J Periodont Res 2006; 41; 560–566

JOURNAL OF PERIODONTAL RESEARCH
doi:10.1111/j.1600-0765.2006.00907.x

Effects of smoking and drinking habits on the incidence of periodontal disease and tooth loss among Japanese males: a 4-yr longitudinal study

Y. Okamoto[1,2], S. Tsuboi[2], S. Suzuki[1], H. Nakagaki[2], Y. Ogura[3], K. Maeda[1], S. Tokudome[1]

[1]Department of Health Promotion and Preventive Medicine, Nagoya City University Graduate School of Medical Sciences, Nagoya, Japan, [2]Department of Preventive Dentistry and Dental Public Health, Aichi-Gakuin University, Nagoya, Japan and [3]Aichi Health Promotion Foundation, Nagoya, Japan

Okamoto Y, Tsuboi S, Suzuki S, Nakagaki H, Ogura Y, Maeda K, Tokudome S. Effects of smoking and drinking habits on the incidence of periodontal disease and tooth loss among Japanese males: a 4-yr longitudinal study. J Periodont Res 2006; 41: 560–566. © Blackwell Munksgaard 2006.

Objective: We investigated the risk of periodontal disease and tooth loss, associated with habits of smoking and alcohol consumption, in a longitudinal study.

Subjects and Methods: The subjects were 1332 Japanese males, 30–59 yr of age, who were free from periodontal disease at the baseline check-up, and who underwent a second check-up 4 yr later. Periodontal disease was diagnosed using the community periodontal index score, based on the clinical probing of pocket depth (≥ 4 mm). Smoking and alcohol consumption patterns were evaluated using a self-administered questionnaire.

Results: A dose–response relationship was observed between the amount of smoking and the incidence of periodontal disease in each age group. The overall odds ratios (95% confidence intervals), adjusted for age and alcohol, were 1.51 (0.95–2.22), 1.58 (1.13–2.22) and 2.81 (1.96–4.03), among smokers consuming 1–19, 20 or 21 or more cigarettes per day, respectively, with a significant linear trend ($p < 0.0001$). A similar association was found between smoking and tooth loss, except for the 50–59-yr-old age group. The adjusted odds ratios were 1.26 (0.60–2.64), 2.01 (1.21–2.32) and 2.06 (1.23–3.48), respectively. A significant linear trend between smoking and tooth loss was also observed ($p = 0.01$). Ex-smokers showed no significant difference compared with nonsmokers. We also found a significant linear trend between alcohol consumption and tooth loss among 30–39-yr-old subjects, while no relationship was observed between alcohol consumption and periodontal disease.

Conclusion: Cigarette smoking was found to be an independent risk factor for periodontal disease and tooth loss. Alcohol consumption was a limited risk factor for tooth loss in the younger age group, but was unrelated to periodontal disease. To prevent periodontal disease and tooth loss, health practitioners need to encourage people to stop smoking or not to start.

Dr Shinkan Tokudome, Department of Health Promotion and Preventive Medicine, Nagoya City University Graduate School of Medical Sciences, 1 Kawasumi, Mizuho-cho, Mizuho-ku, Nagoya 467–8601, Japan
Tel: +81 52 8538174
Fax: +81 52 8423830
e-mail: tokudome@med.nagoya-cu.ac.jp

Key words: alcohol consumption; longitudinal study; periodontal disease; smoking; tooth loss

Accepted for publication March 9, 2006

In Japan, the National Health Promotion Program in the 21st century (Healthy Japan 21) started in 2000, focusing on lifestyle and lifestyle-related diseases. The program set goals to be achieved by 2010 for three diseases (cancer, cardiovascular disease and diabetes), as well as six identifying factors (nutrition and diet, physical activity, rest and mental health, tobacco, alcohol and dental health). The dental health area covers four topics, including prevention of periodontal disease and tooth loss. The targets of the periodontal disease and tooth loss programs are $> 30\%$ decrease in advanced periodontal disease in adults of the 40–59-yr age group, and an increase of up to 20% of persons who still have ≥ 20 teeth at 80 yr of age.

