Excessive Daytime Sleepiness and Alcohol Consumption among Commercial Drivers

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Abstract

Background: Commercial drivers suffering from excessive daytime sleepiness (EDS) have been identified as a major cause of road traffic accidents. Alcohol usage directly affects sleep, adversely affecting next-day alertness and performance.

Aims: To examine the relationship between alcohol consumption and EDS among commercial truck drivers in Japan and the implications of this on public health.

Methods: All participants in this cross-sectional study were commercial motor vehicle (CMV) drivers from Tokyo and Niigata Prefecture. Participants completed a self-administered questionnaire with details of their age, body mass index (BMI), alcohol consumption, Epworth Sleepiness Scale (ESS) score, and tobacco usage. Participants' oxygen desaturation index (ODI) was determined by a pulse-oximetry device that participants took home.

Results: A total of 1422 males registered with the Japan Trucking Association and aged 20–69 years participated. The multivariate-adjusted odds ratio (OR) of EDS among participants aged <43 years was 0.81 (95% CI = 0.47–1.40) for light drinkers, 0.93 (95% CI = 0.51–1.70) for moderate drinkers, and 0.61 (95% CI = 0.21–1.79) for heavy drinkers, compared to non-drinkers. The multivariate-adjusted OR among participants aged ≥43 years was, 1.42 (95% CI = 0.59–3.45) for light drinkers, 1.53 (95% CI = 0.63–3.75) for moderate drinkers, and 3.37 (95% CI = 1.14–9.96) for heavy drinkers (*P* for interaction = 0.05).

Conclusion: We found that the association between ESS and alcohol intake was more evident among those aged ≥43 years, who reported higher levels of EDS with increased alcohol consumption.

Key words: Commercial driving; alcohol intake; driving; sleep quality; occupational health

Introduction

Sleepiness at the wheel has been identified as a major cause of road traffic accidents caused by commercial motor vehicle (CMV) drivers [1,2]. Excessive daytime sleepiness (EDS) among CMV drivers poses a major threat to road traffic safety due to the continuous nature of CMV driving and stressors unique to the profession. Previous studies show that a growing percentage of road traffic accidents are attributable to EDS, with 3%, 10%, and 33% being reported in studies conducted in the United States, France, and New Zealand, respectively [3]. In Australia, 20–30% of accidents involving CMV drivers are reported as being sleep related [4].

Globally, alcohol is both a commonly used drug and a common factor in road accidents. Recent studies demonstrate that the sedative effects of alcohol can directly impact sleep quality and subsequently impair performance [4,5]. The bidirectional impact of alcohol on sleep and performance can be seen in various research settings through increasing Epworth Sleepiness Scale (ESS) scores, which measure varying degrees of EDS [6]. With reference to these increasing ESS scores, results from a previous study found that the ESS was useful for assessing alcohol-induced sleepiness. In addition, it validated the use of ESS as a sensitive tool for both short-term and long-term assessment of alcohol-induced sleepiness [7]. A further study found that alcohol consumption reduced next-day alertness and impaired divided-attention performance, thereby validating its disruptive effects on sleep, and its direct impairment of daytime alertness and performance [8].

The adverse effects of aging on the metabolism of alcohol may impair the elimination of alcohol from the body and, in turn, may directly impact sleep and subsequent daytime sleepiness [9]. Research findings on the relationship between age and alcohol consumption suggest that, after consuming alcohol, older adults (aged 55–74 years) have slower reaction times than younger adults (aged 25–35 years); with older adults already noted for sacrificing reaction time in order to improve the accuracy of an action without the presence of alcohol in their system [10]. In CMV driving, slower reaction times may prove to be the cause of accidents, as high levels of attentiveness and quick decision-making are always required.

While studies exist that assess the relationship between alcohol consumption, impaired driving, and sleep quality through various measurements, few studies examine the direct association between alcohol intake and ESS scores [11]. Therefore, we aimed to examine such a relationship, and also investigate the interaction between age and alcohol intake on EDS.

Methods

We selected the study participants who met the following criteria: male Japanese professional truck-drivers, who were members of the Japan Trucking Association, residing in Tokyo or Niigata Prefecture, and had not been treated for sleep-disordered breathing. Physician epidemiologists or trained staff members explained the study protocol to, and obtained informed consent from, all participants. This study was approved by the Medical Ethics Committee of the University of Tsukuba and the Institutional Review Board of Juntendo University.

