Oral Glucose Tolerance Test among Adolescents with Impaired Fasting Blood Glucose

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ABSTRACT

BACKGROUND

Type 2 Diabetes Mellitus (DM) is emerging as a major health problem even amongst children and adolescents. The onset is usually preceded by period of impaired glucose metabolism known as Impaired Fasting Glucose (IFG) and or Impaired Glucose Tolerance (IGT). This study is aimed at determining the presence of impaired glucose tolerance in adolescents aged 10 to 19 years with impaired fasting glucose.

METHODOLOGY

Oral glucose tolerance test was done for a cohort of 68 adolescents aged 10 to 19 years with impaired fasting blood glucose detected at a school screening. Age, sex, anthropometric measures (height, weight, BMI and BMI percentiles were determined using appropriate methods. Blood pressure and family history of DM was determined. IGT was determined as a two hour post glucose load blood glucose value of $\geqslant$ 7.8mmol/l and < 11.1mmol/l.

RESULT

The mean age of the subjects was 15.08 ± 2.03 years. There were 23 (33.8%) males and 45 (66.2%) females, giving a male to female ratio of 1:2. Thirteen (19.1%) were overweight/obese, 16 (23.5%) had family history of diabetes mellitus and 17(25%) had hypertension. Seven (10.3%) of the subjects had impaired glucose tolerance and no case of diabetes. The mean BMI and fasting blood glucose value was higher in subjects with impaired glucose tolerance compared to those without. There was no statistically significant difference in prevalence of hypertension, overweight/obesity and hypertension in group with or without impaired glucose tolerance.

CONCLUSION

There was no concordance in occurrence of IFG and IGT. Mean fasting blood glucose and mean BMI was higher in those with both IFG and IGT. Screening for only IGT will therefore miss subjects with IFG.

KEYWORDS

Oral Glucose Tolerance Test; Impaired Fasting Blood Glucose; Adolescents; Nigeria.

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INTRODUCTION

The global prevalence of diabetes is rising and available data suggest diabetes is emerging as a major health problem in Africa including Nigeria[1]. This significant rise in diabetes cases is mainly due to type 2 diabetes and is attributed to population growth, increasing life expectancy, urbanization, and the increasing prevalence of obesity and physical inactivity[2]. Before the onset of type 2 diabetes, a preclinical stage of borderline blood glucose may develop as early as in childhood and adolescence as has been shown even in high-income settings such as the USA and the Netherlands[3]. The preclinical stage of type 2 diabetes is usually characterized by different

degree of insulin resistance leading to glucose dysregulation and is usually manifested as impaired fasting glucose(IFG) or Impaired glucose tolerance (IGT).

Impaired fasting glucose (IFG) and Impaired Glucose Tolerance (IGT) are risk factors for the future development of DM and cardiovascular disease[4]. The global burden of IFG and IGT are not available, but the prevalence in adults and adolescents is increasing in parallel with the global increase in prevalence of obesity. About 80% of adolescents with abnormal glucose regulation have IFG[4]. The Prevalence of isolated IFG in adolescents range between 6.7 and 40.5%, while the prevalence of combined IFG and IGT is as high as 16.1%[4,5]. Studies have shown that although the fasting blood glucose is an acceptable method for screening for glucose dysregulation, it is an insensitive way of detecting glucose dysregulation[6]. The presence of both IFG and IGT increases the risk of development of type 2 diabetes and the presence of IGT is an important predictor of progression to Type 2 DM.7 Progression of prediabetes to type 2 Diabetes can take many years but can be rapid especially in presence of IFG and IGT. 8 The Early detection of IFG and IGT is known to help prevents progression to type 2 diabetes and the development of cardiovascular disease.

In spite of the documented increase of type 2DM in adolescents in Nigeria and other developing countries, 1 most studies on prediabetes (IFG and IGT) in adolescents and children have been in developed countries.3. There is a paucity of data on the prevalence of IGT in adolescents with impaired fasting glucose in Nigeria. The aim of this study is to determine the prevalence of IGT and diabetes in adolescents with impaired fasting glucose detected following an initial blood glucose screening and to determine some possible associated factors.

