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Association of Some Vitamins and Minerals with Periodontitis in a Nationally Representative Sample of Korean Young Adults

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Abstract The purpose of this study was to investigate whether the intakes of some kinds of vitamins and minerals are associated with periodontitis in a nationally representative sample of young adults. This study comprised 2049 young adults aged 19–39 years who took both periodontal examination and nutrition survey. The vitamin and mineral intakes were calculated from dietary intake data gained by complete one-day 24-h recall interviews, and the intake levels for each nutrient were classified by the Recommended Nutrient Intake (RNI) in Dietary Reference Intakes for Koreans and median values. Periodontitis was assessed using Community Periodontal Index (CPI). Multivariate logistic regression analyses were performed in a whole sample and subgroups with the strata of gender or smoking, following a complex sampling design. In analyses according to RNI, a lower intake of niacin was significantly associated with periodontitis in young adults (odd ratio [OR] 1.47, 95% confidential interval [CI] 1.09–2.00) and in its subgroup of women (OR 1.70; 95% CI 1.10–2.64) and current non-smokers (OR 1.75; 95% CI 1.22–2.51). Whereas, in analyses according to median intake values, there were significant associations of periodontitis with a lower intake of niacin in women (OR 1.58; 95% CI 1.02–2.46) and current non-smokers (OR 1.50; 95% CI 1.01–2.22), with lower intake of vitamin C in women (OR 1.66; 95% CI 1.04–2.64) and in current non-smokers (OR 1.49; 95% CI 1.04–2.14), with lower intake of iron in women (OR 1.85; 95% CI 1.11–3.07), and with lower intake of vitamin A marginally in women (OR 1.56; 95% CI 1.00–2.44). In young adults, periodonitis is significantly associated with the lower intakes of niacin, vitamin C, and iron, especially in women and current non-smokers.

Keywords Niacin · vitamin C · iron · periodontitis · association

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Introduction

Periodontitis is a chronic inflammatory disease that leads to destruction of the connective tissue and alveolar bone around teeth [1]. Due to its high prevalence in adults, it is a major cause of teeth extraction in adults and represents one of the important public health problems to increase the burden of chronic diseases in many countries [2, 3]. In Korea, the prevalence of periodontitis is about 30% among adults in recent years [4].

Several studies have reported that periodontitis was positively associated with oxidative stress as increased levels of oxidative stress parameters were observed in patients with periodontitis [5, 6]. It has been also noted as the link for periodontitis and chronic systemic disorder [7–9]. Excessive free radicals generated by periodontitis or systemic diseases could inhibit internal regulatory systems and reciprocally worsen the inflammatory process of them [9–11].

Vitamins and minerals are nutrients essential to metabolism of carbohydrate, protein and lipid, and normal operation of body regulation systems including redox reactions [12]. Vitamins like beta-carotene, vitamin C, and E act an important role of antioxidant activity to reduce oxidative stress and suppress inflammatory processes [12, 13], and Vitamin D is also regarded as a modulator of inflammatory diseases [14, 15]. In addition, some minerals to compose antioxidant enzymes like superoxide dismutase regulate oxidative stress [16].

Therefore, we hypothesized that the intake levels of several antioxidant micronutrients could vary oxidative stress-resistant and anti-inflammatory capacity, and subsequently influence the inflammatory process in periodontal tissue and periodontal health. Some studies have reported the association between vitamins, minerals, or antioxidant enzyme-related micronutrients and periodontitis [15, 17–20]. The deficiency of vitamin C affected the gingival tissue [18], and the effect of vitamin-B complex supplementation after periodontal surgery was observed [19]. Several studies reported an adequate vitamin D intake could beneficially influence on periodontal health [15, 20]. In addition, mineral manganese was also associated with periodontitis [21].

However, the evidence on the association between micronutrient intakes and periodontal diseases excepting vitamin D is still restrictive. Furthermore, there are few studies to comprehensively investigate the association between vitamin or mineral intakes and periodontal health from a large-scale data [17]. We previously analyzed the association using a national survey data for Korean adults and found some significance in young adults [22]. Therefore, focusing the young adults, we aimed to determine whether the insufficient intakes of vitamin A, vitamin B complex, vitamin C, calcium (Ca), and iron (Fe) are associated with periodontitis from a nationally representative sample of young adults.

