

Risk of Periodontitis Associated with Alcohol Consumption and Smoking Habit in Korean Adults

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Abstract

Objectives: This study aimed to evaluate the specific effects of alcohol and smoking on periodontitis, and to examine the effects of the interaction between alcohol and smoking on periodontitis.

Methods: This study used data from year 1 of the 6th Korean National Health and Nutrition Examination Survey (KNHANES VI) conducted in 2012. Cross-tabulation analysis was used to investigate the distribution of Community Periodontal Index (CPI), Alcohol Use Disorders Identification Test (AUDIT) scores, and smoking status, based on general characteristics, and to investigate the prevalence of periodontitis, based on AUDIT scores and smoking status. A logistic regression analysis of periodontitis risk and the P-interaction were obtained for the effect of the interaction between alcohol and smoking on periodontitis.

Results: Participants with an AUDIT score of ≥ 8 had a 1.13-fold higher risk of periodontitis, compared to participants with an AUDIT score of ≤ 7 (95% confidence interval [CI], 0.90 - 1.42). Ex-smokers had a 1.27-fold higher risk of periodontitis than never-smokers (95%CI, 1.01 - 1.60), and current smokers had a 2.18-fold higher risk than never-smokers (95% CI, 1.75 - 2.72). Ex- or current smokers with an AUDIT score of ≤ 7 had a 1.47-fold higher risk of periodontitis (95%CI, 1.14 - 1.90), which was significant. Smokers with an audit score of ≥ 8 had 1.99-fold significantly higher risk of periodontitis (95%CI, 1.55 - 2.56). The interaction between smoking and alcohol consumption significantly affected the periodontitis risk (p -interaction < 0.001).

Conclusions: Alcohol consumption and smoking are risk factors for periodontitis.

Keywords: Alcohol; Alcohol Use Disorders Identification Test; Oral Health; Periodontitis; Smoke

Abbreviations

AUDIT: The Alcohol Use Disorders Identification Test; BMI: Body Mass Index; CPI: Community Periodontal Index; KNHANES: Korean National Health and Nutrition Examination Survey; DMFT: Decayed, Missing, and Filled Teeth

Introduction

Periodontitis is an inflammatory disease of the oral soft tissue. When untreated, it can progress to infection of the hard tissues, and eventually result in the loss of teeth or alveolar bone loss [1]. The prevalence of periodontitis is especially high in adults, and it is a main cause of tooth loss in this age group [2].

In the United States, 44.7% of adults ≥ 30 years have periodontitis [3]. The Fourth German Dental Health Survey, conducted in Germany in 2005, found that 70.9% of adults and 87.4% of elderly individuals have periodontitis [4]. In South Korea, the 2007 Korean National Health and Nutrition Examination Survey (KNHANES) results showed that the prevalence of periodontal disease in adults aged 35 - 44 years was 33.6% [5]. Thus, in addition to dental caries, periodontitis is a universal chronic oral disease.

Periodontitis results from a combination of diverse factors such as bacteria-containing dental plaque and dental calculus, which results from the calcification of uncontrolled dental plaque. In particular, oral diseases caused by dental plaque are associated with changes in the intraoral microbiota with major periodontal microorganisms, which include anaerobic bacteria such as *Porphyromonas gingivalis*, *Treponema denticola*, and *Tannerella forsythia* [6].

Exposure to alcohol and smoking is also especially high in adults. Based on data from the World Health Organization (WHO) in 2004, approximately 200 million people worldwide consumed alcoholic beverages, and an estimated 76,300,000 people had alcohol use disorders [7]. Data from the National Survey on Drug Use and Health in 2002–2005 showed that the prevalence of cigarette smoking in the 30 days before the survey was 26.9% in Americans [8]. In Korea, data from the 2013 KNHANES show that the rate of high risk alcohol consumption in adults of 19 years and older was 19.4% for men and 4.8% for women, whereas the proportion of current smokers was 41.4% for men and 5.7% for women [9].

Alcohol consumption and smoking cause various health problems throughout the body. Several studies have demonstrated their harm to oral health [10-13].

Most studies have only analyzed the relationship between alcohol consumption and oral health or the relationship between smoking and oral health. This study, on the other hand, aimed to examine the risk of periodontitis with alcohol exposure and smoking exposure separately, and to analyze how the risk of periodontitis is affected by the interaction between these two independent variables.

