Original Article

Diabetes Mellitus and Periodontitis: Lower Income – More Complicated Course of Disease?

Jurate Peceliuniene[1,2], Irena Zukauskaite[3], Neringa Sadauskaite[2]* and Antanas Norkus[4]

[1]Clinic of Internal Diseases, Family Medicine and Oncology, Vilnius University, Vilnius, Lithuania; [2]Faculty of Medicine, Vilnius University, Vilnius, Lithuania; [3]Faculty of Philosophy, Vilnius University, Vilnius, Lithuania; [4]Institute of Endocrinology, Lithuanian University of Health Sciences, Kaunas, Lithuania

Corresponding author:
Neringa Sadauskaite, Faculty of Medicine, Vilnius University, M. K. Ciurlionio str.21, Vilnius, Lithuania, Tel: +37061356124;
E-mail: sadauskaite.neringa@gmail.com

Abstract

Aim: To evaluate the complaints of periodontal disease, oral hygiene and care related conditions, knowledge of diabetes control and lifestyle in diabetes mellitus patients with periodontal pathology (DP). **Methods:** 44 DP patients were enrolled into the pilot study. Subjects were divided into two groups by periodontal status: slight periodontal status (loss of ≤ two teeth, N=24) and severe periodontal status (SPS) (loss of ≥ three teeth, N=18). **Results:** Major complaints about periodontal disease were bleeding (95.5%), pain (40.9%). Most patients reported brushing twice a day (47.7%), for one minute (53.5%), using the floss less than every other day (63.6%), and having professional oral hygiene at least once a year (56.8%). 59% patients did not know the result of their blood glucose test for diabetes control. Most of the subjects had vocational education (40.9%) and income of 201-400 euros per month (47.7%). SPS was related with lower income – these patients could buy less of expensive dental care items (such as dental rinse aid) or seek for professional oral hygiene. **Conclusions:** Evaluation of subjective patient data showed that the control of diabetes mellitus in DP patients is poor. This can lead to an increased gum bleeding or tooth loss. In order to improve the treatment of such patients, targeted training of diabetes and periodontitis interdisciplinary management is needed for family doctors, endocrinologists and dentists. The SPS may be related with lower income, expensive dental care and unaffordable professional oral hygiene. Therefore, systematic prevention programs are needed for those patients, who are at this risk.

Keywords: Diabetes mellitus; Periodontitis; Complaints; Diabetes control; Income

Introduction

Periodontitis and diabetes mellitus (DM) are two very common, chronic, serious comorbidities, quantifying their association significantly in public health importance with periodontal disease referred to as the sixth complication of diabetes. [1-9] Diabetes and periodontitis together appear to increase systemic inflammation, with evidence of reductions following periodontal treatment. [10] The World Health Organization diabetes key facts state that the prevalence of DM has been rising more rapidly in middle- and low-income countries. [3] The worldwide prevalence data of periodontal disease is from 5% to 20% of the adult population, counting periodontitis as the second most frequent cause of tooth loss and unsatisfactory oral health in the population of Eastern Europe. [7,8,11,12] Studies evaluating diabetes related periodontal pathology in Lithuania are scarce, even though data show that there is almost every third adult from 35 years of age diagnosed with gum problems in the country with at least half of the Lithuanian population from 50-60 years of age having more than five missing teeth (approximately 70% in men and 60.2% in women). [13-15] Additionally, 35% showed that they lost the teeth most often due to periodontal pathology, and, moreover, the overall amount of systemic diseases positively correlated with the severity of periodontitis. Independently of age, gender, smoking and alcohol consumption, moderate and severe periodontitis was associated with a significantly higher risk of diabetes (OR=2.9; P=0.003). [15] Periodontal disease in the diabetic patients causes serious clinical problems, since hyperglycaemia influences the disturbance of the immune response and increases the number of periopathogens. [16] The severity between diabetes and periodontal pathology was found to be related with diabetes type, being more pronounced in patients with type two diabetes patients, which confirms other clinical and also basic science data on the bidirectional interrelation of type two DM, and periodontitis, related to insulin resistance, even though pathogenesis is still not entirely clear by today. [2,11,13,17-22] There are no comprehensive data on DM and periodontitis relationship with subjective complaints, oral hygiene, periodontal care, subjective knowledge of diabetes control, lifestyle and sociodemographic factors, including patients' education and income, which are believed to be common modifiers of periodontitis and may be significant part of population- and individual-based prevention in DP patients in Lithuania. [11,23-25] The purpose of this pilot study was evaluate the complaints of periodontal disease, oral hygiene and care related conditions, knowledge of diabetes control and lifestyle in diabetes mellitus patients with periodontal pathology (DP),

How to Cite this Article: Peceliuniene J, et al. Diabetes Mellitus and Periodontitis: Lower Income – More Complicated Course of Disease?. Ann Med Health Sci Res. 2020;10: 1060-1065.

namely:

- Subjective periodontal disease complaints;
- Diabetes control knowledge and oral hygiene care in daily practice;
- How one of the most severe periodontal status indicators – loss of three and more teeth – is related to a patient's lifestyle and sociodemographic characteristics, oral hygiene, and dental access.

