

Association between oral health behavior and periodontal disease among Korean adults

The Korea national health and nutrition examination survey

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Abstract

This study was performed to assess the association between oral health behavior and periodontal disease using nationally representative data.

This study involved a cross-sectional analysis and multivariable logistic regression analysis models using the data from the Korean National Health and Nutrition Examination Survey. A community periodontal index greater than or equal to code 3 was used to define periodontal disease.

Adjusted odds ratios and their 95% confidence intervals of periodontitis for the toothbrushing after lunch group and the toothbrushing before bedtime group were 0.842 (0.758, 0.936) and 0.814 (0.728, 0.911), respectively, after adjustments for age, sex, body mass index, drinking, exercise, education, income, white blood cell count, and metabolic syndrome. Adjusted odds ratios and their 95% confidence intervals of periodontitis for the floss group and the powered toothbrush group after adjustment were 0.678 (0.588, 0.781) and 0.771 (0.610, 0.974), respectively.

The association between oral health behavior and periodontitis was proven by multiple logistic regression analyses after adjusting for confounding factors among Korean adults. Brushing after lunch and before bedtime as well as the use of floss and a powered toothbrush may be considered independent risk indicators of periodontal disease among Korean adults.

Abbreviations: CPI = community periodontal index, KNHANES = Korean National Health and Nutrition Examination Survey, WHO = World Health Organization.

Keywords: epidemiology, health surveys, nutrition surveys, oral health, periodontitis

1. Introduction

Many studies have been performed regarding oral health behavior. However, no worldwide consensus has been reached yet. Toothbrushing is considered a fundamental self-care behavior for the maintenance of oral health, and brushing twice a day has become a social norm, but the evidence base for this frequency may be weak.^[1] The brushing method recommended to general persons in Korea is the 3-3-3 brushing method campaign,^[2] which involves only toothbrushing behavior (the

time and frequency); 3-3-3 means brushing one's teeth 3 times per day, within 3 minutes after having a meal, for at least 3 minutes each time. High awareness of this in the general Korean population may be due to the campaign by the Korean Dental Association.^[3] Furthermore, it is generally accepted that self-reported infrequent brushers demonstrate a higher incidence (odds ratio, 1.50; 95% confidence interval of 1.34–1.69) and increment (standardized mean difference, 0.28; 95% confidence interval of 0.13–0.44) of carious lesions than frequent brushers.^[1]

To remove dental plaque in interdental area, dental floss has been used along with toothbrushing for a long time.^[4] However, if there is sufficient space between the teeth, many people find the interdental brushes were easier to use. There is some, though weak, evidence that flossing in addition to toothbrushing reduces gingivitis compared to toothbrushing alone.^[5]

It was hypothesized that there is no significant association between oral health behavior and the presence of periodontitis. Moreover, specific oral health behavior regarding the timing and frequency of toothbrushing and the use of secondary oral products does not affect the prevalence of severe periodontitis. This study was performed to assess the association between oral health behavior and periodontal disease using nationally representative data in Korea.

2. Methods

2.1. Survey and subjects

This study used data from the Korean National Health and Nutrition Examination Survey (KNHANES), which was conducted between 2012 and 2014 by the Division of Chronic Disease Surveillance, Cheongju, Korea, under the Korean Centers

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for Disease Control and Prevention and the Korean Ministry of Health and Welfare, Sejong, Korea.^[6,7] The KNHANES is comprised of nationally representative samples based on the standard household surveys using a systematic sampling method. The method was adjusted for the number of households while accounting for region, type of residence, and administration district in the Republic of Korea.^[8] The sampling protocol involved a complex, multistage, stratified probability-cluster survey of the noninstitutionalized civilian population, allowing the KNHANES as a representative sample of in the Republic of Korea.^[8] Trained interviewers visited the subjects in their homes, and the standardized health examination was administered to the participants.

