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Triangular Relationship of Blood Sugar, Obesity and Periodontal Disease at Individual vs. Population Level

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Abstract: There has been indication of correlation between periodontal disease and metabolic syndrome. Reports including review article suggest a triangular relationship between the trios of diabetes, obesity and periodontitis. However, the extent of the correlation has neither been defined, nor data generated to substantiate the correlations. This population-based study investigated the relationship in rural Nigerian communities. The study areas were Ndokwa communities and the research performance site was Catholic Hospital Abbi. A total of 385 subjects participated in a health screening during which fasting blood glucose (FBG), body mass index (BMI) and ODI scores were collected. Among this, a cohort of N = 175 who had lipid profile results were identified. ODI information was collected using a questionnaire and interpreted in collaboration with Dental Clinic at Eku Baptist Government Hospital. Correlation analysis was undertaken, based on FBG, BMI and lipid profile in relation to ODI scores. Correlation was compared in subpopulations and individuals. Results showed that there is strong positive correlation of FBG with ODI scores in subpopulations (r = 0.81). ODI scores correlates strongly and better with BMI in subpopulations (r = 0.94), relative to lipid profile. Association of FBG, lipids and ODI scores was stronger in subpopulations than in individuals. In conclusion there is a triad of relationship between BMI, FBG and periodontal health. Diabetes may be predicted in obese patients who present with ODI at orodental clinic.

Key words: Body mass index · Fasting blood glucose · Diabetes screening · Orodental disease indicators · Orodental health clinic

INTRODUCTION

Diabetes mellitus (DM) is a major cause of death and disability worldwide [1] and its incidence as well as prevalence are rising in both developed and developing nations [2]. Poor oral health affects general health and several oral diseases are related to chronic diseases such as diabetes [3]. Evidence of biological and epidemiological links between periodontal disease (PD) and diabetes, especially type 2 DM (T2DM) has been reported [4]. Increased incidence, prevalence and acuity of periodontitis are found among adults with T2DM [5]. It is known that diabetes is a significant risk factor for periodontitis, especially for T2DM [6]. Potential problem of PD in Ndokwa communities has been investigated albeit with focus on oral hygiene practices whereby it is reported that up to 27% of the study participants presented with gingival bleeding and 34% showed poor hygiene [7].

The relationship of body mass index (BMI) and PD has been reported [8]. It is also suggested that dyslipidaemia could be associated with periodontitis, but its involvement as a risk factor is under investigation [9]. Hyperglycaemia, BMI and dyslipidaemia are metabolic

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components and it is necessary to assess their relationship with PD. There is a gap in knowledge and dearth of data to rationalize the association of metabolic syndrome (MetS) with PD in Nigeria and the present study was set to contribute such data. This is with the understanding that co-morbidity of DM and orodenbtal diseases has been reported in Nigeria [10] and rising prevalence of MetS noted in the country [11]. Therefore, the objective of this study was to evaluate a potential triad of correlations between the trios of BMI, FBG and ODI.

MATERIALS AND METHODS

The study population was drawn from Ndokwa communities, specifically at the Catholic Hospital Abbi in Delta State, Nigeria. Male and female participants, who met the selection criteria, were enrolled in the study. This occurred between the months of December 2015 and March 2016, after all ethical requirements were fulfilled. Subjects for FBG, BMI and ODI scores correlation were 385, while those who had lipid profile were N = 175. ODI results were interpreted at the dental clinic of Eku Baptist Government Hospital.

