Original Research

Prevalence of Hyperglycemia and Risk Factors for Orodental Disease in Nigeria: Implications of Opportunistic Screening

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Abstract

Background: Diabetes mellitus (DM) is associated with complications and orodental disease. Whether screening for DM during orodental health visits is a potential option is yet to be established in Nigeria. This study aims at assessing the prevalence of hyperglycemia in orodental disease as a clinical scenario to capitalize for opportunistic screening. **Materials and Methods:** This study was undertaken in Catholic Hospital Abbi for Ndokwa communities and dental clinic of Eku Baptist Government Hospital, all in Nigeria. However, 474 individuals (433 community-based and 41 dental clinic-based) including 10 orodental cases were screened for hyperglycemia and waist-hip circumference indices. Blood lipid profiles were also performed. Based on fasting blood glucose levels, participants were grouped into non-diabetic (n = 172), prediabetic (n = 168), and diabetic (n = 78). A World Health Organization questionnaire on oral health was used to collect information on orodental disease risk factors. Data were analyzed with IBM SPSS 22 statistical package. **Results:** In the community-based cohort, the prevalence of hyperglycemia was 56.8%, including 38.8% prediabetes and 18.0% undiagnosed DM (UDM). In the dental-based group, 63.4% were hyperglycemic including 53.7% prediabetes and 9.7% UDM. There was significant difference ($P < 0.05$) in the ages of the participants in relation to glycemic status, with 17–29 years having the highest prevalence of UDM. However, 42.5% of the community-based clients had indication(s) of orodental disease. **Conclusion:** This is probably the first study to highlight higher prevalence of hyperglycemia from screening at a dental setting compared to general clinic. Opportunistic screening of DM in dental settings may be an option to consider during clients' orodental health visits.

Keywords: *Diabetes mellitus, Ndokwa communities, Nigeria, opportunistic screening, orodental health*

Introduction

Diabetes mellitus (DM) is a common non-communicable disease worldwide,[1] encompassing a group of metabolic disorders characterized by chronic hyperglycemia that results from defects in insulin secretion (synthesis), insulin action, or both.[2] The disease is a leading cause of death and disability,[3,4] with Nigeria being the most affected country in sub-Saharan region.[5] The incidence and prevalence of DM is increasing in developed and developing nations,[6] and approximately 50%–70% of diabetics remain undiagnosed.[7,8] In Nigeria, 70%–80% of the 4 million people with diabetes remain undiagnosed, and therefore untreated.[9] In general, people show poor attitude toward diabetes screening, and approximately 20%–30% of individuals with DM are identified after macro- or micro-vascular complications become apparent.[10] Early identification of DM and thus intervention has been shown to slow as well as mitigate development of diabetic complications. Hence, clinical opportunistic screening can therefore be useful for diagnosis of DM before symptoms are reported.[11]

Opportunistic screening of diseases in routine practice is an affordable alternative or adjunct to population screening,[11,12] and diagnosis of diabetes through opportunistic screening has been endorsed by World Health Organization (WHO) and International Diabetes Federation (IDF).[13] Dental clinics may be important settings for opportunistic DM screening, and the value of such DM screening among persons with orodental disease in Nigeria is unquantifiable. The rationale is that patients do not have to make additional visits for DM screening, but at present; there is little or no framework for opportunistic

How to cite this article: Anyasodor AE, Nwose EU, Bwititi PT, Aganbi E, Richards RS, Mudiaga LI, *et al*. Prevalence of hyperglycemia and risk factors for orodental disease in Nigeria: Implications of opportunistic screening. Indian J Dent Res 2017;28:507-13.

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Access this article online

Website: www.ijdr.in

DOI: 10.4103/ijdr.IJDR_304_17

Quick Response Code:

screening of DM in dental settings. The prevalence of oral diseases reported in government dental healthcare settings in Nigeria is high.[14] Since DM has a relationship with orodental diseases,[15,16] this makes opportunistic screening for DM in dental clinics and orodental diseases in DM clinics worthwhile. In view of the aforementioned information, this study sought to assess the prevalence of hyperglycemia among orodental disease patients with a view to suggesting opportunistic screening of prediabetes and diabetes in dental settings.

