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ORIGINAL ARTICLE

PREVALENCE OF DRIVING FATIGUE AND ITS ASSOCIATED FACTORS AMONG LOGISTIC TRUCK DRIVERS IN MALAYSIA

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ABSTRACT

Fatigue is a very serious problem for transportation workers that contributes to various issues such as reduced alertness, slower reaction time, and deteriorating driving performance leading to road accidents. This study aimed to determine the prevalence of driving fatigue and its associated factors with individual, work-related, physiological changes in heart rate, and reduced alertness among logistics truck drivers in Malaysia. A cross-sectional study was conducted among 168 truck drivers employed in a logistics and transportation company in several locations including Klang Valley, Johor, and Penang. A self-administered questionnaire was used to obtain demographic and work-related information. The Swedish Occupational Fatigue Inventory (SOFI) and Karolinska Sleepiness Scale (KSS) were used to evaluate the fatigue and level of sleepiness of logistic truck drivers. A heart rate monitor and alertness impairment assessed psychological changes using psychomotor vigilance task (PVT). Measurements were assessed before and after work conditions for subjective sleepiness scale, changes in heart rate, and alertness reduction via PVT. The prevalence of occupational fatigue among logistic truck drivers was 42.9%. There was a strong association between occupational fatigue with age (β= -0.329, 95% CI: -0.644 to -0.013), job satisfaction (β= -0.381, 95% CI: -0.502 to -0.260) and the need for recovery after work (β= 0.172, 95% CI: 0.067 to 0.277) respectively. A significant difference was found in sleepiness levels before and after driving conditions (p<0.001, t=-12.96). However, no significant association was found between heart rate and occupational fatigue (p> 0.05). For PVT mean, the results showed that significant differences were found before and after working conditions (p=0.009, t=2.44). The combination of subjective and objective evaluation of fatigue was identified as the variables contributing to driving fatigue. Age, job satisfaction, and the need for recovery were the intrinsic variables that should be put into consideration in order to overcome the driving fatigue of logistic truck drivers.

Keywords: *occupational fatigue, truck drivers, risk factors, psychomotor vigilance task*

INTRODUCTION

Transport workers especially truck drivers are vulnerable to harmful work surrounding including driving accidents, ergonomic injuries, fatigue, stress, and violence. Fatigue is a significant issue that has been contributing to road crashes and fatalities in various transportation operations. Driving with fatigue resulted in decreased judgement ability, slow reaction, reduced performance for both simple and complex tasks, and loss of conscious awareness behind the wheel[1]. Each year in Malaysia, around 6,740 people are killed in road accidents. Despite the small number of heavy goods vehicles in terms of traffic volumes, more than a thousand die each year in Malaysia in accidents involving truck drivers[2]. Several studies have also been conducted in regards to occupational fatigue but only restricted to a few industries including manufacturing[3,4] and healthcare[5].

Additionally, fatigue among transportation drivers has been documented based on several parameters such as risk factors and health effects[6], physical fatigue[7], performances[8] and psychomotor vigilance[9].

Fatigue is defined as a state of being extremely tired, drained, or drowsy due to various factors including insufficient sleep, prolonged mental or physical work, or extended periods of stress or anxiety[10]. Fatigue can be classified as acute and chronic depending on its principal causes and long-term effect. Acute fatigue varies from discomfort, lowered strength, and reduced motor control, meanwhile, the long-term effect of fatigue is a commonly constant, severe state of tiredness that is not relieved by rest[11]. Fatigue usually reduced alertness on the road and the inability to maintain necessary concentration. This will deteriorate functions such as perceptiveness, concentration, speed of reaction, and stability of reaction. Fatigue also resulted in mood changes which further change emotional stability, increase anxiety, and reduced cognitive functions such as attention, vigilance, and stimuli response[12]. Past researchers have found evidence of a direct relationship between fatigue and human error and injuries. Taylor and Dorn, 2006[13], demonstrated that occupational vehicle drivers were vulnerable to road accidents and driving fatigue accounted for 20% of total road accidents.

