# A Study on the Relationship between Oral Disease and Systemic Diseases Using Original Data of National Health and Nutrition Survey

**Hee-Ja Na[1], Moon Ae-eun[2,*], Jin-Sil Kim[3]**

[1,2]Department of Dental Hygiene, HONAM University, Gwangju Metropolitan City, South Korea

[3]Independent researcher, Gyeonggi-do, South Korea

## ABSTRACT

**Objective:** This study aimed to investigate the associations between periodontal disease and systemic conditions—specifically diabetes mellitus, dyslipidemia, asthma, and allergic rhinitis—using data from the 8th Korea National Health and Nutrition Examination Survey (KNHANES). **Methods:** A total of 6,728 individuals from the 2021 KNHANES dataset were included. Variables related to periodontal health (gum treatment history, chewing discomfort, occlusal discomfort) and systemic disease diagnoses were analyzed. Statistical methods included descriptive statistics, correlation analysis, one-way ANOVA, and multiple regression analysis to determine significant associations between gum disease and systemic conditions. **Results:** Significant associations were found between periodontal treatment and systemic disease diagnoses: dyslipidemia (t = −4.896, p < .001), diabetes (t = .336, p < .001), and allergic rhinitis (t = 6.108, p < .001). Additionally, asthma treatment was significantly associated with gum treatment history (F = 13.915, p < .001). However, no significant association was found between alcohol consultation and periodontal disease. **Conclusion:** The findings suggest that periodontal disease is significantly associated with several systemic conditions, including diabetes, dyslipidemia, asthma, and allergic rhinitis. These results underscore the importance of interdisciplinary healthcare approaches that integrate oral health into chronic disease management strategies.

**Keywords:** Periodontal Disease, Diabetes, Dyslipidemia, Asthma, Allergic Rhinitis, KNHANES.

## INTRODUCTION

Periodontal disease, a chronic inflammatory condition caused by microbial plaque accumulation, has been increasingly recognized as a contributing factor to several systemic diseases, including cardiovascular disease, diabetes mellitus, respiratory illnesses, and metabolic syndrome [1-4]. According to the World Health Organization, the global burden of non-communicable diseases (NCDs) continues to rise, and oral diseases

like periodontitis are now considered part of this public health challenge [5].

Recent evidence highlights that periodontitis may trigger systemic inflammatory responses, contributing to the onset or exacerbation of diabetes and dyslipidemia [6-8]. Chronic hyperglycemia impairs immune function and delays wound healing in periodontal tissues, while dyslipidemia has been linked to greater tissue destruction in the periodontium [9,10]. Inflammatory cytokines associated with periodontal disease can also promote insulin resistance and systemic inflammation [8,11].

In addition, chronic respiratory conditions such as asthma and allergic rhinitis—especially common among children and adolescents—may influence oral health through systemic immune dysregulation and eosinophilic inflammation, which are known to affect periodontal status [12-15]. While the biological plausibility of these links has been suggested, population-based studies exploring the comprehensive associations between periodontal disease and systemic conditions remain limited.

The Korea National Health and Nutrition Examination Survey (KNHANES) provides a nationally representative dataset of medical, nutritional, and oral health data. In addition to medical diagnoses, the survey includes variables such as chewing discomfort and occlusal problems, which may serve as functional indicators of oral health and potential mediators in systemic disease relationships.

Given the increasing recognition of the bidirectional relationships between oral and systemic health, this study aimed to investigate the associations between periodontal disease and systemic conditions, including diabetes, dyslipidemia, asthma, and allergic rhinitis, using data from the 8th KNHANES. We also assessed oral functional symptoms such as chewing discomfort and occlusal discomfort. We hypothesized that periodontal disease would be significantly associated with the presence of these systemic conditions, supporting the need for integrated medical and dental care approaches.

## METHODS

### Study Design and Ethical Approval

This study employed a cross-sectional design using raw data from the 8th Korea National Health and Nutrition Examination Survey (KNHANES), conducted by the Korea Centers for Disease Control and Prevention. Data were collected between March 1 and March 15, 2023. The study protocol was exempted from ethical review by the Bioethics

Committee of Honam University (IRB No. 1041223-202303-HR-01). The KNHANES dataset was officially provided by Korean public institutions and the government and was used as secondary data for this analysis (KNHANES[3], see Figure 1).

