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Original Article

Factors associated with self-reported driver sleepiness and incidents in city bus drivers

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Abstract: Driver fatigue has received increased attention during recent years and is now considered to be a major contributor to approximately 15–30% of all crashes. However, little is known about fatigue in city bus drivers. It is hypothesized that city bus drivers suffer from sleepiness, which is due to a combination of working conditions, lack of health and reduced sleep quantity and quality. The overall aim with the current study is to investigate if severe driver sleepiness, as indicated by subjective reports of having to fight sleep while driving, is a problem for city based bus drivers in Sweden and if so, to identify the determinants related to working conditions, health and sleep which contribute towards this. The results indicate that driver sleepiness is a problem for city bus drivers, with 19% having to fight to stay awake while driving the bus 2–3 times each week or more and nearly half experiencing this at least 2–4 times per month. In conclusion, severe sleepiness, as indicated by having to fight sleep during driving, was common among the city bus drivers. Severe sleepiness correlated with fatigue related safety risks, such as near crashes.

Key words: City bus driver, Working hours, Stress, Driver fatigue, Self-reported sleepiness, Incidents

Introduction

Driver fatigue has received increased attention during recent years and is now considered to be a major contributor to approximately 15–30% of all crashes[1–5]. The main cause of driver fatigue is sleepiness due to sleep loss, being awake for too long, and driving during the circadian low[6]. Work related factors such as stress[7, 8] and shift work[9] also contribute to driver fatigue. In addition it is important to consider the type of task[10, 11], as both cognitive underload and overload contribute to fatigue. Understanding the cause of fatigue is especially important when it comes to recommending appropriate countermeasures[12].

The daily working hours for Swedish bus drivers are regulated by the general Swedish law which sets out requirements of working hours for all professions[1]. Some parts of this law can be neglected with help of collective agreements. In addition there are regulations for driving and rest times[2]. The regulations mainly regulate to the minimum length of breaks, daily and weekly rest periods, and

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[1]Working hours regulation (1982: 673)
[2]Driving and rest time regulation (2008: 475)

maximum driving time. Indirectly, these rules determine how a work schedule can be designed. What to do during breaks and rest periods is not regulated as long as there are not work-related tasks. The regulatory framework stipulates a minimum 45-minute break after a driving period of 4.5 hours. Breaks may be divided into two, but the last break must be at least 30 minutes long. To the best of our knowledge there is no scientific evidence that a maximum driving time of 4.5 hours before a break is optimum. In fact 4.5 hours of continuous driving have been proven to be too long for a driver to stay alert during night time[13]. In summary the regulations state the following:

Driving time: Maximum 9 hours driving per day (2 times a week you may drive 10 hours). In total you may drive 56 hours per week.

Daily rest: During a 24 hours period (30 hours if you are more than one driver) you need to rest at least 11 hours (normal rest) or 9 hours (reduced rest). A driver is permitted to have maximum 3 periods of reduced rest within two "week rest" periods.

Weekly rest: At least 45 hours (possible to reduce to 24 hours if the remaining break hours are made up within a four week period).

In addition, it should also be noted that general speaking it is against the Swedish law to drive when fatigued[3]. However, in practice, it is difficult to monitor whether drivers comply with the law and there is no specific penalty sanction connected with breaking it.

The majority of research to date has been conducted by manipulating sleepiness through night time driving with sleepy drivers in passenger cars on monotonous roads. The results show that driving in the middle of the night increases the number of high risk incidents such as unintentional lane departures[14–16]. Similar results have also been reported in studies of truck drivers, predominantly driving long distances on highways[17–19]. Less is known about the experience and problems of driver fatigue for bus drivers, particularly those driving in busy city environments.

A review about bus drivers' health and work related factors concluded that both physical and psychosocial factors contribute to the driver's health[20]. The factors described as most important were: poor in-vehicle ergonomics, shift work, working alone, the risk of intimidation and violence, and accessibility problems. However, the study did not take into account the relationship between health and sleep quality, nor how it influences bus driving performance.

Physical problems among bus drivers have also been identified by other researchers[21]. One contributing factor to poor health is obesity, which has a high associated risk of obstructive sleep apnoea (OSA), a problem shown to be pronounced in the public transport sector among taxi drivers[22]. Furthermore, in a study with tram drivers in Sweden a high prevalence of sleep disorders was found, particularly OSA, which in turn was associated with work related crashes[23]. The same problems were identified for Swedish truck drivers, with a clear relationship between lack of sleep, sleep disturbance and OSA[24] . Untreated OSA is a problem because OSA drivers who are not treated are more vulnerable to sleep loss and experience more involuntary lane departures[25].

