eISSN 2255-0569

ORIGINAL

Prevalence of prediabetes among first degree relatives of type 2 diabetes individuals in Abakaliki, Ebonyi State Nigeria

Prevalencia de prediabetes entre familiares de primer grado de personas con diabetes tipo 2 en Abakaliki, Estado de Ebonyi, Nigeria

Innocent Sidney Ikechi[1,2], Ezinne Jane Ejike-Odeh[1], Onwe Emmanuel Ifeanyichukwu[1], Chinemerem Ogbu[2], Ude Ugomma Agwu[1], Emmanuel Ifeanyi Obeagu[3]

1. Department of Medical Laboratory Science, Ebonyi State University. Abakaliki, Ebonyi State, Nigeria.
2. Department of Medical Laboratory Science, Evangel University. Akaeze. Ebonyi State Nigeria.
3. Department of Medical Laboratory Science, Kampala International University, Uganda

Corresponding author
Emmanuel Ifeanyi Obeagu
E-mail: emmanuelobeagu@yahoo.com

Received: 25 - X - 2022
Accepted: 25 - XI - 2022

doi: 10.3306/AJHS.2023.38.02.85

Abstract

Aim: This study was aimed at determining the prevalence and factors of pre-diabetes (PD) among first degree relatives, (FDRs) of type 2 diabetes, (T2D) subjects in Abakaliki Metropolis, Ebonyi State, Nigeria.
Methods: 100 participants (70 men and 30 women) were selected through respondent-driven sampling and interviewed about their knowledge, common symptoms and family history of T2D. Venous blood samples were collected after an overnight fast and 2 hours after a 75g oral dose of 75g anhydrous glucose. Samples were collected into fluoride-oxalate bottles, kept at 40ºC and analyzed within 1 hour of collection by the glucose oxidase method. Data were analyzed using SPSS 20.0 and summarized as mean and standard deviation.
Results: Twenty-two FDRs – (17 male and 5 females) had PD giving prevalence rates of 22%, 24.3% and 16.7% respectively for the entire study, males and females populations respectively. 13 (11 male, 2 females; 84.6% and 6.7%) of FDRs with PD had IFG only while 3 each – (4.3 and 10% respectively) - had IGT only. 3 males only (4.3%) had both IFG and IGT. The BMI of subjects with IGT (23.80 ± 2.68 kg/m^2) was significantly higher than IFG (22.09 ± 1.94 kg/m^2) (p = 0.028). Female subjects with PD had significantly higher BMI (21.8 ± 3.38 vs 21.73 ± 3.15 kg/m^2; p = 0.035) than the male FDRs. Almost 25% of FDRs of T2D subjects in Abakaliki have PD and are at risk of developing diabetes.
Conclusion: More men than women were affected. Body mass, among others, may be a contributing factor.

Keywords: Pre-diabetes, impaired fasting glycaemia, impaired glucose tolerance, first degree relatives.

Resumen

Objetivo: El objetivo de este estudio era determinar la prevalencia y los factores de la prediabetes (PD) entre los familiares de primer grado (FDR) de los sujetos con diabetes tipo 2 (T2D) en la metrópolis de Abakaliki, estado de Ebonyi, Nigeria.
Material y métodos: Se seleccionaron 100 participantes (70 hombres y 30 mujeres) mediante un muestreo dirigido por los encuestados y se les entrevistó sobre sus conocimientos, síntomas comunes e historia familiar de la T2D. Se recogieron muestras de sangre venosa después de un ayuno nocturno y 2 horas después de una dosis oral de 75g de glucosa anhidra. Las muestras se recogieron en frascos de oxalato de flúor, se mantuvieron a 40C y se analizaron en la hora siguiente a la recogida por el método de la glucosa oxidasa. Los datos se analizaron con el programa SPSS 20.0 y se resumieron como media y desviación estándar.
Resultados: Veintidós FDR (17 hombres y 5 mujeres) tenían EP, lo que arroja unas tasas de prevalencia del 22%, 24,3% y 16,7%, respectivamente, para la totalidad de la población del estudio, los hombres y las mujeres. 13 (11 hombres y 2 mujeres; 84,6% y 6,7%) de los FDR con EP tenían sólo IFG, mientras que 3 (4,3 y 10% respectivamente) tenían sólo ATG. Sólo 3 varones (4,3%) tenían tanto IFG como ATG. El IMC de los sujetos con ATG (23,80 ± 2,68 kg/m^2) fue significativamente mayor que el de los sujetos con ATG (22,09 ± 1,94 kg/m^2) (p = 0,028). Los sujetos femeninos con EP tenían un IMC significativamente mayor (21,8 ± 3,38 vs 21,73 ± 3,15 kg/m^2; p = 0,035) que los FDR masculinos. Casi el 25% de los sujetos FDR de T2D en Abakaliki tienen EP y están en riesgo de desarrollar diabetes.
Conclusiones: Hay más hombres que mujeres afectados. La masa corporal, entre otros, puede ser un factor contribuyente.

