Relationships between occupational and behavioral parameters and oral health status

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Abstract: The aim of the present study was to assess the influence of various workplace parameters and oral health behaviors on tooth decay, periodontal disease, and the number of teeth present in industrial workers. The study participants were 1,078 workers (808 males, 270 females, mean age 42.8 ± 11.4 yr) employed at 11 different workplaces. Oral examinations and a self-administered questionnaire were conducted for participants. A logistic regression analysis was conducted to identify factors related to their oral health status. Factors significantly associated with decayed teeth were smoking (OR=2.02), not having received tooth brushing instruction (OR=1.73), not having annual dental examinations (OR=1.64) and not brushing before sleeping (OR=0.55). The factors significantly associated with severe periodontal disease were employment with a company with fewer than 50 employees (OR=15.56) and not brushing teeth before bedtime (OR=2.41). The factors significantly associated with having 23 teeth or fewer were subjects in the education and learning support industry compared with manufacturing industry (OR=5.83) and transport industry (OR=12.01). The results of the present study showed that various occupational parameters and health behaviors are associated with oral health status including tooth decay, periodontal disease, and tooth loss.

Key words: Occupational health, Oral health, Periodontal disease, Dental caries, Tooth loss, Workplace

Introduction

In recent years, there has been a focus on the importance of dental health management in workplaces. Previous research has revealed a variety of work-related oral health problems, including associations between declining work performance and temporo-mandibular joint related pain[1], and frequent bruxism and working stress[2]. Moreover, other studies have revealed high levels of work-related stress in workers whose self-evaluation of oral health status was poor[3].

Caries and periodontal disease are the most frequently occurring dental diseases. Periodontal disease is associated with systemic diseases involving a risk of death, including diabetes[4], arteriosclerosis[5], cerebral infarction[6], and myocardial infarction[7]. And work-related psychological dependency, psychological stress due to workload, and other workplace parameters are also associated with periodontal disease[8].

Moreover, caries and periodontal disease are the most common causes of tooth loss[9, 10]. Previous studies have reported major negative effects of tooth loss on overall health, nutritional state, self-respect, and quality of life[11–17]. And previous research indicated age and education level and particular work environment influenced the number of natural teeth[10, 18–20], especially in females[15, 21].

The Report of the Survey of Dental Disease in 2011 revealed high occurrence rates of these conditions in

Table 1.   Business activity of each company

Company	N (Total)	N (Male)	N (Female)	Mean age	Business activity
A	182	171	11	52.2 ± 8.8	Taxi service
B	228	149	79	43.3 ± 10.5	Research and development of new material of system toilet
C	15	12	3	41.6 ± 14.4	Manufacturing plastic products
D	56	34	22	40.4 ± 8.7	Manufacturing and selling medical equipment
E	145	87	58	39.6 ± 9.0	Manufacturing and selling medical equipment
F	31	22	9	47.5 ± 10.4	Manufacturing plastic products
G	40	27	13	36.6 ± 15.0	Manufacturing plastic products
H	30	30	0	38.4 ± 11.3	Manufacturing plastic products
I	21	16	5	41.0 ± 10.3	Manufacturing plastic products
J	197	161	36	41.3 ± 10.7	Manufacturing and selling dental equipment
K	133	99	34	37.8 ± 11.2	Manufacturing and selling Sealing caps

Japan[22]. Among respondents aged 20 yr and older, more than 90% had decayed teeth, more than 70% had symptoms of periodontal disease, and more than 10% had severe periodontal disease (periodontal pockets of ≥4 mm). However, there are no data on company employees in such a national data related to dental disease in Japan.

For the effective implementation of oral health policies within the workplace, the influence of different workplace parameters, such as industrial category, work schedule and occupation on oral health status, is required. However, research that has investigated the effects of such parameters on dental disease via detailed surveys and examined both workplace parameters and oral health behaviors is scarce.

The aim of this study was to investigate the effects of various workplace parameters and oral health behaviors on tooth decay, periodontal disease and the number of teeth present.

