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ORIGINAL ARTICLE

Association Serum Lipid Levels with Periodontal Disease in Korean Adults Over the Age of 50: The Korea National Health and Nutrition Examination Survey, 2016-2018

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PURPOSE: Although the prevalence of periodontal disease in adults over the age of 50 is rapidly increasing, the association between serum lipid levels and periodontal disease in Korean adults over the age of 50 still remains to investigate. Thus, the aim was to determine the effect of serum lipid levels on periodontal disease in older adults over the age of 50 using data from the seventh Korea National Health and Nutrition Examination Survey.

METHODS: The study used the data of 809 adults aged ≥50 years targeted in the 7th Korea National Health and Nutrition Examination Survey, 2016-2018. Levels of total cholesterol, triglyceride, high density- lipoprotein (HDL-cholesterol), and low density-lipoprotein (LDL-cholesterol) and periodontal conditions were measured. Complex-sample chi square test and linear regression were used to analyze the relationship serum lipid levels with periodontal disease.

RESULTS: The results of chi square tests showed that the prevalence of periodontal disease among the elderly ≥50 years were statistically significant differences according to gender, age, education level, marital status, and smoking status. After adjusting for all confounding factors, HDL-cholesterol alleviated periodontal disease, while LDL-cholesterol exacerbates periodontal disease. However, total cholesterol and triglycerides were not connected with periodontal disease.

CONCLUSIONS: Therefore, controlling HDL and LDL cholesterol levels through physical exercise could be a preventative measure for periodontal disease.

Key words: Periodontal disease, Total cholesterol, Triglyceride, HDL-cholesterol, LDL-cholesterol, Physical exercise

INTRODUCTION

The prevalence of periodontal disease is 20-50%, and it is a disease that affects about 11.2% of the world's population [1]. In 2018, the prevalence of periodontal disease in Korea was 23.4% [2], and it took the second place in terms of frequent disease outpatients, with a total cost of 1.345 trillion won [3].

Periodontal disease is an inflammatory disease that progressively destroys the tissues surrounding and supporting the teeth, and it is one of the main causes of tooth loss [4]. The causes of periodontal disease include local causes, such as bacterial biofilm, and systemic causes, such as smoking, stress, drugs, diabetes, malnutrition, and immunosuppression [5]. Periodontal disease is revealed as age-related. The prevalence rate of periodontal disease was 5.2% for men and 2.9% for women at the age of 19-29 in Korea, but increases rapidly to 49.7% for men and 32.8% for women at the age of 50-59 [2]. Middle age is a period in which oral diseases are accumulated in earnest, and examining the variables related to periodontal disease in this period will have great meaning in maintain-

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ing the quality of life through middle age and old age.

Dyslipidemia is a condition in which serum lipids or lipoproteins are high or low outside the normal range, and it appears as an increase in total blood cholesterol, an increase in low density-lipoprotein (LDL-cholesterol), and a decrease in high density-lipoprotein (HDL-cholesterol) [6]. Dyslipidemia causes hypertension, diabetes, metabolic syndrome, stroke and cancer [7-9]. According to previous studies, dyslipidemia has been reported to be related to periodontal disease. Lianhui et al. [10] reported that, after meta-analysis of 7 observational studies, the serum triglycerides and total cholesterol of periodontitis patients were significantly higher than those of the healthy group. A large cross-sectional study of women over 20 years of age showed that low HDL-cholesterol and high LDL-cholesterol were associated with periodontal disease [11]. In response, Fentoğlu et al. [12] reported that lipoprotein-related inflammatory mediators play an important role in the relationship between periodontal disease and hyperlipidemia through the study of 123 hyperlipidemic patients. Buhlin et al. [13] also reported that dyslipidemia induces an increase in the pre-inflammatory state and oxidative stress, resulting in an imbalance in antioxidant defense, and consequently increases the likelihood of periodontitis relaxation.

Although studies on dyslipidemia and periodontal disease are being actively conducted as described above, studies have been mainly conducted on periodontitis patients, women, or adults. There are few studies that have identified the exact risk factors for periodontal disease with cholesterol levels adults over the age of 50, whose prevalence of periodontal disease is rapidly increasing. Therefore, this study aims to determine the effect of serum lipid levels on periodontal disease in older adults over the age of 50 using data from the seventh Korea National Health and Nutrition Examination Survey (KNHANES VII) 2016-2018.

