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Original Article

Screening for prediabetes and risk of periodontal disease

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ABSTRACT

Objective: Diabetes and periodontitis are non-transmissible chronic disorders that exhibit a mutual relationship. A study was made to evaluate the risk of prediabetes and periodontal disease, and to explore the association between them.
Methods: A descriptive cross-sectional study was made of 186 individuals over 18 years of age, without prediabetes or diabetes, or cognitive impairment. Subjects undergoing dental treatment and pregnant women were excluded. Prediabetes risk was assessed based on the Finnish Diabetes Risk Score (FINDRISC), and the individual risk of development and/or progression of periodontal disease was explored with a periodontal disease risk questionnaire.
Results: A total of 135 gingival risk questionnaires and 142 FINDRISC questionnaires were correctly completed. The proportion of subjects with a low, moderate and high risk of periodontal disease was 60.36%, 38.74% and 0.9%, respectively. With regard to the FINDRISC, the proportion of individuals with low, slightly increased, moderately increased and high risk of prediabetes was 54.4%, 32.8%, 8%, and 4.8%, respectively. A significant linear correlation between the two scores was observed ($r = 0.3659$, $p < 0.0005$). The variables associated with a slightly increased risk of prediabetes were age, overweight and smoking, while the variables associated with a moderately increased or high risk were age 40–65 years, tooth loss, overweight and smoking.
Conclusions: These questionnaires may be of benefit to patients and can contribute to develop a chronic care model characterized by collaboration among different healthcare professionals.

1. Introduction

Diabetes mellitus is an important health problem associated to significant morbidity and mortality. The evidence indicates that early diagnosis of the disease, with the adoption of measures to ensure strict blood glucose control, is important in order to avoid or mitigate the complications of diabetes [1–3].

According to the Di@bet.es trial, it is estimated that 13.8% of the Spanish adult population suffers diabetes, and that 14.8% presents some form of prediabetes (glucose intolerance, altered basal blood glucose, or both) [4].

Since the early detection of prediabetes can allow the adoption of treatment measures seeking to avoid progression towards diabetes, consensus-based prevention strategies should be established [5–11].

Prediabetes is the stage preceding diabetes mellitus. Before type 2 diabetes becomes established, the blood glucose levels are seen to increase but remain below the thresholds commonly taken to characterize the disease. According to the American Diabetes Association (ADA) people with prediabetes have a fasting plasma glucose concentration of 100–125 mg/dl (5.6–6.9 mmol/l) and/or

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glucose tolerance with oral glucose test values after two hours of 140–199 mg/dl (7.8–11.1 mmol/l) and/or a glycosylated hemoglobin (HbA1c) level of 5.7–6.4% [2].

Periodontal diseases are chronic inflammatory disorders caused by the presence of bacterial biofilms that affect the periodontal tissues. These diseases in turn induce an immune and inflammatory response at periodontal level that is largely responsible for the associated tissue damage [12,13].

Periodontitis and diabetes are chronic diseases in which one disorder influences the course and outcome of the other. Such interaction moreover appears to increase the risk of complications. Many diabetes risk factors and parameters, including obesity, inflammatory markers, low adiponectin levels and dyslipidemia have also been related to periodontitis [10–14].

However, many people with periodontal disease are not aware of the disorder, despite the presence of clear symptoms such as bleeding of the gums, tooth mobility, etc. Only when very advanced-stage manifestations appear (pain, tooth loss, important tooth mobility, migration or positional changes that have an esthetic impact, etc.) do they seek dental care. The management of advanced-stage periodontal disease may not meet the expectations of the patient, however [14–16]. The use of a self-administered test assessing the risk of suffering periodontal disease could be a simple and inexpensive way to screen for susceptible population groups. The European Federation of Periodontology (EFP) and the International Diabetes Federation (IDF) have developed consensus-based guidelines for physicians, oral health professionals and patients with the aim of improving the early diagnosis, prevention and co-management of diabetes and periodontitis [7,9,12].

Many studies have described a bidirectional relationship between diabetes and periodontal disease [1,3,5–8] Diabetes has an adverse impact upon periodontal health, while periodontal infection has a negative effect upon blood glucose control and the complications of diabetes [5].

We postulate that rapid screening tests can be useful for early detection of the risk of developing diabetes and periodontal disease. A cross-sectional study has been carried out to assess this possibility, analyzing the risk of prediabetes with the Finnish Diabetes Risk Score (FINDRISC), together with the risk of periodontal disease, and the relationship between the two disorders.

