



Fatigue and poor sleep are associated with driving risk among Korean occupational drivers



Sooyoung Kwon^a, Heejung Kim^{a,b,*}, Gwang Suk Kim^{a,b}, Eunhee Cho^{a,b}

^a Yonsei University College of Nursing, 50-1 Yonsei-ro, Seodaemun-gu, Seoul, 03722, Republic of Korea

^b Mo-Im Kim Nursing Research Institute, Yonsei University College of Nursing, 50-1 Yonsei-ro, Seodaemun-gu, Seoul, 03722, Republic of Korea

ARTICLE INFO

Keywords:

Driving risk
Occupational driver
Fatigue
Sleep quality
Daytime sleepiness

ABSTRACT

Background: Occupational drivers are vulnerable to traffic incidents. Although modifiable factors should be emphasized when developing preventive interventions, there is a lack of knowledge concerning how fatigue, sleep, and health status are associated with driving risk in occupational drivers.

Objective: The aim of this study was to identify the associations between driving risk indices with fatigue and sleep-related characteristics in Korean occupational drivers.

Methods: Participants were recruited from commercial vehicle companies specializing in trucks, construction vehicles, taxis, or buses (N = 161). A structured questionnaire consisted of Korean versions of the (1) Traffic Accident Risk Index; (2) Pittsburgh Sleep Quality Index; (3) Epworth Sleepiness Scale; and (4) Short Form-12, version 2. Multiple linear and binary logistic regression analyses were performed using SPSS 24.

Results: Participants' mean age was 53.03 (SD = 9.42) years. Working as bus drivers, high perceived fatigue, excessive daytime sleepiness, and poor mental health status were associated with higher traffic accident risk index scores (all *p*-values < .05). Different factors associated with each risky driving behavior. Working for longer than 12 h per day and excessive daytime sleepiness were associated with consistent risky driving (both *p*-values < .05). High perceived fatigue, normal daytime sleepiness, and poor mental health status were associated with not wearing a seatbelt (all *p*-values = .01). Current smoking habit and alcohol usage were associated with speeding, while poor sleep quality was associated with a car crash occurred within the past year (all *p*-values ≤ .01).

Conclusions: Comprehensive assessments should integrate multidimensional interventions including fatigue reduction, sleep management, and promoting efforts to foster physical and mental health for occupational drivers. Vehicle-related organizations need to develop both individual and systemic support through internal regulations and public policies to prevent the modifiable factors of driving risk.

1. Introduction

Reducing the risk of injury and death due to road traffic injuries is a major public health concern (World Health Organization [WHO], 2015). The WHO reported that the number of global deaths due to injuries and violence was 5.1 million, and the leading cause of injury deaths was road traffic injury (WHO, 2015). While the number of deaths from road traffic injuries has decreased in

* Corresponding author. Yonsei University College of Nursing, 50-1 Yonsei-ro, Seodaemun-gu, Seoul, 03722, Republic of Korea.

E-mail addresses: soo.kwon97@gmail.com (S. Kwon), hkim80@yuhs.ac (H. Kim), gskim@yuhs.ac (G.S. Kim), ehcho@yuhs.ac (E. Cho).

<https://doi.org/10.1016/j.jth.2019.100572>

Received 17 December 2018; Received in revised form 30 May 2019; Accepted 2 June 2019

Available online 06 June 2019

2214-1405/ © 2019 Elsevier Ltd. All rights reserved.

Korea (Korea Traffic Accident Analysis System, 2016), the rate of injury deaths is still high among Organization for Economic Cooperation and Development (OECD) countries (OECD, 2018). The number of road traffic injury deaths was, on average, 5.5 per 100,000 inhabitants in Korea; however, it was 9.1 deaths per 100,000 inhabitants in 2015 (OECD, 2018). Thus, it is essential to identify modifiable factors to prevent road traffic injuries in Korea.

Many studies have emphasized the importance of preventing traffic injuries associated with drowsy driving (Anderson and Horne, 2013; European Commission [EC], 2015; Zhang and Chan, 2014). Drowsy driving results in severe traffic injuries, and occupational drivers who operate trucks, buses, or taxis are vulnerable to drowsy driving (Lee and Oh, 2014). The types of vehicles involved in road traffic injuries related to drowsy driving per 1.0 million registered vehicles in Korea are ranked as follows: commercial truck, 12.02; construction vehicle, 4.44; mini-bus or van, 4.05; and passenger car, 3.77 (Lee and Oh, 2014). Drowsy driving is associated with sleep-related conditions such as severe fatigue (Bener et al., 2017; Jo and Lee, 2014; Meng et al., 2015), insufficient sleep (Jo and Lee, 2014; Lemke et al., 2016), or a poor health condition (Crizzle et al., 2017), as well as work-related factors such as working hours and duration of consistent driving (EC, 2015).

In general, sleep plays an essential role in physical and mental health well-being (Buysse, 2014). Poor sleep quality and severe fatigue are significantly associated with more frequent human errors (Anderson and Horne, 2013; EC, 2015; Jeon et al., 2014). Restricted sleep duration, poor sleep quality, and high sleep demand are high risks of fatigue (EC, 2015), and fatigue delays individuals' reaction time, impairs driving performance, and decreases concentration and cognitive functioning (EC, 2015). Occupational drivers are exposed to high risks of poor sleep quality, poor health status, and excessive fatigue due to long hours of driving (Guglielmi, Magnavita and Garbarino, 2018; Jo and Lee, 2014; Lemke et al., 2016). Insufficient sleep increases the risk of distracted driving (Anderson and Horne, 2013), and poor sleep quality in train drivers is associated with more work-related errors (Jeon et al., 2014). Sleep is one of modifiable lifestyle behaviors (Byrne et al., 2016; Crizzle et al., 2017). Therefore, it is necessary to improve modifiable factors related to drivers' sleep habits to enhance driving safety.

There is an increase in forced risk in occupational drivers responding to work-related and societal changes. Magnavita and Garbarino (2017) insist that the current societal culture and work-related circumstances emphasize work efficiency and hard workload. Workers' sleep reduction has become more common and occupational drivers are likely to drive longer than 8 h a day to complete assigned workload (Kim et al., 2014; Lemke et al., 2016). Specifically, the transportation industry has affected to increase the prevalence of short sleep duration over the last two decades (Luckhaupt et al., 2010). In addition, occupational drivers also experience increased loss of sleep and excessive fatigue caused by sedentary working conditions and irregular working schedules (EC, 2015). Working overtime results in poor concentration on work tasks (Lemke et al., 2016), and long working hours are related to the likelihood of a car crash (Jo and Lee, 2014). Occupational drivers are considered to be one of the most vulnerable working groups in terms of physiological and psychological health and working conditions (Guglielmi et al., 2018; Lemke et al., 2017; Sieber et al., 2014). Therefore, we need to understand the relationship between diverse aspects of risk factors and driving risks among occupational drivers.