Materials and Methods

Study Design and Subject Selection

The data used in this study are a subset of the fourth Korea National Health and Nutrition Examination Survey (KNHANES) conducted in 2009 by Korea Centers for Disease Control and Prevention (KCDC) [22]. The sampling protocol for the KNHANES was designed to involve a complex, stratified, and multistage probability-cluster survey of a representative sample of the non-institutionalized civilian population of Korea. The details for sampling are described in the previous study for the association between manganese and periodontal status using this data and the fourth KNHANES reports [23, 24].

The sample set for 2009 KNHANES included 4600 households and 10,533 participants. Of these participants, 7095 individuals aged 19 years and older had a periodontal examination. Among them, 6242 individuals who had took a one-day 24-h recall interview for assessing dietary intake levels. Focusing to young adults, 2049 young adults aged from 19 to 39 years only were included in the final sample for this study.

Clinical Variables

Periodontitis

The World Health Organization (WHO) community periodontal index (CPI) was used to assess periodontitis [25]. Periodontitis was defined as a CPI greater than or equal to "code 3", which indicates that at least one site had a probing pocket depth of >3.5 mm (code 4 > 5.5 mm). Index tooth numbers were 11, 16, 17, 26, 27, 31, 36, 37, 46, and 47.

A CPI probe (Osung MND CO. Ltd., Seoul, Korea) that met the WHO guidelines was used [25]. The mouth was divided into sextants, and approximately 20 g force was used when probing. In the 2009 KNHANES, 27 trained dentists examined the periodontal status of the participants. The inter-examiner mean of Kappa value was 0.77 (0.53 to 0.94) [26].

Vitamin and Mineral Intake Levels

Nutrition surveys for assessing dietary intake levels were conducted by trained nutritionists at a participant's home. Each survey team was composed of two trained nutritionists. The quality control on the nutritional survey was conducted by the Center for Nutrition Policy and Promotion at Korea Health Industry Development Institute [23, 27].

The daily nutrient intakes were converted from food intake data gained using a complete individual one-day 24-h recall interview for estimating dietary intakes. Each nutrient intake was calculated by multiplying the weight for each food item which a participant reported to take in by nutrient concentration data for the corresponding food code in Korean food composition table [28]. Of nutrients whose intakes were calculated, we analyzed vitamin A, vitamin B complex (thiamin, riboflavin, and niacin), vitamin C, Ca, and Fe.

The nutrient intake levels of participants were classified by two ways. First, according to Recommended Nutrient Intake (RNI) in Dietary Reference Intakes for Koreans (KDRIs) [29], the intake levels of participants for each nutrient were divided into two categories—under RNI and RNI or more. RNIs of each vitamin and mineral for Korean young adults are as follows: vitamin A (men 750 μg RE/day; women 650 μg RE/day); thiamin (men 1.2 mg/day; women 1.1 mg/day); riboflavin (men 1.5 mg/day; women 1.2 mg/day); niacin (men 16 mg NE/day; women 14 mg NE/day); vitamin C (both men and women 100 mg/day), Ca (both men and women 750 mg/day); Fe (men 10 mg/day; women 14 mg/day). RNIs for pregnant and lactating women were determined separately for all nutrients. The concept of RNI is the same as the previous Recommended Dietary Allowance. Second, the intake levels were also divided into two categories by a median value for each nutrient: vitamin A (602.0 μg RE/day); thiamin (1.17 mg/day); riboflavin (1.36 mg/day); niacin (14.5 mg NE/day); vitamin C (81.3 mg/day); Ca (434.7 mg/day); Fe (11.4 mg/day).

Covariates

Socio-demographic variables comprised gender, age, household income, and education level. Household income was the family income adjusted for the number of family members and converted quartiles. Education level was defined as the highest diploma the participant had received.