Subjects and Methods

Subjects

Pilot study was conducted by using questionnaires under patient's oral consent. Only adults with periodontal pathology who visited Vilnius University Hospital Odontology clinic, Lithuania, were invited to participate. After the consent was received, each patient was coded under anonymous ID code to assure having no possibility to identify personal data of participant.

Survey

A questionnaire was developed for the study, consisting of two parts: the patient's therapeutic form and the patient's dental form. The patient's therapeutic form included sociodemographic questions and diabetes-related questions: type of diabetes (type one DM, type two DM, and type three DM or not aware), glycemic control values (patients were asked to present glycated hemoglobin values, fasting glucose values, if known). Subjects were also asked whether first line family members had diabetes; if they smoked. In the patient's dental form subjects were asked about their oral hygiene habits (how many times and for how long they brushed their teeth, what materials they used, whether they visited professional oral hygiene specialist, if regularly so, etc.). Study participants were asked about the main subjective complaints (they could indicate several symptoms), which led them to see a periodontist (bleeding, gum discoloration, pain, dissatisfaction with aesthetics, preventive visit, if they were sent by the dentist, other reason). They were asked if they knew their diagnosis of dental disease and weather they knew how many teeth they had lost due to this disease in order to indicate the severity of periodontitis.

The second phase of the study analyzed, how the severe periodontal state was related to the person's lifestyle and sociodemographic characteristics, oral hygiene and access to dental services.

According to Lang and Tonetti, [26] the recurrence of periodontitis could be identified by six factors: percent of bleeding during probing, probing pocket depth, alveolar bone level and patient's age relation, existing systematic diseases, smoking and loss of teeth. In our study, bleeding during probing, probing pocket depth, alveolar bone level and patient's age relation were not included, since it was a subjective, towards patients knowledge oriented study. Moreover, Fardal et al. [27] used the loss of teeth as a periodontal status measurement to evaluate the effect of possible prognostic factors on periodontal maintenance. Based on this categorization, we also restricted periodontitis status and divided all subjects into two groups, depending on the number of teeth lost due to periodontal pathology (except for two patients who did not answer this question and were therefore not included in the analysis). The first (slight periodontitis) group (N=24) included those respondents who had no tooth loss or lost less than three teeth. In the second (severe periodontitis) group (N=18) were those, who lost more than three teeth.

Statistical analysis

Descriptive statistics were used for the data analysis. Mann Whitney and Fisher exact tests were used to compare group results.

Results

A total 173 patients were invited to participate into the study of which 63 were DP patients, and 44DP subjects filled the questionnaires (response rate – 70%) [Figure 1]. The mean age of the study participants was 56.9 (± 12.5). 14 men (31.8%) and 30 women (68.2%) Ten (22.72%) subjects had type one DM, 33 (75%) – type two DM. One patient did not know what type of DM he had. Most of the respondents had vocational (18 (40.9%) or higher (14 (31.8%) education. 34 (77.3%) subjects stated that they did not smoke [Table 1].

The results of patients' therapeutic form showed that 28 (63.6%) subjects had at least one first line family member, who had been diagnosed with diabetes. Even 23 (59%) patients were unaware of the results of the glucose control test and 16 (41%) reported to have had poor results, but when asked to specifically, they were unable to provide such information [Figure 2]. In general, DP patients were unable to provide accurate numbers when asked to accurately report glycated hemoglobin values, fasting glucose test or glucose test, assessed as self-control, results. Four (10%) patients said they had not even been tested for glucose control at all.

The results of the patient's dental form indicated that the majority of patients visited periodontist a year or more ago (36 (81.8%). Even 42 (95.5%) patients complained of bleeding [Figure 3]. 25 (59.5%) patients reported that periodontal disease