All participants completed a self-administered questionnaire about their age, body mass index (BMI), alcohol consumption, ESS score, and smoking status. This study did not specifically screen for alcohol dependence. Therefore, alcohol consumption levels were first estimated in 'go' units, a traditional Japanese unit of volume corresponding to 23g of alcohol, before being converted into grams of alcohol per body weight (kg). Those who drank ≥0.5 go per day were considered alcohol drinkers. One go is equivalent to 180 ml of sake and corresponds to one bottle (633 ml) of beer, two single shots (75 ml) of whiskey, or two glasses (180 ml) of wine. Alcohol consumption was then divided into four groups following the classification used in a previous study: non-drinkers (no alcohol intake), light drinkers (alcohol intake of <0.5 g/kg body weight), moderate drinkers (alcohol intake of 0.5 to <1.0 g/kg body weight), and heavy drinkers (alcohol intake of ≥1.0 g/kg body weight) [12].

Sleep disorders among the study population were evaluated by questionnaire: sleepiness via the ESS, and estimated sleep-disordered breathing (SDB) according to oxygen desaturation index (ODI) values [14]. ESS was referenced as being representative of high levels of self-reported sleepiness. ESS, while not a diagnostic tool on its own, is nevertheless useful for identifying the prevalence of sleep disorders; scores lower than 11 are defined as normal, and scores greater than or equal to 11 are considered abnormal and indicative of high levels of self-reported sleepiness [12].

Although the ESS was primarily developed to validate obstructive sleep apnoea (OSA), the correlation between high levels of subjective sleepiness and various sleep-related issues means that the scale can be reasonably used for this study [13]. A pulse-oximetry device, PULSOX-3Si (Minolta Co., Osaka, Japan), collected ODI values and was used to evaluate SDB [14]. The criteria and categorisation of SDB are defined, at a 3% ODI level, as 5 and 15 events per hour, which correspond to mild and moderate-to-severe SDB, respectively [15]. The validity of pulse-oximetry was confirmed in the same manner as that used by Tanigawa *et al.*, via synchronous overnight recordings of both PULSOX-3Si and standard polysomnography (PSG) among patients who had been referred to an SDB centre [15].

Age-adjusted mean values and the prevalence of selected potential confounding factors associated with alcohol intake were calculated according to the aforementioned alcohol-intake categories (non-drinkers, light drinkers, moderate drinkers, and heavy drinkers) using the analysis of covariance and the chi-square test. A logistic regression analysis was performed to estimate the odds ratio of the prevalence of ESS scores (<11 and ≥ 11), according to alcohol-intake categories stratified by age (<43 and ≥ 43 years). In addition to age-adjustment, two multivariate-adjustments were carried out. The first multivariate-adjustment of age, BMI (kg/m^2) and smoking status, was carried out to estimate the odds ratio of the prevalence of ESS scores <11 and ≥ 11, according to alcohol-intake category; the second multivariate-adjustment included ODI.

All statistical analyses were performed using SAS version 9.4 software (SAS Institute Inc., Cary, NC, USA). All probability values for statistical tests were two-tailed. P values <0.05 were considered statistically significant.

Results

A total of 1,470 individuals were recruited, but 48 were excluded due to missing pulse-oximetry and alcohol-intake data. Consequently, a total of 1,422 individuals aged 20–69 years participated in this study. The average age of all participants was 43 years. Table 1 shows the characteristics of the study participants according to alcohol consumption: 46% were non-drinkers, 25% were light drinkers, 22% were moderate drinkers, and 7% were heavy drinkers. Heavy drinkers tended to be older, and had a higher prevalence of smoking, and a lower mean BMI compared to non-drinkers.

The results according to alcohol consumption as stratified by age group (<43 years and ≥43 years) are shown in Table 2. The multivariate-adjusted odds ratio (OR) of having ESS scores ≥11 for the <43 years age group were, 0.81 (95% confidence interval (CI) = 0.47–1.40) for light drinkers, 0.93 (95% CI= 0.51–1.70) for moderate drinkers, and 0.61 (95% CI = 0.21–1.79) for heavy drinkers, compared to non-drinkers. The multivariate-adjusted OR for the ≥43 years age group old were 1.42 (95% CI = 0.59–3.45) for light drinkers, 1.53 (95% CI = 0.63–3.75) for moderate drinkers, and 3.37 (95% CI = 1.14–9.96) for heavy drinkers (*P* for interaction = 0.05). Associations were not attenuated after adjusting for ODI, severity of SDB. We did not find an effect modification of BMI or ODI concerning the association of ESS and alcohol intake (not shown in table).

Discussion

The findings show that older commercial truck drivers tend to show more daytime sleepiness with increased alcohol consumption. By stratifying the study population by age, we were able to identify correlations between age and alcohol intake. The findings suggest that the driving performance of older CMV drivers may be more susceptible to the effects of alcohol. The association between heavy drinking and ESS score did not attenuate in the older population after adjusting for ODI.