Biochemical Measurements: Fasting blood glucose (FBG) and lipid profiles were undertaken, using Cardio Chek® analyzer, according to manufacturer's instructions. The criteria for diagnosing DM was $\geq$7.0 mmol/L ($\geq$126 mg/dL) or random plasma glucose (>11.1 mmol/L) ($\geq$200 mg/dL) and prediabetes was defined as impaired fasting glucose (IFG) level of 5.6 to <6.9 mmol/L (100 to <126 mg/dL) [12, 13]. The parameters measured for lipid profile were blood levels of high density lipoprotein – cholesterol (HDL-C), total cholesterol (TC) and triglyceride. Criteria for definition of dyslipidaemia were according to the National Cholesterol Education Program/Adult Treatment Panel III. Dyslipidaemia was defined as consisting of the following abnormalities either singly or in combination: blood levels of TC >5.17 mmol/L (200 mg/dL), HDL-C <1.03 mmol/L (<40 mg/dL) for males; <1.03 mmol/L (<50 mg/dL) for females and blood levels of triglyceride >1.7 mmol/L (>150 mg/dL) [14].

Anthropometric Measurements: These included parameters such as weight (Kg) and height (cm) were measured using the weighing scale and stadiometer, respectively. The BMI was calculated by dividing the weight with height squared (Kg/m^2).

Table 1: Points Awarded to ODI questions 1 –6

ODI#	0	1	2	3	4	5	6
1	No response/ don't know	Yes	No				
2		No	+	++	+++		
3		No	+	++	+++		
5		No	+	++	+++	Poor	Very poor
6		No	+	++	+++		

Key: N = 385 with BMI for triangular relationship with FBG and ODI score

Survey Questionnaire: The World Health Organisation STEPS questionnaire was used to collect ODI information [15]. It contained questions on presence or absence of pathological problems in the mouth/tooth of the participants. The ODI questions involved pain/discomfort, sleep interruption and feeling tensed due to state of the teeth/mouth. Other ODI questions required description of the state of the gum/teeth and difficulty experienced in biting/chewing food, among others.

Statistical Analyses: Logistic regression was performed to determine the correlation of BMI, FBG and lipid profile with ODI score among individuals and subpopulation, using Microsoft Excel (version 2013). The essence of the study between the two groups was to ascertain difference in correlation. The ODI scores were statistically derived from responses to ODI questions (Table 1). Grouping was not performed; instead, correlation analysis was carried out, based on BMI, FBG and lipid profile in relation with ODI scores. Points awarded to ODI questions 4 and 7 were

- 1 for excellent
- 2 for good and very good
- 3 for average
- 4 for poor and very poor (Table 1)

RESULTS

Table 2 shows the correlation of BMI, FBG and ODI scores in the entire study population. A critical observation shows that healthy, prediabetic and diabetic subpopulations exhibited higher correlation than considered individually in a population of 385. Based on individuals, the least correlation was found between ODI scores and BMI. The least correlation, based on subpopulation was observed between ODI scores and FBG.

Table 2 shows correlation of BMI, FBG and ODI scores in the entire study population. Correlations between FBG, blood concentrations of TC, HDL-C and triglyceride and ODI scores in the overall study

Table 2: Correlation of BMI, FBG and ODI scores in the entire study population

Grouping		FBG	BMI	ODI scores
Based on individuals	FBG	1.000		
	BMI	0.301	1.000	
	ODI scores	0.089	-0.034	1.000
Based on subpopulation	FBG	1.000		
	BMI	0.961	1.000	
	ODI scores	0.812	0.942	1.000

Key: FBG = Fasting blood glucose, BMI = Body mass index, ODI scores = Orodental disease indicator scores

Table 3: Correlation of lipid profile, FBG and ODI scores

Based on individuals		FBG	Blood TC	Blood HDL-C	Blood TG	ODI scores
	FBG	1				
	TC	0.058104	1			
	HDL-C	-0.09284	0.516081	1		
	TG	0.218908	-0.00834	-0.22459	1	
	ODI scores	-0.0191	0.025431	-0.01523	0.037103	1
Based on subpopulation	FBG	1				
	TC	0.655355	1			
	HDL-C	-0.47883	0.349304	1		
	TG	0.973181	0.464023	-0.66794	1	
	ODI scores	-0.48172	-0.97761	-0.53867	-0.26721	1

Key: FBG = Fasting blood glucose, TC = Total cholesterol, HDL-C = High density lipoprotein cholesterol; TG = Triglyceride, ODI score = Orodental disease indicator score

population are shown in Table 3. Association of the variables was stronger in subpopulations compared to weak correlation observed in individuals in the total population of 175.