Among the potential risk factors for periodontal disease, the effects of smoking have attracted particular attention, and a systematic review has reported that epidemiologic and clinical studies have consistently detected a moderate to high degree of association between smoking and periodontitis (1). Although the review analysed 52 cross-sectional studies, only 12 took a prospective approach, and, of those, nine consisted of fewer than 500 subjects. The impact of smoking on tooth loss has also been discussed in both cross-sectional (2) and cohort designs (3,4). Finally, although a few researchers have investigated the relationship of alcohol consumption to periodontal disease/tooth loss in cross-sectional or case-control studies (5,6), only one was a prospective study (7).

We therefore undertook this 4-yr-long longitudinal study to examine the relationship between smoking/alcohol consumption and the incidence of periodontal disease/tooth loss, amassing a relatively large cohort of subjects from dental check-ups carried out in Aichi Prefecture, Japan.

Subjects and methods

Two dental check-ups were conducted from 1 April 1996 to 31 March 1997 (baseline check-up) and from 1 April 2000 to 31 March 2001 (second check-up) by a health organization in Aichi Prefecture, Japan. Out of 3063 males aged 30–59 yr who underwent both check-ups, 1419 who were found to be without periodontal disease at the baseline check-up were recruited as subjects of this study. We excluded 73 people who stopped smoking and 14 who had resumed smoking between the two check-ups, for a final number of 1332 eligible for the present study.

At the time of each check-up, participants were asked to fill out a questionnaire on lifestyle, including smoking status, number of cigarettes per day, smoking duration, frequency and amount of alcohol consumption, along with the type of alcoholic beverages consumed. For smoking status, we divided the subjects into three groups: those who smoked at both the baseline and second check-ups (smokers); those who had stopped smoking at the baseline check-up and had not resumed by the second check-up (ex-smokers); and those who did not smoke at either checkup (nonsmokers). Smokers were subdivided into three groups based on the number of cigarettes they smoked per day (1–19, 20, or ≥ 21). As for drinking habit, subjects were divided into three groups based on the amount of alcohol they consumed per day at the baseline check-up: nondrinkers (including ex-drinkers); those consuming < 20 g of alcohol; and those consuming ≥ 20 g of alcohol. Eighty men who stopped or started drinking during two check-ups were excluded from our analysis of alcohol consumption.

Seven dentists, who were informed of the community periodontal index (CPI) in advance, and calibrated probing pressure to 20 g, examined the subject's oral condition using a dental mirror and a CPI probe (YDM Corp., Tokyo, Japan) developed by the World Health Organization (WHO) (8). They determined the number of teeth retained and those decayed, missing, or filled (DMF), as well as the conditions of periodontal tissue, which were evaluated in six sections of dentition and 10 teeth, using CPI scores of 0, 1, 2, 3 and 4 to indicate healthy, bleeding after probing, dental calculus detected by probing, 4- to 5- mm deep pockets, and $>$ 6- mm deep pockets, respectively. The highest CPI score in the six sections was used as the subject's score. Individuals with scores of 3 or 4 were classified as having a periodontal disease (9), while those with scores of 0, 1 or 2 were diagnosed as being without periodontal disease (nonperiodontal disease).

To determine the relationship between smoking/drinking habits and periodontal disease/tooth loss, odds ratios (ORs) with 95% confidence intervals (CIs) were computed, using logistic regression analyses, in three age groups, 30–39 yr; 40–49 yr; and 50–59 yr. The ORs were adjusted for the other habit, and overall ORs adjusted for age and the other habit were also calculated. As a test for trend, we categorized the habits and treated the score for the category as a continuous variable, excluding those who had quit their habits. The impact of current habits of smoking and drinking on periodontal disease/tooth loss was compared using the conditional relative odds ratio (CROR) (10), which evaluates the difference in two ORs derived from the same subjects. All reported *p*-values are two-sided. SAS version 8.2 was used to analyze the data.

Results

The average age [$\pm$ standard deviation (SD)] of the 1323 subjects at baseline was 43.5 ± 6.4 yr. The number of retained teeth ranged from 10 to 32, with the average being 28.0 ± 2.5. Table 1 shows the characteristics of subjects by age group. The proportion of smokers decreased with increasing age, although that of nonsmokers was relatively steady, at $\approx 25\%$. The number of cigarettes smoked per day also decreased with age, while smoking duration was closely correlated to age, with $\approx 80\%$ belonging to the same duration category within a given age group. In contrast, the proportion of drinkers increased with increasing age. About 12%, 20% and 29% of subjects consumed ≥ 20 g of alcohol per day in the 30–39-, 40–49- and 50–59-yr age groups, respectively. The cumulative incidence of periodontal disease, over 4 yr, by age group, was quite high (at 31%, 48% and 56%, for the 30–39-,