Driving fatigue can be grouped into two categories based on the distance travel which was short-haul and long-haul distance. Short-haul distance working primarily during the day, driving in an urban area, and usually driving between 150 and 250 miles (400 km and less) for one delivery. They usually operate with smaller vehicles which enable them to move easily on a city road. Short-haul drivers make multiple stops and required skillful driving on the city roads with narrow laneways and sharp turns and their risk is minimal. They normally spent 30% of the work shift in the warehouse or principal terminal, 30% of the time driving, and the remaining 40% on the customers' premises. The main tasks that short-haul truckers involved included loading and unloading goods at the warehouse and various client locations and driving on the road[14]. In contrast, long-haul truck requires larger vehicle size as they travel long distances and carry huge loads and goods. They usually drive more than 250 (400 km and more) miles and reported working long hours including at night and on weekends. Fatigue is more severe in this group as they have a high intensity of workload and stressful tasks to meet the customer's orders and deadlines. However, it is unclear how similar their experiences are in terms of scope and type affected by fatigue.

There are two types of work activity includes distribution and haulage truck drivers. Distribution working activity duty usually delivered the goods to multiple locations such as the building of wholesalers and retailers. Besides, haulage truckers involved in the job description cover the area including port, customer premises, and car vehicle transport. Distribution of heavy goods vehicles usually weighs between 1 to 5 tons as compared to heavier haulage truckers that may weigh up to 30 tons. The truck drivers are involved in three main work phases as part of their daily operations task, which is loading and unloading at the warehouse, driving, and loading and unloading at a client's premises. Figure 1 illustrates the example of a truck operated by drivers.

Numerous influences contribute to the risk factors of driving fatigue. Long working hours, sleep disruption, work stress and job dissatisfaction contributed to increasing fatigue levels[15]. In Finnish trailer-truck drivers, fatigue is linked to work-related and driver-related factors, and professional drivers who are unable to choose the time of their rest break were more likely to involve in a road accident[16]. Factors related to fatigue among Indonesian truck drivers include duration of driving hour and nighttime working condition[17,18]. In South Africa, illegal long working hours and sleep disruption were among the main factors of driver fatigue[19]. Occupational drivers in Korea with high perceived fatigue, categorized as excessive daytime sleepiness and poor mental health were more likely to involve in traffic accidents[20]. In addition, the study by Mahajan and colleagues[21] among 453 long-haul truck drivers in India revealed that long working hours, less sleep, and night-time driving were among the factors that triggered fatigue and lead to violations.

(a) (b)

Figure 1: The Size of the Truck. Figure (a) is the example of a 3-tonne truck while figure (b) is the example of a 28-tonne truck dimension

The physiological measure of physical and mental fatigue is being successfully used in driving-related human factors research which is heart rate[18,22]. Measurement of heart rate can provide converging evidence for the development of fatigue.

Under normal conditions, heart rate has been found to reduce fatigue and further extended driving hours. As such, this study will incorporate the assessment of physiological changes in heart rate as an indicator of driving fatigue. The psychomotor vigilance task (PVT) has been used widely to assess sustained attention and response to stimuli as a measure of vigilance[9,17]. Increasing the values of PVT mean and PVT lapses are the signs of reduced vigilance and sleep deprivation[23].

The main concern of truck drivers in Malaysia is the accidents that are caused by human error rather than faulty vehicles or road conditions. Considering fatigue can lead to loss of drivers' and other users' health or life[24], decreased level of alertness and vigilance[17], and reduced performance[25], therefore, the study aimed to determine the prevalence of fatigue and examine the causal factors of driving fatigue involving logistic truck drivers in several parts such as demographic factors, work-related factors, and physiological changes in heart rate and psychomotor vigilance task (PVT) on the truck drivers.

METHODS

Participants

This cross-sectional study was conducted from April to October 2021 among 168 logistic truck drivers involved in heavy goods vehicle (HGV) modes of transport in several locations in Peninsular Malaysia. The participants were selected through purposive sampling that meet the inclusion and exclusion criteria. Truck drivers who were aged over 20 years old, poses valid goods driving license (GDL) drove heavy goods vehicles (HGV) as part of their work, at least 6 months of driving experience were included in this study. The drivers with the presence of chronic illness and diagnosed with a sleep-related disorder based on self-reported information were excluded[26].