METHODS

1. Study participants

This study is a secondary analysis study based on the korea national health and nutrition examination survey (KNHANES) VII. The KNHANES is a government-designated statistics conducted by the Korea Disease Control and Prevention Agency (KDCA), and is a statutory survey on people's health behavior, chronic disease prevalence, and food and nutrition intake [14]. For this study, 7,116 people aged 50 or older adults were selected out of 16,489 KNHANES VII subjects, and 809 people who participated in the health survey and oral examination and had no missing values in major variables were selected as final subjects.

2. Outcomes

1) Demographic Characteristics

General variables included gender, age, household income, education level, and marital status and and these variables were collected by self report questionnaires. Health-related characteristics included smoking, alcohol consumption, body mass index (BMI), hypertension and diabetes. Age was categorized into three groups: 50-59, 60-69, and ≥70. Household income was classified into four categories compare to monthly income: low, low middle, upper middle, and high. Educational level was classified as below elementary school graduation, middle school graduation, high school graduation, and university graduation or higher.

Marital status was categorized as married, married-no spouse, and unmarried. Smoking was classified into current smoking, past smoking, and non-smoking, and alcohol consumption was classified as less than once a month, 1-4 times a month, and more than twice a week. BMI was classified as underweight (<18.5 kg/m^2), normal weight (18.5-24.9 kg/m^2), and obese (≥25 kg/m^2). Prevalence of hypertension and diabetes was defined as a case diagnosed by a doctor in the morbidity item of the health questionnaire.

2) Serum lipid levels

Serum lipid levels were measured through a blood test for a total of four items: Total cholesterol, triglyceride, HDL-cholesterol, and LDL-cholesterol.

3) Periodontal Disease

Periodontal disease was measured by the prevalence of periodontal disease and Community Periodontal Index of Treatment Needs (CPITN) using the community periodontal index (CPI). CPI is a tool to measure the severity and degree of periodontal diseases recommended by World Health Organization (WHO). CPI measured the periodontal status in 4 stages based on the 3 characteristics of bleeding, dental calculus, and gingival sulcus. The index teeth included six regions: maxillary right molar, maxillary central incisor, maxillary left molar, mandibular right molar, mandibular central incisor, and mandibular left molar. For each region, 0 points for no periodontal disease, 1 point for bleeding on probing, 2 points for calculus with plaque seen or felt by probing, 3 points for pathological pocket 4-5 mm, and 4 points for pathological pocket 6 mm or more were assigned. The prevalence of periodontal dis-

ease was classified into sound periodontal condition (0-2 points) and periodontal disease (3-4 points) after determining the maximum value of each CPI score in the six regions as the subject's final score [15]. The CPITN is the sum of the CPIs, and has a range of 0 to 24 points, and a higher score means worse periodontal disease status [16].

3. Statistical analysis

Since the data of the KNHANES VII is a sample survey, not a total survey, the data analysis was conducted using a complex sample analysis applying the sample weights presented in the KNHANES VII data. The difference in the prevalence of periodontal disease according to the characteristics of the study subjects was obtained by chi square tests. Complex-sample linear regression analysis was performed to confirm the associations between serum lipid levels and CPITN. Model 1 was an unadjusted analysis, and Model 2 was analyzed by adjusting for gender and age. Complex-sample linear regression analysis was applied to verify the effect of serum lipid levels on CPITN. The model was constructed in three steps. In Model 1, no adjusted variables were input, in Model 2, general characteristics were adjusted, and in Model 3, general characteristics and health-related characteristics were adjusted. Statistical analyses were conducted using SPSS ver. 26.0 software (IBM Co., Armonk, NY, USA), and the statistical significance was determined for $p<.05$.

4. Ethical consideration

The KNHANES VII was conducted with the approval of the Institutional Review Board (IRB) of the KDCA (2018-01-03-P-A). In compliance with the Personal Information Protection Act and the Statistical Act, KDCA provides only de-identified data so that individuals cannot be estimated from the survey data. KNHANES VII can be downloaded from the KNHANES website [14]. Therefore, this study does not contain any information that can confirm the participant's personal identity.