Initially, a total of 23,626 individuals were candidates in the KNHANES. The analysis in this study was confined to a total of 18,382 respondents over 19 years of age. Individuals without values regarding periodontitis were excluded, reducing the sample to 15,754. Finally, 14,527 individuals without missing values for the outcome variables were analyzed. All participants in the survey signed an informed consent form prior to participation. The Institutional Review Board of the Korean Center for Disease Control and Prevention approved this study, and it was accomplished according to the Helsinki Declaration's Ethical Principles for Medical Research Involving Human Subjects.

2.2. Sociodemographic and lifestyle variables

Educational level was classified as having a high school education or higher or having less than a high school education. Smoking status was categorized into 3 groups in accordance with respondents' answers on the self-report questionnaire: current smoker, ex-smoker, and nonsmoker. Nonsmokers were those who had never smoked or had smoked <100 cigarettes in their lifetime, ex-smokers were those who had smoked ≥ 100 cigarettes in the past, and current smokers were those smoking currently and who had smoked ≥ 100 cigarettes. Participants were also categorized, based on the quantity of alcohol consumed (per day for the month prior to the interview), into the following 3 groups: nondrinker, light to moderate drinker (1–30 g/day), and heavy drinker (≥ 30 g/day).^[9] Individuals were regarded as regular exercisers if they performed walking at least 5 times per week for over 30 minutes per session. Residential place and occupation were also noted.

2.3. Anthropometric and biochemical measurements

The measurements performed in this study were done by trained staff members. Body weight was measured to the nearest 0.1 kg, and height was measured to the nearest 0.1 cm. The body mass index was calculated based on the following formula: body-weight in kilograms divided by height in meters squared. Measurement of participant's waist circumference was performed at the narrowest point between the lowest rib and the iliac crest in a standing position.

Systolic blood pressure and diastolic blood pressure were measured 2 times at 5-minute intervals using a standard mercury sphygmomanometer (Baumanometer; W.A. Baum Co., Inc., Copiague, NY). Blood sample was collected from the antecubital vein of each participant after a fasting period of 8 hours. Concentrations of serum fasting plasma glucose, total cholesterol, triglycerides, high-density lipoprotein cholesterol, and white blood cell count were measured from the sample. To measure

levels of serum fasting plasma glucose, total cholesterol, triglycerides, and high-density lipoprotein cholesterol, an automated chemistry analyzer (Hitachi Automatic Analyzer 7600, Hitachi, Tokyo, Japan) and commercially available kits (Daiichi, Tokyo, Japan) were used.^[10]

Metabolic syndrome was defined if 3 or more of the following criteria were fulfilled^[11]: waist circumference of 90 cm or greater in men and 80 cm or greater in women; fasting triglycerides ≥ 150 mg/dL or use of lipid-lowering medication; high-density lipoprotein cholesterol of less than 40 mg/dL in men and less than 50 mg/dL in women or use of medication; blood pressure of 130/85 mmHg or greater or use of antihypertensive medication in a patient with a history of hypertension; and fasting blood glucose of 100 mg/dL or greater or current use of antidiabetic medication. Participants were considered to have diabetes when fasting plasma sugar was ≥ 126 mg/dL, hemoglobin A1c (HbA1c) was $\geq 6.5\%$, they were currently using antidiabetic medications, or they had physician-diagnosed diabetes.^[12] Hypertension was defined if the participants were taking antihypertensive medication or if a systolic blood pressure was ≥ 140 mmHg or a diastolic blood pressure was ≥ 90 mmHg or the current use of antihypertensive medication.^[13]

2.4. Oral health behaviors, periodontal disease, and number of natural teeth

The time of day when participants brushed their teeth and used secondary oral products was recorded as oral health behaviors.^[14] Time of day was categorized as prior to or following breakfast, lunch, and dinner or prior to bedtime and after snack. We calculated the frequency of daily toothbrushing by the total number of times the teeth were brushed per day. Secondary oral products included the following: dental floss, mouthwash, interdental brushes, electric toothbrushes, irrigation devices, tongue cleaners, end-tufted brushes, and special devices for dentures. Self-reported oral state, chewing, and speech ability were categorized into favorable, average, and problematic. Presence of tooth pain, experience of orthodontic treatment, and dental checkup within a year were also evaluated.