Subjects and Methods

Study subjects were workers aged 19–70 yr employed at 11 companies (Company A-K) in the Kanto region of Japan, from April to December 2015. The total number of subjects who consented to the study and with completed data was 1,078 (808 males, 270 females, mean age 42.8 ± 11.4 yr).

The situation of each company was shown in Table 1 follows. The subjects underwent oral examinations and completed a self-administered questionnaire. The study protocol was approved by the Research Ethics Committee of the Faculty of Dentistry, Tokyo Medical and Dental University (No. 1152).

Questionnaire

A self-administered questionnaire containing items pertaining to job category, work schedule, and oral health behavior was completed by each subject prior to the oral examination.

Industrial category

"Industry" was classified via the following three categories based on the Japan Standard Industrial Classification (October 2013)[23]: (1) Education and learning support (Company B); (2) Manufacturing (Company C, D, E, G, H, I, J, K); (3) Transport (Company A, F).

Number of employees at the worksite

The Number of employees at the worksite were classified into 4 groups. These were: (1)300–999 subjects (2)100–299 subjects (3) 50–99 subjects (4) 30–49 subjects.

Job category

Job categories were divided into four groups based on the Japanese Standard Classification of Occupations (JSCO) (December 2009 Statistical Standards Settings, Major Classifications)[24]: (1) Managerial workers; (2) Professional and technical workers; (3) Clerical and related workers; (4) Production process, transport, manual and other workers.

Work schedule

Work schedules were classified as: (1) Daytime work only; (2) Nighttime work/daytime and nighttime work (At least some nighttime work included).

Oral health behavior

Of the 20 items on the "Lifelong Teeth Support Pro-

gram," the eight items below were deemed to be related to oral health behaviors and included in the questionnaire[25].

(1) Having a primary-care dentist;
(2) Brushing teeth in workplace;
(3) Habitual eating between meals;
(4) Smoking habits;
(5) Tooth brushing before sleeping;
(6) Use of an implement to clean areas between teeth (interdental brush/floss);
(7) Had received guidance/instruction regarding tooth brushing;
(8) Dental examinations at least once a year.

Oral health status

A dental mirror and a World Health Organization (WHO)-type periodontal probe were used for the oral examination, and dental and periodontal status were examined visually and by tactile inspection. Periodontal status was evaluated with the Community Periodontal Index (CPI), with the dentition divided into sextants and the highest score of each sextant recorded as the individual's score[26].

The highest CPI code was recorded in each sextant (code 0: no signs of periodontal disease; code 1: gingival bleeding after gentle probing; code 2: supragingival or subgingival calculus; code 3: 4 to 5 mm deep pathologic pockets; and code 4: 6 mm or deeper pathologic pockets) And code X (missing index teeth) was excluded. Periodontal status was divided into two categories: healthy or mild disease group (code: 0–2) and severe diseased group (code: 3–4).

Analysis

The subjects were divided into two groups based on the number of decayed teeth (0 or ≥1), periodontal disease (CPI code 0–2 or 3–4), and number of teeth present (≤23 or ≥24). Chi-squared was used to analyse differences in sex, age, industrial category, number of employees at the work site, job category, work schedule and oral health behaviors.

Logistic regression analysis was performed using the number of decayed teeth, the CPI score and the number of teeth present as dependent variables, and industrial category, number of employees, job category, work schedule, and oral health behaviors as independent variables with adjustment for age and sex. SPSS 20.0 (IBM Japan) was used for statistical analyses, with the significance level set at 5.0%.

Results

Relationships between the occupational parameters and oral health status

As shown in Table 2, there were more male subjects with decayed teeth and there was no significant difference between age groups for decayed teeth. With regard to industrial category, subjects in the education and learning support industry had higher numbers of teeth present than subjects in the manufacturing and transport industries. A significantly higher proportion of night workers had decayed teeth, a worse CPI score, and a lower number of teeth present than daytime workers. The number of decayed teeth was not significantly associated with age, the number of employees or job category.

