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SLEEP DURATION AND SLEEP EFFICIENCY IN UK LONG DISTANCE HEAVY GOODS VEHICLE DRIVERS

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ABSTRACT

Objectives

To profile sleep duration and sleep efficiency in UK long-distance heavy goods vehicle (HGV) drivers and explore demographic, occupational and lifestyle predictors of sleep.

Methods

Cross-sectional analyses were carried out on 329 HGV drivers (98.5% males) recruited across an international logistics company within the midland's region, UK. Sleep duration and efficiency were assessed via wrist-worn accelerometry (GENEActiv) over 8-days. Proportions of drivers with short sleep duration (<6-h/24-h and <7-h/24-h) and inadequate sleep efficiency (<85%) were calculated. Demographic, occupational and lifestyle data were collected via questionnaire and device-based measures. Logistic regression assessed predictors of short sleep duration and inadequate sleep efficiency.

Results

58% of drivers had a mean sleep duration of <6-h/24-h, 91% demonstrated <7-h sleep/24-h and 72% achieved <85% sleep efficiency. Sleeping <6-h/24-h was less likely in morning (odds ratio [OR] 0.45, 95% confidence interval [CI] 0.21–0.94) and afternoon (OR 0.24, CI 0.10–0.60) shift workers (vs night) and if never smoked (vs current smokers) (OR 0.45, CI-0.22–0.92). The likelihood of sleeping <7-h/24-h reduced with age (OR 0.92, CI 0.87–0.98). The likelihood of presenting inadequate sleep efficiency reduced with age (OR 0.96, CI 0.93–0.96) and overweight body mass index category (vs obese) (OR 0.47, CI 0.27–0.82).

Conclusions

The high prevalence of short sleep duration and insufficient sleep quality (efficiency) rate suggest many HGV drivers have increased risk of excessive daytime sleepiness, road traffic accidents and chronic disease. Future sleep research in UK HGV cohorts is warranted given the road safety and public health implications.

Abstract word count: 250

KEY MESSAGES

What is already known about this subject?

- Internationally, HGV drivers are known to have insufficient sleep
- Insufficient sleep carries risks of daytime sleepiness, road traffic accidents, reduced mental well-being and chronic disease in HGV drivers
- Accelerometer-measured sleep data during free living conditions is needed in UK HGV drivers to build on the predominant self-reported evidence-base currently available

What are the new findings?

- Within a UK HGV sample, almost all drivers had short sleep duration (<7-h) and almost three quarters had inadequate sleep efficiency (<85%) compared to National Sleep Foundation recommendations
- Short sleep duration and inadequate sleep efficiency were predicted by shift type, smoking status, age and/or body mass index category

How might this impact on policy or clinical practice in the foreseeable future?

- Further sleep research should develop and evaluate interventions targeting sleep behaviours in HGV drivers
- UK-based logistics companies should include more comprehensive assessments of sleep behaviour and incorporate sleep surveillance as part of routine training and medical evaluation procedures
- Weight management and sleep behaviour awareness training should also be considered

INTRODUCTION

Long-distance heavy goods vehicle (HGV) drivers, responsible for transporting goods within a vehicle in excess of 3.5 tonnes (gross vehicle weight) (1), work within hazardous conditions that jeopardise their health and well-being (2,3). Harmful occupational factors, such as shift working and demanding delivery schedules (2,4,5), and undesirable lifestyles, such as poor nutritional intake, low levels of physical activity and sleep deprivation (5,6), culminate in an increased risk of accidents, higher rates of chronic disease and reduced life expectancy compared to general populations (3,7,8).

