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Diabetes, Periodontitis, and The Oral Microbiome

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Abstract

Research Problem and Objectives

The association between diabetes mellitus and periodontitis has been studied thoroughly. However, the role of the oral microbiome in linking these two diseases still is not clear. The objective of this literature review is to search the current studies on oral dysbiosis in the two diseases and find out whether the oral microbiome could be a possible biomarker indicating diabetes in periodontal patients.

Methods

Search engines, including PubMed and Google Scholar, were employed, using keywords of “diabetes mellitus,” “oral microbiome as biomarkers for diabetes,” “periodontal biomarkers,” and “diabetes and periodontitis relationship.” A year restriction from 2007-2022 was included.

Results

A total of eighteen articles were reviewed. Foremost, the literature on the role of the oral microbiome in periodontal disease was well established. Commensal oral bacteria have been found to be responsible for the initiation of periodontal disease through the process of dysbiosis. As the disease progresses, oral microbiota shifts. Alterations in the oral microbiome also have been demonstrated across differing glycemic status, similar to the shift observed in periodontal disease. However, there was

insufficient evidence to support whether the shifts in the oral microbiome can serve as diagnostic tools in the determination of risk of developing diabetes mellitus in patients with periodontal disease.

Conclusion

The dynamic relationship between periodontal disease and diabetes mellitus still requires attention.There has been no singular cellular mechanism identified to explain the association between them. Currently, there is inconclusive evidence as to if the oral microbiome can serve as biomarkers for the diagnosis or risk determination of diabetes mellitus. Further clinical research is needed in order to identify biomarkers from the oral microbiome in the destructive relationship between diabetes mellitus and periodontitis.

Keywords: Diabetes Mellitus, Periodontitis, Oral Microbiome

Acknowledgments

We would like to thank Dr. Xiaoyuan Han and Dr. Traci Pitts for the guidance in writing this literature review. We would also like to acknowledge the University of the Pacific for providing access to databases and faculty which allowed us to write this literature review. Additionally, we would like to recognize all authors of cited articles.

Oral-Systemic Connection

The term periodontium comes from a Greek origin; “Peri-” meaning “around” and “-odont” meaning “tooth”. Periodontal diseases are those processes involving the periodontium. These include the supportive apparatus surrounding a tooth, which includes the gingival tissue, alveolar bone, cementum, and periodontal ligament.[1] Periodontitis, or inflammation of the surrounding apparatus, is projected to affect up to 90% of individuals across the globe in one form or another. This begs the question, if oral disease is so prevalent across the globe, where does the disease process begin and what does it mean for our body as a whole?

Scientific research has consistently shown an association between oral health and systemic chronic diseases. Systemic chronic diseases are defined as long-lasting illnesses, with duration of more than three months, that affect a person’s life and require constant medical treatment. Systemic diseases more frequently affect aging individuals. According to the Centers for Disease Control and Prevention, 80% of older adults have one chronic condition, and 50% have two or more conditions.[2] The leading causes of death in the United States include heart diseases, cancer, COVID-19, accidents, stroke, chronic lower respiratory diseases, Alzheimer’s disease, and diabetes. The key factor that connects many of these diseases is inflammation. As the gateway to the body, the mouth is challenged by a constant barrage of invaders including bacteria, viruses, parasites, and fungi. Thus, oral health is predominantly compromised by infectious diseases, notably periodontal diseases and dental caries.

Periodontal diseases are infections caused by bacteria in the biofilm that forms on oral surfaces. The basic division in the periodontal diseases is between gingivitis,

which affects the gums, and periodontitis, which may involve all of the soft tissue and bone supporting the teeth. Tissue destruction in periodontitis results in breakdown of the collagen fibers of the periodontal ligament, resulting in the formation of a periodontal pocket between the gingiva and the tooth. Periodontitis may be a slowly progressing disease, but the tissue destruction that occurs is largely irreversible. In the early stages, the condition is typically asymptomatic, and many patients are unaware until the condition has progressed enough to result in gingival bleeding and tooth mobility. The pockets deepen as a result of the further destruction of the fibers of the periodontal ligament and the resorption of the alveolar bone that occurs in conjunction with the progressing attachment loss. Gingival erythema and edema, gingival bleeding, recession, tooth mobility, and tooth loss are typical signs of moderate to severe periodontitis. Periodontitis is a highly prevalent chronic inflammatory disease. Moderate periodontitis affects 40-60% of adults and severe periodontitis affects 10-15% of adults in most populations.[3]