2. Material and methods

2.1. Study design

A descriptive cross-sectional study was made to explore the association between prediabetes and periodontal disease in a population of the region of Murcia (Spain).

The study subjects were recruited on 12 November 2017 at the Odontology stand of the health fair held on occasion of the World Diabetes Day in Murcia. The participants agreed to complete the questionnaires after having been explained the purpose of the study. In appreciation of their participation, the volunteers received a small gift in the form of toothpaste or a toothbrush.

The questionnaires were administered according to the institutional and/or national Ethics Committee standards and in abidance with the Declaration of Helsinki 1964 (and posterior amendments).

We included individuals over 18 years of age who agreed to complete the questionnaires. Subjects diagnosed with prediabetes or diabetes were excluded, as were individuals with cognitive problems, patients receiving periodontal treatments, pregnant women, people with a history of cardiovascular disease or bleeding disorders, and patients receiving anticoagulation therapy or subjected to dialysis.

The Finnish Diabetes Risk Score (FINDRISC) was used to predict the risk of type 2 diabetes. This instrument has been validated [17], and comprises the following items: age, body mass index (BMI), waist circumference, physical activity, fruit and vegetable consumption, medication for the control of arterial hypertension, a history of hyperglycemia, and a family history of diabetes. An identification form and the FINDRISC were completed. The final score was classified as follows: < 7 (low risk), 7–11 (slightly increased risk), 12–14 (moderate risk), 15–20 (high risk) and >20 (very high risk).

On the other hand, a periodontal disease risk questionnaire was also used. This is a validated instrument [15] involving 21 questions that assess the risk of suffering periodontal disease, and which allows the subject to become aware of the problem – thereby contributing to establish an earlier diagnosis of the disease. The multiple choice questions, cover information referred to demographic parameters, alterations of the teeth and gums, daily oral hygiene, healthy habits, family history and general health.

2.2. Statistical analysis

The data from the questionnaires were entered in an MS Excel spreadsheet for subsequent processing with the Stata package (StataCorp 2015, Stata Statistical Software: Release 14. College Station, TX, USA, StataCorp LP). Pearson correlation analysis was used to establish possible correlations between the scores of both tests, while the chi-squared test was used to explore associations between the gingival health and diabetes risk questionnaires, with prior stratification of diabetes risk into three categories: low (<7), slightly increased [7–11] and moderately increased, high or very high (>11). Multivariate logistic regression analysis was performed, in which the response variable was diabetes risk stratified into the aforementioned three categories and the independent variables were the parameters of the periodontal disease risk questionnaire. Low risk constituted the reference category for the response variable in the multivariate logistic regression model. Statistical significance was considered for $p < 0.05$.

3. Results

A total of 186 questionnaires were returned. Of these, 51 periodontal disease risk questionnaires and 44 diabetes risk questionnaires were found to be incomplete and were excluded from the analysis. The final sample therefore comprised 135 gingival risk and 142 FINDRISC questionnaires.

The prevalence of low, moderate and high periodontal risk was seen to be 60.36%, 38.74% and 0.9%, respectively (Table 1). With regard to the FINDRISC, the prevalence of low, slightly increased, moderately increased and high prediabetes risk was 54.4%, 32.8%, 8% and 4.8%, respectively (Table 2).

A positive linear correlation was observed between the two scores ($r = 0.3659$, $p < 0.0005$) (Fig. 1).

The univariate analysis revealed a significant association between the final FINDRISC stratified score and the variables age ($p = 0.003$), tooth loss ($p = 0.001$) and overweight ($p = 0.01$).

In the multivariate analysis adjusted for the gingival health questionnaire items, the variables associated to a slightly increased prediabetes risk were age, overweight and smoking. In turn, the variables associated to moderately increased or high risk were age 40–65 years, tooth loss, overweight and smoking (Table 3).

4. Discussion

Diabetes is an important health problem, and failure to diagnose the disease further worsens the situation. The true challenge is

Table 1
Descriptive analysis of the gingival health questionnaire results.