Healthy sleep (e.g. ≥7-h/24-h (9)) is critical for long-distance HGV drivers' and other road user safety (7,10). Insufficient sleep (i.e. <7-h sleep duration), which can lead to daytime sleepiness, fatigue and impaired vigilance, is responsible for a disproportionately high number of fatigue-related road accidents involving HGV drivers (8,10). Healthy sleep is also essential for well-being and to avoid co-morbidities (11,12). For instance, very short sleep (<6 hours/24-h) is associated with all-cause mortality, diabetes mellitus, cardiovascular disease, obesity, lower self-esteem and optimism compared to regularly obtaining 7-8-h/24-h sleep (11,12). Given the public health and road safety implications, sleep should be a priority lifestyle behaviour for HGV drivers.

Adults should try to achieve 7-8-h/24-h of sleep for good health (13). Sleep efficiency, a measure of the actual time asleep whilst in bed, is used as an indicator of sleep quality and considered 'good' if ≥85% (9). In US and Australian HGV drivers, numerous studies have reported an average sleep duration of <7-h/24-h (7,14,15) and others have observed high proportions (e.g. >40%) of drivers reporting short sleep (16,17). Sleep quality has been self-reported as 'poor' in around a fifth of US and European HGV drivers (7,18,19), with 78% sleep efficiency reported in Australian drivers from device-based data (14). These sleep outcomes compare unfavourably to general populations (20,21).

Sleep behaviour is influenced by multiple demographic, occupational and lifestyle factors. For instance, sleep duration and efficiency generally decrease with age (21), a potentially significant factor in the ageing workforce of UK HGV drivers (22). Shift workers show high rates of sleep disorders compared to conventional workers (23) and less HGV driving experience has been associated with poor sleep quality (19). Poor lifestyles, widespread in HGV drivers (5,6), such as smoking, low levels of physical activity and obesity, are also associated with sleep disorders and sleep deprivation (24–26). Sleep research should explore the distribution of these factors in UK HGV drivers, to help effectively target sleep interventions.

Most research examining sleep in HGV drivers has relied on self-report measures, which can be prone to overestimation (21). Accelerometry is increasingly being utilised, as a convenient and inexpensive method, in large population studies which assess longitudinal patterns in sleep behaviour and health outcomes (e.g., UK Biobank, NHANES). Such sleep data can also provide supplementary estimates of sleep characteristics that self-report cannot, such as fragmented/accumulated sleep during time in bed (27). To date, no information on UK HGV driver's sleep duration and efficiency collected via accelerometry has been reported.

Drawing on the needs identified in this at-risk population, our research aimed to 1) profile the sleep behaviour of a UK HGV driver cohort, and 2) explore potential demographic, occupational and lifestyle-related predictors of short sleep duration and inadequate sleep efficiency.

METHODS

Study design, setting and participants

This cross-sectional study utilised baseline data collected from long-distance HGV drivers taking part in the 'Structured Health Intervention For Truckers (SHIFT)' study; a cluster randomised controlled-trial. The full protocol is available elsewhere (28). Briefly, data collection took place within an international logistics company. Participants were recruited from 25 sites located across the midland's region of the UK (n=1502 employed HGV drivers in total across participating sites), operating within the transport, retail, hospitality, healthcare, pharmaceutical, construction, oil and gas, and automotive industries. All drivers were eligible to take part unless diagnosed with cardiovascular diseases, haemophilia, blood-borne viruses, or had mobility limitations that prevented them from increasing daily physical activity (physical activity was the primary outcome of the SHIFT trial). Ethical approval was obtained from the Loughborough University Ethics Approvals Sub-Committee (Reference: R17-P063) and all participants provided written informed consent.

Measurements

Data collection occurred between January 2018 and July 2019 at respective worksites during a 2-h assessment (undertaken by trained researchers), at the beginning or end of participants working shift. Participants self-reported demographic, occupational and lifestyle information including sex, date of birth, ethnicity, education, shift pattern, years worked as an HGV driver, weekly working hours, smoking status, alcohol intake, and chronotype (Morningness-Eveningness Questionnaire short-version (MEQ) (29)). Height was measured without shoes using a portable stadiometer (Seca 206, Oxford, UK). Weight was determined via Tanita DC-360S scales (Tanita Corporation, Tokyo, Japan). Body mass index (BMI) was calculated as weight (kg)/height^2 (m^2). Daily steps were determined via an activPAL3 micro accelerometer (PAL Technologies Ltd, Glasgow UK) worn continuously for eight-days (following the health assessment) on the midline anterior aspect of the upper thigh (waterproofed using a nitrile sleeve and Hypafix [BSN Medical] dressing). Median number of daily steps were the outcome of interest from the activPAL data.

