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Work and rest sleep schedules of 227 European truck drivers

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Abstract

Objective: To investigate the sleep–wake behavior and performance of a random sample of European truck drivers.

Methods: The drivers completed a questionnaire concerning sleep–wake habits and disorders experienced during the previous 3 months. In addition, they were asked to complete a sleep and travel log that included their usual work and rest periods during the previous two days. They answered questions concerning working conditions and reported their caffeine and nicotine intake during their trips.

Results: A total of 227 drivers, mean age 37.7 ± 8.4 years (96.2% acceptance rate), participated in the study. The drivers were found to have a fairly consistent total nocturnal sleep time during their work week, but on the last night at home prior to the new work week there was an abrupt earlier wake-up time associated with a decrease in nocturnal sleep time. Of the drivers, 12.3% had slept less than 6 h in the 24 h previous to the interview and 17.1% had been awake more than 16 h.

Conclusions: Shifting sleep schedules between work and rest periods can generate long episodes of wakefulness. This type of sleep deprivation is rarely investigated. Its is usually not taken into consideration when creating work schedules, but affects the performance of drivers. Unsuspected shifts occur at the onset of a new workweek. Sleep hygiene education for professional drivers is still far from perfect.

Keywords: Truck drivers; Fatigue; Sleep; Sleepiness; Work; Self induced shift

1. Introduction

Drowsiness and sleeping at the wheel [1,2] have been identified as the reasons behind fatal crashes and highway accidents caused by car and/or truck drivers. Connor et al. [3] have shown an odds ratio of 2.7 (95% confidence interval (95%CI) 1.4–5.4) between sleeping less than 5 h in the last 24 h and being implicated in a sleep related accident. Driving between 02:00 and 05:00 h was associated with an odds ratio of 5.6 (95%CI 1.4–22.7). Sleep hygiene and hours of work are therefore very important factors to take into consideration for improving road safety. Due to these scientific findings, European governments and some truck companies have in recent years developed a greater interest in sleep schedules and road safety. The goals are to improve working conditions and decrease the risk of industrial accidents. Regulating a trucker's workload and amount of rest per 24-h period is a good strategy for improving safety, but it is crucial to consider the periods preceding the beginning of work when evaluating the ability to drive.

European legislation has imposed regulations (EU 3820/85 and 3821/85) on the trucking industry to improve driver safety. In particular, the regulations limit the amount of time truckers are allowed to work during a 24-h period to a maximum of 9 h per day, with the possibility of working 10 h per day 2 days a week. After 6 consecutive working days, drivers are mandated to take a weekly rest period of at least 45 consecutive hours of freely disposed time (section IV, article 6). However, sleep loss is cumulative and the EEC law cannot regulate sleep behaviors during weekends.

We designed a study to evaluate how a random sample of drivers handles sleep–wake schedules at work and during rest periods.

2. Methods

2.1. Design and settings

The study was performed for 4 consecutive days during a

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'Truck Driver Safety Week' organized by The Autoroutes du Sud de la France company. On an annual basis, the company modifies and equips a freeway rest area specifically reserved for professional truck drivers to maximize comfort during the rest stops legally mandated by the European Union. The area has shops, restaurants, and rooms dedicated to the trucking industry; its location is advertised by publicity announcements placed in other rest areas. During the 4 days a team of women interviewers, knowledgeable in sleep disorders, asked truck drivers who stopped in this special area between 08:00 and 20:00 h to participate in a survey.

The drivers were asked to fill out the Basic Nordic Sleep questionnaire [4], which explores sleep–wake patterns and disorders during the previous 3 months; the Epworth Sleepiness Scale, eight items exploring overall sleepiness during the considered period [5]; the Standard Shift Work questionnaire; and a detailed sleep log covering driving duration and sleep episodes during the 2 days prior to the interview. They were then interviewed about working conditions and caffeine intake during the journey.

2.2. Statistical analysis

Descriptive statistics were used after testing the normal distribution of the data. The Kruskal–Wallis test was used to compare usual total sleep time during the work and rest periods. Spearman's coefficient correlation was used to measure the relationship between caffeine consumption, body mass index, sleep debt, and usual sleep schedules.