Diabetes mellitus and periodontitis are closely intertwined diseases that present at an extraordinarily high prevalence in the world. The number of people with diabetes has increased from 108 million in 1980 to 422 million in 2014.[4] Diabetes mellitus is a group of diseases characterized by high levels of blood glucose resulting from defects in insulin production, insulin action, or both. Typically, a glycated hemoglobin test (Hba1C) of 6.5% or higher is diagnostic for diabetes. There are two main types of diabetes: type 1 and type 2 diabetes. Type 1, or insulin-dependent diabetes mellitus, is an autoimmune disease that causes the destruction of the insulin-producing beta cells in the pancreas. Type 1 diabetes primarily is diagnosed in children and younger adults,

and it accounts for a minimal 5% of all diabetes cases. Type 2 diabetes, or noninsulin-dependent diabetes mellitus, is characterized by resistance to insulin and inadequate production of insulin. This is the most common form of diabetes seen in adults, accounting for 90-95% of cases. Generally, Type 2 diabetes can be controlled with lifestyle and dietary changes, PO medications, or in severe cases - exogenous insulin.

The risk of periodontitis is increased by approximately threefold in diabetic individuals compared to non-diabetic individuals. Recent studies have shown that the level of glycemic control is important in determining increased risk. According to the U.S. National Health and Nutrition Examination Survey (NHANE) III, adults with an HbA1C level of greater than 9% had a significantly higher prevalence of severe periodontitis than those without diabetes after controlling for age, ethnicity, education, sex, and smoking.

The oral-systemic connection between periodontitis and diabetes has been well investigated; however, the mechanism of this association remains largely unknown. Most studies explain the relationship from an immunological viewpoint, because of the shared inflammatory nature of both periodontitis and diabetes. The host immune dysfunction in periodontitis is important in the pathogenesis, however, the oral dysbiosis, especially pathogens from dental plaque, also play a role. The composition and diversity of the oral microbiome alter with changes in body nutrition, hormone, and disease status.[5] Also, It has been reported that sugar consumption, often observed in diabetics, alters the metabolic profile and functional modules of the oral microbiome. Here, we review the findings on oral microbiome alteration in periodontitis and diabetes

and summarize the possible mechanism. Specifically, this literature review investigates dysbiosis within the oral microbiome to determine if biomarkers within a periodontally compromised oral cavity are indicative of developing diabetes.

The Oral Microbiome and Periodontitis

It is well documented that the commensal oral bacteria are responsible for the initiation and propagation of periodontitis through the process of dysbiosis, or microbial imbalance. Additionally, periodontitis proceeds cyclically with periods of activity and quiescence until therapeutic action is taken.[1] However, as the disease progresses to a more destructive state, there is an evident shift in the microbiota. The initiation of destructive periodontitis has been associated with dysbiosis where the diversity, richness, and relative proportions of species in the subgingival microbiota are altered.[6] A greater number of anaerobic organisms populate deeper periodontal pockets, such as *Aggregatibacter actinomycetemcomitans*, *Porphyromonas gingivalis, Treponema denticola, and Tannerella forsythia*. When allowed to penetrate deep into the periodontium, these organisms produce inflammation by triggering the release of inflammatory mediators and other defensive products from the host. The presence of these microbiota specifically triggers the production, proliferation, and dissemination of C-reactive protein (CRP).[1] CRP is a benchmark biomarker of inflammation throughout the human body. Moreover, various neutrophil and macrophage compounds, such as tumor necrosis factor-alpha (TNF-a), matrix metalloproteinases (MMPs), and interleukins (IL-1 and IL-8), are seen in abundance within a periodontally diseased

host.[1] Faizuddin and Dharmapalan also reported how autoreactive T cells, natural killer cells, antineutrophil cytoplasmic antibodies (ANCA), heat shock proteins, autoantibodies, and genetic factors play a role in the inflammation process of periodontal disease.[7] It is obvious that this increase in bacteria is coupled with an increase in inflammation, which further propagates periodontitis and generalized dysbiosis within the oral cavity.