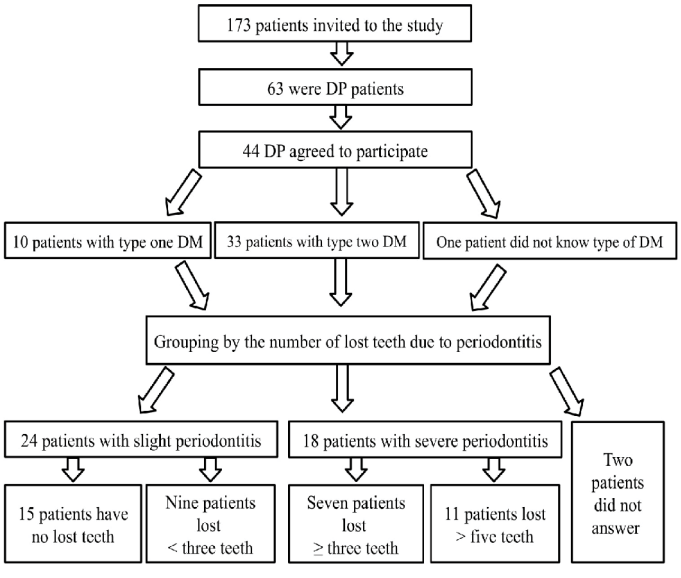

Figure 1: Distribution of collected data.

Table 1: Characteristics of DP subjects enrolled in the study.

Demographic data		Subjects N	Subjects %
Age		Mean 56.9 years	
Gender	Men	14	31.8%
	Women	30	68.2%
Type of diabetes mellitus (DM)	Type one DM	10	22.72%
	Type two DM	33	75%
	Do not know	1	2,27%
Education	Primary	1	2.3%
	Secondary	3	6.8%
	Vocational	18	40.9%
	Higher college	8	18.2%
	Higher university	14	31.8%
Income	EUR ≤ 200	6	13.6%
	EUR 201 - 400	21	47.7%
	EUR 401 - 600	10	22.7%
	EUR 601 - 1000	4	9.1%
	EUR > 1000	3	6.8%
Smoking	Smoke	6	13.6%
	Do not smoke	34	77.3%

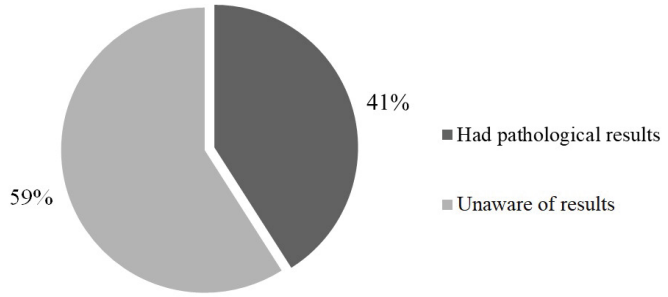

Figure 2: Patients' self-reported results of glucose serum test.

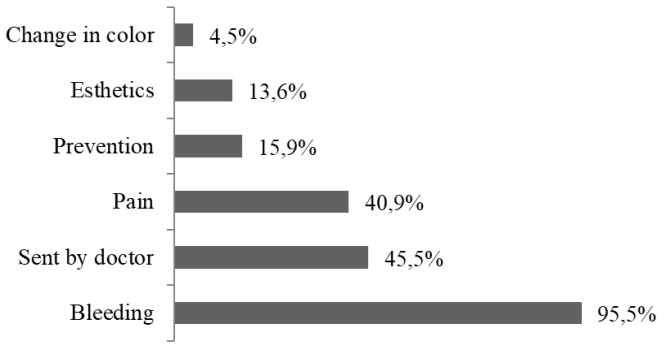

Figure 3: Periodontal complaints of DP patients.

was currently stable and for 13 (31%) patients it was getting worse. 15 (35.7%) patients reported that they had not lost their teeth due to periodontitis, 11 (26.2%) patients had lost five or more teeth and nine (21.4%) patients had lost one-two teeth due to periodontitis.

Most diabetes mellitus and periodontitis patients brushed their teeth twice a day (21 (47.7%) or once a day (17 (38.6%), and only one (2.3%) patient reported tooth brushing every other day. 23 (53.5%) patients cleaned teeth for one minute and 16 (37.2%) – for two minutes. The majority of subjects used dental floss less frequently than every other day (28 (63.6%), while others did to clean their teeth once (9 (20.5%) or twice a day (5 (11.4%). The majority of subjects did not use mouthwash at all (19 (43.2%) or only occasionally (18 (40.9%). 32 (72.7%) patients underwent professional oral hygiene, of which slightly more than half received at least once a year (25 (56.8%).

Study showed that 57% (N=24) of study patients were in slight periodontitis group and 43% had severe periodontitis. Comparing the scores of the slight and severe periodontitis group, the results did not differ by gender (75% vs. 55.6% for women, P=0.161, respectively), age (M=54.5 and M=58.9, P=0.315, respectively). These groups also did not differ in terms of time of visit to the dentists: 79.2% of patients with slight periodontal conditions and 88.9% with more severe periodontal conditions (they were treated for one year or more) (P=0.699). They did not differ according to family history of diabetes (54.2% patients with slight periodontitis and 77.8% with more severe periodontal disease, P=0.104) and types of diabetes (83.3% slight periodontitis patients and 70.6% severe periodontitis patients, P=0.276).

