Research Progress on Periodontal Health Status and Prevention and Treatment in Elderly Diabetic Patients

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Diabetes mellitus (DM) is a group of metabolic diseases caused by multiple factors and characterized by chronic hyperglycemia. These diseases are caused by defects in insulin secretion and/or action, influenced by a combination of genetic and environmental factors. However, the exact etiology and pathogenesis of diabetes remain incompletely understood. Diabetes is a risk factor for periodontal diseases. In diabetic individuals, there is a relative or absolute lack of insulin, and a decrease in cellular sensitivity to insulin can lead to disturbances in fat and protein metabolism, resulting in chronic metabolic disorders throughout the body. This can affect the normal function of tooth tissues and can lead to various oral diseases such as gingivitis and periodontitis. Furthermore, periodontal disease can alter the level of TNF-α in the body, activating multiple pathways such as nuclear factor kappa-B inhibitor kinase, leading to abnormal serine phosphorylation, interfering with signal transduction after insulin binds to its receptor, and resulting in insulin resistance, increased blood sugar levels, and promoting the occurrence and development of diabetes. Therefore, there is a bidirectional relationship of interaction between the two conditions.

1 Periodontal Lesions in Elderly Patients with Diabetes Mellitus

1.1 Periodontal Complications and Pathogenesis in Elderly Patients with Diabetes Mellitus

Extensive scientific research has shown that diabetes mellitus can cause a series of oral complications. Currently, the most widely studied connection between diabetes and periodontal disease has demonstrated that diabetes increases susceptibility to destructive periodontal diseases. Surveys conducted in Norway, Korea, and other

countries on the prevalence of periodontal disease among the elderly population have consistently pointed out that the incidence of periodontal disease is higher in individuals with diabetes than in those without the disease. [1] The following are common periodontal complications and their pathogenic mechanisms in elderly patients with diabetes mellitus.

1.1.1 Periodontitis:

Reports of an association between diabetes and periodontitis date back to the 1960s. Since then, numerous studies have unequivocally demonstrated the relationship between diabetes and periodontal disease in humans and animals. [2]

Epidemiological data indicate that diabetes is a major risk factor for periodontitis. [3] Periodontitis is now considered the sixth major complication of diabetes. A recent observational study of individuals aged 40 and above showed that the incidence of periodontitis in patients with diabetes was significantly higher than in non-diabetic patients. [4] Compared to non-diabetic patients, the risk of periodontitis in diabetic patients is increased by approximately 10 times. Yang et al. conducted a cross-sectional study on elderly patients with type 2 diabetes and found that they were more susceptible to periodontitis than healthy individuals. [5]

Both diabetes and periodontitis are characterized by chronic inflammation, manifesting as enhanced inflammatory responses and weakened immune responses. Therefore, the impact of diabetes on periodontitis is primarily reflected in its various effects on periodontal tissue inflammation. Currently studied mechanisms include: ① The periodontal tissue is rich in blood vessels, so the typical mechanisms of microvascular and macrovascular lesions caused by diabetes can be used to explain the lesions in periodontal tissue. The accumulation of advanced glycation end products in periodontal tissue can affect the interaction between cells and the matrix, as well as between the matrix and itself. ② Periodontitis is associated with changes in the structure of the oral microbiota, and diabetes participates in the alteration of the subgingival bacterial community through changes related to oral mechanisms, providing a favorable microenvironment for the growth of pathogens. Xiao et al.

found that diabetes increases the expression level of IL-17 in the body, altering the oral microbiota and thereby increasing its pathogenicity. [6] ③ The unique tissue microecology of the periodontium distinguishes it from other tissues and organs. There is a continuous invasion of bacterial biofilms in the periodontium, so immune inflammatory responses are crucial for maintaining periodontal tissue health. Diabetes can alter the function of immune cells such as neutrophils, monocytes, and macrophages, leading to exacerbated inflammatory responses and weakened immune responses in the periodontium. Through sampling and analysis of periodontitis patients, A et al. found that the transcriptional balance of monocytes in the circulating blood of T2DM patients with periodontitis is severely disrupted, tending to express proinflammatory subtypes. The levels of systemic inflammatory mediators, including C-reactive protein (CRP), TNF-α, and IL-6, are elevated in healthy gingival areas of T2DM patients with periodontal disease, which can also affect the repair and resolution of inflammation, thereby accelerating periodontal destruction. [7] ④ Oxidative stress is a major pathway linking diabetes and periodontitis, which can activate systemic proinflammatory pathways. Allen et al. found that patients with periodontitis and type 2 diabetes have high levels of oxidative stress markers in their plasma, indicating that periodontitis is associated with increased oxidative stress in patients with type 2 diabetes. [8]

