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Level of fatigue and daytime sleepiness among heavy vehicle drivers in Sri Lanka

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Abstract

Heavy vehicle crash rates are high in Sri Lanka. International studies showed that fatigue and day time sleepiness are linked to heavy vehicle crashes. The aim of this study is to examine the level of fatigue, day time sleepiness and their associated factors among heavy vehicle drivers in Sri Lanka. A descriptive cross-sectional study was carried out in 403 heavy vehicle drivers through an interviewer administered structured questionnaire consisting of the 'Fatigue Severity Scale' (FFS) and the 'Epworth Sleepiness Scale' (ESS). The mean age of the study sample was 36.5±8.6 years and all were males. They drive an average of 129.03±87.24 km/day. It was found that the mean FFS score in the study participants was 2.43±0.99 and the mean ESS score was 6.57±4.07. Prevalence of fatigue (FSS score ≥4) was 8.7% (n=35) and the prevalence of excessive day time sleepiness (EDS) (ESS score >10) was 14.4% (n=58). Working for non-fixed schedule, married marital status, and working more than 11 hours/day are found to be significant risk factors for being fatigue. Drivers who were having night sleep of less than 6 hours were found to have a higher risk of EDS. A high prevalence of fatigue (8.7%) and EDS (14.4%) among heavy vehicle drivers was found which may link to heavy vehicle crashes. The occupational health service providers should be aware of the possibility of fatigue and daytime sleepiness in heavy vehicle drivers and its overall risk on the roads to take necessary actions.

Keywords: Fatigue, Excessive daytime sleepiness, Heavy vehicle drivers, Road traffic accidents, Sri Lanka.

Introduction

At present nearly 6 people die and 50 people get injured daily, from road traffic crashes in Sri Lanka.[1] Compared to the crash rate of non-heavy vehicles, a higher rate was noted among heavy vehicles in Sri Lanka during last few years.[2] Reasons for this difference in Sri Lanka were not studied. As reported by Gunawardane *et al*.[1] Lorries and Private buses accounted for the highest proportions (48% and 34% respectively) of heavy vehicle crashes in Sri Lanka. In another study done by Kumarage *et al.*[3] a significant proportion of fatal road traffic crashes in Sri Lanka were associated with the fatigued condition of the driver.

Fatigue and sleepiness were found to be major contributing factors for heavy vehicle accidents in several studies conducted in other countries. In a survey done in United States it showed that 58% of road accidents in which only one heavy vehicle was involved, was linked to fatigue, in nearly 18% of cases the driver admitted that he had fallen asleep.[4] Another survey done among 960 Australian drivers, 77.5% rated fatigue as at least a substantial problem and 50.6% reported feeling fatigue on their last trip.[5] In similar US survey among long distance truck drivers, 47% had fallen asleep at the wheel at some time.[6]

As stated by Dobbie[7] even though the phenomenon of fatigue is heavily researched it does not have a universally accepted definition. Grandjean[8] defines fatigue as 'a gradual and cumulative process associated with a loss of efficacy and a disinclination for any kind of effort'. According Hossain *et al*.[9] fatigue is 'a state in which one's capacity or efficacy for work is reduced following physical and mental effort, it does not

Practice Points

- Fatigue and sleepiness are found to be among the major contributing factors for heavy vehicle accidents in many countries.
- Prevalence of fatigue was 8.7% and the prevalence of excessive daytime sleepiness (EDS) was 14.4% among Sri Lankan heavy vehicle drivers.
- Working a non-fixed schedule, marital status, and working more than 11 hours per day are found to be significant risk factors for fatigue.
- Drivers who were having night sleep of less than 6 hours were found to have a higher risk of EDS.
- Further studies focusing on fatigue and sleep disorders in heavy vehicle drivers should be conducted and occupational health service providers should be aware of the possibility of fatigue and daytime sleepiness in heavy vehicle drivers and its overall risk on the roads for necessary action.

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necessarily imply the irresistible desire for or tendency to fall asleep'.

