Sleep Medicine xxx (2012) xxx–xxx

Contents lists available at SciVerse ScienceDirect

Sleep Medicine

journal homepage: www.elsevier.com/locate/sleep

Original Article

The factors associated with preferences for napping and drinking coffee as countermeasures for sleepiness at the wheel among Japanese drivers

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ARTICLE INFO

Article history:
Received 26 April 2011
Received in revised form 19 July 2011
Accepted 22 July 2011
Available online xxxx

Keywords:
Nap
Coffee
Countermeasure for sleepiness
Traffic safety
Professional drivers
Drowsy driving
Sleep-related accidents

ABSTRACT

Objective: We explored differences between professional and non-professional drivers in terms of the factors associated with preferences for generally accepted, effective countermeasures for sleepiness at the wheel – i.e., napping and drinking coffee.
Methods: We performed a cross-sectional questionnaire survey. Data from professional (n = 716) and non-professional (n = 3365) drivers were used for analyses.
Results: The results showed that professional drivers experienced drowsy driving and traffic accidents due to falling asleep more often than non-professional drivers. Multiple logistic regression analyses showed that variables which may act as aggravating factors for sleepiness (i.e., engagement in shift-work and insufficient sleep) were associated with preferences for these countermeasures among non-professional drivers. In contrast, among professional drivers, being male and having experienced traffic accidents due to drowsy driving were associated with a preference for napping, while longer annual driving distances and shorter periods after the acquisition of driving licenses were associated with drinking coffee.
Conclusion: Our results suggest that non-professional drivers are likely to take these effective countermeasures when they feel or have the potential to experience sleepiness at the wheel. However, this tendency was not observed in professional drivers, and it is speculated that they do not use naps as a countermeasure until they have experienced traffic accidents due to drowsy driving. Sleep education for professional drivers and their employers is desirable for preventing drowsy driving-related traffic accidents.

1. Introduction

Accidents and sleepiness are closely related. Approximately 9–20% of vehicular accidents are thought to be sleep-related [1]. Previous studies have shown that sleepiness at the wheel caused by various sleep-related problems, such as insufficient sleep [2–4], engagement in shift-work [5,6], and sleep disorders [3,7,8], clearly elevates the risk of drowsy driving and associated traffic accidents. It has also been shown that drivers' objective sleepiness, measured using maintenance of wakefulness tests or multiple sleep latency tests, predict an increased risk of car-accidents and impair driving performance [9–13]. In addition, accidents caused by drowsy driving are likely to have disastrous outcomes [1,14], leading to elevated economic costs [15].

There are many differences between the driving circumstances of professional and non-professional drivers. For example, since professional drivers are required to deliver their cargo on time, they are urged to drive for long periods while sleep-deprived and on irregular driving schedules [16,17]. In addition, previous research has shown that sleep apnea syndrome is very prevalent among professional drivers [16,18,19]. Together, these factors are thought to make sleepiness at the wheel more prominent in professional drivers, leading to an increased prevalence of drowsy driving and associated traffic accidents [17,20–23].

A number of results from laboratory- and questionnaire-based epidemiological studies have shown that napping and drinking coffee are effective countermeasures for drowsy driving [6,24–28]. Taking a nap as a countermeasure for sleepiness at the wheel is common among drivers between 46 and 64 years of age, those who have already experienced a sleep-related traffic accident, and those who experience severe sleepiness during driving [29]. It has also been reported that professional drivers [29], especially long-haul truck drivers [20], tend to nap as a countermeasure for sleepiness. In regard to preference for caffeine ingestion, being male, being a professional driver, being over 25 years of age, and having experience driving under severe sleepiness were reported to be associated factors [29]. However, differences between

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doi:10.1016/j.sleep.2011.07.020

professional and non-professional drivers in terms of factors associated with preferences for using countermeasures for drowsy driving have not yet been clarified. Clarifying this issue would contribute to promoting awareness among drivers of the appropriate countermeasures for sleepiness at the wheel. Therefore, this cross-sectional questionnaire was designed to explore the factors associated with preferences for napping and drinking coffee as countermeasures for sleepiness while driving among professional and non-professional drivers.

2. Methods

2.1. Participants and procedure

This study was part of a research project conducted in the Tokyo metropolitan area that explored the relationship between sleep problems and traffic accidents. It targeted drivers who visited the Tokyo Metropolitan Driver and Vehicle Licensing Center to acquire or renew their driving licenses, and the eligible population included 12862 drivers who visited the center on weekdays during two weeks in October 2008. Part of the data from this subject population has already been reported by Abe et al. (in press) [30], who explored the determinant factors for traffic accidents due to drowsy driving. Responses were collected from 8314 drivers who gave written consent to participate by signing the top page of the questionnaire. Data from newly licensed drivers ($n = 1569$), those who had a driving license for an unknown period of time ($n = 705$), and those who did not answer the question about whether or not they drove professionally ($n = 16$) were excluded from the analyses. Data from drivers with an annual driving distance of 0 km ($n = 382$) or unknown annual driving distance ($n = 1561$) were also excluded. Consequently, the following analyses are based on data from 4081 drivers (mean age: 42.4 ± 13.4 years; 3021 men, 818 women, 242 of unknown gender; 716 professional drivers, 3365 non-professional drivers). This study was approved by the ethics committee of the Neuropsychiatric Research Institute, Tokyo, Japan.

