3rd Pillar of Health

Prepared by Third Pillar of Health Limited

A study of fatigue in those who drive for work

For

National Highways

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Executive Summary

Fatigue is widely recognised as a major risk in those who drive. Whilst we know that fatigue leads to accidents and incidents for all types of drivers, it is often difficult to ascertain fatigue as a contributory factor in accidents and incidents.

Tiredness and fatigue in those who drive for work is costing organisations, individuals, the government and taxpayer each day. One estimate suggests fatigue costs £1,357 per worker per annum. Extrapolating this figure the cost of fatigue in those who drive for work is £9.2bn each year in the UK.

We set out to better understand fatigue risk in different working patterns. Our aim was to understand where and when fatigue risk increases and how driving-specific job characteristics impact fatigue risk.

This report presents the results of a study, undertaken with a number of fleets, to better understand fatigue risk in those who drive for work. The aim of the study was to understand where and when fatigue risk increases and how driving-specific job characteristics impact that risk.

This study was conducted on behalf of National Highways Commercial Vehicle Incident Prevention team. By improving our understanding of fatigue as a health and safety risk we can reduce its impact, with corresponding benefits for individual drivers, their employers, other road users, the emergency services and the health service.

In conjunction with National Highways and Driving for Better Business we publicised the study to organisations and fleets highlighting the opportunity the study provided to obtain data on fatigue in their own operations.

Despite significant efforts to promote the study widely, the number of organisations that participated was relatively low. We know fatigue and working patterns can be a ‘difficult’ topic. Perhaps this perceived difficulty meant organisations did not want to ‘open the box’ and risk the problem being exposed in black and white. In some prospective participating fleets, despite initial enthusiasm, interest waned when discussed with a wider audience at the organisation. We also saw reluctance from drivers, even in those fleets which did take part, to participate in a voluntary study, even though there were personal benefits to doing so. Given driver fatigue is a key risk in those who drive for work this is noteworthy.

We designed and created a user-friendly web application to collect data on sleepiness and the impact of fatigue on performance at multiple points during a shift from voluntary participants. Participants were informed of the study through their managers, supervisors and communications from their employer.

A large percentage of respondents are not obtaining sufficient good quality sleep prior to work. Average sleep was 6 hours 37 minutes prior to work. 48% of respondents fail to achieve seven or more hours of sleep prior to work. 78% of respondents are not meeting their sleep need over a week or shift cycle. 26% of respondents are at risk of sleep apnoea and 36% are at risk of insomnia. 65% regularly experience sleepiness at work and for 31% sleepiness interferes with daily work activities at least a few days a month.

Our key findings in respect of how driving-specific job characteristics impact fatigue risk include:

- Those driving light commercial vehicles were more likely to report high levels of sleepiness and fatigue affecting performance at work
- Those with the longest history of driving for work had comparably high levels of sleepiness and were more likely to report fatigue as being very or extremely likely to affect performance at work
- Those whose job roles required little or no physical activity had a greater chance of fatigue affecting their performance at work
- In results from our alertness and cognition test it took (c. 20%) longer to process information on the night shift (versus the day and back shift) to achieve similar levels of accuracy.

We found that other job characteristics increased the risk of sleepiness and impacted drivers' performance at work. These characteristics included where driving is not the main part of their job role, those who drive cars, younger and female workers.

Another interesting finding from this study is that rather than fatigue risk increasing with each consecutive shift, we found it fluctuated over a week or shift schedule, often peaking in the middle of the pattern.

As a result of the findings of this study, we would encourage all organisations with workers who drive as part of their job to undertake training and implement interventions, to help their staff get an objective view of their alertness, improve their sleep, understand the signs of driver fatigue, be familiar with effective strategies to reduce or mitigate fatigue and be clear on the actions they should take if they are too tired to drive safely. Drivers should be familiar with the organisation's policies and directives pertaining to driving whilst tired.