Materials and Methods

Design and setting of the study

This population- and hospital-based study was carried out in Ndokwa communities and the dental clinic of Eku Baptist Government Hospital (EBGH) in Delta State, Nigeria. This hospital situated in Eku, a town in Delta State, services Ndokwa communities and other Delta State residents. Participants (males and females) were selected for the study, based on probability sampling and given self-administered WHO questionnaires to elicit information on their orodental health. These participants were also screened for DM, and those with indication of periodontitis, based on questionnaire responses were referred to EBGH dental clinic for confirmation and dental attention. Patients who had come to EBGH for dental clinic visit were also screened for DM.

Individuals were recruited between 08:00 and 10:00 hours, and the exercise lasted from December 2015 to March 2016. Adult males and females constituted the target population. Random sample selection was adopted in the community-based study. This occurred by random selection of streets, families, and narrowing it to individuals in Ndokwa communities. Each individual was chosen entirely by chance, and each member of the population had equal chance of being included in the sample. The StalCalc application of Epi-Info software (version 7.1, CDC Atlanta, Georgia, USA) was used in determining the population size at EBGH. This was based on the capacity of the EBGH and the number of in-patients and out-patients of the clinic per year.

Inclusion and exclusion criteria

The participants were 18 years and above, and residing in the hospital catchment zones of the two study areas. Participation was voluntary, and only occurred following the signing of the consent form and upholding the important ethical principle of informed consent. Individuals who were pregnant at the period of the screening and known diabetics were excluded from the study. Participants who were undergoing anticoagulation therapy or had systemic diseases such as cancer and bleeding tendencies; among others were not enrolled.

Ethics

The study was approved by the Human Research Ethics Committee (HREC) of Charles Sturt University, Australia (protocol number: 2015/286). HREC of Novena University and Ndokwa West Local Ministry of Health Department also approved the research. Awareness and public lectures about the research preceded the exercise. These were organized and carried out in market places, schools, churches and hospitals in Ndokwa communities. Before data collection, information sheets and consent forms were made available so that potential participants were informed of the study, thus allowing for informed consent to enrol in the study.

Study procedure

Anthropometric measurements

The anthropometric measurements (waist and hip circumferences [WHCs]) were taken, using ergonometric circumference measuring tape (Seca 203). Measurement of waist circumference (WC) was made at the approximate midpoint between the lower margin of the last palpable rib and the top of the iliac crest. The hip circumference (HC) was taken around the widest portion of the buttocks.[17] These measurements were used to calculate the WHCs as well as waist-hip ratio (WHR). Guidelines described by WHO to ensure the accuracy of these measurements were followed, and recommendations for cut-offs for WC and WHR were adopted.[18] Although this was an African population, the cut-offs were based on Europids values as recommended for central obesity, and were WC >94 cm (men) and >80 cm (women). The WHR cut-offs value for men was ≥0.90 and ≥0.85 cm for women.[17]

The anthropometric measurements were carried out in accordance with standard operational procedures of Catholic Hospital Abbi and dental clinic of EBGH. Staff of the hospitals supported by Hons students from Department of Community and Public Health of Novena University, Nigeria, performed the measurements.

Biochemical measurements

Fasting blood glucose (FBG) and random blood glucose as well as lipid profiles were carried out using CardioChek® analyzer, according to manufacturer's instructions. The criterion for diagnosing DM was ≥7.0 mmol/L (≥126 mg/dL) or random plasma glucose (>11.1 mmol/L) (≥200 mg/dL), and prediabetes was defined as impaired fasting glucose level of 5.6–<6.9 mmol/L (100–<126 mg/dL).[19,20] Based on the FBG results, participants were grouped into non-diabetic, prediabetic and diabetic. The parameters measured for lipid profile were high-density lipoprotein cholesterol (HDL-C), total cholesterol (TC), and triglyceride (TG). Cut-off values of the parameters were 1.0 mmol/L (≤40 mg/dL) (indicating low HDL in men) and 1.3 mmol/L (≤50 mg/dL) (low HDL in women), 5.2 mmol/L (≥200 mg/dL) for hypercholesterolemia and 1.7 mmol/L (≥150 mg/dL) for hypertriglyceridemia as per classification of the IDF.[17] These measurements were

undertaken at the same venues where anthropometric measurements were performed. The CardioChek® PA analyzer was operated and calibrated by 'Friends Diagnostic Laboratories'. Use of the equipment was also supervised by 'Friends Diagnostic Laboratories'.

