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Original Article

Comparison of risk factors for tooth loss between professional drivers and white-collar workers: an internet survey

Seitaro SUZUKI[1]*, Koichi YOSHINO[1], Atsushi TAKAYANAGI[1], Yoichi ISHIZUKA[1], Ryouichi SATOU[1], Hideyuki KAMIJO[2] and Naoki SUGIHARA[1]

[1]Department of Epidemiology and Public Health, Tokyo Dental College, Japan
[2]Department of Social Security for Dentistry, Tokyo Dental College, Japan

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Abstract: This cross-sectional study was conducted to examine tooth loss and associated factors among professional drivers and white-collar workers. The participants were recruited by applying screening procedures to a pool of Japanese registrants in an online database. The participants were asked to complete a self-reported questionnaire. A total of 592 professional drivers and 328 white-collar workers (male, aged 30 to 69 years) were analyzed. A multiple logistic regression analysis was performed to identify differences between professional drivers and white-collar workers. The results showed that professional drivers had fewer teeth than white-collar workers (odds ratio [OR], 1.74; 95% confidence interval [95% CI], 1.150–2.625). Moreover, a second multiple logistic regression analysis revealed that several factors were associated with the number of teeth among professional drivers: diabetes mellitus (OR, 2.68; 95% CI, 1.388–5.173), duration of brushing teeth (OR, 1.66; 95% CI, 1.066–2.572), frequency of eating breakfast (OR, 2.23; 95% CI, 1.416–3.513), frequency of eating out (OR, 1.70; 95% CI, 1.086–2.671) and smoking status (OR, 2.88; 95% CI, 1.388–5.964). These findings suggest that the lifestyles of professional drivers could be related to not only their general health status, but also tooth loss.

Key words: Professional drivers, Oral conditions, Internet survey, Lifestyle factors, Remaining teeth, Oral health behavior, Male

Introduction

Professional drivers have been reported to constitute a particular disease risk group because of their characteristic working environment[1–3]. The main business of professional drivers is driving, and they are exposed to whole-body vibration, noise, and exhaust gas. In addition, when they drive, they are under stress and tend to smoke[4]. Moreover, professional drivers have been reported to be at risk for diseases such as cardiovascular disease, lower back pain and diabetes mellitus[3, 5–8]. Kurosaka *et al.* reported that drivers with coronary artery disease not only have a high prevalence of various risk factors, but also tend to have three or more risk factors simultaneously[9]. Therefore, to improve the health status of professional drivers, a multi-angle approach is necessary. Meanwhile, few reports have discussed the oral conditions of professional drivers. However, the factors that have been reported as risk factors for diseases among professional drivers, such as smoking, can also be considered as risk factors for oral diseases[10]. Therefore, our hypothesis was that professional drivers would have fewer teeth than white-collar workers and the pur-

*To whom correspondence should be addressed.
E-mail: suzukiseitarou@tdc.ac.jp

poses of this study were to reveal tooth loss among professional drivers and to identify factors associated with tooth loss. In this study, we selected white-collar workers as a control group because several studies examining the general health and oral conditions of this group have already been reported[11–13].

Materials and Methods

Subjects

This internet-based survey was conducted in Japan from February 20, 2015, to March 11, 2015. We assumed that 3 weeks would be sufficient to obtain answers from the participants. The Participants were selected from people registered with an online research company called Macromill (http://www.macromill.com/global/index.html). They were aged 30 to 69 years and were fulltime or non-fulltime workers including nurses, cooks and professional drivers. We selected this age range because the proportion of persons with missing teeth increases at ages beyond 30 years, according to the Survey of Dental Diseases in Japan[14], and the number of registrants over 70 years of age was too small to analyze. The respondents completed the questionnaire after they had agreed to participate in the survey via a website. As a result, among the respondents who were male, we selected 737 respondents who were professional drivers by occupation and 620 respondents who were teachers, clerks, salespersons, or administrators and were collectively referred to as white-collar workers[15].