Oral health behaviors included daily frequency of tooth brushing and usage of dental floss or an interdental brush. General health behaviors did two smoking variables, smoking status, and the amount of smoking. First, participants were divided into three groups depending on the status: non-smokers (those who had never smoked or had smoked fewer than 100 cigarettes in their lifetime); current smokers (those who currently smoked and had smoked 100 cigarettes or more in their lifetime); and past smokers (those who had smoked in the past but were not current smokers). In addition, the amount of smoking was considered and converted to “pack-year”, which indicated how many years a person smoked assuming he or she smoked one pack of cigarettes per day.

Oral health status was based on the number of decayed permanent teeth (DT), while systemic conditions included diabetes and obesity.

Statistical Analysis

The complex sampling design of the survey was considered, and individual weighted factors were used when obtaining variances. Multivariate logistic regression analyses were applied to examine the relationships between vitamins and minerals intake levels and periodontitis. The odd ratios (ORs) of lower nutrients intakes (under RNI or median) for periodontitis were adjusted for the above mentioned covariates in the multivariate logistic regression models. Because of significant interactions between periodontitis and gender or smoking, subgroup analyses were performed to gain stratified estimates according to them. Statistical analyses were performed using SPSS statistical software version 19.0 (SPSS, Chicago, IL).

Results

The prevalence of periodontitis defined as a CPI code ≥3 was 13.6% in young adults aged 19–39 years (n = 2049). Table 1 lists the characteristics of participants categorized by periodontal status, including socio-demographic characteristics, oral and systemic health status, and oral and general health behaviors. Tables 2 and 3, respectively, present the distribution of daily vitamin and mineral intake levels divided by the RNI and median intake for periodontitis and no periodontitis groups.

Table 4 shows the association between the lower nutrient intakes under RNI and periodontitis in the multivariate logistic regression model. In the total sample for young adults, lower intake of niacin was only significantly associated with periodontitis (Odds ratio [OR] 1.47; 95% confidential interval [CI] 1.09–2.00). In subgroup analyses, lower intake of niacin was associated in its subgroup of women (OR1.70; 95% CI1.10–2.64) and current non-smokers (OR1.75; 95% CI1.22–2.51).

Table 5 shows the association between the lower nutrient intakes under median intake value and periodontitis in the multivariate logistic regression model. There was no significant association in the total sample of young adults except the marginal association of niacin. In subgroup analyses, however, there were significant associations of periodontitis with a lower intake of niacin in women (OR 1.58; 95% CI 1.02–2.46) and current non-smokers (OR 1.50; 95% CI 1.01–2.22), with a lower intake of vitamin C in women (OR 1.66; 95% CI 1.04–2.64) and in current non-smokers (OR 1.49; 95% CI 1.04–2.14), with a lower intake of iron in women (OR 1.85; 95% CI 1.11–3.07), and with a lower intake of vitamin A marginally in women (OR 1.56; 95% CI 1.00–2.44).

Discussion

This study investigated whether lower levels of vitamin and mineral intakes were associated with poor periodontal health in young adults aged 19–39 years after adjusting for socio-demographic variables, oral and general health behaviors, and oral and general health status.

In the analyses, the levels of nutrient intakes were classified by two ways. First, we used RNI of DRIs as a standard of nutrition intake with dichotomous frame. However, the sufficient intake levels of certain nutrients according to DRIs could be different from the sufficient intake levels for periodontal health because DRIs are index for general health. It is the reason why we additionally analyzed using a median intake value for each nutrient. With the standard of DRIs, niacin intake level was only associated with periodontal status in young adults and in its subgroups including women and current non-smokers. Whereas, based on the intake levels according to a median, more nutrients presented the significant results. Even though there is no association in the total young adults except marginal association of niacin, several nutrients including niacin, riboflavin, iron, and marginally vitamin A

Table 1 Univariate comparisons of characteristics in participants with and without periodontitis