Table 1. Characteristics of subjects by age group

Characteristics	Age group			
	30–39 yr	40–49 yr	50–59 yr	Total
Smoking status				
Nonsmokers	105 (24.7%)	150 (23.3%)	68 (25.8%)	323
Ex-smokers	63 (14.8%)	213 (33.1%)	108 (40.9%)	384
Smokers	257 (60.5%)	280 (43.5%)	88 (33.3%)	625
Amount of smoking				
• 1–19 cigarettes/d	54 (12.7%)	43 (6.7%)	11 (4.2%)	108
• 20 cigarettes/d	114 (26.8%)	124 (19.3%)	44 (16.7%)	282
• ≥21 cigarettes/d	89 (20.9%)	113 (17.6%)	33 (12.5%)	235
Duration of smoking				
• 1–9 yr	12 (2.8%)	12 (1.9%)	0 (0.0%)	24
• 10–19 yr	204 (48.0%)	18 (2.8%)	7 (2.7%)	229
• 20–29 yr	41 (9.7%)	228 (35.5%)	7 (2.7%)	276
• ≥30 yr	0 (0.0%)	22 (3.4%)	74 (28.0%)	96
Alcohol consumption				
Nondrinkers	100 (23.5%)	140 (21.8%)	54 (20.5%)	294
1–20 g alcohol/d	276 (64.9%)	376 (58.5%)	134 (50.8%)	786
> 20 g alcohol/d	43 (11.5%)	127 (19.7%)	76 (28.8%)	252
Periodontal disease				
No	293 (68.9%)	332 (51.6%)	115 (43.6%)	740
Yes	132 (31.1%)	311 (48.4%)	149 (56.4%)	592
Missing teeth at baseline				
0	255 (60.0%)	311 (48.4%)	120 (45.5%)	686
1	81 (19.1%)	111 (17.3%)	56 (21.2%)	248
2	41 (9.7%)	92 (14.3%)	32 (12.1%)	165
3	24 (5.6%)	58 (9.0%)	14 (5.3%)	96
≥ 4	24 (5.6%)	71 (11.0%)	42 (15.9%)	137
Teeth lost during four yr				
0	390 (91.8%)	551 (85.7%)	224 (84.9%)	1165
1	29 (6.8%)	74 (11.5%)	27 (10.2%)	130
2	5 (1.2%)	13 (2.0%)	7 (2.7%)	25
≥ 3	1 (0.2%)	5 (0.8%)	6 (2.3%)	11
Total	425	643	264	1332

40–49- and 50–59-yr age groups, respectively) while that of teeth retained was much lower (at 8%, 14% and 15%, for the 30–39-, 40–49- and 50–59-yr age groups, respectively).

Table 2 shows crude and alcohol-adjusted ORs with 95% CIs of periodontal disease for smokers and ex-smokers compared with nonsmokers in each age group. In all age groups, smokers consuming > 20 cigarettes per day showed significantly high ORs (i.e. 2.16, 2.03 and 15.1 among the 30–39-, 40–49- and 50–59-yr age groups, respectively. A dose–response relationship, according to the amount of smoking, was clearly detected in every age group, and linear trends for smoking effects (calculated excluding ex-smokers) were statistically significant. We also found an effect modification between smoking and age. For example, subjects in the 50–59-yr age group presented a higher OR for periodontal disease than those in younger groups against an equivalent amount of smoking, and this interaction was significant ($p = 0.03$). No significant association was found for ex-smokers in any age group. These results remained essentially unchanged after adjusting for alcohol consumption. The overall ORs (95% CIs),

Table 2. Odds ratios for periodontal disease (PD) by smoking status and age group