The KNHANES used the community periodontal index (CPI) developed by the World Health Organization to evaluate the presence of periodontal disease.^[15] The index teeth are 11, 16, 17, 26, 27, 31, 36, 37, 46, and 47. The mouth was divided into sextants and each sextant was examined only if 2 or more teeth were present, which were not scheduled for extraction. If there were no index teeth which were qualified for examination, all remaining teeth were examined and the highest score was recorded. If the participant had at least 1 site with a ≥ 3.5 -mm pocket in the index teeth, the participant's CPI is ≥ 3 . If CPI is 3 or greater, the participants were considered to have periodontitis.^[16] The participants were considered to have severe periodontitis if the CPI was ≥ 4 , indicating that ≥ 1 site has a 5.5-mm pocket or larger in the index teeth.

2.5. Statistical analysis

Results are presented as means \pm standard error or percentages (standard error). The relationship between the values, including the time of day for toothbrushing, frequency of toothbrushing, usage of secondary oral products, and periodontal disease, was obtained by independent *t* tests for continuous variables or chi-square tests for categorical variables. Log transformation was applied to the value when appropriate. Multivariable logistic

Table 1**The baseline characteristics of the study individuals according to the presence of periodontal disease.**

	Periodontitis		<i>P</i> [*]
	No	Yes	
Unweighted n	10,370	4157	
Age, years	41.8±0.2	54.1±0.3	<0.0001
Body mass index, kg/m ²	23.50±0.05	24.36±0.07	<0.0001
Waist circumference, cm	79.6±0.2	83.7±0.2	<0.0001
Number of natural teeth	25.9±0.1	23.9±0.1	<0.0001
White blood cell count, ×10 ³ /μL [†]	5.84 (5.80, 5.89)	6.20 (6.13, 6.26)	<0.0001
Male (yes)	45.5 (0.6)	59.3 (0.8)	<0.0001
High school education or higher	80.9 (0.6)	58.0 (1.2)	<0.0001
Income (low)	11.9 (0.5)	20.2 (0.9)	<0.0001
Smoking			<0.0001
Nonsmoker	64.3 (0.6)	46.4 (1.0)	
Ex-smoker	14.8 (0.4)	22.6 (0.8)	
Current smoker	20.9 (0.6)	31.0 (0.9)	
Drinking			<0.0001
Nondrinker	22.2 (0.5)	28.1 (0.9)	
Mild to moderate drinker	69.6 (0.6)	60.5 (1.0)	
Heavy drinker	8.3 (0.4)	11.3 (0.6)	
Regular exercise (yes)	40.5 (0.7)	36.2 (0.9)	0.0001
Residence (urban)	85 (1.5)	75.7 (2.2)	<0.0001
Occupation (yes)	62.4 (0.6)	65.6 (1.0)	0.0043
Diabetes mellitus (yes)	5.7 (0.3)	16.5 (0.7)	<0.0001
Hypertension (yes)	19.3 (0.5)	38.3 (1.0)	<0.0001
Metabolic syndrome (yes)	21.5 (0.5)	39.7 (1.0)	<0.0001

Data are presented as means±standard error or percentages (standard error).

^{*} *P*-values were obtained by independent t-tests for continuous variables or chi-square tests for categorical variables.[†] Log transformation was applied to the value, and the geometric mean (95% confidence interval) is shown.

regression analysis was used to evaluate the risk of periodontal disease in relation to oral health behavior, and odds ratios and 95% confidence intervals were calculated after adjusting for potential confounders.^[17] Model 1 was adjusted for age and sex. Model 2 was adjusted for variables in model 2 plus body mass index, drinking, exercise, education, income, white blood cell count, and metabolic syndrome. Statistical analysis was performed using statistical analysis software (SAS version 9.2; SAS Institute, Inc., Cary, NC), using survey sampling and analysis procedures to account for the complex sampling design. *P* < 0.05 was considered a statistically significant difference.