Previous studies indicated that severe fatigue (Bener et al., 2017; Jo and Lee, 2014), insufficient sleep (Anderson and Horne, 2013; Jo and Lee, 2014), and excessive daytime sleepiness (Bener et al., 2017; Lemke et al., 2016; Zhang and Chan, 2014) were risk factors for road traffic injuries. However, many studies focused on (1) describing the current prevalence of traffic injuries and characteristics associated with drowsiness while driving (Kim and Jung, 2016; Lee and Oh, 2014; Lim and Chia, 2015), (2) examining the relationship between sleep disorders and drowsy driving (Kim et al., 2015), or (3) identifying the associations between perceived fatigue and car crashes among commercial truck drivers (Jo and Lee, 2014). There is a lack of studies that identified modifiable factors associated with both overall risk and specific risky behaviors among occupational drivers. Therefore, we explored the characteristics of multiple driving risk indices and identified associated factors such as fatigue and sleep-related characteristics among occupational drivers in Korea.

2. Methods

2.1. Study design and procedures

This study employed a cross-sectional, descriptive design. Occupational drivers (N = 180) were recruited via convenience sampling. To ensure generalizability, we tried to diversify the types of recruiting companies: two construction companies with over 100 employees, one taxi company with over 100 employees, three bus companies and one shuttle bus company, and three truck companies with less than 15 employees. After obtaining the company's permission through telephone contact, we advertised the study participation via flyer, word-of-mouth, and onsite visit. Inclusion criteria were (1) aged older than 19 years, (2) employed as an occupational driver at a commercial vehicle company for at least 6 months, (3) able to read and write Korean, and (4) able to understand the purpose of the study and voluntarily agreeing to participate. We excluded anyone diagnosed with a sleep-related disorder or currently receiving treatment for it based on self-reports. Of the 180 respondents, 19 were excluded because (1) ten participated in a pilot study to confirm the readability of the Korean-translated survey questionnaires, (2) eight had incomplete response, and (3) one withdrew due to time constraints.

The final sample size (N = 161) was sufficient to conduct a multiple linear and binary logistic regression analysis based on the statistical power analysis calculation using G*power 3.1 program by Cohen's (1988) methods. A minimum sample size of 131 was obtained for a multiple linear regression for 13 predicted variables with an effect size = 0.15, significance set at $\alpha = 0.05$ (two-tailed), and a power of 0.80. We also performed a power analysis for a binary logistic regression analysis with an odds ratio of 1.72 based on the meta-analysis result of the association between daytime sleepiness and traffic incidents among occupational drivers

(Zhang and Chan, 2014); $Pr = 0.26$, which was the car crash experience ratio reported by Korean commercial truck drivers in a previous study (Jo and Lee, 2014); significance set at $\alpha = 0.05$ (two-tailed), and a power of 0.80. A minimum sample size of 152 was required for a binary logistic regression.

Institutional Review Board approval was obtained from the affiliated institute of the principal investigator prior to performing this study (no. Y-2018-0006). Data were collected from March 22 to May 4, 2018. All participants provided written, informed consent and those who completed a structured survey received a \$3 gift to acknowledge their contribution to this study. Data were anonymized and de-identified with no personal information, and confidentiality was ensured.

2.2. Variables

A structured questionnaire was utilized, consisting of (1) sociodemographic and work-related characteristics, (2) driving risk indices, (3) fatigue and sleep-related characteristics, and (4) general health status.

2.2.1. Sociodemographic and work-related characteristics

Participants self-reported sociodemographic variables such as age, sex, body mass index (BMI), any diseases diagnosed by physicians (diabetes, high blood pressure, heart disease, cerebrovascular disease, gastrointestinal disease, lung disease, musculoskeletal disease, depressive disorder, sleep disorder, cancer, and others), smoking status, alcohol use, and exercise. Age was dichotomized and coded as '0' = < 60 and '1' = ≥ 60 according to the retirement age of the Korean Act on Prohibition of Age Discrimination in Employment and Elderly Employment Promotion (2016). BMI was calculated using self-reported height and weight and classified per the WHO's (2000) recommendations. Regular exercise was dichotomized as yes = *regularly exercise three times or more per a week* and no = *other*. We included work-related characteristics such as vehicle type (taxi, bus, truck, and others), duration of experience in years and months as an occupational driver, and working hours per day (start and end time). The working hours per day was dichotomized by the maximum number of working hours (12 h) per the Korean Labor Standards Act (2014).

2.2.2. Driving risk indices

Driving risk indices included the (1) Traffic Accident Risk Index (TARI), (2) three risky-driving behaviors, and (3) a car crash experience. The TARI was developed by Lee and Lee (2010) and revised in Song and Lee's (2011) study to assess traffic incident risk with six items consisting of self-reports about near miss experience during the past year (2 items), traffic incident anxiety by self-evaluation (2 items), and traffic incident anxiety by others (2 items). This was measured on a 5-point Likert-type scale (1 = *strongly disagree* to 5 = *strongly agree*), and mean scores were calculated (range = 1–5). Higher scores indicate a higher risk of traffic incidents. Cronbach's α was 0.87 when it was developed (Lee and Lee, 2010), and 0.88 for this study. Three risky driving behaviors were assessed with 3 questions: "How often do you continue to drive despite fatigue, bad weather, or heavy traffic because you must deliver or pick up a load at a given time?," "How often do you wear a seatbelt?," and "How often do you drive 10 miles (16 km) per hour or more over the speed limit?" These questions were derived from Chen, Sieber and colleagues' (2015) study using the injury and safety component of the National Institute for Occupational Safety and Health's long-haul-truck driver survey. Risky driving behaviors were measured using multiple choices options including "*always*," "*often*," "*sometimes*," and "*never*" and categorized as risky driving behaviors (coded as 1; *always* or *often*) or safe driving behaviors (coded as 0; *sometimes* or *never*). Wearing a seatbelt was reversely recoded. Car crash experience was assessed with one question: "Have you been involved in a car crash within the past year?" Responses were dichotomized as 0 = *no* and 1 = *yes*. The questions regarding three risky driving behaviors and one car crash experience were translated into Korean and revised per content validity index (CVI) evaluation by three experts who were fluent in both Korean and English (Lynn, 1986). The experts rated each item on a 4-point scale (1 = *not relevant*, 2 = *somewhat relevant*, 3 = *quite relevant*, 4 = *highly relevant*), and CVI was computed as the number per each item rated of either 3 or 4, divided by the number of experts (Lynn, 1986). The result of CVI in each item was 1.0, which was satisfied by content relevance suggested by Lynn (1986). We performed a pilot study to confirm readability with 10 occupational drivers and excluded the data for final analysis.