Materials and Methods

The analysis in this study was conducted using data from the first year of KNHANES VI conducted in 2012. Among the data from KNHANES VI, the participants for the final analysis consisted of the 4269 adults, aged 19 years or older, who had undergone a Community Periodontal Index (CPI) test as part of an oral health examination, and had responded to the questionnaires about smoking and the Alcohol Use Disorders Identification Test (AUDIT).

Oral Examination

The CPI was used to examine the participants' periodontium. The CPI uses a probe needle to measure bleeding, the presence of dental calculus, and the presence of a periodontal pocket for six teeth, and to assign scores based on the following criteria: CPI 0, healthy periodontium; CPI 1, bleeding; CPI 2, formation of dental calculus; CPI 3, formation of a shallow periodontal pocket; and CPI 4, formation of a deep periodontal pocket. In borderline cases that were difficult to judge, the lower score was given. The patient's overall CPI score was defined as the highest score among the teeth examined. Participants were classified into the healthy periodontium group (CPI 0–2) or the periodontal disease group (CPI 3–4), based on the CPI scores.

Alcohol consumption and smoking habit

The AUDIT scores were used to measure the participants' alcohol consumption. The AUDIT score was developed by the WHO and is measured by 10 questions pertaining to subjects such as the frequency and amount of alcohol consumption and difficulties in daily living caused by alcohol consumption. Based on the WHO criteria, a total score of ≥ 8 after summing the scores of individual questions is

categorized as hazardous and harmful alcohol use, and interpreted as alcohol dependence [14]. Therefore, we used a score of 8 as the cut-off point in this study.

For smoking status, participants were classified as never smokers, ex-smokers, and current smokers. To analyze the interaction between alcohol and smoking, participants were classified into the following groups: no exposure to alcohol or smoking, exposure to alcohol or smoking, and exposure to both alcohol and smoking.

Analysis

A complex sample design was used to analyze the data of the participants so that the results of the analysis would be representative. A planning file was generated using the estimated variance as a stratification variable and the survey group as a clustering variable, with weights applied to the health examination and health questionnaires according to the year. A complex sample cross-tabulation analysis was performed to examine the distribution of CPI scores, AUDIT scores, and smoking status, based on the general characteristics. A multiple logistic regression analysis was performed to examine the risk of periodontitis, based on alcohol dependence, smoking status, and the interaction between alcohol dependence and smoking. Confounding variables for the multiple logistic regression analysis were sex; age; household income; education level; and visits to the dentist within the last year for which the data were obtained from a self-report questionnaire; body mass index (BMI), which was obtained from physical measurements; and diabetes, which was assessed by blood tests results. In addition, alcohol consumption and smoking are separate risk factors for periodontitis; therefore, smoking habit was used as an additional confounding variable when analyzing the effects of alcohol on periodontitis risk, and the AUDIT score was used as a confounding variable when analyzing the effects of smoking on periodontitis risk. Statistical analysis was performed using IBM SPSS Statistics (version 21.0, IBM Corporation, New York, NY, USA). A value of $p < 0.05$ was considered significant.

Results

The periodontitis group (CPI = 3–4) consisted of 2.0% of all participants (1234 individuals) with 32.9% of male participants and 20.5% of female participants having periodontitis. The prevalence of periodontitis was significantly higher for participants ≥ 65 years (50.3%), living in rural areas (36.9%) (p -value < 0.001), and with lower education levels and household income (p -value < 0.001). Periodontitis prevalence was also significantly higher in the obese group (BMI ≥ 25 kg/m²) (33.6%), the diabetic group (54.3%), and the group with a decayed, missing, filled teeth (DMFT) index of 0 (28.5%) (p -value < 0.001). However, there was no significant relationship between periodontitis and an oral health examination within the last year (Table 1).