The triggering of the inflammatory response is part of the host immune system initiating protections for the human body from the invading bacteria. Thus, the disease process is two-fold. The first aspect involves the response to the initial bacteria, while the second aspect relates to the destruction caused by the inflammatory immune response. Moreover, during the periodontal disease process, a host immune response is triggered to defend against the invading bacteria.[1] During this process, as the host is protecting itself against the invading bacteria, the defense mechanisms also lead to the destruction of the periodontium. Specifically, the pathogenic microbiota invading the oral atmosphere causes an innate and adaptive inflammatory immune response. In order to neutralize the bacteria, the body's defense system destroys osseous and connective tissues around the tooth.[8] Furthermore, in relation to the immune response, Faizuddin and Dharmapalan describe, "autoantibodies detected in periodontal disease are derived from preexisting natural antibodies and play a physiological role in the elimination of dead cells and damaged tissue constituents that have appeared during the tissue degradation which occurred in periodontal disease."[7] In the body's attempt at bringing the oral cavity back to eubiosis, the inflammatory response and production of autoantibodies may wipe out damaged host tissue and bacterial invasions without

allowing regrowth of new healthy tissue. This autoimmune attack is not seen just in the oral microbiome; rather, it is seen in a wide range of systemic autoimmune diseases.

As suggested earlier, the inflammatory process triggers the dissemination of CRP, TNF-a, MMPs, and IL-1,8. An elevated serum CRP level suggests that the inflammation arising as a result of periodontitis may correlate with cardiovascular pathology. Ultimately, this suggests that a disease traditionally considered to be confined to the oral cavity may have a catastrophic impact on systemic health. Moving forward, there are many similarities between the oral microbiome of periodontally compromised individuals and those with diabetes. Of particular interest is how diabetes mellitus is associated with certain pathologic processes that enhance periodontal breakdown.

The Oral Microbiome and Diabetes

Because of the dynamic interaction between the oral microbiome and the human body, the physiological or pathological changes in the body are associated with the diversity or composition alteration of oral bacteria. The alteration of the oral microbiome is associated with human diseases, including diabetes mellitus.[9] However, investigations of the relationship between the oral microbiome and diabetes or diabetes co-existing periodontitis are limited.

Blood glucose levels alter the composition of the oral microbiome; however, it is not clear how the community composition changes by glycemic or diabetic status. Notably, high sugar consumption, frequently observed in diabetics, is associated with reduced phosphatidylethanolamine biosynthesis.[10] This reduced

phosphatidylethanolamine biosynthesis directly correlates to an increased insulin resistance, advancing the diseased state.[10] Additionally, Long et al. found that within the phylum Actinobacteria, five families, including *Actinomycetaceae, Bifidobacteriaceae, Coriobacteriaceae, Corynebacteriaceae,* and *Micrococcaceae,* were less abundant among diabetics, compared to controls. Long et al. also showed that genra *Mobiluncus, Atopobium,* and *Corynebacterium* were less prevalent among diabetic cases than controls. In an additional study performed by Long et al., it was shown that *Streptococci* and *Lactobacilli,* in the phylum Firmicutes, were more abundant in patients with diabetes. Genra *Actinomyces* and *Atopobium* were associated with decreased risk of diabetes. Oppositely, the family *Gemellaceae* in the phylum Firmicutes were associated with an increased risk of diabetes.[11] Although Tam et al. did not find correlations between glycemic status and species composition of the oral microbiome in their study, they reported an association between obesity and increased *Firmicutes* phylum. Matasha et al. studied the oral microbiome shift according to glycemic status and the presence of periodontal disease. They reported an increased abundance of phyla, *Actinobacteria* and *Fusobacteria*, in oral microbiome, was associated with higher risk of diabetes in patients with periodontitis.[12]