	%	%	%	N
Are you a male or female?	Female	Male		132
	71.21	28.79		
How old are you?	<40	40–65	>65	130
	41.54	47.69	10.77	
What is your race?	Other groups	Negro		134
	99.25	0.75		
What is your socioeconomic level?	High	Average	Low	135
	3.70	94.81	1.48	
Do your gums often bleed?	No	Yes		131
	70.99	29.01		
Have your gums retracted or do your teeth seem longer?	No	Yes		123
	71.54	28.46		
Do you teeth move?	No	Yes		131
	87.79	12.21		
Have you lost any teeth recently?	No	Yes		133
	79.70	20.30		
Have you visited the dentist in the last few years?	Yes	No		123
	100	0		
Do you brush your teeth regularly?	3 times a day	2 times a day	Once a day or less 13.43	134
	53.73	32.84		
Are you overweight?	No	Yes		130
	76.15	23.85		
Do you smoke?	No	Ex-smoker	Yes	
	59.70	21.64	18.66	
Do you have a lot of stress?	No	Some	A lot	131
	32.82	35.88	31.30	
Do you drink more than two glasses of beer or wine a day?	No	Yes		134
	90.30	9.70		
Have your parents or siblings suffered diseases of the gums?	No	Yes		123
	67.48	32.52		
Do you have diabetes?	No	Yes		135
	100	0		
Do you have osteoporosis?	No	Yes		125
	92	8		

Table 2
Descriptive analysis of the FINDRISC results.

	%	%	%	%	N
Age	<45	45–54	55–64	>64	141
	51.77	24.82	10.64	12.77	
Body mass index	<25	25–30	>30		133
	55.65	32.33	12.03		
Waist circumference	<94/80	94-102/80-88	>102/>88		134
	61.94	31.34	6.72		
Daily physical activity	Yes	No			141
	73.05	26.95			
Fruit or vegetables	Daily	Not daily			141
	82.27	17.73			
Medication for high blood pressure	No	Yes			139
	84.17	15.83			
History of hyperglycemia	No	Yes			142
	90.85	9.15			
Relatives with diabetes	No	Grandparents, uncles	Parents, siblings		140
	58.57	12.86	28.57		

therefore to identify asymptomatic individuals in opportunistic scenarios. The results of the present study suggest the existence of an association between a moderately increased to high risk of prediabetes and patient age, tooth loss, smoking and overweight.

Kowall et al. [18] found periodontitis and edentulism to be associated with poorly controlled diabetes mellitus but not with prediabetes or well controlled diabetes. The global findings suggest that only severe blood glucose alterations are related to an increased risk of periodontitis and tooth loss [19].

It is important to evaluate the early stages of these disorders in order to better understand their natural course and the interrelationships between them. Edentulism indicates an increased risk of diabetes and can have a substantial impact upon patient quality of life, with eating problems and dietetic deficiencies [4–6].

Prevention programs require procedures for selecting or screening for individuals at increased risk of developing diabetes. A number of tools have been developed with this purpose in mind. The Finnish Diabetes Risk Score (FINDRISC) is probably one of the most efficient tools. There is no evidence to suggest that screening for type 2 diabetes contributes to reduce morbidity-mortality in the general population, though there are data suggesting that interventions targeted to risk groups reduce the incidence of diabetes or delay development of the disease [17].

The periodontal disease risk questionnaire is able to screen for

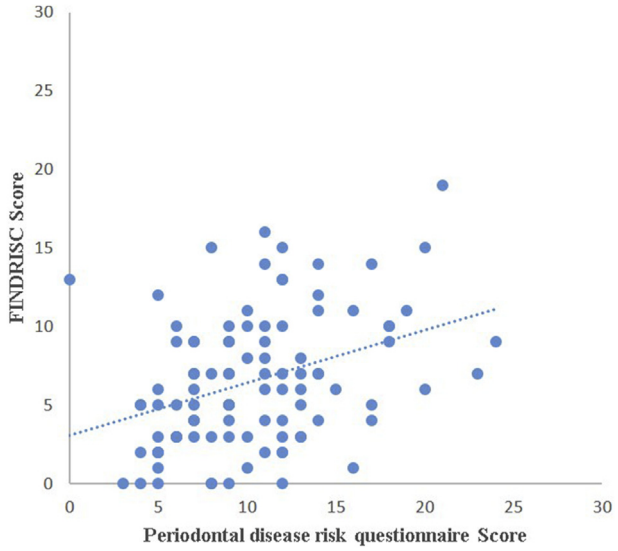

Fig. 1. A positive linear correlation was observed between the two scores. The Finnish Diabetes Risk Score (FINDRISC) and, a periodontal disease risk questionnaire.