Data showed that the more complicated condition of patients might be associated with lower income, but not with education and with associated factors: patients with lower income could less afford expensive dental care (e.g. dental rinse) and private treatment (e.g. professional oral hygiene) [Table 2].

Discussion

Diabetes has been confirmed as a major risk factor for periodontitis, which is a possible complication of diabetes mellitus, and the risk of periodontitis increases by approximately threefold in poorly controlled diabetes compared to nondiabetic individuals. [7,28] Diabetes and periodontitis together appear to increase systemic inflammation, with evidence of reductions following periodontal treatment. [10] Data on periodontitis disease subjective complaints and patient's diabetes control awareness are scarce, and this study is significant to highlight the importance of this relationship when evaluating patient subjective data. Even though oral health knowledge and behavior become more of the target in general population in the world, [28] to our knowledge, diabetes control awareness in association with subjective periodontal complaints was the first time evaluated in periodontology population with DM in Lithuania. The results of our study showed that the main complaint about periodontal disease in diabetes mellitus and periodontitis patients was bleeding, which was common in almost all DP patients. This may indicate that periodontal disease is not adequately controlled as bleeding may indicate inflammation of the periodontal tissues as well as potentially adverse effects of diabetes control. Better awareness of both, diabetes and diabetes control, are needed: although all patients were diagnosed with diabetes, 60% of patients did not know whether the glucose control test showed good control of their diabetes, and those who knew that test results were good, could not tell the exact test value and/or percentage mean. Improvement in diabetes awareness and periodontal disease, and diabetes relationship awareness may help to improve DP control

Table 2: Comparison of lifestyle, sociodemographic and oral hygiene characteristics of DP patients with slight and severe periodontal disease.

Index	Value	Slight periodontitis patient n = 24	%	Severe periodontitis patient n = 18	%	P-value
Income	Up to 400 € per month	11	45.8%	14	77.8%	0.037
	400 € per month and more	13	54.2%	4	22.2%	
High education	Yes	15	62.5%	6	33.3%	0.059
	No	9	37.5%	12	66.7%	
Smoking	Yes	3	12.5%	3	16.7%	0.519
	No	21	87.5%	15	83.3%	
Cleaning with a toothbrush	Daily	22	91.7%	14	77.8%	0.204
	Less than daily	2	8.3%	4	22.2%	
Cleaning with dental floss	Daily	9	37.5%	3	16.7%	0.128
	Less than daily	15	62.5%	15	83.3%	
Duration of cleaning	Two – three minutes	10	41.7%	7	38.9%	0.555
	One minute or less	14	58.3%	11	61.1%	
Use of dental rinse	Yes	17	70.8%	6	33.3%	0.017
	Never	7	29.2%	12	66.7%	
Had professional oral hygiene	Yes	15	62.5%	17	94.4%	0.017
	No	9	37.5%	1	5.6%	
Visits dentist	Public sector	13	54.2%	16	88.9%	0.017
	Private sector	11	45.8%	2	11.1%	

over these comorbidities, also to fit the WHO recommendation of employing integrated public health preventive strategies, which should also be based on common risk factor approach, [25] such as smoking, stress and low socioeconomic status, which are known to be associated with periodontal disease as well as other systemic chronic diseases. [28,29]

It cannot be ruled out that one-third of DP study patients who stated cigarette smoking could improve the course of both, periodontal and DM, by giving up this harmful habit. It is known that periodontal disease is more advanced in diabetic smokers compared with diabetic non-smokers, and even smokers without diabetes are 3 times more likely to have a severe form of periodontal disease than non-smokers; they also present significantly increased the loss of alveolar bone and higher prevalence of tooth loss compared with non-smokers, and they have poor outcomes of all forms of periodontal treatments. [30-37] Smoking also contributes to insulin resistance which negatively affects type two diabetes [38-40] and, acting in a manner of vicious cycle, negatively affects the course of diabetic periodontal disease, and increases the risk of attachment loss. [33] We did not evaluate the severity of periodontal status in relation with particular type of DM, however, more research is needed to evaluate this relationship in DP patients in the future. Although, in Alharthi et al. [41] study, poor periodontal condition was also linked to the number of lost teeth, used in order to investigate the periodontal condition after quitting smoking.