Pathogens from subgingival plaque are considered an initiation of periodontitis. Among the few studies exploring the community composition of subgingival plaque in diabetics, there has been no agreement on the effect of diabetes mellitus on the subgingival microbiome. However, most studies have reported more P*.gingivalis* in the subgingival plaque from diabetic patients. For example, Ebersole et al. found that, in type 1 diabetes, more *P. gingivalis*, *A. actinomycetemcomitans*, and *Campylobacter*

species were present at periodontitis sites. In type 2 diabetes, more *P. gingivalis* and *Candida* species, but less *T. forsythia* were found.[13] Hintao further reported profound differences in subgingival microbiota of type 2 diabetes using 16S rRNA gene sequencing. The diabetic subjects presented higher abundance of total closed of TM7, *Aggregatibacter*, *Neisseria*, *Actinomyces*, *Capnocytophaga*, *Gemella*, *Eikenella*, *Selenomonas*, *Fusobacterium*, *Veillonella*, and *Streptococcus* and lower percentages of *Synergistetes*, *Tannerella*, *Porphyromonas*, *Filifactor*, *Eubacterium*, and *Treponema*s; moreover, some species, such as *F. nucleatum*, *V. parvula*, *Veillonella dispar*, and *E. corrodens* were detected significantly more often in diabetics.[14] Makiura et al. found that *P. gingivalis* was detected more frequently in subjects with increased HbA1c values after periodontal treatment than those patients with decreased HbA1C values. Further, *P. gingivalis* with type II fibriae was detected only in HbA1-c increased subjects. These findings suggest that *P. gingivalis* is related to changes in HbA1c values in patients with type 2 diabetes mellitus. Piyamas et al. demonstrated that the numbers of P. gingivalis T. forsythia in the gingivitis sites were higher in patients of controlled and poorly controlled insulin dependent diabetes mellitus than those of the non-diabetes mellitus group. In sites indicative of periodontitis, poorly controlled insulin dependent diabetes mellitus patients demonstrated higher quantities of P. gingivialis.

Mechanism: Periodontitis and Diabetes

At the center of the complex relationship between diabetes mellitus and periodontal disease is widespread cellular inflammation that compromises overall

metabolic function. Diabetes mellitus is a well-established risk factor for periodontal disease in individuals due to its effects on systemic glycemic control, oxidative stress, and proper immune function. Also, it is clear that there is no single cellular mechanism associated with diabetes that predisposes an individual to periodontitis or progression of the disease. Rather, a suite of molecular pathways and biomarkers interact and exert influence over the periodontal disease process, and these may provide early diagnosis of systemic conditions during oral evaluation.

Excessive sugars in the hyperglycemic state of diabetes type 1 and 2 leads to glycosylation of proteins and lipids to produce advanced glycation end products (AGE). Accumulation of AGEs has been observed in gingival tissues, and it is associated with upregulated production of inflammatory mediators IL-1B, TNF-a, and IL-6 upon binding of RAGE receptor.[3] RAGE receptors are widely expressed on various cell types and their expression can be sustained via a positive feedback loop with constant AGE presence. Upon binding to RAGE, reactive oxygen species (ROS) are produced contributing to apoptosis via expression of caspase-3.[15] This mechanism was demonstrated in vitro, using human PDL fibroblasts harvested from freshly extracted, non-infected teeth.[15] Exposure of the PDL fibroblasts from extracted human teeth to AGE products resulted in apoptotic changes with cytokine secretion. Additionally, morphological changes in the fibroblasts suggested a disruption in adhesion and junctional structures within the PDL potentially contributing to unprotected access to the periodontium.[15]