When one considers "sleepiness", it signals the likelihood of falling asleep and it is defined as 'a difficulty in remaining awake'.[10] Whereas daytime sleepiness has been defined by Johns and Hocking[11] as 'the sense of the propensity to doze or fall asleep when intending to remain awake'.

Several independent studies have showed poor correlation between subjective fatigue and sleepiness scores, providing support for the concept of fatigue and sleepiness as two distinct and independent phenomena.[12,13]

According to Jackson and others,[10] when drivers are fatigued or sleepy, vigilance and alertness deteriorate, resulting in adverse changes in driving performance, including increased line crossing and poor speed control. As found by the same authors, commercial vehicle drivers have a higher risk of sleep-related crashes.

So the aim of this study is to describe the level of fatigue, daytime sleepiness and their associated factors, among heavy vehicle drivers attending the National Transport Medical Institute, Kandy, Sri Lanka.

Materials and Methods

A descriptive cross-sectional study was carried out among heavy vehicle drivers attending the National Transport Medical Institute, Kandy for the renewal of heavy vehicle driving licenses. A total of 403 heavy vehicle drivers were included in the study through non-random sequential sampling technique. Interviewer administered close-ended pre-coded questionnaire was used for data collection. This questionnaire consisted of two parts; part one included questions on the drivers' age, their years of professional driving experience, their types of employment, vehicle types driven, average workday lengths, average driving distances, driving during risk hours, and questions on the degree to which driver fatigue was perceived as a hazard to road safety. Part two consisted of Fatigue Severity Scale (FSS)[13] and Epworth Sleepiness Scale (ESS),[17] which were used to measure the level of fatigue and level of daytime sleepiness among the study participants. Prevalence of fatigue and Excessive Daytime Sleepiness (EDS), between groups were compared and tested for statistical significance by chi-square test and Fisher's exact test and correlations were tested by Spearman's rank correlation coefficient. A 'p' value of less than 0.05 was considered as statistically significant. Data was analysed with SPSS 17 statistical software. Ethical clearance for the study was obtained by the Ethics Review Committee of the Faculty of Medicine Colombo.

Fatigue Severity Scale (FFS)
The FSS is a self-administered questionnaire with 9 items. Those items investigate the level of fatigue in different situations during the past week.[14] 'The FSS emphasizes functional impact of fatigue and contains items on physical, mental and social aspects, although these are not divided in explicit domains. Items are brief and easily understandable statements related to fatigue. These are rated on a seven-grade Likert scale. Grading of each item ranges from 1 to 7, where 1 indicates strong disagreement and 7 strong agreements, and the final score represents the mean value of the 9 items. The total FSS score represents the mean score of each of the nine items, yielding a score range between 1 and 7, higher scores indicating a higher level of fatigue'.[15] An average score of 4 or more was considered as fatigue.[14-16] Developers of this tool, Krupp *et al*.[17] believe that FSS is an 'useful in the evaluation of fatigue in both clinical research studies and surveys. Its brevity and simple self-report format make it a cost-effective alternative to more elaborate methods'. Even though this tool has not been used in earlier studies on drivers this has been used to measure the level of fatigue level among shift workers[9] and also to measure fatigue level among women.[14] Taylor *et al*.[18] also stated that FSS is an 'appropriate and useful measures of fatigue-related symptomatology and disability within a general population of individuals with varying levels of fatigue'.

The Epworth Sleepiness Scale (ESS)
The Epworth Sleepiness Scale is a brief, self-administered questionnaire with 8 questions which refers to the usual way of life in recent times of a person. 'It provides a measure of a person's general level of daytime sleepiness, or their average sleep propensity in daily life. The ESS asks people to rate, on a 4-point scale (0-3), their usual chances of dozing off or falling asleep in 8 different situations or activities that most people engage in as part of their daily lives, although not necessarily every day'.[19] 'The total ESS score is the sum of 8 item-scores and can range between 0 and 24.The higher the score, the higher the person's level of daytime sleepiness'.[19] A total score of more than 10 out of 24 may indicate Excessive Daytime Sleepiness, and may be indicative of a sleep disorder.[20]

Results

To obtain the required sample size, data collectors were conducted interviews and 403 questionnaires were completed.The mean age of study participants was 36.51 (SD=8.61) years ranging from 23 years to 77 years of age and All participants of this study were males. The mean BMI was 22.91 Kg/m^2, which ranged from 16.30 to 38.75 Kg/m^2 and 29% of participants were either overweight or obese. Proportion of drivers who were having <5 years driving experience was 23.6% (n=95). Socio-demographic work characteristics of the respondents are shown in Table 1.