In this study, an association between ESS and alcohol intake was found among the older population, but not among the younger population. As adults continue to age, their ability to metabolise alcohol changes due to diminished enzyme activity [16]. The diminished capabilities of older adults to metabolise, distribute, and eliminate alcohol in their system compared with younger adults leads to adverse effects on the central nervous system at lower levels of alcohol intake; organs such as the brain and liver are far more sensitive to alcohol toxicity. Greater sensitivity to alcohol, and this having an ostensibly negative impact on driving precision measurements among older adults, is supported by other studies; one study reported a three- to 17-fold increased risk of fatal motor-vehicle accidents among older adults with alcohol in their system compared with younger adults with alcohol in their system [17].

A supporting study that focused on the interactions between age and moderate alcohol-effects on simulated driving performance, noted that the risk of motor vehicle accidents increased among drivers aged 55 years or older, and that this risk was increased with alcohol usage [18]. A further study reported similar findings through higher ESS scores among older adults, representing an increase in EDS levels compared to younger adults and a greater potential to cause adverse sleep-related accidents [19]. These findings support those of our study; both indicate that ESS scores increase with age and that, due to older adults being less effective at eliminating alcohol, they are at a higher risk of potential accidents. A connection can be seen in that increased alcohol usage directly impacts SDB, and that this is correlated with increased ESS scores. This connection may be the reason why we found significant results in the older population and not in the younger population. Furthermore, in a rapidly aging society such as Japan, the average age of CMV drivers will continue to increase, as will their risk of developing sleep disorders.

Although increased subjective sleepiness does not directly translate to SDB, it nevertheless indicates the development of a potentially dangerous event [20]. It was found that middle-aged CMV drivers showed greater daytime sleepiness with increased alcohol consumption compared with younger drivers; this highlights the importance of employers implementing stringent alcohol-consumption policies. From a public-health policy perspective, a lack of systematic screening has caused inconsistencies in detecting and treating those with high levels of subjective sleepiness, as seen in both Japan and the United States [21,22]. An example of screening inconsistencies can be seen among those studies suggesting a correlation between BMI and daytime sleepiness. Focusing primarily on individuals with a high BMI makes it difficult to identify those without a high BMI, such as Asians who have a normal or non-obese BMI but high levels of body fat; these individuals are equally at risk of weight-related diseases, such as SDB, despite them having a lower BMI [23].

Our findings highlight the significant impact of alcohol intake on subjective sleepiness among CMV drivers, especially older CMV drivers for whom alcohol, even at low levels, continues to be an area of concern. Accidents could be mitigated through the use of electronic logging devices within CMVs, which would allow employers to evaluate employee capabilities (by automatically logging employee duty status such as CMV location/motion status and working hours) and, if necessary, carry out extra precautions if their driving capabilities pose a threat to public health. The American Thoracic Society has guidelines for identifying sleepiness and driving risk; these would be of supplemental benefit to the use of logging devices, focussing primarily on sleep education to help those at greatest risk. Consequently, this would allow drivers to recognize the symptoms and consequences of drowsiness. Using education, questionnaires, and technology would allow for a structured and comprehensive evaluation of CMV drivers and provide them with the required education and treatment.

Limitations to this study are that it does not focus on alcohol dependence, shares limitations common to cross-sectional studies such as the difficulty of identifying and interpreting potential associations/mechanisms, and limitations common to subjective reports like the ESS such as recall bias. In addition, the sample size of our study was not large enough to identify the previously mentioned existence of a potential mechanism of alcohol consumption impacting ESS scores; a larger sample size, along with a longitudinal analysis, could potentially identify the causal mechanism. Furthermore, we did not identify alcohol dependency in this study, which possibly included several drivers with daily alcohol consumption indicative of alcohol dependency; this small population may have affected associations within our study population. Our hypothesis concerned older adults because the average age of CMV drivers, like the global population age, is increasing. However, it would not be prudent to further explore the relationship among alcohol-dependent drivers using a limited study population, due to existing knowledge that alcohol serves as an aggressor to SDB and, in turn, increases ESS scores, and the association of increased ESS scores and subsequent sleep disorders. Despite its weaknesses, this is one of few studies on the population of CMV drivers that highlights the association between age, alcohol intake, and EDS.

Specialised policy development and implementation, particularly for CMV drivers in Japan, should be employed. In addition to looking at BMI as a risk factor for identifying high levels of subjective sleepiness among CMV drivers, we should also look at alcohol abstinence. The effect alcohol has on the older population may directly affect subjective levels of EDS, which may result in poorer driving performance.