Results of our study showed that more than 60% of patients claimed to have lost one or more teeth due to periodontal disease, and as many as 43% had lost at least three teeth, resulting them living with severe periodontitis and complications. Other studies, which objectively assessed the association between diabetes mellitus and periodontitis disease, provided similar results. A prospective study in Brazil showed that diabetic patients with poor glycemic control had more severe periodontitis and more tooth loss than those with good glycemic control or those who had no diabetes. It was thought that good glycemic control was important for good periodontal status. [23] Moreover, recent data showed that already prediabetic conditions, also obesity were related with chronic periodontitis, [42,43] pointing on glycemic control in prediabetic patient, which could reduce the severity of periodontal disease, if timely treated. That is why early diagnosis and prevention is thought to be crucial to avoid the largely irreversible tissue damage that occurs in periodontitis. [42] Most of other studies objectively assessed the association between diabetes mellitus and severity of periodontitis rather evaluated subjective data of DP patients, however, provided similar results, showing that diabetic patients with poor glycemic control had more severe periodontitis, and more tooth loss than those with good glycemic control or those without diabetes. Fernandes et al. [44] found that all patients with type 2 diabetes had periodontitis: one third – severe periodontitis and two thirds – moderate. A study by Katagiri et al. [45] revealed that improved glycemic control without a special treatment of periodontitis reduced periodontal tissue bleeding, but deep periodontal pockets persisted. The findings suggested that glycemic control could reduce gingivitis but not deep periodontal pockets. It is important to note, that bidirectional approach towards diabetes was also found: loss of more than three teeth was associated with an increased risk of diabetes. There were data showing that periodontitis was not an independent risk factor for diabetes. [46] However, the question whether increased risk of diabetes is linked with periodontitis, needs more detailed research.

Our study's results suggest that poor periodontal disease control may also be due to inadequate oral hygiene: more than 50% of patients brushed less than twice a day and more than 60% – for less than 2 minutes. We found that 70% used dental floss less frequently than every other day. The results are worse than those found by Bhardwaj et al., [47] showing that roughly half of the population brushed twice a day in dental population. These subjective results of our study suggest that

both, diabetes mellitus and periodontitis, are potentially poorly controlled by DP patients and that awareness of DP as comorbid diseases makes the need to pay more attention to oral health improvement, which is poor to none in DP patients in Lithuania. A similar study on patients' knowledge of the association between diabetes mellitus and periodontitis was conducted in Germany, also clinical examination of periodontal status in healthy and diabetic patients was assessed. Results showed that 90% of diabetic patients had periodontitis and 60% had no knowledge of the possible link. [48] Shanmukappa et al. [49] found that the knowledge and awareness about the association between DM and periodontal disease were significantly associated with lack of knowledge, especially in those with lower education and shorter diabetes experience. Other study found that teachers have satisfactory knowledge on oral health, [50] what can be explained by educational level. Additionally, recent data showed that frequent tooth brushing may be an attenuating factor and the presence of periodontal disease and an increased number of missing teeth may be augmenting factors for the occurrence of new-onset diabetes. Improving oral hygiene may be associated with a decreased risk of occurrence of new-onset diabetes. [51]

To our knowledge, no study has been conducted in Lithuania to assess the relationship between education, disease literacy, income and the severity of periodontitis in DP patients. We found that most of the respondents had an income from 201 to 400 euros per month (21 (47.7%). While in Lithuania, the minimum wages for unqualified employees were EUR 555 with the average gross salary of the 2019 first quarter EUR 1,108 per month (netto salary – EUR 713) in Vilnius city municipality. [52,53] In Lithuania, a person is entitled to a state social insurance old age pension if he/she reaches the statutory retirement age (as of 2019, the retirement age in Lithuania was 63.10 for men and 62.8 for women). [54] The average old-age pension due (2019) was EUR 344.9 and the average pension with the required record was EUR 365 in Lithuania. [55] Also, data on patients' literacy are scarce enough in DP population: Berkman et al. [56] aimed to update a 2004 systematic review and determine whether low health literacy was related to poorer use of health care, outcomes, costs and disparities in health outcomes among persons of all ages. Despite the conclusion that low health literacy was associated with poorer health outcomes and poorer use of health care services, authors noted that many limitations for the search by that time, namely, limited number of articles published in English; no availability of medical subject heading terms for identifying relevant studies; also no evidences concerning oral health literacy (speaking and listening skills) and outcomes were found. Recently, a study by Celeste et al. [57] sought to determine whether financial status and education could influence the development of periodontitis. The results showed that the incidence of moderate periodontitis in higher educated and higher income individuals was lower than in less educated and lower income individuals. Higher-income subjects had better access to oral hygiene and health care. [57] Study by Baskaradoss [58] showed that patients with poor oral health knowledge had significantly worse periodontal health. Also lower levels of health literacy were associated with a lower understanding of the importance of prevention and maintenance, and, consequently, inferior health. [28] Authors also concluded that by improving the oral health literacy the efforts to improve the adherence to medical instructions, self-management skills and the overall treatment outcomes may become more successful. [54] A review by Klinge et al. [59] noted that in 29 of the 36 studies, socioeconomic status of the subjects had an impact on their periodontal tissue disease. Authors have suggested that individuals from lower social backgrounds are more prone health-damaging behaviors that make them less likely to care about health what also looks quite consistent with our study's data. Data from the Dental Atherosclerosis Risk in Communities study, presented by Borrell et al., [60] showed the impact of individual income and education in association with severe periodontitis.