3. Results

Table 1 describes the baseline characteristics of the study individuals according to the presence of periodontal disease. The mean age, body mass index, and waist circumference were found to be significantly higher in participants with periodontitis (*P* < 0.05). In addition, there was a significant difference in the status of education, income, smoking, and drinking between individuals with and without periodontitis (*P* < 0.05). The percentage of individuals with diabetes mellitus, hypertension, or metabolic syndrome was significantly higher in those with periodontitis (*P* < 0.05).

Table 2 shows the characteristics of the study individuals regarding oral health behavior. The percentage of individuals who had had a dental checkup within a year was lower in the periodontitis group (*P* < 0.05). The number of individuals with

Table 2**The baseline characteristics of the study individuals regarding oral health behavior.**

Variable	Periodontitis		<i>P</i> [*]
	No	Yes	
Unweighted n	10,370	4157	
Tooth pain (yes)	35.6 (0.7)	45.7 (1)	<0.0001
Dental checkup within a year (yes)	27.9 (0.6)	26.7 (0.9)	0.2599
Chewing			<0.0001
Problematic	14.9 (0.4)	33.9 (0.9)	
Average	14.6 (0.4)	20.2 (0.8)	
Favorable	70.4 (0.6)	45.9 (0.9)	
Speech			<0.0001
Problematic	5.5 (0.3)	13.6 (0.6)	
Average	8.5 (0.3)	15.6 (0.7)	
Favorable	86 (0.4)	70.8 (0.9)	
Self-reported oral status			<0.0001
Favorable	15.4 (0.5)	10.4 (0.6)	
Average	45.1 (0.7)	32.8 (0.9)	
Problematic	39.5 (0.7)	56.8 (1)	
Number of natural teeth			<0.0001
0–20	7.9 (0.3)	17.5 (0.7)	
21–27	36.3 (0.6)	54.2 (1)	
28	55.9 (0.6)	28.3 (1)	
Experience of orthodontic treatment (yes)	8.2 (0.4)	2.0 (0.3)	<0.0001
Frequency of toothbrushing per day			<0.0001
≤1	8.0 (0.3)	15.1 (0.7)	
2	36.1 (0.6)	43.2 (0.9)	
≥3	55.9 (0.6)	41.7 (1.0)	

Data are presented as means±standard error or percentages (standard error).

^{*} *P*-values were obtained by chi-square tests for categorical variables.

chewing problems, speech problems, or problematic self-reported oral status was significantly higher in the periodontitis group (*P* < 0.05). The percentage of individuals with orthodontic treatment was lower in the periodontitis group (*P* < 0.05). In addition, the percentage of individuals who brushed 3 times or more per day was lower in the periodontitis group (*P* < 0.05).

The percentage of periodontitis according to timing of toothbrushing is shown in Fig. 1A. The percentage of periodontitis was significantly lower with toothbrushing after lunch, or toothbrushing before bedtime (*P* < 0.05). Figure 1B shows the percentage of periodontitis according to the use of secondary oral products. The percentage of periodontitis was significantly lower for the floss, interdental brush, or powered toothbrush group (*P* < 0.05).

Figure 2 demonstrates adjusted odds ratios and their 95% confidence intervals of periodontitis categorized by the toothbrushing frequency and the use of floss after adjustments for age, sex, body mass index, drinking, exercise, education, income, white blood cell count, and metabolic syndrome. Adjusted odds ratios and their 95% confidence intervals of periodontitis for individuals with floss use and toothbrushing 2 times per day was 0.675 (0.510, 0.892) when individuals who did not floss and brushed their teeth once or less per day were considered as a reference. Adjusted odds ratios and their 95% confidence intervals of periodontitis for individuals with floss use and toothbrushing 3 times or more per day was 0.506 (0.389, 0.658).