In early 2025 we will run a second study, in conjunction with National Highways Commercial Vehicle Incident Prevention team, to test the hypothesis that asking drivers to do our 60-second alertness and cognition test at the beginning of their shift and providing them with an objective overview of their alertness, along with clear messaging on driver fatigue, will improve driver behaviours and in turn the key metrics organisations track. You can find out more later in the report.

Organisations who effectively address driver fatigue in their drivers will see economic benefits. We would expect to see improvements in a number of key metrics. These include accidents and incidents, fuel consumption, harsh braking, lane deviations, penalty charge notices and many more.

Third Pillar of Health will now use the data collected in this study to develop a new app for fleets and fleet managers to help better understand the potential contribution of fatigue in accidents and incidents, including shift patterns and job characteristics. Having a tool that is in daily use across fleets will answer questions on how much of a major risk fatigue actually is and potentially increase the focus on this risk, with corresponding benefits for all stakeholders involved in driving for work. If you would like to be kept abreast of developments, please contact us using the details on the first page of this report.

Introduction

This study has been conducted on behalf of National Highways who funded the study and specifically the Commercial Vehicle Incident Prevention team. The study sought to better understand fatigue risk in different working patterns and how job characteristics impact fatigue risk.

We hope the results of our research will help better inform those who manage drivers about fatigue risk.

The study collected data at multiple points during work shifts from voluntary participants across a wide range of organisations, working a variety of shift patterns and job roles, using a web application that could be accessed via computer, tablet or smartphone with Wi-Fi or mobile data connection. Users provided us with data on their levels of sleepiness and the extent to which fatigue was affecting their performance at work. Some users also undertook an alertness and cognition test at the beginning of a shift and answered six questions on their previous sleep duration, sleep quality, bedtime, wake time, start work and finish work times.

Our study was based on subjective assessments of sleepiness and the impact on participants' own performance at work. We deliberately did not use any wearable technology in this study as the costs would have limited the number of participants. There are concerns over the reliability of subjective responses. However, our focus on the relative risk of fatigue rather than the absolute level of risk mitigates this issue to some extent. For some groups we did not have the largest data sets and in some instances one or two users can skew results if they consistently show high or low levels of sleepiness throughout a shift. Whilst we obtained a good cross section of organisations and driving roles, we did not obtain extensive data for all types of driving roles.

Doing all we can to prevent commercial vehicle incidents is likely to have a significant return for society. There are an estimated 4.7 million company vehicles on the road in the UK, in addition to this around 2.1 million privately owned cars are used for business purposes (1). It is estimated that 22% of all vehicle miles travelled on Britain's roads are for work purposes (2).

More informal estimates, including registered HGVs, vans and company cars estimate the figure at 6.3 million. The number of cars used for work purposes (the grey fleet) is almost impossible to estimate accurately but a reasonable estimate would bring the total number of vehicles being driven for work to c. 20 million, which is half of all UK registered vehicles.

A 2005 research report found that people driving for work tended to have higher blameworthiness in collisions. Speeding, observational failures and fatigue have been identified as key contributory factors (3).

Research conducted for the Transport Research Laboratory in 2003 found that when mileage was adjusted for, those who drive for work have 50% more collisions than those who do not (4). The research pointed to three key reasons why this might be the case for all types of work-related driving. The three factors were fatigue, time pressure and in-car distractions (such as mobile phones).

The statistics also provide a compelling reason to do all we can to prevent commercial vehicle incidents. One third of road traffic collisions ("RTCs") in Britain involve someone driving for work (5). In 2012 the HSE estimated from the Labour Force Survey that there were 70-100,000 non-fatal work-related RTC injuries a year, with around 30-40,000 of these causing more than 3 days absence. Data collected for vehicles at the scene of reported collisions in the UK by police officers from 2014 shows that over 42,000 drivers/riders who were involved in road collisions where someone was injured were driving for work purposes (6). In 2014, 14,043 casualties involved vans and light commercial vehicles and 6,873 involved heavy goods vehicles (6). In 2016, almost 6,000 people were killed or seriously injured in RTCs involving someone driving for work (7).