3. Results

3.1. Subjects

Out of 236 truck drivers, 227 (96.2%) agreed to participate. 98.7% of the sample were men. Their mean age was 37.7 ± 8.4 years (range 19–58 years). French was the first language for 97.8% of the population. 93.8% were employees of large trucking companies and the remaining 6.2% were independent operators. 89.4% drove 40-ton trucks, 94.3% were alone on their trucks, and 96% had no co-driver. Their mean yearly professional driving distance was 129 898 ± 33 903 km (range 15 000–250 000 km/about 9375–156 250 miles).

95.2% of the subjects consumed caffeine daily during the journey (mean of 4.9 ± 3 cups of coffee or caffeinated beverages, range 0–20); 14.6% ingested 10 or more cups of coffee daily.

42.3% acknowledged being 'regular cigarette smokers' and 32.6% indicated an increase in cigarette smoking during their professional duties. Alcohol consumption was not explored per protocol design.

Drivers had a mean body mass index (BMI) of 27.1 ± 4 kg/m^{-2} and their mean neck circumference was 41 cm (SD 3 cm). BMI correlated negatively with caffeine consumption (Spearman, $\rho = 0.16$, $P < 0.02$). 6.2% reported very loud snoring associated with nocturnal sleep apnea.

The mean Epworth Sleepiness Scale (ESS) score of our drivers was 6.9 ± 3.5; 15% reported an ESS score > 11; with 0.8% > 16.

3.2. The current journey

The majority of our drivers started their working week on Monday and ended it on Friday evening. The mean actual duration of the current trip was 2.6 ± 2 days when our interviewers met the drivers. The mean distance driven before the interview was 1175 ± 1307 km (734.4 ± 816 miles). 19.2% began the trip between 02:00 and 05:00 h; 51% started out between 06:00 and 12:00 (noon).

The mean duration of driving in the 24 h just before the interview was 517.9 ± 142 min. During this time 46.5% of the truckers had driven more than 9 h, 23.5% had driven more than 10 h, and 14.6% more than 11 h. During their journey, they had stopped 4.3 ± 1.3 times for a mean duration of 783 ± 285 min.

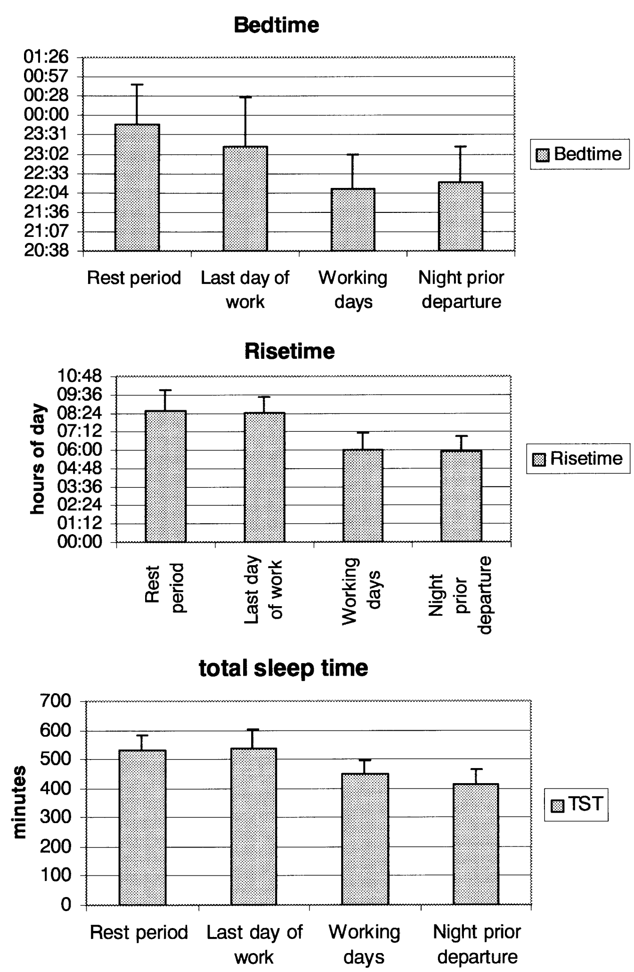

Fig. 1. Habitual rise times, bed times and total sleep time of drivers during work and days-off periods (means and SD/2; SD/2 was used due to large SD).

