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The association between the development and diagnosis of pulmonary disorder and oral health disease

Hae Eun Shin[1], Young-Ran Yeun[2], Yi Sub Kwak [3*], Hye-Young Kim[4*]

[1]Department of Preventive Dentistry, School of Dentistry, Kyungpook National University, Daegu, South Korea

[2]Department of Nursing, Kangwon National University, Hwangjogil, Dogyeeup, Samcheok, Gangwondo, Republic of Korea

[3*] DEU Exe-Physio Lab, Department of physical education, Dong-Eui University, Eomgwangno, Busanjin-gu, Busan, Republic of Korea

[4*] Department of Dental Hygiene, College of Health Science, Kangwon National University, Samcheok-si, Republic of Korea

Abstract

Periodontal disease and lung disease have many shared risk factors including: oral inflammation, genetics, smoking, and ageing. A more specific relationship outside of these risk factors has not yet been identified. Data collected from the Korean National Health and Nutrition Examination Survey (KNHANES) was analyzed to identify if a relationship exists between periodontal disease and lung disease. Of the 10,000 KNHANES participants, 5,251 cases completed an oral examination and all pulmonary function tests and these cases were selected for analysis. The KNHANES data analysis identified relationships between the oral healthcare maintenance practices and pulmonary function and subjective oral health, lung dysfunction, and higher decayed, missing, and filled-teeth (DMFT) index. The incidence of periodontal disease was 1.313 times higher in subjects classified with obstructive ventilation disorder. Future longitudinal studies are necessary to establish a clear correlation between periodontal disease and lung disease, but the conclusions drawn from the present study suggests a relationship is present between the development of periodontal disease and lung disease.

Keywords: Periodontal disease, Multi-factorial disease, Spirometry, Pulmonary function**.**

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Introduction

Periodontal disease is a pathological inflammatory condition marked by a serious gum infection that is caused by the bacteria that resides in plaque buildup. Periodontal disease when not treated, can permanently damage the gums, lead to tooth loss, destroy the jaw bone, or develop into a life-threatening infection. Periodontal disease affects about 30% of Korean adults and over 50% of the world's population [1-3]. Previous research has identified oral inflammation, an early warning sign of periodontal disease, as an indicator for other diseases such as chronic respiratory disease, cardiovascular disease, diabetes, and rheumatoid arthritis [4-6]. Evaluating the relationship among these diseases and the shared risk factors is important for understanding the cause of occurrence and etiology of multi-factorial diseases like periodontal disease.

Lung disease and cancers are the 5th leading cause of death in the world, affecting approximately 1.69 million people a year [7]. As of 2015, lung disease and cancers are also the 5th leading cause of death for men and the 4th leading cause of death for women in Korea [8]. Lung disease is associated with multiple risk factors including: genetics, smoking, ageing, atmospheric pollution, etc. [9]. Previous studies have identified many of these same risk factors, as risk factors that contribute to periodontal disease [10-12].

The Korean National Health and Nutrition Examination Survey (KNHANES) has proven to be a reliable and representative assessment of Korean health and nutritional status. In addition to many other components, KNHANES, utilizes a dental examination to assess oral health and a spirometry test to assess pulmonary function. Data collected with the KNHANES quantifies the prevalence of obstructive pulmonary disease, restrictive pulmonary disease, the oral hygiene status, and the standard oral health of adults over 40 years old in Korea.

Other than the identified risk factors shared between the development of periodontal disease and lung disease [13-15], a more specific relationship has not yet been established. Therefore, the purpose of this study was to identify if a relationship is present between periodontal disease and lung disease. It is hypothesized that the analysis of the KNHANES data will identify a significant relationship between periodontal disease and lung disease, including risk factors, development, and diagnoses.

Subjects and Methods

Subjects

The subject population was classified by either age, gender, level of education, and income. With regards to age, subjects were separated into 4 age groups: (1) 40-49 years old, (2) 50-59 years old, (3) 60-69 years old, and (4) 70-79 years old. With regards to education, subjects were separated into 3 groups: (1) Below middle school graduation, (2) Below high school graduation, and (3) Above college graduation. With regards to income, subjects were separated into 4 groups depending on Monthly Household Equalization (Monthly household income/√number of household members): (1) Low, (2) Medium-low, (3) Medium-high, and (4) High.