Palabras clave: Prediabetes, glucemia alterada en ayunas, tolerancia alterada a la glucosa, familiares de primer grado.

Introduction

Pre-diabetes (PD) is a health condition with blood glucose level above normal but lower than the defining limits for T2D. A person with PD, has blood glucose levels consistently high but not yet high enough to be classified as type 2 diabetes[1]. The presence of PD is considered a risk factor rather than a clinical entity in its own right[2]. Individuals with PD may have one of these conditions- impaired fasting glycaemia (IFG), impaired glucose tolerance (IGT) or both. The risk factors for PD include: being overweight. being 45 years or older, having a parent, brother, or sister with type 2 diabetes and being physically active less than 3 times a week.

According American Diabetes Association, PD can be defined by a glycated hemoglobin (HbA1c) between 5.7 and 6.4%. Individuals with PD may be euglycemic in their daily lives as shown by normal or near normal HbA1c[1]. IGT manifests hyperglycaemia only when standard oral glucose tolerance test is performed and it may be directly involved in cardiovascular diseases[3]. Subjects with PD have increased risk of progressing to diabetes and macro-vascular complications.

Not all individuals with PD progress to T2D []. 50% remain in their abnormal glycemic state, 25% revert to normal glucose tolerance leaving 25% to progress to T2D,[4]. Aging, high total cholesterol, high LDL-cholesterol, high conicity index and longer urban residence after migration were significantly associated with pre-diabetes, were associated with prediabetes[5]. IGT and IFG have heterogeneous pathogenesis and different rates of progression to diabetes[6]. Both present with IR but the sites of IR differ. Elevated hepatic insulin resistance is a typical finding in IFG, with almost normal skeletal muscle sensitivity. Individuals with IFG have moderate hepatic IR and impaired early (1=30 minutes) exocytosis of insulin from secretory vesicles during OGTT,[6,7]. Because the late phase plasma insulin response is intact and muscle sensitivity is normal or near-normal, the 2 hour glucose returns to the initial FPG level[6]. Those with IGT have moderate to severe muscle insulin resistance with small changes in liver sensitivity [DeFronzo and Abdul-Ghani, 2011] and impaired early and late insulin (60-120 minutes) response during OGTT[8]. Although FPG is not elevated, there is a progressive and sustained PG rise during OGTT and 2 hour level remain above the fasting level[6]. Individuals with IFG have normal 2 hour PG but their 1 hour PG level may be elevated. Similarly, the 1 hour level in those with IGT exceeds those with NGT and is higher than the 2 hour values during OGTT. The 1 hour PG concentration during OGTT correlates more strongly with insulin secretion, insulin resistance and insulin secretion/insulin resistance index than the 2 hour PG concentration. Subjects with both of the conditions have approximately double the rate of developing diabetes compared with subjects with just one. Both conditions are associated with metabolic syndrome and manifest insulin resistance and impaired insulin secretion[2,9]. However, there are differences in the nature of these defects between these conditions[10]. Because PD is not a clinical entity, it progress to T2D without the sufferer being aware of it. Early detection and control of PD will lead to delay in the development of the condition and/or its complications[9,10]. To the best of our knowledge, no studies have reported the prevalence of PD in Abakaliki adult population.

Materials and Methods

This case-control study enlisted 100 FDRs of T2D subjects and 100 apparently healthy non relative of diabetes subjects as control. Sample size was calculated using the formula by Cochram[11]. The subject were not receiving any drug treatment at the time of sample collection. The FDRs had first degree relatives with clinical diabetes or family history of diabetes to qualify for inclusion in the study. The control subject had no FDR with diabetes or family history of diabetes. Ethical approval was obtained from the Ethic Committee of Ebonyi State University Teaching Hospital and informed consent was obtained before sample collection.