Male participants were more likely to have severe periodontal disease than female participants, and the proportions generally increased with age. Employees in the transport industry exhibited particularly poor oral health compared with other industrial categories and subjects working in companies with lower numbers of employees were significantly more likely to have severe periodontal disease. With regard to job category, managers and other workers generally exhibited significantly poorer oral health than subjects with other types of jobs. Nighttime working was also significantly associated with poorer oral health. While male and female subjects did not differ significantly with regard to having ≤23 present teeth, there were significant differences in their CPI scores and the presence of tooth decay in ≥1 tooth.

Relationships between oral health behaviors and oral health status

As shown in Table 3, seven oral health behaviors investigated were significantly associated with decayed teeth. However, there were no significant differences between having decayed teeth and "Habitual eating between meals". Smokers and participants who did not brush their teeth before sleeping were more likely to have severe periodontal disease. Notably, there were many subjects who did not eat between meals but had severe periodontal disease. Moreover, many smokers had a lower number of teeth present. Notably however, there were also many subjects with ≤23 teeth present who reported that they had a primary care dentist, did not eat between meals, or had dental examinations at least once a year.

Table 2.   Relationships between the occupational parameters and oral health status

	n		Total (N=1078)	Decayed tooth (≥1) (n=355)			Severe Periodontal disease (CPI score 3–4) (n=109)			Lower number of Teeth (≤23) (n=77)		
				n	(%)	p Value	n	(%)	p Value	n	(%)	p Value
Sex	808	Male		291	36.0	<0.001	99	12.3	<0.001	63	7.8	0.093
	270	Female		64	23.7		10	3.7		14	5.2	
Age	161	19–29		57	35.4		5	3.1		1	0.6	
	266	30–39		80	30.1		16	6.0		3	1.1	
	319	40–49		109	34.2	0.577	22	6.9	<0.001	10	3.1	<0.001
	243	50–59		84	34.6		49	20.2		37	15.2	
	89	≥60		25	28.1		17	19.1		26	29.2	
Industrial category	228	Education and learning support		57	25.0		8	3.5		3	1.3	
	637	Manufacturing		201	31.6	<0.001	57	8.9	<0.001	26	4.1	<0.001
	213	Transport		97	45.5		44	20.7		48	22.5	
Number of employees at the worksite	361	300–999 subjects		104	28.8		15	4.2		10	2.8	
	575	100–299 subjects		206	35.8	0.080	73	12.7	<0.001	55	9.6	0.001
	127	50–99 subjects		38	29.9		15	11.8		12	9.4	
	15	–49 subjects		7	46.7		6	40.0		0	0.0	
Job category	131	Clerical and related workers		40	30.5		9	6.9		5	3.8	
	110	Managerial workers		44	40.0		15	13.6		7	6.4	
	249	Professional and technical workers		68	27.3	0.070	14	5.6	0.012	1	0.4	<0.001
	588	Production process, transport, manual and other workers		203	34.5		71	12.1		64	10.9	
Work schedule	890	Daytime work only		267	30.0	<0.001	71	8.0	<0.001	39	4.4	<0.001
	188	Nighttime work/Daytime and nighttime work		88	46.8		38	20.2		38	20.2	