The percentage of severe periodontitis among individuals with periodontitis is shown in Fig. 3. The percentage of severe

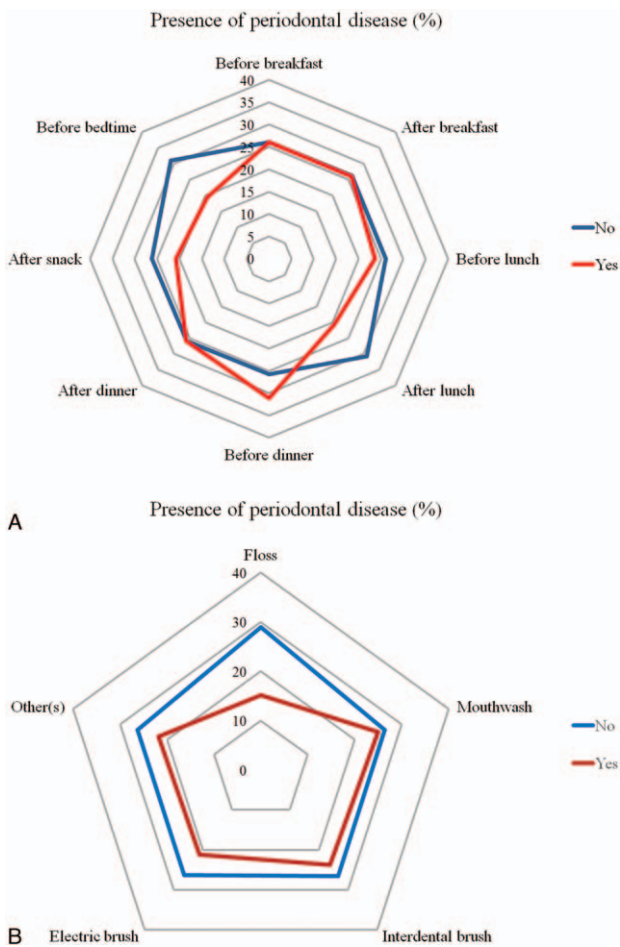


Figure 1. (A) The prevalence of periodontitis according to toothbrushing timing. (B) The prevalence of periodontitis according to the use of secondary oral products.

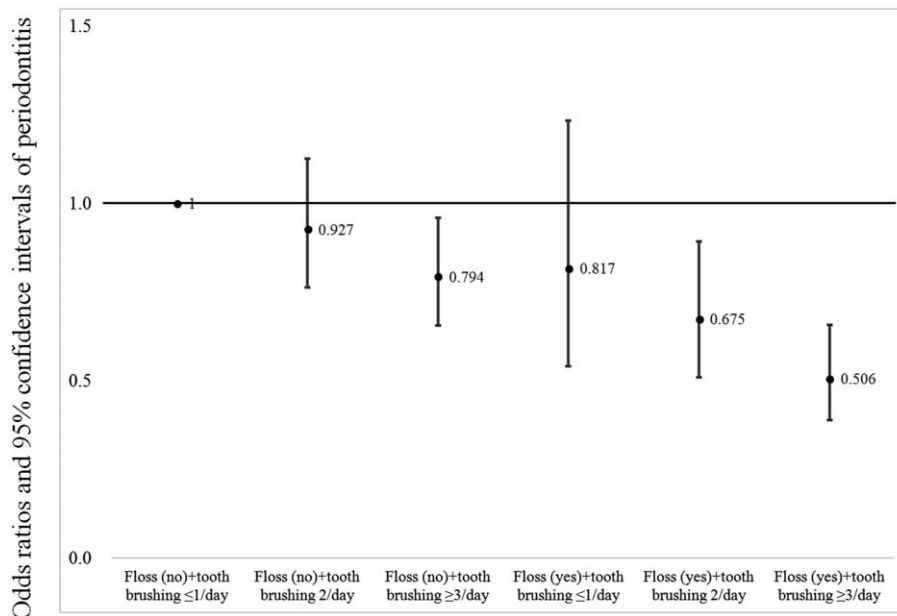
periodontitis was significantly lower in the toothbrushing after dinner group ($P < 0.05$).