Our research and report are specifically focused on fatigue. Whilst there is no single definition of fatigue, it is generally thought to be the decline in mental and / or physical performance that results from prolonged mental or physical exertion, lack of quality sleep or disruption of the internal body clock.

Fatigue can be exacerbated by the work environment, including dim lighting, high temperatures, high noise and high comfort; by the type of work being undertaken including complex, boring or monotonous work; or by shift design including long periods or work, insufficient breaks and extended workdays.

According to the Canadian Standard Association's report on workplace fatigue the effects of fatigue can be mental, physical or subjective. The effects of fatigue include reduced mental capacity, inattention, indecisiveness, physiological weakness, physical exhaustion, tiredness, drowsiness, weariness, sleepiness and lethargy. Additional effects of fatigue include poor communication, irritability, reduced reaction time, increased risk-taking, errors in judgement, lack of motivation and forgetfulness. It is easy to understand how the effects of fatigue can impair performance whilst driving but also in interactions with clients, colleagues and the general public.

According to the National Safety Council's ("NSC") 2018 "fatigue in safety critical industries" report (encompassing construction, manufacturing, transportation and utilities) 90% of employers in safety-critical industries feel the effects of fatigue, 67% reported declines in productivity and 32% said they had experienced safety incidents as a result of fatigue. 69% of employees report feeling tired at work and 50% of employers report finding employees asleep on the job. Interestingly, 94% of employers feel fatigue is a safety risk whilst only 80% of employees agreed. The report pointed to 2014 research estimating that 13% of workplace injuries could be attributed to fatigue. The research also showed that workers with sleep problems were 1.62 times more likely to be injured than those without.

As the NSC report pointed out, risk factors for fatigue include shift work, quick shift returns (less than 12 hours off), long shifts (over 10 hours), long work weeks (over 50 hours), high risk hours (at night or early morning), demanding jobs (either physically or cognitively), no (or few) rest breaks during a shift, sleep loss (getting less than our sleep need) and long commutes (over 30 minutes each way).

An article in 2015 (8) suggests some of the reasons why transportation workers, in particular, may struggle to achieve sufficient good quality sleep. It was suggested that; working away from home, sleeping during the day and long commutes contribute to sleep deficiency. Consider also the extended time spent on the roads, long hours and variable shifts.

The March 2014 Sleepiness, Safety & Transport study (9) pointed out that "driving involves the processing of complex visual, tactile and auditory information in order to produce well-coordinated motor output." Also, as the study points out, "neuroimaging studies demonstrate that even a single night of sleep deprivation may negatively impact on driving performance. Driving performance and neurocognitive vigilance rates and reaction times are significantly impaired after sleep deprivation."

The study also alluded to a piece of research that found "there is an almost six-fold increase in the odds of crashes involving injury for vehicles driven by people who are not fully alert or sleepy or by people reporting less than 6 hours of sleep during the previous 24 hours."

A 2010 study by Neylan et al. of 189 police academy recruits published in the *Chronobiology International Journal* found that psychomotor vigilance decreased proportionately at a rate of 3.5% for every lost hour of sleep. These finding are also relevant in the transport sector, where many roles require high levels of vigilance (10).

Those who work shifts, be it early or late starts, rotating shifts or variable start and finish times can be particularly at risk of fatigue.

There are clearly additional issues in respect of shift working and how it affects performance in transportation. A submission on managing fatigue in transport to the Australian House of Representatives standing committee on communication, transport and the arts in 2000 noted that, "Each hour of night work imposes a greater workload than the same hour during a day shift, because of the effects of circadian rhythms. Work, which is physically or mentally demanding, monotonous or requires high vigilance can lead to fatigue which will be worsened by night work."

The submission went on to say that “performance on tasks which require high levels of vigilance and concentration, such as driving, inspection or maintenance work will be reduced between the hours of 02:00 and 06:00 and / or after long worked shifts, due to the effects of fatigue and disrupted circadian rhythms.” Work patterns that allow for adequate rest reduce the ill-health effects of shift working. A fit and healthy workforce are more resilient to stress and illness.