Anthropometric measurements were taken for the calculation of BMI using standard methods. Two milliliters of blood was collected from the ante cubital vein using standard method. Thereafter each of the FDRs received 75g of oral anhydrous glucose powder in 250ml of clean cold water and a second blood sample was collected 2 hours post glucose load. Collected samples were kept at 40C until analyzed usually within 3 hours of collection using the Glucose oxidase method of Trinder as described by Cheesbrough[12].

Data were entered in MS Excel 2007 sheet and analyzed using SPSS for Social Science software version 20.0 (SPSS Inc. Chicago, IL, USA) and summarized as means and standard deviations for quantitative variables. Differences between continuous variables were analyzed using Student's "t" test and statistical significance was placed at $p<0.05$.

Prediabetes was diagnosed as FPG between 5.6 and 6, 1 mmol/l and/or 2hppG between 7.8 and 11.0 mmol/l[9].

Results

22 FDRs – (17 male and 5 females) had PD. These gave prevalence rates of 22%, 24.3% and 16.7% respectively for the entire study, males and females populations respectively. 13 (11 male, 2 females) of FDRs with PD had IFG only (84.6 and 6.7%) while 3 each – (4.3 and 10%) - had IGT only. 3 males (4.3%) had both IFG and IGT.

Table I: Showing comparison of the characteristics of the subjects with and without PD.

Group/Parameter	BMI (kg/m²)	FPG (mmol/l)	2hppG (mmol/l)	Age (years)
FDRs (100) Controls (100) p-value	21.77 ± 3.24 20.66 ± 2.73 0.017	4.73 ± 1.01 4.33 ± 0.67 0.028	5.55 ± 1.29 4.77 ± 0.39 0.030	25.44 ± 4.44 24.56 ± 2.73 0.046
Male FDRs (70) Female FDRs (30) p-value	21.73 ± 3.15 21.8 ± 3.38 0.035	4.53 ± 0.95 4.24 ± 1.15 0.058	5.58 ± 1.23 5.47 ± 1.45 0.572	22.42 ± 3.25 23.51 ± 2.54 0.056
IFG (16) IGT (3) p-value	22.09 ± 1.94 23.80 ± 2.68 0.028	6.20 ± 0.47 5.00 ± 1.73 0.073	6.66 ± 1.31 9.50 ± 1.35 0.049	23.09 ± 2.64 24.08 ± 1.74 0.052

The FDRs of T2D subjects with or without PD had significantly higher FPG, (4.73 ± 1.01mmol/l vs 4.33 ± 0.67; p = 0.028), 2hppG, (5.55 ± 1.29mmol/l vs 4.77 ± 0.39; p = 0.030) and BMI, (21.77 ± 3.24 kg/m^2 vs 20.66 ± 2.73 kg/m^2; p = 0.017). (**Table I**).

Male subjects with PD had higher FPG, (4.53 ± 0.95mmol/l, vs 4. 24 ± 1.15 P =0.014) and higher 2hppG, (5.58 ± 1.23mmol/l vs 5.47 ± 1.45mmol/l; p = 0.572) than the female FDRs. However, the female FDRs had significantly higher BMI than their male counterpart, (21.8 ± 3.38 vs 21.73 ± 3.15 p = 0.035) (**Table I**).

FDRs with IFG had significantly higher FPG, (6.20 ± 0.47 mmol/l vs 5.00 ± 1.73; p = 0.073). However, IGT subjects had significantly higher BMI (23.8 ± 2.68 kg/m^2 vs 22.09 ± 1.94 kg/m^2) and 2hppG (vs 9.50 ± 1.35 vs 6.66 ± 1.31 mmol/l; p = 0.049; p = 0.028) than those with IFG, (**Table I**).

Discussions

This study recorded a prevalence of PD of 22% among the FDRs of T2D. In a study.in the general population of the same geographical zone as this, Ezeala-Adikaibe et al. [13] reported a prevalence of 7.6%. Majority of the FDRs with PD (19 out of 22) were males giving a prevalence of 27% and 10% for male and female FDRs. Much higher figures than these have earlier been reported for Nigeria and sub-Saharan Africa with projected increases worldwide by 2035[14,15]. Ogbu *et al*.[16] reported a prevalence of 15.5% for apparently healthy subjects within the same age range in Owerri Municipality in Imo State in the same geographical zone as the current studies. The prevalence of PD among the male FDRs was significantly higher than among the females, (27% vs 10%). This agrees with the report of Ogbu *et al*.[16] but there does not seem to be any explanation for this yet.

