PREVALENCE OF PRE-DIABETES AND UNREPORTED DIABETES MELLITUS IN POPULATION AGED 45 YEARS AND ABOVE IN OWERRI MUNICIPALITY, IMO STATE NIGERIA.

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SUMMARY

Background:
Unreported diabetes mellitus and glucose intolerance have substantial clinical importance. Glucose intolerance precedes diabetes mellitus and it is associated with cardiovascular complications. Subjects with prediabetes have near normal glycated haemoglobin and may only be detected when oral glucose tolerance was performed. Early detection may prevent or delay diabetes and its complications. This study determined the prevalence of un-reported diabetes mellitus and glucose intolerance in Owerri Municipality, Imo State of Nigeria.

Methodology:
1,012 apparently healthy subjects aged 45 years and above were recruited for the study. Their anthropometric parameters were measured using standard methods and plasma glucose was measured using glucose oxidase method. Diagnosis of diabetes and pre-diabetes was made according to WHO criteria.

Results:
A total of 157 subjects had pre-diabetes giving a prevalence of15.5%. Subjects of aged 40 – 59 years were mostly affected. IFG alone, IGT alone and a combination of IFG +IGT occurred in 30.6%, 62.4% and 7.0% respectively of the study population. The highest prevalence of IFG was recorded in the 40 – 49 years age group while that of IGT occurred in the 50 – 59 years range. A combination of IFG and IGT occurred rarely in the study population, 7.0% and none was detected after the age of 59 years. A greater proportion of males, 18%, than females, 14.5%, had pre-diabetes. Unreported diabetes was detected in 8.6% of the study population, most of them in the 50 – 69 years age bracket. It was more prevalent in the female subjects, 11.1% than in the male subjects 4.4%. The mean BMI, WHR, FPG and 2hppG of the pre-diabetes subjects were 28.76 ±3.5kg/m^2, 0.94 ±0.14, 5.28 ± 0.75 mmol/l and 8.43 ± 1.57mmol/l respectively. Among the male pre-diabetes subjects, peak values for BMI and FPG occurred after 70 years of age while in their female counterparts, peak mean values for these parameters occurred much earlier, 40 -59 years range.

Conclusions:
The report showed high prevalence of glucose intolerance and un-reported diabetes mellitus in the population. The need for regular screening of the population for glucose intolerance was highlighted in order to reduce the incidence of diabetes and its complications.

Key words: Un-reported diabetes mellitus, impaired fasting glycaemia, impaired glucose tolerance, pre-diabetes.

INTRODUCTION.

Unreported diabetes mellitus (URDM) and abnormal glucose tolerance are considered to have substantial clinical importance [1, 2]. Diabetes has a precipitating factor known as pre-diabetes: impaired glucose tolerance (IGT) and impaired fasting glycaemia (IFG), [3]. These are metabolic states between normal glucose homeostasis and diabetes. Subjects with pre-diabetes have increased risk of progressing to diabetes and macro-vascular complications [4, 5]. Individuals with IGT or IFG may be euglycaemic in their daily lives as shown by normal or near-normal glycated haemoglobin [6]. IGT manifests hyperglycaemia only when standard oral glucose tolerance test (OGTT) is performed and it may be directly involved in the pathogenesis of cardio-vascular disease (CVD) [7]. IGT may have a higher risk for CVD than IFG.

Not all individuals with pre-diabetes progress to diabetes. 50% remain in their abnormal glycaemic state, 25% revert to normal glucose tolerance leaving 25% to progress to diabetes over an observational period of 3-5 years, [4, 8, 9]. Factors that facilitate progression into diabetes include older age, over-weight and existence of other diabetes risk factors, [10]. IGT and IFG have heterogeneous pathogenesis and different rates of progression to diabetes, [11, 12]. Subjects with both of the conditions have approximately double the rate of developing diabetes compared with subjects with just one. Earlier reports show that 25% of hypertensive subjects in Enugu Nigeria had prediabetes (IFG =14% IGT = 15%; IFG+IGT =6%) and 14% had URDM (13). In Omani population, India, the prevalence of prediabetes was reported to be 35%; IFG+IGT, 9% (14). Among US adolescents, prediabetes 16.1%, IFG 13.1% and IGT 3.4% were reported (15)