A self-report study from the UK has demonstrated that excessive day time sleepiness is common among bus drivers, with 20% having an Epworth Sleepiness Score greater than 10, and 8% of drivers have fallen asleep at the wheel in the last month. Overall, 18% reported having a near-miss and 7% an accident at work due to sleepiness[26]. Bus drivers in Iran and in Buenos Aires also have problems and report being partially sleep deprived, and having high daytime somnolence and fatigue[27, 28]. In the case of Buenos Aires it was conclude that drivers have poor work-rest conditions and high levels of anxiety[27]. There was also a correlation between crashes and nights away from home[27]. It is not known whether the major contributing factors to driver sleepiness are related to working conditions, lack of health, sleepiness related factors or a combination of these factors.

High levels of work stress and disturbed sleep is a dangerous combination contributing towards diseases and poor workplace performance[29]. It has been argued that in the future, work stress for bus drivers might increase as it is predicted that traffic, problems with accessibility, risk of threats and violence at work, will increase. Additionally, schedules will become more time pressured and manoeuvring within increasingly congested urban environments will become more difficult[20].

Bus drivers' working hours include early morning starts, split shifts and long working hours. A representative survey of Swedish shift workers showed that irregular working hours, split shifts and long working hours are a major problem[30]. However, the focus of the latter study was not to investigate bus drivers nor did the study consider to what degree shift work contributes to problems with fatigue, sleep and driving performance. In general long

[3]Trafikförordningen 1998: 1276, Chapter 3 §1

working hours have been proven to contribute to increased sleepiness and increase risk for crashes, especially in combination with sleep loss, lack of breaks and difficult working conditions[31].

The overall aim of the current study is to investigate if severe driver sleepiness, as indicated by subjective reports of having to fight sleep while driving, is a problem for city based bus drivers in Sweden and if so, to identify the determinants related to working conditions, health and sleep which contribute towards this. It is hypothesized that city bus drivers suffer from sleepiness, which is due to a combination of working conditions, lack of health and reduced sleep quantity and quality.

Method

Participants

All bus drivers working 70% of full time or more, at four bus depots in the area of Stockholm, Sweden received a questionnaire and were invited to participate in this study. In total 231 drivers responded corresponding to a response rate of 65%. The researchers visited the depots and handed out the questionnaires to the drivers. Questionnaires were sent by post to drivers who were not at work on the day the questionnaires were distributed. In addition two reminders were sent out by post. In order to guarantee that the bus driver's responses were independent and that the drivers were not under pressure to respond, the bus company was not involved in questionnaire distribution at all. The responders were entered into a lottery with a number of gift cards as the prizes. The study received ethical approval (Regional Ethical Review Board, Linköping EPN 2014/59-31).

The company use two types of work hours schedules; a fixed shift system and a flexible shift system. The flexible shift system was partly based on self-scheduling, within certain limits and could be either time searched or daily searched. For example, the start and finishing times of the work shifts and the staffing need were set by the employer. The drivers know several weeks beforehand when they will have their days off, but not the working hours for the days that they will work. Under time search conditions the driver applies for a specific schedule 4.5 – 6.5 weeks before and will be informed 2 weeks before. Under daily search conditions the driver was informed 2 – 4 days in advance about their schedule. Regardless of work type it is possible for the driver to be allocated working hours at all times of the day and night.

The questionnaire

The questionnaire included 35 questions covering five topic areas: background, working hours, sleep, health and work. Most of the questions required a response on a scale from; 1 = Never, 2 = Seldom (once or a couple of times each year), 3 = Sometimes (several times per month), 4 = Often (1 – 2 times a week), 5 = Mostly (3 – 4 times a week), and, 6 = Always (at least 5 time a week). Bus drivers rated their overall stress during the last 3 months on a 10 point scale from low levels (1) to high levels (10).