Sleep

Participants wore a tri-axial accelerometer (GENEActiv, ActivInsights Ltd, Kimbolton, UK) on the non-dominant wrist continuously for eight-days (during work and non-work periods), following the health assessment, to estimate sleep duration and efficiency. The device collected data at 100 Hz with a ±8*g* dynamic range. Participants were provided with a daily log to record time into bed, sleep onset time (explained to the participant as ‘lights out’), wake-up time, out of bed time, working periods and any non-wear periods.

Data processing

GENEActiv devices were initialised and downloaded using manufacturer proprietary software (GENEActiv v.3.1). Accelerometer files were processed in the R package GGIR version 1.8-0 (30) to generate sleep outcome variables. Sleep windows were guided by the self-reported sleep onset time and out of bed time provided by the daily log. Where sleep log data were missing, automated sleep window detection was used (31). Sleep duration within this window was calculated using a validated sleep detection algorithm (27). Briefly, arm angle relative to the horizontal plane is detected to determine sleep periods; a low frequency of changes in arm angle can be identified as sleep if occurring within a specified sleep window period. The sleep window is determined by the daily log (sleep onset and out-of-bed times) or the algorithm if daily log data were not available (the longest block/series of sustained inactivity, with no more than a 60-min gap between blocks, within a 24-h period (noon-noon)). This algorithm has demonstrated high sensitivity and specificity in detecting sleep periods (27). A wear time of ≥16 hours over a 24-h period was required to determine a valid night of sleep data (27). Individual nights of data with a sleep window >13-h or <2-h or sleep duration >12-h or <1-h were identified as erroneous and removed. Participants were included in the analysis if providing ≥3 nights of valid data. Supplementary file S1 includes two additional more stringent quality control criteria and sensitivity analyses within these robust subsamples of data. Variables of interest from GGIR analysis included sleep window onset (‘lights out’), sleep window end (‘out of bed’ time), sleep window duration (duration between ‘lights out’ and ‘out of bed’ time), sleep duration (periods of sleep accumulated during the sleep window) and sleep efficiency (sleep duration/window duration*100). Short sleep duration was identified as <6-h/24-h (12) and <7-h/24-h (9), and inadequate sleep efficiency as <85% (9).

activPALs were initialised and downloaded using manufacturer proprietary software (activPAL Professional v.7.2.38). Event files were generated and processed using the freely available Processing PAL software (https://github.com/UOL-COLS/ProcessingPAL, version 1.3, University of Leicester, (Leicester UK)), which uses a validated algorithm to determine waking wear time (32). Participants providing ≥10 hours of valid waking wear time daily, on ≥3 days, were included in the analysis. The first day of data was removed from the analysis.

Statistical analysis

Descriptive data were reported as mean and standard deviations (or median and interquartile range), or numbers and percentages as appropriate. Continuous data were reported for age, years as an HGV driver, average weekly working hours, and daily steps. Alcohol intake score, a discrete variable, was calculated by combining scores from two 5-point items; *how often do you have a drink containing alcohol?* (answers ranging from 'Never' to '4 or more times a week') and *How many units of alcohol do you have on a typical day when you are drinking?* (answers ranging from '1 or 2' to '10 or more'*).* Each item was scored 0-4 for a combined score out of 8 (units-per-week could not be calculated from these two question items). Participants were grouped for shift pattern (morning, afternoon, night or rotating), smoking status (never, previous smoker, current smoker), BMI (normal (20.0-24.9 kg/m^2), overweight (25–29.9 kg/m^2), obese (≥30.0 kg/m^2)), and chronotype (based on MEQ scores: Eveningness (<12), Intermediate (12–17) and Morningness (>17) (33)). Due to inconsistent work times between worksites for each shift pattern, it was not possible to provide clear definitions of shift types. Differences in demographic, occupational and lifestyle factors between those who did or did not provide valid GENEActiv data were compared using independent t-tests, Mann-Whitney U tests or Pearson chi-square tests.