1.1.2 Gingivitis:

The various stages of gingival inflammation preceding periodontitis are collectively referred to as gingivitis. Both type 1 and type 2 diabetes have been reported to affect the occurrence of gingivitis. Most studies have shown that the incidence of gingivitis is significantly higher in adult patients with type 1 diabetes. Yuan et al. used an artificially induced mouse model of type 1 diabetes and found that type 1 diabetes exacerbates gingival inflammation in the early stages. [9] Recently, studies have found that gingivitis is more common in type 2 diabetes. Currently, there is limited research on the relationship between gingivitis and diabetes. Existing views suggest that diabetes can lead to changes in the periodontal microbiota. [10] The

pathological manifestations of gingivitis include increased apoptosis of periodontal epithelial cells and connective tissue fibroblasts. Kang et al. demonstrated through an experimental induction of gingivitis by inoculating rats with Actinobacillus that diabetes aggravates cell apoptosis through a Caspase-3-dependent mechanism. [11] Therefore, diabetes can exacerbate the impairment of the gingival epithelial barrier function. More biological connections between diabetes and gingivitis still need further exploration and

1.2 Influencing factors of periodontal diseases among elderly diabetic patients

1.2.1 Patient's condition

① Age of the patient: The oral cavity undergoes many physiological or pathological changes related to age, which can directly or indirectly increase the risk of oral diseases among the elderly. A large amount of research evidence indicates that the immune function of the human body changes with age, and immune factors are closely related to the incidence of periodontal diseases. Many studies have shown that immune senescence affects the inflammatory mechanism of periodontal diseases, but whether aging will worsen the condition or increase disease susceptibility still needs further research. [12]

② Lifestyle habits: A study of elderly people in England in 1993 showed that long-term exposure to tobacco products is a significant risk factor for periodontal diseases [13]. In 2015, Javes et al. conducted a controlled trial on 50 patients with type II diabetes and found that periodontitis was more severe among smokers than non-smokers. [14]

③ Education level and socioeconomic factors: For individuals, their level of education, economic ability, and social status largely determine their cognitive ability. Wu et al. conducted weighted descriptive and multiple linear regression analyses on NHANES data from elderly groups over 60 years old and found that cognitive function is closely related to oral health, and elderly people with lower cognitive function scores have worse oral health conditions. [15] The data from the fourth national oral health survey in China showed that income level has a significant impact

on the oral health-related quality of life of the elderly, which is consistent with surveys conducted in Sweden, the United States, and other countries. [16]

1.2.2 Diabetes-related factors:

Extensive research evidence supports that blood sugar control level is related to periodontal health status and is an important determinant of the impact of diabetes on periodontal diseases. [17] PI et al. investigated the prevalence of periodontitis among adults aged 65 and above in the United States and found significant differences in the prevalence of severe and non-severe periodontitis among the elderly depending on diabetes control status. [18] Koche et al. reviewed a large amount of epidemiological data showing that patients with uncontrolled or poorly controlled blood sugar levels have more severe periodontitis and a higher tooth loss rate compared to patients with controlled diabetes. [19]

1.2.3 Oral health behaviors:

Daily oral hygiene behaviors have a positive impact on improving and maintaining oral hygiene for patients with periodontal diseases. [20] Factors related to oral hygiene behaviors mainly include tooth brushing frequency, the frequency of using dental floss, and the frequency of visiting dentists. A survey of oral health quality of life among elderly people in Brazil showed that elderly groups who used fewer dental services and brushed their teeth less frequently had worse oral health conditions. [21] Huang et al. conducted a cross-sectional survey of the number of remaining teeth in diabetic patients in rural communities in Taiwan and found that the elderly group with the lowest frequency of using dental floss had the fewest remaining teeth. [22]