the risk of developing periodontal disease in the general population. The use of a self-administered questionnaire informing the individual of the potential risk of suffering periodontal problems is a simple and inexpensive strategy for identifying susceptible population groups that in turn require more detailed evaluation of their periodontal health by qualified professionals [15]. At individual level, such instruments would allow the patient to know his or her risk of suffering periodontal disease, thereby increasing personal awareness of the problem and contributing to establish an earlier diagnosis with the aim of improving the prognosis. Furthermore, knowing the risk of developing a given disease can favorably motivate people to adopt a healthy lifestyle and lessen the risk (e.g., improved oral hygiene, smoking cessation, etc.) [8,12–15]. Health professionals require rapid and easy screening tools, and the incorporation of questionnaires such as those evaluated in our study can contribute to improve professional practice.

Some studies have suggested that the dental office can play an important role in the diagnosis and management of diabetes. In 2010, Greenberg et al. analyzed the attitudes and perceived barriers referred to the assessment of medical conditions among dental professionals [20]. A total of 77% of them considered it very important or somewhat important for dentists to detect diabetes. The great majority (85%) were clearly willing to refer a patient for medical consultation. Lalla et al. in turn found a simple algorithm comprising two dental parameters (number of missing teeth and percentage of deep periodontal pockets) to be effective in identifying dental patients with prediabetes or undiagnosed diabetes [21].

Barasch et al. evaluated the usefulness of randomly measured glucose levels in detecting prediabetes or undiagnosed diabetes in the dental clinic and found 18% of the studied individuals to have prediabetes or diabetes [22].

Table 3
Distribution of the FINDRISC according to the variables of the gingival health questionnaire, and association to diabetes risk.

		Low		Slightly increased					Moderate, high or very high				
		n	%	n	%	RRR	95%CI		n	%	RRR	95%CI	
Gender	Female	42	51.85	28	34.57	1.00			11	13.58	1.00		
	Male	18	56.25	11	34.38	0.41	0.10	1.72	3	9.38	0.27	0.01	7.50
Age group	<40	33	75	9	20.45	1.00			2	4.55	1.00		
	40–65	25	46.3	20	37.04	6.14	1.26	29.90	9	16.67	51.56	1.96	1355.40
	>65	2	16.67	7	58.33	56.80	3.25	993.85	3	25	21.43	0.25	1830.96
Frequent bleeding of the gums	No	45	56.25	25	31.25	1.00			10	12.5	1.00		
	Yes	14	45.16	13	41.94	3.23	0.65	16.11	4	12.9	2.46	0.06	103.68
Retracted gums and long teeth	No	45	56.25	25	31.25	1.00			10	12.5	1.00		
	Yes	12	44.44	13	48.15	0.62	0.11	3.58	2	7.41	0.02	0.00	1.78
Tooth mobility	No	55	55.56	33	33.33	1.00			11	11.11	1.00		
	Yes	6	46.15	5	38.46	3.40	0.30	38.14	2	15.38	4.00	0.06	263.76
Recent tooth loss	No	53	58.89	31	34.44	1.00			6	6.67	1.00		
	Yes	7	30.43	8	34.78	2.75	0.37	20.58	8	34.78	45.67	1.61	1293.69
Regular tooth brushing	Three times a day	38	57.58	23	34.85	1.00			5	7.58	1.00		
	Twice a day	19	55.88	10	29.41	1.03	0.22	4.71	5	14.71	2.56	0.15	43.71
	Maximum once a day	4	28.57	6	42.86	2.54	0.19	33.62	4	28.57	22.27	0.54	913.66
Overweight	No	54	63.53	25	29.41	1.00			6	7.06	1.00		
	Yes	6	23.08	13	50	8.74	1.43	53.37	7	26.92	219.87	6.05	7990.10
Smoking	No	41	59.42	21	30.43	1.00			7	10.14	1.00		
	Ex-smoker	13	59.09	6	27.27	0.49	0.10	2.35	3	13.64	0.89	0.02	34.57
	Yes	6	27.27	12	54.55	7.39	1.00	54.83	4	18.18	203.38	1.87	22063.66
Stress	No	15	45.45	13	39.39	1.00			5	15.15	1.00		
	Some	22	55	15	37.5	1.08	0.21	5.65	3	7.5	0.48	0.01	19.61
	A lot	22	57.89	10	26.32	0.44	0.08	2.49	6	15.79	0.35	0.01	8.68
More than two glasses of beer or wine a day	No	56	54.37	34	33.01	1.00			13	12.62	1.00		
	Yes	4	40	5	50	0.24	0.02	2.74	1	10	1.61	0.03	96.96
Relatives with problems of the gums	No	40	55.56	23	31.94	1.00			9	12.5	1.00		
	Yes	19	55.88	11	32.35	1.61	0.37	7.02	4	11.76	3.55	0.20	62.15
Osteoporosis	No	52	53.61	35	36.08	1.00			10	10.31	1.00		
	Yes	5	55.56	2	22.22	0.02	0.00	0.77	2	22.22	0.01	0.00	2.12