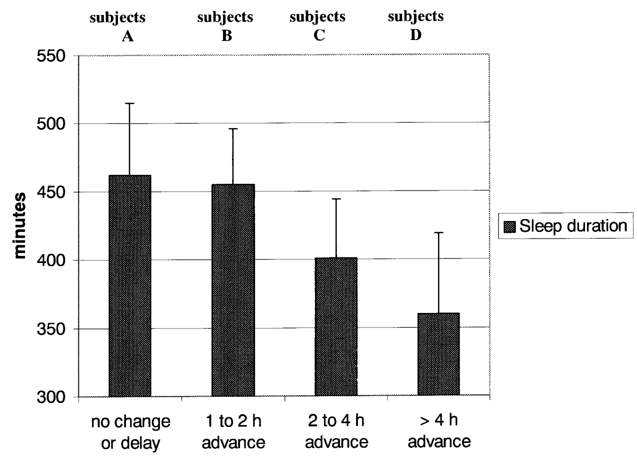

Fig. 2. Relationship between wake-up time the day of departure and sleep duration the night before departure (mean and SD/2; SD/2 was used due to large SD).

3.3. Sleep schedules during the last three months

Fig. 1 presents the reported 'habitual' rise time and bedtime of the drivers. This schedule is divided into the following four categories:

(A) during the first 4 days (usually Monday through Thursday), at work;
(B) at the end of the last workday and during the first night at home (usually Friday night);
(C) during the complete day-off rest period at home (usually Saturday night); and
(D) the last night at home just prior to departure (usually Sunday night).

The drivers have a fairly consistent total nocturnal sleep time during the working week (usually Monday through Thursday). On the last workday and during the first night at home (usually Friday night) there is a mean bedtime delay of 67 ± 115 min compared to their nocturnal sleep onset time on the prior workdays. During the complete rest period at home (usually on Saturday night) there is a further delay: a mean of 31 ± 112 min change compared to the preceding night (usually Friday). During these two first nights at home there is also an increase in total nocturnal sleep time. On the last night home, just prior to the new workweek, there is an abrupt earlier wake-up time associated with a decrease in nocturnal sleep time. The mean nocturnal sleep time decrease is 181 ± 145 min compared to the preceding (usually Saturday) night.

Fig. 2 shows the behavior of the drivers on the night just prior to departure. We divided our population of drivers into four groups according to their wake-up time on the day of departure. Subjects of group A ($n = 34$) wake up at the same time (or slightly later) as on the previous day. They show a mild reduction of sleep duration the night before departure (462 ± 107 versus 496 ± 84 min of total stopping time) and a moderately delayed bedtime. However, of all groups, these group A individuals are those who have the longest sleep before the new trip. All other groups wake up earlier than on Sunday morning—from 1 to 2 h (group B), to more than 4 h (group D).

This earlier wake-up time is associated with a significant curtailment of nocturnal sleep (Kruskal–Wallis, $P < 0.001$). The subjects who wake up the earliest are those who report the least amount of total sleep.

There is a negative relationship between duration of sleep during working days (middle of the week and last day of work) and caffeine consumption (Spearman, $\rho = 0.19$, $P < 0.001$ and $\rho = 0.14$, $P < 0.05$). During rest periods (days off) this relationship does not exist.

3.4. Sleep schedules in the 24 h immediately preceding the interview

The interviews were performed from Monday through Thursday. The mean 24-h total sleep time was 473 ± 127 min; 2.2% of the drivers had slept less than 4 h; 12.3% had slept less than 6 h. On the other hand, 11.8% had slept more than 10 h. We compared the sleep time associated with the journey to the habitual total sleep time reported during the complete rest period (day off) at home (usually on Saturday night). We labeled a negative value 'sleep debt'. 36.7% of the drivers had a 'sleep debt' > 2 h, 11.9% had a 'sleep debt' > 4 h and 2.2% had a 'sleep debt' ≥ 6 h.

Drivers interviewed on Monday were asked about their nocturnal sleep before departure. In these cases, no significant difference could be demonstrated between reports on the 24 h preceding the interview and the usual sleep duration.