Even though we did not seek primarily to evaluate the relationship between income and periodontitis severity, our data showed that patients with lower income were significantly more likely to have more severe periodontitis, and it could be consistent with Bertoldi et al. [61] pilot study's data on a need for the public health administration to adopt a socioeconomic assessment. Additionally, Celeste et al. [57] showed that the threshold-effect of income on periodontitis, and interactions with race/ethnicity and education, exists.

Thus, by finding that the severity of periodontal state may be associated with lower income, expensive dental care and unaffordable professional oral hygiene we point on the systematic prevention programs' need for DP patients, who are at this risk.

Conclusion and Recommendations

Our study suggests that:

- Almost all DP patients complained of gum bleeding, tooth loss, and less often other active symptoms of periodontal disease. This could indicate poor patient control of periodontal disease and critically low knowledge of their disease, especially in the light of diabetes.
- The control of diabetes mellitus as well as oral hygiene in DP patients was found poor. This could lead to an increased gum bleeding or tooth loss. Most DP patients did not realize the importance of diabetes control, nor were they aware of their glucose control values, indicating an unsatisfactory level of patient knowledge.
- The severity of periodontal state may be associated with lower income, expensive dental care and unaffordable professional oral hygiene. Therefore, systematic prevention programs are needed for those patients, who are at this risk.

Lack of diabetes control and poor oral hygiene may lead to a loss of both glycemic and periodontal diseases control. Therefore, there is a need of a patient education and emphasis on the relationship between diabetes mellitus and periodontal disease in DP patient population.

Moreover, we suggest that in order to improve the treatment of such patients, more of the doctors – general practitioners,

endocrinologists, internal disease doctors, odontologists need to be more aware of significant link between these two diseases.

Conflicts of Interest

The authors state that there are no conflicts of interest regarding the publication of this article.