Logistic regression assessed demographic, occupational and lifestyle predictors of three outcomes: <6-h/24-h and <7-h/24-h sleep duration and <85% sleep efficiency. Age, shift pattern, years as an HGV driver, average weekly working hours, chronotype, smoking status, alcohol intake, BMI category and valid nights of sleep data were independent variables entered into each of the three models via forced entry. Statistical analyses were conducted using SPSS v.23 (SPSS Inc., Chicago, IL, USA). Statistical significance was set at $P<0.05$.

RESULTS

386 HGV drivers were recruited into the trial (25.7% recruitment rate across participating work sites) and underwent baseline measures. Of these, 329 provided valid GENEActiv data (85.2%) and are included in this analysis. Comparisons between those providing valid GENEActiv data (n=329) and those who did not (n=57) revealed significantly more daily steps in those not providing valid data (+1237 steps, $P<0.05$) and differences ($P<0.05$) within smoking status and chronotype categories. There was a smaller proportion of current smokers (-16.7%, $P<0.05$) in the group without valid data, more intermediate chronotypes (+18.2%, $P<0.05$) and fewer morning chronotypes (-15.0%, $P<0.05$).

Table 1 provides details of the full sample (n=329). Most participants were male, White British ethnicity, married and educated to General Certificate of Secondary Education (GCSE) level. 90% reported working some form of shift pattern (i.e., deviation from conventional 8am-6pm working hours). Most were morning shift workers, obese and morning chronotypes.

Table 1. Sample characteristics. Data presented as number (percentage) or mean ± standard deviation unless otherwise stated.

Variable	**n (%) / mean ± SD***
Full sample, n (%)	329 (100)
Sex	
Male, n (%)	324 (98.5)
Age	
Overall, mean ± SD, (years)	47.8 ± 4.9
Ethnicity	
White British, n (%)	261 (79.3)
Other White, n (%)	45 (13.7)
Other ethnicities**, n (%)	23 (7.0)
Marital Status	
Married, n (%)	173 (52.6)
Co-habiting, n (%)	58 (17.6)
Single, n (%)	41 (12.5)
Other, n (%)	57 (17.3)
Education	
GCSE or equivalent, n (%)	214 (65.0)
A-level or equivalent, n (%)	33 (10.0)
University degree or higher, n (%)	82 (24.9)
Shift pattern	
Morning, n (%)	211 (64.1)
Afternoon, n (%)	35 (10.6)
Night, n (%)	63 (19.1)
Rotating, n (%)	19 (5.8)
Years worked as HGV driver	
Overall, median ± IQR	15.0 ± 8.6 - 25.0
Hours worked per week	
Overall, median ± IQR	48.0 ± 45.0 – 50.0
Steps per day (activPAL) (n=298)*	
Number of valid days, median ± IQR	8.0 ± 7.0 – 8.0
Valid waking wear time, median ± IQR, hours/day	16.5 ± 15.9 – 17.2
Overall, median ± IQR, steps/day	8544 ± 6902 - 10625
Smoking status	
Never smoked, n (%)	133 (40.4)
Previous smoker, n (%)	140 (42.6)
Current smoker, n (%)	56 (17.0)
Alcohol intake score	
Overall, mean ± SD	3.7 ± 2.1
Body mass index (BMI)	
Overall, median ± IQR, BMI (kg/m^2)	29.8 ± 27.0 – 33.2
Normal weight (19.5 – 24.9 kg/m^2), n (%)	37 (11.2)
Overweight (25 – 29.9 kg/m^2), n (%)	134 (40.7)
Obese (≥30 kg/m^2), n (%)	158 (48.0)
Chronotype	
Evening, n (%)	28 (8.5)
Intermediate, n (%)	111 (33.7)
Morning, n (%)	190 (57.8)