Age group	Smoking status	Number PD(+)/PD(–)	OR*	95% CI	Trend *p*	OR†	95% CI	Trend *p*
30–39 yr	Nonsmokers	29/76	1.00	Reference	0.04	1.00	Reference	0.05
	Ex-smokers	13/50	0.67	(0.32–1.42)		0.66	(0.31–1.41)	
	Smokers							
	• 1–19 cig./d	18/36	1.22	(0.60–2.50)		1.21	(0.59–2.49)	
	• 20 cig./d	31/83	0.99	(0.55–1.81)		0.98	(0.53–1.79)	
	• ≥21 cig./d	41/48	2.17	(1.19–3.97)		2.16	(1.17–3.98)	
40–49 yr	Nonsmokers	64/86	1.00	Reference	0.002	1.00	Reference	0.003
	Ex-smokers	88/125	0.92	(0.60–1.40)		0.89	(0.58–1.37)	
	Smokers							
	• 1–19 cig./d	21/22	1.27	(0.64–2.51)		1.20	(0.60–2.39)	
	• 20 cig./d	68/56	1.63	(1.01–2.64)		1.58	(0.97–2.56)	
	• ≥21 cig./d	70/43	2.17	(1.31–3.59)		2.03	(1.22–3.39)	
50–59 yr	Nonsmokers	28/40	1.00	Reference	< 0.0001	1.00	Reference	< 0.0001
	Ex-smokers	53/55	1.38	(0.75–2.54)		1.43	(0.77–2.66)	
	Smokers							
	• 1–19 cig./d	7/4	2.46	(0.66–9.24)		2.60	(0.68–9.86)	
	• 20 cig./d	31/13	3.39	(1.51–7.61)		3.49	(1.53–7.95)	
	• ≥21 cig./d	30/3	14.3	(3.97–51.6)		15.1	(4.14–54.8)	

*OR, crude odds ratio.
†OR, odds ratio adjusted for alcohol consumption.
CI, confidence interval.

adjusted for age and alcohol consumption for periodontal disease, were 0.95 (0.64–1.32), 1.51 (0.95–2.22), 1.58 (1.13–2.22) and 2.81 (1.96–4.03), among ex-smokers, and smokers consuming 1–19, 20 or ≥21 cigarettes per day, respectively. A statistically significant linear trend between smoking and the risk of periodontal disease was observed ($p < 0.0001$).

Table 3 shows crude and alcohol-adjusted ORs, according to the amount of smoking, for tooth loss compared with nonsmokers by age group. Among the 30–39- and 40–49-yr age groups, we observed significant linear trends based on the number of cigarettes smoked. However, for the 50–59-yr age group, the dose–response relationship was unclear, and the linear trend was not statistically significant. Again, there were no significant differences between ex-smokers and nonsmokers in any age group. These results were also unchanged after adjustment for alcohol consumption. No significant interaction between age and smoking effect on tooth loss was found. The overall ORs adjusted for age and alcohol consumption were 1.11 (0.68–1.85) for ex-smokers, 1.26 (0.60–2.64) for those smoking 1–19 cigarettes per day, 2.01 (1.21–3.32) for those smoking 20 cigarettes per day, and 2.06 (1.23–3.48) for those smoking ≥21 cigarettes per day. A statistically significant linear trend between smoking and tooth loss was also noted ($p = 0.01$).

As shown in Table 4, ORs for periodontal disease in drinkers among the 30–39- and 40–49-yr age groups were close to those of nondrinkers, and no significant relationship was observed in either crude or smoking-adjusted analyses. Among men aged 50–59 yr, on the other hand, the ORs of drinkers appeared low. However, individual ORs and linear trend were not statistically significant. The overall ORs for periodontal disease adjusted for age and smoking were close to 1.0 [i.e. 0.88 (0.65–1.17) for drinkers consuming < 20 g of alcohol, and 1.05 (0.73–1.51) for drinkers consuming ≥20 g of alcohol]. No dose–response

Table 3. Odds ratios for tooth loss (TL) by smoking status and age group

Age group	Smoking status	Number TL(+)/TL(–)	OR*	95% CI	Trend *p*	OR†	95% CI	Trend *p*
30–39 yr	Nonsmokers	4/101	1.00	Reference	0.02	1.00	Reference	0.03
	Ex-smokers	1/62	0.41	(0.05–3.73)		0.36	(0.04–3.28)	
	Smokers							
	• 1–20 cig./d	21/147	3.61	(1.20–10.8)		3.30	(1.09–10.0)	
	• ≥21 cig./d	9/80	2.84	(0.84–9.56)		2.47	(0.72–8.53)	
40–49 yr	Nonsmokers	16/134	1.00	Reference	0.03	1.00	Reference	0.03
	Ex-smokers	27/186	1.22	(0.63–2.35)		1.14	(0.59–2.21)	
	Smokers							
	• 1–20 cig./d	26/141	1.54	(0.79–3.01)		1.48	(0.76–2.91)	
	• ≥21cig./d	23/90	2.14	(1.07–4.27)		2.03	(1.00–4.10)	
50–59 yr	Nonsmokers	9/59	1.00	Reference	0.25	1.00	Reference	0.30
	Ex-smokers	15/93	1.06	(0.44–2.57)		1.07	(0.44–2.61)	
	Smokers							
	• 1–20 cig./d	9/46	1.28	(0.47–3.49)		1.34	(0.49–3.68)	
	• ≥21 cig./d	7/26	1.77	(0.59–5.25)		1.67	(0.56–4.99)	