Moreover, based on the Comprehensive Survey of Living Conditions in Japan[16], which is a national survey conducted to study the basic living conditions of subjects, we excluded respondents whose family income was less than 2 million yen or more than 8 million yen to minimize the effect of income on the number of present teeth[17]. Eventually, 592 male professional drivers and 328 male white-collar workers aged 30 to 69 years were analyzed (total, 920 people). All the subjects were male because there were few female drivers.

Questionnaire

The participants completed a self-reported questionnaire.

The questionnaire items were selected after considering the factors associated with the number of present teeth and the characteristics of professional drivers. Dental care utilization patterns[18], smoking[10, 19, 20], and dental hygiene habits[21, 22] have been reported as factors related to the number of present teeth, and BMI[3], systemic diseases[3, 5, 6, 8, 9, 23], eating habits[5, 23], sleeping hours[2] have been reported as factors related to professional driving as an occupation. In addition, working environment factors were selected as possible confounders. Height and weight were determined using the questions, "How tall are you?" and "How much do you weigh?" The BMI was then calculated based on the responses and was categorized as <25 or ≥ 25 kg/m^2. Family income was determined using the question, "How much is your annual family income?" The response was then categorized as <4 million yen or ≥ 4 million yen. Information was also collected on working environment (working hours: "How many hours do you work a day?", categorized as <8 h or ≥ 8 h; shift work: "Do you work in shifts?", categorized as yes or no; duration of employment: "How long have you been working?", categorized as <10 years or ≥ 10 years; night work: "Do you have night work?", categorized as yes or no), systemic diseases that have been reported to be related to professional driving ("Do you have any of the following diseases: diabetes mellitus, hypertension, hypercholesterolemia, cardiovascular disease, lower back pain, or gastrointestinal illnesses?", categorized as yes or no), dental care utilization patterns ("Have you visited a dental clinic within the past year?", "Do you visit the same dentist?", and "Do you have regular dental check-ups?", categorized as yes or no), lifestyle (frequency of eating breakfast and dinner on weekdays: "How often do you eat breakfast and dinner on weekdays?", categorized as every day or not every day; frequency of eating out on weekdays: "How often do you eat out on weekdays?", categorized as time and more per week or never; smoking status: "Do you smoke?", categorized as smokers or ever smokers and non-smokers; sleeping hours: "How many hours do you sleep at night?", categorized as <6 h or ≥ 6 h; eating snacks between meals: "Do you eat snacks between meals?", categorized as yes or no), and dental hygiene habits (frequency of daily brushing: "How often do you brush your teeth a day?", categorized as <2 or ≥ 2; duration of brushing teeth: "How many minutes do you brush your teeth?", categorized as <3 minutes or ≥ 3 minutes; timing of brushing teeth: "When do you brush your teeth: before eating breakfast, after eating breakfast, after eating lunch, after eating snack, after eating dinner, or before bed time?", categorized as yes or no for each option). The number of present teeth was determined by asking "How many teeth do you have?"

Statistical analysis

We divided the subjects into two groups: <20 teeth or ≥ 20 teeth. First, to compare the number of present teeth between professional drivers and white-collar workers, we selected adjustment factors to adjust for possible confound-

Table 1. Characteristics of participants related to adjustment factors comparing job categories using the chi-squared test

Adjustment factors		Professional drivers		White-collar workers		
		n	%	n	%	*P values*
Age group (years)	30–49	297	50.2	183	55.8	0.113
	50–69	295	49.8	145	44.2	
Annual family income	<4 million yen	232	39.2	94	28.7	0.002
	≥4 million yen	360	60.8	234	71.3	
Working hours	<8 h	118	19.9	120	36.6	<0.001
	≥8 h	474	80.1	208	63.4	
Shift work	No	308	52.0	242	73.8	<0.001
	Yes	284	48.0	86	26.2	
Duration of employment	<10 years	368	62.2	179	54.6	0.030
	≥10 years	224	37.8	149	45.4	
Night work	No	454	76.7	255	77.7	0.744
	Yes	138	23.3	73	22.3	

ers: age, family income, and working environment. A chi-squared test (or the Fisher exact test for cases with fewer than five cells in the contingency table) was used for the adjustment factors in professional drivers and white-collar workers to investigate the differences in the distributions of each characteristic. Next, a multiple logistic regression analysis was performed using the number of present teeth as the dependent variable (0=having 20 teeth and more, 1=having fewer than 20 teeth), and the adjustment factors and job category as independent variables.