### Study Population

From the 7,020 participants in the 8th KNHANES (2021), a total of 6,728 individuals were selected for analysis based on complete data for both systemic diseases (asthma, allergies, dyslipidemia, diabetes) and oral health (chewing problems). Sociodemographic variables included gender, age, household income, region (17 cities/provinces), education level, and subjective health perception. These variables were collected via structured interviews and self-administered questionnaires.

Gender was classified as male or female, and individuals aged ≥1 year were included. Education level was categorized as elementary school or below, middle school graduate, high school graduate, and college graduate or higher. Household income was categorized into lower, lower-middle, upper-middle, and upper levels. The internal consistency reliability of these seven sociodemographic items was acceptable (Cronbach's α = 0.6) (KNHANES[3], see Figure 1).

### Data Collection

#### Oral Health Variables

Oral health was assessed by two primary items: "Have you received gum (periodontal) treatment in the past year?" (1 = Yes, 2 = No), and "Do you experience discomfort when chewing due to issues with teeth, dentures, or gums?" Responses to the latter were measured on a 5-point Likert scale (1 = Very uncomfortable, 5 = Not at all uncomfortable). The internal consistency of these oral health items was confirmed with a Cronbach's alpha of 0.65 (KNHANES[3], see Figure 1).

#### Asthma, Alcohol Use, Dyslipidemia, and Allergic Rhinitis

Asthma is now understood as a syndrome rather than a single disease, often involving eosinophilic airway inflammation. Fractional exhaled nitric oxide (FeNO) levels are used to guide treatment strategies for asthma symptom reduction. Participants were asked, "Have you been diagnosed with asthma or allergic rhinitis in the past year?" with responses coded as 1 = Yes and 2 = No.

Hyperlipidemia was assessed by asking, "Have you ever been diagnosed with dyslipidemia by a doctor in the past year?" using a 4-point scale (0 = No, 1 = Yes, 8 = Yes for

child/adolescent, 9 = Unknown). Medical consultation for alcohol-related issues was assessed with a 2-point scale (1 = Yes, 2 = No). Cronbach's alpha values for these items were: hyperlipidemia = 0.56, alcohol = 0.54, asthma = 0.67, and allergic rhinitis = 0.69 (KNHANES[3], see Figure 1).

### Diabetes

Insulin dysfunction may impair the synthesis and homeostasis of periodontal tissues by elevating blood glucose levels and suppressing immune function. Studies among Pima Indians revealed that diabetic individuals exhibited higher prevalence and severity of periodontitis compared to non-diabetics. Similarly, Taylor et al. reported that hyperglycemia negatively affects periodontal tissue, while periodontitis may impair glycemic control.

In this study, diabetes was assessed with the question, "Have you been diagnosed with diabetes in the past year?" (1 = Yes, 2 = No). The reliability of this item was verified (Cronbach's α = 0.65). All health measurements were conducted in accordance with the Mobile Examination Center protocols of KNHANES[3] (see Figure 1).

### Variables and Operational Definitions

#### Dependent Variable

The primary dependent variable was periodontal disease, measured by two items:

"Have you received gum (periodontal) treatment in the past year?" (1 = Yes, 2 = No), and

"Do you feel discomfort when chewing due to problems with your teeth, dentures, or gums?" assessed on a 5-point Likert scale.

The internal reliability of these items was acceptable (Cronbach's α = 0.65) (KNHANES[3], see Figure 1).

Additionally, medical diagnoses of diabetes, dyslipidemia, asthma, and allergic rhinitis (including children/ adolescents), along with chewing problems, main complaints, alcohol use, and smoking status were considered in relation to periodontal treatment.

#### Independent Variables

Independent variables included:

Medical diagnosis of dyslipidemia (1 = Yes, 8 = Yes including children/adolescents, 9 = No/Unknown)

Recent diagnosis of diabetes (1 = Yes, 2 = No)

Medical consultation regarding alcohol use (1 = Yes, 2 = No)

Smoking status: 1 = Smokes daily, 2 = Smokes occasionally, 3 = Does not smoke

(KNHANES[3], see Figure 1)

#### Control Variables

Control variables included region (17 cities/provinces), gender (0 = Female, 1 = Male), age group (19–29 = Young adults, 30–64 = Middle-aged, ≥65 = Older adults), household income (low, middle, high), subjective health awareness (1 = Very good to 5 = Very poor), and education level (1 = Elementary or below, 2 = Middle school graduate, 3 = High school graduate, 4 = College graduate or higher) (KNHANES[3], see Figure 1).