Characteristics	No periodontitis		Periodontitis	
	n	Weighted % (95% CI)	*n*	Weighted % (95% CI)
Socio-demographic variables				
Age (*n* = 2049)	29.27 (28.84–29.71)[a]		33.07 (32.20–33.95)[a]	
Gender (*n* = 2049)				
Male(*n* = 833)	687	83.6 (79.9–86.8)	146	16.4 (13.2–20.1)
Female(*n* = 1216)	1083	90.3 (87.8–92.4)	133	9.7 (7.6–12.2)
Highest diploma (*n* = 2039)				
Primary school	12	58.6 (37.4–77.0)	6	41.4 (23.0–62.6)
Middle school	38	90.1 (78.9–95.7)	5	9.9 (4.3–21.1)
High school	925	87.0 (83.7–89.7)	148	13.0 (10.3–16.3)
≥University or College	788	87.1 (83.8–89.8)	117	12.9 (10.2–16.2)
Household income[b] (*n* = 2028)				
<25%	137	85.5 (78.2–90.6)	26	14.5 (9.4–21.8)
25–50%	401	84.6 (80.6–88.0)	73	15.4 (12.0–19.4)
50–75%	609	85.8 (81.6–89.2)	100	14.2 (10.8–18.4)
>75%	604	89.5 (86.2–92.0)	78	10.5 (8.0–13.8)
Oral health status				
Active caries (*n* = 2049)	0.98 (0.87–1.09)[a]		1.44 (1.09–1.80)[a]	
Systemic health status				
Diabetes (*n* = 1917)				
Normal	1495	87.7 (85.2–89.8)	216	12.3 (10.2–14.8)
Impaired fasting glucose	142	80.9 (72.7–87.0)	36	19.1 (13.0–27.3)
Diabetes mellitus	24	82.9 (60.5–93.9)	4	17.1 (6.1–39.5)
BMI[c] (*n* = 2008)				
Underweight	146	90.6 (84.2–94.6)	16	9.4 (5.4–15.8)
Normal	1172	87.2 (84.7–89.4)	183	12.8 (10.6–15.3)
Obese	414	84.3 (79.8–87.9)	77	15.7 (12.1–20.2)
Oral health behaviors				
Daily frequency of tooth brushing (*n* = 2045)				
Once or less	121	85.2 (79.2–89.8)	23	14.8 (10.2–20.8)
Twice	631	85.0 (80.8–88.4)	112	15.0 (11.6–19.2)
Three times or more	1015	88.3 (85.8–90.4)	143	11.7 (9.6–14.2)
Use of floss or interdental brush (*n* = 2045)				
No	1224	87.6 (84.8–90.0)	190	12.4 (10.0–15.2)
Yes	543	84.8 (80.6–88.3)	88	15.2 (11.7–19.4)
General health behavior				
Smoking status (*n* = 2037)				
Non-smoker(*n* = 1204)	1079	90.7 (88.1–92.9)	125	9.3 (7.1–11.9)
Past smoker(*n* = 292)	246	85.2 (80.4–89.0)	46	14.8 (11.0–19.6)
Current smoker(*n* = 541)	437	81.3 (76.3–85.5)	104	18.7 (14.5–23.7)
Pack-years (*n* = 2036)	3.04 (2.74–3.33)[a]		6.56 (5.37–7.75)[a]	

CPI community periodontal index, *95% CI* 95% confidence interval

[a] Weighted mean and 95% confidence interval

[b] Household income is the monthly average family equivalent income (=monthly average household income/√[the number of household members])

[c] Underweight, <18.5 kg/m^2 ; Normal, 18.5–24.9 kg/m^2 ; Obese, ≥25 kg/m^2

Table 2 Univariate comparisons of vitamin and mineral intake levels divided by RNI in participants with and without periodontitis (n = 2049)