2.2.3. Fatigue and sleep-related characteristics

We assessed perceived levels of fatigue while driving using a measure developed by Park et al. (2004) in Korea. The instrument comprises 10 items measured on a 5-point Likert-type scale, and higher scores indicate higher levels of perceived fatigue while driving. Cronbach's α was 0.92 when it was developed (Park et al., 2004), and 0.91 in this study. Sleep quality was measured using the Pittsburgh Sleep Quality Index (Buysse et al., 1989) translated to Korean which was provided by Mapi Research Trust. Higher scores indicate poorer sleep quality. Cronbach's α was 0.83 when it was developed (Buysse et al., 1989), and 0.80 in this study. Daytime sleepiness was assessed with the Epworth Sleepiness Scale (ESS). The ESS was developed by Johns (1991) and the Mapi Research Trust provides a Korean-translated version. The ESS scores range from 0 to 24 and total scores over 10 were categorized as "excessive daytime sleepiness" (Johns, 1991). Cronbach's α was 0.79 in Heaton and Anderson's (2007) study with long haul truck drivers, and 0.72 in this study.

2.2.4. General health status

General health status was measured using the Korean-translated Short Form-12 Health Survey, version 2, which comprises physical and mental health components (Ware et al., 1996). Each component score ranges from 0 to 100, which are obtained via the calculation method provided by Quality Metric Incorporated, and higher scores indicate better health status. Cronbach's α s were 0.67 for the physical and 0.70 for the mental health components when it was developed (Ware et al., 1996), and 0.74 for both in this study.

Table 1
Sociodemographic and work-related characteristics of participants (N = 161).

Variables	Categories	n (%)	M ± SD	
Age (years) ^a	< 60	117 (73.1)	53.03 ± 9.42	
	≥ 60	43 (26.9)		
BMI (kg/m ²) ^a	Normal (18.5–22.9)	35 (21.7)	25.16 ± 3.06	
	Overweight (23–24.9)	41 (25.5)		
	Obese (≥ 25)	82 (50.9)		
Diseases diagnosed ever ^{a,b}	Yes	70 (43.5)		
		Hypertension		37 (52.9)
		Diabetes mellitus		16 (22.9)
		Gastrointestinal disease		16 (22.9)
Smoking	Yes	75 (46.6)		
	No	86 (53.4)		
Alcohol use	Yes	102 (63.4)		
	No	59 (36.6)		
Regular exercise	Yes	40 (24.8)		
	No	121 (75.2)		
Types of vehicle	Truck	79 (49.2)		
	Construction vehicle	40 (24.8)		
	Taxi	21 (13.0)		
	Bus	21 (13.0)		
Driving experience (years)			16.72 ± 11.01	
Working hours per day (hours) ^a	≤ 12	104 (65.4)	11.59 ± 2.49	
	> 12	55 (34.6)		

Note. BMI = Body mass index.

^a Missing data were excluded.

^b Multiple choices were allowed.

2.3. Data analyses

Descriptive statistics were conducted as frequencies (percentages) or means (standard deviations [SD]). To confirm the final model of each driving risk index, we included significant variables based on findings from a univariate analysis ($p < .05$) into multiple linear regression and binary logistic regression analyses. In addition, Pearson's correlation analyses and diagnostic assumptions were checked including normality, linearity, homoscedasticity, multicollinearity, and independence of errors of independence variables. We selected independent variables such as two age groups, smoking, alcohol use, vehicle type (taxi, buses, trucks, or construction vehicles), working hours per day, perceived fatigue, sleep quality, excessive daytime sleepiness, and mental health status. Analyses were conducted with SPSS 24.0 (IBM Corp., Armonk, NY, USA), and the significance level was set at $\alpha = 0.05$.

3. Results

3.1. General characteristics

Table 1 shows participants' sociodemographic and work-related characteristics. Participants' mean age was 53.03 (SD = 9.42) years, and 26.9% were aged 60 years or older. The average BMI was 25.16 (SD = 3.06) kg/m², and about half (50.9%) were categorized as obese. Of the 70 participants (43.5%) who had a diagnosed disease, the most common one was hypertension (52.9%), followed by diabetes (22.9%) and gastrointestinal disease (22.9%). Almost half (46.6%) were current smokers, and about two thirds (63.4%) consumed alcohol. Further, 75.2% did not exercise regularly. Of the 161 drivers, their vehicle types were categorized as trucks (n = 79), construction vehicles (n = 40), taxis (n = 21), or buses (n = 21). Mean driving experience as an occupational driver was 16.72 (SD = 11.01) years. Participants reported 11.59 (SD = 2.49) working hours per day on average, and 34.6% worked over 12 h per day.

3.2. Characteristics of driving risk

Participants' mean TARI score was 1.97 (SD = 0.76). About half (50.9%) were consistently driving despite fatigue, bad weather, or heavy traffic in order to deliver or pick up a load at a given time, and 30.4% did not wear a seatbelt. The prevalence of "often" or "always" driving over the speed limit was 17.4%, and a quarter (24.8%) had been involved in a car crash within the past year (Table 2).

Table 2
Characteristics of driving risk (N = 161).

Questions	Risky driving n (%)	Safe driving n (%)
Consistent driving despite fatigue, bad weather, or heavy traffic for your work?	82 (50.9)	79 (49.1)
How often do you wear a seatbelt?	49 (30.4)	112 (69.6)
How often do you drive 10miles (16 km) per hour or more over the speed limit?	28 (17.4)	133 (82.6)
	Yes n (%)	No n (%)
A car crash occurred within the past year?	40 (24.8)	121 (75.2)

3.3. Factors associated with TARI

In the multiple linear regression analysis, the model explained 35.1% of the TARI. Bus drivers (as compared with taxi drivers; $\beta = 0.27, p < .01$), high perceived fatigue ($\beta = 0.29, p < .01$), excessive daytime sleepiness ($\beta = 0.22, p < .01$), and poor mental health status ($\beta = -0.18, p = .02$) were associated with higher TARI scores (Table 3).

3.4. Factors associated with risky driving behaviors and car crash experience

In the binary logistic regression analysis, the model explained 24.2% of consistent risky driving. Working for longer than 12 h per day compared with working 12 h per day or less (odds ratio [OR] = 3.79, 95% confidence interval [CI] = 1.75–8.22) and excessive daytime sleepiness (OR = 10.11, 95% CI = 1.10–92.68) were associated with consistent risky driving. The model explained 37.9% of not wearing a seatbelt. High perceived fatigue (OR = 1.09, 95% CI = 1.02–1.15) and poor mental health status (OR = 0.92, 95% CI = 0.86–0.98) were associated with not wearing a seatbelt. Excessive daytime sleepiness (OR = 0.06, 95% CI = 0.01–0.46) was associated with wearing a seatbelt. The model explained 38.1% of speeding. Current smoking habit (OR = 4.25, 95% CI = 1.46–12.38) and alcohol usage (OR = 7.38, 95% CI = 1.86–29.30) were associated with speeding. The model explained 20.4% of a car crash occurred within the past year, and poor sleep quality (OR = 1.29, 95% CI = 1.08–1.54) was associated with car crash experience (Table 4).