Table 3 demonstrates the adjusted odds ratios and their 95% confidence intervals from multivariable logistic regression analyses regarding oral health behavior for individuals with periodontal disease. Adjusted odds ratios and their 95% confidence intervals of periodontitis for the toothbrushing after lunch group and the toothbrushing before bedtime group were 0.842 (0.758, 0.936) and 0.814 (0.728, 0.911), respectively, after adjustments for age, sex, body mass index, drinking, exercise, education, income, white blood cell count, and metabolic syndrome. Adjusted odds ratios and their 95% confidence intervals of periodontitis for the floss group and the powered toothbrush group after adjustment were 0.678 (0.588, 0.781) and 0.771 (0.610, 0.974), respectively,

4. Discussion

This study aimed to identify associations between oral health behavior and periodontal disease. This study clearly showed that a lower prevalence of periodontal disease was associated with toothbrushing after lunch and toothbrushing before bedtime. The use of floss and the use of a powered toothbrush were associated with a lower prevalence of periodontal disease. Toothbrushing after dinner was also associated with a lower prevalence of severe periodontitis.

Mechanical plaque removal with a manual toothbrush remains the primary method for maintaining good oral hygiene.^[1,18–21] Toothbrushing frequency has varied among different studies.^[22] A study from Khartoum State, Sudan, showed that the frequency of children who brushed their teeth regularly at least once a day was high (83.4%).^[22] However, a previous study of the Chinese population showed that, in general, a high percentage of the 2105 respondents reported inadequate oral hygiene practices (ie, 66.7% or 1402 of respondents brushed their teeth once a day or less).^[23] The percentage of toothbrushing once or less per day in



P -value: 0.5174

Figure 2. The adjusted odds ratios and their 95% confidence intervals for individuals with periodontal treatment needs from multivariable logistic regression analyses regarding oral health behavior ($P < 0.05$).

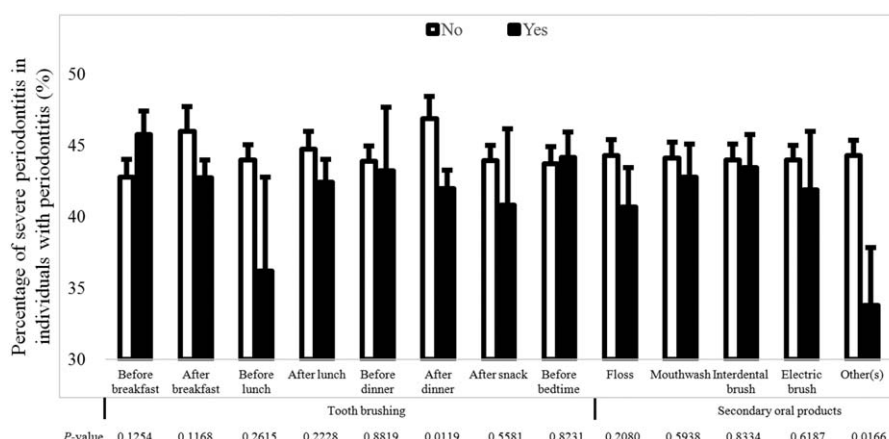


Figure 3. Percentage of severe periodontitis among individuals with periodontitis according to oral health behavior.

