Original

Comparison of the oral health problems and behavior of male daytime-only and night-shift office workers: An Internet survey

Yoichi Ishizuka[1], Koichi Yoshino[1], Atsushi Takayanagi[1], Naoki Sugihara[1], Yoshinobu Maki[2] and Hideyuki Kamijyo[3]

[1]Department of Epidemiology and Public Health, Tokyo Dental College, 2-9-18 Misaki-cho, Chiyoda-ku, Tokyo 101-0061, Japan, [2]Department of Social Science Dentistry, Tokyo Dental College, 2-9-18 Misaki-cho, Chiyoda-ku, Tokyo 101-0061, Japan and [3]Department of Social Security for Dentistry, Tokyo Dental College, 2-9-18 Misaki-cho, Chiyoda-ku, Tokyo 101-0061, Japan

Abstract: Objective: The aim of this study was to compare the oral health problems and behavior of full-time male daytime-only and night shift office workers. **Methods:** The participants were recruited by applying screening procedures to a pool of Japanese registrants in an online database. During the period of 20 February 2015 to 11 March 2015, participants were asked to complete a questionnaire about their oral health. A total of 325 daytime-only workers and 351 workers who sometimes worked night shifts, ages 30 to 69, were analyzed in this study. **Results:** Overall, the mean number of teeth of the night shift workers was lower than that of the daytime-only workers (p=0.002). When analyzed by age group, a significant difference was seen in the 50-69 age group (p =0.016). The percentage of night shift workers with decayed teeth was higher than that of the daytime-only workers (p<0.001). The night shift workers were more likely to report gingival bleeding (p=0.015) and stomatitis (p=0.025) than the daytime-only workers. The percentage of night shift workers reporting frequent brushing behavior was lower than that of the daytime-only workers (p =0.040). The independent variables found to correlate significantly with tooth decay were night shift work (OR, 1.79; 95% CI, 1.20-2.67), current smoking habit (OR, 1.66; 95% CI, 1.13-2.46), and BMI of ≥25 (OR, 1.56; 95% CI, 1.02-2.39). **Conclusions:** These results indicate a relationship between night shift work and oral health problems. Night shift workers may require additional support for oral health maintenance.

Introduction

Night shift work is known to take a toll on general health and is associated with a number of lifestyle-related diseases. Night shift work has been shown to be associated with ischemic stroke[1], breast cancer[2], diabetes[3], hypertension[4], and obesity[5]. It is well known that many physiological functions follow a circadian rhythm and that long-term disturbance of that rhythm has clinical consequences[1-5]. In their investigation of the relationship between shift work and oral health, Han et al.[6] found an association between shift work and periodontal health. They found that shift workers aged ≥45 years were at higher risk for periodontitis. However, there have been very few studies investigating the association of night shift work with oral health.

Lifestyle changes that cause a disturbance to the circadian rhythm can have a negative influence on oral health behavior, such as tooth brushing and sugar intake. Therefore, our hypothesis was that night shift workers would have more oral health problems, such as tooth loss, decayed teeth, and discomfort, than daytime-only workers. The aim of this study was to compare the oral health problems and behavior of full-time male daytime-only workers with those of individuals whose work also included night shifts.

Methods

Participants

This Internet-based survey was conducted in Japan from 20 February 2015 to 11 March 2015. A total of 676 male participants were selected via the procedure described below.

Selection of participants

Participants were selected from a pool of 1,187,791 people registered with an online research company called Macromill (http://www.macromill.com/) who had agreed to participate in oral health-related surveys when they registered. These registrants were invited to participate in this survey and provided their informed consent by clicking the corresponding button, after which the screening survey began. The questionnaire for this study was then sent to registrants who met the following criteria: age 30-69, male, full-time worker, and worked in the daytime only or worked a shift rotation involving night shifts. The registrants filled out the questionnaire and sent their responses via e-mail. The data from the first 103 daytime-only and night shift respondents in each 10-year age group (30-39, 40-49, 50-59, 60-69) were collected and analyzed in this study.

Work schedules

Night shift workers were defined as those working on a shift rotation schedule that included a 10 PM to 5 AM shift. Daytime-only workers were defined as non-shift workers who only work during the daytime. The daytime-only workers might, however, have overtime work.