2.2. Questionnaire

Drivers responded anonymously to items pertaining to accident history, socio-demographic variables, driving-related variables, and sleep-related variables, including their preferences for countermeasures to cope with sleepiness at the wheel. In this study, the drivers who answered yes to the question "Do you drive a car as a profession (taxi, bus, or transportation business)?" were classified as professional drivers. The drivers were asked whether they used each of a list of countermeasures when they felt sleepiness at the wheel (stopping driving to take a rest, napping, drinking coffee, chewing gum, opening a window, smoking, listening to the radio, and talking with a passenger, among other measures). The questionnaire also asked participants to subjectively report the number of traffic accidents they had been involved in over the past five years that were caused by falling asleep (none, one, two, and three or more). Demographic variables included gender, age (years), height (cm), weight (kg), and engagement in shift-work (yes/no). Driving-related variables included how long they had had a driving license (new license holder, 3 years–<10 years, 10 years–<20 years, 20 years–<30 years, and ⩾30 years), annual driving distance (km), frequency of subjective sleepiness while driving (never, occasionally, sometimes, and usually), and the subjective number of times they had experienced drowsy driving during the past year (none, once, twice, and three or more times). Sleep-related variables included self-reported duration of usual nocturnal sleep on weeknights (<6 h, 6 h–<7 h, 7 h–<8 h, 8 h–<9 h, and ⩾9 h), current awareness of insufficient sleep (yes/no/unknown), a self-rated measure of daytime sleepiness (Epworth Sleepiness Scale: ESS) [31], whether another person had noticed loud snoring or apnea in them during sleep (yes/no), and the existence of diagnosed sleep disorders (yes/no).

2.3. Statistical analyses

For each variable, comparisons were made between the professional and non-professional drivers using a *t*-test or chi-square test. A *t*-test was also used to compare the number of countermeasure categories reportedly used by drivers in the two groups when they became sleepy. Univariate logistic regression analyses were performed to explore the factors associated with preferences for napping and drinking coffee, respectively. The variables of ESS, BMI, and annual driving distance were categorized dichotomously before being entered into the equation (ESS ⩾11 points [31], BMI ⩾25 kg/m^2 [32], and driving distance – the median of annual driving distance of all drivers [5000 km] – respectively). Age was also dichotomized using 25 years of age as a cut-off point, because younger drivers are at a higher risk of traffic accidents caused by falling asleep while driving [33]. The amount of time since a driving license was acquired was divided into two almost equal groups of those with fewer and those with more than 20 years of experience. Next, using the variables that showed significant or nearly significant associations (including $p < 0.10$) in the univariate model as the independent variables, multivariate logistic regression analyses (forward selection) were performed. All statistical analyses were conducted using SPSS 11.5J (SPSS Japan Inc., Tokyo, Japan). An alpha level of 0.05 was used as the indicator of statistical significance.

3. Results

3.1. Differences in demographic, driving, and sleep-related variables between professional and non-professional drivers

Larger percentages of professional drivers were male and shift-workers than non-professional drivers (Table 1; % male: 92.5% vs. 75.8%, $\chi^2 = 92.15$, $p < 0.001$; % shift-workers: 27.3% vs. 9.4%, $\chi^2 = 170.12$, $p < 0.001$). A *t*-test showed that professional drivers had a higher average BMI than non-professional drivers (22.7 ± 3.3 kg/m^2 vs. 23.2 ± 3.3 kg/m^2, $t[3918] = 3.31$, $p < 0.001$). There was no significant difference in age between the two groups (non-professional: 42.34 ± 13.42 years vs. professional: 42.90 ± 13.06 years, $t[4041] = 1.01$, n.s.).

A larger percentage of professional drivers (46.5%) than non-professional drivers (41.8%; $\chi^2 = 5.46$, $p < 0.05$) reported that their usual nocturnal sleep duration on weeknights was under six hours. Of the professional drivers, 35% reported current awareness of insufficient sleep, which was higher than the corresponding percentage for non-professional drivers (28.3%, $\chi^2 = 14.11$, $p < 0.001$). There were no differences between the two groups in terms of diagnosed sleep disorders and subjective daytime sleepiness, measured using ESS (sleep disorders: 2.6 vs. 1.8%, $\chi^2 = 1.77$, n.s.; ESS: 8.57 ± 4.75 vs. 8.53 ± 4.32, $t[2853] = 0.19$, n.s.). However, the percentage of drivers with loud snoring or apnea during sleep was higher for professional drivers than non-professional drivers (26.4 vs. 20.2%, $\chi^2 = 13.03$, $p < 0.001$).