Procedures

The drivers were screened to fulfill the inclusion and exclusion criteria. The demographic, and work-related factors such as age, employment history, and driving duration, were obtained using a questionnaire. Then, the drivers completed the self-reported fatigue, sleepiness scale rating, and heart rate measurement before and after driving work conditions.

Instruments

Firstly, participants were required to complete a set of the questionnaire about demographic characteristics, work-related characteristics, physiological changes in heart rate, fatigue, and sleepiness information. Fatigue was assessed using Swedish Occupational Fatigue Inventory (SOFI) questionnaire[27]. SOFI has five dimensions and 20 items which encompass lack of energy, physical exertion, physical discomfort, lack of motivation, and sleepiness. Rating of SOFI was measured based on a 7-point Likert scale ranging between 0 which denotes not at all and 6 which represents a very high degree. The total score ranged from 0 to 120, and the higher score indicates greater severity of fatigue. Many studies have reported that SOFI has excellent psychometric properties in occupational and transport drivers[28,29].

The subjective assessment of Karolinska Sleepiness Scale (KSS) was used to measure sleepiness level[30]. KSS consists of a nine-point scale ranging from 1 to 9 in which scale-1 denotes extremely alert and scale-9 interprets being extremely sleepy at a maximal level. Participants were asked to perform KSS self-evaluation twice in different conditions which were once at the beginning of the shift before the driving trip and once at the end of the shift after the driving trip monitored by the researchers. The Need for Recovery (NFR) scale was used to evaluate work-related fatigue symptoms such as burnout and induced when drivers lack time to recover during periods of work. It contains 11 dichotomous items and respondents were asked to answer at the end of their work shift[31]. Changes in the heart rate during driving were monitored among the participants. The drivers completed measurements of heart rate before and after the driving trip. Heart rate was monitored using Fitbit Charge 4 to collect heart rate per minute (bpm). Psychomotor Vigilance Task (PVT) was used to measure the alertness and vigilance reduced before and after driving conditions.

Data were analyzed using SPSS, version 25.0. Data is presented using a frequency distribution table as mean and standard deviation, where appropriate. Bivariate analysis was performed using Independent t-test, one-way ANOVA, and Pearson correlation to calculate the correlation between predictor variables and occupational fatigue, and we then calculated multiple regressions using the stepwise options. The pre-test was conducted before the actual data collection with 10% of the estimated studied population (n=16). The result of internal consistency showed good reliability with the value of Cronbach's alpha being 0.787. Ethical approval was obtained from the Ethics Committee for Research of Universiti Putra Malaysia with the reference number JKEUPM-2020-346 dated on 23rd December 2020. An informed consent form was obtained from all participating truck drivers and was assured of total anonymity. Participation in this study was voluntary and the interview session was conducted privately without interference from the management.

RESULTS

Demographic and work-related characteristics

Table 1 provides the demographic information and work-related characteristics of truck drivers. Considering male is dominant and overrepresentation in the transport and occupational drivers, 98.8% of them were males and 1.4% were females. The mean age of the drivers was 36.37 (SD=9.53) years of age, ranging between 23 and 64. Truck drivers had a mean body mass index (BMI) of 26.87 (SD=5.91) and it is estimated at 28% (n=47) indicating obesity (BMI ≥ 30) and risk for sleep disorders. The final database included the distribution drivers (n=77) and haulage drivers (n=91). The average sleeping hours every day is 6.42 (SD=1.38), which interprets more than 50% of the respondents have slept between 6 and 7 hours per day. The smoking rate of truck drivers was 62.5% which is much higher than the general adult population in Malaysia who smoke which is 22.8%[32] and most of the drivers 73.8% had their physical activity at least once a week.

Majority of the drivers worked 6 days per week with one day off. Most of the drivers reported (73.2%) that they had between 1 to 4 years of experience driving HGV. Most of the drivers (90.5%) worked between 4 to 12 hours per day, and the remaining (9.5%) worked greater than 12 hours as they travelled across the state for a long-distance trip. The average driving distance per day of the drivers was 275.01km (215.16), meanwhile, 47.6% of the truck drivers drove a truck weight between 1 and 5 tonnes and 52.4% drove a truck between 6 to 40 tonnes. Almost half of the drivers (46%) worked in distribution units and haulage (54%). During their journey, 44% (n=77) of the drivers at least stopped once for a rest break, followed by 33% (n=57) who stopped twice during a trip and 22% had regular breaks more than 2 times in driving duration per day. In terms of work stress, almost 43% reported having work stress while working and it is reported only a small percentage had an accident in 3 years (15%). The mean for job satisfaction is 145 (SD=24.97).