Immunological interference is another way in which diabetes can influence periodontal disease status. Altered polymorphonuclear leukocytes (PMN ‘s) function

may be associated with metabolic changes associated with diabetes, causing premature release of ROS and delay apoptosis. These processes may prolong the inflammatory response.[3] Disturbances in macrophage function, triggered by hyperglycemia, also can change the body's immune response towards periodontitis-causing pathogens. These hypoglycemic changes can promote increases in GLUT-1 receptors and rapid aging of monocytes toward a senescence-associated secretory phenotype (SASP) as demonstrated in an animal study in rodents.[16] Transition of monocytes to SASP is marked by increased secretion in IL-1B which is also a hallmark of periodontal inflammation. GLUT-1 receptors on monocytes promote upregulation of downstream mammalian targets of rapamycin (mTOR) leading to premature SASP. Macrophage senescence is an essential feature of immune dysfunction, and it may lead to the progression of periodontal disease.[16]

An additional significant risk factor associated with diabetes is disruption in the bone repair/destruction cycle. Loss of the periodontium mainly is influenced by a disequilibrium between osteoblast and osteoclast activity. An increase in RANKL and decrease in osteoprotegerin (OPG) has been noted in gingival crevicular fluid resulting in unregulated osteoclast resorption of bone.[17] AGE products linked with hyperglycemia trigger ROS production from mitochondria which can activate RANKL signaling and subsequent osteoclastic activity in the sulcus.[17] Additionally, AGE product binding of RAGE receptors produce high levels of NF-kB. This transcription factor also promotes osteoclastogenesis while inhibiting osteoblast differentiation, thus leading to a net loss of bone structure.

It is well understood that both periodontitis and metabolic disturbances, like diabetes, are associated with a dysbiosis in bacterial populations of the oral cavity. Over 700 bacterial species have been identified as part of the oral microbiome and health is generally associated with stable bacterial populations while disease is associated with unstable populations, regardless of make-up.[18] It appears that this shift in bacterial population can produce a bidirectional etiology, resulting in diabetes and periodontal disease. A marked increase in *Bacteroides* species has been observed in diabetic patients with early onset periodontal disease. Specifically, high levels of *P. gingivalis*, part of the *bacteroides* family, has been linked to temperature, pH, and oxygen changes contributing to the progression of periodontal disease.[18] Additionally, hyperglycemia has been shown to stimulate an immune response involving interleukins and TNFa which further contributes to dysbiosis while also producing an inflammatory state that further exacerbates both diabetes and periodontitis.

Conclusion

Current research exploring the relationship between the oral microbiome and the human body was analyzed to determine if oral cavity dysbiosis plays a significant role, as a potential biomarker, within the dynamic relationship between periodontitis and diabetes mellitus. It was determined that diabetes is a well-established risk factor for periodontal disease, due to the immunological and inflammatory interferences; however, no singular mechanism has been identified to explain the direct association. Additionally, there was inconclusive evidence as to whether the oral microbiome can

serve as biomarkers for the diagnosis or risk determination of diabetes mellitus. Finally, there was conflicting evidence regarding the genre of bacteria found in patient populations significant for diabetes and periodontitis. In sum, further clinical research is needed to identify whether biomarkers from the oral microbiome play a significant role within the destructive relationship between diabetes mellitus and periodontal disease.

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Abstract

Research Problem and Objectives: The association between diabetes mellitus and periodontitis has been studied thoroughly. However, the role of oral microbiome in linking these two diseases is still not clear. The objective of this literature review is to search the current studies on oral dysbiosis in the two diseases and find out whether the oral microbiome could be a possible biomarker indicating diabetes in periodontal patients.

Methods: We used the search engines, including PubMed and Google Scholar, and included keywords, which are “diabetes mellitus”, “oral microbiome as biomarkers for diabetes”, “periodontal biomarkers” and “diabetes and periodontitis relationship”, with a year restriction from 2007-2022.

Keywords: Diabetes Mellitus, Periodontitis, Oral Microbiome

Abstract (continued)

Results: A total of 18 articles were reviewed in this paper. We found that the role of the oral microbiome in periodontal disease has been well documented. Commensal oral bacteria have been found to be responsible for the initiation of the disease through the process of dysbiosis. As the disease progresses, oral microbiota shifts. Alterations in the oral microbiome have also been demonstrated across differing glycemic status, similar to the shift observed in periodontal disease. However, there is insufficient evidence to support whether the shifts in the oral microbiome can serve as diagnostic tools in the determination of risk of developing diabetes mellitus in patients with periodontal disease.