*OR, crude odds ratio.
†OR, odds ratio adjusted for alcohol consumption.
CI, confidence interval.

Table 4. Odds ratios for periodontal disease (PD) by alcohol consumption and age group

Age group	Alcohol consumption	Number PD(+)/PD(–)	OR*	95% CI	Trend *p*	OR†	95% CI	Trend *p*
30–39 yr	Nondrinkers	26/60	1.00	Reference	0.38	1.00	Reference	0.43
	• 1–20 g alcohol/d	81/178	1.05	(0.62–1.78)		1.11	(0.64–1.90)	
	• > 20 g alcohol/d	16/31	1.19	(0.59–2.54)		1.17	(0.54–2.55)	
40–49 yr	Nondrinkers	65/66	1.00	Reference	0.35	1.00	Reference	0.59
	• 1–20 g alcohol/d	162/192	0.86	(0.57–1.28)		0.87	(0.58–1.31)	
	• > 20 g alcohol/d	71/56	1.29	(0.79–2.10)		1.19	(0.72–1.97)	
50–59 yr	Nondrinkers	31/18	1.00	Reference	0.07	1.00	Reference	0.06
	• 1–20 g alcohol/d	66/59	0.65	(0.33–1.28)		0.60	(0.29–1.24)	
	• > 20 g alcohol/d	41/33	0.72	(0.34–1.51)		0.74	(0.34–1.64)	

*OR, crude odds ratio.
†OR, odds ratio adjusted for alcohol consumption.
CI, confidence interval.

Table 5. Odds ratios for tooth loss (TL) by alcohol consumption and age group

Age group	Alcohol consumption	Number TL(+)/TL(–)	OR*	95% CI	Trend *p*	OR†	95% CI	Trend *p*
30–39 yr	Nondrinkers	4/82	1.00	Reference	0.03	1.00	Reference	0.05
	1–20 g alcohol/d	24/235	2.09	(0.71–6.21)		2.04	(0.68–6.14)	
	> 20 g alcohol/d	5/42	2.44	(0.62–9.57)		2.19	(0.54–8.79)	
40–49 yr	Nondrinkers	15/116	1.00	Reference	0.07	1.00	Reference	0.14
	1–20 g alcohol/d	49/305	1.24	(0.67–2.30)		1.24	(0.66–2.30)	
	> 20 g alcohol/d	23/104	1.71	(0.85–3.45)		1.54	(0.75–3.16)	
50–59 yr	Nondrinkers	7/42	1.00	Reference	0.13	1.00	Reference	0.15
	1–20 g alcohol/d	21/104	1.21	(0.48–3.06)		1.25	(0.49–3.20)	
	> 20 g alcohol/d	9/65	0.83	(0.29–2.40)		0.90	(0.30–2.64)	

*OR, crude odds ratio.
†OR, odds ratio adjusted for alcohol consumption.
CI, confidence interval.

relationship was found, and no association was noted between alcohol consumption and periodontal disease when smokers were excluded from the analysis.

Table 5 shows the associations between alcohol consumption and tooth loss in each age group. Drinkers in the 30–39-yr age group consuming ≥20 g of alcohol had a 2.4-fold greater OR than nondrinkers, and a dose–response relationship was observed. After adjusting for the amount of smoking, the linear trend was also statistically significant. In this age group, heavy drinkers consuming ≥60 g per day showed an OR of 10.7 (1.36–84.4). For the 40–49-yr age group, only a weak positive relationship was found. Among the 50–59-yr age group, no consistent relationship was noted between alcohol consumption and tooth loss. The overall ORs for drinkers who consumed < 20 g or ≥20 g of alcohol, were 1.39 (0.87–2.21) and 1.44 (0.84–2.49), respectively, after adjusting for smoking; the linear trend was not significant ($p = 0.18$).