Table 1a: Demographic and Work-Related Characteristics of the Truck Drivers (N=168)

Variables	Frequency (%)	Mean (SD)
Gender		
Male	166 (98.8)	
Female	2 (1.2)	
Age (years)		
20 – 35	92 (54.8)	36.37 (9.53)
≥ 36	76 (45.2)	
Body mass index (BMI)		
<25	65 (38.7)	26.87 (5.91)
25 – 29.9	56 (33.3)	
≥ 30	47 (28)	
Average sleep per day (hours)		
≤ 5	36 (21.4)	6.42 (1.38)
6 – 7	99 (58.9)	
≥ 8	33 (19.6)	
Smoking		
Yes	105 (62.5)	
No	63 (37.5)	
Regular exercise		
Yes	124 (73.80)	
No	44 (26.2)	
Driving experience (years)		
1 – 4	123 (73.2)	4.13 (4.19)
5 – 9	25 (14.9)	
≥ 10	20 (11.9)	
Working duration (hours)		
< 12	152 (90.5)	9.60 (3.0)
≥ 12	16 (9.5)	
Average driving distance per day (km)		275.01 (215.16)
Size of truck		
1- 5 tonne	80 (47.6)	
6 – 40 tonne	88 (52.4)	
Work activity		
Distribution	77 (45.8)	
Haulage	91 (54.2)	

Table 1b: Demographic and Work-Related Characteristics of the Truck Drivers (N=168)

Frequency of rest break		
Once	74 (44.0)	
Twice	57 (33.9)	
≥ 3	37 (22.1)	
Work stress	72 (42.9)	
Yes	96 (57.1)	
No		
Accident history in 3 years		
Yes	26 (15.5)	
No	142 (84.5)	
Job satisfaction score		145.02 (24.97)
Need for Recovery (NFR) scale		53.45 (28.14)

KSS, Heart Rate, and Psychomotor Vigilance Task (PVT) (Mean and Lapse)
Table 2 shows the mean, standard deviation (SD), and ranges of the KSS sleepiness level, heart rate, and PVT (mean and lapse) of the respondents. Based on the result, The mean (SD) of the KSS before starting the work was 3.08 (1.37) and increase slightly at the end of the work condition to 4.66 (1.48). It was reported that 10% (n=17) of the respondents had a KSS level ≥ 7. The mean (SD) heart rate before work was 83.87 (9.48) and 84.52 (8.85) after work condition. The heart rate ranges from 60 to 110 bpm. The mean and SD of PVT mean were 517.71 (90.16) and after work condition was 504.57 (81.30). The range values of PVT mean between 368 to 776. In another, the mean (SD) of PVT lapse before starting the shift was 34.35 (24.30) and 32.40 (23.00) after the end of a work shift. The range values of PVT lapse between 2 to 87.

Table 2: KSS, Heart Rate, and Psychomotor Vigilance Task (PVT) Values of the Truck Drivers (n=168)

Variables		Mean (SD)	[Range]
KSS	Before shift	3.08 (1.37)	[1 - 6]
	After shift	4.66 (1.48)	[1 - 9]
Heart Rate	Before shift	83.87 (9.48)	[60 - 110]
	After shift	84.52 (8.85)	[60 - 105]
PVT mean	Before shift	517.71 (90.16)	[368.74 - 776.48]
	After shift	504.57 (81.30)	[353.25 - 779.31]
PVT Lapse	Before shift	34.35 (24.30)	[2 - 85]
	After shift	32.40 (23.00)	[2 - 87]

Swedish Occupational Fatigue Inventory (SOFI)
Table 3 shows the mean and standard deviation of the fatigue dimensions consisting of lack of energy, physical exertion, physical discomfort, lack of motivation, and sleepiness scores before and after the trips. The mean and SD of occupational fatigue was 45.13 (22.57) while the range in between 0 to 100.