This study also employed drinking frequency, smoking experience, and Body Mass Index (BMI) as descriptive characteristics to separate the subjects into more specific populations. Subjects were divided into 2 groups based off reported drinking frequency: (1) Under once a month and (2) Over once a month. Subjects were also divided into 2 groups based off reported smoking experience: (1) No experience smoking and (2) Smoked or smoking. BMI was used a determinant of general health and subjects were divided into 3 groups based off measured BMI: (1) Below 18.5 was considered underweight, (2) More than 18.5 less than 25.0 was considered normal, (3) More than 25.0 was considered overweight.

Data Collection

This study was performed using data collected from the 6th Korean National Health and Nutrition Examination Survey (KNHANES, 2013-2015). The final data set selected for analysis consisted of 5,251 cases that completed an oral examination and all pulmonary function tests.

Pulmonary function test

Spirometry is a common respiration test used to evaluate pulmonary function. Forced Expired Volume (FEV1) is the volume of air expired in 1 second during forced exhalation. Forced Vital Capacity (FVC) is the total volume of air that can be expired during forced exhalation. By measuring forced exhalation and calculating the FEV1/FVC% ratio, pulmonary dysfunction may be diagnosed by comparing the measured FEV1/FVC% ratio to a predicted value [10-12].

Pulmonary function test was completed using the Digital Spirometer 1022 (Sensor Medic, Anaheim, CA, USA). Each spirometry trial consisted of maximum inhalation followed by maximum forced exhalation through the spirometer. Subjects performed 3 to 8 trials in order to obtain an FEV1/FVC% ratio that was used to diagnose pulmonary dysfunction. The criteria for diagnosing pulmonary dysfunction are: FEV1 and FVC values below 0.8 and an FEV1/FVC% ratio below 0.7 [10-12]. In this study subjects were either classified as normal, FEV1 and FVC values above 0.8 and an FEV1/FVC% ratio above 0.7, or as restrictive ventilatory defect, FEV1 and FVC values below 0.8 and an FEV1/FVC% ratio below 0.7.

Oral health

Dental health and the prevalence of periodontal disease were assessed using the Community Periodontal Index for Treatment Needs (CPITN). CPITN scores are judged by the inspection of the: first and second mandibular molars of the left and right side, the maxillary right central incisory, and the mandibular right central incisory.

Periodontal status was classified by a numerical point ranking system. Healthy periodontal tissue was 0 points. Hemorrhagic, or bleeding, periodontal tissue with plaque formation was between 1 to 2 points. Periodontal tissue with pocket formation with pocket depth between 3.5~5.5 mm was between 2 to 3 points. Periodontal tissue with deep pocket formation with pocket depth over 5.5 mm was 3 to 4 points. For this study cases with scores between 0 to 2 was considered normal. Cases with scores between 3 to 4 were classified as periodontal disease cases. The number of remaining teeth was determined based on the assumption normal adults have 28 teeth and do not have a third molar. Oral hygiene status was also identified using a subjective oral health assessment that assessed oral hygiene behaviors such as: the number of daily tooth brush cleanings, and experience with auxiliary oral hygiene devices, etc.

Data Analysis

Every data analysis was using Composite sample design analysis to every result have representativeness. A composite sample crossover analysis was performed to identify a relationship between pulmonary function and general characteristics, oral health behavior and periodontal disease, number of remaining tooth. Also oral health related index according to pulmonary function used Composite sample general linear model, and relationship with periodontal disease used Composite sample logistic regression analysis. Collected data was using IBM SPSS (IBM 23.0 for windows, SPSS Inc, USA) to analyze and significance level was specify 5% for judgement Statistical significance.

Results

The crossover analysis of demographic variables including: age, sex, income level, education level, BMI, drinking frequency and smoking experience did not identify any significant differences in the presence or absence of periodontal disease due to these general characteristics ($P<.05$). There was a significant difference in the presence of periodontal disease due to lung function limitations ($P=.005$) (Table 1).

