Prevalence of prediabetes in secondary school students in Port Harcourt, Nigeria

Jaja T, Oduwole A O, Fetuga B, and Abdus-Salam I A

Abstract:
This study aimed to assess the prevalence of prediabetes using impaired fasting glucose (IFG) in secondary school students aged 10 to 19 years in Port Harcourt, Nigeria, and to determine associated risk factors. Fasting blood glucose (FBG), blood pressure (BP), and body mass index (BMI) was measured. All students who had a FBG of 5.6 - 6.9mmol/l were asked to undergo an oral glucose tolerance test (OGTT). A total of 880 students were studied. The prevalence of IFG using the International Society for Paediatric and Adolescent Diabetes (ISPAD) criteria was 17% and prevalence was comparatively higher in subjects who were obese, had systolic prehypertension or diastolic hypertension, as well as a family history of diabetes. There was, however, no statistical association between the BMI percentile categories, BP category, sex and age category, or family history of diabetes and occurrence of IFG. The prevalence of IFG was 4% using the World Health Organization (WHO) criteria. Only one child had diabetes. Sixty-six (42%) students who had IFG had an OGTT, of which 10(15%) had IGT. We conclude that prediabetes is common in this population, and screening should be considered, at least in those with obesity or a family history in diabetes.

Introduction

There is a current worldwide increase in prevalence of type 2 diabetes in children, especially amongst adolescents. Studies mainly from America show that type 2 diabetes represents 8 to 45% of new cases of diabetes in children and is commonly diagnosed between the ages of 12 and 16 years.[1] This increase in prevalence has been well documented in the United States of America, especially among minority groups, and groups with a high incidence of obesity.[2,3] In Africa, 12.1 million people were estimated to be living with diabetes in 2010, and this is projected to increase to 23.9 million by 2030, with type 2 diabetes accounting for most cases.[4]

The onset of type 2 diabetes is usually preceded by an asymptomatic preclinical state known as prediabetes. Prediabetes is marked by IFG or IGT, associated with resistance or deficiency of insulin.[5] The prevalence of prediabetes ranges in adults from 2.2% to 16.2% with a prevalence of 7.3% in sub-Saharan Africa.4 The prevalence amongst US teens has progressively increased from 9% in 2000 to 23% in 2008.[6] In a cross-sectional study amongst Hispanic children in the USA with a history of obesity and a family history of type 2 diabetes, the prevalence of prediabetes was 32%.[7]

Risk factors associated with the development of prediabetes and diabetes include obesity, overweight, family history, acanthosis nigricans, hypertension, polycystic ovarian syndrome and hyperlipidaemia.[8] In a study by Mbanya et al, a significant proportion of the offspring of Cameroonians with type 2 diabetes had either type 2 diabetes (4%) or IGT (8%).[9] Although prediabetes has been documented commonly in the obese, it has also been noted amongst the non-obese.

The transition from prediabetes to diabetes may take many years, but may occur rapidly. In some cases, there may be reversal with adequate life style modification.[10]

Most of the studies done on prediabetes in Africa are in adults, and little is known about the prevalence in children and adolescents. The purpose of this study was to determine the prevalence of prediabetes in secondary school students, aged 10 - 19 years in Port Harcourt, Nigeria using IFG, and to determine associated risk factors.

Patients and methods

This was a cross sectional study carried out amongst students in public secondary schools in Port Harcourt Local Government Area (LGA) of Rivers State, Nigeria over a two-month period, March 2013 to May 2013. Port Harcourt is the capital of Rivers State, a major industrial area of the Niger Delta region of Nigeria, with much oil exploration and urbanisation. Rivers State has an estimated population of 5.3 million, using the 2006 census with Port Harcourt LGA accounting for 541 115 of the state population covering a land area of 109km2.

Ethical approval for this study was obtained from the Ethics committee of the University of Port Harcourt Teaching Hospital and from the Rivers State Ministry of

Jaja T, Consultant Paediatric Endocrinologist, Department of Paediatrics, University of Port Harcourt Teaching Hospital, Rivers State; Oduwole AO, Consultant Paediatric Endocrinologist and Co-ordinator, Paediatric Endocrinology Training Centre for West Africa, Lagos University Teaching Hospital, Nigeria; Fetuga B, Consultant Paediatric Endocrinologist, Department of Paediatrics, Olabisi Onabanjo University Teaching Hospital , Ogun State, Nigeria; Abdus -Salam I A, Consultant Public Health Physician and State Epidemiologist, Lagos State ministry of Health. Correspondence to: Jaja T. Email: Tamunopriyej@yahoo.com