Table 3.   Relationships between oral health behaviors and oral health status

		Decayed tooth (≥1)						Severe Periodontal disease (CPI score 3,4)						Lower number of Teeth (≤23)					
		Total (N=355)		Male (N=291)		Female (N=64)		Total (N=109)		Male (N=99)		Female (N=10)		Total (N=77)		Male (N=63)		Female (N=14)	
		(%)	p	(%)	p	(%)	p	(%)	p	(%)	p	(%)	p	(%)	p	(%)	p	(%)	p
(1) Having a primary-care dentist	Yes	28.6	<0.001	31.0	<0.001	23.0	0.646	10.6	0.510	13.1	0.374	4.5	0.242	8.8	0.005	9.8	0.011	6.5	0.100
	No	40.3		43.4		25.7		9.3		11.0		1.4		4.3		4.9		1.4	
(2) Brushing teeth in workplace	Daily	26.0		31.1		19.6		6.4		7.4		5.2		5.9		9.0		2.1	
	Sometimes	38.5	0.013	41.6	0.136	32.3	0.056	12.4	0.083	16.8	0.038	3.2	0.620	8.1	0.639	8.4	0.757	7.5	0.207
	Never	32.8		35.1		18.8		10.4		11.7		2.5		7.1		7.3		6.3	
(3) Habitual eating between meals	Never	35.7		36.9		21.4		15.9		16.1		14.3		13.2		12.5		21.4	
	Daily	30.1	0.460	36.9	0.914	20.0	0.504	6.0	0.003	9.4	0.174	1.0	0.035	8.0	0.001	10.7	0.004	4.0	0.019
	Sometimes	33.2		35.4		26.3		10.0		11.8		4.5		5.1		5.3		4.5	
(4) Smoking habits	No	27.3		30.4		20.6		7.9		10.5		2.2		5.3		6.5		2.6	
	Yes	38.7	<0.001	46.4	<0.001	42.4	0.018	15.3	0.002	15.3	0.160	15.2	0.001	10.7	0.003	9.3	0.160	21.2	<0.001
	Quit	45.9		39.4		33.3		12.0		13.6		0.0		12.0		12.1		11.1	
(5) Tooth brushing before sleeping	Daily	31.3		34.4		23.9		8.0		10.4		2.5		6.3		7.0		4.6	
	Sometimes	41.9	0.012	44.5	0.029	25.9	0.442	13.6	<0.001	14.0	0.006	11.1	0.012	8.4	0.086	8.5	0.277	7.4	0.265
	Never	27.8		29.7		0.0		22.8		23.0		20.0		12.7		12.2		20.0	
(6) Use of an implement to clean areas between teeth	Daily	25.5		24.1		29.3		10.1		12.0		4.9		8.7		9.3		7.3	
	Sometimes	28.2	0.001	31.6	0.001	20.8	0.518	8.0	0.205	9.4	0.189	5.0	0.408	6.5	0.663	6.4	0.548	6.7	0.328
	Never	38.3		41.7		24.8		11.6		14.1		1.8		7.2		8.3		2.8	
(7) Had received guidance/instruction regarding tooth brushing	Yes	26.6	<0.001	28.7	<0.001	21.4	0.153	10.6	0.497	13.0	0.418	4.6	0.209	7.2	0.916	7.4	0.642	6.6	0.081
	No	43.7		46.9		29.7		9.3		11.1		1.4		7.0		8.3		1.4	
(8) Dental examinations at least once a year	Yes	21.4	<0.001	24.9	<0.001	14.4	0.005	9.1	0.469	11.7	0.783	3.8	0.922	10.0	0.020	12.2	0.007	5.8	0.732
	No	37.6		39.8		29.5		10.5		12.4		3.6		6.0		6.3		4.8	

Table 4. Logistic regression analysis with "Decayed teeth" as the dependent variable