Number of participants

We did not include the data from 46 business managers and company executives, because few of these respondents were night shift workers. Furthermore, we excluded public employees, because the category of public employee includes many different types of jobs. A total of 325 daytime-only workers and 351 night shift office workers were analyzed in this study. Participants were divided into two age groups (30-49 and 50-69) because tooth loss increases at a distinctly higher rate from around 50 years old.

Questionnaire items

Respondents were asked to report their yearly household income, years of service on the job, smoking status (current smoker or not), diabetes and hypertension status (yes or no), and height and weight (BMI was then calculated and categorized as <25 or ≥25). Oral health status items elicited the number of present teeth, reasons for tooth loss (caries, periodontitis, or fracture), presence of untreated tooth with a hole (yes or no), and presence or

absence of the following symptoms: pain when consuming something cold, pain in the teeth or gingiva, bleeding from the gingiva, swelling in the gingiva, difficulty opening the mouth, bad breath, spaces between the teeth, and frequent stomatitis. Concerning oral health behavior, respondents were asked whether they brush their teeth every day (yes or no), how frequently they brush their teeth every day (<2 or ≥2), whether they brush before going to sleep (yes or no), whether they use fluoride toothpaste (yes or no), how many minutes they spend brushing their teeth (<3 or ≥3), whether they use an interdental brush (yes or no), whether they visit a dental clinic regularly (yes or no), whether they had visited a dental clinic within the past year (yes or no), whether they were able to visit a dental clinic when they want to (yes or no), and why they were unable to visit a dental clinic (unable to go during the hours the clinic is open, cost of treatment, too busy, multiple visits required for treatment, do not like treatment, no clinics nearby).

Statistical analysis

A chi-squared test (or Fisher's exact test in cases with fewer than five cells in the contingency table) was used to make comparisons between the daytime-only and night shift groups. The Mann-Whitney *U* test was used to compare the number of teeth of the two groups.

Odds ratios (ORs) and 95% confidence intervals (CIs) were determined using multiple logistic regression analyses (forced entry method). The dependent variable was set as participants with decayed teeth. The model included known risk factors and variables showing a difference in association between daytime-only workers and night shift workers. Work schedule, age, household income, years of service, hypertension, smoking habit, BMI, and daily brushing frequency were set as the independent variables. Spearman's correlation coefficient was used to investigate the relationships among the independent variables. The data was analyzed using the IBM SPSS Statistics, Version 23.0, software (IBM Corp., Armonk, NY, USA). This study was approved by the ethical committee of Tokyo Dental College (Approval Number 602).

Results

Table 1 presents a comparison of the basic characteristics of the daytime-only and night shift workers. There were significant differences between the two groups in annual family income among participants aged 50-69 (p<0.001) and among all participants in aggregate (p=0.011). There were significant differences in years of service between the two groups among participants aged 50-69 (p<0.001) and among all participants in aggregate (p<0.001).

Table 2 shows the general health behavior and disease status of the daytime-only and night shift workers. For all participants in aggregate, the percentage of smokers was

Table 1. Basic characteristics of the daytime-only and night shift workers

			30-49		50-69		Total	
			%	n	%	n	%	n
		Day	53.2	173	46.8	152	100	325
		Night	51.3	180	48.7	171	100	351
Region	Hokkaido	Day	5.2	9	3.9	6	4.6	15
		Night	5.0	9	7.0	12	6.0	21
	Tohoku	Day	5.2	9	3.3	5	4.3	14
		Night	6.7	12	7.0	12	6.8	24
	Kanto	Day	38.7	67	42.1	64	40.3	131
		Night	35.0	63	34.5	59	34.8	122
	Chubu	Day	15.0	26	21.1	32	17.8	58
		Night	24.4	44	18.1	31	21.4	75
	Kinki	Day	15.0	26	18.4	28	16.6	54
		Night	17.2	31	17.5	30	17.4	61
	Chugoku	Day	6.9	12	1.3	2	4.3	14
		Night	3.9	7	5.3	9	4.6	16
	Shikoku	Day	2.3	4	2.6	4	2.5	8
		Night	3.3	6	3.5	6	3.4	12
	Kyushu	Day	11.6	20	7.2	11	9.5	31
		Night	4.4	8	7.0	12	5.7	20
	Test		n.s.		n.s.		n.s.	
Annual family income								
	<4 million yen	Day	16.8	29	12.5	19	14.8	48
		Night	22.8	41	27.5	47	25.6	90
	4-6	Day	34.7	60	21.7	33	32.3	105
		Night	41.1	74	32.2	55	38.5	135
	≥6	Day	35.8	62	53.3	81	24.9	81
		Night	28.3	51	30.4	52	23.9	84
	Unknown	Day	12.7	22	12.5	19	12.6	41
		Night	7.8	14	9.9	17	8.8	31
	Test		n.s.		p<0.001		p=0.011	
Years of service								
	<10 years	Day	39.3	68	30.9	47	35.4	115
		Night	47.2	85	50.9	87	49.0	172
	≥10 years	Day	60.7	105	69.1	105	64.6	210
		Night	52.8	95	49.1	84	51.0	179
	Test		n.s.		p<0.001		p<0.001	