Variable	Number (%)	IFG (FBG 5.6-6.9mmol/l)
Age		
10-12.9 y	139 (16%)	27 (19%)
13-15.9 y	418 (47%)	80 (19%)
16-19.0 y	323 (37%)	45 (14%)
Gender		
Female	577 (66%)	99 (17%)
Male	303 (34%)	53 (17%)
Weight		
Underweight	20 (2%)	3 (15%)
Normal weight	736 (84%)	117 (16%)
Overweight	101 (11%)	24 (24%)
Obese	23 (3%)	8 (35%)
Systolic BP		
Normal	750 (85%)	124 (17%)
Prehypertension	72 (8%)	16 (22%)
Hypertension	58 (7%)	12 (21%)
Diastolic BP		
Normal	745 (85%)	126 (17%)
Prehypertension	105 (12%)	19 (18%)
Hypertension	30 (3%)	7 (23%)
Family history of diabetes		
Yes	99 (11%)	24 (24%)
No	781 (89%)	128 (16%)

Note:
1. Underweight was below the 5th BMI percentile, normal weight 5th-85th percentile, overweight 85th-95th percentile, and obese >95th percentile.
2. Normal BP was <90th percentile for age and sex, prehypertension was 90th-95th percentile, and hypertension was >95th percentile.

Table 1. Demographic characteristics and impaired fasting glucose status of school children

Education. Permission was also obtained from individual head teachers of schools selected, and consent was obtained from students and parents.

Schools and students were selected using multistage sampling from a list of schools provided by the Rivers State Ministry of Education. The sample size was calculated using a prevalence of 50%, because no other study has been done in this region in children. A minimum sample size of 1180 was determined and recruited following which 880 students met inclusion criteria and were analysed. Students who were known to have diabetes, those who did not fast for the FBG determination, and those whose parents did not give consent, were excluded.

A pretested self-administered questionnaire was used to obtain information on family history of diabetes. Blood pressure and anthropometric data, which included weight, height and BMI, were determined using appropriate methods by pretrained field assistants. BMI percentiles were determined for each subject based on age and sex and categorised into underweight, normal weight, overweight and obesity. BP percentiles based on age and sex were also determined and classified into prehypertension, hypertension and normal blood pressure.

FBG was determined for recruited subjects following an 8 to 12 hours overnight fast, using the Accu-chek Active Roche Diagnostics glucometer. Quality control of the glucometers was done using Accu-chek control solutions daily to ensure correct results. Results were classified based on the ISPAD or WHO criteria into normal, impaired fasting, and diabetic range glucose levels. Analysis in this report was based on the ISPAD criteria because previous studies have used these values and reports have shown that complications of prediabetes have been recorded with blood glucose as low as 5.6mmol/l, as advocated by ISPAD. According to ISPAD criteria, IFG is FBG of 5.6 - 6.9mmol/l (100 -125mg/dl) and WHO criteria of IFG is FBG of 6.1-6.9mmol/l (110 -125mg/dl).[11,12]

All results were recorded into respective students questionnaire and data entered into an Excel sheet and analysed using SPSS version 17. Frequency distributions and cross tabulations were used and prevalence of prediabetes was computed. Significance levels were determined by the Chi square test and level of statistical significance was considered at a p value of <0.05.

Results

Eight hundred and eighty (880) students aged 10 to 19 years were analysed. There were 577 (66%) females and 303 (34%) males. The mean age of students studied was 15±2 years. There was no statistically significant difference between the mean age of males and females. Table 1 shows the demographic data.

The mean FBG was 5.2±0.5mmol/l. Overall, 17% of students were identified to have IFG based on the ISPAD criteria, with an equal sex distribution. Using WHO criteria, the IFG prevalence was 4%, and one subject had diabetes.

The relationship between age, gender, weight category, blood pressure and family history of diabetes with IFG is shown in Table 2. The data showed that there was no statistically significant difference in the prevalence of IFG with age, sex, weight category, blood pressure and family history. Thirty-two (26%) of the overweight and obese students had IFG, compared to 117 (16%) of normal weight students ($p= 0.156$). The prevalence of IFG was 21% and 19% in those with systolic and diastolic prehypertension and hypertension respectively.

Twenty-four (24%) of students a with family history of diabetes had IFG compared to 16% without. This difference was not statistically significant.

Sixty-six (43%) of students with IFG accepted to under-

take an OGTT, out of which 10 (15%) had IGT. The prevalence of prediabetes was higher using the ISPAD criteria (17%) compared to use of the WHO criteria (4%).

Discussion

The prevalence of prediabetes depends on the definition used.[14] Significant differences in prevalence can depend on whether prediabetes is defined by IFG or IGT, as well as on the age and ethnic group of the patients and the criteria used.[13] Prediabetes in students in public secondary schools in our study using the ISPAD criteria was highly prevalent. In the few school-based studies, prevalence of prediabetes using IFG was estimated to vary from 6.7% to 40.5%.[14-17] In this study the prevalence of prediabetes using IFG was 17%. This is similar to a report by Aboulella et al in Egypt of 16% but lower than reports of 23% from Jordan.[15,16] In an earlier report, prevalence of prediabetes amongst US adolescents aged 12 to 19 years using IFG was 13%.[18] Also, in a study in Mexico amongst 1534 apparently healthy children aged 6 to 18 years, prevalence of prediabetes using IFG was 18.3%.[19] The difference in prevalence of IFG in different studies may be due to differences in environmental risk factors, genetic, socioeconomic factors, prevalence of other associated risk factors for prediabetes and diabetes, and the method of blood glucose determination. The use of IFG in the determination of prediabetes in this study is according to the recommendation of the ISPAD. IFG accounted for nearly 80% of adolescents with prediabetes in most studies.[18,20] The prevalence of prediabetes using IGT amongst adolescents is lower than prevalence using IFG in most studies.[18,20,21] The prevalence amongst USA adolescents aged 12 to 19 years, was 13% using IFG and 3% when IGT was used. The difference in prevalence shows that the tests represent different aspect and different stages of progression of glucose dysregulation. Although this study did not set out to test for IGT in all children, however 10% of the 66 children with IFG who accepted to do the OGTT had IGT.