Furthermore, to examine the effect of each factor on the number of present teeth according to each job category, we performed a chi-squared test and a multiple logistic regression analysis for each job category. The multiple logistic regression analyses were developed using the number of present teeth as the dependent variable (0=having 20 teeth and more, 1=having fewer than 20 teeth), and the adjustment factors and statistically significant factors identified using a chi-squared test were included as independent variables. All the multiple logistic regression analyses were developed using a forced entry method.

The data were analyzed using the computerized statistical package SPSS, version 22.0 (SPSS Japan, Inc. Tokyo. Japan), and a significance level of 5% was used. This study was approved by the ethical committee of Tokyo Dental College (Approval number 602).

Result

Table 1 shows the adjustment factor-related characteristics of the participants comparing job categories. Significant differences in family income ($P=0.002$), working hours ($P=<0.001$), shift work ($P=<0.001$), and duration of employment ($P=0.030$) were observed.

Table 2. Results of a multiple logistic regression analysis comparing job categories n=920

Independent variables		OR	95% CI	*P values*
Job category	White-collar workers	1.00		
	Professional drivers	1.74	1.150–2.625	0.009
Age group (years)	30–49	1.00		
	50–69	2.30	1.600–3.301	<0.001
Annual family income	≥4 million yen	1.00		
	<4 million yen	1.45	1.016–2.066	0.040
Working hours	<8 h	1.00		
	≥8 h	0.76	0.513–1.137	0.185
Shift work	No	1.00		
	Yes	1.34	0.925–1.940	0.122
Duration of employment	<10 years	1.00		
	≥10 years	0.78	0.538–1.126	0.184
Night work	No	1.00		
	Yes	1.04	0.683–1.585	0.853

The results of a multiple logistic regression analysis comparing job categories is shown in Table 2. The dependent variable was the number of present teeth, and the independent variables were the adjustment factors and job category. Job category was significantly associated with the number of present teeth between professional drivers and white-collar workers (odds ratio [OR], 1.74; 95% confidence interval [95% CI], 1.150–2.625).

Table 3 shows a comparison of professional drivers and white-collar workers for factors associated with the number of present teeth. Among professional drivers, signifi-

Table 3. Comparison of factors associated with having fewer than 20 teeth between professional drivers and white-collar workers using the chi-squared test