A common problem is how workers perceive fatigue affects their work. A finding from research conducted on the Tideway (London sewer) construction project, is workers generally felt they could work through fatigue. However, a study undertaken on a Vancouver construction project in 2010 noted that, “inadequate sleep has been associated with numerous major work-related accidents, but a common problem is that individuals do not either understand their state of fatigue or its consequences or both”. (11)

A 2015 study exploring the impact of fatigue during a simulated manual handling task (the short distance manual transport of heavy materials) suggested workers cannot simply work through fatigue. The study showed that as fatigue increased, workers were less able to process hazard information and reached a point where even if they identified a hazard, they were physically unable to respond to avoid the hazard. (12)

In the October 2018 NSC ‘Fatigue in Safety Critical Industries’ report, ninety seven percent of safety-critical workers had at least one risk factor for on-the-job fatigue, which can cause hazardous jobsite conditions and 80% had two risk factors. The authors noted that; “the role of fatigue in the aetiology of accidents may be twofold: first, fatigue may decrease the ability to process information about a hazardous situation; and second, it may decrease the ability to respond.”

According to figures from the Department for Transport in 2016 six thousand people were killed or seriously injured in road traffic collisions involving someone driving for work (13). A 2022 study by UCL and Agilysis for National Highways and Roadsafe, referenced on the Driving for Better Business website, estimated that 29% of all road fatalities and 21% of all casualties (fatalities, serious injuries and slightly injured) occur in driving for work collisions. In 2018, 520 people died in collisions with a driver or rider driving for work. Only 12% of those who died were those driving for work. 5% were passengers and 83% were other road users.

Occupational accidents, no matter in which industry, result in devastating socioeconomic consequences because, in addition to causing physical and mental disability, fatal accidents have significant personal, societal, and financial costs.

According to the National Safety Council’s ‘Employee Cost Calculator for fatigue’ in Production, Transportation and Materials Moving Operations the annual cost of fatigue per worker is £1,357. This breaks down as £403 for absenteeism, £460 for decreased productivity and £474 for healthcare – which for the most part is a cost to the NHS in the UK.

Using the 4.7m company cars and 2.1m personal cars used for business then there are 6.8m people who are driving for work. **The annual costs of fatigue for those who drive for work in the UK is therefore £9.2 billion (6.8m x £1,357).** This breaks down as £2.7bn for absenteeism, £3.1bn for decreased productivity and £3.2bn for healthcare.

There are also other indirect costs associated with accidents whilst driving for work, including:

Loss of company reputation and contracts	Fines and costs of prosecution
Damage to products, plant, building and equipment	Management and administrative time
Replacement staff costs and sick pay	Loss of production or production delays
Excess on a claim	Increased insurance premiums and excess
Offenders own legal fees	Claims from third parties
Accident investigation and paperwork	Repairs to damaged equipment
Alternative transport for repair duration	Inconvenience

Re-delivery	Staff down time for medical appointments / attendance at court etc.

Another interesting consideration in respect of fatigue when driving for work was noted in the submission to the (Australian) House of Representatives. The submission touched on measures some transport workers take to overcome fatigue at work and to help them sleep after a shift. “Use of drugs such as caffeine or amphetamines by workers trying to overcome the effects of fatigue and / or alcohol or sleeping pills to try to get to sleep is a hazard of shift work and unrealistic work schedules.” In our opinion we do not regard this as a ‘hazard’ but a function of poor knowledge in the workforce with potentially serious repercussions.”

Our research set out to understand some key questions, including:

- Do longer shift result in higher levels of sleepiness and a greater impact on performance at work?
- Is sleepiness and the impact on performance greater where driving is the main part of a worker’s job?
- Does sleepiness and the impact on performance reduce with more years spent driving for work?
- Does the type of vehicle being driven have any effect on sleepiness and performance at work?
- Does the level of seniority with an organisation have any effect on sleepiness and performance at work?
- Do jobs requiring physical activity increase the likelihood of fatigue?
- Does sleepiness and the impact on performance reduce as age increases?
- Does (biological) sex impact on sleepiness and performance at work?