individuals with periodontitis was 15.1% in this study. It has been shown that toothbrushing and dental service use are associated with the number of untreated carious and missing tooth surfaces in adulthood.^[24] Furthermore, a previous report showed that meticulous toothbrushing once per day is sufficient to maintain oral health and to prevent caries and periodontal diseases.^[25] A systematic review and meta-analysis showed that the odds of having carious lesions differed less when subgroup analysis was conducted to compare the incidence between those who brushed ≥ 1 time/day and those who brushed < 1 time/day (odds ratio: 1.56; 95% confidence interval: 1.37–1.78).^[11]

In many countries, including America and Australia, brushing twice a day has become the social norm.^[1] In previous research, participants were told to brush their teeth twice a day; teeth brushing frequencies were 1.9 times per day in the probiotic group and 2.0 times per day in the control group.^[19] The odds of having carious lesions differed still but less so once subgroup analysis was conducted to compare the incidence between ≥ 2 and < 2 times/day (odds ratio: 1.45; 95% confidence interval: 1.21–1.74).^[11] Another study suggested that regular brushing (twice a day) with a fluoride toothpaste may have a greater

impact on caries in young children than restricting sugary foods.^[20] Infrequent toothbrushing was evaluated as a risk factor for periodontitis, and a fixed-effects model yielded a significant overall odds ratio estimate of 1.41 (95% confidence interval: 1.25–1.58, $P < 0.05$) for infrequent compared to frequent toothbrushing.^[26] Another report from Goiania in Brazil showed that 77.7% of participants brushed 3 times or more.^[21] This study showed that the majority (55.9%) of participants without periodontitis brushed 3 times or more, but the majority (43.2%) of participants with periodontitis brushed 2 times per day.

Brushing time also has to be considered. A previous report showed that the average brushing time of the participants was 45 seconds.^[27] Furthermore, it has been shown that toothbrushing for 2 minutes is much more effective than toothbrushing for 45 seconds regarding oral health and removal of plaque.^[28] Similarly, it was shown that toothbrushing for 2 minutes was effective at brushing all teeth surfaces.^[29] Irrespective of the type of toothbrush (manual vs powered), a good and thorough toothbrushing of 2 minutes may be sufficient for oral health.^[30] Some researchers have even suggested that toothbrushing for at least for 3 minutes is practically unnecessary.^[31] It should also be

Table 3

The adjusted odds ratios and their 95% confidence intervals from multivariable logistic regression analyses regarding oral health behavior for individuals with periodontal disease.

Variable	Odds ratio (95% confidence interval)			
	Model 1	P	Model 2	P
Toothbrushing				
Before breakfast	1.069 (0.965, 1.184)	0.2014	1.003 (0.896, 1.122)	0.9596
After breakfast	0.875 (0.788, 0.972)	0.0125	0.982 (0.873, 1.105)	0.7641
Before lunch	0.876 (0.622, 1.233)	0.4476	0.752 (0.523, 1.081)	0.1235
After lunch	0.765 (0.695, 0.843)	< 0.0001	0.842 (0.758, 0.936)	0.0014
Before dinner	1.140 (0.889, 1.461)	0.3027	1.055 (0.816, 1.364)	0.683
After dinner	0.945 (0.860, 1.039)	0.2422	1.004 (0.904, 1.116)	0.9405
After snack	0.751 (0.574, 0.981)	0.0356	0.785 (0.59, 1.046)	0.0982
Before bedtime	0.810 (0.729, 0.899)	< 0.0001	0.814 (0.728, 0.911)	0.0003
Floss	0.628 (0.549, 0.718)	< 0.0001	0.678 (0.588, 0.781)	< 0.0001
Mouthwash	1.103 (0.975, 1.248)	0.1183	1.096 (0.959, 1.252)	0.1776
Interdental brush	0.970 (0.852, 1.103)	0.6415	0.992 (0.864, 1.139)	0.909
Powered toothbrush	0.766 (0.612, 0.958)	0.0196	0.771 (0.610, 0.974)	0.0293
Other (s)	0.685 (0.543, 0.864)	0.0014	0.727 (0.568, 0.930)	0.0112