The mean FSS score was 2.43 (SD=0.99) which ranged from 1.0 to 6.11. As shown in Table 2 only 8.7% (n=35) of drivers had average FSS score of 4 or more, indicative of fatigue. Mean ESS Score was 6.57$\pm$4.07 with a range of 0 to 19. According to the ESS Scores obtained by heavy vehicle drivers in the study, 14.4% (n=58) had scores higher than 10, indicating Excessive

Table 1: Socio-demographic details of the respondents

Variables	Frequency (%)	Mean±SD
Age (years)		36.5±8.61
<35	184 (45.7%)	
35-64	215 (53.3%)	
>64	4 (1.0%)	
Marital status		
Married	384 (82.9%)	
Single	67 (0.5%)	
Separated	2 (0.5%)	
Body mass index		
<18.5	0	
18.5 - <25	286 (71.0%)	
25-29.9	97 (24.1%)	
>30	20 (5.0%)	
Chronic medical conditions (self-reported)	6 (1.5%)	
Heavy vehicle driving experience		10.1±9.11
<5	95 (23.6%)	
5-9	111 (27.5%)	
10-14	101(25.1%)	
>15	96 (23.8%)	
Working hours per day		9.3±2.25
Hours of driving per day		4.6±2.1
Hours of continuous driving		
<2	304 (75.4%)	
2-4.5	86 (21.4%)	
>4.5	13 (3.2%)	
Working days per week		5.6± 1.2
7 days	115 (28.5%)	
Driving distance		129.3±87.2
Driving to a fixed schedule (Yes)	161(40%)	

Daytime Sleepiness.

Associated factors of fatigue and daytime sleepiness among study population

Table 2 shows the prevalence rates of EDS and Fatigue for some of risk factors analysed. Chi squared test was used to compare differences between prevalence rates. According to univariate analysis, working more than 11 hours per day and not working for fixed schedule were risk factors for fatigue, but only night sleep less than 6 hours was associated with the EDS out of the factors studied.

Independent risk factors for EDS and fatigue as determined from the multiple logistic regression analysis are listed in Table 3. The strongest risk factor identified for fatigue was working for non-fixed schedule. Marital status (married) and working more than 11 hours per day also proved to be significant risk factors for fatigue. None of the risk factors become significant in multivariate analysis for EDS.

Associations between FSS and ESS Scores

Spearman's rho correlational coefficient, between FSS Scores and ESS Scores of heavy vehicle drivers in this study was 0.240 (p-0.001), indicating a statistically significant weak association.

Perception of drivers on driver fatigue

To assess the perception of drivers on driver fatigue as a hazard to road safety three questions were asked. As shown in Table 4, drivers who stated that tiredness or fatigue as a problem for themselves always or often while driving had a higher prevalence of EDS than drivers who rated as sometimes, rarely or never.

Discussion

The aim of this study was to describe the level of fatigue, daytime sleepiness and their associated factors among heavy vehicle drivers attending NTMI-Kandy. According to the findings considerable proportion of heavy vehicle drivers were found to be suffering from of the fatigue and excessive daytime sleepiness (8.7% and 14.4% respectively).