Questionnaire

The WHO questionnaire was used to elicit demographic and oral health information.[21] The questionnaire was in hard copy, and self-administered for those who were able to fill it; and participants who were not literate enough to complete the questionnaires were assisted in filling it. The number of participants who had at least one orodental disease indicator (ODI) was noted. Orodental health indicator questions used for the analyses were 8 in number (Annex 7: WHO oral health questionnaire for adults).

Statistical analyses

The statistical analyses for the study were carried out, using IBM SPSS 22 statistical packages (IBM New York, USA). The mean and standard deviation were used to present continuous variables. Differences in mean values of age, biochemical and anthropometric variables between gender and glycemic status were assessed using Mann–Whitney U-test and Kruskal–Wallis H-test, respectively. These are nonparametric tests used when assumption of normality is not met. Frequency of diabetes and orodental health risk indicators were analyzed, and the 95% confidence interval was generated based on 1000 bootstrap resampling. These were then cross-tabulated across gender and age group, and result was expressed in percentages. Data were expressed as figures and tables.

Results

Table 1 shows the descriptive statistics of the study population in relation to gender. In all, higher mean values were observed in the females than males. There was significant difference ($P < 0.05$) in the mean values of TC ($P = 0.001$), HDL-C ($P = 0.002$), and WC ($P = 0.025$) between both sexes. Males had higher mean value of TG than females. The mean values of age, FBG, TC, HDL-C, TG, WC, HC, and WHR for participants that presented at the dental clinic (EBGH) are also shown in Table 1. Females had higher mean values in most parameters, including age, FBG, TC, HDL-C, WC, and HC. The mean values of TG and WHR were higher in males than females. TC ($P = 0.001$), HDL-C ($P = 0.010$), WC ($P = 0.027$), and HC ($P \leq 0.0001$) showed significant difference between males and females [Table 1].

The descriptive statistics as it relates to glycemic status are shown in Table 2. The mean age of the prediabetic individuals in Ndokwa was less compared to the diabetics. The mean values of TC, HDL-C, TG, WC, HC, and WHR were higher in participants with diabetes than those with prediabetes. There was significant difference ($P < 0.05$) in the mean age ($P = 0.002$), TG ($P = 0.005$), WC ($P = 0.003$), and HC ($P = 0.007$) between prediabetes and diabetes. Majority of the following indices: age, TC, HDL-C, TG, WC, HC, and WHR of the individuals at the dental clinic were higher in diabetic individuals than in prediabetic individuals. There was significant difference in the age ($P = 0.034$) of both groups [Table 2].

The glycemic status of the study population [Figure 1] shows the prevalence of hyperglycemia in the

Table 1: Descriptive statistics of the study population with respect to gender

	All population		Male		Female		*U*-test
	n	Mean±SD	*n*	Mean±SD	*n*	Mean±SD	
Ndokwa community							
Age (years)	394	47.7±20.5	167	46.2±20.9	225	49.0±20.1	0.173
FBG (mmol/L)	417	5.9±1.1	175	5.9±1.0	240	5.9±1.2	0.360
TC (mg/dL)	203	144.5±61.7	86	134.5±61.3	117	151.9±61.2	0.001
HDL-C (mg/dL)	203	44.0±18.9	86	39.8±17.3	117	47.0±19.6	0.002
TG (mg/dL)	202	125.4±62.9	86	126.6±66.5	117	123.9±60.4	0.901
WC (cm)	191	90.2±15.0	98	87.6±12.8	93	92.9±16.6	0.025
HC (cm)	187	100.0±12.2	94	99.7±10.1	93	100.2±14.1	0.594
WHR	187	0.9±0.2	94	0.9±0.08	93	0.9±0.3	0.217
Dental clinic							
Age (years)	41	39.5±15.3	24	36.8±15.1	17	43.4±15.2	0.185
FBG (mmol/L)	41	5.9±0.7	24	5.8±0.5	17	6.0±0.9	0.915
TC (mg/dL)	41	144.5±39.1	24	127.7±29.3	17	168.2±39.7	0.001
HDL-C (mg/dL)	41	47.0±15.0	24	41.8±14.0	17	54.4±13.4	0.010
TG (mg/dL)	41	111.3±65.7	24	113.2±67.9	17	108.6±64.3	0.500
WC (cm)	32	93.8±16.1	17	88.2±9.2	15	100.3±19.8	0.027†
HC (cm)	32	103.0±15.7	17	95.7±16.5	15	111.2±9.8	<0.0001†
WHR	32	0.9±0.3	17	1.0±0.4	15	0.90±0.1	0.526†