### Statistical Analyses

Data were analyzed using SPSS Statistics version 21.0. Descriptive statistics were used to calculate the mean and standard deviation of general characteristics. One-way ANOVA was conducted to assess the association between asthma treatment and gum disease treatment, while a chi-square ($\chi^2$) test analyzed the relationship between alcohol counseling and gum disease treatment.

Pearson correlation analysis was performed to examine relationships among gender, dyslipidemia, asthma, chewing problems, occlusion discomfort, and gum disease treatment ($p < 0.01$**).

Lastly, multiple regression analysis was conducted to determine the effects of dyslipidemia, diabetes, and allergic rhinitis (including children/adolescents) on periodontal treatment outcomes. Statistical significance was set at $p < 0.05$ (KNHANES[3], see Figure 1).
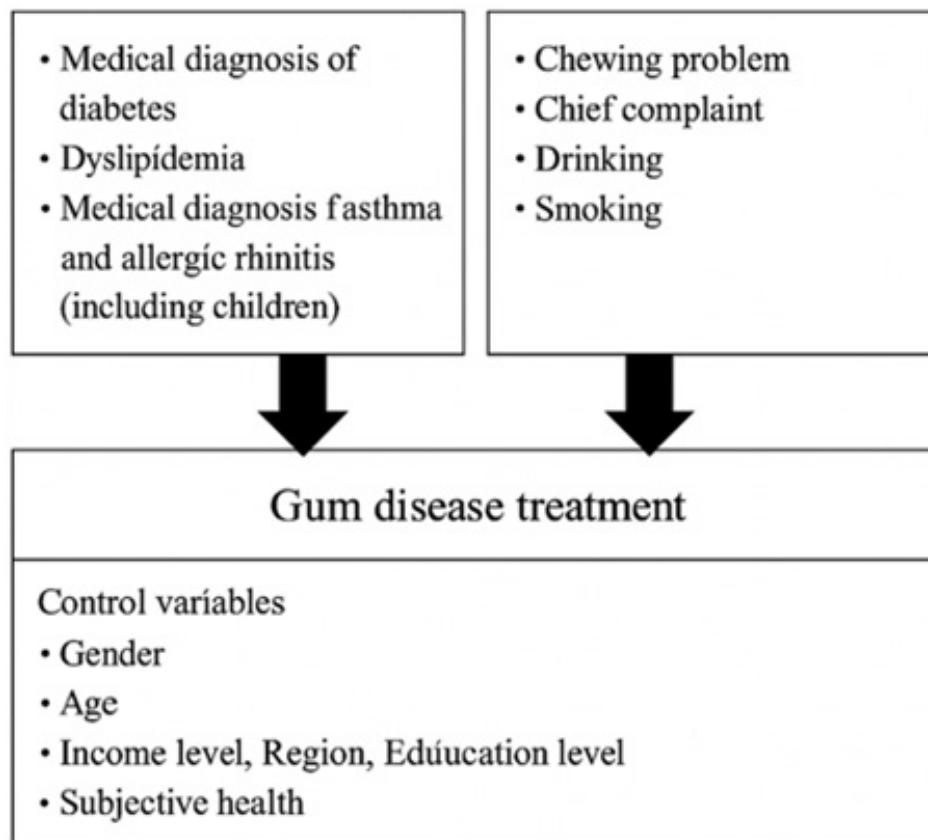
**Figure 1.** Conceptual Framework of the Study.

## RESULTS

### General Characteristics

A total of 7,090 individuals from 17 cities and provinces participated in the 2021 Korea National Health and Nutrition Examination Survey. Among them, 6,728 individuals were included in the analysis based on complete data. The mean age was 46.46 years (SD = 22.667). The mean coding for gender (1 = male, 2 = female) was 1.55 (SD = 0.498), and the average monthly household income was 466.90 (SD = 337.494; unit: 1,000 KRW). The mean value for subjective health perception was 3.02 (SD = 1.634), and the mean education level (on a scale from 1 to 4) was 2.75 (SD = 2.743). Data on monthly and daily smoking rates among adults were also collected but not further specified.

### Association between Asthma Treatment and Gum Disease Treatment

One-way analysis of variance (ANOVA) was performed to examine the association between asthma treatment and gum disease treatment. The mean value for those not receiving asthma or gum treatment (n = 3,464) was 7.79 (SD = 1.362), while for those who received treatment (n = 3,210), the mean was 7.88 (SD = 1.177). The difference between the groups was statistically significant (F = 13.915, p < 0.001),

indicating a meaningful association between asthma and periodontal treatment.