References

1. Bascones-Martínez A, Muñoz-Corcuera M, Bascones-Ilundain J. Diabetes and periodontitis: A bidirectional relationship. Medicina Clínica (English Edition) 2015;145:31-35.
2. Deshpande K, Jain A, Sharma R, Prashar S, Jain R. Diabetes and periodontitis. J Indian Soc Periodontol. 2010;14:207.
3. https://www.who.int/news-room/fact-sheets/detail/diabetes.
4. Loe H. Periodontal Disease: The sixth complication of diabetes mellitus. Diabetes Care 1993;16:329-334.
5. Maruyama K, Sato S. Effect of high-glucose conditions on human periodontal ligament endothelial cells: in vitro analysis. Odontology 2016;105:76-83.
6. Mirza BA, Syed A, Izhar F, Ali Khan A. Bidirectional relationship between diabetes and periodontal disease: review of evidence. J Pak Med Assoc. 2010;60:766-768.
7. Pečeliūnienė J, Repčienė N, Sadauskaitė N, Prialgauskaitė U, Norkus A. Diabetes and periodontitis: a two-way street. Short review. Lietuvos endokrinologija. Kaunas: Medicininės informacijos centras, 2018;26:2-4.
8. https://www.efp.org/publications/projects/perioanddiabetes/news/perio-diabetes-launch-world-diabetes.
9. Saini R, Saini S, Sugandha R. Periodontal disease: The sixth complication of diabetes. J Family Community Med. 2011;18:31.
10. Preshaw PM, Taylor JJ, Jaedicke KM, De Jager M, Bikker JW, Selten W, et al. Treatment of periodontitis reduces systemic inflammation in type 2 diabetes. J Clin Periodontol. 2020;47:737-746.
11. Caton JG, Armitage G, Berglundh T, Chapple IL, Jepsen S, Kornman KS, et al. A new classification scheme for periodontal and peri-implant diseases and conditions - Introduction and key changes from the 1999 classification. J Clin Periodontol. 2018;20:S1-S8.
12. http://www.who.int/oral_health/publications/en/.
13. Pranckeviciene A, Siudikiene J, Ostrauskas R, Machiulskiene V. Severity of periodontal disease in adult patients with diabetes mellitus in relation to the type of diabetes. Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub. 2014;158:117-123.
14. Pranckeviciene A, Siudikiene J, Ostrauskas R, Machiulskiene V. Long-term effect of periodontal surgery on oral health and metabolic control of diabetics. Clin Oral Investig. 2017;21:735-743.
15. Staniulyte A, Rovas A, Puriene A. The Association between Periodontal Pathology and Systemic Health. Paper presented at the 22nd Congress of the European Association of Dental Public Health - Challenges in Oral Epidemiology Community Dental Health 2017;34:S1-S53.
16. Pawlowicz A, Tymczyna-Borowicz B, Ptasiewicz M. The state of the oral health in patients with type 2 diabetes. Pol Merkur Lekarski 2020;48:27-31.
17. Lalla E, Lamster IB, Drury S, Fu C, Schmidt AM. Hyperglycemia, glycoxidation and receptor for advanced glycation endproducts: Potential mechanisms underlying diabetic complications, including diabetes-associated periodontitis. Periodontol. 2000;23:50-62.
18. Llambés F. Relationship between diabetes and periodontal infection. World J. Diabetes. 2015;6:927.
19. Gurav AN. Periodontitis and Insulin Resistance: Casual or Causal Relationship? Diabetes Metab. 2012;36:404.
20. Gurav, AN. Periodontal therapy – An adjuvant for glycemic control. Diabetes Metab Syndr. 2012;6:218-223.
21. Tonetti MS, Greenwell H, Kornman KS. Staging and grading of periodontitis: Framework and proposal of a new classification and case definition. J Clin Periodontol. 2018;89:S159-S172.
22. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. Diabetes care. 2004;27:1047-1053.
23. Costa FO, Miranda Cota LO, Pereira Lages EJ, Soares Dutra Oliveira AM, Dutra Oliveira PA, Cyrino RM, et al. Progression of Periodontitis and Tooth Loss Associated with Glycemic Control in Individuals Undergoing Periodontal Maintenance Therapy: A 5-Year Follow-Up Study. J Periodontol. 2013;84:595-605.
24. Jepsen S, Blanco J, Buchalla W, Carvalho JC, Dietrich T, Dörfer C, et al. Prevention and control of dental caries and periodontal diseases at individual and population level: consensus report of group 3 of joint EFP/ORCA workshop on the boundaries between caries and periodontal diseases. J Clin Periodontol 2017;18:S85-S93.
25. Nazir MA. Prevalence of periodontal disease, its association with systemic diseases and prevention. Int. J Health Sci. 2017;11:72-80.
26. Lang NP, Tonetti MS. Periodontal risk assessment for patients in supportive periodontal therapy (SPT). Oral Health Prev Dent. 2003;1:7-16.
27. Fardal Ø, Grytten J, Martin J, Houlihan C, Heasman P. Using prognostic factors from case series and cohort studies to identify individuals with poor long-term outcomes during periodontal maintenance. J Clin Periodontol 2016;43:789-796.
28. Abu-Gharbieh E, Saddik B, El-Faramawi M, Hamidi S, Basheti M. Oral Health Knowledge and Behavior among Adults in the United Arab Emirates. BioMed Res Int. 2019;1-7.
29. Petersen PE, Ogawa H. Strengthening the Prevention of Periodontal Disease: The WHO Approach. J Periodontol. 2005;76:2187-2193.
30. Albandar JM, Streckfus CF, Adesanya MR, Winn DM. Cigar, Pipe, and Cigarette Smoking as Risk Factors for Periodontal Disease and Tooth Loss. J Periodontol. 2000;71:1874-1881.
31. Johnson GK, Hill M. Cigarette Smoking and the Periodontal Patient. J Periodontol. 2004;75:196-209.
32. Kanmaz B, Lappin DF, Nile CJ, Buduneli N. Effects of smoking on non-surgical periodontal therapy in patients with periodontitis stage III or IV, and grade C. J Periodontol. 2020;91:442-453.
33. Obradović R, Kesić LJ, Gašić J, Petrović M, Živković N. Role of smoking in periodontal disease among diabetic patients. West Indian Med J. 2012;61:98-101.
34. Ramseier CA, Anerud A, Dulac M, Lulic M, Cullinan MP, Seymour GJ, et al. Natural history of periodontitis: Disease progression and tooth loss over 40 years. J Clin Periodontol. 2017;44:1182-1191.
35. Reners M, Brecx M. Stress and periodontal disease. Int J Dent Hyg. 2007;5:199-204.
36. Sanz M, Daiuto F, Deanfield J, Fernandez-Avilés F. European workshop in periodontal health and cardiovascular disease--scientific evidence on the association between periodontal and cardiovascular diseases: a review of the literature. European Heart Journal Supplements 2010;12:B3-B12.
37. Underner M, Maes I, Urban T, Meurice JC. Effects of smoking on periodontal disease. Revue des maladies respiratoires. 2009;26:1057-1073.
38. Bajaj M. Nicotine and Insulin Resistance: When the Smoke Clears. Diabetes 2012;61:3078-3080.
39. Facchini FS, Hollenbeck CB, Jeppesen J, Chen YD, Reaven GM. Insulin resistance and cigarette smoking. The Lancet. 1992;339:1128-1130.
40. SKM AI, Seo M, Lee YS, Moon SS. Association of periodontitis with insulin resistance, β-cell function, and impaired fasting glucose before onset of diabetes. Endocr J. 2015:EJ15-0350.
41. Alharthi SS, Al-Motlag SK, Wahi MM. Is Trying to Quit Associated With Tooth Loss and Delayed Yearly Dental Visit Among Smokers? Results of the 2014 Behavioral Risk Factor Surveillance System. J Periodontol 2017;88:34-49.