4. Discussion

4.1. Key findings

This study was performed to identify associated factors with multidimensional driving risks, specifically focusing on fatigue, sleep quality, daytime sleepiness, and health status among Korean occupational drivers. Our findings suggest the following: (1) high perceived fatigue, excessive daytime sleepiness, and poor sleep quality increase driving risks; (2) poor mental health status was associated with higher TARI scores or certain risky behaviors; (3) those working for longer than 12 h per day or as a bus driver were a vulnerable group; and (4) current smoking habit and alcohol use were associated with speeding.

4.2. Fatigue and sleep-related characteristics related to driving risk

Occupational drivers with higher perceived fatigue reported higher TARI scores and risky driving behavior such as not wearing a seatbelt. Several studies showed that severe fatigue was associated with car crash experiences (Bener et al., 2017; Jo and Lee, 2014;

Table 3
Factors associated with traffic accident risk index (N = 161).

Variables	Categories	B	SE	β	t (p)
	(Constant)	2.11	0.46		4.62 (< .01)
Age group (ref. = < 60)	≥ 60	-0.11	0.12	-0.07	-0.90 (.37)
Smoking (ref. = no)	Yes	-0.09	0.10	-0.06	-0.86 (.39)
Alcohol use (ref. = no)	Yes	-0.01	0.10	-0.01	-0.09 (.93)
Vehicle type (ref. = taxi)	Bus	0.59	0.20	0.27	3.00 (< .01)
	Truck/construction vehicle	0.24	0.15	0.14	1.53 (.13)
Working hours per day (ref. = ≤ 12 h)	> 12 h	0.19	0.11	0.12	1.77 (.08)
Fatigue		0.03	0.01	0.29	3.76 (< .01)
PSQI		0.02	0.02	0.07	0.82 (.42)
ESS (ref. = normal [≤ 10])	Excessive daytime sleepiness (> 10)	0.65	0.20	0.22	3.16 (< .01)
MCS		-0.02	0.01	-0.18	-2.42 (.02)

$R^2 = .392$ Adj. $R^2 = .351$

Note. ref. = reference group; PSQI = Pittsburgh Sleep Quality Index; ESS = Epworth Sleepiness Scale; MCS = Mental Component Summary.

Table 4
Factors associated with relevant risky behaviors and car crash experience (N = 161).

Variables	Categories	Consistent risky driving		Not wearing a seatbelt		Speeding		A car crash occurred within the past year	
		OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Age group (ref. = < 60)	≥60	0.56	0.24–1.34	0.46	0.16–1.36	0.42	0.08–2.17	0.68	0.24–1.91
Smoking (ref. = no)	Yes	0.72	0.35–1.50	1.36	0.59–3.11	4.25*	1.46–12.38	0.47	0.21–1.07
Alcohol use (ref. = no)	Yes	1.41	0.67–2.93	0.57	0.24–1.34	7.38**	1.86–29.30	1.39	0.59–3.27
Vehicle type (ref. = taxi)	Bus	2.05	0.48–8.68	–	–	0.40	0.02–10.09	2.03	0.27–15.13
	Truck/construction vehicle	1.89	0.62–5.78	–	–	4.71	0.47–46.99	3.67	0.71–19.03
Working hours per day (ref. = ≤ 12 h)	> 12 h	3.79**	1.75–8.22	1.33	0.57–3.12	1.61	0.56–4.64	1.41	0.60–3.34
Fatigue		1.02	0.97–1.08	1.09*	1.02–1.15	1.06	0.98–1.14	0.99	0.93–1.05
PSQI		1.10	0.94–1.29	1.01	0.85–1.20	1.17	0.94–1.47	1.29**	1.08–1.54
ESS (ref. = normal [≤ 10])	Excessive daytime sleepiness (> 10)	10.11*	1.10–92.68	0.06*	0.01–0.46	1.50	0.24–9.28	2.05	0.47–8.89
MCS		1.02	0.97–1.07	0.92*	0.86–0.98	0.99	0.92–1.06	1.00	0.95–1.06
		Cox & Snell R ² = .182		Cox & Snell R ² = .269		Cox & Snell R ² = .231		Cox & Snell R ² = .138	
		Nagelkerke R ² = .242		Nagelkerke R ² = .379		Nagelkerke R ² = .381		Nagelkerke R ² = .204	

Note. ref. = reference group; PSQI = Pittsburgh Sleep Quality Index; ESS = Epworth Sleepiness Scale; MCS = Mental Component Summary; — = unable to specify.

* $p < .05$, ** $p < .01$.

Meng et al., 2015; Zhang and Chan, 2014); thus, it is vital to manage drivers' fatigue appropriately to promote safety. For example, to compare a job similar to occupational driving, pilots have specific working hour regulations and are provided with systematic management (i.e., Fatigue Risk Management System) to promote aviation safety (Lee and Hwang, 2012). Regulations for occupational drivers such as taking a 30-min break after working for 4 h have been recently established in Korea. Moreover, previous studies showed that a break for drivers to rest or nap reduced the risk of road traffic incidents (Chen and Xie, 2014; Garbarino et al., 2016a,b). Therefore, the relevant traffic authorities established supplemental rest areas on highways for drivers in order to prevent car crashes related to drowsy driving (Jung et al., 2017). However, these regulations are imperfect as they receive limited public support and lack surveillance systems. Most occupational drivers do not take breaks and continue driving despite drowsiness to complete their work on time (Lee and Oh, 2014). Consistently, more than half of the current participants drove for work despite fatigue, bad weather, or heavy traffic. Multidisciplinary efforts among relevant policymakers and the owners of commercial vehicle companies should recognize the importance of promoting breaks among occupational drivers to improve fatigue risk management.