### Association between Alcohol Counseling and Gum Disease Treatment

A chi-square ($\chi^2$) analysis was conducted to explore the relationship between one-year alcohol counseling and gum disease treatment. Among adults, 2,744 individuals did not receive alcohol counseling, while 650 did. Among those who received counseling, 16 individuals were also treated for gum disease, whereas 4 were not. Among adolescents, 704 did not receive counseling, and 7 did; however, there was no statistically significant association found between alcohol counseling and periodontal treatment.

### Correlation Analysis

- Correlation analysis revealed the following significant associations (all at p < 0.001):

- Gum disease treatment and dyslipidemia: r = −0.078

- Gum disease treatment and asthma: r = 0.093

- Chewing discomfort and dyslipidemia: r = 0.755

- Chewing discomfort and gender: r = −0.044

- Occlusion discomfort and dyslipidemia: r = 0.096

• Occlusion discomfort and chewing problems: r = −0.820

These findings suggest that occlusion discomfort is strongly associated with both chewing problems and dyslipidemia. Furthermore, gum disease treatment shows a weak but statistically significant correlation with both dyslipidemia and asthma.

**Regression Analysis**

Multiple regression analysis was performed to determine the effect of systemic diseases on periodontal treatment. The model was statistically significant (F = 32.308, p < 0.001), explaining approximately 14% of the variance in gum disease treatment (adjusted $R^2$ = 0.14).

• Dyslipidemia diagnosis: t = −4.896, p < 0.001

• Diabetes diagnosis: t = 0.336, p < 0.001

• Allergic rhinitis diagnosis: t = 6.108, p < 0.001

These results confirm that diagnoses of dyslipidemia, diabetes, and allergic rhinitis are significantly associated with gum disease treatment.

## DISCUSSION

Periodontal disease is an infectious condition caused by pathogenic bacteria in dental plaque, which affects approximately 20–50% of the global population [16,17]. Chronic inflammation in the surrounding dental tissues leads to alveolar bone resorption [18], a major cause of tooth loss [19], and a risk factor for developing or exacerbating systemic diseases [20,21]. In particular, asthma patients exhibit elevated fractional exhaled nitric oxide (FeNO), reflecting eosinophilic inflammation in the respiratory tract [22-25].

In the present study, 7,090 participants from 17 cities/provinces were surveyed (Table 1). The mean age was 46.46 years (SD 22.667), and the mean monthly household income was 466.90 (SD 337.494) (1,000 KRW). One-way ANOVA revealed a significant association between asthma treatment and gum disease treatment (F = 13.915, p < 0.001), suggesting that about half of the Korean population sample showed a notable link between asthma management and periodontal care.

According to the local infection theory, pathogenic bacteria such as Aggregatibacter actinomycetemcomitans, Tannerella forsythia, Porphyromonas gingivalis, and Treponema denticola, along with inflammatory mediators including IL-1β, IL-6, and TNF-α, can disseminate through the bloodstream [18]. Periodontal disease has thus been identified as a risk

factor for cardiovascular disease [26] and has been linked to diabetes [27]. Socioeconomic characteristics, smoking, drinking, and oral health behaviors may also influence periodontal outcomes and alveolar bone destruction [28]. In this study, periodontal disease and alcohol counseling among adults aged ≥19 years showed no significant relationship. Correlation analysis indicated higher associations between chewing discomfort and dyslipidemia (r = 0.096, p < 0.001) and between chewing discomfort and occlusion problems (r = −0.820, p < 0.001), suggesting that discomfort in mastication might be related to systemic or structural factors.

Several studies have emphasized the interplay between periodontal disease and systemic conditions, particularly diabetes. Taiyeb-Ali et al. [29] reported that periodontitis may serve as an independent risk factor for worsening diabetic complications, although more specific studies are needed before establishing causality. In Chen et al.'s [30] case-control study, periodontal treatment reduced systemic inflammatory markers (e.g., CRP), potentially improving metabolic control. Patients with type 2 diabetes commonly exhibit dyslipidemia—elevated triglycerides and decreased HDL-cholesterol—due to impaired metabolism of chylomicrons and VLDL under hyperglycemia [31]. In the present study, doctor-diagnosed dyslipidemia was based on total cholesterol, HDL, LDL, and triglycerides, whereas diabetes was assessed using fasting blood sugar, HbA1c, and insulin levels. Our regression analysis (F = 32.308, p < 0.001) showed that physician-diagnosed dyslipidemia (t = −4.896, p < 0.001), diabetes (t = 0.336, p < 0.001), and allergic rhinitis (t = 6.108, p < 0.001) were significantly associated with gum disease treatment, suggesting a multifaceted link between oral health and systemic conditions.