Variables	Non-periodontitis		Periodontitis	N (%)	
	(n=3,847)		(n=1,404)	P-value*	
Age					.789
40-49	1,231	(39.6)	426	(39.6)	
50-59	1,202	(34.8)	437	(33.5)	
60-69	894	(16.9)	345	(17.9)	
70-79	520	(8.7)	196	(9.0)	
Gender					.159
Male	1,809	(52.3)	693	(54.8)	
Female	2,038	(47.7)	711	(45.2)	
Income					.157
Low	818	(21.4)	330	(24.8)	
Middle-low	998	(26.0)	343	(24.5)	
Middle-high	1,002	(25.9)	365	(25.3)	
High	1,029	(26.7)	366	(25.3)	
Education					.082
≤ Middle	1,449	(31.8)	579	(35.6)	
High	1,338	(37.5)	468	(36.5)	
≥ College	1,060	(30.7)	357	(27.9)	
BMI					.624
Under and normal	2469	(63.7)	912	(64.5)	
Overweight	1377	(36.3)	492	(35.5)	
Alcohol					.255
≤ 1 per month	1,592	(37.7)	559	(35.7)	
>1 per month	2,255	(62.3)	845	(64.3)	
Smoking					.287
None	2,156	(51.2)	738	(49.2)	
Done or do	1,691	(48.8)	666	(50.8)	
Disorder of ventilation					.005*
Normal	2,990	(80.6)	1,038	(75.8)	
Restrictive disorder	313	(7.6)	130	(9.0)	
Obstructive disorder	544	(11.8)	236	(15.2)	

Table 1. Demographic distribution according to periodontitis. *: P<.05, by complex samples chi-square test.

Table 2 identifies the relationship between various oral health and hygiene behaviors and attenuated lung function. A statistically significant difference in the normal lung function classification was present for subjects who brush their teeth more than 3 times in a day and regularly use dental floss and oral mouth rinsing solutions (P<.05).

Variables	Lung function				N (%) p-value*
	Normal (n=4,028)		Disorder (n=1,223)		
Self-perceived oral health status					.003*
Healthy	1,929	(48.3)	666	(54.6)	
Normal	1,543	(37.8)	404	(34.0)	
Not healthy	556	(13.9)	153	(11.4)	
Oral examination/1 year					.164
Yes	1,347	(33.9)	382	(31.4)	
No	2,681	(66.1)	841	(68.6)	
Brushing frequency					<.001*
≤ 1	418	(10.3)	230	(18.3)	
2	1,555	(38.0)	502	(41.2)	
3	1,431	(35.6)	364	(29.7)	
≥ 4	624	(16.1)	127	(10.8)	
Use of dental floss					<.001*
Yes	838	(21.3)	159	(14.7)	
No	3,190	(78.7)	1,064	(85.3)	
Use of interdental brush					.064
Yes	837	(20.4)	203	(18.3)	
No	3,191	(79.6)	1,020	(82.4)	
Use of mouth rinsing solution					.026*
Yes	932	(23.6)	236	(17.9)	
No	3,096	(76.4)	987	(80.1)	

Table 2. Oral health behavior and lung function. *: p<0.05 by complex samples chi-square test.

The DMFT index of subjects classified with normal lung function was found to be significantly lower than that of the subjects classified with restrictive or obstructive disorder of ventilation (P<.05). Better self-perceived oral health was also found to be related to a statistically significantly higher classification of normal lung function (P<.05) (Table 3).

Variables	Disorder of ventilation						(mean ± SD) p-value**
	Normal		Restrictive	Obstructive			
DT	0.53	± 1.26	0.63	± 1.44	0.53	± 1.17	.077
DMFT	6.90	± 5.20	7.41	± 5.83	7.83	± 6.70	.021**
Self-perceived oral health status	2.52	± 0.93	2.43	± 0.89	2.42	± 0.96	.010**
Number of remaining tooth	24.97	± 5.23	25.00	± 4.94	24.80	± 5.37	.757

Table 3. Oral health status according to lung function. **: p<0.05 by complex samples general linear model.

The logistic regression analysis identified a strong relationship between lung function and periodontal disease. The risk of developing periodontal disease was 1.259 times higher for subjects with restrictive ventilation disorder than in subjects with normal pulmonary function (P<.05). When the analysis was adjusted for age, sex, household income, education level, drinking frequency, and smoking status, the risk of developing periodontal disease was 1.266 times higher, but not statistically significant (P>.05). The risk of developing periodontal disease was 1.363 times higher for subjects with obstructive ventilation disorder than in subjects with normal pulmonary function (P<.05). When the analysis was adjusted for age, gender,

household income, education level, drinking frequency, and smoking status, the risk of developing periodontal disease was 1.313 times higher (P<.05) (Table 4).

Variables	I		II	III		
	OR	95% CI	OR	95% CI	OR	95% CI
Normal	ref.		ref.		ref.	
Restrictive	1.259	0.971-1.633	1.253	0.962-1.634	1.266	0.966-1.657
Obstructive	1.363	1.108-1.678	1.344	1.066-1.696	1.313	1.039-1.660

Table 4. Logistic regression analysis for association between periodontal disease and lung function. *: p<0.05. CI: Confidence Interval; OR: Odds Ratio. I: Unadjusted model. II: Age, gender adjusted model. III: Age, gender, Income, education, alcohol, smoking adjusted model.