Other(s) included irrigation device, tongue cleaner, end-tufted brush, and/or a special device for dentures. Model 1: age and sex adjusted. Model 2: model 1 + body mass index, drinking, exercise, education, income, white blood cell count, and metabolic syndrome adjusted.

considered that only 19% of Korean students have had their dentist tell them that they were brushing their teeth well compared to 76% of students from the United States ($P < 0.05$).^[32] The effect of infrequent brushing on the incidence and increment of carious lesions was shown to be higher in deciduous than permanent dentition.^[1] The prevalence of oral soft- and hard-tissue lesions related to mechanical tooth-cleansing procedures was evaluated, and the subjects with a good oral hygiene status, as well as those who brushed more than twice daily, showed a high frequency of lesions.^[33]

This study clearly showed that a lower prevalence of periodontal disease was associated with toothbrushing after lunch and before bedtime, and toothbrushing after dinner was associated with a lower prevalence of severe periodontitis. In a previous report, 60.9% of male and 88.8% of female participants from Chiba Prefecture, Japan, brushed their teeth almost every day at bedtime ($P < 0.05$).^[34] A previous report also suggested that infrequent toothbrushing may be associated with severe forms of periodontal disease.^[26]

This study clearly showed that the use of floss was associated with a lower prevalence of periodontal disease. However, only a small percentage of a sample from the United States flosses daily.^[35] A previous report mentioned that there is weak, highly unreliable evidence from several studies that flossing plus toothbrushing may be associated with a small reduction in plaque at 1 and 3 months.^[5] Habit formation has been proposed as a means to promote the maintenance of such healthy behaviors.^[36] Those who flossed after brushing (rather than before) tended to form stronger flossing habits and, at 8-month follow-up, flossed more frequently.^[36]

This study also clearly showed that a powered toothbrush was associated with a lower prevalence of periodontal disease. It should be emphasized that removing dental plaque may play a key role in maintaining oral health.^[37] There is conflicting evidence for the relative merits of manual versus powered toothbrushing in achieving this.^[37] The effectiveness of a powered toothbrush at reducing plaque and in maintaining gingival health was determined when compared to a standard manual brush, and the powered toothbrush was found to be more effective than the manual toothbrush at plaque removal; in addition, the papillary bleeding scores were significantly lower in the powered toothbrush group after 1 week of product use.^[38] It has been suggested that powered toothbrushes reduce plaque and gingivitis more than manual toothbrushing in the short and long terms, but the clinical importance of these findings remains unclear.^[37]

This study found no significant association between the use of an interdental brush or having a dental checkup within a year and the presence of periodontitis. A previous report showed that there was insufficient evidence to determine whether interdental brushing reduced or increased levels of plaque when compared to flossing.^[4] Regarding regular visits, more than half of a sample from the United States visited their dentists regularly, but 53.6% of Chinese participants never visited a dentist.^[23,35] Regular, routine oral health examinations have been suggested for the maintenance of oral health.^[39] A previous study showed that participants who had a regular checkup were less likely to have visible plaque,^[39] but no significant association was noted between regular visits and the presence of periodontitis in this study.

This study has several limitations that should be considered. With the design of this study being cross-sectional, the causal direction and risk of periodontitis cannot be suggested.^[40] Furthermore, oral health behavior was obtained from interviews using the recall method.^[41] However, it should be reinforced that

this study had the great strength of using a nationally representative sample.^[42] The sampling units were based on the population and housing census from the National Census Registry in Korea, and survey sample weights adjusted for participation rate and response rate were used for all analyses.^[43] This indicates that the results from this study are reliable and represent the general population.^[44]

Conclusively, the association between oral health behavior and periodontitis was proven by multiple logistic regression analyses after adjusting for confounding factors among Korean adults. Brushing after lunch and before bedtime and the use of floss and a powered toothbrush may be considered independent risk indicators of periodontal disease among Korean adults.

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