Variable	N	%	CPI [†] (0-2)		CPI (3-4)		p-value
			N	%	N	%	
All	4269	100.0	3035	73.0	1234	27.0	
Gender							
Male	1983	46.5	1256	67.1	727	32.9	< 0.001
Female	2286	53.5	1779	79.5	507	20.5	
Age (year)							
19 - 44	1973	46.2	1711	86.9	262	13.1	< 0.001
45 - 64	1564	36.6	953	58.7	611	41.3	
≥ 65	732	17.1	371	49.7	361	50.3	
Living area							
Metropolis	2752	64.5	2110	78.2	642	21.8	< 0.001
Urban	728	17.1	448	63.2	280	36.8	
Rural	789	18.5	477	63.1	312	36.9	
Educational level (year)							
≤ 6	796	18.6	417	51.3	379	48.7	< 0.001
7 - 9	427	10.0	254	58.1	173	41.9	
10 - 12	1587	37.2	1173	75.3	414	24.7	
> 12	1458	34.2	1191	82.1	267	17.9	
Unknown	1	0.02	0	0	1	100.0	
Household income							
< 2000	1187	27.8	717	62.9	470	37.1	< 0.001
2000 - 2990	764	17.9	546	73.4	218	26.6	
3000 - 3990	679	15.9	525	79.2	154	20.8	
≥ 4000	1618	37.9	1235	76.2	383	23.8	
Unknown	21	0.5	12	54.9	9	45.1	
BMI[‡]							
< 18.5 kg/m ²	185	4.3	158	86.8	27	13.2	< 0.001
18.5 - 24 kg/m ²	2692	63.1	1967	74.9	725	25.1	
≥ 25 kg/m ²	1369	32.1	888	66.4	481	33.6	
Unknown	23	0.5	22	96.6	1	3.4	
Diabetes Mellitus							
No	2692	63.1	2093	79.1	599	20.9	< 0.001
IFG [§]	869	20.4	536	2.3	333	2.3	
Yes	388	9.1	187	45.7	201	54.3	
Unknown	320	7.5	219	73	101	27.0	
Dental caries							
DMFT = 0	381	8.9	267	71.5	114	28.5	< 0.001
DMFT ≥ 1	3888	91.1	2768	73.1	1120	26.9	
Experience of oral examination within 1 year							
No	3010	70.5	2147	73.6	863	26.4	0.341
Yes	1249	29.3	882	71.5	367	28.5	
Unknown	10	0.2	6	67.2	4	32.8	
Dental visit within 1 year							
No	2243	52.5	1629	74.8	614	25.2	0.023
Yes	2015	47.2	1399	70.8	616	29.2	
Unknown	11	0.3	7	68.5	4	31.5	

Table 1: Distribution of Community periodontal index according to general characteristics in KNHANES VI*.

*The Sixth Korean National Health and Nutrition Examination Survey

[†]Community periodontal index

[‡]Body Mass Index = Weight (kg)/ Height (m²)

[§]Impaired Fasting Glucose

The group with an AUDIT score of ≥ 8 or contained 31.2% of the study participants. An AUDIT score of ≥ 8 was more common for participants who were male (52.5%), aged 44 years or less (38.5%), had 10 - 12 years of education (38.7%), had a household income of 30 - 39.9 million Korean Republic wons (KRW) (38.4%), were obese (BMI ≥ 25 kg/m²) (40.3%), had impaired fasting glucose (i.e., diabetes group) (39.9%), and had a DMFT index of 0 (37.9%) (p -value < 0.001). However, the AUDIT score showed no significant relationship with the area of residence, or with oral health examination or visit to the dentist within the last year.

Among all participants, the never smoker group was largest at 56.9%, whereas the ex-smoker group comprised 21.1% and the current smoker group comprised 21.9% of the participants. The current smoker group contained 42.2% male participants and 7.4% female

participants (p-value < 0.001); 29.6% of participants were 44 years old or younger, which was the highest among the age groups, and 12.3% of participants were 65 years or older, which was the lowest (p-value < 0.001). There was a significantly higher proportion of current smokers with 10 - 12 years of education and participants with a household income of 2 - 2.99 million KRW (30.0% and 31.5%, respectively). There was also a significant association between smoking status and BMI, diabetes status, DMFT index, and oral health examination or visit to the dentist within the last year (Table 2).