RESULTS

1. Differences in the prevalence of periodontal disease according to the characteristics of participants

The characteristics of the participants and differences in the prevalence of periodontal disease according to the general characteristics were summarized in Table 1. The prevalence of periodontal disease among the elderly ≥50 years was 59.7%, and there were statistically significant differences according to gender ($p<.001$), age ($p=.001$), education level ($p=.013$), marital status ($p=.033$), and smoking status ($p<.001$). The prevalence of periodontal disease in men was 67.5%, and the prevalence of women was 52.2%. The prevalence of periodontal disease was found to be higher with age, lower educational background, and unmarried individuals. Current or past smoking had a relatively higher prevalence of periodontal disease than non-smoking. There was no difference in the

Table 1. Characteristics of the participants

Variables	Periodontal disease			*p*-value
	Total	Yes	No	
	N	N (weighted %)	N (weighted %)	
Gender				<.001
Male	433	294 (67.5)	139 (32.5)	
Female	376	189 (52.2)	187 (47.8)	
Age (yr)				.001
50–59	367	194 (52.5)	173 (47.5)	
60–69	285	181 (64.0)	104 (36.0)	
≥70	157	108 (70.0)	49 (30.0)	
Household income				.073
Low	233	150 (63.3)	83 (36.7)	
Low middle	204	129 (66.2)	75 (33.8)	
Upper middle	135	92 (54.7)	73 (45.3)	
High	207	112 (54.5)	95 (45.5)	
Education level				.013
≤Elementary school	266	176 (67.6)	90 (32.4)	
Middle school	148	89 (60.5)	59 (39.5)	
High school	238	138 (57.9)	100 (42.1)	
≥University	157	80 (49.7)	77 (50.3)	
Marital status				.033
Married	613	352 (57.3)	261 (42.7)	
Married-no spouse	177	118 (67.9)	59 (32.1)	
Unmarried	19	13 (68.0)	6 (32.0)	
Smoking				<.001
Current	201	153 (75.3)	48 (24.7)	
Past	206	130 (63.9)	76 (36.1)	
Never	402	200 (51.5)	202 (48.5)	
Alcohol consumption				.056
<1/mo	376	215 (57.1)	161 (42.9)	
1–4/mo	196	107 (56.6)	89 (43.4)	
≥2/week	237	161 (67.5)	76 (32.5)	
BMI (kg/m^2)				.164
Underweight	3	2 (71.8)	1 (28.2)	
Normal	397	225 (56.4)	172 (43.6)	
Obesity	409	256 (63.1)	153 (36.9)	
Hypertension				
Yes	351	222 (63.1)	129 (36.9)	.185
No	458	261 (57.7)	197 (42.3)	
Diabetes mellitus				
Yes	168	111 (66.1)	57 (33.9)	.106
No	641	372 (58.4)	269 (41.6)	

Table 2. Associations between serum lipid levels and periodontal disease

Lipid profile	Model	B	SE	*p*-value
Total cholesterol	Model 1	-0.005	0.004	.210
	Model 2	-0.002	0.004	.571
Triglyceride	Model 1	-0.001	0.001	.930
	Model 2	-0.001	0.001	.578
HDL	Model 1	-0.032	0.019	.095
	Model 2	-0.026	0.018	.152
LDL	Model 1	0.000	0.005	.972
	Model 2	0.004	0.005	.445

prevalence of periodontal disease according to the disease-related variables, diabetes and hypertension.

2. Association between serum lipid levels and CPITN

The results of verifying the association between serum lipid levels and CPITN were showed in Table 2. As HDL-cholesterol increased, CPITN was found to decrease, but there was no statistically significant difference (B = -0.032, p = .095). Total cholesterol, triglyceride, and LDL-cholesterol concentrations did not show a significant association with CPITN in both the unadjusted model and the sex and age-adjusted model.