Fatigue severity scale was used to measure the level of fatigue in this study. In several studies[15, 16] a mean FSS score of 4 or more was used to define fatigue. So in this study we also defined drivers as having fatigue if their mean FSS score was 4 or more. The time frame covering by FSS was not clearly mentioned in the original article[17] but National Women's Health Resource Center[14], use it as one week with the permission of the principal author (Prof. Lauren B Krupp). Same time

Table 2: Prevalence of fatigue and EDS within risk factor groups on univariate analysis

Risk factors	Respondents	Prevalence	
		Fatigue n (%)	EDS n (%)
Total population	403	35 (8.7%)	58 (14.4)
Marital status			
Married	334	9.9 (33%)	15.0 (50%)
Unmarried	67	2.9 (2%)	11.6 (8%)
Age (years)			
≤30	184	8.3 (9%)	13.0 (14%)
>30	219	8.8 (26%)	14.9 (44%)
Heavy vehicle driving experience			
≤ 10	230	9.4 (24%)	14.6 (37%)
>10	138	7.4 (11%)	14.1 (21%)
BMI			
<30	383	8.6 (33%)	14.1 (54%)
≥30	20	10.0 (2%)	20.0 (4%)
Workday length			
≤ 11	288	6.6 (19%)*	12.8 (37%)
>11	115	13.9 (16%)	18.3 (21%)
Hours of continuous driving			
≤2	304	8.2 (25%)	14.8 (45%)
>2	99	10.1 (10%)	13.1 (13%)
Driving distance per day			
≤200	340	8.5 (29%)	13.8 (47%)
>200	63	9.5 (6%)	17.5 (11%)
Driver's night time sleep			
< 6	40	2.5 (1%)	25.0 (10%)*
≥6	363	9.4 (34%)	13.2 (48%)
Fixed schedule			
Yes	161	3.7 (6%)*	15.5 (25%)
No	242	12.0 (29%)	13.6 (33%)
Differences within risk factor group *p<0.05 EDS - Excessive Daytime Sleepiness			

Table 3: Logistic regression results to assess the risk factors for fatigue and EDS

Variables	Fatigue				EDS			
	Odds Ratio	95% CI		P value	Odds Ratio	95% CI		P value
		Lower	Upper			Lower	Upper	
Age (years) (<=30*/>30)	0.84	0.32	2.20	0.728	1.15	0.51	2.62	0.733
Marital status (unmarried*/ married)	5.43	1.16	25.43	0.032†	1.26	0.49	3.20	0.633
BMI (<30*/≥30)	1.43	0.29	7.18	0.662	1.48	0.46	4.75	0.509
Work schedule (fixed*/not fixed)	3.97	1.55	10.15	0.004†	0.92	0.51	1.65	0.777
Workday length (≤11h*/>11h)	2.33	1.07	5.09	0.033†	1.62	0.86	3.05	0.133
Continuous driving (≤2h*/>2h)	0.81	0.32	2.04	0.650	0.59	0.27	1.29	0.188
Driving distance/day (≤200*/ >200km)	1.46	0.50	4.26	0.492	1.50	0.66	3.42	0.332
Night-time sleep (≥6*/<6)	0.24	0.03	1.82	0.166	2.13	0.96	4.71	0.063
Heavy vehicle driving experience (>10yrs*/≤10yrs)	1.73	0.74	4.05	.205	1.23	0.64	2.38	0.533
*Reference category; †Values are significant $p<0.05$. EDS - Excessive Daytime Sleepiness								

Table 4: Relationship of driver fatigue problem rating with fatigue and EDS (n=403)

Questions	Rating	N	Fatigue	EDS
Is tiredness or fatigue a problem for you when you drive?	Always/Often	38	10.5%	28.9%**
	Sometimes/Rarely/ Never	365	8.5%	12.9%
Do you think tiredness or fatigue is a problem for other drivers?	Always/Often	144	10.4%	20.1%*
	Sometimes/Rarely/ Never	259	7.7%	11.2%
Do you think tiredness or fatigue is dangerous on the road?	Always/Often	218	10.1%	17.0%
	Sometimes/Rarely/ Never	285	7.0%	11.4%
Differences between two groups * p<0.05 **p<0.01 EDS - Excessive Daytime Sleepiness				

frame of one week also used in this study.