Both conditions are associated with metabolic syndrome and manifest insulin resistance and impaired insulin secretion, [16, 17]. However, there are differences in the nature of these defects between the two conditions, [16]. Because pre-diabetes is not a clinical entity, it may progress to diabetes without the sufferer being aware of it. Clinical trials have demonstrated the effectiveness of intensive glycaemic and blood pressure control to reduce the long-term complications of diabetes [18, 19]. Early detection and control of pre-diabetes will lead to delay in the development of diabetes and its complications. To the best of our knowledge, no studies have reported the prevalence of prediabetes in adult Owerri population.

MATERIALS AND METHODS

The study was carried out in Owerri Municipality of Imo State of Nigeria. The inhabitants are mainly Igbos and it has a population of 125,337 (2006 Census in Nigeria). The study was approved by the Ethic Committee of The Federal Medical Centre, Owerri and involved a total of 1,012 apparently healthy adults (males 273, females 739) aged =>40years. Informed consent was obtained from all subjects before sample collection. Pregnant women were excluded. Fasting and 2-hour post-prandial (2-hpp) blood samples were obtained using standard methods, [20] and put into fluoride-oxalate bottle for glucose estimation which was done within 2 hours of sample collection using reagent kit from Bio Systems S.A (Costa, Brava 30, Barcelona Spain). For the 2-hours blood sample, subjects received 75g of glucose D dissolved in 250 – 300ml water over a period of 5 minutes.

Anthropometric measurements of height, weight, waist and hip circumference (WC, HC) were taken using standard methods,

[21]. Body weight in light clothing was measured to the nearest 0.1kg using electronic scale. An average of two readings was taken. Height was measured to the nearest 0.5cm using vertically mounted measuring device. Body mass index (BMI), was calculated as weight in kilograms divided by square of height in meters, (kg/m^2). Waist circumference was measured to the nearest 0.5cm at a level midway between the lowest rib and the iliac crest using measuring tape. Waist to hip ratio (WHR) was also calculated. Subjects were classified using BMI as underweight $\leq 18.5 kg/m^2$, normal weight 18.5 – $24.9 kg/m^2$, overweight 25 – $29.9 kg/m^2$, obese class 1 30 – $34.9 kg/m^2$, obese class 2 35 – $39.9 kg/m^2$, morbid obesity $\geq 40 kg/m^2$.

Data analyses were done using GraphPad software. Mean values of parameters were compared using student's 't' test and ANOVA statistics and results were presented as mean ± standard deviation or as count and percentage of status or category. Results were also presented according to age and sex of subjects.

Pre-diabetes was diagnosed as impaired fasting glcaemia (IFG), fasting plasma glucose (FPG) 5.6 – 6 9mmol/l, 2hpp glucose <11.0mmol/l, or as impaired glucose intolerance (IGT), FPG >6.9mmol/l, 2-hpp glucose 7.7 – 10.9mmol/l. Diabetes was diagnosed as FPG >7.0mmol/l or 2-hpp glucose >11.0mmol/l; normal glucose tolerance (NGT) as, FPG <5.6mmol/l, 2-hppG <7.7mmol/l ; IFG alone as, FPG 5. – 6.9, 2-hppG <7.7mmol/l; IGT alone as, FPG <5.6mmol/l, 2-hppG 7.7 -10.9mmol/l, [22].

RESULTS.