Overall, by analyzing original data from the Korea National Health and Nutrition Examination Survey, we found that gum disease treatment was significantly related to dyslipidemia, diabetes, and allergic rhinitis, underscoring the need for integrated strategies addressing both oral and systemic health. However, this study had limitations in that it relied solely on the survey items available in the KNHANES dataset, making it difficult to include other relevant factors not measured by the survey. Future research should explore additional confounding variables and utilize longitudinal designs to further clarify the causal pathways between periodontal and systemic diseases.

## CONCLUSION

This study utilized data from the 8th Korea National Health and Nutrition Examination Survey to examine the

associations between periodontal disease and systemic health conditions. The analysis revealed statistically significant relationships between periodontal treatment and medical diagnoses of diabetes, dyslipidemia, asthma, and allergic rhinitis. These findings support the growing body of evidence that periodontal health is closely linked to systemic health.

While the cross-sectional design limits causal interpretation, the study highlights the importance of oral health management in individuals with chronic diseases. The inclusion of functional oral health indicators such as chewing discomfort and occlusal problems further emphasizes the clinical relevance of integrating oral health screening into public health policies. Future longitudinal studies are warranted to clarify causal pathways and strengthen the foundation for collaborative medical-dental care.

## CLINICAL RELEVANCE

### Scientific Basis for Research

The findings demonstrate a noteworthy association between asthma treatment (including pediatric and adolescent patients) and gum disease treatment, suggesting the need for interdisciplinary attention to both respiratory and oral health.

### Main Results

Gum disease treatment showed significant relationships with the following factors: dyslipidemia, diabetes diagnosis, allergic rhinitis or asthma diagnosis. These results support the hypothesis that oral health status is closely linked to various systemic conditions.

## ACKNOWLEDGEMENTS

None.

## CONFLICT OF INTEREST

The author declares no conflict of interest.

## AUTHOR CONTRIBUTION

All authors approved the final version of this manuscript prior to submission and agreed to be responsible for all aspects of the work.

NHJ: Contributed to study conception and design, data search and selection, analysis and interpretation, drafted the manuscript, and critically revised it.

KJS: Responsible for English editing, table revision, and critically revising the manuscript.

Both authors contributed equally to ensuring the accuracy and integrity of the work.

## DATA AVAILABILITY STATEMENT

Research data are not shared.

## REFERENCES

1. Grasso MA, Comer AC, DiRenzo DD, Yesha Y, Rishe ND. (2015). Using Big Data to Evaluate the Association between Periodontal Disease and Rheumatoid Arthritis. AMIA Annu Symp Proc. 2015:589-593.

2. DeStefano F, Anda RF, Kahn HS, Williamson DF, Russell CM. (1993). Dental disease and risk of coronary heart disease and mortality. BMJ. 306(6879):688-691.

3. Beck J, Garcia R, Heiss G, Vokonas PS, Offenbacher S. (1996). Periodontal disease and cardiovascular disease. J Periodontol. 67(10 Suppl):1123-1137.

4. Mercado F, Marshall RI, Klestov AC, Bartold PM. (2000). Is there a relationship between rheumatoid arthritis and periodontal disease? J Clin Periodontol. 27(4):267-272.

5. World Health Organization. (2010). A conceptual framework for action on the social determinants of health. Geneva: World Health Organization.

6. Mackenzie RS, De Miliard H. (1963). Interrelated effects of diabetes, arteriosclerosis and calculus on alveolar bone loss. J Am Dent Assoc. 66:192-198.

7. Chapple IL, Genco R; working group 2 of the joint EFP/AAP workshop. (2013). Diabetes and periodontal diseases: consensus report of the Joint EFP/AAP Workshop on Periodontitis and Systemic Diseases. J Periodontol. 84(4 Suppl):S106-S112.

8. Iacopino AM. (2001). Periodontitis and diabetes interrelationships: role of inflammation. Ann Periodontol. 6(1):125-137.

9. Lee JB, Yi HY, Kwang HB. (2013). The association between periodontitis and dyslipidemia based on the Fourth Korea National Health and Nutrition Examination Survey. J Clin Periodontol. 40(5):437-442.

10. Wakai K, Kawamura T, Umemura O, Hara Y, Machida J, Anno T, et al. (1999). Associations of medical status and physical fitness with periodontal disease. J Clin Periodontol. 26(10):664-672.

