangaré-Bah M, Maugendre D: Diabetes an impaired fasting glucose in rural and urban populations in Futa Jallon (Guinea): prevalence and associated risk factors. Diabetes Metab 2007, 33(2):114-120.

27 Utzschneider K, Carr D, Hull R, et al. Impact of intra-abdominal fat and age on insulin sensitivity and b-cell function. Diabetes. 2004;53:2867–2872

28 Mahmoud U Sani , Kolawole W Wahab , Bashir O Yusuf , Maruf Gbadamosi , Omolara V Johnson and Akeem Gbadamosi; Modifiable cardiovascular risk factors among apparently healthy adult Nigerian population - a cross sectional study BMC Research Notes 2010, 3:11doi:10.1186/1756-0500-3-11

29 Grant JF, Nicks N, Taylor AW, Chittleborough CR, Phillips PJ, Gender-specific epidemiology of diabetes: a representative cross-sectional study, International journal for Equity in Health 2009,8.6 dio:10.1186/1475-9276-8-6

30 Janus ED, Watt NM, Lamt KS. Diabetes mellitus-Prevalence and associated cardiovascular risk Factors and implications of diagnostic criteria (ADA 1997 and WHO 1998) in a 1996 community-based population study in Hong Kong Chinese. Hong Kong Cardiovas-cular Risk Factors Steering Committee. American diabetes Association. Diabetic Med 2000; 17: 741-745.

31 Yusuf S,Reddy S, Stephanie. O, Sonia. A: Global Burden of Cardiovascular Diseases Part I: General Considerations, The Epidemiologic Transition, Risk Factors, and the Impact of Urbanization. Circulation 2001, 104:2746-22753.

32 Dahiru T, Jibo A, Hassan AA, Mande AT. Prevalence of diabetes in a semi-urban community in Northern Nigeria. Niger J Med. 2008 Oct-Dec;17(4):414-6.

33 Oyegbade OO, Abioye-Kuteyi EA Kolawole BA, Ezeoma IT, Bello IS .Screening for diabetes mellitus in a Nigerian family practice population SA Fam Pract 2007;49(8):15

34 Ogbu I. S. I. , Neboh C. I. The prevalence of prediabetes among hypertensive patients in Enugu, southeast Nigeria.Nigerian medical journal; 2009 : 50 : 1 : 14-17

35 Ayesha a. Motala, Tonya Esterhuizen, Eleanor Gouws, Fraser J. Pirie, Mahomed A.K. Omar, diabetes and other disorders of glycemia in a rural south african communityprevalence and associated risk factors; diabetes care 31:1783–1788, 2008

36 Levitt NS, Katzenellenbogen JM, Bradshaw D, Hoffman MN, Bonnici F. Theprevalence and identification of risk factors for NIDDM in urban Africans inCape Town, South Africa. Diab Care 1993; 16:601–607.

37 Rimm E.B, J. Chan, M.J. Stamper, G.A. Corditz, W.C.Willet, Prospective study of cigarette smoking, alcohol use and the risk of diabetes in men, British Medical Journal 310 (1995) 555-559.

38 United State Department of Health and Human Services. Reducing the health consequences of smoking: 25 years of progress. A report of the Surgeon General. Rockville, Maryland: US Department of Health and Human Services, Public Health Service, Centers for Disease Control, Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 1989. DHHS Publication No (CDC) 89-8411.

39 Department of Health and Human Services. Epidemiology.In: National Heart, Lung, and Blood Institute. Report of the Task Force on Research in Epidemiology and Prevention of Cardiovascular Diseases. Rockville, MD: Public Health Service, National Institutes of Health, 1994:19-72.

40 De Rosa S, Pacileo M, Sasso L, Di Palma V, Maietta P, Paglia A, Brevetti L, Cirillo P, Chiariello M. Monaldi . Review Insights into pathophysiology of smoke-related cardiovascular disease. Arch Chest Dis. 2008 Jun; 70(2):59-67.

41 Mohan V, Vijayaprabha R, Rema M, et al. Clinical profile of lean NIDDM of south India.Diabetes Res Clin Pract 1997; 38:149-50

42 Akhtar H, Stein Vaaler, Sayeed M.A, Hajera Mahtab, Ali Keramat S.M, Azad Khan A.K. Type 2 diabetes and impaired fasting blood glucose in rural Bangladesh: a population-based study. European Journal of Public Health .2006; 17(3) 291-296.

43 Sayeed MA, Banu A, Malek MA, Khan AK. Blood pressure and coronary heart disease in NIDDM subjects at diagnosis: prevalence and risks in Bangladesh population. Diabetes Res Clin Pract 1998;39:147-55.

44 Olatunbosun ST, Ojo PO, Fineberg NS, Bella AF. Prevalence of diabetes mellitus and impaired glucose tolerance in a group of urban adults in Nigeria.J Natl Med Assoc 1998;90:293-301.

45 Lu FH, Yang YC, Wu JS, et al. A population-based study of the prevalence and associated factors of diabetes mellitus in southern Taiwn. Diabet Med 1998;15:564-72.

46 El-Hazmi MAF, Al-Swailem AR, Warsy AS, et al. Lipid and Related Parameters in Saudi Type 2 Diabetes Mellitus Patients. Ann Saudi Med 1999; 19:304-307.

47 Saleh M. Al Osaimi, Khalid S. AL-Gelban. Diabetes Mellitus- Prevalence and associated cardiovascular risk factors in a Saudi sub-urban community.Biomedical Research 2007;18(3):147-153