Independent variable		Odds ratio			p value
Industrial category	Education and learning support (reference)	1.00			
	Manufacturing	1.04	0.61	1.78	0.875
	Transport	1.47	0.68	3.18	0.327
Number of employees at the worksite	300–999 subjects (reference)	1.00			
	100–299 subjects	1.01	0.64	1.58	0.974
	50–99 subjects	0.78	0.44	1.39	0.393
	30–49 subjects	1.63	0.51	5.18	0.406
Job category	Clerical and related workers (reference)	1.00			
	Managerial workers	1.52	0.83	2.78	0.174
	Professional and technical workers	0.80	0.47	1.36	0.410
	Other workers	0.86	0.53	1.39	0.533
Work schedule	Daytime work only (reference)	1.00			
	Nighttime work/daytime and nighttime work	1.60	0.96	2.65	0.072
Having a primary-care dentist	Yes (reference)	1.00			
	No	1.13	0.83	1.55	0.434
Brushing teeth in workplace	Daily (reference)	1.00			
	Sometimes	1.18	0.77	1.82	0.441
	Never	0.82	0.54	1.23	0.328
Habitual eating between meals	Never (reference)	1.00			
	Daily	0.98	0.62	1.54	0.925
	Sometimes	0.98	0.67	1.43	0.901
Smoking habits	Never (reference)	1.00			
	Yes	2.02	1.47	2.77	<0.001 ***
	Quit	1.52	0.88	2.63	0.133
Tooth brushing before sleeping	Daily (reference)	1.00			
	Sometimes	1.28	0.90	1.82	0.169
	Never	0.55	0.31	0.97	0.039 *
Use of an implement to clean areas between teeth	Daily (reference)	1.00			
	Sometimes	1.09	0.69	1.72	0.726
	Never	1.37	0.87	2.15	0.172
Had received guidance/instruction regarding tooth brushing	Yes (reference)	1.00			
	No	1.73	1.29	2.32	<0.001 ***
Dental examinations at least once a year	Yes (reference)	1.00			
	No	1.63	1.14	2.34	0.007 **

Age and sex were included as adjustment factors in this model
*p<0.05, **p<0.01, ***p<0.001

Logistic regression analysis
Decayed teeth

The risk of having at least one decayed tooth was 2.02 times higher in smokers than in non-smokers (Table 4). It was also 1.73 times higher in subjects who had not received tooth brushing instruction than in those who had, and 1.64 times higher in subjects who did not attend for an annual dental examination than in those who did. However, it was 0.55 times lower in subjects who brush teeth before sleeping than not.

Periodontal disease (CPI scores)

The relative risks of having severe periodontal disease are shown in Table 5. Subjects in companies with fewer than 50 employees working on the site were 15.56 times more likely to have severe periodontal disease than those working in companies with 300 employees or more working on the site. Subjects who did not brush their teeth daily before bedtime were 2.41 times more likely to than those who did not.

Number of teeth

The relative risks of having ≤23 teeth present are shown in Table 6. Compared with subjects in the education and learning support industry, those in the manufacturing industry were 5.83 times more likely to have ≤23 teeth present, and those in the transport industry were 12.01 times more likely.

Table 5.   Logistic regression analysis with "Community Periodontal Index score" as the dependent variable

Independent variable		Odds ratio			*p* value
Industrial category	Education and learning support (reference)	1.00			
	Manufacturing	1.63	0.53	4.99	0.393
	Transport	1.43	0.35	5.79	0.615
Number of employees at the worksite	300–999 subjects (reference)	1.00			
	100–299 subjects	1.71	0.72	4.09	0.227
	50–99 subjects	2.58	0.93	7.18	0.070
	30–49 subjects	15.56	3.40	71.23	<0.001 **
Job category	Clerical and related workers (reference)	1.00			
	Managerial workers	1.24	0.44	3.49	0.685
	Professional and technical workers	1.20	0.43	3.41	0.726
	Other workers	1.21	0.47	3.09	0.695
Work schedule	Daytime work only (reference)	1.00			
	Nighttime work/daytime and nighttime work	1.56	0.74	3.31	0.243
Having a primary-care dentist	Yes (reference)	1.00			
	No	1.01	0.61	1.69	0.960
Brushing teeth in workplace	Daily (reference)	1.00			
	Sometimes	1.30	0.63	2.68	0.482
	Never	0.81	0.40	1.63	0.556
Habitual eating between meals	Never (reference)	1.00			
	Daily	0.49	0.24	1.02	0.057
	Sometimes	0.79	0.46	1.33	0.371
Smoking habits	Never (reference)	1.00			
	Yes	1.52	0.95	2.41	0.079
	Quit	1.02	0.45	2.33	0.962
Tooth brushing before sleeping	Daily (reference)	1.00			
	Sometimes	1.35	0.79	2.30	0.275
	Never	2.41	1.22	4.74	0.011 *
Use of an implement to clean areas between teeth	Daily (reference)	1.00			
	Sometimes	0.78	0.39	1.57	0.488
	Never	1.12	0.57	2.22	0.736
Had received guidance/instruction regarding tooth brushing	Yes (reference)	1.00			
	No	0.63	0.38	1.03	0.064
Dental examinations at least once a year	Yes (reference)	1.00			
	No	1.16	0.68	1.98	0.590