Poor sleep quality and daytime sleepiness were risk factors of driving risks. Zhang and Chan (2014) reported that excessive daytime sleepiness was significantly associated with crash risks for professional drivers in a meta-analysis. Especially, occupational drivers are vulnerable to poor sleep quality and drowsy driving, as they work irregular schedules. Notably, on-duty drivers report less sleep and poorer sleep quality compared to off-duty drivers (Lemke et al., 2016, 2017). Many occupational drivers have a much shorter duration of sleep as compared to that of other industrial workers (Luckhaupt et al., 2010). Less sleep increases the risk of car crashes or worksite errors (Anderson and Horne, 2013; Jeon et al., 2014; Lemke et al., 2016, 2017), and sleep duration is closely related to sleep quality (Lemke et al., 2016). Several studies about improving sleep quality reported the effects of non-pharmacological methods such as exercise (Sarris and Byrne, 2011; Yang et al., 2012), cognitive behavioral treatment (Mitchell et al., 2012; Montgomery and Dennis, 2004), and light therapy (Montgomery and Dennis, 2004) rather than a pharmacological approach. Healthcare providers should consider both pharmacological and non-pharmacological methods to enhance sleep quality for occupational drivers considering their irregular working schedules. Moreover, previous studies to prevent drowsy driving have been performed such as sensor development and applications to detect drowsiness while driving (Choi et al., 2012; Jung et al., 2014). These studies focused on diverse methods to detect sleepiness while driving and to provide time-prompted feedback such as alarms that assess drowsy driving by eye-blinking, facial-movement (Choi et al., 2012), or heart-rate sensors (Jung et al., 2014). Several new devices to promote safe driving have been commonly used due to recent technologic developments, such as artificial intelligence. Thus, relevant traffic authorities should consider applying smart detecting systems to prevent drowsy driving.

Interestingly, excessive daytime sleepiness increased the likelihood of wearing a seatbelt in this study. Perhaps some participants decide to wear a seatbelt only when they feel drowsy. However, long-haul truck drivers in the United States reported they did not wear a seatbelt for several reasons: no history of violating traffic laws, absence of a company-wide safety program, and no regulations about wearing a seatbelt (Chen et al., 2015a,b). Nonetheless, this finding shows that low safety consciousness is associated with not wearing a seatbelt. Specifically, more than double the participants in the current study reported not wearing a seatbelt compared to the above U.S. study (i.e., 13.8%; Chen et al., 2015a,b) and a prior Korean study (i.e., 13.4%; Korea Traffic Safety Authority, 2017). Moreover, our research team found that there was no seatbelt system for drivers on the old city buses. Wearing a seatbelt plays a key role in reducing injuries or death related to car crashes (Korea Traffic Safety Authority, 2017). It is essential that drivers become aware of the importance of wearing a seatbelt, and it is critical to confirm the installation and inspection of seatbelts in all

commercial vehicles in Korea.

Poor mental health status was more associated with driving risks than was physical health status. Participants with poor mental health reported higher TARI scores and a higher likelihood of not wearing a seatbelt compared to those with better mental health. Occupational drivers display high levels of job stress (Kim et al., 2014); specifically, bus drivers who experienced a car crash or conflict with passengers have reported post-traumatic stress disorder and severe depressive symptoms (Choi et al., 2011). Occupational drivers usually drive vehicles alone and have less chance to interact with people, which is considered a stressful work-related characteristic (Hilton et al., 2009; Shattell2012), and poor mental health increases the risk of car crashes or near misses (Hilton et al., 2009). Occupational drivers are vulnerable to both mental and physical health problem, which affects their traffic incident risks. They have also reported a high prevalence rate of chronic diseases or obesity due to stressful and irregular working conditions (Lim and Chia, 2015; Sieber et al., 2014) and severe depressive symptoms or loneliness (Choi et al., 2011; Shattell et al., 2012). Recent studies have shown that even early stages of sleep disorders are associated with poor psychological distress (Guglielmi et al., 2018) and health outcomes (Magnavita and Garbarino, 2017). However, little research has focused on the mental health problems or mental health management programs for occupational drivers (Choi et al., 2011; Kim et al., 2014). Therefore, further research concerning comprehensive physical and mental health promoting programs including sleep related health among occupational drivers is needed.

4.3. Work-related characteristics and driving risks

Vehicle type was also associated with driving risks. Different characteristics of driving fatigue were reported according to the vehicle type (Meng et al., 2015), and truck drivers reported a high rate of a car crash experience related to drowsy driving (Zhang et al., 2016). Truck drivers have a high risk of severe traffic injury due to the size of vehicles and long-distance driving (Meng et al., 2015). Moreover, bus drivers must drive on a pre-fixed bus schedule despite driving risk and may easily get distracted while driving due to interactions with passengers. For bus drivers in Korea, long working hours (Kim et al., 2014) and conflict with passengers (Choi et al., 2011) are associated with job-related stress levels. Meng et al. (2015) showed differences in fatigue between truck and taxi drivers. Each occupational driver has unique job conditions; therefore, future studies should identify the diverse work-related conditions such as working schedule, average working hours, break schedule, and risk factors based on vehicle type.

Long working hours was associated with driving risks. Working long hours decreases job performance and concentration (Lemke et al., 2016); when this is paired with insufficient breaks, it results in drowsy driving, which increases driving risks (Anderson and Horne, 2013; Lee and Oh, 2014). Chen and Xie (2014) reported that taking frequent but short breaks was effective in reducing fatigue-related crash risk among truck drivers. Several countries have regulations concerning driving hours, breaks, and working period to prevent car crashes by reducing physical and psychological fatigue. U.S. federal law—"The Hours of Service of Drivers"—regulates that 8 h of consistent driving requires a break of at least 30-min, and a maximum of 11 h of driving is allowed for long-haul truck drivers only after a consecutive 10-h off-duty break (Summary of Hours of Service Regulations of the USA, 2017). The European Union also regulates that professional drivers should take a 45-min break after a maximum of 4.5 h of consistent driving, and they are not allowed to drive over 9 h per day (Department for Transport of UK, 2014). Although the 2017 regulations in Korea were noted above, relevant traffic authorities should closely monitor and support commercial vehicle companies to ensure these regulations are followed, which will likely decrease traffic incidents.

4.4. Modifiable health behaviors and driving risks

Occupational drivers had poor health behaviors (i.e., smoking, alcohol consumption, insufficient exercise, obesity) and high prevalence of chronic diseases, which were associated with driving risks. Korean commercial drivers showed a higher likelihood of severe alcohol drinking and smoking compared to other job types such as manufacturing, constructions, or commercials in a previous study (Chon et al., 2010). The smoking rate of long-haul truck drivers (51%) is much higher than that of the general adult population (19%, $p < .01$) in the United States (Sieber et al., 2014). Further, our results concerning drivers' diseases (i.e., hypertension, diabetes, and gastrointestinal diseases) were consistent with the results of a previous study that examined Korean occupational drivers (Kim and Hwang, 2011). Specifically, occupational drivers have a higher prevalence of diabetes and hypertension than do general adults (Sieber et al., 2014); both diseases are known as co-morbidities of sleep disorders, specifically obstructive sleep apnea (Garbarino et al., 2016a,b). Moreover, truck drivers showed a high prevalence of insomnia (Guglielmi et al., 2018), which is associated with road traffic injuries (Garbarino et al., 2016a,b; Garbarino et al., 2017). Smoking, alcohol consumption, and exercise are modifiable lifestyle factors, and they are closely associated with chronic diseases such as hypertension and diabetes (WHO, 2015). Thus, clinical professionals should provide health screening programs to detect undiagnosed early stage sleep disorders and integrated education programs that help occupational drivers quit smoking, drink less, and exercise more. Moreover, driver-tailored health promotion programs are recommended to promote a system-based approach while taking into consideration both the workplace and individual change (Crizzle et al., 2017). Therefore, relevant community authorities or policymakers should set policies to provide comprehensive health promotion programs for sustainability.