The average annual driving distance was longer for professional drivers than non-professional drivers (16141.5 ± 23564.9 vs. 6610.2 ± 11244.8 km, $t[4079] = 16.31$, $p < 0.001$). The percentage of drivers who had their driving licenses for more than 20 years was higher for professional drivers (48.9%) than non-professional drivers (44.0%; $\chi^2 = 5.66$, $p < 0.05$). Thirty-one percent of

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Table 1
Differences between descriptive variables for professional and non-professional drivers.

	Professional	Non-professional	*P*-value
Demographic variables			
Gender (% of male drivers)	92.5	75.8	$p < 0.001$
Age (years)*	42.90 ± 13.06	42.34 ± 13.42	n.s.
BMI (kg/m^2)*	23.2 ± 3.3	22.7 ± 3.3	$p < 0.001$
Shift-work (% of drivers engaged)	27.3	9.4	$p < 0.001$
Driving-related variables			
Period after acquisition of driving license (% of drivers who had licenses for over 20 years)	48.9	44.0	$p < 0.05$
Annual driving distance (km)*	16141.5 ± 23564.9	6610.2 ± 11244.8	$p < 0.001$
Frequency of occurrence of subjective sleepiness while driving (% of drivers who answered "sometimes" or "usually")	31.3	20.2	$p < 0.001$
Experience of drowsy driving during the past year (% of drivers who experienced at least one instance)	17.8	10.1	$p < 0.001$
Experience of traffic accidents caused by falling asleep in the prior five years (% of drivers who experienced at least one instance)	3.5	1.2	$p < 0.001$
Sleep variables			
Usual nocturnal sleep duration on weeknights (% of drivers who slept fewer than 6 hrs)	46.5	41.8	$p < 0.05$
Current awareness of insufficient sleep (% who said yes)	35.0	28.3	$p < 0.001$
Existence of diagnosed sleep disorders (% who said yes)	2.6	1.8	n.s.
Existence of loud snoring or apnea during sleep (% who said yes)	26.4	20.2	$p < 0.001$
ESS score*	8.57 ± 4.75	8.53 ± 4.32	n.s.

BMI: body mass index, ESS: Epworth Sleepiness Scale.
* Values are expressed as mean ± SD.

professional drivers reported that they sometimes or usually experienced sleepiness while driving, and this rate was significantly higher than the rate for non-professional drivers (20.2%, $\chi^2 = 41.03$, $p < 0.001$). The percentage of drivers who reported experiencing drowsy driving at least once in the preceding year was also higher among professional than non-professional drivers (professional: 17.8%, non-professional: 10.1%, $\chi^2 = 26.17$, $p < 0.001$). In addition, 3.5% of the professional and 1.2% of the non-professional drivers reported experiencing traffic accidents due to falling asleep while driving during the preceding five years; the rate for professional drivers was significantly higher than that for non-professional drivers ($\chi^2 = 14.54$, $p < 0.001$).

3.2. Countermeasures for sleepiness at the wheel

The percentage of drivers who used at least one kind of countermeasure when they felt sleepy at the wheel was higher for non-professional (77.7%) than professional (70.9%) drivers ($\chi^2 = 14.89$, $p < 0.001$). A *t*-test showed that non-professional drivers used a significantly larger number of countermeasures than professional drivers (2.08 ± 1.82 vs. 1.87 ± 1.88 categories; $t[4079] = 2.79$, $p < 0.01$).

The most popular countermeasure was to stop driving to take a rest, reportedly used by more than 40% of the drivers in both groups (Fig. 1). The percentage of drivers who used napping as a countermeasure was 20.4% for professional and 18.5% for non-professional drivers. Drinking coffee was reported to be used as a countermeasure by 30% of non-professional and 27.7% of professional drivers. Between the groups, there were no significant differences in the rates of drivers who took naps ($\chi^2 = 1.32$, n.s.) and drank coffee ($\chi^2 = 1.40$, n.s.) as countermeasures. Chewing gum, opening a window, and talking with passengers were preferred by non-professional drivers more than professional drivers ($\chi^2 = 13.96$, $p < 0.001$; $\chi^2 = 4.79$, $p < 0.05$; $\chi^2 = 33.53$, $p < 0.001$, respectively). On the other hand, smoking was more widely preferred by professional than non-professional drivers ($\chi^2 = 10.89$, $p < 0.01$). Between professional and non-professional drivers, there were no differences in rates of listening to the radio or the use of other kinds of countermeasures (listening to the radio: $\chi^2 = 0.92$, n.s.; others: $\chi^2 = 1.61$, n.s.).