Vitamin and minerals	No periodontitis		Periodontitis	
	n	Weighted % (95% CI)	*n*	Weighted % (95% CI)
Vitamin A				
Lower	1012	86.5 (83.5–89.0)	163	13.5 (11.0–16.5)
Higher	758	87.3 (83.8–90.1)	116	12.7 (9.9–16.2)
Thiamin				
Lower	885	87.6 (84.6–90.1)	132	12.4 (9.9–15.4)
Higher	915	86.1 (82.9–88.8)	147	13.9 (11.2–17.1)
Riboflavin				
Lower	1085	86.5 (83.6–89.0)	177	13.5 (11.0–16.4)
Higher	685	87.3 (83.8–90.2)	102	12.7 (9.8–16.2)
Niacin				
Lower	894	86.1 (82.9–88.8)	150	13.9 (11.2–17.1)
Higher	876	87.5 (84.5–90.0)	129	12.5 (10.0–15.5)
Vitamin C				
Lower	1058	85.9 (83.0–88.4)	176	14.1 (11.6–17.0)
Higher	712	88.2 (84.8–90.9)	103	11.8 (9.1–15.2)
Calcium				
Lower	1483	86.8 (84.4–88.9)	233	13.2 (11.1–15.6)
Higher	287	86.9 (80.9–91.2)	46	13.1 (8.8–19.1)
Iron				
Lower	973	88.5 (86.1–90.6)	137	11.5 (9.4–13.9)
Higher	797	85.2 (81.6–88.2)	142	14.8 (11.8–18.4)

RNI recommended nutrient intake in dietary reference intakes for Koreans, the same as the previous recommended dietary allowance, *Lower* under RNI, *Higher* RNI or more, *CPI* community periodontal index, *95% CI* 95% confidence interval

were associated with periodontal status in women or non-smoker groups. Even though the tendencies of the results from RNI and median are similar, median intake values could be a better criteria for dividing lower and higher nutrient intake levels for periodontal health than RNI based on the results of this study.

In this study, the intakes of niacin was associated with periodontitis in both young adults and their subgroups whether with a criteria of RNI or medians. There were studies on the influence of niacin deficiency on necrotizing periodontal disease in marmoset [30] and the effect of vitamin B complex including niacin in healing periodontal tissue after surgery [19]. However, there has been no study to investigate niacin and periodontitis using a representative large-scale data. This study revealed their association with a nationally representative sample.

Niacin generally referring both nicotinic acid and nicotinamide is vitamin B3, which is defined as the dietary precursors to nicotinamide adenine dinucleotide (NAD). It participates in more reactions than any other vitamin-derived cofactors [31, 32]. Nicotinic acid has been conventionally used as an effective therapeutic agent regulating lipid profile such as blood lipoprotein and suppressing cardiovascular diseases through high-affinity nicotinic acid G-protein-coupled receptor 109A [31–33]. In addition, several studies have reported that nicotinic acid has anti-inflammatory, anti-atherogenic, or anti-oxidative effects by adiponectin [34–37]. GPR109Ain adipose tissue interacts with niacin, releases adiponectin, and corrects dyslipidemia, which could prevent vascular inflammations, subsequent atherosclerosis and its related cardiovascular diseases [38, 39]. Therefore, as a considering feature of periodontal tissue with an abundant vessel system and the increased oxidative stress and inflammation with periodontitis, we assume that the beneficial effects of niacin to reduce ROS and protect endothelial cells also could contribute to suppress inflammation of periodontal tissue.

There are other vitamins and minerals associated with periodontitis. A lower intake of Vitamin A was not statistically significant but marginally associated with periodontitis in women. Because vitamin A is one of the anti-oxidant nutrients and involved in epithelial cell metabolism, it could be related to oxidative pressure on periodontal tissue. A recent study also reported that oral administration of retinoic acid inhibited inflammation of periodontal tissue and alveolar bone resorption [40].

Table 3 Univariate comparisons of vitamin and mineral intake levels divided by median intake value in participants with and without periodontitis (*n* = 2049)

Vitamin and minerals	No periodontitis		Periodontitis	
	n	Weighted % (95% CI)	*n*	Weighted % (95% CI)
Vitamin A				
Lower	883	86.7 (83.4–89.4)	141	13.3 (10.6–16.6)
Higher	887	87.0 (83.7–89.6)	138	13.0 (10.4–16.3)
Thiamin				
Lower	890	87.9 (85.0–90.4)	134	12.1 (9.6–15.0)
Higher	880	85.8 (82.6–88.6)	145	14.2 (11.4–17.4)
Riboflavin				
Lower	883	87.0 (83.9–89.6)	141	13.0 (10.4–16.1)
Higher	887	86.7 (83.5–89.3)	138	13.3 (10.7–16.5)
Niacin				
Lower	883	86.9 (83.8–89.6)	141	13.1 (10.4–16.2)
Higher	887	86.7 (83.6–89.3)	138	13.3 (10.7–16.4)
Vitamin C				
Lower	876	85.7 (82.5–88.5)	148	14.3 (11.5–17.5)
Higher	894	87.9 (84.8–90.4)	131	12.1 (9.6–15.2)
Calcium				
Lower	892	87.6 (84.8–90.0)	132	12.4 (10.0–15.2)
Higher	878	86.1 (82.8–88.9)	147	13.9 (11.1–17.2)
Iron				
Lower	888	87.4 (84.8–89.6)	136	12.6 (10.4–15.2)
Higher	882	86.3 (82.9–89.2)	143	13.7 (10.8–17.1)