2 Current Status and Assessment Tools for Periodontal Health in Elderly Diabetic Patients

2.1 Differences in Periodontal Status among Elderly Diabetic Patients

As the sixth major complication of diabetes, numerous studies have shown that there are differences in the severity of periodontal diseases between diabetic and non-diabetic patients, with T2DM patients exhibiting more severe periodontal supporting tissue lesions, particularly in periodontitis. Juliana et al. [23] collected 106 subjects over 50 years old, including 45 cases without periodontitis and 61 cases with periodontitis. Among them, there were more cases of periodontitis in patients with prediabetes and diabetes, but the difference was not statistically significant. Further examination results showed that compared with the non-diabetic group, the diabetic group had the highest severity of periodontitis, with a strong positive correlation between HbA1c and PD levels greater than or equal to 6, CAL greater than or equal to 5, and the highest percentage of BOP areas. In terms of pathogens, Xie et al. [24] compared the differences in subgingival plaque pathogens between 61 elderly patients with simple periodontitis (simple group) and 37 elderly patients with T2DM complicated with periodontitis (combined group) during the same period. Except for Fusobacterium nucleatum, the detection rates of other pathogens in the subgingival plaque of the combined group, including Aggregatibacter actinomycetemcomitans, Porphyromonas gingivalis, Micrococcus microaerophiles, Prevotella intermedia, Tannerella forsythia, etc., were higher than those in the simple group, and the difference was statistically significant ($P<0.05$), which was consistent with the study by Xie Fen et al. [25]. Additionally, the number of Aggregatibacter actinomycetemcomitans and Porphyromonas gingivalis was positively correlated with the level of HbA1c. Studies have also shown that some inflammatory factors are differentially expressed in elderly T2DM patients. For example, IL-8 is highly expressed in the serum and gingival crevicular fluid of patients with diabetic periodontitis [26], and through the measurement of PD, IL-8, IL-6, IL-10, and MIP1α are only correlated with the severity of periodontitis in T2DM periodontitis patients, and not significantly associated with simple T2DM [27]. Furthermore, serum IL-1β and urine DPd levels are abnormally elevated in patients with T2DM complicated

with periodontitis, which may provide new directions for the diagnosis and treatment of T2DM complicated with periodontitis [28].

2.2 Oral Health Assessment Tools for T2DM Patients

The current oral health assessment tools for elderly T2DM patients are primarily survey scales, which are used to screen for oral health conditions among elderly T2DM patients and provide relevant recommendations, aiming to achieve early detection and early treatment. The Kayser-Jones Brief Oral Health Status Examination (BOHSE) [29] was developed in 1995, but due to linguistic and cultural differences, it is mainly used in English-speaking countries. It was translated into Chinese in 2016 by domestic scholars and has good reliability and validity [30]. Based on BOHSE, Chalmers et al. [31] modified and developed the Oral Health Assessment Tool (OHAT), which is also a commonly used oral health screening tool, but there is still no Chinese version available. To better align with the oral health conditions of the elderly, Hassel et al. [32] developed the Geriatric Oral Health Assessment Index (GOHAI) scale, which was translated and validated by domestic scholars Ling Junqi et al. [33] translated the GSEOH into Chinese and measured its Cronbach's α coefficient as 0.913 and test-retest correlation coefficient as 0.743, indicating good reliability. However, the existing assessment tools are only targeted at the elderly population or specific diseases , and there are still few studies on assessment tools for elderly T2DM patients. Domestic scholar Zhou Yunru [34] adapted and revised the Chinese version of the Health-Promoting Lifestyle Profile II (HPLP II) and the Chinese version of GOHAI to form an oral health assessment scale with good reliability and validity for elderly diabetic patients. A questionnaire survey of 300 elderly diabetic patients showed that there was a