The mean age of the study population was 56±8.5 years, (males 59.9±10.7, females 54.5±7.0 years; p>0.05), BMI $28.0 \pm 4.4 kg/m^2$ (males 26.3 ±2.7, females 28.6 ±4.4; p<0.05), WHR 0.97±0.1, FPG 4.76 ±1.9mmol/l (males 4.6 ±1.9, females 4.8 ±1.9; p>0.05), 2-hpp glucose 6.93 ±3.7mmol/l (males 5 .96 ±2.8, females 7.29 ±3.9, p<0.05), (Table 1). Mean values of BMI and WHR were highest in the 50 – 59 years age range 29.0 $\pm 4.2 kg/m^2$ and 1.02 ±0.1, FPG in the 60 -69 years age range 5.3 ±3.0mmol/l, 2 hpp glucose in the 50 - 59years range.

A total of 157 subjects had pre-diabetes giving a prevalence of15.5%. Subjects of aged 40 – 59 years were mostly affected, 72.6%, and less than 2% of them were aged ≥70 years. IFG alone, IGT alone and a combination of IFG +IGT occurred in 30.6%, 62.4% and 7.0% respectively of the study population. The highest prevalence of IFG was recorded in the 40 – 49 years age group while that of IGT occurred in the 50 – 59 years range. (Table 2a) A combination of IFG and IGT occurred rarely in the study population, 7.0% and none was detected after the age of 59 years (Table 2).

A greater proportion of males, 18%, than females, 14.5%, had pre-diabetes. In the male group, pre-diabetes was common in the 40 – 49 years and ≥70 years age brackets while in the female group no pre-diabetes was detected in ≥70 years age group (Tables 2b&c). URDM was detected in 8.6% of the study population, most of them in the 50 – 69 years age bracket. Beyond this age, no URDM was detected in both sexes. (Table 2) URDM was more prevalent in the female subjects, 11.1% than in the male subjects 4.4%. In the later group, URDM occurred only in the 50 – 69 years age bracket while the condition was detected from 40 to 69 years of age in the female subjects (Tables 3 & 4).

The mean BMI, WHR, FPG and 2hppG of the pre-diabetes subjects were 28.76 $\pm 3.5 kg/m^2$, 0.99 ±0.14, 5.28 ± 0.75 mmol/l and 8.43 ± 1.57mmol/l respectively. Mean BMI differed across the age groups, (p< 0.0001). Female subjects had values higher than those of their male counterparts. 82%

of the female prediabetes subjects had mean BMI values higher than 30kg/m2 and they are found within the 40 – 59 years age range. 84% of the male prediabetes subjects were overweight (BMI 25 – 29.9kg/m2).

Mean values of WHR also differed across the age groups, ($p<0.0001$). Men generally had higher values than women and the highest values for both sexes were recorded in the 50 – 59 years age group. All the male subjects recorded values higher than 0.9 and their female counterparts higher than 0.85. Among the male pre-diabetes subjects, peak values for BMI and FPG occurred after 70 years of age while in their female counterparts, peak mean values for these parameters occurred much earlier, 40 -59 years range. (Table 3).

Mean FPG values differed with age, ($p< 0.0001$). Lowest mean values were recorded in the 60 – 69 years age range. There were no significant difference in mean values of FPG in the 40 – 49 age range for both sexes, 5.4 ± 0.1 and 5.7 ± 0.4mml/l. 34% and 32% of the men and women respectively recorded mean FPG >5.6mmol/l. Highest mean value for the men occurred in the ≥70years while that of the women was in the 40 – 49 years age group.

Differences according to age as recorded in the other parameters occurred in 2HPPG, ($p<0.0001$). Least mean values for the women, 7.2 ± 1.0mmol/l, was recorded in the 40 – 49 years age range when FPG was highest. 66% of the male and all the female prediabetes subjects had mean 2HPPG >7.0mmol/l.