Conclusion: The dynamic relationship between the periodontal and diabetes mellitus still requires attention.There has been no singular cellular mechanism identified to explain the association between them. Currently, there is inconclusive evidence as to if the oral microbiome can serve as biomarkers for the diagnosis or risk determination of diabetes mellitus. Further clinical research is needed in order to identify biomarkers from oral microbiome in the destructive relationship between diabetes mellitus and periodontitis.

The Oral-Systemic Connection

- Periodontal disease is a highly prevalent disease, with moderate periodontitis affecting 40-60% of adults and severe affecting 10-15%[16].
- Diabetes mellitus is highly prevalent
- The risk of periodontitis is increased by approximately threefold in diabetic individuals compared to non-diabetic individuals. Recent studies have shown that the level of glycemic control is important in determining increased risk.
- The composition and diversity of the oral microbiome alter with changes in body nutrition, hormone, and disease status [10].
- The oral-systemic connection between periodontitis and diabetes has been well investigated, however, the mechanism of this association is still largely unknown. Most studies explain the relationship from an immunological viewpoint, because of the shared inflammatory nature of both periodontitis and diabetes.

Oral Microbiome and Periodontitis

- The initiation of destructive periodontitis has been associated with dysbiosis where the diversity, richness, and relative proportions of species in the subgingival microbiota are altered [21]. A greater number of anaerobic organisms populate deeper periodontal pockets, such as *Aggregatibacter actinomycetemcomitans*, *Porphyromonas gingivalis, Treponema denticola, and Tannerella forsythia*.
- The presence of these microbiota specifically triggers the production, proliferation, and dissemination of C-reactive protein (CRP) [5] . CRP is a benchmark biomarker of inflammation throughout the human body. Moreover, various neutrophil and macrophage compounds such as tumor necrosis factor-alpha (TNF-a), matrix metalloproteinases (MMPs), and interleukins (IL-1 and IL-8) are seen in abundance within a periodontally diseased host [5].
- Faizuddin and Dharmapalan describe, “autoantibodies detected in periodontal disease are derived from preexisting natural antibodies and play a physiological role in the elimination of dead cells and damaged tissue constituents that have appeared during the tissue degradation which occurred in periodontal disease.” So, the inflammatory response and production of autoantibodies may wipe out damaged host tissue and bacterial invasions without allowing regrowth of new healthy tissue. This autoimmune attack is not seen just in the oral microbiome; rather, it is seen in a wide range of systemic autoimmune diseasest [18].

Oral Microbiome and Diabetes

- Long et. al. found that within the phylum Actinobacteria, five families, including *Actinomycetaceae, Bifidobacteriaceae, Coriobacteriaceae, Corynebacteriaceae* and *Micrococcaceae,* were less abundant among patients with diabetes when compared to the controls. It was also shown that genra *Mobiluncus, Atopobium* and *Corynebacterium* were less prevalent among diabetes cases than controls.
- In another study, it was shown that *Streptococci* and *Lactobacilli,* in the phylum Firmicutes, were more abundant in patients with diabetes. Genra *Actinomyces* and *Atopobium* were associated with decreased risk of diabetes. Oppositely, the family Gemellaceae in the phylum Firmicutes were associated with an increased risk of diabetes [9].
- Ebersole et al. found that, in type 1 diabetes, more *P. gingivalis*, *A. actinomycetemcomitans*, and *Campylobacter* species were present at periodontitis sites. In type 2 diabetes, more *P. gingivalis* and *Candida* species., but less *T. forsythia* were found [4].
- *P. gingivalis* with type II fibriae was detected only in HbA1-c increased subjects. These findings suggest that *P. gingivalis* is related to changes in HbA1c values in patients with type 2 diabetes mellitus. Piyamas et. al, demonstrated that the numbers of P. gingivalis T. forsythia in the gingivitis sites, were higher in patients of controlled and poorly controlled insulin dependent diabetes mellitus than those of the non diabetes mellitus group.