Factors			Professional drivers				White-collar workers			
			Having fewer than 20 teeth				Having fewer than 20 teeth			
			n_1	n_2	%	*P values*	n_1	n_2	%	*P values*
Characteristics	Age group (years)	30–49	297	41	13.8	<0.001	183	15	8.2	0.017
		50–69	295	82	27.8		145	25	17.2	
	BMI	<25	396	78	19.7	0.389	228	28	12.3	1.000
		≥25	196	45	23.0		100	12	12.0	
	Annual family income	<4 million yen	232	57	24.6	0.078	94	16	17.0	0.096
		≥4 million yen	360	66	18.3		234	24	10.3	
Working environment	Working hours	<8 h	118	34	28.8	0.022	120	15	12.5	1.000
		≥8 h	474	89	18.8		208	25	12.0	
	Shift work	Yes	284	69	24.3	0.054	86	11	12.8	0.849
		No	308	54	17.5		242	29	12.0	
	Duration of employment	<10 years	368	80	21.7	0.531	179	27	15.1	0.091
		≥10 years	224	43	19.2		149	13	8.7	
	Night work	Yes	138	33	23.9	0.338	73	10	13.7	0.686
		No	454	90	19.8		255	30	11.8	
Systemic diseases	Diabetes mellitus	Yes	54	23	42.6	<0.001	29	5	17.2	0.374
		No	538	100	18.6		299	35	11.7	
	Hypertension	Yes	141	42	29.8	0.004	59	9	15.3	0.509
		No	451	81	18.0		269	31	11.5	
	Hypercholesterolemia	Yes	74	24	32.4	0.013	32	5	15.6	0.567
		No	518	99	19.1		296	35	11.8	
	Cardiovascular disease	Yes	6	1	16.7	1.000	6	0	0.0	1.000
		No	586	122	20.8		322	40	12.4	
	Lower back pain	Yes	96	18	18.8	0.681	43	6	14.0	0.626
		No	496	105	21.2		285	37	11.9	
	Gastrointestinal disease	Yes	18	6	4.9	0.233	9	2	22.2	0.302
		No	574	117	20.4		319	38	11.9	
Dental care utilization	Dental visits in past year	Yes	299	67	22.9	0.225	149	20	13.4	0.612
		No	293	56	18.7		179	20	11.2	
	Visiting same dentist	Yes	351	78	22.2	0.305	182	23	12.6	0.866
		No	241	45	18.7		146	17	11.6	
	Regular dental check-ups	Yes	244	55	22.5	0.411	126	19	15.1	0.227
		No	348	58	19.5		202	21	10.4	
Life style	Frequency of eating breakfast on weekdays	Every day	378	60	15.9	<0.001	244	30	12.3	1.000
		Not every day	214	63	29.4		84	10	11.9	
	Frequency of eating dinner on weekdays	Every day	516	101	19.6	0.069	295	36	12.2	1.000
		Not every day	76	22	28.9		33	4	12.1	
	Frequency of eating out on weekdays	1 time and more per week	191	53	27.7	0.005	111	16	14.4	0.378
		Never	401	70	17.5		217	24	11.1	
	Smoking status	Smokers or ever smokers	471	113	24.0	<0.001	218	34	15.6	0.007
		Non-smokers	121	10	8.3		110	6	5.5	
	Sleeping hours	<7 h	339	76	22.4	0.262	180	23	12.8	0.738
		≥7 h	253	47	18.6		148	17	11.5	
	Eating snacks between meals	Yes	451	93	20.6	0.905	241	32	13.3	0.559
		No	141	30	21.3		81	8	9.9	
Dental hygiene habits	Frequency of daily brushing	<2	254	64	25.2	0.024	110	11	10.0	0.476
		≥2	338	59	17.5		218	29	13.3	
	Duration of brushing teeth	<3 minutes	286	74	25.9	0.003	163	24	14.7	0.180
		≥3 minutes	306	49	16.0		165	16	9.7	
Timing of brushing teeth	Before eating breakfast	Yes	227	54	23.8	0.176	105	16	15.2	0.279
		No	365	69	18.9		223	24	10.8	
	After eating breakfast	Yes	265	45	17.0	0.042	196	19	9.7	0.121
		No	327	78	23.9		132	21	15.9	
	After eating lunch	Yes	73	18	24.7	0.441	66	5	7.6	0.291
		No	519	105	20.2		262	35	13.4	
	After eating snack	Yes	14	6	42.9	0.050	6	0	0.0	1.000
		No	578	117	20.2		322	40	12.4	
	After eating dinner	Yes	137	17	12.4	0.006	74	10	13.5	0.689
		No	455	106	23.3		254	30	11.8	
	Before bed time	Yes	307	65	21.2	0.840	179	24	13.4	0.501
		No	285	58	20.4		149	16	10.7	

n_1: total number of participants for each item, n_2: the number of participants who had fewer than 20 teeth

Table 4. Factors associated with having fewer than 20 teeth among professional drivers and white-collar workers using the multiple logistic regression analysis