Variable	Total N	%	AUDIT [†]		p-value	Smoke habit						p-value
			≥ 8			Non-smoker		Ex-smoker		Current smoker		
			N	%		N	%	N	%	N	%	
All	4269	100.0	1334	31.2		2430	56.9	903	21.2	936	21.9	
Gender												
Male	1983	46.5	1012	52.5	< 0.001	426	23.4	774	34.4	783	42.2	< 0.001
Female	2286	53.5	322	15.0		2004	86.4	129	6.2	153	7.4	
Age												
19 - 44	1973	46.2	700	38.5	< 0.001	1174	54.8	288	15.6	511	29.6	< 0.001
45 - 64	1564	36.6	497	34.1		879	51.1	353	24.7	332	24.2	
≥ 65	732	17.1	137	19.1		377	50.9	262	36.8	93	12.3	
Living area												
Metropolis	2752	64.5	848	34.3	0.647	1599	54.2	567	20.9	586	24.9	0.349
Urban	728	17.1	229	35.7		407	52.4	163	22.2	158	25.5	
Rural	789	18.5	257	36.1		424	49.8	173	20.8	192	29.4	
Educational level (year)												
≤ 6	796	18.6	165	22.7	< 0.001	497	60.4	178	21.8	121	17.7	< 0.001
7 - 9	427	10.0	120	32.7		222	49.3	112	25.9	93	24.8	
10 - 12	1587	37.2	559	38.7		880	51.6	292	18.5	415	30.0	
> 12	1458	34.2	489	35.7		831	53.0	320	22.5	307	24.5	
Unknown	1	0.0	1	100.0		0	0.0	1	100.0	0	0.0	
Household income (KRW 10,000)												
< 2000	1187	27.8	297	28.7	0.001	634	50.3	304	25.1	249	24.6	0.004
2000 - 2990	764	17.9	243	35.7		414	49.5	148	19.0	202	31.5	
3000 - 3990	679	15.9	243	38.4		398	55.0	131	19.3	150	25.8	
≥ 4000	1618	37.9	542	36.4		973	55.6	316	20.6	329	23.8	
Unknown	21	0.5	9	49.6		11	53.9	4	17.3	6	28.8	
BMI[‡]												
< 18.5 kg/m ²	185	4.3	43	26.0	< 0.001	122	66.3	32	14.2	31	19.5	< 0.001
18.5 - 24 kg/m ²	2692	63.1	791	33.0		1598	55.3	544	20.9	550	23.8	
≥ 25 kg/m ²	1369	32.1	496	40.3		690	45.9	325	22.8	354	31.3	
Unknown	23	0.5	4	16.2		20	86.8	2	9.0	1	4.2	
Diabetes Mellitus												
No	2692	63.1	828	34.0	< 0.001	1626	56.4	486	18.4	580	25.3	< 0.001
IFG [§]	869	20.4	314	39.9		435	45.9	235	26.4	199	27.7	
Diagnosis	388	9.1	124	37.2		191	43.7	104	27.5	93		
Unknown	320	7.5	68	25.8		178	53.1	78	24.7	64	22.2	
Dental caries												
DMFT = 0	381	8.9	134	37.9	< 0.001	175	42.4	95	26.9	111	30.8	< 0.001
DMFT ≥ 1	3888	91.1	1200	34.5		2255	54.2	808	20.5	825	25.3	
Experience of oral examination within 1 year												
No	3010	70.5	939	34.4		1710	52.8	611	20.3	689	26.9	0.041
Yes	1249	29.3	392	35.9	0.494	716	53.8	288	23.1	245	23.1	
Unknown	10	0.2	3	41.0		4	38.9	4	43.5	2	17.6	
Dental visit within 1 year												
No	2243	52.5	725	35.7	0.391	1294	53.2	429	19.4	520	27.4	0.010
Yes	2015	47.2	606	33.9		1131	52.9	470	23.1	414	24.0	
Unknown	11	0.3	3	39.4		5	41.3	4	41.8	2	16.9	

Table 2: Distribution of Alcohol consumption and smoking habit according to general characteristics in KNHANES VI-1*.

*The Sixth Korean National Health and Nutrition Examination Survey

[†]Alcohol Use Disorder Identification Test

[‡]Body Mass Index = Weight(kg)/ Height(m²)

[§]Impaired Fasting Glucose

After correcting for confounding variables, compared to the group with AUDIT scores of 7 or below, the group with scores of ≥ 8 had a 1.13-fold higher risk of periodontitis (95%CI, 0.90 - 1.42), which was borderline significant. Compared to never smokers, ex-smokers had a 1.27-fold higher risk of periodontitis (95%CI, 1.01 - 1.60) and current smokers had a 2.18-fold higher risk of periodontitis (95%CI, 1.75 - 2.72), both of which were significant (Table 3).