Mechanism

- In hyperglycemic patients, the presence of advanced glycation end products has been observed in gingival tissues resulting in the production of various inflammatory mediators that bind RAGE receptors. Subsequent production of ROS contribute to apoptosis of PDL fibroblasts further contributing to periodontal breakdown [11].
- Altered PMN function due to immunological interferences in diabetic patients diminish the body's ability to respond to periodontal pathogens in deep pockets [22].
- Disruption of the bone repair/destruction cycle contributes to the loss of periodontium due to increased RANKL and decreased OPG[1]. Increased RANKL secretion is associated with increased AGE[1].
- Dysbiosis of oral microbiome is observed in both periodontitis and diabetes [13]. Little evidence is available suggesting similar microbial populations in both diseased states. However, a significant dysbiosis in both situations suggests microbial populations play a key role in disease progression.

Conclusion

Current research exploring the relationship between the oral microbiome and the human body was analyzed to determine if oral cavity dysbiosis plays a significant role, as a potential biomarker, within the dynamic relationship between periodontitis and diabetes mellitus. It was determined that diabetes is a well-established risk factor for periodontal disease, due to the immunological and inflammatory interferences; however, no singular mechanism has been identified to explain the direct association. Additionally, there was inconclusive evidence as to whether the oral microbiome can serve as biomarkers for the diagnosis or risk determination of diabetes mellitus. Finally, there was conflicting evidence regarding the genre of bacteria found in patient populations significant for diabetes and periodontitis. In sum, further clinical research is needed to identify whether biomarkers from the oral microbiome play a significant role within the destructive relationship between diabetes mellitus and periodontal disease.

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OKU Sutro Excellence Day Project Cover Sheet

(ONE Cover Sheet per project)

Project Title: Diabetes, Periodontitis and The Oral Microbiome

Award Category: DDS & IDS - PIP: Bench or Clinical Research

List names of all contributors to this project:

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8. Enter your abstract text here (300 word max) :

Research Problem and Objectives
The association between diabetes mellitus and periodontitis has been studied thoroughly. However, the role of the oral microbiome in linking these two diseases still is not clear. The objective of this literature review is to search the current studies on oral dysbiosis in the two diseases and find out whether the oral microbiome could be a possible biomarker indicating diabetes in periodontal patients.

Methods
Search engines, including PubMed and Google Scholar, were employed, using keywords of “diabetes mellitus,” “oral microbiome as biomarkers for diabetes,” “periodontal biomarkers,” and “diabetes and periodontitis relationship.” A year restriction from 2007-2022 also was included.

Results
A total of twenty-two articles were reviewed. Foremost, the literature on the role of the oral microbiome in periodontal disease is well established. Commensal oral bacteria have been found to be responsible for the initiation of periodontal disease through the process of dysbiosis. As the disease progresses, oral microbiota shifts. Alterations in the oral microbiome also have been demonstrated across differing glycemic status, similar to the shift observed in periodontal disease. However, there was insufficient evidence to support whether the shifts in the oral microbiome can serve as diagnostic tools in the determination of risk of developing diabetes mellitus in patients with periodontal disease.

Conclusion
The dynamic relationship between periodontal disease and diabetes mellitus still requires attention. There has been no singular cellular mechanism identified to explain the association between them. Currently, there is inconclusive evidence as to if the oral microbiome can serve as biomarkers for the diagnosis or risk determination of diabetes mellitus. Further clinical research is needed in order to identify biomarkers from the oral microbiome in the destructive relationship between diabetes mellitus and periodontitis.

Keywords: Diabetes Mellitus, Periodontitis, Oral Microbiome

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Thank you for filling out the OKU Sutro Excellence Day Project Cover Sheet!Please merge this Cover Sheet with your Final Project Materials (ie, research poster, clinical case, paper, or other creative production) before uploading to the Final Project Submission Form.