*Number (percentage)/mean (standard deviation).
**Other Ethnicities group includes nine ethnic categories; Indian (n=6), Black Caribbean (n=4), Black African (n=3), White Irish (n=3), White and Black Caribbean (n=2), Other Asian (n=2), White and Black African (n=1), Other Black (n=1), Chinese (n=1).
***N=33 participants did not provide valid activPAL data, n=298 included in the analysis. All other variables include a full sample of data (n=329). HGV, heavy goods vehicle; GCSE, General Certificate of Secondary Education

Table 2 reports sleep data for the whole sample and by different occupational and lifestyle factors. The sample demonstrated a mean sleep duration of 5.8±1.0-h, with most drivers (58%) having a mean sleep duration <6-h/24-h and almost all (91%) demonstrating <7-h sleep/24-h. Almost three-quarters (72.0%) demonstrated inadequate sleep efficiency (<85%).

Table 3 shows logistic regression models that include demographic, occupational and lifestyle-related predictors of short sleep duration (<6-h and <7-h) and inadequate sleep efficiency (<85%). Drivers were less likely to sleep <6-h/24-h if morning or afternoon shift workers compared to night shift workers and if never smoked compared to current smokers. The likelihood of sleeping <7-h/24-h reduced with age. The likelihood of having inadequate (<85%) sleep efficiency reduced with age and in the overweight BMI category compared to obese.

Table 2. sleep characteristics in long-distance UK HGV drivers for the full sample and across occupational and behavioural groups. Data presented as number (percentage) or mean ± standard deviation unless otherwise stated.

Variable	n (%) / mean ± SD*
Valid nights, n ± SD	5.7 ± 0.6
Sleep window onset, mean ± SD, 24-h	23:00 ± 2.4
Sleep window end, mean ± SD, 24-h	06:02 ± 2.4
Sleep window duration, mean ± SD, h	7.3 ± 0.9
Sleep duration	
Overall, mean ± SD, h	5.8 ± 1.0
<6 hours, n (%)	192 (58.4)
≥6 hours, n (%)	137 (41.6)
<7 hours, n (%)	299 (90.9)
≥7 hours, n (%)	30 (9.1)
Sleep efficiency	
Overall, median ± IQR, sleep efficiency score (%)	80.1 ± 72.8 – 85.7
<85%, n (%)	237 (72.0)
≥85%, n (%)	92 (28.0)

	Sleep duration (h) mean ± SD	Sleep efficiency (%) median ± IQR
Shift pattern		
Morning (n=211)	5.8 ± 0.9	80.7 ± 74.2 – 85.8
Afternoon (n=35)	5.9 ± 1.1	78.7 ± 69.4 – 85.3
Night (n=63)	5.4 ± 1.0	76.4 ± 68.2 – 84.2
Rotating (n=19)	5.9 ± 1.2	79.8 ± 75.3 – 88.8
Smoking status		
Never smoked (n=133)	5.9 ± 0.9	80.2 ± 73.3 – 87.3
Previously smoked (n=140)	5.7 ± 1.0	79.8 ± 71.1 – 85.4
Current smoker (n=56)	5.6 ± 1.0	79.7 ± 77.7 – 84.0
Body mass index (BMI)		
Normal weight (19.5 – 24.9 kg/m^2) (n=37)	5.9 ± 1.1	81.3 ± 69.8 – 86.6
Overweight weight (25.0 – 29.9 kg/m^2) (n=134)	5.9 ± 1.0	81.0 ± 74.7 – 87.4
Obese weight (≥ 30.0 kg/m^2) (n=158)	5.6 ± 1.0	78.7 ± 71.3 – 84.5
Chronotype		
Evening (n=28)	5.7 ± 1.1	75.1 ± 66.9 – 86.5
Intermediate (n=111)	5.6 ± 1.1	78.8 ± 71.5 – 84.3
Morning (n=190)	5.9 ± 0.9	81.1 ± 74.4 – 86.7

h, hours; IQR, interquartile range; BMI, body mass index. *Number (percentage)/mean (standard deviation).