Variable	N (CPI ≥ 3)	Periodontitis			
		Crude OR		Adjusted OR*	
AUDIT					
≤ 7	791	1	Ref.	1	Ref.
≥ 8	443	1.37	1.15 - 1.63	1.13	0.90 - 1.42
Smoking					
Non-smoker	541	1	Ref.	1 [†]	Ref.
Ex-smoker	330	1.97	1.61 - 2.40	1.27	1.01 - 1.60
Current smoker	363	2.25	1.85 - 2.72	2.18	1.75 - 2.72

Table 3: Risk of periodontitis according to alcohol consumption and smoke habit.

*OR and 95% CI estimated using multiple logistic regression model adjusted for gender, age, education level, household income, diabetes mellitus, obesity, and dental visit within 1 year

To analyze the effect of the interaction between alcohol consumption and smoking on the prevalence of periodontitis, participants were divided into individuals with AUDIT scores ≤ 7 or ≥ 8 , into never smokers or smokers (i.e., ex- or current smoker), and into the ex-smokers and current smokers groups. Compared to never smokers with AUDIT scores of ≤ 7 , never smokers with AUDIT scores of ≥ 8 had a 0.92-fold higher risk of periodontitis (95%CI, 0.65 - 1.29), which was statistically insignificant. Ex- and current smokers with AUDIT scores of ≤ 7 had a 1.47-fold higher risk of periodontitis (95%CI, 1.14 - 1.90), which was significant. Ex- and current smokers with a high alcohol dependence (AUDIT ≥ 8) had a 1.99-fold higher risk of periodontitis (95%CI, 1.55 - 2.56), which was significant. In addition, the interaction between smoking and alcohol consumption had a statistically significant effect on the risk of periodontitis (p-interaction < 0.001) (Table 4).

Variable	N (CPI ≥ 3)	Periodontitis			
		Crude OR		Adjusted OR [†]	
AUDIT (-)* Smoking (-) [†]	467	1	Ref.	1	Ref.
AUDIT (+) [‡] Smoking (-)	74	0.83	0.61 - 1.13	0.92	0.65 - 1.29
AUDIT (-) Smoking (+) [§]	324	1.94	1.55 - 2.42	1.47	1.14 - 1.90
AUDIT (+) Smoking (+)	369	2.15	1.76 - 2.63	1.99	1.55 - 2.56
p-interaction					< 0.001

Table 4: Interaction for periodontitis between alcohol consumption and smoke habit.

*AUDIT score ≤ 7

[†]Never smoker

[‡]AUDIT score ≥ 8

[§]Ex-smoker or current smoker

// OR and 95% CI estimated using multiple logistic regression model adjusted for gender, age, education level, household income, diabetes mellitus, obesity, and dental visit within 1 year

Discussion

This study aimed to investigate the effects of alcohol consumption and smoking on oral health, specifically periodontitis. The results revealed that the group with high alcohol dependence (AUDIT score ≥ 8) had a 1.13-fold higher risk of periodontitis, which showed borderline significance. This is consistent with a study by Kim, *et al.* [15], in which a borderline significant association between harmful alco-

hol use and CPI was reported. In addition, ex-smokers and current smokers showed 1.27-fold and 2.18-fold higher risks of periodontitis, respectively, and these were significant. Park, *et al.* [16] previously reported that, among males, heavy drinkers had 1.271-fold higher periodontal treatment needs. The present study did not perform separate analyses by sex; however, these results are similar to those in the present study when the analysis was corrected for sex. Moreover, the group that was exposed to both alcohol and smoking had a significant 1.99-fold higher risk of periodontitis, compared to the groups exposed to either one of the factors, which demonstrates that the interaction between smoking and alcohol consumption has a statistically significant effect on periodontitis risk.