Five different sleep and wake indexes were calculated using the six point scale from 1 = Never to 6 = Always, with an equal size of spaces between the check boxes. The indexes were calculated as an average response of all the relevant questions included for a specific index. The average was calculated for each participant and then taken across participants. The five indexes included the following aspects:

- *Disturbed Sleep*: difficult to fall asleep, waking up repeatedly, waking up too early and disturbed sleep.
- *Sleepiness:* sleepiness at work, sleepiness during non-work time, nodding off during work, nodding off during non-work time, a general feeling of the need to fight sleepiness to stay awake.
- *Fatigue:* persistent feeling of fatigue, physical or mental feeling of fatigue.
- *Impaired waking*: difficult to wake up, not rested when waking up and feeling exhausted when waking up.
- *Sleep Apnoea:* Self-reported snoring, gasping for breath, and breathing cessations during sleep.

All indexes, except the fatigue component, were part of the Karolinska Sleep Questionnaire (Åkerstedt *et al.*, 2002). In addition, the bus drivers were asked if they regularly obtained enough sleep (1 = yes to 5 = not at all) and how many hours sleep they need to be rested.

One question addressed how often the bus drivers have to fight to stay awake while driving the bus. The response alternatives for this question were: Never, Occasionally, 2 – 4 times a month, 2 – 3 times a week, and at least 4 times a week. Bus drivers were also asked if they had experienced incidents defined as "minor material damage on properties, near road crashes, etc." during the last 10 years where "driver fatigue was a contributing factor".

Statistical analysis

All statistical analyses were conducted using IBM SPSS 22.0 statistical software (IBM Corp., Armonk, NY, USA). All significance levels were set to 0.05.

To describe the city based bus drivers' situation in rela-

tion to working conditions, health and sleep related factors an exploratory approach was taken. A variety of variables known to be associated with sleepiness were used and correlations to incidents and experience of fighting to stay awake while driving were calculated.

Univariate logistic regression was used to identify single variables contributing to drivers self-reporting having to fight sleepiness to stay awake while driving the bus 2–4 times a month or more often and for those with experience of sleepiness related incidents.

The investigated variables were: **Background**: gender, age, marital status, Body Mass Index (BMI), exercise; **Sleep/Sleepiness/health**: enough sleep, disturbed sleep index, sleepiness index, fatigue index, impaired waking up index, sleep apnoea index, snoring, general level of stress the last 3 months, self-rated health, and **Working**: years as bus driver, working hours, the prevalence of: long shifts, split shift, variations in starting times, and, short rest time (< 11 hours) between shifts.

The significant variables from the univariate single factor (crude) analysis were then included in a second step, using a multiple logistic regression in order to find the most optimal model to discriminate between those drivers that often have to fight to stay awake while driving the bus from those that do not. The same analysis approach was used to discriminate between those drivers who had experienced a self-reported sleepiness incident and those that had not. For both the multiple logistic regression analysis,

Table 1. Background factors. Percentage, number (n) or mean, standard deviation (sd)

	Percentage or mean	**n**	
Gender–Male	74%	172	
Age	51 years (sd 10.1)	231	
Working as bus drivers	13.5 years (sd 11.3)	230	
Marital status: Married/Cohabitation	73%	164	
Single	23%	52	
Single, but in a relationship	4%	10	
BMI	27.7 (sd 4.5)	231	
Exercise (No)	38%	87	
Enough sleep (No)	22%	231	
General health status (Poor)	10%	22	
Snoring	16%	37	
Sleep need (hours)	7.49 (sd 1.02)	225	
Stress (1 min–10 max)	4.3 (sd 2.59)	223	
KSQ (1 good–6 poor): Disturbed sleep	2.86 (sd 1.13)	220	
Sleepiness	2.49 (sd 1.09)	216	
Fatigue	2.72 (sd 1.29)	223	
Impaired waking	2.67 (sd 1.16)	217	
Sleep Apnea	1.95 (sd 1.10)	161	
Working schedules Fixed:	38%	87	
Time search:	45 %	104	
Daily decided:	17%	39	
Working hours at least once each month	**Percentage or mean**	**n**	***Consider as a problem*[4]**
Morning	78%	179	19%
Day	70%	158	18%
Evening	51%	116	22%
Night	22%	50	48%
Mixed	30%	67	54%
Split shift (> 1.5 h between)	64%	145	36%
Variation of starting time	55%	123	62%
Less than 11 hours rest between shift	33%	75	56%
10 hours a day or more	59%	133	68%
6 days or more of continuously work	11%	25	32%
10 h or more of overtime each week	12%	28	25%
Short notice	38%	83	49%

[4]Among those that report this type of working hours

a forward stepwise approach used thresholds for entry at a probability of 0.05 and the probability for removal at 0.10.