Table 1
Age, sleep and driving times of subjects per number of continuous hours of wakefulness[a]

No. of continuous hours awake	%	Age (years)	TST before departure (min)	Wake-up time	Starting time on duty	Driving (min)	Time off duty
≤14	59.4	37 ± 9	449 ± 151	06:31 ± 2:47	07:42 ± 3:29	442 ± 151	16:23 ± 4:56
14.1–15.9	23.5	39 ± 8	431 ± 111	06:01 ± 2:40	07:41 ± 4:03	540 ± 203	20:10 ± 3:06
16–17	11.1	39 ± 8	459 ± 159	06:06 ± 1:56	08:56 ± 5:38	527 ± 173	22:34 ± 4:40
17.1–20	3.9	34 ± 8	458 ± 80	07:35 ± 5:11	09:53 ± 5:59	593 ± 186	23:20 ± 3:57
≥20.1	2.1	34 ± 5	354 ± 109	04:33 ±1:12	12:24 ± 7:02	702 ± 182	05:24 ± 1:51

[a] Note that times are expressed in '24-h clock' format. TST, total stopping time.

Table 2
Distribution of percentage of drivers based on duration of driving and cumulative period of time awake

	Cumulative period of time awake (h)				
	≤14	14.1–15.9	16–17	17.1–20	>20
Duration of driving <10 h	$n = 128$ (56.4%)	$n = 40$ (17.7%)	$n = 15$ (6.6%)	$n = 5$ (2.2%)	$n = 1$ (0.4%)
Duration of driving >10 h	$n = 7$ (3%)	$n = 13$ (5.8%)	$n = 10$ (4.5%)	$n = 4$ (1.7%)	$n = 4$ (1.7%)

3.5. Maximum time awake

The next calculation investigated the time elapsed between the last sleep period (minimum duration of 120 min) and the last time the driver stopped before the interview. Data were obtained from the sleep logs of the current journey if it had lasted more than 24 h ($n = 198$ drivers). We examined the maximum duration of continuous wake time (with driving) occurring during that period. The end of a driving segment was selected as a cut-off point.

As can be seen in Table 1, 59.4% of drivers performed their legal daily driving during a wake period lasting 14 h or less. The remaining 40.6% performed and ended their daily driving requirements after having been awake for a longer period, with 2.1% reaching more than 20 waking hours. This last group had spent a full day and night awake. The increase of wake time is significantly associated with a longer duration of driving (Spearman, $\rho = 0.60$, $P < 0.01$); see Table 2.

4. Discussion

Previous studies have shown that sleepiness among professional drivers is not uncommon [6,7]. Our results show that many of our subjects shift the onset of their longest sleep period while at home, probably because they want to adhere to the same schedule as family members. Thus, each week, drivers are subjected to a 'jet lag' phenomenon. The effect of a 1-h shift due to daylight savings is well known: there is a known increase in driving accidents [8]. Our professional drivers often exhibited more significant shifts in time on a weekly basis.

Furthermore, our drivers have a sleep debt which is demonstrated here by the reported sleep rebound at home and by the comparison between 'desired' sleep time and the recorded sleep time during the journey. During the trip our truckers frequently combine nocturnal driving (19.2% start their trip in a very dangerous time zone for traffic accidents, i.e. between 02:00 and 05:00 h [3]) with extensive wake periods (>16 h), negatively affecting performance [9]. In addition, drivers use this extra time to drive for longer periods, another risk factor for accidents [10] and a violation of European work regulation (which clearly has huge gaps).

In this new study we chose to work jointly with the interviewed drivers, and our sample probably missed the worst offenders against driving time regulations. Drivers who want to drive for extensive periods of time are less willing to spend an hour at a rest area answering a questionnaire in order to help scientists better understand sleep behaviors among the trucking community.

The alertness of our drivers is quite comparable to that reported by Maycock [11]. This suggests that our sample may not necessarily be biased toward the best drivers in terms of sleep hygiene and alertness. Independent of a possible bias of selection, and even if we consider that the majority of our participating drivers are rather successful in limiting sleep deprivation (12.5% only of our sample slept less than 6 h during working conditions), our sample of truckers overlooks many factors that impact on road safety. Regulations that only mandate 'driving breaks' neglect important factors.

As shown in our study, the education of our drivers needs to be improved. But regulators of professional driving need to take into consideration socio-familial needs in addition to professional requirements. They should also consider (1) the distance between home and the starting locations of the journey, and (2) the impact of the start time of the journey on circadian shifts.

Drivers should manage their own sleep needs, but operators should manage scheduling and dispatching in such a manner as to allow drivers to get their physiologically necessary daily rest.

Acknowledgements

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