METHODOLOGY

This report was part of a study on screening for impaired fasting glucose in adolescents in Port Harcourt. A cohort of adolescents detected with impaired fasting glucose following screening of adolescents in secondary schools in Port Harcourt were further evaluated using an oral glucose tolerance test to detect presence of Impaired Glucose Tolerance (IGT). A total of 152 students were detected to have impaired fasting glucose following which 68(44.7%) accepted to do an oral glucose tolerance test. For each school visited, students who had impaired fasting glucose had an Oral Glucose Tolerance Test (OGTT) using the World Health Organization protocol.6 Students were weighed and using clean disposable cups and bottled drinking water, a glucose solution containing 1.75g/kg to a maximum of 75g of glucose was dissolved in 200mls of water and given to the subjects to drink over ten to fifteen minutes. Two hours after, blood glucose was done using the accu-check glucometer as approved for the study and the result recorded in student's respective questionnaire. The result was categorized as Impaired Glucose Tolerance if 2-hour blood glucose level was $\geqslant$ 7.8mmol/l to < 11.1mmol/l.4 Subjects were classified into underweight, normal weight, overweight and obese based on BMI percentile for age and sex. Blood pressure was also classified into normal blood pressure, prehypertension and hypertension based on blood pressure percentile for age and sex.

Ethical approval for this study was obtained from the Ethics committee of the University of Port Harcourt Teaching Hospital, Rivers State Ministry of Health and consents obtained from parents and guardians. Assent was obtained from the students however 84 students declined to do an OGTT.

RESULTS

Sixty eight adolescents with impaired fasting blood glucose had an oral glucose tolerance test. There were 23(33.8%) males and 45(66.2%) females, giving a male to female ratio of 1:2. The age of the students ranged from 10.9 to 19 years with a mean age of 15.08 ± 2.03 years. The mean age of 15.70 ± 1.93 years for the males was higher than that of

14.75 ± 2.02 for the females. The difference was not statistically significant (t = 1.86, df = 1, p = 0.067). Twenty three (33.8%) of the students belonged to the age group of 10 – 14 years while 45 (66.2%) were in the older age group of 15 – 19 years.

The 2 – hour blood glucose levels post Oral Glucose Tolerance Test (OGTT) ranged from 4 – 8.9 mmol/l with a mean value of 6.63 ± 1.0 mmol/l. The females had a higher mean 2 – hour blood glucose level (6.79 ± 0.98 mmol/l) compared to the males (6.33 ± 1.04 mmol/l). The difference was not statistically significant (t = 1.78, df = 1, p = 0.079). Seven (10.3%) of the students with impaired fasting blood glucose also had Impaired Glucose Tolerance (IGT) with a 2 – hour blood glucose level ⩾ 7.8 mmol/l. No subject had diabetic range blood glucose of ⩾ 11.1mmol/l 2-hour post OGTT. The Fasting Blood Glucose (FBG) on the other hand ranged from 5.6 – 6.7 mmol/l with a mean value of 5.90 ± 0.30 mmol/l. The females also had a higher mean FBG (5.93 ± 0.31 mmol/l) compared to the males (5.84 ± 0.27 mmol/l). The difference was not statistically significant (t = 1.14, df = 1, p = 0.260).

The Body Mass Index (BMI) of the adolescents with impaired FBG ranged from 16 to 30.51 kg/m^2 with a mean BMI of 21.77 ± 3.48 kg/m^2. The mean BMI of 22.33 ± 3.77 kg/m2 for females was higher than that of 20.67 ± 2.57 kg/m^2 for the males. The difference was not statistically significant (t = 1.89, df = 1, p = 0.063). Five (7.3%) of the students were obese, 8 (11.8%) were overweight and 55 (80.9%) were normal weight. None of the adolescents were underweight. Seventeen (25.0%) of the students had hypertension while 51(75.0%) did not. Sixteen (23.5%) had a family history of diabetes while 52(76.5%) did not. Table 1 shows the difference in mean age, mean BMI and mean fasting blood glucose of subjects with and without impaired glucose tolerance. There was no statistically significant difference with mean age, mean BMI or mean FBG.

Table 2 shows the relationship between IGT and some variables. Impaired GT was higher among the older adolescents aged 15 – 19 years, females, overweight and obese adolescents, hypertensive adolescents and those without a family history of diabetes. None of the observed differences however were statistically significant.