3 Prevention and Treatment Measures of Periodontal Diseases for Elderly Diabetic Patients

Data shows that 30% of the elderly population in China (aged 60 and above) suffers from diabetes (78.13 million, over 95% of which is type 2 diabetes) in 2020. There are 3.9 million people in the UK with diabetes. Among Americans aged 65 and

above, the prevalence of diabetes exceeds 25%[35]. The prevalence of diabetes among the elderly has increased significantly, and complications caused by diabetes, especially periodontal diseases, have had a significant adverse impact on the health of the elderly. Diabetes complications caused by poor glycemic control are major risk factors affecting the health and survival of the elderly. The increasing prevalence of diabetes in the elderly has become a significant burden on society, and the prevention and treatment of diabetes has become a research focus in various countries[36].

3.1 Preventive Measures for Periodontal Diseases among Elderly Diabetic Patients

A comparative study has shown that compared to diabetic patients, non-diabetic patients tend to have healthier behaviors and lifestyles, including exercise and less smoking. At the same time, diabetic patients with a lower body mass index (BMI) but a higher body fat percentage may experience muscle atrophy. It is recommended that physical fitness management for elderly diabetic patients should be assessed based on BMI and body fat percentage to prevent muscle atrophy. As patients age, the duration of the disease increases, and diabetes-related complications emerge, the prevalence of periodontitis in diabetic patients increases significantly ($P<0.05$)[37]. Early prevention and treatment of periodontitis are extremely important. Attention should be paid to the periodontal health status of elderly long-term ill and diabetic patients, and targeted oral preventive health care should be carried out for this population[38]. Diabetic patients are more likely to suffer from periodontal diseases than non-diabetic patients. Therefore, implementing preventive oral health care is an essential part of diabetes self-care[39]. Yuqing Z et al[40]. used multivariate logistic regression analysis to investigate the relationship between diabetes, periodontal diseases, and preventive oral health behaviors. Their results showed that the weighted prevalence of periodontal diseases among diabetic adults was higher than that among non-diabetic adults (58.0% vs 37.6%). Diabetic patients were less likely to perform daily proximal cleaning (aOR 0.85, 95% CI, 0.75 ~ 0.95) and less likely to visit a dentist for preventive care in the past year. For diabetic patients over 75 years old, physically weak or with muscle atrophy and malnutrition, it may be necessary to shift the dietary

treatment strategy from treating obesity/metabolic syndrome to preventing frailty. To prevent frailty, optimal energy intake, adequate protein and vitamin intake, and a healthy dietary pattern should be recommended.

In diabetic patients, maintaining blood sugar levels during oral treatment increases the risk of infection, and antibiotics should be reasonably used during some oral surgeries. Gao Ruihan et al[41]. found that eldecalcitol (ELD) can partially correct the imbalance of Th17/Treg cells through STAT3/STAT5 signal transduction, thus having a preventive effect on periodontitis (PD) and diabetes-related periodontitis (DPD), and ELD has more advantages in preventing DPD. Additionally, Tanweer Tahreem et al[42]. applied dental composites containing magnesium-doped zinc oxide nanoparticles to alloxan-induced diabetic models, thereby preventing secondary caries. They also used zinc oxide magnesium NPs doped as an antibacterial agent in resin composites to avoid biofilm and secondary caries formation. Meanwhile, probiotic Lactobacillus rhamnosus EM1107 can prevent hyperglycemia, alveolar bone loss, and inflammation in diabetic and periodontitis rat models. Berniyanti Titiek et al. confirmed that poor glycemic control can induce gingival oxidative stress, thereby aggravating periodontal tissue damage. An important factor in preventing periodontitis in type 2 diabetic patients is to control blood sugar levels through regular medication and regular maintenance of oral health. A study also analyzed local and regional changes in odontogenic sinusitis in diabetic patients with periodontal lesions, demonstrating the role of sub-antimicrobial dose doxycycline adjuvant therapy in preventing sinus complications in diabetic patients with periodontal lesions and glycemic control (HbA1c). HbA1c and blood sugar measurement are minimally invasive methods for preventing diabetes complications.