†Exact significance test, the significance level is 0.05. FBG=Fasting blood glucose, TC=Total cholesterol, HDL-C=High-density lipoprotein cholesterol, TG=Triglyceride, WC=Waist circumference, HC=Hip circumference, WHR=Waist-to-hip ratio, SD=Standard deviation

Table 2: Descriptive statistics of the study population with respect to glycemic status

	Normal		Prediabetes		Diabetes		*H*-test
	n	Mean±SD	*n*	Mean±SD	*n*	Mean±SD	
Ndokwa community							
Age (years)	160	50.3±21.8	156	43.2±19.6	65	51.9±17.2	0.002
TC (mg/dL)	44	142.1±47.0	110	136.6±52.8	48	163.2±85.1	0.118
HDL-C (mg/dL)	44	48.2±20.5	110	41.4±18.2	48	46.2±18.7	0.043
TG (mg/dL)	44	100.8±47.8	110	125.5±64.5	48	147±63.9	0.005
WC (cm)	51	85.8±13.4	89	90.1±15.6	42	94.9±14.7	0.003
HC (cm)	48	95.5±12.1	89	101.0±10.4	41	102.1±15.3	0.007
WHR	48	0.9±0.1	89	0.9±0.2	41	1.0±0.3	0.220
Dental clinic							
Age (years)	15	37.9±14.9	22	36.9±14.1	4	59.8±10.0	0.034
TC (mg/dL)	15	141.5±38.8	22	142.6±41.4	4	166.5±25.4	0.311
HDL-C (mg/dL)	15	46.1±16.5	22	46.9±14.4	4	50.8±15.9	0.913
TG (mg/dL)	15	97.9±55.7	22	110.7±67.3	4	164.8±81.6	0.161
WC (cm)	12	93.1±14.8	18	94.6±18.1	2	91.5±3.5	0.976
HC (cm)	12	100.1±22.3	18	104.1±10.7	2	110.0±4.2	0.534
WHR	12	1.0±0.43	18	0.9±0.09	2	0.8±0.06	0.496

The significance level is 0.05. TC=Total cholesterol, HDL-C=High-density lipoprotein cholesterol, TG=Triglyceride, WC=Waist circumference, HC=Hip circumference, WHR=Waist-to-hip ratio, SD=Standard deviation

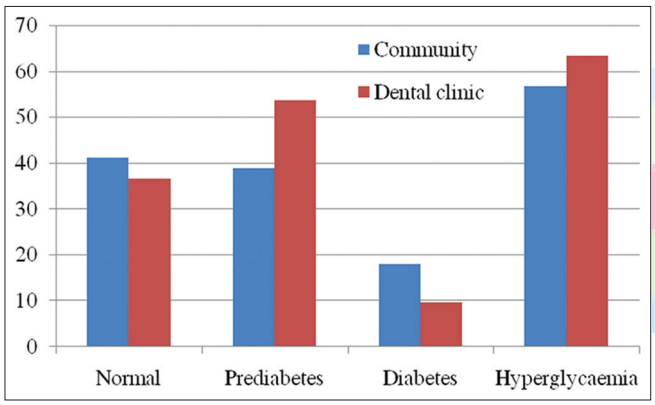

Figure 1: Glycemic status of the study population

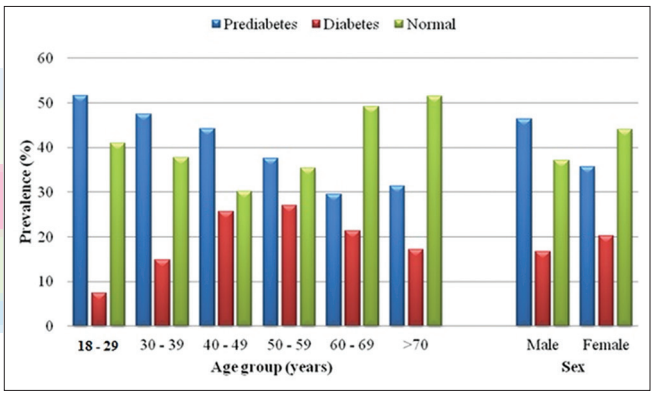

Figure 2: Age and sex distribution of Ndokwa population in relation to glycemic status

hospital-based study to be higher than noted in the community. However, the prevalence of diabetes in Ndokwa communities was nearly twice the observation at the dental clinic. Highest prevalence of diabetes and prediabetes was observed in the age groups 50–59 and 18–29 years, respectively; and more females had diabetes than males [Figure 2].