According to Tirosh *et al*.[17], individuals with glucose levels approximating 5.2 mmol/l, considered as normal and below the IFG threshold, are at increased risk for developing diabetes. In this study several of the FDRs but none of the control had FPG above this threshold. It is conceivable that postprandial glucose levels below 7.8 mmol/l, the cut off point for defining IGT, also confer increased risk for developing T2D[18]. Curiously none of the FDRs in this study attained this level of postprandial glucose level. According to Weir and Bonner-Weir[19], the level of plasma glucose that define IGT occurred rather late just before conversion to diabetes. This is in line with the concept that total body glucose disposal can gradually worsen from normal tolerance to IFG to IGT and then to T2D. Consequently, there are more FDRs with IFG (16; 16%) than IGT (3; 3%) or IFG plus IGT (3; 3%). This is not in agreement with Ogbu *et al*.[16] who recorded, 30.6%, 62.4% and 7.0% respectively. The later 2 stages, IGT and IFG plus IGT, are terminal stages of PD and individuals do not remain long in them before entering clinical diabetes. However, individuals can live with IFG for much longer time before progressing to IFG plus IGT and then diabetes. IGT and IFG have heterogeneous pathogenesis and different rates of progression to diabetes[20]. Subjects with both conditions, IFG plus IGT, have approximately double the rate of developing diabetes compared with subjects with just one.

From the result of this study, it would appear that being FDR predisposes to presence of metabolic syndrome, (MetS). The FPG, 2hppG and BMI of the FDRs with or without PD were significantly higher than those of the controls though not yet in the range for the definition of MetS[21]. One of disposing factors for PD and MetS is age. The subjects used for this study were all above 35 years of age so it is not possible to predict from this study at what age factors of MetS and PD started to manifest in them. To confirm this, it is would be necessary to study younger FDRs. From the results of the current study, it is apparent that BMI is a factor in the different plasma glucose concentrations recorded. Though within the range considered normal, 18-23 kg/m^2, significant differences exist along with PG of groups as can be seen from **table I**. One study reported that weight did not influence the development of overt diabetes or prediabetes conditions[22].

Not adequate attention is given to PD in the prevention of diabetes. This is evident from the paucity of current literature on the topic. However, individuals at risk of

developing T2D when diagnosed at the PD stage can be saved from the scourge of diabetes. With lifestyle changes, the progression to clinical diabetes can be delayed or even prevented and even when diabetes eventually results, the complications will not be as severe as otherwise[23]. The long period of time it takes to progress to diabetes should be taken advantage of to stop PD subjects progressing to diabetes. This is possible if people at risk do their blood glucose, fasting and 2hpp, annually and are followed up to ensure the glucose concentration is not rising even within the range considered normal. PD subjects are prone to cardiovascular events and macro-vascular complications[5,24].

Conclusion

One quarter of the population of FDRs of type 2 diabetes subjects in Abakaliki have PD and are at risk of developing diabetes. More men than women were affected. Body mass, among others, is a contributing factor. Because the work was carried out in the capital city only, the results may not be representative of the entire state. It is recommended that PD be accorded the status of clinical entity to prevent, by simple life-style changes, sufferers progressing to diabetes.

Authors Contributions'

ISIO conceived and supervised the project; EEJ, OEI, OCC, UUA and EIO took part in the identification, collection and analysis of samples.

Authors' Declaration of Conflict of Interests

The authours declared that there is no conflict of interest.

References

1. American Diabetes Association Standards of medical care in diabetes. Classification and diagnosis of diabetes. 2016.

2. American Diabetes Association. Classification and Diagnosis of Diabetes: Standards of Medical Care in Diabetes-2018. Diabetes Care. 2018; 41: S13-S27.

3. Nissen SE, Wolski K. Effect of rosiglitazone on the risk of myocardial infarction and death from cardio-vascular causes. N Engl J Med.2007; 356(24): 2457-71.

4. Yaturu S. Prediabetes Progression to Diabetes among Veterans. Journal of Diabetes Mellitus. 2020; 10, 202-7.

5. Gombet T, Longo-Mbenza B, Ellenga-Mbolla B, Ikama MS, Kimbally-Kaki G, Nkoua JL, et al. Prevalence rates and cardiometabolic determinants of diabetes mellitus and pre-diabetes with projected coronary heart disease at bank site of Brazzaville. World Journal of Cardiovascular Diseases 2014; 4(2).

6. DeFronzo RA, Abdul-Ghani MA. Preservation of bet cell function: the key to diabetes prevention. J Clin Endocrionol Metab. 2009; 96(8):2354-66.