3.2 Treatment measures for periodontal diseases of elderly diabetic patients

With the rapid increase in the prevalence of diabetes worldwide, this chronic disease is no longer considered a systematic health issue but the beginning of a fatal disease. Researches show that diabetes and periodontal diseases react to each other's formation and severity. If patients with prediabetes are not diagnosed and treated

adequately in time, they have a potentially higher risk of causing periodontal diseases and other complications. The combination of risk factors including individual, social, environmental, and genetic factors plays a crucial role in the development of diabetes and the severity of periodontitis. Diabetes essentially affects gingival diseases, periodontal diseases, salivary secretion disorders, and their parameters. Therefore, it is essential to take effective treatment plans for diabetes and its periodontal complications in time.

Combined antibacterial photodynamic therapy (aPTD) can significantly reduce the proportion of positive sites of periodontal pathogens. aPTD is a non-invasive adjunctive therapy that has a positive impact on periodontal diseases and blood sugar control in patients with type 2 diabetes (T2DM). Zheng Yanfen et al. have developed a multifunctional GOx-CAT nanogel (GCN) system for treating diabetic oral mucosal ulcers. This multifunctional GCN with ROS exhaustion, continuous oxygen supply, and good biocompatibility may provide a new treatment strategy for effectively treating diabetic oral mucosal ulcers. For T2DM patients with poor glycemic control, the periodontal treatment effect of single-rooted teeth receiving Er: YAG laser (ERL)-assisted non-surgical periodontal therapy (NSPT) is better[43].

At the same time, some studies have examined the relationship between age and treatment effect size using bivariate and multivariate meta-regression models, demonstrating that multi-component periodontal therapy can significantly reduce probing depth (PD), clinical attachment level (CAL), and glycated hemoglobin (HbA1c) in patients with periodontitis and diabetes. With increasing age, the effect size of PD (trend P = 0.020) and CAL (trend P = 0.028) showed a significant downward trend. Therefore, clinicians should consider the age of patients when making periodontal treatment plans, and may need to adopt more active or personalized strategies for the elderly to achieve the best treatment effect[44].

The study by AlAali Khulud A et al. showed the effectiveness of methylene blue-PDT combined with miconazole in improving oral health-related quality of life and significantly reducing Candida colony-forming units (CFU) counts in diabetic

patients receiving implant-supported full dentures[45]. The acute phase of type 1 diabetes (T1D) is characterized by oral microbiota imbalance, which can be partially improved through glycemic control. Compared with untreated diabetic patients, the blood sugar status of diabetic patients receiving periodontal and restorative treatment has improved. Cimões Renata's study showed that the use of enamel matrix derivatives (EMD) on the basis of simplified partial pedicle flaps (SPPF) can be used to control the clinical effect of intraosseous defects (ID) in periodontal patients with T2DM. Studies on diabetic animal models have shown that activating peroxisome proliferator-activated receptor α (PPARα) in cellular metabolism and inflammation through oral fenofibrate and/or pemafibrate is a promising target for treating DR. Liquid smoke from coconut endocarp (LS-CE) contains high antioxidants, accelerates the cellular response of macrophages, and promotes the healing of oral ulcers in diabetic patients[46]. Lemon peel essential oil can stimulate lymphocyte count and interleukin (IL)-10 expression and can be used to treat traumatic diabetic oral ulcers.

It is essential for dentists and diabetologists to collaborate and educate patients to maintain oral hygiene procedures. A study using Andersen's behavioral modeling (ABM) confirmed that age, the number of missing teeth, diabetes, proximal interdental cleaning, and perceived stress are related factors affecting oral health-related quality of life (OHRQoL), while good oral hygiene habits can promote periodontal health. At the same time, implementing oral hygiene education and guidance can affect the decline in plaque index and oral hygiene index in diabetic patients. Studies have also shown that various factors, including educational level and oral health status, are statistically significant in the relationship between type 2 diabetic patients' awareness of periodontitis and periodontitis/diabetes ($p < 0.05$)[47].