Several previous studies have shown a significant relationship between smoking and periodontal health. Shereef, *et al.* [17] compared a current smoker group with a nonsmoker group and demonstrated a significant effect on clinical attachment loss, whereas Tanaka, *et al.* [18] reported that the risk of periodontal disease in ever smokers was 1.56-fold higher than in never smokers, and that the risk of periodontal disease showed a positive correlation with the amount of smoking with borderline significance. Another study investigating women of childbearing age reported that smoking was a strong independent risk indicator for periodontitis [19]. The results of the present study also demonstrated that smoking was a positive risk factor for periodontitis, with the ex-smoker group having a 1.28-fold higher risk of periodontitis, compared to the nonsmoker group, and the current smoker group having a 2.26-fold higher risk. Furthermore, participants who had been exposed only to smoking but not alcohol showed a 1.46-fold elevation in periodontitis risk, whereas participants exposed to both smoking and alcohol showed a 1.99-fold rise in the risk of periodontitis. This finding demonstrated a positive interaction between smoking and alcohol consumption. This supports the results of animal experiments showing the development of periodontitis and furcation defects in mice simultaneously exposed to nicotine and alcohol [20]. It also shows trends similar to those observed in a previous study that reported that, compared to a no-smoking and no-drinking group, a ≥ 15 cigarettes per day and ≥ 0.5 glasses per day group had a 2.16-fold (1.72 - 2.72) higher risk of periodontitis, and a ≥ 13 pack years and ≥ 6.8 glass years group showed a 2.41-fold (1.04 - 1.06) higher risk [11].

In smokers, the oxygen tension is lower in the periodontal pocket, which is favored by anaerobic species [21]. This factor demonstrates that smoking interferes with the supply of oxygen to tissues and cells. In addition, smoking can impair revascularization in bones and soft tissues, which has an important role in the periodontium and in wound healing such as during dental implant treatment [22]. Furthermore, alcohol increases osteocyte apoptosis and has a direct effect on the number and activity of osteoblasts and osteoclasts [23].

Therefore, simultaneous exposure to smoking and alcohol can be an important harmful factor in periodontitis, and other diseases of the oral soft and hard tissues. Hence, the results in this study, which demonstrated the increased prevalence of periodontitis in the group exposed to both alcohol and smoking in comparison to the groups exposed to only one of these two factors, are well supported by known biological mechanisms. This is a strength of the present study.

This study nevertheless has several limitations. First, the independent variables of alcohol dependence and smoking status were investigated using a questionnaire. Measuring the levels of cotinine in the blood would have been a more precise method of examining smoking exposure. In a study by Lee, *et al.* [11], the risk of periodontitis was analyzed relative to the amount and duration of smoking and alcohol consumption, distinguishing between short-term and long-term exposure. The present study, on the other hand, simplified the definitions of smoking and alcohol dependence and analyzed the effect on periodontitis risk irrespective of the amount and duration of exposure. Therefore, it is highly significant that we were able to show an effect of alcohol dependency and smoking while using criteria that differ from those used in the previous study in not accounting for amount and duration. Moreover, the finding that a history of smoking had a significant effect on periodontitis risk, even in individuals who were not currently smoking, was particularly important. Second, this was a cross-sectional study. To demonstrate that alcohol and smoking are independent variables, exposure to alcohol and smoking needs to occur before the development of periodontitis. To this end, a cohort study could provide more profound results. Third, this study used the CPI as an index of periodontitis. The CPI is an easy method of evaluating the need for periodontal treatment in a local community;

however, it only assesses part of the mouth (e.g., half-mouth, index teeth, or fixed sites), and it therefore can underestimate the prevalence of periodontitis such as severe periodontitis [24]. Despite the limitations of this study, that alcohol dependence and smoking behavior are significant risk factors for periodontitis is a very meaningful result. Moreover, it was very important to demonstrate that alcohol and smoking act as independent variables, and that exposure to both of these factors showed a separate association with periodontitis.

In the future, further research will need to be conducted to investigate various other independent variables and their effects on oral health so that they can be used as indicators of oral health. In conclusion, this study revealed that alcohol and smoking are risk factors for periodontitis, and highlighted the need for further detailed research into various risk factors that can cause oral disease.

Conclusion

Alcohol consumption and smoking are risk factors for periodontitis.

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Conflict of Interest

This study was conducted without any external financial support.

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