In the present study the mean FSS score of heavy vehicle drivers was 2.43 (SD=0.99). This was slightly higher than the mean FSS score of 2.3 (SD=0.7) for healthy adults, in the original study.[17] Hossain *et al.*[13] reported the mean FSS score of 2.2 (SD=0.5) for their least fatigue group. Nearly one in twelve (8.7%, n=35) heavy vehicle drivers participated in this study was found to be fatigue (FSS>4). This indicates that the fatigue is a significant problem in this study population.

To measure the day time sleepiness Epworth sleepiness scale was used. This tool is used to measure the level of day time in many studies [21-24] done among heavy vehicle drivers. The mean ESS score of present sample of heavy vehicle drivers was 6.57 (SD=4.07). This was higher than the mean ESS score of 4.77 (SD=3.27) reported for lorry drivers in Iran[21] and New Zealand (5.27; SD=3.67).[23] However, the mean ESS score was found to be similar to a study[25] done among 260 truck drivers in Brazil, which was 6.56 (SD=4.2). The ESS score more than 10 used to define excessive daytime sleepiness in this study as proposed by the developer of this tool.[19] Same cutoff also used in several other studies.[11, 21] Time frame in ESS was mentioned as 'in recent times' to judge the sleepiness in given situations. According to the developer (Dr. M. Jons) of this tool: 'It was a deliberate decision not to specify this time scale more accurately. It was intended to mean long enough for the subject to have experienced each situation referred to and to have formed an estimate of his/her chances of dozing in each. This may be a few weeks to a few months'.[19]

Prevalence of EDS in the present study sample was 14.4%, which is higher than the 9.1% as reported by Sadeghniat & Labafinezhad,[21] in a sample of lorry drivers. When compared with the Iranian study[21], the mean hours of driving per day in present study is well below the Iranian study(11.56+3.70 vs 4.58+2.06). Nearly one in seven drivers were having EDS (ESS>10) indicating this was a significant problem for present study population.

As reported by Kaminska and others,[26] the self-administered ESS scores were higher than the scores given by the physician. Since this study was interviewer administered the ESS scores resulted might be lower than the self-rated ESS scores of this study sample.

As reported by Neu *et al.*[27] fatigue and sleepiness are two different phenomena. According to the same authors, these were used synonymously mainly in the studies, in which only one of these dimensions was studied. To support the above fact there were several studies which showed weak correlation between subjective fatigue assessed by FSS and subjective sleepiness assessed by ESS.[12, 13] Due to the above reasons, fatigue and sleepiness were considered as two distinct phenomena in this study. Results of the present study also revealed statistically significant weak association (Spearman's rho–0.240, p=0.001). This further supports findings of previous studies.[12, 13] Both the scales in our study appear to be internally consistent as implied by cronbach's alpha 0.731 for FSS and 0.627 for ESS.

The mean age of the study sample was 36.51 years (SD=8.6). Therefore the heavy vehicle drivers in this study are younger than the drivers of the studies conducted by Sadeghniat & Labafinezhad[21] (43.23 years +9.72) and Souza *et al.*[25] (38.2 years +10.6).

Body Mass Index of the study participants ranged from 16.30 to 38.75 Kg/m^2 and mean BMI was 22.91 Kg/m^2 (SD=3.86). This was lower than drivers of the studies conducted in Iran[21] [n=386; 26.37 Kg/m^2 (SD=3.88)] and in Brazil[25] [n=260; 27.64 Kg/m^2 (SD=4.34)]. But the mean BMI of the study was higher than the mean BMI of 21.1 Kg/m^2 (SD=0.2) for men in Sri Lankan study[28] done among 4532 adults (using multi-stage random cluster sampling technique). According to the WHO international guidelines on BMI,[29] 29.1% of heavy vehicle drivers in this study were either overweight or obese. A Similar finding was reported by Katulanda *et al.*[28] in their study on prevalence of overweight and obesity in Sri Lankan adults. According to the findings of this study obesity is not significantly

associated with fatigue or EDS.

In our study, marital status (married), proved to be significant risk factor for fatigue but not for the EDS. However, study conducted by Nugent *et al.*[30] in Northern Ireland reported married status as a risk factor for EDS.