Comparisons of KSS, heart rate, and PVT (mean and lapse) before and after driving condition
The mean and standard deviation (SD) values of sleepiness level, heart rate, PVT mean, and PVT lapse (before and after) driving condition were shown in Table 4. The statistical test results showed that there was a significant association between sleepiness levels before and after the driving condition ($p<0.001$, $t= -12.96$). In addition, the result of heart rate shows that there was no significant difference between heart rate values before and after the driving trip ($p=0.458$, $t=-0.74$). Meanwhile, the result of PVT means showed a significant association before and after driving conditions ($p=0.009$, $t=2.44$), meanwhile, PVT lapse illustrates there is no statistical significance before and after driving conditions ($p=0.108$).

Associated Factors of Occupational Fatigue
Table 5 reports the Multiple Linear Analysis of occupational fatigue with associated factors. Based on the Simple Linear analysis, it was found that driving experience (years), working duration (hours), work stress, accident history in three years, age (years), job satisfaction score (JSS), and need for recovery (NFR) after work were

eligible to enter the linear regression model. The model had an R^2 of 0.532 and an adjusted R^2 of 0.283. Young drivers had higher occupational fatigue as compared to senior drivers (□= -0.329, 95% CI -0.644 to -0.013, *p*=0.041). Drivers who had lower job satisfaction were more susceptible to fatigue (β = -0.381, 95% CI:-0.502 to -0.260, *p*=<0.001). Participants who obtained a higher need for recovery (NFR) scale were reported to have higher occupational fatigue (β= 0.172, 95% CI 0.067 to 0.277, *p*=0.002). Age was found inversely related to fatigue, as an increase in the age of the truck drivers, the risk of experiencing driving fatigue was reduced. A similar result was found with job satisfaction which is, the higher the score of job satisfaction, the lower the risk of the truck drivers being fatigued. However, in terms of NFR, the higher NFR, the higher the risk of occupational fatigue among them. The prediction model of the Occupational Fatigue score is Occupational fatigue (score) = 103.141 - [0.329 * age] – [0.381 * job satisfaction score] + [0.172 * NFR scale (Equation 1).

The summary of the results showed that every one-unit increase in age will significantly decrease the occupational fatigue score by 0.329 units. Every one-unit increase in job satisfaction score will significantly reduce the occupational fatigue score by 0.381 unit and every one-unit increase in the NFR will significantly increase the occupational fatigue score by 0.172.

Table 3: Mean, Standard Deviation, and Ranges of SOFI Dimensions of the Truck Drivers (N=168)

Dimensions	Mean	SD	Minimum	Maximum
Lack of energy	3.01	1.30	0	6
Physical exertion	2.43	1.31	0	6
Physical discomfort	2.00	1.46	0	6
Lack of motivation	1.81	1.32	0	5
Sleepiness	2.03	1.34	0	5
Occupational fatigue	45.13	22.57	0	100

Table 4: The Comparisons of KSS, Heart Rate, and PVT (mean and lapse) Before and After Driving Condition

Variables	Before driving (Mean, SD)	After driving (Mean, SD)	*t-statistics*	*P-value*
KSS	3.08 (1.35)	4.66 (1.48)	-12.96	0.001**
Heart rate	83.76 (9.65)	84.68 (8.85)	-0.74	0.458
PVT mean	516.85 (89.0)	504.57 (81.30)	2.44	0.009*
PVT lapse	34.35 (24.3)	32.40 (23.0)	1.62	0.108

** significant at p<0.05*
*** significant at p<0.001*

Table 5a: Associated Factors of Occupational Fatigue among Logistic Truck Drivers

Variables	SLR[a]		MLR[b]		
	b(95% CI)	p-value	Adjusted β (95% CI)	*t* statistics	p-value
Driving experience (years)	-0.533 (-1.355, 0.289)	0.202	-	-	-
Working duration (hours)	-0.303 (-1.455, 0.848)	0.604	-	-	-
Work stress	9.712 (2.904, 16.520)	0.005*	-	-	-
Accident History in 3 years	11.445 (2.103, 20.788)	0.017*			