higher among night shift workers than daytime-only workers, and this difference was also significant for all participants in aggregate (p=0.046).

Table 3 shows the self-assessed oral health status of the daytime-only and night shift workers. Overall, the mean number of teeth was lower among night shift workers than daytime-only workers (p=0.002), and this difference was also significant among the 50-69 age group (p= 0.016). Tooth decay was higher in night shift workers for both age groups (p=0.011 for the 30-49 age group and p= 0.019 for the 50-69 age group).

For the 30-49 age group, a higher percentage of night shift workers reported pain in the teeth or gingiva (p= 0.034), gingival bleeding (p=0.010), gingival swelling (p =0.033), and stomatitis (p=0.016). This was also true for participants of both age groups combined (p=0.015 for gingival bleeding and p=0.025 for stomatitis).

Table 4 shows the results for oral health behavior, again comparing the two groups. For all age groups com- bined, the percentage of night shift workers reporting fre- quent brushing (twice or more per day) was lower than that of daytime-only workers (p=0.040).

Table 2. General health behavior and diseases of the daytime-only and night shift workers

		30-49			50-69			Total		
		%	n	Test	%	n	Test	%	n	Test
	Day	53.2	173		46.8	152		100	325	
	Night	51.3	180		48.7	171		100	351	
Current smoker	Day	31.8	55		26.3	40		29.2	95	
	Night	39.4	71		33.3	57		36.5	128	p=0.046
Diabetes	Day	2.3	4		11.2	17		6.5	21	
	Night	2.2	4		13.5	23		7.7	27	
Hypertension	Day	6.4	11		28.9	44		16.9	55	
	Night	8.9	16		31.6	54		19.9	70	
BMI	Day	24.3	42		23.0	35		23.7	77	
25 and over	Night	22.8	41		28.7	49		25.6	90	

Table 3. Self-assessed oral health status of the daytime-only and night shift workers

		30-49			50-69			Total		
				Test			Test			Test
Mean number of teeth	Day	25.8 (±6.9)			24.9 (±6.1)			25.4 (±6.5)		
	Night	25.2 (±6.8)			22.3 (±8.3)		p=0.016	23.8 (±7.7)		p=0.002
		%	n	Test	%	n	Test	%	n	Test
Presence of decayed teeth	Day	15.6	27		15.1	23		15.4	50	
	Night	26.7	48	p=0.011	25.7	44	p=0.019	26.2	92	p<0.001
Symptoms										
Pain when ingesting something cold	Day	27.2	47		23.0	35		25.2	82	
	Night	31.1	56		26.9	46		29.1	102	
Pain in the teeth or gingiva	Day	8.7	15		17.8	27		12.9	42	
	Night	16.1	29	p=0.034	16.4	28		16.2	57	
Gingival bleeding	Day	17.3	30		16.4	25		16.9	55	
	Night	28.9	52	p=0.010	19.9	34		24.5	86	p=0.015
Gingival swelling	Day	6.9	12		17.8	27		12.0	39	
	Night	13.9	25	p=0.033	13.5	23		13.7	48	
Difficulty opening the mouth	Day	3.5	6		2.6	4		3.1	10	
	Night	3.3	6		1.8	3		2.6	9	
Bad breath	Day	15.6	27		21.7	33		18.5	60	
	Night	22.2	40		22.2	38		22.2	78	
Frequent stomatitis	Day	4.6	8		8.6	13		6.5	21	
	Night	11.7	21	p=0.016	11.1	19		11.4	40	p=0.025

In the 30-49 age group, night shift workers were more likely to report an inability to visit a dental clinic when they want to (p>0.05), but daytime-only workers reported that being too busy for work was the reason (p=0.006). Conversely, in the 50-69 age group, daytime-only workers were more likely to report an inability to visit a dental clinic (p=0.039), but no clear reason for this could be determined from this data.