		Professional drivers n=592			White-collar workers n=328		
		OR	95% CI	*P values*	OR	95% CI	*P values*
Diabetes mellitus	No	1.00			1.00		
	Yes	2.68	1.388–5.173	0.003	0.97	0.300–3.106	0.966
Hypertension	No	1.00			1.00		
	Yes	1.31	0.790–2.160	0.298	0.93	0.359–2.419	0.884
Hypercholesterolemia	No	1.00			1.00		
	Yes	0.93	0.468–1.857	0.842	1.37	0.411–4.553	0.610
Frequency of eating breakfast on weekdays	Every day	1.00			1.00		
	Not every day	2.23	1.416–3.513	0.001	0.93	0.391–2.228	0.877
Frequency of eating out on weekdays	Never	1.00			1.00		
	1 time and more per week	1.70	1.086–2.671	0.020	1.78	0.842–3.790	0.131
Smoking status	Non-smokers	1.00			1.00		
	Smokers+ever smokers	2.88	1.388–5.964	0.004	2.81	1.083–7.300	0.034
Frequency of daily brushing	<2	1.00			1.00		
	≥2	1.00	0.619–1.626	0.991	2.30	0.935–5.640	0.070
Duration of brushing teeth	≥3 minutes	1.00			1.00		
	<3 minutes	1.66	1.066–2.572	0.025	0.51	0.248–1.057	0.070
Brushing teeth after eating breakfast	Yes	1.00			1.00		
	No	1.34	0.832–2.152	0.229	2.43	1.054–5.617	0.037
Brushing teeth after eating dinner	Yes	1.00			1.00		
	No	1.58	0.840–2.955	0.156	0.65	0.259–1.646	0.366

Age, annual family income, working hours, shift work, duration of employment, and night shift were included as adjustment factors in the model.

cant differences in age group ($P<0.001$), working hours ($P=0.022$), diabetes mellitus ($P<0.001$), hypertension ($P=0.004$), hypercholesterolemia ($P=0.013$), frequency of eating breakfast ($P<0.001$), frequency of eating out ($P=0.005$), smoking status ($P<0.001$), frequency of daily brushing ($P=0.024$), duration of brushing teeth ($P=0.003$), brushing after breakfast ($P=0.042$), and brushing after eating dinner ($P=0.006$) were observed. Meanwhile, among white-collar workers, significant differences in age group ($P=0.017$), smoking status ($P=0.007$) were observed.

The results of a multiple logistic regression analysis for factors associated with the number of present teeth in professional drivers and white-collar workers is presented in Table 4. The independent variables were adjustment factors and factors that were significantly different according to a chi-squared test. The dependent variable was the number of present teeth. Among professional drivers, the highest OR was observed for the smoking status (OR, 2.88; 95% CI, 1.388–5.964), followed by diabetes mellitus (OR, 2.68; 95% CI, 1.388–5.173), frequency of eating breakfast (OR, 2.23; 95% CI, 1.416–3.513), frequency of eating out (OR, 1.70; 95% CI, 1.086–2.671), and duration of brushing teeth (OR, 1.66; 95% CI, 1.066–2.572). Meanwhile, among white-collar workers, the smoking status (OR, 2.81; 95% CI, 1.083–7.300) and brushing teeth after eating breakfast (OR, 2.43; 95% CI, 1.054–5.617) were significantly different.

Discussion

The results of our study revealed several factors that are associated with tooth loss among professional drivers. The first multiple logistic regression analysis showed that, compared with white-collar workers, professional drivers had fewer teeth than white-collar workers (see Table 2). Furthermore, the results of a second multiple logistic regression analysis showed differences in factors associated with tooth loss between professional drivers and white-collar workers (see Table 4). Among professional drivers, smoking status, diabetes mellitus, frequency of eating breakfast, frequency of eating out, and duration of brushing teeth were associated with the number of teeth, though only smoking status and brushing teeth after eating breakfast were associated with tooth loss among white-collar workers. This result shows that compared with white-collar workers, professional drivers have different factors that are associated

with tooth loss.