Lower under median, *Higher* median or more, *CPI* community periodontal index, *95% CI* 95% confidence interval

Vitamin C intake under a median intake value was also associated with periodontitis in women and non-smokers. Vitamin C is an anti-oxidant nutrient and important to gingival health. Therefore, insufficient intake of vitamin C could be related to periodontitis, which corresponded to previous studies reporting the increased risk of periodontal diseases in the group with deficiencies of Vitamin C from a national survey data [41].

Of minerals, a lower intake of Fe was associated with periodontitis in women. Fe is related to oxidation and would be important to periodontal tissue with rich vessel system as an element of hemoglobin [12]. Although the levels of Fe intake does not reflect proportionally the concentration of Fe in blood and the amount of saved Fe in the tissue, a cross-sectional study supports with limited Fe deficiency could influence poorly periodontal health. The study reported patients with Fe-deficiency anemia had more periodontal breakdowns than patients without it [42].

In non-smoker group, poor vitamin and mineral intakes and periodontal health had a strong association. Thus, nutritional support affected more periodontitis in non-smokers although the proportion of periodontitis was higher in smokers. In non-smoker, anti-oxidant and regulation effects on gingival epithelium health of vitamins and minerals may be more important than in smokers as smoking is an important detrimental factor to periodontal health. The negative effects of smoking might mask the positive effect of vitamin and minerals.

Meanwhile, in terms of gender, women were more affected from nutritional status than men. We assumed that vitamin deficiencies could affect the control of sex hormones such as estrogen positively related to anti-oxidant capacity and worsen periodontal health [43]. In addition, the significance of Fe in women could be addressed in terms of menstruation cycle of women. In young women, lower Fe intake would contribute more to the occurrence of iron deficiency anemia and poor periodontal health as most young women regularly lose iron with menstruation [42]. However, further studies are needed to elucidate the modifying effect of gender on the association between nutrition and periodontitis.

There are several limitations in this study. First of all, in KNHANES data, the internal level of some vitamins and minerals can only be supposed by KDRIs. Therefore, the criteria assessing internal nutrient status were the amounts of intake calculated from a dietary survey data but not biochemical indicators. Even though several countries adopt a 24-h recall to yield the amount of nutrition intakes [24], it could not represent perfectly habitual nutrients intakes of individuals due to the shortness of survey days (a one-day 24-h recall in

Table 4 Adjusted odd ratios and 95% confidence intervals of lower vitamin and mineral intakes (by RNI) for periodontitis in young adults and its subgroups according to the strata of gender or smoking

Vitamin and minerals	Total	Gender		Current smoker	
		Men	Women	No	Yes
	OR, 95% CI	OR, 95% CI	OR, 95% CI	OR, 95% CI	OR, 95% CI
Vitamin A	1.150	0.999	1.436	1.164	1.169
	0.816–1.622	0.642–1.555	0.920–2.241	0.813–1.668	0.615–2.223
Thiamin	0.972	0.757	1.367	1.093	0.794
	0.709–1.332	0.453–1.267	0.854–2.189	0.746–1.603	0.484–1.302
Riboflavin	1.062	0.825	1.466	1.275	0.831
	0.758–1.490	0.531–1.281	0.896–2.399	0.867–1.874	0.474–1.457
Niacin	1.474	1.263	1.703	1.749	1.258
	1.088–1.997	0.814–1.961	1.098–2.641	1.219–2.510	0.742–2.131
Vitamin C	1.256	1.063	1.457	1.427	1.069
	0.898–1.758	0.692–1.634	0.870–2.439	0.959–2.123	0.665–1.718
Calcium	1.083	0.875	1.968	1.369	0.878
	0.697–1.682	0.518–1.478	0.862–4.489	0.777–2.411	0.456–1.691
Iron	1.084	0.802	1.684	1.194	0.973
	0.757–1.552	0.485–1.326	0.900–3.152	0.763–1.868	0.567–1.670