Discussion

This study was designed to identify the relationship between lung ventilation disorder and oral health using data collected from the KNHANES (2013-2015). Previous studies have confirmed an association between oral health and hygiene behaviors and pulmonary dysfunction [16]. Liu et al. reported that chronic obstructive pulmonary disorder (COPD) was associated with a decreased frequency of proper oral care behavior (*i.e.* toothbrush use) and a decrease in COPD frequency was associated with improved oral hygiene status. These findings have been supported by other studies confirming the negative effects of inadequate oral hygiene behavior on the development of COPD [17].

Scaling is dental procedure involving the removal of dental plaque and tartar. Zhou et al. [18] identified scaling as a treatment that may help improve risk factors for the development of COPD. Zhou reported a statistically significant (P<.05) relationship between a lower DMFT index and normal lung function. These conclusions are consistent with the present study.

Contrary to the results of this study, Shin et al. [19], found that the DMFT index results were not statistically significantly related to lung function. However, Shin et al. did identify that the risk of developing COPD was 3.93 times higher for individuals with 20 or less teeth. These results are congruent with the present study and supported by findings in other studies. Barros et al. [20] reported that edentulism, or toothlessness, was associated with attenuated pulmonary function. Liu et al. [16] concluded that the severity of lung disease is associated with a smaller number of teeth. Kim et al. [21] also found that tooth loss was significantly related to lung ventilation disorder. The contradictory conclusion drawn from Shin et al. [19] regarding the relationship between the DMFT index and lung function, could be a result of a DMFT index distribution that is inconsistent with other studies [22,23].

Jin et al. [24] concluded that there were no statistically significant associations between the risk factors of periodontal disease and the risk factors of attenuated pulmonary function.

This result is supported by Scannapieco et al. [25] who also found that there was no significant association between gingival bleeding and respiratory disease. Jin et al. did also conclude that there was a higher prevalence of periodontal disease in subjects with pulmonary disease then there was in subjects with normal pulmonary function. This conclusion does support the findings of the present study that there is a relationship present between periodontal disease and lung disease. This relationship has also been previously identified by Deo et al. [22] who reported that periodontal disease is a common factor in subjects with severe COPD and that poor periodontal status is associated with an increased risk for developing COPD. Katancik et al. [23] identified that subjects with chronic lung disease had a higher occurrence of loss of gingival attachment.

Conclusion

The purpose of this study was to identify a relationship between periodontal disease and lung disease in Korean adults using primordial data gathered with the 6th KNHANES. From the data analysis the following conclusions were obtained: (1) A significant difference is present in the distribution of oral healthcare maintenance practices, such as the number of daily tooth brush and dental floss cleanings, among subjects with normal pulmonary function and subjects with attenuated pulmonary function, (2) Higher DMFT indexes were observed in subjects with lung dysfunction and low subjective oral health, and (3) The incidence of periodontal disease was 1.313 times higher in subjects classified with obstructive ventilation disorder.

Limitations

The results from this study do not deduce any causal relationship but do identify a strong correlational relationship between periodontal disease and lung disease. Future mechanistic studies are needed to identify the causal relationship between the shared risk factors and development of periodontal disease and lung disease. It is possible that the prevalence of periodontal disease was underestimated in the KNHANES data gathered due to the episodic nature of gingival recession and periodontal disease. Therefore, more research is required to establish a clear correlation between oral health and lung ventilation. Future research should take a longitudinal approach, combining various analyses and clinical trials, to account for the periodic nature of periodontal disease.

However, this study analyzed the data of the KNHANES which has been proven to be a reliable representation of the degree of Korean public health. The present study provides evidence supporting the relationship between oral health and pulmonary function using a large-scale data collection.