11. Taylor GW. (2001). Bidirectional interrelationships between diabetes and periodontal diseases: an epidemiologic perspective. Ann Periodontol. 6(1):99-112.

12. Current status and issues of atopy. asthma friendly school in Korea, 2009.

13. Kim CK, Koh YY, Callaway Z. (2009). The validity of induced sputum and bronchoalveolar lavage in childhood asthma. J Asthma. 46(2):105-112.

14. Handoyo S, Rosenwasser LJ. (2009). Asthma phenotypes. Curr Allergy Asthma Rep. 9(6):439-445.

15. Steerenberg PA, Janssen NA, de Meer G, Fischer PH, Nierkens S, van Loveren H, et al. (2003). Relationship between exhaled NO, respiratory symptoms, lung function, bronchial hyperresponsiveness, and blood eosinophilia in school children. Thorax. 58(3):242-245.

16. Petersen PE, Kandelman D, Arpin S, Ogawa H. (2010). Global oral health of older people-call for public health action. Commun Dent Health. 27(4):257-267.

17. Kassebaum N, Bernabé E, Dahiya M, Bhandari B, Murray C, Marcenes W. (2014). Global burden of severe periodontitis in 1990-2010: a systematic review and meta-regression. J Dent Res. 93(11):1045-1053.

18. Van Dyke TE, van Winkelhoff AJ. (2013). Infection and inflammatory mechanisms. J Clin Periodontol. 40(Suppl 14):S1-S7.

19. De Pablo P, Chapple IL, Buckley CD, Dietrich T. (2009). Periodontitis in systemic rheumatic diseases. Nat Rev Rheumatol. 5(4):218-224.

20. Pizzo G, Guiglia R, Lo Russo L, Campisi G. (2010). Dentistry and internal medicine: from the focal infection theory to the periodontal medicine concept. Eur J Intern Med. 21(6):496-502.

21. Kinnane O, Reilly A, Grimes J, Walker R, Pavia S. (2016). Acoustic absorption of hemp-lime construction. Constr Build Mater. 122:674-682.

22. Kassebaum N, Bernabé E, Dahiya M, Bhandari B, Murray C, Marcenes W. (2014). Global burden of severe periodontitis in 1990-2010: a systematic review and meta-regression. J Dent Res. 93(11):1045-1053.

23. Steerenberg PA, Janssen NA, de Meer G, Fischer PH, Nierkens S, van Loveren H, et al. (2003). Relationship between exhaled NO, respiratory symptoms, lung function, bronchial hyperresponsiveness, and blood eosinophilia in school children. Thorax. 58(3):242-245.

24. Jatakanon A, Lim S, Kharitonov SA, Chung KF, Barnes PJ. (1998). Correlation between exhaled nitric oxide, sputum eosinophils, and methacholine responsiveness in patients with mild asthma. Thorax. 53(2):91-95.

25. Covar RA, Szefler SJ, Martin RJ, Sundstrom DA, Silkoff PE, Murphy J, et al. (2003). Relations between exhaled nitric oxide and measures of disease activity among children with mild-to-moderate asthma. J Pediatr. 142(5):469-475.

26. Cardinale F, de Benedictis FM, Muggeo V, Giordano P, Loffredo MS, Iacoviello G, et al. (2005). Exhaled nitric oxide, total serum IgE and allergic sensitization in childhood asthma and allergic rhinitis. Pediatr Allergy Immunol. 16(3):236-242.

27. Karim El Kholy, Genco RJ, Van Dyke TE. (2015). Oral infections and cardiovascular disease. Trends Endocrinol Metab. 26(6):315-321.

28. Ziukaite L, Slot DE, Van der Weijden FA. (2018). Prevalence of diabetes mellitus in people clinically diagnosed with periodontitis: a systematic review and meta-analysis of epidemiologic studies. J Clin Periodontol. 45(6):650-662.

29. Taiyeb-Ali TB, Raman RP, Vaithilingam RD. (2011). Relationship between periodontal disease and diabetes mellitus: an Asian perspective. Periodontol 2000. 56(1):258-268.

30. Chen L, Luo G, Xuan D, Wei B, Liu F, Li J, Zhang J. (2012). Effects of non-surgical periodontal treatment on clinical response, serum inflammatory parameters, and metabolic control in patients with type 2 diabetes: a randomized study. J Periodontol. 83(4):435-443.

31. Goldberg J, Nairn AC, Kuriyan J. (1996). Structural basis for the autoinhibition of calcium/calmodulin-dependent protein kinase I. Cell. 84(6):875-887.