Table 5 shows the logistic regression analysis for tooth decay. There were no strong relationships (|r|>0.3) among the independent variables by Spearman's correlation coefficient. The independent variables found to be correlated with tooth decay were night shift (OR, 1.79; 95% CI, 1.20-2.67), current smoking habit (OR, 1.66; 95% CI, 1.13-2.46), and BMI of ≥25 (OR, 1.56; 95% CI, 1.02-2.39).

Table 4. Oral health behavior of the daytime-only and night shift workers

		30-49		50-69		Total		
		%	n	%	n	%	n	
Oral health behavior	Day	53.2	173	46.8	152	100	325	
	Night	51.3	180	48.7	171	100	351	
			Test		Test			Test
Brushes teeth every day	Day	93.1	161	92.8	141	92.9	302	
	Night	90.0	162	87.7	150	88.9	312	
Brushes twice or more per day	Day	73.4	127	71.1	108	72.3	235	p=0.040
	Night	66.1	119	63.7	109	65.0	228	
Brushes before bed	Day	64.2	111	55.9	85	60.3	196	
	Night	60.6	109	46.8	80	53.8	189	
Uses fluoride toothpaste	Day	49.1	85	34.2	52	42.2	137	
	Night	42.8	77	33.3	57	38.2	134	
Spends 3 minutes or more when brushing	Day	52.0	90	52.6	80	52.3	170	
	Night	57.8	104	44.4	76	51.3	180	
Uses an interdental brush	Day	44.5	77	50.7	77	47.4	154	
	Night	38.9	70	46.2	79	42.5	149	
Has a regular dental clinic	Day	52.0	90	66.4	101	58.8	191	
	Night	43.9	79	67.3	115	55.3	194	
Visits a dental clinic regularly	Day	42.2	73	49.3	75	45.5	148	
	Night	35.0	63	43.9	75	39.3	138	
Visited a dental clinic in the past year	Day	43.4	75	52.6	80	47.7	155	
	Night	38.3	69	51.5	88	44.7	157	
Unable to visit a dental clinic when wants to	Day	39.3	68	41.4	63	40.3	131	
	Night	46.7	84	30.4 (p=0.039)	52	38.7	136	
Reasons for being unable to visit a dental clinic								
Cannot go when clinic is open	Day	57.4	39	54.0	34	55.7	73	
	Night	65.5	55	53.8	28	61.0	83	
Cannot afford treatment cost	Day	13.2	9	11.1	7	12.2	16	
	Night	17.9	15	17.3	9	17.6	24	
Too busy with work	Day	61.8	42	44.4	28	53.4	70	p=0.025
	Night	39.3 (p=0.006)	33	40.4	21	39.7	54	
Multiple visits required for treatment	Day	16.2	11	11.1	7	13.7	18	
	Night	16.7	14	9.6	5	14.0	19	
Does not like treatment	Day	4.4	3	9.5	6	6.9	9	
	Night	8.3	7	7.7	4	8.1	11	
No dental clinics nearby	Day	0.0	0	0.0	0	0.0	0	
	Night	1.2	1	3.8	2	2.2	3	

Discussion

Previous reports[7,8] have indicated that a self-reported questionnaire is a feasible option for measuring oral health conditions such as number of present teeth and decayed teeth. After adjusting for confounding factors, the independent variable of night shift work was determined to be a risk factor for the presence of untreated decayed teeth. This indicates that night shift work is associated with a decline in oral health status. This may be primarily caused by differences in oral health behavior such as the percentage of night shift workers who brush their teeth twice a day or more. This behavior directly causes oral health problems such as gingival bleeding and gingival swelling. However, the exact mechanism whereby night

Table 5. Factors contributing to tooth decay by multiple logistic regression analysis