4 Summary and Prospect

As the global population ages rapidly, the incidence of diabetes in the elderly has shown a significant upward trend, which is closely related to economic, social, behavioral, environmental, demographic, and age factors. Due to the systematic and complex relationship between these influencing factors, the prevention and treatment

of diabetes in the elderly is a long-term and arduous task. In the future, further targeted research on diabetes in the elderly needs to be promoted to early identify risk factors, explore and analyze the interaction mechanism between risk factors, and provide scientific and healthy lifestyle advice to the elderly based on dietary structure, behavioral factors, muscle gain and fat reduction, and psychological construction. The promotion of proactive health concepts among the elderly will effectively reduce the risk of diabetes in the elderly, delay the occurrence and development of diabetic complications, thereby improving the quality of life and health level of the elderly, and contributing to the realization of healthy aging.

REFERENCES

[1]Sødal ATT, Skudutyte-Rysstad R, Diep MT, Koldsland OC, Hove LH. Periodontitis in a 65-year-old population: risk indicators and impact on oral health-related quality of life. BMC Oral Health. 2022;22(1):640.

[2]Lee KS, Kim EK, Kim JW, et al. The relationship between metabolic conditions and prevalence of periodontal disease in rural Korean elderly. Arch Gerontol Geriatr. 2014;58(1):125-129.

[3]Belting, S.M.; Hiniker, J.J.; Dummett, C.O. Influence of diabetes mellitus on the severity of periodontal disease. J. Periodontol. 1964, 35, 476-480.

[4]Preshaw PM, Alba AL, Herrera D, Jepsen S, Konstantinidis A, Makrilakis K, Taylor R. Periodontitis and diabetes: a two-way relationship. Diabetologia. 2012 Jan;55(1):21-31.

[5]Yang Jie, Tang Wei, Liang Beibei, et al. Comparison of periodontal health status between elderly patients with type 2 diabetes and healthy people [J]. Practical Geriatrics, 2023,37 (3): 270-273.

[6]Xiao E, Mattos M, Vieira GHA, et al. Diabetes Enhances IL-17 Expression and Alters the Oral Microbiome to Increase Its Pathogenicity. Cell Host Microbe. 2017;22(1):120-128.

[7]Salvi, G.E.; Kandylaki, M.; Troendle, A.; Persson, G.R.; Lang, N.P. Experimental gingivitis in type 1 diabetics: A controlled clinical and microbiological study. J. Clin. Periodontol. 2005, 32, 310-316.

[8]Allen, E.M.; Matthews, J.B.; O' Halloran, D.J.; Griffiths, H.R.; Chapple, I.L. Oxidative and inflammatory status in Type 2 diabetes patients with periodontitis. J. Clin. Periodontol. 2011, 38, 894-901.

[9]Yuan X, Amin V, Zhu T, Kittaka M, Ueki Y, Bellido TM, Turkkahraman H. Type 1 diabetes mellitus leads to gingivitis and an early compensatory increase in bone remodeling. J Periodontol. 2023 Feb;94(2):277-289.

[10]Zhi QH, Si Y, Wang X, et al. Determining the factors associated with oral health-related quality of life in Chinese elders: Findings from the fourth national survey. Community Dent Oral Epidemiol. 2022;50(4):311-320.

[11]Kang J, de Brito Bezerra B, Pacios S, Andriankaja O, Li Y, Tsiagbe V, Schreiner H, Fine DH, Graves DT. Aggregatibacter actinomycetemcomitans infection enhances apoptosis in vivo through a caspase-3-dependent mechanism in experimental periodontitis. Infect Immun. 2012 Jun;80(6):2247-2256.

[12]Raslan SA, Cortelli JR, Costa FO, et al. Clinical, microbial, and immune responses observed in patients with diabetes after treatment for gingivitis: a three-month randomized clinical trial. J Periodontol. 2015;86(4):516-526.

[13]Jette AM, Feldman HA, Tennstedt SL. Tobacco use: a modifiable risk factor for dental disease among the elderly. Am J Public Health. 1993;83(9):1271-1276.