Table 5b: Associated Factors of Occupational Fatigue among Logistic Truck Drivers

Age (years)	0.548 (-0.902, -0.195)	0.003*	-0.329 (-0.644, -0.013)	-2.056	0.041*
Job satisfaction score	-0.423 (-0.545, -0.300)	<0.001**	-0.381 (-0.502, -0.260)	-6.221	<0.001**
NFR scale	0.204 (0.085, 0.323)	0.001*	0.172 (0.067, 0.277)	3.227	0.002*

ᵃ Simple Linear Regression, ᵇ Multiple Linear Regression
R^2 = 0.283. The model reasonably fits well.
** significant at p<0.05*
*** significant at p<0.001*

DISCUSSION

This study found that nearly half of the truck drivers (42.9%) were found to be fatigued while driving. Similarly, Phatrabuddha[33] reported that 43.4% of the transport drivers were fatigued based on subjective and objective assessments. Besides, Meng[34] and Pertulla[16] reported a lower prevalence of fatigue while driving among truck drivers with 38.0% and 27.8% respectively. Approximately 89% of professional drivers in Poland declared fatigue at work[35]. Work stress was found to be statistically significant with occupational fatigue in the simple linear analysis. Increased work stress would increase the risk of occupational fatigue. Work stress originally comes from task-related features such as time pressure, traffic congestion, shift pattern, or social pattern which led to psychophysiological stress. The typical stressors among professional drivers include working overtime and working shifts as it increases the risk of traffic accidents, aggressive driving, back pain as well as fatigue[36].

Work stress is associated with risky driving behaviours that can lead to errors and violations. Fatigue is associated with risky driving and can cause a greater incidence of occupational disease for example cardiovascular disorders and musculoskeletal systems another health-related problem[37]. Accident history showed a significant relationship with occupational fatigue level. Increasing the accident history would increase the risk of occupational fatigue among truck drivers. According to Abidin and colleagues[38], despite the crashes involving trucks and lorries which showed a steady decrease over the six years (2006 to 2011), when compared with a private vehicle, crashes involving lorries were two times higher. In addition, approximately 15% of commercial vehicles accident was caused by driver fatigue and falling asleep. The occurrence of crashes and accidents is usually associated with the number of breaks taken and the duration of the breaks. The high frequency of breaks taken during a shift reduced the odds ratio of crash[39].

The result showed a significant negative relationship between age and occupational fatigue score. This indicates that young age was related to the high level of occupational fatigue. Young and less experienced truck drivers were more likely to experience fatigue and involve in fatigue crashes[24]. Another possible reason is that young drivers were likely to work more than senior drivers to generate more income especially overtime as documented almost 43% of drivers aged between 20 to 39 worked over 8 hours per day. It was reported that younger drivers between 18 and 29 years old were more likely to have a higher accident rate due to a lack of driving experience[40]. According to Hajducik[41], the professional drivers aged between 26-35 and 36-50 were grouped into the riskiest and most irresponsible drivers in terms of attitude. They are vulnerable to the highest workload and family responsibility for working life, childcare, and other family and related issues. Age and work characteristics were among the factors that contribute to excessive sleepiness and poor sleep quality. The increasing age reduced the risk of excessive sleepiness and decreased the risk of accidents[42,43]. Another significant characteristic to observe is driving for long hours and inadequate sleep before the shifts would increase the risk of occupational fatigue. A study by Gander[44] revealed that fatigue was identified as a factor in 5.1% of truck crashes in New Zealand. The accident occurred involved the physiological risk factors of fatigue including being awake for more than 12 hours, sleeping less than 6 hours in a day, and the time of crash which usually takes place between midnight and early morning.

The result of the present study showed that working duration was not statistically significant with occupational fatigue. These are somewhat unexpected findings as working hours usually influence the fatigue of the drivers. One of the reasons is the drivers take a high number of breaks and rest in between their trips. This would allow them to have better work trips and reduce the feeling of fatigue. It is noted that working longer than 12 hours contributed to risky driving[20]. In contrast, other researchers stated that increasing the driving duration (3 to 4 hours) was found to degrade the performances that affect several cognitive functions such as attention, reactions, operating ability, and perception[17]. A longer working hour with insufficient breaks results in drowsy drivers and increases the chances of fatigue-related crashes. However, this study, clearly showed that working hours were not contributed to fatigue and might be attributed to the good adaptation of the drivers to the nature of the job. Concerning the driving experience, this study showed no significant association with occupational fatigue. This result was in line with a study of professional drivers in Poland which concluded that the feeling of fatigue was rarely determined by job seniority[35]. Senior professional drivers who worked longest in the organization constitute the lowest percentage of fatigue symptoms ($p<0.05$).