The CRORs (95% CIs) of periodontal disease for current smoking, relative to current drinking, were 1.13 (0.53–2.43), 1.99 (1.10–3.62), and 6.25 (1.71–22.8), among 30–39-, 40–49- and 50–59-yr-old subjects, respectively. In contrast, corresponding CRORs (95% CIs) of tooth loss were 1.76 (0.38–8.15), 0.94 (0.37–2.38) and 1.26 (0.33–4.82), respectively. Subjects in the older age groups showed a greater impact of smoking than of drinking on periodontal disease; there was no consistent tendency for tooth loss.

Discussion

We found positive dose–response relationships between alcohol consumption and tooth loss among 30–39-yr-old subjects as well as between the amount of smoking and periodontal disease/tooth loss in most age groups among healthy Japanese males free from periodontal disease at baseline in a 4-yr longitudinal study. The impact of a current smoking habit on periodontal disease was significantly greater than that of a current drinking habit among the 40–49- and 50–59-yr age groups.

A number of positive associations reported between smoking and periodontal disease are very similar in both cross-sectional (6,11–17) and prospective (18–22) studies. The estimated risks (ORs or rate ratios) found from cohort studies among inhabitants or workers ranged between 1.4 (21) and 14.2 (22). Evidence for smoking as an etiologic factor in periodontal disease, based on Hill's criteria (23), has been published (24), and very few studies have reported a lack of association between them (25). In the present study, in each age group, the highest OR was observed among subjects smoking more than 20 cigarettes per day. Although the OR was 15.1 among 50–59-yr-old subjects, it was ≈2 among the other age groups. The relatively low ORs of periodontal disease in this study may partly be a result of the young mean age and high prevalence of periodontal disease, suggesting that, using a broad diagnostic criteria with CPI scores of 0, 1 or 2, subjects were classified as nonperiodontal disease, while those with CPI scores of 3 or 4 were diagnosed as having periodontal diesese (26). As age is a major risk factor for periodontal disease, all our analyses were age-adjusted. However, the interaction between periodontal disease and age or smoking habit has not been fully discussed.

The impact of smoking on tooth loss has also been reported in several cohort studies (3,4). In the present study, we also detected a positive dose–response effect after adjusting for age. Although the positive relationship between smoking and tooth loss was clearly observed in the 30–39- and 40–49-yr age groups, the interaction between age and smoking was not significant. The probability of tooth loss was proportional to the severity of the periodontal disease (12,13). Substantial pocket depth, attachment loss and alveolar bone resorption may be possible causes for tooth loss, and therefore the progression from smoking to tooth loss via periodontal disease seems plausible. A report from Japan, however, has found that smoking was an independent risk factor for tooth loss, even after adjustment for periodontal disease (27). As the subjects of our study were free from periodontal disease at baseline, and the duration between the two check-ups was relatively short, there may be a causal path from smoking to tooth loss other than via periodontal disease.

The relationship between alcohol consumption and periodontal disease, on the other hand, has rarely been reported. Several cross-sectional studies (5,6) have shown a positive rela-

tionship. Only one prospective study, with more than 50,000 subjects, found a linear positive association between alcohol consumption and periodontitis (7). In that large-scale cohort study, the authors suggested that the risk was elevated by ≈30% for the highest quintile of alcohol consumption after adjustment for potential confounders. Only red wine consumption showed a linear trend, while beer exhibited no consistent relationship. In the present study, the very low proportion of red wine drinkers in Japan might explain the lack of any association between alcohol and periodontal disease.

Reports on the relationship between alcohol consumption and tooth loss are also few and somewhat controversial. In one study, for example, alcohol was a risk factor for tooth loss among White subjects but not among Black subjects (28), while a report from Japan found a preventive effect of alcohol on tooth loss (27). In the present study, only the 30–39-yr-old age group showed a marginally positive linear trend. An extremely high OR of 10.7 (95% CI: 1.36–84.4), observed among heavy drinkers in the 30–39-yr age group, should be interpreted with caution because of the limited number of subjects. The effects of alcohol consumption on periodontal disease/tooth loss are far fewer than those of cigarette smoking, and further research is needed to confirm the impact of alcohol.