[14]Javed F, Al-Kheraif AA, Salazar-Lazo K, et al. Periodontal Inflammatory Conditions Among Smokers and Never-Smokers With and Without Type 2 Diabetes Mellitus. J Periodontol. 2015;86(7):839-846.

[15]Tonetti MS, Bottenberg P, Conrads G, et al. Dental caries and periodontal diseases in the ageing population: call to action to protect and enhance oral health and well-being as an essential component of healthy ageing - Consensus report of group 4 of the joint EFP/ORCA workshop on the boundaries between caries and periodontal diseases. J Clin Periodontol. 2017;44(18):135-144.

[16]Moeller J, Starkel R, Quinonez C, Vujicic M. Income inequality in the United States and its potential effect on oral health. J Am Dent Assoc. 2017; 148(6): 361-368.

[17]Wide U, Hakeberg M. Oral health-related quality of life, measured using the five-item version of the Oral Health Impact Profile, in relation to socio-economic status: a population survey in Sweden. Eur J Oral Sci. 2018; 126(1): 41-45.

[18]Eke PI, Wei L, Borgnakke WS, Thornton-Evans G, Zhang X, Lu H, McGuire LC, Genco RJ. Periodontitis prevalence in adults ≥ 65 years of age, in the USA. Periodontol 2000. 2016 Oct;72(1):76-95.

[19]Kocher T, König J, Borgnakke WS, Pink C, Meisel P. Periodontal complications of hyperglycemia/diabetes mellitus: Epidemiologic complexity and clinical challenge. Periodontol 2000. 2018;78(1):59-97.

[20]Bai Yixiu, Li Yanqiu, Wang Bing, et al. The impact of diversified health education on the self-efficacy and oral health of patients with chronic periodontitis [J]. Chinese Journal of Preventive Medicine, 2019,20 (5):470-474.

[21]Dos Santos CM, Martins AB, de Marchi RJ, Hilgert JB, Hugo FN, Padilha DM. Assessing changes in oral health-related quality of life and its factors in community-dwelling older Brazilians. Gerodontology. 2013;30(3):176-186.

[22]Huang JC, Peng YS, Fan JY, et al. Factors associated with numbers of remaining teeth among type 2 diabetes: a cross-sectional study. J Clin Nurs. 2013;22(13-14):1926-1932.

[23]Portes j, Bullón b, Gallardo i, Et Al. Prevalence Of Undiagnosed Diabetes And Prediabetes Related To Periodontitis And Its Risk Factors In Elderly Individuals [J]. Journal Of Dentistry, 2023, 132: 104480.

[24]Xie Fen, Sun Xiaochun, Zhou Meiyan, et al. Analysis of detection of periodontal pathogens in elderly patients with type 2 diabetes mellitus complicated with periodontitis% J Chinese Laboratory Diagnostics [J] 2022, 26 (7): 1073-1077.

[25]Xie Fen, Pang Hongxia, Wu Yunfei, et al. Serum IL-1 β And urinary DPd in elderly patients with type 2 diabetes complicated with periodontitis% J Chinese Journal of Gerontology [J] 2021, 41 (21): 4737-4741

[26]Ohara y, Yoshida n, Kawai h, Et Al. Development Of An Oral Health-Related Self-Efficacy Scale For Use With Older Adults [J]. Geriatrics & Gerontology International, 2017, 17(10): 1406-1411.

[27]Xu Yuxin, Wu Hongmei, Ma Junchi, et al. Sinicization and reliability validity testing of the self-efficacy scale related to oral health in the elderly: A nursing study [J] 2021, 35 (16): 2858-2863.

[28]Xiang Shengxiao, Tian Miao, Wang Shu, et al. Development and reliability and validity testing of the oral health literacy scale for hospitalized stroke patients. Nursing study [J] 2022, 36 (8): 1337-1345.

[29]Yuki F,Takuma N,Hiroki F, et al. Importance of physical evaluation using skeletal muscle mass index and body fat percentage to prevent sarcopenia in elderly Japanese diabetes patients.[J]. Journal of diabetes investigation,2019,10(2).

[30]Zhao Caijun The Sinicization and Application of Kayser Jones Concise Oral Health Examination Checklist [D]; Chongqing Medical University, 2016.