Independent variable	n	Dependent variable: participants with at least one decayed tooth			
		n	(%)	OR (95% CI)	p-value
Work schedule					
Daytime-only	325	50	(15.4)	1	
Night shift	351	92	(26.2)	1.79 (1.20-2.67)	0.004
Age					
30-49	353	75	(21.2)	1	
50-69	323	67	(20.7)	1.01 (0.68-1.50)	0.974
Annual household income					
<4 million yen	133	38	(28.6)	1	
4-6	218	40	(18.3)	0.63 (0.37-1.07)	0.087
≥6	266	55	(20.7)	0.83 (0.50-1.39)	0.488
Unknown	59	9	(15.3)	0.60 (0.26-1.39)	0.234
Years of service					
<10 years	287	71	(24.7)	1	
≥10 years	389	71	(18.3)	0.74 (0.50-1.10)	0.234
Hypertension					
No or unknown	551	119	(21.6)	1	
Yes	125	23	(18.4)	0.71 (0.41-1.21)	0.206
Smoking habit					
No	453	80	(17.7)	1	
Yes	223	62	(27.8)	1.66 (1.13-2.46)	0.011
BMI					
<25	509	97	(19.1)	1	
≥25	167	45	(26.9)	1.56 (1.02-2.39)	0.039
Daily brushing frequency					
<2 times	213	54	(25.4)	1	
≥2 times	463	88	(19.0)	0.78 (0.52-1.17)	0.235

shift work influences oral health behaviors was not investigated in this study.

Smoking was correlated with untreated decayed teeth in this study. Bernabe et al.[9] investigated the relationship between daily smoking and caries increment in adults. They found that daily smoking was related to the net decayed teeth increment but was not related to the net filled teeth, missing teeth, or decayed, missing, and filled teeth increments over a 4-year period. Smokers also had poor dental attendance, high sugar consumption, and infrequent toothbrushing. Concerning the correlation between shift work and smoking, van Amelsvoort et al.[10] reported that independent of educational level, shift workers are more prone to start smoking than daytime workers. This may be one of the reasons for the higher percentage of untreated decayed teeth among night shift workers in the current study.

Concerning the association of night shift work with high BMI, Morikawa et al.[11] reported that continuous shift work was a risk factor for increased BMI during a

10-year period. Antunes et al.[12] conducted a review of research on obesity and shift work and found that most studies did not find a difference between shift workers and daytime workers with respect to total energy intake and macronutrient intake. However, many reports did find that there were differences in eating habits and food selection among shift workers. In a cross-sectional study, Morikawa et al.[11] found that among subjects aged 30 and over, total energy intake was the highest among shift workers who worked midnight shifts. Previous reports on the relationship between BMI and caries found no association between the number of carious lesions and obesity in adult[13,14]. These reports suggest that dietary habits may be contributing to the higher number of untreated decayed teeth among night shift workers. They may also be contributing to the higher percentage of oral health problems among night shift workers.

Vimalananda et al.[3] reported that even though lifestyle and BMI explained a major part of the association of shift work with incident diabetes, a long duration of shift work

resulted in an increased risk of diabetes after controlling for those factors. Shift work is associated with disrupted circadian rhythms and reduced total duration of sleep[15]. Leproult et al.[16] reported that circadian misalignment is associated with increased insulin resistance and inflammation, independent of sleep loss. These factors may help explain the higher percentage of gingival bleeding and gingival swelling among night shift workers.

Low socioeconomic status is a barrier to dental attendance, and such barriers appear to have negative effects on oral health[17,18]. Universal health insurance in Japan covers most illnesses, so anyone can receive care at any hospital in the country. Therefore, Japanese people can access treatment more easily and at a lower cost than in most areas of the world[19]. Although universal healthcare insurance covers dental prostheses in Japan, individual financial status is associated with prosthesis use[20,21]. Although we were not able to match detailed information regarding socioeconomic status in this study, there is a need for future inquiry into how this factor influences night shift workers' behavior.

There were several limitations in this study, the first of which is the possibility of selection bias due to the fact that this was an Internet survey. The second limitation of this study is that we were unable to match detailed job information with annual household income between the two groups. The third limitation of this study is that the oral health status information was self-assessed and self-reported. The fourth limitation of this study is that we did not report detailed data regarding the night shift workers' schedules, such as data regarding overtime, use of flextime systems, break time, and number of holidays. The final limitation of this study is that it was a cross-sectional survey.

In spite of these limitations, the results of this study do show a clear relationship between night shift work and oral health problems, and this study is the first to provide empirical evidence of such an association. Further research on this issue, as well as stronger measures to provide oral health maintenance support for night shift workers, are warranted.

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