Table 3. Logistic regression models including demographic, occupational and lifestyle-related predictors of short sleep duration (less than 6-h and less than 7-h) and inadequate sleep efficiency (<85%).

	<6-h		<7-h		<85%	
	OR	**(95% CI)**	**OR**	**(95% CI)**	**OR**	**(95% CI)**
Age, years	0.98	(0.95, 1.01)	0.92	(0.87, 0.98)	0.96	(0.93, 0.99)
Shift type						
Morning	0.45	(0.21, 0.94)	1.11	(0.32, 3.84)	0.75	(0.34, 1.61)
Afternoon	0.24	(0.10, 0.60)	0.42	(0.11, 1.67)	0.87	(0.31, 2.44)
Rotating	0.40	(0.13, 1.28)	0.59	(0.09, 3.87)	0.56	(0.16, 1.95)
Night	1		1		1	
Total HGV years	1.00	(0.97, 1.03)	1.03	(0.98, 1.07)	1.00	(0.97, 1.03)
Average weekly working hours	1.00	(0.97, 1.04)	0.99	(0.93, 1.05)	0.98	(0.94, 1.02)
Daily steps	1.00	(1.00, 1.00)	1.00	(1.00, 1.00)	1.00	(1.00, 1.00)
Smoking status						
Never	0.45	(0.22, 0.92)	0.77	(0.22, 2.75)	0.49	(0.22, 1.01)
Previous	0.67	(0.33, 1.36)	0.72	(0.21, 2.47)	0.66	(0.30, 1.48)
Current	1		1		1	
Alcohol intake score	0.97	(0.87, 1.09)	0.94	(0.78, 1.14)	1.03	(0.91, 1.17)
BMI category						
Normal	0.55	(0.25, 1.20)	0.60	(0.17, 2.12)	0.53	(0.23, 1.25)
Overweight	0.67	(0.40, 1.11)	0.69	(0.29, 1.63)	0.47	(0.27, 0.82)
Obese	1		1		1	
Chronotype						
Morning	0.46	(0.16, 1.33)	0.65	(0.13, 3.20)	0.68	(0.22, 1.01)
Intermediate	1.11	(0.64, 1.92)	2.00	(0.70, 5.69)	1.63	(0.88, 3.03)
Evening	1		1		1	
Nights of valid sleep data	0.83	(0.54, 1.26)	1.09	(0.59, 2.03)	1.06	(0.69, 1.62)

OR, odds ratio; CI, confidence interval; HGV, heavy goods vehicle; BMI, body mass index.

For clarity on continuous and discreet variables, using the <6-h model (short sleep) as an example, the likelihood of having less than 6-h sleep per 24 hours reduced by 2% with every year increase in age, reduced by 3% for every unit increase of alcohol score (this discreet variable has a total score of 8), and reduced by 17% for every valid night of sleep data (although the 95% confidence intervals for each of these variables spanned 1.0). Total years as an HGV driver, average weekly working hours and daily steps did not increase or decrease the likelihood of sleeping less than 6-h per 24 hours.