Results

Most bus drivers were men (74%), with an average age of 51 years (SD 10.1 y), with 13.5 years' experience of bus driving (SD 11.3 y). Average BMI indicated that drivers were overweight (27.7 BMI, SD 4.5). The type of shift was mostly fixed (38%) or time searched (45%). Working more than 10 hours a day, having a variety of starting times and working without 11 hours rest between shifts was common, and were all rated as a major problem by the drivers. Split shift was also common (64%), but not considered as a major problem by the majority (36%), early mornings were also common (78%), and not considered as a major problem either (19%), see Table 1.

In total 42% of the drivers took naps at least once every second day, 16% were smokers and 15% were regular snuff users. Among the drivers 19% reported that they have to fight sleepiness in order to stay awake while driving the bus, at least 2–3 times a week, and 45% reported that this happens at least 2–4 times a month, see Fig. 1.

In total 4% had had to stop the bus, at least once, during the previous 6 months for an unplanned break due to fatigue, 17% reported having wanted to stop but not being able to. During the last 10 years 19% of the drivers had experience of at least one fatigue related incident.

The bus drivers were grouped according to two criteria. First, if they have to fight sleepiness to stay awake while driving the bus at least 2–3 times a week (n=45) or not (n=185). Second, if they had experienced a sleepiness related incident (n=43) or not (n=165). The correlation between experiencing and incident and fighting to stay awake was significant (r=0.39; $p<0.01$). Univariate logistic regression for single variables showed an increased risk of the need to fight sleepiness to stay awake while driving the bus for variables related to: the level of drivers' exercise, if they have shifts containing a variation in starting times, if they have working days longer than 10 hours, high levels on the indexes for sleep quality, sleepiness, fatigue, impaired waking, and for risk of sleep apnoea, if they report snoring, high levels of stress last 3 months, poor self-reported health and not getting enough sleep (see Table 2).

Univariate logistic regression for sleepiness related incidents showed an increased risk related to; if they have working days longer than 10 hours, high levels — indicating problems — on the indexes for sleep quality, sleepiness, fatigue, impaired waking, if they report snoring, high levels of stress, poor self-reported health and not getting enough sleep, see Table 2.

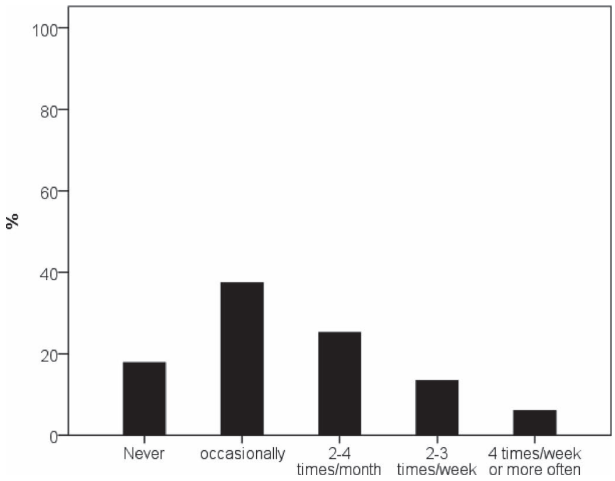

Fig. 1. Frequency distribution for "how often do you have to fight sleepiness in order to stay awake while driving the bus".

Variables with significant Odds Ratio were subsequently included in a multivariate logistic regression.

The regression relating to "**fight to stay awake**" resulted in a model containing: sleepiness index (OR 6.229; CI 2.736–14.182; $p<0.01$) and level of stress during the last 3 months (OR 1.447; CI 1.072–1.953; $p=0.02$). The model had an overall classification rate of 89.0 %.

The regression relating to "**incidents in the last 10 years related to sleepiness**" resulted in a model containing: fatigue index (OR 2.579; CI 1.770–3.758; $p<0.01$) and self-reported general health (OR 4.131; CI 1.088–15.682; $p=0.04$). The model had an overall classification rate of 84%.

Discussion

Driver sleepiness is a problem for city bus drivers, with 19% having to fight to stay awake while driving the bus 2–3 times each week or more and nearly half experiencing this at least 2–4 times per month. Typically, truck drivers have been the main focus when considering driver sleepiness in the transport industry. However, these findings demonstrate that driver sleepiness is not a problem restricted to long distance monotonous highway driving it is prevalent also among city bus drives.