3. Effect of serum lipid levels on CPITN

Table 3 demonstrates the effect of serum lipid levels on CPITN. Model I was analyzed regarding serum lipid levels with respect to CPITN. As a result of the regression coefficient significance test, total cholesterol (B = -0.03, p = .002), triglyceride (B = 0.04, p = .031), and LDL (B = 0.03, p = .005) were found to have an effect on CPITN.

Model II was analyzed the effect of serum lipid levels on CPITN by adjusting for general characteristics. It was verified that LDL (B = 0.03, p = .026) affects CPITN.

Model II was analyzed the effect of serum lipid levels on CPITN by adjusting for general characteristics and health related characteristics. HDL-cholesterol (B = -0.04, p = .048) and LDL-cholesterol (B = 0.03, p = .017) were found to have an effect on CPITN. That is, as the HDL increased by 1 mg/dL, CPITN decreased by 0.04 points, and as the LDL increased by 1 mg/dL, CPITN increased by 0.03 points.

DISCUSSION

Periodontal disease, a chronic inflammatory disease, is one of the representative oral diseases and is caused by pathogenic microorganisms, genetic factors, and environmental factors. Periodontal disease is also reported to be closely related to various systemic diseases such as pregnancy side effects, cardiovascular disease, respiratory disease, diabetes, and osteoporosis [17-20]. However, the pathogenic factors acting on the development process have not been clearly identified, and the effects of extra oral physical factors such as nutritional disorders and metabolic disorders on periodontal disease have not been accurately identified [21,22]. Considering the risk factors that periodontal disease induces or persists systemically and can deteriorate the quality of life for a long period of time, finding and excluding the risk factors is an effective way to improve oral health [23]. This study was conducted to provide basic data for the management of periodontal disease in older people by identifying the effect of serum lipid levels in adults over 50 years of age on periodontal disease, which is rapidly increasing in the prevalence of periodontal disease.

As a result of the study, HDL-cholesterol impacts on alleviated periodontal disease, while LDL-cholesterol aggravated periodontal disease. Total cholesterol and triglycerides were not connected with periodontal disease. This is similar to a study reported by Nepomuceno et al. [24] that peritoneal disease (PD) is significantly aggregated with reduction in HDL-cholesterol and evolution of LDL-cholesterol and triglyceride concentrations by meta-analyzing 19 papers. However, this study was somewhat different from studies targeting adults 19 years of age or older. In a study analyzing the correlation of total cholesterol levels, triglyceride levels, and periodontal conditions, Kim and Nam [25] showed that prevalence of periodontal disease was high in high-triglyceride group, adjusted for the subjects' demographic characteristics such as age, gender, house income, marital status, home ownership, number of persons living together, health insurance coverage, and economic activity. Han et al. [26] reported that high triglycerides and low HDL-cholesterol were significantly associated with periodontal disease in a study on the relationship between dyslipidemia and periodontitis according to age, sex, smoking, and alcohol use. This difference is thought to be due to the high correlation between periodontal disease and age. Han and Yi [27] also supported the results of this study by reporting that HDL-cholesterol was associated with periodontal disease in both the under 40 age group and the over 40 age group, and LDL was associated in the over 40 age group.

Dyslipidemia and periodontitis are both chronic inflammatory diseases characterized by an elevated level of inflammatory mediators. Chronic systemic inflammation can change lipid metabolism and raise plasma levels of unregulated cytokines and hormones. Fentolu et al. [28], reported that increased concentrations of tumor necrosis factor alpha