Age and sex were included as adjustment factors in this model
*$p<0.05$, **$p<0.001$

Discussion

In this study, numerous workplace parameters and oral health behaviors were significantly associated with the indicators of oral health status. The results of the current study suggest that annual examinations by a dentist and tooth brushing instruction are beneficial for preventing dental caries. While oral hygiene is strongly associated with caries[27], this study suggest that tooth brushing instruction has a greater impact than brushing frequency. Further, given that once dental caries occurs, the damage is irreversible. Our study also underpins the importance of regular dental examinations, and of heeding the advice

provided by the dental professional based on those examinations. However, workers who brushed before sleeping had more caries than those who did not brush before sleeping. There is the possibility that the workers with caries feel anxious for their teeth and brush more compared with those without caries.

The subjects working in small companies (fewer than 50 employees) were at increased risk of periodontal disease. The Japanese Industrial Safety and Health Law obliges businesses with 50 employees or more to appoint a company physician and perform health management of their workers[28]. There is no such obligation to appoint a company physician in small companies (fewer than 50

Table 6. Logistic regression analysis with "number of teeth present" as the dependent variable

Independent variable		Odds ratio			p value
Industrial category	Education and learning support (reference)	1.00			0.026
	Manufacturing	5.83	1.26	26.88	0.024 *
	Transport	12.01	1.97	73.28	0.007 **
Number of employees at the worksite	300–999 subjects (reference)	1.00			0.471
	100–299 subjects	0.54	0.19	1.49	0.232
	50–99 subjects	0.94	0.28	3.10	0.919
	30–49 subjects	0.00	0.00		0.998
Job category	Clerical and related workers (reference)	1.00			
	Managerial workers	0.64	0.16	2.48	0.517
	Professional and technical workers	0.14	0.02	1.30	0.084
	Other workers	0.77	0.26	2.33	0.645
Work schedule	Daytime work only (reference)	1.00			
	Nighttime work/daytime and nighttime work	1.47	0.61	3.55	0.390
Having a primary-care dentist	Yes (reference)	1.00			
	No	0.80	0.39	1.63	0.534
Brushing teeth in workplace	Daily (reference)	1.00			
	Sometimes	1.21	0.50	2.89	0.676
	Never	1.05	0.45	2.42	0.909
Habitual eating between meals	Never (reference)	1.00			
	Daily	1.31	0.59	2.90	0.501
	Sometimes	0.55	0.28	1.05	0.071
Smoking habits	Never (reference)	1.00			
	Yes	1.54	0.84	2.80	0.162
	Quit	0.90	0.35	2.29	0.822
Tooth brushing before sleeping	Daily (reference)	1.00			
	Sometimes	1.12	0.55	2.30	0.749
	Never	1.03	0.42	2.53	0.955
Use of an implement to clean areas between teeth	Daily (reference)	1.00			
	Sometimes	0.64	0.28	1.47	0.297
	Never	0.78	0.34	1.81	0.568
Had received guidance/instruction regarding tooth brushing	Yes (reference)	1.00			
	No	1.17	0.63	2.19	0.621
Dental examinations at least once a year	Yes (reference)	1.00			
	No	0.59	0.32	1.10	0.099

Age and sex were included as adjustment factors in this model
*$p<0.05$, **$p<0.01$

employees) and in such companies health policies may be deficient, which may have an impact on oral health management.