Table 3 on frequency of indicators of periodontitis in Ndokwa communities in the previous 12 months shows that of the total 474 respondents, over a third had the presence of periodontitis, about a quarter reported that they had experienced pain or discomfort in their mouths or teeth, and three-quarters had not had their sleep interrupted due to the state of their teeth. The majority described their teeth or mouth or gums as in good health, and had not experienced difficulties in chewing or biting foods. Overall, 184 (42.5%) participants had ODIs, and of this, only 2 people visited the dental clinic [Table 3].

Discussion

The results of the study show that the prevalence of hyperglycemia in Ndokwa communities was less than obtained at the dental clinic [Figure 1]. A lower prevalence rate of 3% of undiagnosed DM was reported by Ejike *et al*.[22] in Southeast Nigeria. Shittu *et al*.[23] noted a lower prevalence rate (10.6%) of hyperglycemia in Oyo State, Nigeria, compared to the observations in Ndokwa communities and dental clinic in the present study. It is possible that the higher prevalence of DM in this study could be attributed to poor health-seeking behavior of the Ndokwa residents. The finding of high prevalence of prediabetes and hyperglycemia in dental participants is significant in that orodental visits can be used for opportunistic screening of DM. Studies show that early screening and treatment make for cost-effective management of diabetes.[24] One important way this could be achieved is through opportunistic screening.

Table 3: Frequency of periodontitis indicators in Ndokwa communities

Responses	Frequency	Prevalence (%)	95% CI
During the past 12 months, did your teeth or mouth cause any pain or discomfort?			
No answer	15	3.2	1.7-4.8
Yes	127	26.8	22.8-31.2
No	326	68.8	64.3-72.8
Don't know	5	1.1	0.2-2.1
Because of the state of your teeth or mouth, how often have you had sleep that is often interrupted during the past 12 months?			
Don't know	29	6.1	4.0-8.2
No	351	74.1	70.3-78.3
Sometimes	44	9.3	6.8-12.0
Fairly often	14	3.0	1.5-4.4
Very often	4	0.8	0.2-1.7
Because of the state of your teeth or mouth, how often have you felt tense because of problems with teeth or mouth during the past 12 months?			
Don't know	31	6.5	4.4-8.6
No	341	71.9	67.7-76.4
Sometimes	47	9.9	7.2-12.7
Fairly often	18	3.8	2.1-5.7
Very often	5	1.1	0.2-2.1
Because of the state of your teeth or mouth, how often have you experienced difficulty in chewing foods during the past 12 months?			
Don't know	25	5.3	3.6-7.4
No	307	64.8	60.3-69.2
Sometimes	57	12.0	9.1-15.0
Fairly often	25	5.3	3.4-7.4
Very often	30	6.3	4.2-8.6
Because of the state of your teeth or mouth, how often have you experienced difficulty in biting foods during the past 12 months?			
Don't know	22	4.6	3.0-6.5
No	303	63.9	59.7-68.1
Sometimes	52	11.0	8.0-13.9
Fairly often	31	6.5	4.4-9.3
Very often	35	7.4	5.1-9.6
How would you describe the state of your gums?			
Excellent	121	25.5	21.5-29.5
Very good	106	22.4	18.8-26.2
Good	102	21.5	17.9-25.3
Average	86	18.1	14.8-21.5
Poor	35	7.4	5.1-9.9
Very poor	8	1.7	0.6-3.0
Don't know	15	3.2	1.7-4.6
How would you describe the state of your teeth?			
Excellent	134	28.3	24.3-32.1
Very good	90	19.0	15.6-22.8
Good	98	20.7	17.1-24.5
Average	94	19.8	16.2-23.4
Poor	32	6.8	4.9-9.1
Very poor	11	2.3	1.1-3.8
Don't know	14	3.0	1.5-4.6
Presence of periodontitis indicator	**Frequency**		**Overall prevalence (%)**
Yes	184		42.5
No	249		57.5
Total	433		100.0

CI=Confidence interval

The highest occurrence of prediabetes [Figure 2] in the age group 18–29 years observed in the study is in agreement with global observations that there is an increasing prevalence of type 2 DM in adolescents around the world,[25] and justifies the need for early screening of people in this age bracket. The high prevalence of ODIs [Table 3] observed in the present study needs to be addressed. Yet, this study reports poor compliance to confirmation of their oral health status at the dental clinic. There is a need for oral health promotion and periodic screening in the population to negate long-term complications.