3.3. Factors associated with preference for napping

The univariate logistic regression analysis showed that being male, being a shift-worker, having current awareness of insuffi-

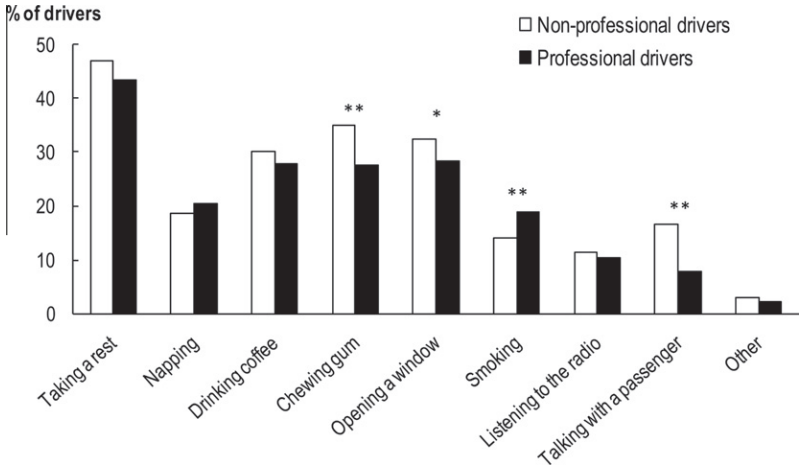

Fig. 1. Comparison of the percentages of drivers who use different countermeasures when they feel sleepy at the wheel. $^{**}p < 0.01$, $^{*}p < 0.05$ (chi-square test) between professional and non-professional drivers. Participants were allowed to choose multiple countermeasures.

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Table 2
Results of logistic regression analyses of factors associated with napping as a countermeasure among non-professional drivers.

Predictor		Univariate model				Multivariate model (forward selection)			
		N	Odds ratio (95% CI)		*p*	*N*	Adjusted odds ratio (95% CI)		*p*
Gender	Female	768	1.00	(ref)		558	1.00	(ref)	
	Male	**2403**	**1.70**	**(1.35–2.14)**	**<0.001**	**1784**	**1.79**	**(1.38–2.33)**	**<0.001**
Shift-work	No	3019	1.00	(ref)		2117	1.00	(ref)	
	Yes	**313**	**1.76**	**(1.35–2.30)**	**<0.001**	**225**	**1.48**	**(1.09–2.01)**	**<0.05**
Current awareness of insufficient sleep	No	2126	1.00	(ref)		1490			
	Yes	**943**	**1.48**	**(1.22–1.79)**	**<0.001**	665			n.s.
	Unknown	**263**	**1.36**	**(0.99–1.87)**	**<0.10**	187			n.s.
Loud snoring and respiratory pauses during sleep	No	2651	1.00	(ref)					
	Yes	673	1.19	(0.96–1.46)	0.114				
Existence of diagnosed sleep disorders	No	3239	1.00	(ref)					
	Yes	61	1.42	(0.79–2.56)	0.244				
Experience of drowsy driving	No	2433	1.00	(ref)		2107			
	Yes	**274**	**1.71**	**(1.30–2.24)**	**<0.001**	235			n.s.
Experience of traffic accidents caused by falling asleep	No	2584	1.00	(ref)		2314			
	Yes	**32**	**2.03**	**(0.99–4.17)**	**<0.10**	28			n.s.
BMI (kg/m^2)	<25	2552	1.00	(ref)		1858			
	⩾25	**675**	**1.32**	**(1.08–1.63)**	**<0.01**	484			n.s.
Annual driving distance (km)	⩽5000	2050	1.00	(ref)		1449	1.00	(ref)	
	>5000	**1315**	**1.43**	**(1.20–1.71)**	**<0.001**	**893**	**1.50**	**(1.23–1.83)**	**<0.001**
Usual nocturnal sleep duration on weeknights (hours)	7–8	518	1.00	(ref)		354			
	<5	**273**	**1.58**	**(1.09–2.28)**	**<0.05**	194			n.s.
	5–6	**1119**	**1.51**	**(1.14–1.99)**	**<0.01**	795			n.s.
	6–7	1281	1.15	(0.87–1.52)	0.333	895			n.s.
	⩾8	143	0.74	(0.42–1.29)	0.289	104			n.s.
Frequency of subjective sleepiness while driving	Never or occasionally	2697	1.00	(ref)		1890	1.00	(ref)	
	Sometimes or usually	**621**	**1.33**	**(1.08–1.64)**	**<0.01**	**452**	**1.33**	**(1.05–1.68)**	**<0.05**
ESS score	⩽10	1673	1.00	(ref)					
	⩾11	731	0.92	(0.75–1.13)	0.403				
Age (years)	>25	2980	1.00	(ref)					
	⩽25	352	1.22	(0.93–1.60)	0.155				
Period after acquisition of driving license (years)	3–20	1884	1.00	(ref)		1342	1.00	(ref)	
	>20	**1481**	**0.67**	**(0.56–0.81)**	**<0.001**	**1000**	**0.70**	**(0.58–0.86)**	**<0.001**