4.5. Strength and limitations

The first strength of this study is that we assessed driving risk factors across various aspects. Most prior studies about driving risks identified only one or two risky driving behaviors and their association with traffic injury experiences. However, driving risk is associated with multiple indices (Kockum et al., 2017); therefore, our comprehensive approach contributes to the literature and

informs relevant public policies. The second strength is that we surveyed a hard-to reach group. Occupational drivers have limited time or a low participation rate regarding the completion this kind of a survey. Our findings can assist clinical professionals and relevant policymakers in understanding work-related health problems among occupational drivers and utilize the findings to provide tailored health management.

However, this study had several limitations. First, it is difficult to generalize our results because it is a cross-sectional design using small size and convenience sampling. We attempted to recruit diverse types of companies; however, only a small number of companies voluntarily allowed their employees to participate in the study. Future studies should consider random or stratified, or quota sampling while taking into account work-related characteristics for the generalization of result. Each working condition differs per vehicle type. We recruited different kinds of occupational drivers to reflect the aspect of a professional job; however, bus and taxi drivers tend to work in shifts, while truck and construction drivers tend to follow regular daytime working hours. Therefore, future studies should compare different indices based on vehicle types or determine how organizational aspects are related to driving risks of occupational drivers using multi-level analysis. Third, we only obtained subjective information for this study. Participants self-reported their sleep quality and sleep duration; however, most occupational drivers do not work regular hours and thus have irregular sleeping habits. Objective sleep measures such as actigraphic devices should be considered for use to prevent recall bias. In addition, future studies should include participants with sleep disturbances that are prevalent among occupational drivers, such as obstructive sleep apnea via medical examination.

5. Conclusions

Driving risks are associated with high perceived fatigue, poor sleep quality, excessive daytime sleepiness, poor mental health status, vehicle type, and long daily working hours among occupational drivers. This suggests that we need to develop health management interventions to enhance drivers' sleep quality, improve their physical and mental health status, and manage their fatigue. Specifically, clinical professionals should provide integrated health promotion programs based on systematic approach. Vehicle-related organizations need to establish and supervise internal regulations and public policies to reduce occupational drivers' car crash risks.

Competing interests

The authors declare that they have no competing interests.

Financial disclosure

The Authors did not receive any specific funding for this work.

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or non-for-profit sectors.

Acknowledgements

Not applicable.

References

- Act on Prohibition of Age Discrimination in Employment and Elderly Employment Promotion. Retrieved from the Statutes of the Republic of Korea website: https://elaw.klri.re.kr/eng_service/lawView.do?hseq=37583&lang=ENG 19.04.01.
- Anderson, C., Horne, J.A., 2013. Driving drowsy also worsens driver distraction. *Sleep Med.* 14 (5), 466–468. <https://doi.org/10.1016/j.sleep.2012.11.014>.
- Bener, A., Yildirim, E., Özkan, T., Lajunen, T., 2017. Driver sleepiness, fatigue, careless behavior and risk of motor vehicle crash and injury: population based case and control study. *J. Traffic Transp. Eng.* 4 (5), 496–502. <https://doi.org/10.1016/j.jtte.2017.07.005>.
- Buysse, D.J., 2014. Sleep health: can we define it? Does it matter? *Sleep* 37 (1), 9–17. <https://doi.org/10.5665/sleep.3298>.
- Buysse, D.J., Reynolds, C.F., Monk, T.H., Berman, S.R., Kupfer, D.J., 1989. The Pittsburgh Sleep Quality Index: a new instrument for psychiatric practice and research. *Psychiatr. Res.* 28 (2), 193–213. [https://doi.org/10.1016/0165-1781\(89\)90047-4](https://doi.org/10.1016/0165-1781(89)90047-4).
- Byrne, D.W., Rolando, L.A., Aliyu, M.H., McGown, P.W., Connor, L.R., Awalt, B.M., et al., 2016. Modifiable healthy lifestyle behaviors: 10-year health outcomes from a health promotion program. *Am. J. Prev. Med.* 51 (6), 1027–1037. <https://doi.org/10.1016/j.amepre.2016.09.012>.
- Chen, C., Xie, Y., 2014. The impacts of multiple rest-break periods on commercial truck driver's crash risk. *J. Saf. Res.* 48, 87–93. <https://doi.org/10.1016/j.jsr.2013.12.003>.
- Chen, G.X., Collins, J.W., Sieber, W.K., Pratt, S.G., Rodríguez-Acosta, R.L., Lincoln, J.E., et al., 2015a. Vital signs: seat belt use among long-haul truck drivers—United States, 2010. *MMWR (Morb. Mortal. Wkly. Rep.)* 64 (8), 217–221. Retrieved from: <http://www.cdc.gov/mmwr/pdf/wk/mm6408.pdf>.
- Chen, G.X., Sieber, W.K., Lincoln, J.E., Birdsey, J., Hitchcock, E.M., Nakata, A., et al., 2015b. NIOSH national survey of long-haul truck drivers: injury and safety. *Accid. Anal. Prev.* 85, 66–72. <https://doi.org/10.1016/j.aap.2015.09.001>.
- Choi, W.S., Cho, S., Kim, K.Y., Cho, Y.S., Koo, J.W., Kim, H.R., 2011. The relationship between the experience of an accident and post traumatic stress disorder in bus drivers. *Korean Journal of Occupational and Environmental Medicine* 23 (2), 139–148. Retrieved from: <http://wprim.whooc.org/cn/admin/article/articleDetail?WPRIMID=153754&articleId=153754>.
- Choi, J.M., Song, H., Park, S.H., Lee, C.D., 2012. Implementation of driver fatigue monitoring system. *The Journal of Korean Institute of Communications and Information Sciences* 37 (8C), 711–720. <https://doi.org/10.7840/kics.2012.37C.8.711>.
- Chon, S.H., Kim, J.Y., Cho, J.J., Ryoo, J.G., 2010. Job characteristics and occupational stress on health behavior in Korean workers. *Korean Journal of Family Medicine*