DISCUSSION

This study reported interaction of MetS and PD (ODI) in Nigeria and showed a positive relationship. The MetS components measured associated well with ODI in subpopulations of correlation analysis (Table 3), but the association in individuals was poor. Since ODI, which is the initial stage of PD related positively with MetS, it is worthwhile to use studies involving PD to discuss findings of this study. The National Health and Nutrition Examination Survey (NHANES) report corroborates the observation that MetS is positively associated with PD [16]. A link between MetS and PD was established in a study in China [17] and this supports findings of the study. In Jordan, a positive relationship between MetS and PD was observed [18], which is consistent with this current report.

Periodontitis may expose individuals to MetS through mechanisms activated by the translocation of oral bacteria and/or their products into blood circulation. Immune and inflammatory processes that initiate or aggravate MetS may subsequently be triggered by these bacteria [19, 20]. The inflammatory markers in the individual components of MetS can up-regulate the periodontal inflammatory process and the constant periodontal inflammation may exacerbate inflammatory components of MetS [21].

In Table 3, positive correlation of ODI scores with FBG was stronger among subpopulations than in individuals. It was also observed that ODI scores with BMI correlated better in the subpopulations than in individuals. FBG has been found to be one of the two most important metabolic components associated with PD, the other component being abnormal lipid metabolism [22]. A study in Jordan [4], where a link was observed between prediabetic condition and periodontal health confirms the observation of this study. In a study among United States population, it was shown that periodontitis was positively associated in a linear relation with IFG and diabetes [23] and this finding supports the report of the present study.

In this study, ODI related better with BMI than FBG in the subpopulation compared to individuals. A report, using NHANES III database established an association between BMI and PD [24]. In a study in United Arab Emirates among T2DM patients, no association was observed between periodontitis and BMI [25]. Another study among Japanese adults suggested that independent of BMI, a high WHR is associated with a risk of periodontitis, particularly in higher BMI categories. Nevertheless, individuals with low WHRs and having any level of BMI had insignificant risk of periodontitis [26].

There has been indication of correlation of between periodontal disease and MetS [21]. There are reports including review article suggesting triangular relationship between the trios of diabetes, obesity and periodontitis [27]. However, the extent of the correlation has neither been defined, nor data generated to substantiate the correlations; especially as it may vary individual level versus group. Thus, this report contributes evidence of triangular correlation and substantiates the discourse.

The correlation between lipid profile and ODI (Table 3) showed a negative/very weak association. Other studies gave conflicting accounts of lipid profile and PD to the observation of this study. For instance, absence of relationship has been reported between serum lipids and PD among patients at Kaunas University of Medicine, Lithuania [28]. In the Fourth Korean NHANES, it was shown that dyslipidaemia, except pre-hypercholesterolaemia was associated with periodontitis [29].

It is known that exacerbation of hyperlipidemia state is linked with periodontal inflammation by the up-regulation of serum and gingival crevicular fluid pro-inflammatory cytokines [30]. Dyslipidaemia has been suggested to conduit to a pro-inflammatory state, resulting in elevated levels of pro-inflammatory cytokines and oxidative stress [21]. This leads to the presence of systemic inflammation and can lead to down regulation of host protective mechanisms [31]. The observed differences in the results of this study can be attributed to methodological issues. Again, some factors such as genetics, hormonal changes associated with MetS, age and gender differences as well as other uncontrollable factors are possibly implicated.

CONCLUSIONS

Findings of this study suggest a relationship between MetS and periodontal health. FBG and BMI associated well with PD, among the components that constitute MetS. This means that in addition to FBG, BMI can be used to predict PD and vice versa. More longitudinal, well-designed, multi-centric studies based on large populations are recommended to substantiate the relationship.

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