There was a significant mean difference in the sleepiness scale before and after working conditions ($p<0.05$). The significant increases in the sleepiness level after a driving trip due to many reasons including less alertness, long-distance travel, monotonous or highway road, or night-time driving[45]. Further analysis showed that young truck drivers aged between 20 and 35 presented a significant increase in sleepiness level after the working duration in contrast to senior drivers aged 36 or more. Young drivers were more susceptible to sleepiness and performed decreased alertness which increased the risk of road crashes[46]. Approximately, 21.5% of drivers had a daily sleep of fewer than 6 hours, which is considered sufficient to fully function for the next working day. Moreover, 10% of the truck drivers experienced severe sleep disruption after working conditions (KSS $\geq$ 7) which is considered low. No significant difference in heart rate was also found before and after the shift work. It concludes that heart rate was less sensitive to fatigue. Heart rate variability was found to be more effective and showed a good result for sleepiness and fatigue detection[47,48]. There was a significant increase in alertness after working conditions ($p<0.05$). The result indicates that there was no alertness reduced after the working duration. A study by Iridiastadi[17] among commercial drivers in Indonesia reported that the reaction time of PVT parameters was not statistically significant with fatigue. According to Baulk[49], the PVT measure is not sensitive in assessing fatigue during the work day since it measures only a minimal decrease in performance.

The multivariate analysis confirmed that age, job satisfaction, and the need for recovery (NFR) scale could have influenced occupational fatigue among truck drivers. This study found a strong interaction between job satisfaction and occupational fatigue in a such way that drivers who had lower job satisfaction scores had higher occupational fatigue. The criteria that cover job satisfaction include pay, promotion, supervision, benefits, coworkers, nature of work, and communication[50]. This finding confirms another study that showed job satisfaction gave an impact on driver retention since they work for long hours, have difficult working conditions, lack of pay, and tight schedule[51]. Results also showed that the need for recovery (NFR) scale was significantly associated with occupational fatigue ($p<0.05$). The current study reported that truck drivers were in high need of recovery as they insufficiently recuperated at the end of the work shift and start the next working day with a residual need for recovery. The need for recovery is the result of task-specific effort which has become troublesome to the point that workers were no longer adequate to respond to the demand imposed by the task. NFR was found to be a suitable instrument to quantify the difficulties workers experience in recovering from work due to fatigue-inducing changes for example increasing working hours[31]. Samadi[52] suggests that reducing workload, proper work-rest schedules, and providing conditions for enough recovery after works were the solutions to recover from fatigue after work.

Study limitation

A cross-sectional study design was employed and thus, it does not reflect a deep understanding of the overall causality of factors. In addition, the small sample size in this study does not represent the whole transport and logistics sectors in Malaysia. For future research, it would be interesting to incorporate the laboratory simulation of driving tasks to investigate fatigue especially to test the effect of types of roads on fatigue for example, monotonous and traffic roads. Therefore for future studies, more focus should be on fatigue-related crashes and the effect of fatigue on productivity.

CONCLUSION

In general, the prevalence of fatigue in the current study was 42.9% and the results suggest that fatigue in logistics truck drivers was significantly associated with age, job satisfaction, and the need for recovery after work. Young drivers with the least experience indicated a high occupational fatigue level than senior drivers, meanwhile, drivers with low job satisfaction scores present high occupational fatigue. Drivers who have a high score of NFR after work will no longer be physically or mentally able to perform a task were found to be associated with occupational fatigue. Therefore, in order to prevent the occurrence of driver fatigue, it is relevant to ensure better working conditions for example adequate breaks between trips, sufficient rest before the next working day, and adherence to law and enforcement.

Conflict of interests
The authors declare no potential conflict of interest.

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