Table 1: Association between mean Age, BMI and FBG of adolescents with impaired and normal glucose tolerance

	NGT	GT I	P- value
Mean Age(yrs)	15.17±2.0	14.66±2.3	0.500
Mean BMI(kg/m2)	21.74±3.5	21.94±3.6	0.892
Mean FBG (mmol/l)	5.88±0.30	6.01±0.29	0.280

Table 2: Relationship between Oral Glucose Tolerance Test Results and some variables

		Oral Glucose Tolerance			
		IGT N (%)	NGT N (%)	Total N	p value
Age group	10 – 14 ye ars	2 (8.7)	21 (91.3)	23	0.559
	15 – 19 years	5 (11.1)	40 (88.9)	45	
Gender	Male	1 (4.4)	22 (95.6)	23	0.24
	Female	6 (13.3)	39 (86.7)	45	
Weight category	Normal	5 (9.1)	50 (90.9)	55	0.402
	Overweight or Obese	2 (15.4)	11 (84.6)	13	
Family history of diabetes	Yes	1 (6.2)	15 (93.8)	16	0.474
	No	6 (11.5)	46 (88.5)	52	
Hypertension	Yes	3 (17.6)	14 (82.4)	17	0.235
	No	4 (7.8)	47 (92.2)	51	

DISCUSSION

From a large number of adolescents with impaired fasting glucose, a cohort of 68 adolescents who gave consent was evaluated further to detect impaired glucose tolerance and other influencing factors.

The American Diabetes Association encourages the use of fasting blood glucose for the diagnosis of impaired glucose regulation and diabetes mellitus[4]. However the World

Health Organization recommends the use of the Oral Glucose Tolerance test as a screening procedure.6 This different diagnostic criteria, have led to different results regarding prevalence rates of impaired glucose regulation.

In this study, out of the 68 adolescents with impaired fasting glucose, 7(10.3%) had IGT following an oral glucose tolerance test. Previous studies have shown that the fasting glucose level is an insensitive method for detecting impaired glucose regulation[6]. In a study by Sinha et al[9], a low prevalence of IFG in obese children and adolescents with IGT was found, this study just like in this report showed a low concordance between IFG and IGT in detecting impaired glucose regulation. There was no case of Type 2 DM detected in this study, this may be due to the fact that this study was not done in a group of adolescents who are specifically at risk for type 2 DM and this may also indicate that while IFG and IGT may be present, there is still a preserved beta cell function which is usually absent with development of clinical type 2 diabetes mellitus. Only a small number of subjects meet criteria for IFG and IGT occurring together showing that these categories overlap only to a very limited extent in children as already reported in adults.10 The presence of IFG and IGT as seen in about 10% of subjects in the report is hallmarked by a profound insulin resistance and a new additional defect in glucose sensitivity of second phase insulin secretion[11].

IGT and type 2 DM are far more common in obese adolescents, in females and in the presence of other cardiometabolic risk factors such as hypertension, hypertryglyceridaemia and family history of type 2 DM[4,6]. In this study, there was no statistically significant association between any of the factors evaluated such age, weight, family history of DM and blood pressure and the development of IGT in adolescents with IFG. However the presence of IFG and IGT in this study was higher in females, in obese and overweight adolescents and in those with hypertension and in adolescents in the age group 15 to 19 years. The mean fasting blood glucose and BMI was also higher in subjects with the presence of both IFG and IGT.

IGT and IFG are reported to have different incidence at development of diabetes and micro vascular complications[12,13]. The development of type 2 diabetes consists of two main factors which include decreased insulin secretion and insulin sensitivity. Researchers have described several factors such as insulin secreting capacity, insulin resistance, age, BMI, triglyceride and ethnicity to influence the elevation of two hour post glucose level (2hPG) and Fasting Plasma Glucose (FPG). IFG and IGT are not interchangeable and represent different abnormalities of glucose regulation[14]. In subject with only IFG, there is a measure of disturbed carbohydrate metabolism in the basal state while in IGT, it is a dynamic measure of carbohydrate intolerance after a standardized glucose load as was determined in these subjects. The presence of both IFG and IGT therefore represent the presence of abnormality at different stages of carbohydrate metabolism. There is therefore need to compare and evaluate further the progression to diabetes in the group of African adolescents with dominant IFG to those with dominant IGT, and those with combined disorder. The use of IGT solely to detect subjects at risk for type 2DM may leave some subjects with IFG and other risk factors unidentified as shown in this report where only 10.3% of subjects with IFG had IGT.

CONCLUSION

Only 10.3% of adolescents with IFG had IGT in this report, showing a lack of concordance in the use of IGT and IFG in identification of subjects with risk factors for type 2 DM. Mean fasting blood glucose level, mean BMI level was higher amongst those with both IGT and IFG. IGT determined by the standard oral glucose test is not present in all subjects with IFG. There is need for initial use of fasting blood glucose screen to identify adolescents with IFG.

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