- 31 (6), 444–452. <https://doi.org/10.4082/kjfm.2010.31.6.444>.
- Cohen, J., 1988. In: *Statistical Power Analysis for the Behavioral Sciences*, second ed. Lawrence Erlbaum, Hillsdale, NJ.
- Crizzle, A.M., Bigelow, P., Adams, D., Gooderham, S., Myers, A.M., Thiffault, P., 2017. Health and wellness of long-haul truck and bus drivers: a systematic literature review and directions for future research. *Journal of Transport & Health* 7, 90–109. <https://doi.org/10.1016/j.jth.2017.05.359>.
- Department for Transport of UK, 2014. Simplified Guidance EU Drivers Hours Working Time Rules. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/603096/simplified-guidance-eu-drivers-hours-working-time-rules.pdf 18.11.10.
- European Commission, 2015. Fatigue, European Commission, Directorate General for Transport. Retrieved from https://ec.europa.eu/transport/road_safety/sites/roadsafety/files/ersosynthesis2015-fatigue-summary5_en.pdf 18.11.10.
- Garbarino, S., Durando, P., Guglielmi, O., Dini, G., Bersi, F., Fornarino, S., et al., 2016a. Sleep apnea, sleep debt and daytime sleepiness are independently associated with road accidents. A cross-sectional study on truck drivers. *PLoS One* 11 (11), e0166262. <http://doi.org/10.1371/journal.pone.0166262>.
- Garbarino, S., Lanteri, P., Durando, P., Magnavita, N., Sannita, W., 2016b. Co-morbidity, mortality, quality of life and the healthcare/welfare/social costs of disordered sleep: a rapid review. *Int. J. Environ. Res. Public Health* 13 (8), 831. <http://doi.org/10.3390/ijerph13080831>.
- Garbarino, S., Magnavita, N., Guglielmi, O., Maestri, M., Dini, G., Bersi, F.M., et al., 2017. Insomnia is associated with road accidents. Further evidence from a study on truck drivers. *PLoS One* 12 (10), e0187256. <https://doi.org/10.1371/journal.pone.0187256>.
- Guglielmi, O., Magnavita, N., Garbarino, S., 2018. Sleep quality, obstructive sleep apnea, and psychological distress in truck drivers: a cross-sectional study. *Soc. Psychiatr. Psychiatr. Epidemiol.* 53 (5), 531–536. <https://doi.org/10.1007/s00127-017-1474-x>.
- Heaton, K., Anderson, D., 2007. A psychometric analysis of the Epworth sleepiness scale. *J. Nurs. Meas.* 15 (3), 177–188. <https://doi.org/10.1891/106137407783095748>.
- Hilton, M.F., Staddon, Z., Sheridan, J., Whiteford, H.A., 2009. The impact of mental health symptoms on heavy goods vehicle drivers' performance. *Accid. Anal. Prev.* 41 (3), 453–461. <https://doi.org/10.1016/j.aap.2009.01.012>.
- Jeon, H.J., Kim, J.H., Kim, B.N., Park, S.J., Fava, M., Mischoulon, D., et al., 2014. Sleep quality, posttraumatic stress, depression, and human errors in train drivers: a population-based nationwide study in South Korea. *Sleep* 37 (12), 1969–1975. <https://doi.org/10.5665/sleep.4252>.
- Jo, G.H., Lee, M.S., 2014. The relation of commercial motor vehicle driver's fatigue and traffic accident. *Korean Review of Crisis and Emergency Management* 10 (10), 1–14. Retrieved from <http://www.earticle.net/article.aspx?sn=233431>.
- Johns, M.W., 1991. A new method for measuring daytime sleepiness: the Epworth Sleepiness Scale. *Sleep* 14 (6), 540–545. <https://doi.org/10.1093/sleep/14.6.540>.
- Jung, S.J., Shin, H.S., Chung, W.Y., 2014. Driver fatigue and drowsiness monitoring system with embedded electrocardiogram sensor on steering wheel. *IET Intell. Transp. Syst.* 8 (1), 43–50. <https://doi.org/10.1049/iet-its.2012.0032>.
- Jung, S., Joo, S., Oh, C., 2017. Evaluating the effects of supplemental rest areas on freeway crashes caused by drowsy driving. *Accid. Anal. Prev.* 99, 356–363. <https://doi.org/10.1016/j.aap.2016.12.021>.
- Kim, E.Y., Hwang, S.Y., 2011. Incidence risk of cardiocerebrovascular disease, preventive knowledge, stage of change and health behavior among male bus drivers. *Korean Journal of Adult Nursing* 23 (4), 321–331. Retrieved from http://www.koreascience.or.kr/article/ArticleFullRecord.jsp?cn=SOKHBY_2011_v23n4_321.
- Kim, K.T., Jung, K.Y., 2016. Current status and proposal of drowsy driving. *Journal of Sleep Medicine* 13 (2), 35–39. <https://doi.org/10.13078/jsm.16007>.
- Kim, H.R., Yi, Y., Lee, K.J., Kim, H.G., 2014. The effect of emotional labor for job stress in bus drivers. *Korean Journal of Occupational Health Nursing* 23 (1), 20–27. <https://doi.org/10.5807/kjohn.2014.23.1.20>.
- Kim, K.B., Sung, H.H., Park, S.N., Kim, B.J., Park, C.E., 2015. Correlation between sleep disorders and sleepy drivers. *Korean Journal of Clinical Laboratory Science* 47 (4), 216–224. <https://doi.org/10.15324/kjcls.2015.47.4.216>.
- Kockum, S., Ortlund, R., Ekfjorden, A., Wells, P., 2017. Volvo Trucks Safety Report 2017. Retrieved from <https://www.volvotrucks.com/en-en/news/volvo-trucks-magazine/2018/sep/safety-report-2017.html> 19.04.29.
- Korea Traffic Accident Analysis System, 2016. Report on Traffic Accidents in Korea, 2015. Retrieved from http://taas.koroad.or.kr/web/bdm/srs/selectStaticReportsList.do?menuId=WEB_KMP_IDA_SRS_ORT 18.11.10.
- Korea Traffic Safety Authority, 2017. Report on Traffic Culture Index of Korea. 2017. Retrieved from <http://www.ts2020.kr/tsk/rck/InqDetPTRTrafficSafety.do?bbsSn=5402&bbsCd=110&ctgCd=-1> 18.11.14.
- Labor Standards Act, 2014. Retrieved from the Statutes of the Republic of Korea Website. https://elaw.klri.re.kr/eng_service/lawView.do?hseq=31900&lang=ENG 19.04.01.
- Lee, K.H., Hwang, H.W., 2012. A study on the legal proposal of crew's fatigue management in the aviation regulations. *The Korean Journal of Air & Space Law and Policy* 27 (1), 29–73. Retrieved from <http://www.papersearch.net/thesis/article.asp?key=3086057>.
- Lee, S.Y., Lee, S.C., 2010. A validation study and confirmatory factor analysis of the traffic accident risk index (TARI). *Korean Journal of Industrial and Organizational Psychology* 23 (1), 75–87. Retrieved from <http://www.dbpia.co.kr/Journal/ArticleDetail/NODE06370357>.
- Lee, W.Y., Oh, J.S., 2014. Report on Drowsy Driving: Causes and Preventive Strategies. Seoul: Korea ROAD Traffic Authority. Retrieved from <http://library.koroad.or.kr/skyblueOutsideimage/72855.pdf> 18.11.12.
- Lemke, M.K., Apostolopoulos, Y., Hege, A., Sönmez, S., Wideman, L., 2016. Understanding the role of sleep quality and sleep duration in commercial driving safety. *Accid. Anal. Prev.* 97, 79–86. <https://doi.org/10.1016/j.aap.2016.08.024>.
- Lemke, M.K., Hege, A., Apostolopoulos, Y., Wideman, L., Sönmez, S., 2017. Work and sleep among transport operators: disparities and implications for safety. *Journal of Transport & Health* 7, 298–309. <https://doi.org/10.1016/j.jth.2017.08.006>.
- Lim, S.M., Chia, S.E., 2015. The prevalence of fatigue and associated health and safety risk factors among taxi drivers in Singapore. *Singap. Med. J.* 56 (2), 92–97. <https://doi.org/10.11622/smedj.2014169>.
- Luckhaupt, S.E., Tak, S., Calvert, G.M., 2010. The prevalence of short sleep duration by industry and occupation in the National Health Interview Survey. *Sleep* 33 (2), 149–159. <https://doi.org/10.1093/sleep/33.2.149>.
- Lynn, M.R., 1986. Determination and quantification of content validity. *Nurs. Res.* 35 (6), 382–385. <https://doi.org/10.1097/00006199-198611000-00017>.
- Magnavita, N., Garbarino, S., 2017. Sleep, health and wellness at work: a scoping review. *Int. J. Environ. Res. Public Health* 14 (11), 1347. <https://doi.org/10.3390/ijerph14111347>.
- Meng, F., Li, S., Cao, L., Li, M., Peng, Q., Wang, C., Zhang, W., 2015. Driving fatigue in professional drivers: a survey of truck and taxi drivers. *Traffic Inj. Prev.* 16 (5), 474–483. <https://doi.org/10.1080/15389588.2014.973945>.
- Mitchell, M.D., Gehrman, P., Perlis, M., Umscheid, C.A., 2012. Comparative effectiveness of cognitive behavioral therapy for insomnia: a systematic review. *BMC Fam. Pract.* 13 (1), 1–11. <https://doi.org/10.1186/1471-2296-13-40>.
- Montgomery, P., Dennis, J., 2004. A systematic review of non-pharmacological therapies for sleep problems in later life. *Sleep Med. Rev.* 8 (1), 47–62. [https://doi.org/10.1016/S1087-0792\(03\)00026-1](https://doi.org/10.1016/S1087-0792(03)00026-1).
- Organization for Economic Cooperation and Development, 2018. *Road Accidents* (Indicator). <https://doi.org/10.1787/2fe1b899-en> 18.11.12.
- Park, K.O., Lee, M.S., Jung, S.H., Kim, I.S., Oh, Y.A., 2004. Development of a fatigue symptom checklist for commercial drivers: an experimental trial. *Korean Journal of Occupational and Environmental Medicine* 16 (3), 287–302. <http://www.dbpia.co.kr/Article/NODE01156256>.
- Sarris, J., Byrne, G.J., 2011. A systematic review of insomnia and complementary medicine. *Sleep Med. Rev.* 15 (2), 99–106. <https://doi.org/10.1016/j.smrv.2010.04.001>.
- Shattell, M., Apostolopoulos, Y., Collins, C., Sönmez, S., Fehrenbacher, C., 2012. Trucking organization and mental health disorders of truck drivers. *Issues Ment. Health Nurs.* 33 (7), 436–444. <https://doi.org/10.3109/01612840.2012.665156>.
- Sieber, W.K., Robinson, C.F., Birdsey, J., Chen, G.X., Hitchcock, E.M., Lincoln, J.E., et al., 2014. Obesity and other risk factors: the national survey of US long-haul truck driver health and injury. *Am. J. Ind. Med.* 57 (6), 615–626. <https://doi.org/10.1002/ajim.22293>.
- Song, H.H., Lee, S.C., 2011. Changes in traffic accident risk degree according to driving workload rate and moderate effect of ego-resilience. *Korean Journal of Industrial and Organizational Psychology* 23 (1), 29–50. Retrieved from <http://www.dbpia.co.kr/Journal/ArticleDetail/NODE06370388>.
- Summary of Hours of Service Regulations, 2017. Retrieved from the Federal Motor Carrier Safety Administration of the USA Website. <https://www.fmcsa.dot.gov/>