The main strength of this present study is its prospective design that enables us to calculate the incidence ORs. Prevalence comprises both the incidence and duration of a disease, and therefore is not a good indicator for evaluating an exposure effect on disease occurrence. In addition, a relatively large number of subjects allowed us to conduct a stratified analysis by age group, which revealed several interactions between age groups and the effects of smoking/drinking habits on periodontal disease/tooth loss.

Several limitations of this study, however, should be kept in mind. First of all, for the diagnosis of periodontal disease we used CPI, which was developed to screen for the treatment needs of periodontal disease by the WHO. Although it does not measure attachment loss, the index is useful for dealing with a large number of study subjects, including patients. Therefore, it has been widely used, despite lacking a way to measure attachment loss. Second, we lacked information on potential confounders, such as body mass index, diabetes, physical activity and oral hygiene practices. Lastly, because of a strong correlation between age and smoking duration, we did not distinguish an effect of smoking duration from an effect of age on periodontal disease. It is highly plausible that the high OR of smokers for periodontal disease among the older groups is caused by their long-term exposure to smoking. However, one could also interpret it as just an age–smoking interaction, regardless of the smoking duration.

Although many reports have implicated periodontal disease as a potential risk factor in systemic outcomes, including those of diabetes (29), heart disease (30), chronic obstructive pulmonary disease (31), cerebrovascular disease (32), adverse pregnancy (33) and all-cause mortality (34), the causal effects of periodontal disease on these outcomes remain unclear. These associations may be caused by bias induced by self-reported smoking (35) or confounding by smoking (36). Regardless of a causative role for periodontal disease in these maladies, periodontal disease/tooth loss are considered to represent a lower quality of life (QOL), which is why the Ministry of Health, Welfare and Labor in Japan is focusing on this theme in the 'Healthy Japan 21' project. Thus, to quit smoking (or not to start) is, by all means, the most practical way to prevent periodontal disease/tooth loss, tobacco-related diseases and increase the QOL.

References

1. US Department of Health and Human Services. *The Health Consequences of Smoking. A Report of the Surgeon General.* Atlanta, GA: US Department of Health and Human Services, Center for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2004.
2. Daniell HW. Postmenopausal tooth loss. Contributions to edentulism by osteoporosis and cigarette smoking. *Arch Intern Med* 1983;**143:**1678–1682.
3. Holm G. Smoking as an additional risk for tooth loss. *J Periodontol* 1994;**65:**996–1001.
4. Osterberg T, Mellstrom D. Tobacco smoking: a major risk factor for loss of teeth in three 70-year-old cohorts. *Community Dent Oral Epidemiol* 1986;**14:**367–370.
5. Sakki TK, Knuuttila ML, Vimpari SS, Hartikainen MS. Association of lifestyle with periodontal health. *Community Dent Oral Epidemiol* 1995;**23:**155–158.
6. Shizukuishi S, Hayashi N, Tamagawa H *et al.* Lifestyle and periodontal health status of Japanese factory workers. *Ann Periodontol* 1998;**3:**303–311.
7. Pitiphat W, Merchant AT, Rimm EB, Joshipura KJ. Alcohol consumption increases periodontitis risk. *J Dent Res* 2003;**82:**509–513.
8. Cutress TW, Ainamo J, Sardo-Infirri J. The community periodontal index of treatment needs (CPITN) procedure for population groups and individuals. *Int Dent J* 1987;**37:**222–233.
9. Takami Y, Nakagaki H, Morita I *et al.* Blood test values and community periodontal index scores in medical checkup recipients. *J Periodontol* 2003;**74:**1778–1784.
10. Suzuki S, Moro-oka T, Choudhry NK. The conditional relative odds ratio provided less biased results for comparing diagnostic test accuracy in meta-analyses. *J Clin Epidemiol* 2004;**57:**461–469.
11. Beck JD, Koch GG, Rozier RG, Tudor GE. Prevalence and risk indicators for periodontal attachment loss in a population of older community-dwelling Blacks and Whites. *J Periodontol* 1990;**61:**521–528.
12. Grossi SG, Zambon JJ, Ho AW *et al.* Assessment of risk for periodontal disease. I. Risk indicators for attachment loss. *J Periodontol* 1994;**65:**260–267.
13. Grossi SG, Genco RJ, Machtei EE *et al.* Assessment of risk for periodontal disease. II. Risk indicators for alveolar bone loss. *J Periodontol* 1995;**66:**23–29.
14. Ahlberg J, Tuominen R, Murtomaa H. Periodontal status among male industrial workers in southern Finland with or without access to subsidized dental care. *Acta Odontol Scand* 1996;**54:**166–170.
15. Dolan TA, Gilbert GH, Ringelberg ML *et al.* Behavioral risk indicators of attachment loss in adult Floridians. *J Clin Periodontol* 1997;**24:**223–232.
16. Norderyd O, Hugoson A. Risk of severe periodontal disease in a Swedish adult population. A cross-sectional study. *J Clin Periodontol* 1998;**25:**1022–1028.