CI: confidence interval, ref: reference category, BMI: body mass index, ESS: Epworth sleepiness scale.

cient sleep, experiencing drowsy driving, having higher BMI, driving longer annual distances, sleeping fewer than six hours on usual weeknights, frequently experiencing subjective sleepiness while driving, and having shorter driving histories were all associated with a preference for napping among non-professional drivers. The multivariate logistic regression analysis revealed that frequency of subjective sleepiness while driving, being male, being a shift-worker, having longer annual driving mileage, and having shorter driving history were significantly associated with using napping as a countermeasure (Table 2).

As for professional drivers, univariate logistic regression analysis revealed that being male, being a shift-worker, driving longer annual distances, experiencing traffic accidents caused by falling asleep, and having shorter driving histories were significantly associated with a preference for napping as a countermeasure for sleepiness. However, the results of the multivariate logistic regression analysis revealed that napping was only associated with being male and experiencing traffic accidents caused by falling asleep (Table 3).

3.4. Factors associated with preference for drinking coffee

The univariate logistic regression analysis of the data from non-professional drivers showed that being younger (⩽25 years), being a shift-worker, having current awareness of insufficient sleep, experiencing traffic accidents by falling asleep, sleeping fewer than six hours on usual weeknights, and having had a driver's license for a shorter period of time (3–20 years) were associated with a preference for drinking coffee among non-professional drivers (Table 4). The multivariate logistic regression analysis revealed that, in non-professional drivers, engaging in shift-work, having an awareness of insufficient sleep, and having gone through a period of fewer than 20 years following acquisition of driver's license were factors associated with drinking coffee as a countermeasure for sleepiness at the wheel.

In regard to professional drivers, the variables that showed significant association with a preference of drinking coffee in univariate logistic regression analysis were longer annual driving distance (>5000 km/year), shorter period after acquisition of driving license (3–20 years), and younger age (⩽25 years). The multivariate logistic regression model also showed a significant association between the former two variables and a preference for drinking coffee (Table 5).

4. Discussion

The results of this study show traffic accidents caused by falling asleep to be more common among professional than non-professional drivers. In addition, a larger proportion of professional drivers were likely to experience drowsy driving and reported frequent experiences of sleepiness while driving. These results are compatible with previous studies that have reported a high incidence of sleep-related accidents [34] and frequent sleepiness at the wheel [20,34] among professional drivers.

In this study, the annual driving distance was longer and the number of shift-workers was higher among professional drivers than non-professional drivers. Many previous studies have shown that long-haul and nighttime driving elevates the risk of sleepiness while driving and the risk of sleep-related traffic accidents [1,6,35]. These are common driving conditions for professional drivers and, thus, causative of the frequent occurrence of sleepiness while driv-

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Table 3
Results of logistic regression analyses of factors associated with napping as a countermeasure among professional drivers.

Predictor		Univariate model				Multivariate model (forward selection)			
		N	Odds ratio (95% CI)		*p*	*N*	Adjusted odds ratio (95% CI)		*p*
Gender	Female	50	1.00	(ref)		37	1.00	(ref)	
	Male	**618**	**4.38**	**(1.34–14.29)**	**<0.05**	**435**	**4.91**	**(1.47–16.36)**	**<0.01**
Shift-work	No	515	1.00	(ref)		339			
	Yes	**193**	**1.72**	**(1.17–2.53)**	**<0.01**	133			n.s.
Current awareness of insufficient sleep	No	397	1.00	(ref)					
	Yes	246	0.88	(0.59–1.30)	0.514				
	Unknown	60	0.90	(0.46–1.78)	0.770				
Loud snoring and respiratory pauses during sleep	No	516	1.00	(ref)					
	Yes	185	1.11	(0.74–1.68)	0.602				
Existence of diagnosed sleep disorders	No	667	1.00	(ref)					
	Yes	18	1.10	(0.36–3.38)	0.874				
Experience of drowsy driving	No	438	1.00	(ref)					
	Yes	95	1.36	(0.84–2.20)	0.208				
Experience of traffic accidents caused by falling asleep	No	490	1.00	(ref)		455	1.00	(ref)	
	Yes	**18**	**3.39**	**(1.31–8.77)**	**<0.05**	**17**	**3.84**	**(1.41–10.47)**	**<0.01**
BMI (kg/m^2)	<25	512	1.00	(ref)					
	⩾25	181	1.04	(0.69–1.57)	0.854				
Annual driving distance (km)	⩽5000	239	1.00	(ref)		145			
	>5000	**477**	**1.62**	**(1.07–2.44)**	**<0.05**	327			n.s.
Usual nocturnal sleep duration on weeknights (hours)	7–8	87	1.00	(ref)					
	<5	78	1.14	(0.52–2.52)	0.741				
	5–6	251	1.41	(0.75–2.65)	0.285				
	6–7	253	1.33	(0.71–2.51)	0.372				
	⩾8	38	0.56	(0.17–1.83)	0.341				
Frequency of subjective sleepiness while driving	Never or occasionally	481	1.00	(ref)					
	Sometimes or usually	219	1.23	(0.84–1.81)	0.286				
ESS score	⩽10	309	1.00	(ref)					
	⩾11	142	0.88	(0.57–1.37)	0.568				
Age (years)	>25	658	1.00	(ref)					
	⩽25	53	1.28	(0.67–2.47)	0.455				
Period after acquisition of driving license (years)	3–20	366	1.00	(ref)		258			
	>20	**350**	**0.58**	**(0.40–0.85)**	**<0.01**	214			n.s.