7. Clark A. Pancreatic Islet Pathology in type 2 diabetes in Pancreatic Beta Cell in Health and Disease Seino, S. Bell, G. J, ed Springer, New York. 2008; 4: 381-8.

8. Basu A, Pedsersen MG, Cobelli C. Commentary. Pre-diabetes: evaluation of beta-cell function. Diabetes. 2012; 61(2):270-1.

9. Ranlo-Halsted BA, Edelman SV. The natural history of type 2 diabetes: implications for clinical practice. Primary care. 2011; 26(4): 771-89.

10. Filippini T, Wise LA, Vinceti M. Cadmium exposure and risk of diabetes and prediabetes: A systematic review and dose-response meta-analysis. Environ Int. 2022 Jan;158:106920. doi: 10.1016/j.envint.2021.106920.

11. Cochram WG. Sampling techniques. 3rd Ed. New York. John Wiley & Sons.1977;

12. Cheesbrough M. District Laboratory Practice in Tropical Countries. Part 1. Second Edition Cambrdge University Press. 2009; Pp 340-9

13. Ezeala-Adikaibe B, Mbadiwe N, Okwara C, Onodugo O, Onyekonwu C, Ijoma U, et al. Diabetes and Pre-Diabetes among Adults in an Urban Slum in South East Nigeria. Journal of Diabetes Mellitus 2018; 8, 131-44.

14. Olatunbosun ST, Ojo PO, Fineberg N, Bella AF. Prevalence diabetes mellitus and impaired glucose tolerance in a group of urban adults in Nigeria. J Natl Med Asso.2008; 90: 293-301.

15. Gerstein HC, Santaguida P, Raina P, Morrison KM, Balion C, Hunt D, Yazdi H, Booker L. Annual incidence and relative risk of diabetes in people with various categories of dysglycemia: a systematic overview and meta-analysis of prospective studies. Diabetes Res Clin Pract. 2007 Dec;78(3):305-12. doi: 10.1016/j.diabres.2007.05.004.

16. Ogbu ISI, Azodo EC, Chinwuba AU .Prevalence of prediabetes and unreported diabetes mellitus in a population aged 45 years and above in Owerri municipality, Imo State Nigeria. Intl J Med Health Dev 2012; 17(2): 30-7.

17. Tirosh A, Shai I, Tekes-Manova D, Israeli E, Pereg D, Shochat T, Kochba I, Rudich A; Israeli Diabetes Research Group. Normal fasting plasma glucose levels and type 2 diabetes in young men. N Engl J Med. 2005 Oct 6;353(14):1454-62. doi: 10.1056/NEJMoa050080.

18. Perreault L, Pan Q, Mather KJ, Watson KE, Hamman RF, Kahn SE; Diabetes Prevention Program Research Group. Effect of regression from prediabetes to normal glucose regulation on long-term reduction in diabetes risk: results from the Diabetes Prevention Program Outcomes Study. Lancet. 2012 Jun 16;379(9833):2243-51. doi: 10.1016/S0140-6736(12)60525-X.

19. Weir GC, Bonner-Weir S. Five stages of evolving β – cell dysfunction during progression to diabetes. Diabetes 2004; 2: 97-113

20. Levitan EB, Song Y, Fotd ES, Liu S. Is non-diabetes hyperglycaemia a risk factor for cardio-vascular disease? A meta-analysis of prospective study. Arch Intern Med 2004; 64:2147-55

21. Expert Panel on Detection, Evaluation and Treatment of High Blood Cholesterol in Adults. Executive Summary of the Third Report of the National Cholesterol Evaluation Programme/ Adult Treatment Panel 111 (NCEP/ ATP111). Circulation 2011;106(25): 3143-421.

22. Afifi Raouf M, Saad AE, Al Shehri A. Prevalence and Correlates of Prediabetes and Diabetes Results-I: A Screening Plan in a Selected Military Community in Central Saudi Arabia. Journal of Diabetes Mellitus. 2017; I7 (1)

23. Trolice, M. Defining prediabetes in polycystic ovarian syndrome. Open Journal of Obstetrics and Gynecology 2011; 1, 36-41.

24. Keenan HA, Costacou T, Sun JK, Doria A, Cavellerano J, Coney J, Orchard TJ, Aiello LP, King GL. Clinical factors associated with resistance to microvascular complications in diabetic patients of extreme disease duration: the 50-year medalist study. Diabetes Care. 2007 Aug;30(8):1995-7. doi: 10.2337/dc06-2222.