DISCUSSION

This is the first study in the UK to profile the sleep behaviour of long-distance HGV drivers using an accelerometer assessment of sleep. We found that more than half of drivers in this study (58%) had a mean sleep duration of <6-h, and almost all (91%) demonstrated <7-h sleep/24-h. Short sleep duration (<-6 or <7-h) is associated with increased risk of premature mortality, morbidity (12), reduced mental well-being (11), and road traffic accidents (7,10). Previous studies in US HGV drivers have reported a mean self-reported sleep duration of <7-h (7,15), a ~60-min longer sleep duration compared to the present study (6.9-h (7) and 6.7-h (15) vs 5.8-h) (7,15). These differences may be partly due to self-reported measures overestimating sleep duration, compared to accelerometer measures (14,21). For example, Baulk et al. (14), using wrist-worn accelerometry in 37 Australian HGV drivers, observed an average of 6.3-h sleep duration, compared to 7.7-h when self-reported. Although not an HGV driver study, Zhu et al. (21), using the same wrist-worn accelerometry and sleep detection procedures as the present study, observed almost identical proportions of middle-to-older-aged UK males (n=82,995) achieving <6-h/24-h (60%) and <7-h/24-h (91%) sleep duration, respectively, as seen herein. This suggests sleep duration in UK HGV drivers, although short for most, is comparable to other UK males within the same age groups. Nevertheless, our data suggests that drivers require on average ~80 mins (17%) additional sleep for reduced morbidity risk and enhanced road safety (7,12). More studies using wrist-worn accelerometry are needed to confirm this, including longitudinal studies that account for temporal and seasonal sleep variation.

Almost three-quarters (72.0%) of drivers had a mean sleep efficiency of <85% in this study. Insufficient sleep quality (efficiency) is associated with reduced psychological well-being (9) and an increased risk of road traffic accidents in HGV drivers (7). Our findings are consistent with previous international evidence suggesting that insufficient sleep quality is highly prevalent within this workforce. A small sample of Australian HGV drivers have exhibited a mean sleep efficiency of 78% from wrist-worn accelerometry data (14). Approximately one fifth of Italian (17.3% n=526) (18) and Belgian (17.3% n=476) (19) HGV drivers have self-reported poor sleep quality previously. Zhu et al. (21) reported a mean sleep efficiency of 81% in middle-to-older-aged UK males (n=82,995) compared to a median 80% efficiency in the present study. This suggests that sleep efficiency is similar in UK HGV drivers compared to other similar-aged UK males.

The low sleep efficiency in combination with the short sleep duration is important when considering the sleep window (time spent in bed). A mean sleep window duration of 7.3-h suggests that, albeit marginally, drivers on average provided themselves with sufficient time in bed to achieve ≥7-h of sleep but most were unsuccessful. Some drivers may present with sleep disorders such as obstructive sleep apnoea or insomnia (34), but this was not captured in this study. Future studies should account for these factors, although sleep disorders are often undiagnosed within this occupational group (35). Sleep hygiene behaviours (i.e., practices that optimise sleep) in UK cohorts, and the occupational barriers to healthy sleep habits, also need to be explored using mixed-methods approaches to inform sleep interventions.

Logistic regression analyses revealed different predictors of short sleep duration between the <6-h and <7-h models. This may be partly explained by only 9.1% of drivers sleeping for ≥7-h/24-h, whereas 41.6% of drivers achieved ≥6-h/24-h, suggesting the <6-h model is a better fit of the data. Within the <6-h model, morning and afternoon shift workers were 55% and 76% less likely to have short sleep duration compared to night shift workers, respectively. Although approximately 90% of the sample were shift workers, who are more likely to have sleep disorders compared to those working conventional hours (i.e., 8am – 6pm) (23), our analysis demonstrated the greatest risk of short sleep was evident in night shift workers. Night shift workers are particularly vulnerable to circadian rhythm misalignment (36), resulting in reduced sleep duration and quality (23) and increased risk of fatal occupational accidents (37). These workers may benefit the most from countermeasures known to enhance circadian adaption and benefit sleep outcomes such as maximising work time rest periods and napping opportunities, or improving lifestyle behaviours (e.g. increased physical activity) (36). Also, within the <6-h model, the likelihood of short sleep duration reduced by 55% in those who never smoked compared to current smokers. This is unsurprising given smoking is associated with a host of sleep disorders (24). Contrary to previous evidence (21), increasing age reduced the likelihood of short sleep duration and inadequate sleep efficiency within the <7-h and <85% models, respectively. It could be that older drivers implemented better sleep hygiene practices through experience, and perhaps earned more favourable shift patterns over time (e.g., morning shifts) compared to younger age groups. Supplementary file S2, which reports sleep outcomes and shift types by age groups, broadly supports this argument. However, it should be noted that age was not a strong predictor in either the <7-h or <85% models (OR 0.92 and 0.96, respectively). Nevertheless, if these trends are repeated in future studies, further qualitative research with older HGV drivers (e.g., >50 years of age) may illustrate effective sleep hygiene behaviours that younger less experienced drivers could benefit from.