CI: confidence interval, ref: reference category, BMI: body mass index, ESS: Epworth sleepiness scale.

Table 4
Results of logistic regression analyses of factors associated with drinking coffee as a countermeasure among non-professional drivers.

Predictor		Univariate model				Multivariate model (forward selection)			
		N	Odds ratio (95% CI)		*p*	*N*	Adjusted odds ratio (95% CI)		*p*
Gender	Female	768	1.00	(ref)					
	Male	2403	1.03	(0.86–1.23)	0.754				
Shift-work	No	3019	1.00	(ref)		2296	1.00	(ref)	
	Yes	**313**	**1.52**	**(1.20–1.93)**	**<0.001**	**250**	**1.41**	**(1.13–1.91)**	**<0.01**
Current awareness of insufficient sleep	No	2126	1.00	(ref)		1610	1.00	(ref)	
	Yes	**943**	**1.39**	**(1.18–1.63)**	**<0.001**	**725**	**1.32**	**(1.10–1.58)**	**<0.05**
	Unknown	**263**	**1.29**	**(0.98–1.70)**	**<0.10**	211	1.10	(0.82–1.49)	0.499
Loud snoring and respiratory pauses during sleep	No	2651	1.00	(ref)					
	Yes	673	1.02	(0.85–1.22)	0.842				
Existence of diagnosed sleep disorders	No	3239	1.00	(ref)		2501			
	Yes	**61**	**1.61**	**(0.96–2.69)**	**<0.10**	45			n.s.
Experience of drowsy driving	No	2433	1.00	(ref)					
	Yes	274	1.16	(0.90–1.50)	0.243				
Experience of traffic accidents caused by falling asleep	No	2584	1.00	(ref)		2316			
	Yes	**32**	**2.18**	**(1.08–4.41)**	**<0.05**	30			n.s.
BMI (kg/m^2)	<25	2552	1.00	(ref)					
	⩾25	675	0.95	(0.79–1.15)	0.619				
Annual driving distance (km)	⩽5000	2050	1.00	(ref)					
	>5000	1315	1.13	(0.98–1.32)	0.101				
Usual nocturnal sleep duration on weeknights (hours)	7–8	518	1.00	(ref)		371			
	<5	**273**	**1.47**	**(1.07–2.02)**	**<0.05**	212			n.s.
	5–6	**1119**	**1.36**	**(1.08–1.71)**	**<0.05**	866			n.s.
	6–7	1281	1.14	(0.90–1.43)	0.277	988			n.s.
	⩾8	143	0.70	(0.45–1.10)	0.122	109			n.s.
Frequency of subjective sleepiness while driving	Never or occasionally	2697	1.00	(ref)					
	Sometimes or usually	621	1.10	(0.78–1.13)	0.939				
ESS score	⩽10	1673	1.00	(ref)					
	⩾11	731	0.92	(0.92–1.32)	0.282				
Age (years)	>25	2980	1.00	(ref)		2264			
	⩽25	**352**	**1.53**	**(1.22–1.93)**	**<0.001**	282			n.s.
Period after acquisition of driving license (years)	3–20	1884	1.00	(ref)		1467	1.00	(ref)	
	>20	**1481**	**0.62**	**(0.53–0.72)**	**<0.001**	**1079**	**0.65**	**(0.55–0.76)**	**<0.001**

CI: confidence interval, ref: reference category, BMI: body mass index, ESS: Epworth sleepiness scale.

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Table 5
Results of logistic regression analyses of factors associated with drinking coffee as a countermeasure among professional drivers.