[31]Chalmers j m, King p l, Spencer a j, Et Al. The Oral Health Assessment Tool--Validity And Reliability [J]. Australian Dental Journal, 2005, 50(3): 191-199.

[32]Hassel A J, Rolko C, Koke U, Et Al. a German Version Of The Gohai [J]. Community Dentistry And Oral Epidemiology, 2008, 36(1): 34-42.

[33]Ling Jungui, Wang Adan Development of the Chinese version of the Geriatric Oral Health Assessment Index (GOHAI) [J] 2003, (3): 5-9

[34]Zhou Xuru Study on the current situation of oral health quality of life in elderly patients with diabetes and its correlation with their health behavior [D]; China Medical University, 2022

[35]Yuki F,Takuma N,Hiroki F, et al. Importance of physical evaluation using skeletal muscle mass index and body fat percentage to prevent sarcopenia in elderly Japanese diabetes patients.[J]. Journal of diabetes investigation,2019,10(2).

[36]Yoshiaki T,Takuya O,Kenji T, et al. Nutrition Management in Older Adults with Diabetes: A Review on the Importance of Shifting Prevention Strategies from Metabolic Syndrome to Frailty.[J]. Nutrients,2020,12(11).

[37]Nahla N,Balsam N. Antibiotic Prescription for Dental Procedures in Type 1 Diabetic Children.[J]. International journal of clinical pediatric dentistry,2023,16(1).

Tahreem T,Fatima N R,Iqra S, et al. Dental Composites with Magnesium Doped Zinc Oxide [38]Nanoparticles Prevent Secondary Caries in the Alloxan-Induced Diabetic Model[J]. International Journal of Molecular Sciences,2022,23(24).

[39]Zhengzhang G. What Is Dentists' Role in Modulating Environmental and Epigenetic Determinant in Oral Health of Diabetic Patients?[J]. Journal of Biosciences and Medicines,2023,11(2).

[40]Yuqing Z,G S L,Ling S, et al. Disparities in Preventive Oral Health Care and Periodontal Health Among Adults With Diabetes.[J]. Preventing chronic disease,2021,18.

[41]Ruihan G,Weidong Z,Yujun J, et al. Eldecalcitol effectively prevents alveolar bone loss by partially improving Th17/Treg cell balance in diabetes-associated periodontitis[J]. Frontiers in Bioengineering and Biotechnology,2023,11.

[42]Tahreem T,Fatima N R,Iqra S, et al. Dental Composites with Magnesium Doped Zinc Oxide Nanoparticles Prevent Secondary Caries in the Alloxan-Induced Diabetic Model[J]. International Journal of Molecular Sciences,2022,23(24).

[43]Chenchen F,Yi D,Liqin T, et al. Adjunctive Er:YAG laser in non-surgical periodontal therapy of patients with inadequately controlled type 2 diabetes mellitus: A split-mouth randomized controlled study.[J]. Journal of periodontal research,2021,57(1).

[44]Zheng Z,Xiang Q,Yaguang Z, et al. Age differences in the effects of multi-component periodontal treatments on oral and metabolic health among people with diabetes mellitus: a meta-epidemiological study.[J]. Journal of dentistry,2023,135.

[45]A K A,S A A,A A A, et al. Efficacy of adjunct photodynamic therapy on Candida growth and oral health quality of life in denture stomatitis patients with type 2 diabetes mellitus wearing implant-retained overdentures: a randomized clinical study.[J]. Photodiagnosis and photodynamic therapy,2023,42.

[46]Renata C,M L S,Arnaldo J C F D, et al. Treatment of intrabony periodontal defects in controlled diabetic patients with an enamel matrix derivative: a split-mouth randomized clinical trial.[J]. Clinical oral investigations,2021,26(3).

Bridi F V,Cavalcanti V C,Da P G C, et al. The Importance of Integrated Healthcare in the

[47]Association Between Oral Health and Awareness of Periodontitis and Diabetes in Type 2 Diabetics.[J]. Oral health & preventive dentistry,2021,19(1).

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