City bus driving is arguably the opposite of monotonous highway driving because drivers are required to interact more with dynamic traffic situations, engage with passengers and regularly stop and start the vehicle. These findings demonstrate a pressing need to understand and pre-

Table 2. Univariate logistic regressions – dependent variable: have to fight sleepiness to stay awake or experience of sleepiness related incidents. OR = odds ratio, CI = Confidence interval; *p* = sig. level. Significant values are presented in bold.

	Have to fight sleepiness			Sleepiness related incidents (n = 43) vs no sleep related incidents (n = 165)		
Univariate variables	***OR***	***CI***	***p***	***OR***	***CI***	***p***
Gender: males vs female (ref)	0.937	0.447 – 1.961	0.862	1.641	0.708 – 3.804	0.25
Age (years): 25 – 34 (ref)						
35 – 44	0.421	0.061 – 2.99	0.381	1.219	0.176 – 8.423	0.682
45 – 54	0.857	0.215 – 3.461	0.827	1.492	0.302 – 7.374	0.841
55 – 64	1.071	0.268 – 4.921	0.922	1.820	0.367 – 9.035	0.624
65 – 68	1.429	0.333 – 6.131	0.631	2.600	0.495 – 13.668	0.464
Marital status: Married /Cohabit. (ref)						
Single	1.014	0.459 – 2.240	0.973	0.909	0.410 – 2.017	0.815
Single but in a relationship	1.065	0.215 – 5.263	0.939	na	na	na
BMI:	1.040	0.973 – 1.112	0.245	1.038	0.969 – 1.111	0.285
Exercise: no vs yes (ref)	**2.177**	**1.125 – 4.213**	**0.020**	1.661	0.838 – 3.296	0.146
Enough sleep: no vs yes (ref)	**9.123**	**4.393 – 18.945**	**<0.01**	**6.161**	**2.917 – 13.014**	**<0.01**
Self-reported general health (Bad)	**9.992**	**3.869 – 25.805**	**<0.01**	**6.746**	**2.515 – 18.099**	**<0.01**
Snoring: no (ref) vs yes	**6.780**	**3.153 – 14.581**	**<0.01**	**2.975**	**1.310 – 6.754**	**<0.01**
Stress	**1.703**	**1.438 – 2.018**	**<0.01**	**1.339**	**1.166 – 1.539**	**<0.01**
Index: Sleepiness	**7.884**	**4.270 – 4.557**	**<0.01**	**2.573**	**1.785 – 3.708**	**<0.01**
Sleep quality	**3.112**	**2.123 – 4.561**	**<0.01**	**1.807**	**1.305 – 2.507**	**<0.01**
Fatigue	**3.856**	**2.595 – 5.728**	**<0.01**	**2.292**	**1.689 – 3.111**	**<0.01**
Impaired Waking	**5.331**	**3.230 – 8.796**	**<0.01**	**2.307**	**1.642 – 3.242**	**<0.01**
Sleep Apnea	**1.747**	**1.247 – 2.448**	**<0.01**	1.238	0.881 – 1.740	0.218
Driving bus (years)	1.008	0.980 – 1.037	0.566	0.981	0.949 – 1.013	0.239
Working hours Morning	2.532	0.941 – 6.812	0.066	1.551	0.639 – 3.766	0.332
Day	0.193	0.875 – 4.279	0.103	1.428	0.668 – 3.052	0.358
Evening	1.023	0.533 – 1.964	0.946	0.780	0.398 – 1.528	0.468
Night	0.848	0.377 – 1.904	0.689	0.593	0.245 – 1.437	0.247
Split shift	1.340	0.411 – 1.340	0.411	0.965	0.474 – 1.964	0.921
Variation of starting time	**2.933**	**1.395 – 6.166**	**0.005**	1.589	0.784 – 3.221	0.199
Less than 11 hours rest between shift	1.225	0.613 – 2.448	0.565	1.512	0.738 – 3.098	0.259
10 hours a day or more	**3.423**	**1.558 – 7.519**	**0.002**	**2.790**	**1.254 – 6.208**	**0.012**

vent driver sleepiness beyond the traditional confines of highway driving. The two factors that predict if a driver regularly has to fight to stay awake while driving are: sleepiness index and, the overall stress level the last three months. The fatigue index and self-reported general health were both predictors of drivers who reported sleepiness related incidents (21% of the bus drivers). Overall, these results support the hypothesis that bus drivers suffer from sleepiness due to a variety of variables including working conditions, poor health and reduced sleep quantity and quality.