References

1. Moon HS. Suggestions for professionalization and improvement of oral health ministration in Korea. J Korean Dent Assoc 1997; 6: 351-352.
2. Burt B. Position paper: Epidemiology of periodontal diseases. J Periodontol 2005; 76: 1406-1419.
3. Sanz M, D'Aiuto F, Deanfield J, et al. European workshop in periodontal health and cardiovascular disease-scientific evidence on the association between periodontal and cardiovascular diseases: a review of the literature. Eur Heart J Suppl 2010; 12: 83-112.
4. Ying Ouyang X, Mei Xiao W, Chu Y, et al. Influence of periodontal intervention therapy on risk of cardiovascular disease. Periodontol 2000 2001; 56: 227-257.
5. Taiyeb-Ali TB, Raman RP, Vaithilingam RD. Relationship between periodontal disease and diabetes mellitus- an Asian perspective. Periodontol 2000 2011; 56: 258-268.
6. Martinez-Martinez RE, Abud-Mendoza C, Patino-Marin N, et al. Detection of periodontal bacterial DNA in serum and synovial fluid in refractory rheumatoid arthritis patients. J Clin Periodontol 2009; 36: 1004-1010.
7. Lopez AD, Shibuya K, Rao C, et al. Chronic obstructive pulmonary disease: current burden and future projections. Eur Respir J 2006; 27: 397-412.
8. Statistics Korea. 2015 Causes of death statistics. Daejeon: Statistics Korea;2016: 13
9. Lee GY. Review: Epidemiology of chronic obstructive pulmonary disease. Tuberc Respir Dis 2003; 55: 333-343.
10. Ries AL. Measurement of lung volumes. Clin Chest Med 1989; 10: 177-186.
11. Pauwels FA, Buist AS, Calverley PM, et al. Global strategy for the diagnosis, management, and prevention of chronic obstructive pulmonary disease. NHLBI/WHO Global Initiative for chronic obstructive lung disease (GOLD) workshop summary. Am J Respir Crit Care Med 2001; 163: 1256-1276.
12. Pellegrino R, Viegi G, Brusasco V, et al. Interpretative strategies for lung function tests. Eur Respir J 2005; 26: 948-968.
13. Terashima T, Chubachi S, Matsuzaki T, et al. The association between dental health and nutritional status in chronic obstructive pulmonary disease. Chron Respir Dis 2017; 14: 334-341.
14. Terpenning MS. The relationship between infections and chronic respiratory diseases: an overview. Ann Periodontol 2001; 6: 66-70.
15. Hayes C, Sparrow D, Cohen M, et al. The association between alveolar bone loss and pulmonary function: the VA dental longitudinal study. Ann Periodontol 1998; 3: 257-261.
16. Liu Z, Zhang W, Zhang J, et al. Oral hygiene, periodontal health and chronic obstructive pulmonary disease exacerbations. J Clin Periodontol 2012; 39: 45-52.
17. Wang Z, Zhou X, Zhang J, et al. Periodontal health, oral health behaviours, and chronic obstructive pulmonary disease. J Clin Periodontol 2009; 36: 750-755.
18. Zhou X, Han J, Liu Z, et al. Effects of periodontal treatment on lung function and exacerbation frequency in patients with chronic obstructive pulmonary disease and chronic periodontitis-a 2-year pilot randomized controlled trial. J Clin Periodontol 2014; 41: 564-572.
19. Shin HS, Ahn YS, Lim DS. Association between the number of existing permanent teeth and chronic obstructive pulmonary disease. J Dent Hyg Sci 2016; 16: 217-224.
20. Barros SP, Suruki R, Loewy ZG, et al. A cohort study of the impact of tooth loss and periodontal disease on respiratory events among COPD subjects-modulatory role of systemic biomarkers of inflammation. PloS One 2013; 8: e68592.
21. Kim SW, Han K, Kim SY, et al. The relationship between the number of natural teeth and airflow obstruction: a cross-sectional study using data from the Korean National Health and Nutrition Examination Survey. Int J Chron Obstruct Pulmon Dis 2016; 11: 13-21.
22. Deo V, Bhongade ML, Ansari S, et al. Periodontitis as a potential risk factor for chronic obstructive pulmonary disease: a retrospective study. Indian J Dent Res 2009; 20: 466-470.
23. Katancik JA, Kritchevsky S, Weyant RJ, et al. Periodontitis and airway obstruction. J Periodontol 2005; 76: 2161-2167.
24. Jin HJ, Kim EK, An SY, et al. Relationship between periodontal status and chronic obstructive pulmonary disease. J Korean Acad Oral Health 2013; 37: 147-153.
25. Scannapieco FA, Ho AW. Potential associations between chronic respiratory disease and periodontal disease: analysis of national health and nutrition examination survey III. J Periodontol 2001; 72: 50-56.

*Correspondence to:

Yi-Sub Kwak

Department of physical education

Dong-Eui University

Eomgwangno, Busanjin-gu, Busan, 47340,

Republic of Korea

E-mail: ysk2003@deu.ac.kr

Hye-Young Kim

Department of Dental Hygiene

College of Health Science

Kangwon National University

Samcheok-si, 25949,

Republic of Korea

E-mail: khy0606@daum.net