	IFG	No IFG	Significance
Total	152 (17%)	728 (83%)	
Gender			**p=0.769**
Male	53	250	
Female	99	478	
Age group			**p=0.260**
10-12.9 y	27	112	
13-15.9 y	80	338	
16-19.0 y	45	278	
Weight category			**p=0.156**
Underweight	3	17	
Normal	117	618	
Overweight	24	77	
Obese	8	15	
Systolic BP			**p=0.668**
Normal	124	625	
Prehypertension	16	55	
Hypertension	12	46	
Diastolic BP			**p=0.910**
Normal	126	617	
Prehypertension	19	85	
Hypertension	7	23	
Family history			**p=0.142**
Yes	24	75	
No	128	653	

Note:
1. Underweight was below the 5th BMI percentile, normal weight 5th-85th percentile, overweight 85th-95th percentile, and obese >95th percentile.
2. Normal BP was <90th percentile for age and sex, prehypertension was 90th-95th percentile, and hypertension was >95th percentile.

Table 2. Association of age, gender, weight category, blood pressure and family history of diabetes by IFG

The prevalence of prediabetes has been found to be high among adolescents with obesity.[16-18] The twofold increase in prevalence of IFG over a five year period in the NHANES study between 1999 to 2006 was attributed to the rapid rise in the prevalence of obesity amongst adolescents. In our study, although there was no statistically significant difference in the prevalence of prediabetes between normal weight and overweight or obese students, the prevalence of IFG was higher amongst overweight and obese subjects. This finding has been reported by D'Narayanappa and colleagues[17] in Indian prepubertal children, and Aboulella and colleagues.[17] In the study on 'STOPP' type 2 diabetes, conducted amongst 8th grade students with a mean age of 14 years, 40% had IFG. In those with a BMI ≥ 95th percentile, the prevalence of IFG increased to 47%, while it was 36% in students with normal BMI (<85th percentile[14]). The reason for the high prevalence of prediabetes in overweight and obese subjects may be due to the presence of insulin resistance and toxicity to beta cells due to the high level of free fatty acids in obese individuals.[22] In our study, no association was found between prediabetes and overweight or obesity as reported in other studies.[14,15,17] The reason for lack of association cannot be ascertained, but it is a known fact that insulin resistance can be seen in both the obese and non-obese.[22]

The risk of developing prediabetes and type 2 diabetes

in obese children depends on genetic factors, onset of puberty, developmental and nutritional factors.[22] Based on genetics, family history of diabetes is a strong factor for development of IFG even in the absence of obesity.[11] In our study, the prevalence of prediabetes was higher in children with a positive family history of diabetes. In a study of children and adolescents aged 7-15 years from Mexico, IFG was identified in 88% of those with a family history, compared to 2% of those without; and the presence of family history in a first degree relative was associated with IFG, even in the absence of obesity.[23] Similarly, among obese children from Germany, a history of parental diabetes was associated with a 9.5 fold increased risk for prediabetes, making family history of diabetes a very important risk factor for development of prediabetes and type 2 diabetes.[24]

As with other associated risk factors for cardio-metabolic diseases evaluated in this study, the prevalence of both systolic and diastolic blood pressure increase was noted to be higher in students with prediabetes. Although there was no statistically significant association between raised BP and prediabetes, the findings in this report may indicate a clustering of risk factors.

Adolescents aged 12-15 years have been reported to have a significantly higher rate of prediabetes than those aged 16 to 19 years.18 This may be related to the pubertal insulin resistance that occurs during early adolescence.[13] In this study, although there was no specific look at the Tanner stages for the students studied, there were proportionately higher numbers of children with prediabetes amongst those in early and mid-adolescence, also coinciding most likely with early Tanner stages. The higher prevalence may therefore be accounted for by higher insulin resistance recorded in early adolescence.[13]

We conclude that prediabetes is prevalent in secondary school students in Port Harcourt, Nigeria. It was commoner in subjects with overweight or obesity, prehypertension and hypertension, and a family history of diabetes. There was no statistically significant association with prediabetes and any evaluated risk factor. However, screening for prediabetes will be helpful in adolescents who have a family history of diabetes, or have hypertension, or obesity.

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