Almost half of the city bus drivers surveyed experienced having to fight sleepiness while driving the bus at least twice per month. This is higher levels than those reported among French car drivers in the last year (28%)[32] and among Finnish drivers the last 12 months (15.9%)[33].

As with all passenger transport, one individual — the driver — is responsible for the safety of all the passengers and of other road users. In order to maximize safety, it is crucial that passenger transport drivers are alert and vigilant to the driving task. Under experimental conditions it has repeatedly been demonstrated that individuals who report feeling sleepy also have impaired driving performance[6, 34]. This is further confirmed in the current study, where there was a significant correlation ($r = 0.39$; $p < 0.01$) between those that had to fight to stay awake while driving and those who experienced sleepiness related incidents. Safety measures to ensure city bus driver vigilance are of great importance because bus crashes commonly result in injuries and are most prevalent on urban roads[35]. The proportion of city bus drivers who had sleep-related incidents while working was similar to that reported by a sur-

vey of UK city bus drivers[26] suggesting that driver sleepiness for bus drivers is a universal problem, not specific to Stockholm.

Local city bus drivers have demanding shift schedules with implications for sleepiness. Shift workers are known to experience reduced sleep, increased sleepiness, and sometimes poorer health[36]. In particular, sleepiness has exacerbated safety implications for shift workers who drive as part of their employment. For example, sleep related driving impairment and crashes are a recognized problem for truck drivers[17–19]. Truck drivers undertake the majority of their driving on long monotonous highways. These are circumstances recognized as being associated with driver sleepiness incidents. However, the current work has demonstrated that driver sleepiness within the transport industry is also a problem for those predominantly driving in cities. The highly dynamic nature of city driving requires fast responses and quick decision making. Both reaction time[37] and flexibility of decision making in cognitive task[38] are impaired by sleepiness, suggesting that sleepy drivers have impaired responses to safety critical events. Despite the apparent dangers of driver sleepiness in cities comparatively little is known about its consequences. In the study considering French car drivers with crashes due to sleepiness (5.2% of all crashes) it was shown that they most often occurred in the city (53.8%), during short trips (84.6%) and during day time (84.6%)[32]. Future transportation research should consider driver sleepiness beyond the traditional confines of highway driving e.g. bus drivers, taxi drivers, tram drivers etc.

For city bus drivers, poor health is a clear predictor of sleep related incidents. Although, poor health was not very common in this sample, those drivers that did report poor health were at significantly greater odds of having a sleep related incident at work. A link between poor self-rated health, disturbed sleep, and increased fatigue has been observed in other studies[39, 40]. One possible approach to reduce sleep related incidents would be to develop a targeted health intervention for those drivers who have most severe health problems. Such an intervention would need to be broad considering the wide range of factors which lead to bus driver poor health[20]. Another approach could be to identify if the working conditions directly contribute to severe health problems and try to intervene. The fatigue index was also a predictor of sleep related incidents. The nature of bus driving is often high mental workload, particularly in a city there is need for prolonged periods of heightened vigilance. It is not surprising that drivers experience fatigue under these circumstances. To some extent fatigue may be easier to mitigate than sleepiness. For example providing regular breaks from driving where the driver can do light physical activity (such as take a brief walk) may be sufficient to reduce fatigue. It is important to recognise both driver sleepiness and driver fatigue as separate concepts that most likely require different countermeasures[12]. One difficulty to overcome in developing interventions to improve health and reduce fatigue is that the majority of bus drivers have irregular work hours. Therefore, planning to obtain adequate sleep prior to shift, to eat healthily and undertake exercise may be difficult. Achieving these things is easier when it is possible to plan chores and social life in advance allowing time for sleep. For example, a more regular shift system is likely to facilitate a healthier lifestyle facilitating opportunities, for example, to attend exercise classes or team sport. This might be one contributing factor for those drivers (38%) who do not regularly exercise.

Sleepiness was as expected a predictor of having to fight to stay awake. On the surface this may appear intuitive, however it also indicates that drivers are aware of their sleepiness. This has potential to be used as a point of intervention. Drivers should be encouraged to report severe sleepiness incidents, such as having to fight sleep during driving, to their employer. Sleepiness reports are often a key component in fatigue risk management programs[41].