Income could be a confounder in analyses of this data. Income has been reported to be associated with tooth loss and dental care utilization[24–26]. We adjusted for the effect of income on tooth loss because the purpose of our study was to reveal the factors associated with tooth loss among professional drivers.

Some previous studies have discussed the factors that were identified as being associated with the number of teeth in the present study. For example, the relationship between the number of teeth and the smoking status has been reported in past studies[10, 19, 20]. In our study, the same relationship was observed for both professional drivers and white-collar workers. Nitin *et al.* has reported high smoking rates among truck drivers[4]. Hence, a smoking cessation program for professional drivers might decrease tooth loss.

A relationship between professional driving and diabetes mellitus has also been reported[3, 7]. In particular, professional drivers reportedly have a high prevalence of undiagnosed diabetes mellitus[23]. Moreover, an association between diabetes mellitus and periodontal diseases has also been reported[27, 28]. Aida *et al.* showed that approximately 40% of all tooth extractions in Japan are caused by periodontal disease[29]. The results of the present study suggest that improvements in diabetes mellitus might decrease tooth loss of professional drivers.

A relationship between eating habits and systemic diseases has been supported by several studies. Siu *et al.* found that eating out 6 times and more per week can increase the risk of undiagnosed diabetes mellitus[23]. Moreover, Kurosaka *et al.* pointed out that irregular eating habits can cause obesity and diabetes mellitus[9]. In addition, Raanaas *et al.* reported a relationship between eating habits and neck and lower back pain among Norwegian taxi drivers. They also pointed out the possibility of a lack of spare time to spend on eating because of the busyness of their work[5]. Meanwhile, regarding tooth loss, Yoshida *et al.* reported that among approximately 2,000 employees of a large petroleum chemical plant, irregular eating habits might have been a cause of greater tooth loss because the frequency of eating was an indicator of healthy food habits, and not maintaining a proper rhythm in daily life could lead to tooth loss[30]. These reports indicate that inadequate eating habits among professional drivers may affect not only their general health status, but also tooth loss. The present study revealed a similar relationship between the frequency of eating breakfast and the number of teeth. Therefore, improvements in lifestyle, including dietary counseling, might contribute to a decrease in tooth loss.

Although several reports have shown that the frequency of tooth brushing is related to the number of remaining teeth[21, 22], few reports reporting the duration of brushing are available. In the present study, Table 3 shows significant differences in the frequency of daily brushing and the duration of brushing teeth, although a multiple logistic regression analysis of professional drivers showed that only the duration of brushing teeth was significantly different (see Table 4). As stated previously, professional drivers may not be able to maintain a proper rhythm in their daily life or to find a place for tooth brushing while working. Therefore, they may not have sufficient time for tooth brushing. The present results indicate the necessity of tooth brushing instruction to enable professional drivers to brush their teeth effectively in a limited amount of time.

This study was a large-scale, self-reported survey conducted via the Internet. As for the self-reported data, the validities of the number of present teeth[31, 32], the presence of chronic conditions[33, 34], and the BMI[35, 36] data have been previously reported. However, the other items might contain incorrect information because of the use of a self-reported questionnaire.

Internet surveys can be a source of selection bias. Moreover, we were unable to control for factors such as education, the amount of sugar consumption, medication, the control of systemic diseases, or the status of periodontal disease. So, these factors could be additional confounders. In addition, the number of participants was selected by the Internet research company. Therefore, we could not take the results of a sample size estimation into account. Finally, this study was a cross-sectional study; therefore, further research is required to demonstrate a causal relationship.

In conclusion, we revealed that professional drivers, compared with white-collar workers, had a higher risk of tooth loss. Moreover, lifestyle was strongly associated with tooth loss among professional drivers. These findings suggest that the lifestyles of professional drivers could be related to not only their general health status, but also tooth loss.

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