DISCUSSIONS

The prevalence of pre-diabetes in the study population was high. It rose from the age of 40 years to peak at the age of 59 years, falling to lowest rates at the age of 70 years. Prevalence of IGT and URDM followed similar curve while IFG had virtually zero prevalence at the age of 50 - 69 years. Highest blood glucose levels and most of the obese women were found within the 40 – 59 years age range. Women had higher 2HPPG than men and most of the women were found in the same age range. It is also in the same age range that the highest mean values for BMI and WHR ratio were found. These facts may explain the observed trends for prediabetes and its factors in the study population. IGT is diagnosed as failure of blood glucose to fall to near fasting level after 2 hours *post prandial*. This was observed within 50 – 69 years in the prediabetes subjects hence the peak incidence of IGT in this age range. IFG is diagnosed with fasting blood glucose which was found to be elevated mostly in the 40 – 49 and ≥70 years age ranges hence its predominance in these age ranges. Less number of subjects had elevated FPG (34% and 32% of men and women respectively) than 2HPPG (66% of men and 100% of women) and this fact manifested in this study as double the rate of IFG (30.6%) for IGT (62.4%)

The highest rates of URDM, prediabetes and IGT occurred together in the 50 – 59 years age range. This may indicate the superior predictive value of IGT in the development of pre-diabetes and DM in the population over IFG. IGT has been reported to be a better predictor of future DM than IFG, [4]. This may be due to the fact that in isolated IGT, there are decreased early-phase (0 – 10 min) and late-phase (60 – 120 min) post- prandial insulin secretion. The defective late insulin secretion, combined with muscle and hepatic insulin resistance also present in IGT, results in prolonged hyperglycemia after a glucose load. In IFG, there is decreased early-phase but normal late-phase insulin secretion combined with only hepatic insulin resistance [23]. Diabetes can more easily develop in the former than later state.

Most of the IFG seen in this study occurred after 70 years of age when no case of URDM was detected. IGT was reported to be a stronger risk factor for type 2 diabetes mellitus than IFG [4]. Yet more subjects had IGT than IFG or IFG+IGT in this study. Peak values for BMI and WHR coincided with that of IGT in the population and this may account for the high prevalence of IGT in this age range. Obesity, especially visceral obesity, is associated with insulin resistance. Individuals with IGT may be euglycaemic in their daily lives as shown by normal or near-normal glycated haemoglobin. They manifest glucose intolerance only when challenged with an oral glucose load. Therefore 2-hour OGTT may be used to confirm normal random or FP glucose in the population. This is necessary because 20 - 50% of such individuals progress to diabetes within 10 years; a third may revert to normal glucose tolerance while the rest remain in the IGT stage, [3, 24, 25]. IGT is also a leading cause of end-stage renal disease and of blindness with a high risk for neuropathy and gangrene, [26]. It has a potentially important role in public health and as a target for experimental strategies for prevention of type 2 diabetes, [4]. One of the advantages of relying on FPG rather than 2-hPG values is the superior reproducibility of the former as reported by Mooy et al, (1996)[27]. Indeed, the lower reproducibility of the 2-hPG might theoretically partially explain the higher sensitivity for progression from IGT to diabetes mellitus that have been reported, [4].

Baseline glucose is the most consistent predictor of progression to diabetes. Plasma glucose was elevated in the 40 -59 years age range falling in the next decade, 60 – 69 years and rose again thereafter. This trend favours the development of diabetes in the 50 – 69 age range and this is found to be the case in this study. The rise in plasma glucose in the ≥70 years range results in IFG with low probability of development of diabetes mellitus as seen in this study. IFG developed in the male subjects much later in life, ≥ 70 years, than in the female subjects, 40 – 49 years age range. The females also had an increased prevalence of IFG in ≥ 70 years age range. The female subjects had significantly elevated BMI, FBG and 2hPPG than their male counterparts, (Table1). This is made manifest in the greater percentage of the female subjects who had prediabetes than their male counterparts. It also confirms the disordered glucose metabolism reported in overweight and obesity [10].

The prevalence of pre-diabetes and its variables recorded in this study disagreed with the values reported from other parts of the country. Olatunbosun [28], reported a prevalence of 0.8% for URDM, 2.2% for IGT in a younger population, (mean age 40.02 years) in Ibadan. Bakari and Onyemelukwe, 2004 [29] reported 0% prevalence for IFG, 7.7% and for still a younger age group, (mean age 48.69 ± 8.0 years) and a smaller sample size, 39, among Hausa-Fulani subjects of Northern Nigeria.