It is important to underscore that the detection and diagnosis of diabetes is evolving constantly. If data indicating a high diabetes risk are obtained, the patient should be referred to the physician for implementation of the opportune preventive and therapeutic protocols(5,6,11).

The European Federation of Periodontology (EFP) and the International Diabetes Federation (IDF) have developed consensus-based guidelines for physicians, oral health professionals and patients with the aim of improving the early diagnosis, prevention and co-management of diabetes and periodontitis [9–12]. Inadequate blood glucose control in diabetes is associated to poorer periodontal conditions and outcomes. Periodontitis is associated to altered blood glucose and increased insulin resistance in diabetic individuals, as well as to an increased risk of diabetes and its complications. Periodontal treatment is safe and effective in diabetic patients and is associated with glycosylated hemoglobin reductions of 0.27–0.48% after three months – though studies involving longer durations of follow-up have yielded inconclusive results [7,23].

In this context, knowledge of the relationship between diabetes mellitus and periodontal disease is required not only on the part of the health professionals that deal with type 2 diabetes but also on the part of the diabetic patients themselves. Many diabetic people are not aware of the health complications (including oral problems) of the disease, and in many cases, they receive little information from the healthcare professionals. Patients should be informed about the oral health benefits of adequate diabetes and prediabetes control [9–12].

Likewise, patients should be informed that successful periodontal treatment can have a positive impact upon metabolic control and the complications of diabetes. The assessment of possible periodontal disease should form part of a diabetes care visit [23]. Diabetic patients should be questioned about any signs or symptoms of periodontitis such as bleeding of the gums when brushing or eating, tooth mobility, spacing or migration, bad breath and/or abscesses or suppuration of the gums.

Immediate periodontal evaluation should be recommended if the case history findings prove positive. In all individuals with recently diagnosed diabetes mellitus, referral for periodontal evaluation should form part of ongoing diabetes management [9].

4.1. Practical implications

Oral health professionals have a role to play in identifying prediabetes and undiagnosed diabetes, and physicians in turn should be aware of the periodontal diseases and their implications for the control of blood glucose and the complications of diabetes.

People with diabetes should be warned that they have an increased risk of suffering gingivitis and periodontitis. They also should be made aware of the fact that the presence of periodontitis can make blood glucose control more difficult to achieve, and that there is an increased risk of other complications such as eye, kidney and cardiovascular problems [1–7].

Our study has a number of limitations. On one hand, the participants were volunteers who may have been more concerned about their health than the rest of the population. On the other hand, cases of prediabetes were defined on the basis of a validated questionnaire, though due medical evaluation is required before a firm diagnosis can be made. In turn, the gingival clinical parameters were collected from a validated questionnaire, and here again an oral exploration would be advisable. Lastly, the sample size limitations imply that on stratifying the participants into subgroups (low, slightly increased, moderately increased and high risk of prediabetes), some of these subgroups may have very limited data referred to some of the variables – this resulting in estimates with wide 95% confidence intervals.

Our identification protocol can easily be applied in diabetology/odontology clinical settings. Recent evidence suggests that the professionals are willing to incorporate the detection of disease conditions corresponding to other disciplines in their routine practice.

Thus, while the findings of our study need to be supported by large prospective trials, the use of tools of this kind as an added screening strategy can facilitate early prevention, with important benefits for the patients.

Author contributions

DS, EDP, FJG, MPS,AILP, PLJ- study concept and design; acquisition of data; analysis and interpretation of data; drafting of the manuscript; critical revision of the manuscript for important intellectual content; statistical analysis; obtained funding; administrative, technical, or material support; study supervision DS,PLJ- critical revision of the manuscript for important intellectual content; statistical analysis and interpretation of results.

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