42. Maboudi A, Akha O, Heidari M, Mohammadpour RA, Gheblenama P, Shiva A. Relation between Periodontitis and Prediabetic Condition. J Dent. 2019;20:83.

43. Gulati NN, Masamatti SS, Chopra P. Association between obesity and its determinants with chronic periodontitis: A cross-sectional study. J Indian Soc Periodontol. 2020;24:167-172.

44. Fernandes JK, Wiegand RE, Salinas CF, Grossi SG, Sanders JJ, Lopes-Virella MF, et al. Periodontal Disease Status in Gullah African Americans With Type 2 Diabetes Living in South Carolina. J Periodontol. 2009;80:1062-1068.

45. Katagiri S, Nitta H, Nagasawa T, Izumi Y, Kanazawa M, Matsuo A, et al. Effect of glycemic control on periodontitis in type 2 diabetic patients with periodontal disease. J Diabetes Investig. 2013;4:320-325.

46. Ide R, Hoshuyama T, Wilson D, Takahashi K, Higashi T. Periodontal disease and incident diabetes: a seven-year study. J Dent Res. 2011;90:41-46.

47. Bhardwaj V. Tooth brushing behaviours and dental abrasion among the population in Shimla, Himachal Pradesh in India: A cross-sectional study. J Craniomaxillofac Surg. 2014;3:89.

48. Weinspach K, Staufenbiel I, Memenga-Nicksch S, Ernst S, Geurtsen W, Günay H. Level of information about the relationship between diabetes mellitus and periodontitis - results from a nationwide diabetes information program. Eur J Med Res. 2013;18:6.

49. Shanmukappa SM, Nadig P, Puttannavar R, Ambareen Z, Gowda TM, Mehta DS. Knowledge, attitude, and awareness among diabetic patients in Davangere about the association between diabetes and periodontal disease. J Int Soc Prev Community Dent. 2017;7:381.

50. Rasheed NMA, Shetty AC. Oral health knowledge among female primary school teachers in Riyadh city, Kingdom of Saudi Arabia. Int J Appl Dent Sci. 2017;3:164-170.

51. Chang Y, Lee JS, Lee KJ, Woo HG, Song TJ. Improved oral hygiene is associated with decreased risk of new-onset diabetes: a nationwide population-based cohort study. Diabetologia 2020;2:1-0.

52. https://www.vz.lt/vadyba/personalo-valdymas/2019/03/04/vidutines-algos-lietuvos-savivaldybese--nuo-672-iki-1108-eur.

53. https://tradingeconomics.com/lithuania/wages

54. https://www.renkuosilietuva.lt/en/old-age-pensions/

55. Lithuanian Ministry of Social Security and Labour. Available at : https://socmin.lrv.lt/en/(accessed 1 March 2020)

56. Berkman ND, Sheridan SL, Donahue KE, Halpern DJ, Crotty K. Low Health Literacy and Health Outcomes: An Updated Systematic Review. Ann Intern Med. 2011;155:97-107.

57. Celeste RK, Oliveira SC, Junges R. Threshold-effect of income on periodontitis and interactions with race/ethnicity and education. Revista Brasileira De Epidemiologia 2019;22:e190001.

58. Baskaradoss JK. Relationship between oral health literacy and oral health status. BMC Oral Health 2018;18.

59. Klinge B, Norlund A. A socio-economic perspective on periodontal diseases: a systematic review. J Clin Periodontol. 2005;32:314-325.

60. Borrell LN, Beck JD, Heiss G. Socioeconomic Disadvantage and Periodontal Disease: The Dental Atherosclerosis Risk in Communities Study. Am J Public Health. 2006;96:332-339.

61. Bertoldi C, Lalla M, Pradelli JM, Cortellini P, Lucchi A, Zaffe D. Risk factors and socioeconomic condition effects on periodontal and dental health: A pilot study among adults over fifty years of age. Eur J Dent. 2013;7:336.