- [regulations/hours-service/summary-hours-service-regulations](#) 18.11.10.
- Ware, J.E., Kosinski, M., Keller, S.D., 1996. A 12-Item Short-Form Health Survey: construction of scales and preliminary tests of reliability and validity. *Med. Care* 34 (3), 220–233. Retrieved from. <http://www.jstor.org/stable/3766749>.
- World Health Organization, 2000. *The Asia-Pacific Perspective: Redefining Obesity and its Treatment*. Regional Office for the Western Pacific. Health Communications Australia, Sydney Retrieved from. <http://www.who.int/iris/handle/10665/206936> 18.11.10.
- World Health Organization, 2015. Health in 2015 from MDGs to SDGs. Geneva. Retrieved from. http://apps.who.int/iris/bitstream/10665/200009/1/9789241565110_eng.pdf?ua=1 18.11.10.
- Yang, P.Y., Ho, K.H., Chen, H.C., Chien, M.Y., 2012. Exercise training improves sleep quality in middle-aged and older adults with sleep problems: a systematic review. *J. Physiother.* 58 (3), 157–163. [https://doi.org/10.1016/S1836-9553\(12\)70106-6](https://doi.org/10.1016/S1836-9553(12)70106-6).
- Zhang, T., Chan, A.H., 2014. Sleepiness and the risk of road accidents for professional drivers: a systematic review and meta-analysis of retrospective studies. *Saf. Sci.* 70, 180–188. <https://doi.org/10.1016/j.ssci.2014.05.022>.
- Zhang, G., Yau, K.K., Zhang, X., Li, Y., 2016. Traffic accidents involving fatigue driving and their extent of casualties. *Accid. Anal. Prev.* 87, 34–42. <https://doi.org/10.1016/j.aap.2015.10.033>.