17. Wakai K, Kawamura T, Umemura O *et al*. Associations of medical status and physical fitness with periodontal disease. *J Clin Periodontol* 1999;**26:**664–672.
18. Ismail AI, Morrison EC, Burt BA, Caffesse RG, Kavanagh MT. Natural history of periodontal disease in adults: findings from the Tecumseh Periodontal disease study, 1959–87. *J Dent Res* 1990;**69:** 430–435.
19. Brown LF, Beck JD, Rozier RG. Incidence of attachment loss in community-dwelling older adults. *J Periodontol* 1994;**65:**316–323.
20. Beck JD, Sharp T, Koch GG, Offenbacher S. A 5-year study of attachment loss and tooth loss in community-dwelling older adults. *J Periodont Res* 1997;**32:**516–523.
21. Elter JR, Beck JD, Slade GD, Offenbacher S. Etiologic models for incident periodontal attachment loss in older adults. *J Clin Periodontol* 1999;**26:**113–123.
22. Norderyd O, Hugoson A, Grusovin G. Risk of severe periodontal disease in a Swedish adult population. A longitudinal study. *J Clin Periodontol* 1999;**26:**608–615.
23. Hill AB. The environment and disease: association or causation? *J R Soc Med* 1965;**58:**295–300.
24. Gelskey SC. Cigarette smoking and periodontitis: methodology to assess the strength of evidence in support of a causal association. *Community Dent Oral Epidemiol* 1999;**27:**16–24.
25. Thomson WM, Slade GD, Beck JD, Elter JR, Spencer AJ, Chalmers JM. Incidence of periodontal attachment loss over 5 years among older South Australians. *J Clin Periodontol* 2004;**31:**119–125.
26. Bergström J. Tobacco smoking and risk for periodontal disease. *J Clin Periodontol* 2003;**30:**107–113.
27. Yoshida Y, Hatanaka Y, Imaki M *et al*. Epidemiological study on improving the QOL and oral conditions of the aged -Part 2: Relationship between tooth loss and lifestyle factors for adults men. *J Physiol Anthropol Appl Human Sci*. 2001;**20:**369–373.
28. Drake CW, Hunt RJ, Koch GG. Three-year tooth loss among Black and White older adults in North Carolina. *J Dent Res* 1995;**74:**675–680.
29. Grossi SG, Genco RJ. Periodontal disease and diabetes mellitus: a two-way relationship. *Ann Periodontol* 1998;**3:**51–61.
30. Joshipura KJ, Hung HC, Rimm EB, Willett WC, Ascherio A. Periodontal disease, tooth loss, and incidence of ischemic stroke. *Stroke* 2003;**34:**47–52.
31. Garcia RI, Nunn ME, Vokonas PS. Epidemiologic associations between periodontal disease and chronic obstructive pulmonary disease. *Ann Periodontol* 2001;**6:**71–77.
32. Wu T, Trevisan M, Genco RJ, Dorn JP, Falkner KL, Sempos CT. Periodontal disease and risk of cerebrovascular disease: the first national health and nutrition examination survey and its follow-up study. *Arch Intern Med* 2000;**160:**2749–2755.
33. Offenbacher S, Katz V, Fertik G *et al*. Periodontal infection as a possible risk factor for preterm low birth weight. *J Periodontol* 1996;**67:**1103–1113.
34. Garcia RI, Krall EA, Vokonas PS. Periodontal disease and mortality from all causes in the VA Dental Longitudinal Study. *Ann Periodontol* 1998;**3:**339–349.
35. Spiekerman CF, Hujoel PP, DeRouen TA. Bias induced by self-reported smoking on periodontitis–systemic disease associations. *J Dent Res* 2003;**82:**345–349.
36. Hyman JJ, Reid BC. Cigarette smoking, periodontal disease and chronic obstructive pulmonary disease. *J Periodontol* 2004;**75:**9–15.