Key Points

What is already known about this subject:

- Alcohol consumption can adversely affect sleep quality, which can lead to excessive daytime sleepiness. Excessive daytime sleepiness is a major factor in road traffic accidents.
- Commercial drivers generally do not get enough sleep; many drivers do not realize that they may suffer from excessive daytime sleepiness, which results in reduced vigilance and slower reaction times.
- Underdiagnosis and undertreatment of sleep disorders is common. No one questionnaire or survey is superior in identifying excessive sleepiness, and drivers may misreport or ignore warning signs.

What this study adds:

- There is an association between alcohol intake and ESS scores among older commercial drivers.
- Alcohol intake has a more significant effect on subjective sleepiness among older commercial drivers.
- The focus should be shifted away from BMI as a means for identifying potential at-risk commercial drivers for sleep-disorder screening to alcohol consumption. The use of universal BMI cut-off points to identify high levels of subjective sleepiness is not effective.

What impact this may have on practice, policy or procedure:

- Increased focus on alcohol consumption policies would help reduce sleep-related driving issues.
- Questionnaires (i.e. Epworth Sleepiness Scale) and technology (i.e. pulse-oximetry devices and electronic logging devices) should be used for screening for sleep disorders among commercial drivers.
- Utilizing technology that logs drivers’ capabilities or actions (such as sudden lane-changes) and self-reporting via questionnaires will help encourage alcohol abstinence among commercial drivers, thereby promoting better sleep and reducing sleepiness while driving.

Funding

This study was supported by a grant sponsor: The Japan Society for the Promotion of Science; Grant number: No. 18390194. Grant sponsor: The Ministry of Education, Culture, Sports, Science and Technology, Japan; Grant number: No. 17659184.

Acknowledgements

The authors are deeply grateful to the Japan Trucking Association for their assistance. We would also like to thank Ms. Yukiko Ichikawa and Ms. Miyuki Notsute for their excellent technical assistance and help with data collection for this study.

Competing interests

None declared.

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Table 1. Alcohol consumption characteristics of study participants

	Current Alcohol Intake (g/kg body weight)								
	Non-drinkers		**<0.5**		**0.5 to <1.0**		**>1.0**		***P* for difference**
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	
Number	651		356		310		105		
Age, year	41.4	11.5	43.5	10.6	45.2	9.8	43.4	9.8	<.0001
BMI, kg/m^2	24.3	4.3	24.1	3.4	23.7	3.0	23.2	2.7	0.008
Current Smokers	67%		65%		71%		83%		0.003

Table 2. Age-adjusted and multivariate-adjusted odds ratio and 95% confidence interval (CIs) according to alcohol consumption

		Current Alcohol Intake (g/kg body weight)					
	Non-drinkers	**< 0.5**		**0.5 to <1.0**		**≥1.0**	
		OR	95% CI	OR	95% CI	OR	95% CI
ESS≥11 (Number of Cases: 132)							
Age-adjusted (95% CI)	1	0.89	0.56–1.41	0.95	0.59–1.55	1.03	0.51–2.08
Multivariate-adjusted OR	1	0.91	0.58–1.44	1.02	0.63–1.67	1.15	0.56–2.35
Multivariate-adjusted with ODI OR	1	0.92	0.57–1.49	1.03	0.62–1.71	1.14	0.55–2.35
<43 Years Old (Number of Cases: 93)							
Age-adjusted (95% CI)	1	0.79	0.46–1.37	0.87	0.48–1.59	0.55	0.19–1.61
[1]Multivariate-adjusted OR (95% CI)	1	0.81	0.47–1.40	0.93	0.51–1.70	0.61	0.21–1.79
[2]Multivariate-adjusted OR (95% CI)	1	0.80	0.45–1.43	0.93	0.49–1.74	0.63	0.21–1.84
≥43 Years Old (Number of Cases: 39)							
Age-adjusted (95% CI)	1	1.35	0.56–3.26	1.36	0.56–3.28	2.73	0.96–7.82
[1]Multivariate-adjusted OR (95% CI)	1	1.42	0.59–3.45	1.53	0.63–3.75	3.37	1.14–9.96*
[2]Multivariate-adjusted OR (95% CI)	1	1.49	0.60–3.71	1.58	0.63–3.96	3.12	1.02–9.58*

* = P<0.05

[1] Multivariate-adjustment of age, BMI (kg/m^2), and smoking status.
[2] Multivariate-adjustment of age, BMI (kg/m^2), smoking status and ODI.