High level of overall stress during the last three months was a predictor for those that had to fight to stay awake while driving the bus. It is expected that the stress rating refers to the bus drivers work situation, which is characterized by high workload and low job control, e.g. due to low possibilities to influence work. Lack of control, in combination with high job demands, is associated with risk for chronic stress[8]. One countermeasure might be to target improving the bus drivers' coping skills towards this type of stress making them less affected by factors they cannot influence.

Standard advice to sleepy drivers is to stop and take a break when fatigued[42, 43]. However, for passenger transport operators this is not feasible. A positive finding from the current study is that 4% of drivers had stopped the bus due to fatigue. This means that faced with a safety critical situation that would put themselves, passengers and other road users in danger these drivers intervened and stop their bus. However, 17% of participants wanted to stop the bus but did not. Drivers that recognise their fatigue as being so severe that they would like to stop are a critical safety risk. It is important to address these issues in fatigue risk management programs targeted to city bus driving and

empower drivers to take breaks when they need to.

The demographics of the bus driver population would suggest that they are at high risk for OSA: predominantly male, older aged, overweight. However, while these features are prevalent in this sample, signs of OSA, based on the Sleep Apnoea index, were not. The proportion of bus drivers who are obese is similar to that of an Argentinian bus driver population, although, formal diagnosis of OSA was not undertaken[23]. Despite the signs of OSA, based on the Sleep Apnoea index, a greater proportion of Swedish bus drivers reported good sleep quality compared to the similar Argentinean sample[28]. Nevertheless, snoring was significantly more likely reported by drivers who have to fight to stay awake and have experienced sleep-related incidents, and the sleep apnoea index was significantly greater in drivers that have to fight to stay awake. This suggests that there would be some value in screening high risk drivers for OSA, perhaps as part of an intervention for those with poor health. However, it is not clear how best to introduce OSA treatment as acceptance of CPAP in OSA diagnosed bus drivers is reportedly low[44].

Employers have an important role to play in ensuring drivers are fit for duty. One aspect of this is to create workplace conditions which minimise the risk of driver sleepiness. This is of extra importance in situations, such as in Sweden, where official regulations are not optimized for ensuring drivers are alert[45]. From both an organizational and policy point of view targeted interventions for city bus drivers should include reducing sleepiness, stress and fatigue, but also improving health. As part of this there are some noticeable factors within employer control which significantly differ between drivers who have to fight to say awake and those that do not which could be addressed. Both variable start times and working longer than 10 hour days were significantly more likely for those who reported fighting sleep than those who did not. Similarly, days in excess of 10 hours were more prevalent for those who had experienced a sleep related incident. These factors are also considered to be a problem for fatigue by many drivers. Long working hours contribute to increased sleepiness and increase risk for crashes[46]. A large proportion of city bus drivers are currently working with less than 11 hours break between shifts, which is in conflict with shift scheduling recommendations which propose that rest time between the shifts should be at least 12 hours and preferably 15 or 16 hours to facilitate adequate rest opportunity[47]. Reducing the number of working hours in a day, providing consistent start times and sufficient breaks between shifts are changes that an employer could make which are likely to reduce driver sleepiness.

The study has several limitations; one is related to the nature of self-reported questionnaires that may result in unreliable estimates. This is however the case in all methods based on self-reporting. Furthermore, in this study extra caution has been taken in order to make sure that the bus operator company and the union were not involved in the planning of the study or the data collection. Another limitation is related to the response rate of 65%. However, this is a rather high response rate compared to other Swedish studies about bus drivers[48]. A non-response analysis could not be undertaken and there is a risk that selection bias might have influenced the results. It is therefore difficult to say if the presented results are a correct estimation of driver sleepiness and sleepiness-related critical incidents. There is a risk that there was an over representation of drivers that were not native Swedish speakers in the group of no responders. The questionnaire consisted of 35 questions and for a non-native speaker it might have been too difficult to complete. In future studies it translation of the questionnaire, at least into English, should be considered. A final limitation is that the study did not go into detail about the bus companies work organization and policies in relation to bus drivers situation. This should be regarded as an important factor in future studies.

Conclusion

In conclusion, severe sleepiness, as indicated by having to fight sleep during driving, was common among the city bus drivers. Severe sleepiness correlated with fatigue related safety risks, such as near crashes. It is important to mitigate driver sleepiness and there is a need for fatigue risk management programs for city bus transport operations. The programs should involve both organisational countermeasures related to improved shift scheduling and psychosocial working conditions, as well as individual countermeasures related to sleep hygiene, stress management and lifestyle factors.

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