Predictor		Univariate model				Multivariate model (forward selection)			
		N	Odds ratio (95% CI)		*p*	*N*	Adjusted odds ratio (95% CI)		*p*
Gender	Female	50	1.00	(ref)					
	Male	618	0.83	(0.45–1.55)	0.563				
Shift-work	No	515	1.00	(ref)					
	Yes	193	1.10	(0.77–1.59)	0.605				
Current awareness of insufficient sleep	No	397	1.00	(ref)					
	Yes	246	1.04	(0.73–1.48)	0.837				
	Unknown	60	1.21	(0.67–2.17)	0.526				
Loud snoring and respiratory pauses during sleep	No	516	1.00	(ref)					
	Yes	185	1.06	(0.73–1.53)	0.778				
Existence of diagnosed sleep disorders	No	667	1.00	(ref)					
	Yes	18	0.72	(0.23–2.21)	0.717				
Experience of drowsy driving	No	438	1.00	(ref)					
	Yes	95	1.09	(0.69–1.71)	0.720				
Experience of traffic accidents caused by falling asleep	No	490	1.00	(ref)					
	Yes	18	0.45	(0.15–1.39)	0.166				
BMI (kg/m^2)	<25	512	1.00	(ref)					
	⩾25	181	0.78	(0.53–1.16)	0.782				
Annual driving distance (km)	⩽5000	239	1.00	(ref)		238	1.00	(ref)	
	>5000	**477**	**1.66**	**(1.15–2.39)**	**<0.01**	**473**	**1.69**	**(1.17–2.45)**	**<0.01**
Usual nocturnal sleep duration on weeknights (hours)	7–8	87	1.00	(ref)					
	<5	78	1.31	(0.65–2.69)	0.447				
	5–6	251	1.61	(0.91–2.87)	0.103				
	6–7	253	1.48	(0.83–2.63)	0.183				
	⩾8	38	0.81	(0.31–2.12)	0.665				
Frequency of subjective sleepiness while driving	Never or occasionally	481	1.00	(ref)					
	Sometimes or usually	219	1.02	(0.72–1.46)	0.893				
ESS score	⩽10	309	1.00	(ref)					
	⩾11	142	1.38	(0.92–2.07)	0.115				
Age (years)	>25	658	1.00	(ref)		658			
	⩽25	**53**	**1.97**	**(1.11–3.50)**	**<0.05**	53			n.s.
Period after acquisition of driving license (years)	3–20	366	1.00	(ref)		363	1.00	(ref)	
	>20	**350**	**0.50**	**(0.36–0.70)**	**<0.001**	**348**	**0.48**	**(0.34–0.67)**	**<0.001**

CI: confidence interval, ref: reference category, BMI: body mass index, ESS: Epworth Sleepiness Scale.

ing, drowsy driving, and of sleep-related traffic accidents among this population. In addition, as shown in previous studies [3,17], shorter habitual sleep time and current awareness of insufficient sleep were common among professional drivers. Such poor sleep habits could also play a role in increasing sleepiness at the wheel for professional drivers.

The existence of sleep disorders, especially obstructive sleep apnea syndrome, also increases the risk of drowsy driving [7,15]. Although previous studies reported a high prevalence of obstructive sleep apnea syndrome in professional drivers [16,18,19], no difference was found in this study between the percentage of professional drivers who had been diagnosed with sleep disorders and the percentage of non-professional drivers diagnosed. However, BMI and the percentage of drivers who had loud snoring or apnea during sleep were higher among professional than non-professional drivers. Since obesity and snoring are core characteristics of obstructive sleep apnea syndrome and are used as reliable screening items for the syndrome [36–38], more professional than non-professional drivers may have undiagnosed sleep apnea, possibly contributing to the elevated levels of sleepiness at the wheel in the former group.

The mean ESS score of professional drivers did not significantly differ from that of non-professional drivers, despite the professional group's larger proportion of shift-workers and drivers with potential sleep apnea and shorter usual sleep times. These results may suggest that professional drivers are likely to underestimate their sleepiness in daily settings. Previous studies have shown that cumulative sleep loss leads to underestimation of subjective sleepiness [39], and that the ESS score cannot correctly gauge participants' sleepiness, especially among shift-work drivers with sleep apnea syndrome [40]. These phenomena may partly explain why there are no significant differences in the ESS score of the two groups. However, further study is needed to clarify the inconsistency between the result of ESS and the frequency of the occurrence of subjective sleepiness while driving.

Although a larger proportion of professional drivers reported frequent sleepiness while driving than non-professional drivers, the results of our study showed that professional drivers used fewer countermeasures. Specifically, the percentages of professional drivers who reported chewing gum, opening a window, and talking with passengers as countermeasures were lower than the corresponding rates for non-professional drivers. On the other hand, there were no differences in preferences for countermeasures known to be effective – that is, napping and drinking coffee [24]. In this study, about 20% of drivers in both groups reported napping as a countermeasure for sleepiness at the wheel; this was lower than the percentage of drivers who reportedly stopped driving to rest, drank coffee, chewed gum, and opened windows as countermeasures. This finding is notably consistent with the results of Anund et al. (2008), which showed that napping was not the first choice to reduce sleepiness at the wheel. They reported that napping and caffeine ingestion were used as countermeasures more frequently by professional than non-professional drivers [29]. However, this tendency was not confirmed by this study.