CONCLUSIONS

The report showed high prevalence of glucose intolerance and un-reported diabetes mellitus in the population. The need for regular screening of the population for glucose intolerance was highlighted in order to reduce the incidence of diabetes and its complications.

TABLE 1: Clinical characteristics of the study population; number in bracket.

Parameter	Whole population (1,012)	Males (273)	Females (739)	p-value (M v F)
Age (years)	56 ±8.5	59.9 ± 10.7	54.5 ± 7.0	> 0.05
BMI (Kg/m^2)	28 ± 4.4	26.3 ± 2.7	28.6 ± 4.4	< 0.05
WHR	0.97 ± 0.1	0.97 ± 0.1	0.97 ± 0.1	>0.05
FPG (mMol/l)	4.76 ± 1.9	4.6 ± 1.9	4.8 ± 1.9	< 0.05
2HPPG (mMol/l)	6.93 ± 3.7	5.96 ± 2.8	7.29 ± 3.9	< 0.05

TABLE 2: Prevalence (%) of IFG, IGT, IFG +IGT, Pre-diabetes and URDM in the whole study population and variation with age; number in bracket.

Condition	40 – 49 years (300)	50 – 59 years (371)	60 – 69 year (260)	≥ 70 years (81)	Total 1,012
IFG alone	(27) 9.0	(2.0) 0.5	(2.0) 0.8	(32) 39.5	(63) 6.2
IGT alone	(23) 7.7	(51) 13.7	(23) 8.8	(2) 2.4	(99) 9.8
IFG + IGT	(5) 1.7	(6)) 1.6	(0) 0	(0) 0	(11) 1.0
Pre-diabetes	(55) 18.4	(59) 15.8	(25) 9.6	(34) 41.9	(173) 17.0
URDM	(7) 2.3	(58) 15.6	(22) 8.4	(0) 0	(87) 8.6
NGT	(238) 79.3	(254) 68.4	(213) 81.9	(47) 58	(752) 74.3

TABLE 3: Prevalence (%) of IFG, IGT, IFG +IGT, URDM and NGT in the male population and variation with age; number in bracket

Condition	40 – 49 years (74)	50 – 59 years (48)	60 – 69 years (88)	≥ 70 years (63)	Total 273
IFG alone	(0) 0	(0) 0	(1) 1.1	()1 (25.4	(17) 6.2
IGT alone	(18) 24.3	(4) 8.3	(6) 6.8	(1) 1.6	(29)10.6
IFG + IGT	(2) 2.7	(1) 2.0	(0)0	(0) 0	(3) 1.1
Pre-diabetes	(20) 27.0	(5) 10.4	(7) 7.9	(17) 27	(49) 17.9
URDM	(0)0	(5) 10.4	(7) 7.9	(0) 0	(12) 4.4
NGT	(54) 72.9	(38) 79.1	(14) 15.9	(46) 73.0	(212) 77.6

TABLE 4: Prevalence (%) of IFG, IGT, IFG +IGT, URDM and NGT in the female study population and variation with age; number in bracket

Condition	40 – 49 years (226)	50 – 59 years (324)	60 – 69 years (172)	≥ 70 years (18)	Total 740
IFG alone	(27) 11.9	(2) 0.6	(1) 0.6	(16)88.9	(46) 6.2
IGT alone	(5) 2.2	(47)14.5	(17) 9.0	(1) 5.5	(70)9.5
IFG + IGT	(3) 1.3	(5) 1.5	(0)0	(0) 0	(9) 1.2
Pre-diabetes	(35) 15.9	(54) 17.0	(18) 10.5	(0) 0	(107)14.5
URDM	(7)3.1	(53) 16.4	(22) 12.8	(0) 0	(82) 11.1
NGT	(184) 81.4	(217) 67	(40) 23.2	(0) 0	(189) 25.5

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