Tooth/mouth pain or discomfort was the most prevalent ODI in the current study, suggesting that it is the most commonly occurring sign of orodental disease to be considered, especially in epidemiological studies. The prevalence of the individual indicators such as tooth/mouth pain may be associated with sociocultural determinants such as poor living conditions, poor access to safe water or sanitary facilities, low education levels and lack of traditions, beliefs and culture in support to oral health.[26]

However, female participants had higher mean blood TG and HDL-C levels as well as WC values. In the dental participants, HC was also higher in females than in males [Table 1]. In a hospital-based study in Ethiopia, more elevated mean levels of FBG, HDL-C, and TC in females were reported by Ambachew *et al*.,[27] and it agrees with findings of this report. Some female participants were menopausal, and lipid profile is altered in menopause due to various reasons. The hormonal changes associated with menopause exert a significant effect on metabolism of plasma lipids and lipoproteins.[28] Majority of the metabolic components measured are gender dependent, and the contribution of these components is different in men and women.[29]

This study observed that the mean ages of those diagnosed with prediabetes and diabetes were 43.2 ± 19.6 and 51.9 ± 17.2 years (Ndokwa communities) and 36.9 ± 14.1 and 59.8 ± 10.0 years (dental clinic), respectively. Perhaps, the slight difference is due to factors that include socioeconomics and population size of the study. The 59.8 years noted in dental clinics was probably because they were patients, and orodental disease is associated with DM.[15,16] It is known that prevalence of prediabetes increases with age,[30] since aging induces decrease in insulin sensitivity and alteration or insufficient

compensation of beta cell function in the face of increasing insulin resistance.[31]

The levels of mean TC, HDL-C, TG, WC, HC, and WHR were higher in diabetics than in prediabetics. Dyslipidemia is related to obesity, and obesity causes insulin resistance.[32] Obesity is associated with high WC, HC, and WHR. This suggests why levels/values of TC, TG, WC, HC, and WHR were more in diabetics than prediabetic individuals. Most cross-sectional studies suggest that WC or WHR is better indicator of diabetes risk than body mass index.[28] Since these indices are affordable, they could make prediction of diabetes easier. The remarkable phenomenon about a decreased mean level of HDL-C observed in the prediabetics is its ability to exacerbate to frank DM and other complications such as dyslipidemia and hypertension.[33,34] The former and latter complications are well recognized markers of cardiovascular disease. This underscores the need for prompt screening program, preventive strategy, and risk factor detection for prediabetes.[35]

In Table 1, the mean value of TC reported at both study settings are within the classification of the National Heart, Lung, and Blood Institute (NHLBI)[36] as 'desirable'. This implies that the participants had good TC level. Mean HDL-C levels for males: 1.0 ± 0.4 mmol/L (39.8 ± 17.3 mg/dL) and females: 1.2 ± 0.5 mmol/L (47.0 ± 19.6 mg/dL) in Ndokwa communities were within the definition of IDF as 'risk factor'. The mean TG levels observed in the study populations are in agreement with cut-off points set by IDF[9] and NHLBI.[36]

TG and TC levels [Table 2] measured in the prediabetics were less than in diabetics, but within desirable range. This is probably pathophysiological since in DM, lipid abnormalities are prevalent because major key enzymes and lipid metabolic pathways are affected due to deficiency of insulin production and secretion.[37-39] In diabetes, blood lipid levels are affected because of interrelationship between carbohydrates and lipid metabolism. This means that disorder in carbohydrate metabolism may affect lipid metabolism and vice versa.[40] The lipid changes associated with DM are attributed to increased free fatty acid flux secondary to insulin resistance. It therefore means that if control interventions are not embraced, the observed rising levels of TG and TC would likely become the norm with time.[39]

Conclusion

In countries such as Nigeria, where the prevalence of diabetes is rising, opportunistic screening of DM becomes an option. This is because most people tend to be reluctant to check their diabetes status. Opportunistic screening of diabetes in dental settings is an option to consider. A translational research on the best approach to making policies that will favor cost-effective opportunistic screening at dentistries coupled with its implementation is highly recommended.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

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