Notably, the results of this study revealed that factors associated with preferences for napping and drinking coffee as countermeasures for sleepiness at the wheel differed between professional and non-professional drivers. For non-professionals, the preference for napping was associated with male drivers, frequency of subjective sleepiness while driving, and the existence of conditions that could cause increased sleepiness while driving (i.e., shift-work, long driving distances). In addition to a preference for drinking cof-

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fee, engagement in shift-work and awareness of insufficient sleep also appeared as associated factors. These results could indicate that non-professional drivers are likely to nap or drink coffee in situations in which sleepiness could be elevated.

For professional drivers, long annual driving distances and shorter periods following the acquisition of driving licenses showed significant association with preference of drinking coffee; however, no other sleepiness-related variables appeared as the associated factor for this countermeasure. This result may suggest that, in contrast to non-professional drivers, professional drivers do not tend to drink coffee in situations where sleepiness could be elevated. In addition, preference for napping was only associated with being male and experiencing a traffic accident due to drowsy driving, which suggests that professional drivers often avoid napping until they have experienced a sleep-related vehicular accident. As mentioned above, in contrast to the results of previous studies conducted in western countries [29], no difference was found between the rates of professional and non-professional drivers who take naps as countermeasures in this study. This may be because the driving situations of Japanese professional drivers make it difficult for them to nap during work time. Further research is needed to explore the relationship between a preference for napping and driving conditions. Alternately, it is also possible that fewer drivers in Japan have knowledge of the efficiency of this countermeasure than those in western countries. Notably, the present study shows that both professional and non-professional drivers with more experience tend to hesitate to use these countermeasures. This may imply that more experienced drivers are likely to underestimate the deterioration of their driving performance due to sleepiness, or underestimate the effects of countermeasures.

Interestingly, our results show that female drivers, both professional and non-professional, are hesitant to nap as a countermeasure for sleepiness. This contrasts with the trend found among the general population, where more females than males nap frequently in daily settings other than driving [41]. In this regard, Anund et al. (2008) reported results similar to ours, and they suggested issues of personal security and privacy in cars might be the cause of female drivers' hesitation [29]. This indicates that more secure parking lot situations are needed for female drivers to nap as a countermeasure for sleepiness at the wheel. Additionally, it is possible that social demands on female drivers, including the burden of housework, may decrease their spare time and make it difficult for them to nap when they experience sleepiness at the wheel. Further research on this issue is needed to improve the safety of female drivers.

Our study has some limitations. First, this survey was conducted only in the Tokyo metropolitan area, and the driving situations in urban and country environments may differ. For this reason, the study's population of subjects may not necessarily represent general Japanese drivers. In addition, the annual driving distance of drivers in this study was relatively low compared to that of previous studies conducted in other countries [42,43]. Thus, any application of this study's overall results to drivers in other countries should be done cautiously. Second, the definition of professional drivers was based only on drivers' questionnaire answers. Moreover, we could not assess the type of driving profession to which participants belonged. Driving situations might differ among drivers of long- and short-haul trucks [20], taxis, and buses. Hakkanen and Summala (2000) reported that, compared to short-haul drivers, long-haul drivers tend to drive more at night, feel more severe sleepiness at the wheel, and nap more frequently during breaks [20]. Therefore, it is possible that the factors associated with napping differ between long- and short-haul drivers. Third, whether participants had experienced traffic accidents was assessed based on drivers' subjective reports, possibly resulting in recall bias. In addition, since our study relied on a cross-sectional survey with a retrospective design, detailed causal relationships between preferences for countermeasures and accidents could not be clarified.

In conclusion, among the drivers surveyed for this study, napping was not a common countermeasure for coping with sleepiness at the wheel. In particular, professional drivers who had not experienced traffic accidents due to falling asleep seemed hesitant to nap when they felt sleepy. In addition, they did not tend to drink coffee even when they were in driving situations in which sleepiness was likely to increase. Many previous experimental and intervention studies showed that these countermeasures decrease drivers' sleepiness and improve their driving performance [24,26–28]. Therefore, it should be emphasized that using countermeasures can contribute to decreased sleepiness at the wheel and possibly reduces the risk of sleepiness-related traffic accidents. Professional drivers and their employers (e.g., transportation companies) should be educated about the importance of napping and drinking coffee to cope with sleepiness at the wheel, as this could contribute to drivers' safety.

Conflict of interest

The ICMJE Uniform Disclosure Form for Potential Conflict of Interest associated with this article can be viewed by clicking on the following link: doi:10.1016/j.sleep.2011.07.020.

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