Mean years of experience in heavy vehicle driving in this study was 10.13 years (SD=9.11). This is lower than, 16.06 years (SD=10.19) of Iranian lorry drivers[21] and 13.31 years (SD=10.14) of New Zealand truck drivers.[23] In the present study, it was found that nearly one fourth (23.6%) of the drivers had less than 5 years of experience in heavy vehicle driving. This also supports the fact that present study sample is less experience in heavy vehicle driving. Being a less experience driver increase the likelihood of crashing.[31]

The mean workday length of this sample of drivers was 9.37 hours (SD=2.25). This was lower than the average workday length of 11.89 hours (SD=1.683) reported in a study among 600 New Zealand truck drivers.[32] Hartley[33] reported that accident risk increased substantially after 11 hours of work. Results of this study also showed a statistically significant difference in prevalence of fatigue between drivers who work <11 hours and >11 hours (X2= 5.546, df=1, p=0.01). Therefore workday length more than 11 hours has to be considered as a risk factor for being fatigue.

The mean hours of driving per day in this study was 4.58 hours (SD=2.06) .This was much lower than the 11.56 hours (SD=3.7) reported in Iranian lorry drivers[21]. In that study 76.2% of drivers drove more than 8 hours per day compared to 3.0% in this study. In the present study 60% of the drivers were not on fixed schedule and more importantly working for non-fixed schedule is identify as the strongest risk factor for being fatigue in the present study.

The majority of heavy vehicle drivers in this study drove 2 or less hours continuously without a break. This is a good counter measure to prevent fatigue or sleep related crashes.[31, 34] In this study investigator consider two or more periods of time as continuous period unless separated by an interval of half an hour as defined in Motor Traffic Act.[35] Only 3.5 % (n=13) of drivers had exceeded the legal continuous driving period of 4½ hours.

Based on the evidence fatigue expert group[36] agreed the minimum sleep of six continuous hours per twenty four hours. Heavy vehicle drivers in this study had a mean night time sleep of 7.10 hours (SD=1.318). This is higher than the value of 6.85 hours (SD=1.20) found in Iranian lorry driver's study[21] and 5.97 hours (SD=1.47) as reported by Souza *et al*.[25] in their study among truck drivers in Brazil. In Brazil truck driver's study 23.8% of drivers slept less than 5 hours. But in present study only 9.9% of drivers had average night time sleep less than 5 hours. In this study statistically significant higher prevalence of EDS was observed among drivers who were having night sleep less than 6 hours compared to drivers who were having night sleep of 6 hours or more. This implies that night sleep less than 6 hours is associated with EDS.

In the study conducted by Charlton and others[23] among truck drivers in New Zealand 34.8% rated fatigue as being a problem for other drivers always and often, whereas only 2.1% rated fatigue as often a problem for themselves. However, 88.5% of the drivers believed that fatigue was always dangerous on road. In the present study 35.8% rated fatigue as being a problem for other drivers always and often, and 9.4% rated fatigue as often a problem for themselves. But, only 22.1% of the drivers believed that fatigue was always dangerous on road. This indicates the poor knowledge of heavy vehicle drivers in this study on driver fatigue. Higher prevalence of fatigue and EDS was observed among drivers who stated tiredness or fatigue as a problem for themselves and other drivers than who do not stated it as a problem. This difference in the prevalence of EDS was statistically significant.

There are few limitations of the present study need to be taken in to account. Firstly, data collected in study were retrospective and subjective so recall bias and information bias were unavoidable. Sampling of this study was done through a non-random sequential sampling method, but this may not represent adequately the study population. Finally, the environment, within which the data were collected is somewhat threatening, due to the fact that majority of heavy vehicle drivers are depend on their medical certificate for their livelihoods. But this could not have influenced the study findings, as it was told that the findings will be kept confidential.

Conclusion

High prevalence of fatigue and EDS were found among Sri Lankan heavy vehicle drivers. Further studies focusing on fatigue and sleep disorders in heavy vehicle drivers should be conducted and occupational health service providers should be aware, of the possibility of fatigue and daytime sleepiness in heavy vehicle drivers and its overall risk on the roads, for necessary action.

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