Drivers who were overweight were 53.0% less likely to have inadequate sleep efficiency compared to drivers who were obese. UK HGV drivers have higher than nationally representative rates of obesity (28) which was reflected in our sample as almost half of drivers were obese (48.0%). Sleep deprivation and obesity are bi-directional (26) and given the host of environmental and occupational triggers for weight gain (e.g., shift work, prolonged sedentary driving, unhealthy food options at service stations) the two may exacerbate one another over time within this workforce. Our analysis suggests that being overweight may include better sleep efficiency compared to being obese, which would be an important outcome from preventing weight gain in HGV drivers if reaching a normal BMI category through weight loss cannot be achieved.

Our findings suggest that UK HGV drivers are potentially sleep deprived which carries important implications for UK road safety and public health. Further sleep research within UK cohorts is critical to effectively inform UK workplace policy for HGV drivers. However, as part of routine training and medical evaluation procedures, UK-based logistics companies should include more comprehensive assessments of sleep behaviour (e.g., Epworth Sleepiness Scale) and incorporate sleep surveillance (e.g., sleep logs, accelerometry). These approaches will provide a better understanding of sleep deprivation and potentially detect undiagnosed sleep disorders, common within this workforce (35). Furthermore, given the high prevalence of obesity within UK HGV drivers (22), which is central to many chronic diseases and has a bi-directional relationship with sleep (26), weight management and sleep behaviour awareness training could be prudent workplace policies that warrant consideration.

A strength of this study is the use of a validated sleep detection process to profile sleep outcomes. This study has good generalisability to other UK HGV drivers due to the breadth of recruitment (25 worksites across the UK midlands region, operating within sub-contracts across eight different industries). Another strength is the study sample, a priority, yet hard to reach, occupational group for health interventions, given the array of health risk factors observed. Limitations include the cross-sectional nature of the present analyses, all worksites being located within a single parent logistics organisation and a potential recruitment bias for a health intervention study. However, the sample age (mean 47.8 years), sex distribution (98.5% males) and high rates of overweight and obesity compared to 45-54 year old UK males (88.7% vs 79.0%) indicate that the present sample are representative of UK HGV drivers (22,28). Diagnosed sleep disorders were not captured, which would have enhanced the interpretation of sleep outcomes. We also acknowledge the limitations of a movement-based detection process to capture sleep which is a complex physiological process. Naps were not measured in this study, which anecdotally occurred within some shift workers and may have impacted sleep outcomes. Specifically, sleep duration per 24-h will have likely been underestimated in some early morning and night shift workers. Furthermore, sleep behaviours, such as insomnia or sleep latency, may have been misclassified as sleep if little arm/body movement occurred (27).

In conclusion, most drivers had short sleep duration and insufficient sleep quality, therefore it is plausible that these drivers are at increased risk of excessive daytime sleepiness, road traffic accidents and chronic disease. Given the implications for road safety and public health, future research is warranted. Studies should explore sleep behaviour between work periods and non-work periods to understand if and how drivers may compensate for sleep deprivation between shifts. A greater understanding of sleep behaviours in this occupational group should inform interventions designed to improve sleep and improve driver health and road safety over the longer-term.

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