In our data, the proportion of participants who have a dental examination at least once a year was fewer in small companies than those in other companies. Also Table 3 indicate that regular dental examination affect the number of dental caries. It is important to make the environment to conduct regular dental check-up with the support of company physician.

The decline in numbers of teeth associated with older age that was identified in the current study matches the data reported in the Report of the Survey of Dental Dis-

ease[22] and the results of other study[28]. Previous research has shown that tooth loss is associated with age, tooth brushing, smoking, and dental clinic visits[29]. Tooth loss is more frequent in workers in the manufacturing and transport industries than in the education and learning support industry. In our study, the transport industry was mainly represented by taxi and bus companies. Suzuki et al.[30] reported that taxi drivers had disproportionately low numbers of teeth present and that was evidently associated with diabetes, dietary and tooth brushing habits and smoking. From our data not describing in "Result", Smoker were 11.8% in Education and learning support category, 27.6% in manufacturing industry and 36.6% in Transport indus-

try, which had a significant difference. However, there was no significant difference with adjusting various factors. As for this, it was considered that cutoff value of the number of the teeth was different because of the difference of subject's age or whether or not oral health examination was conducted.

The results of the present study suggest that total health management including oral health by an industrial company physician may result in improved oral health among workers. In the future, we believe that even small-scale companies should establish a system whereby there is a company physician appointed to provide supplementary assistance for oral health.

Our results also indicate that there is a need for companies to take countermeasures against oral disease. For occupations in manufacturing and transport (including taxi and bus drivers) where the worker cannot toothbrush for long periods, programs that fit the special needs of the workers should be provided.

Further, regular workplace dental checkups should be arranged. These regular dental checkups should include treatment recommendations and instructions on oral health behaviors, such as effective tooth brushing techniques.

In workplaces primarily populated by adults, dental healthcare policies must be implemented that are focused on preventing periodontal disease, which occurs and progresses with advancing age. The prevention of periodontal disease not only results in improved oral health, it also has profound effects on overall physical health. In the early stages of periodontal disease, there are few subjectively perceptible symptoms. It is important to promote an awareness of the early symptoms of periodontal disease and to provide support that motivates workers to favourable oral health behaviors.

Workplace smoking-related measures are a particularly important aspect of healthy workplace practices. Given that smoking is a well-known risk factor for periodontal disease[31, 32], providing guidance aimed at encouraging employees to stop smoking would be an effective strategy for preventing periodontal disease. A common risk factor approach that combines smoking cessation and support with an emphasis on oral health is an important part of measures designed to prevent "lifestyle-related" diseases[33]. In a previous prospective cohort study[34], dental treatment costs for male employees who were smokers were 14% higher over a five-yr period than those of non-smokers. Furthermore, even current non-smokers with a past history of smoking had lower dental costs than current smokers. Thus, smoking-targeted measures should be implemented as an effective way of reducing dental costs.

Future research must also address the limitations of the present study. In this study, socioeconomic status was not examined. An income and the education level of subjects are very important index to consider this study. However, it was difficult to obtain such difficult personal information in each company. We will examine it in a next study in another company or internet investigation.

There are many previous reports of adverse effects on tooth acid erosion in workplaces[35–38], and measures and policies for acidic dental erosion are currently being considered. However, there are few reports of studies that have investigated the effects of various workplace parameters on dental caries, periodontal disease and tooth loss. Thus, the current study is important.

In order to implement more effectively dental health policies at worksites, future research must focus on the collection of more detailed data concerning the oral health of workers via clinical examinations and the results of these examinations should be analysed in conjunction with data derived from questionnaires administered to these same subjects. Studies investigating the potential benefits of interventions such as dental health instruction programs are also required. It is important that the focus of such studies should not be limited to oral health status improvements alone. The relationships between oral health behaviors and their effects on dental diseases, work performance, and medical expenses also should be examined, to achieve more effective oral health procedures and policies tailored to specific types of workplaces.

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