RNI recommended nutrient intake in dietary reference intakes for Koreans, *CPI* community periodontal index, *OR* adjusted odd ratio, *95% CI* 95% confidence interval

The multivariate logistic regression model was adjusted for socio-demographic variables (age, gender, household income, and educational level), oral health behaviors (daily frequency of tooth brushing and use of floss or interdental brush), general health behavior (smoking status and pack-years), oral health status (active caries), and general health status (diabetes mellitus and obesity); Higher vitamin and mineral intakes (by RNI) is reference values

Table 5 Adjusted odd ratios and 95% confidence intervals of lower vitamin and mineral intakes (by median) for periodontitis in young adults and its subgroups according to the strata of gender or smoking

Vitamin and minerals	Total	Gender		Current smoker	
		Men	Women	No	Yes
	OR, 95% CI	OR, 95% CI	OR, 95% CI	OR, 95% CI	OR, 95% CI
Vitamin A	1.174*	0.964	1.558	1.279	1.041
	0.834–1.653†	0.604–1.540	0.996–2.437	0.885–1.848	0.547–1.982
Thiamin	0.954	0.746	1.279	1.043	0.815
	0.695–1.308	0.444–1.253	0.801–2.043	0.707–1.540	0.496–1.339
Riboflavin	1.127	0.918	1.490	1.174	1.054
	0.810–1.568	0.586–1.437	0.895–2.480	0.779–1.723	0.605–1.836
Niacin	1.377	1.175	1.581	1.499	1.270
	0.973–1.947	0.692–1.996	1.015–2.464	1.011–2.221	0.723–2.232
Vitamin C	1.302	1.032	1.659	1.490	1.123
	0.930–1.822	0.667–1.597	1.041–2.644	1.037–2.141	0.669–1.887
Calcium	1.004	0.826	1.297	1.188	0.782
	0.743–1.356	0.542–1.258	0.833–2.021	0.793–1.780	0.454–1.346
Iron	1.175	0.869	1.848	1.395	0.977
	0.842–1.640	0.546–1.385	1.111–3.074	0.931–2.089	0.588–1.624

CPI community periodontal index, *OR* adjusted odd ratio, *95% CI* 95% confidence interval

The multivariate logistic regression model was adjusted for socio-demographic variables (age, gender, household income, and educational level), oral health behaviors (daily frequency of tooth brushing and use of floss or interdental brush), general health behavior (smoking status and pack-years), oral health status (active caries), and general health status (diabetes mellitus and obesity); Higher vitamin and mineral intakes (by median) is reference values

Korea) and the dependence of the memory of individuals. Thus, using biochemical values would reflect nutrient status more accurately. However, KDRIs were established as based on biochemical markers, which is one of the biochemical indicators for niacin status [29].

Another limitation of this study in terms of dental examination is that periodontitis were assessed using CPI. Although CPI is an easy way to assess the prevalence of periodontitis in population surveys and epidemiological studies, it may overestimate or underestimate periodontal status due to the use of representative teeth and pseudo-pockets [44].

Finally, it is not possible to determine the direction of causal-relationship between vitamin and mineral intake levels and periodontitis as this study is a cross-sectional study.

Nevertheless, an association was found between vitamins, minerals, and periodontitis after adjusting for various potential confounders including sociodemographic variables, oral and general health behavioral factors, and oral health status. In addition, this study was carried out comprehensively on a Korean representative population sample.

The results of this study were only made from the analysis of epidemiologic data. Therefore, further studies on the mechanism of the association between micronutrients and periodontitis are required.

In young adults, periodonitis is significantly associated with the lower intakes of niacin, vitamin C, and iron, especially in women and current non-smokers.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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