Table 3. Effect of serum lipid levels on CPITN

Variable	Model 1			Model 2			Model 3		
	B	SE	*p*-value	B	SE	*p*-value	B	SE	*p*-value
Total cholesterol	-0.03	0.01	.002	-0.02	0.01	.072	-0.01	0.01	.110
Triglyceride	0.04	0.00	.031	0.00	0.00	.281	0.00	0.00	.482
HDL	-0.02	0.02	.589	-0.02	0.02	.229	-0.04	0.02	.048
LDL	0.03	0.01	.005	0.03	0.01	.026	0.03	0.01	.017
Gender									
Male				2.81	0.36	< .001	2.00	0.62	.001
Female				(ref)			(ref)		
Age (yr)									
50 – 59				0.70	0.51	.178	0.60	0.53	.257
60 – 69				1.22	0.51	.017	1.17	0.52	.027
≥ 70				(ref)			(ref)		
Household income				0.55	0.56				
Low				1.32	0.51	.328	0.54	0.55	.321
Low middle				-0.40	0.50	.011	1.34	0.51	.009
Upper middle				0.55	0.56	.414	-0.24	0.47	.609
High				(ref)			(ref)		
Education level									
≤ Elementary				2.59	0.57	< .001	2.30	0.54	< .001
Middle school				1.82	0.59	.002	1.48	0.58	.011
High school				1.63	0.52	.002	1.36	0.51	.008
≥ University				(ref)			(ref)		
Marital status									
Married				-1.54	1.35	.257	-1.29	1.35	.340
Married-no spouse				-0.24	1.40	.860	-0.03	1.40	.983
Unmarried				(ref)			(ref)		
Smoking									
Current							0.84	0.64	.192
Past							0.09	0.61	.880
Never							(ref)		
Alcohol consumption									
< 1/mo							-1.23	0.55	.026
1 – 4/mo							-1.17	0.56	.038
≥ 2/week							(ref)		
BMI									
Underweight							4.03	1.21	.001
Normal							0.01	0.34	.974
Obesity							(ref)		
Hypertension									
Yes							0.78	0.37	.039
No							(ref)		
Diabetes mellitus									
Yes							-0.37	0.41	.367
No							(ref)		

(TNF-ft), interleukin-1 (IL-1) and IL-6 in gingival crevicular fluid (GCF) and serum could be linking factors between periodontal disease and Dyslipidemia. Zhou et al. [29] also said that dyslipidemia plays an important role in the development of periodontitis by affecting the production of pro-inflammatory cytokines. As the relationship between dyslipidemia and periodontitis becomes clear as described above, a therapeutic strategy to limit dyslipidemia is required for clinical management of periodontitis.

Gender, age, income level, education level, systemic disease, sleep time, oral health level, chewing problem and chewing discomfort are reported

to be related as risk factors for periodontal disease other than the blood lipid concentration confirmed in this study [30]. In this study, the prevalence of periodontal disease also showed a tendency to increase with age. Kim and Ahn [30] reported that the cause of the increase in periodontal disease with increasing age was not due to aging itself, but rather as a result of the accumulation of plaque and tartar over time.

Smoking showed a high association with periodontal disease as in previous studies [31]. Smoking has been reported to be a major factor in tooth loss and to have a significant impact on the occurrence and progression of periodontal disease [32,33]. Smoking cessation intervention is considered essential for successful periodontal improvement.

This study is of great significance as the first paper to confirm the effect of serum lipid levels on periodontal disease in the elderly over 50. The limitations of this study in deriving such analysis results are as follows. First, the number of people surveyed was small because the subjects were over 50 years of age during the National Health and Nutrition Survey and a total of four items, total cholesterol, triglyceride, HDL-cholesterol, and LDL-cholesterol, were measured through blood tests. Second, there was a large difference in the prevalence of periodontal disease according to gender, but stratification analysis according to gender could not be conducted. In the future, studies are needed to confirm the effect of serum lipid levels on periodontal disease according to gender. Third, it may not be able to predict disorder since this is a cross-sectional study.

Although the findings show a link between periodontal disease and serum lipid levels, further research using follow-up cohort designs is needed to fully understand the true relationship between serum lipid levels and periodontal disease.

CONCLUSIONS

This study used 809 adults aged 50 or older as analysis data among the KNHANES VII data to find out the relationship between serum lipid levels and periodontal disease in the middle and elderly. The results have shown that HDL-cholesterol impacts on alleviated periodontal disease, while LDL-cholesterol aggravates periodontal disease. However, It seems that the total cholesterol and triglycerides were not connected with periodontal disease.

CONFLICT OF INTEREST

The authors declare that they do not have conflict of interest.

AUTHOR CONTRIBUTIONS

Conceptualization: Y Yeun; Data curation: Y Yeun; Formal analysis: Y Yeun, H Kim, Y Kwak ; Funding acquisition: H Kim; Methodology: H Kim, Y Kwak; Visualization: H Kim, Y Kwak; Writing - original draft: H Kim, Y Kwak.

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