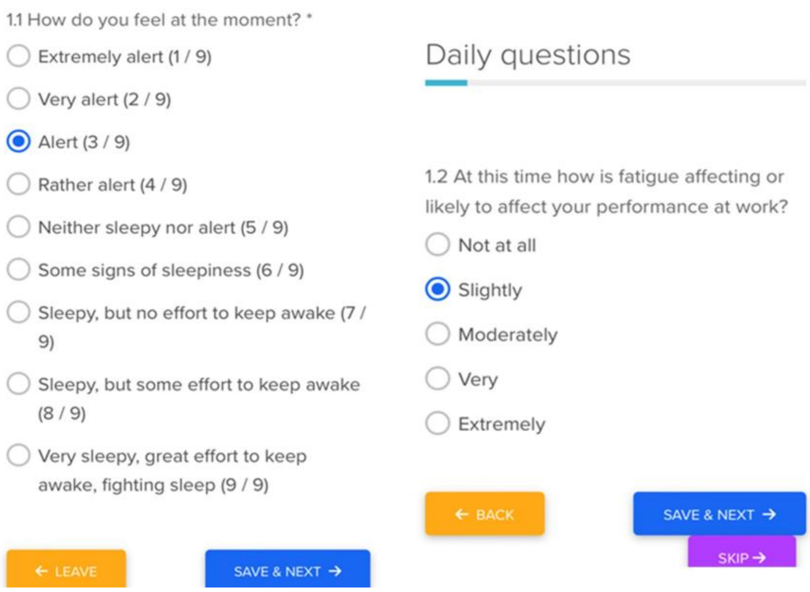
Methodology

To gain a better understanding of fatigue in those who drive for work we gathered data on:

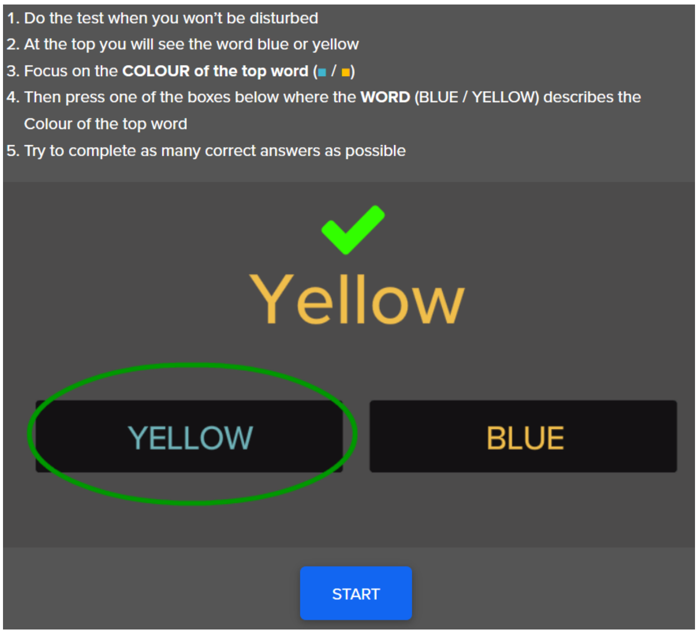
- Sleepiness levels via the (extensively validated) Karolinska Sleepiness Scale (“KSS”)
- The extent to which fatigue impacts performance at work
- Performance on an alertness and cognition test (similar to the validated Stroop test)
- Prior period sleep duration, sleep quality, bedtime, wake time, start work and finish work times
- Sleepiness levels and the impact on performance based on the hours of continual wakefulness
- Demographic data and data about their job characteristics (see Appendix 1 – registration questionnaire)
- More in-depth questions about sleep quality, sleep duration, sleep need, workday sleep debt, daytime sleepiness, lifestyle habits and life satisfaction from the (voluntary) sleep health self-assessment that all respondents could access and complete.

To collect the data, we designed and built a brand new web application which could be accessed via computer, tablet or smartphone with Wi-Fi or mobile data connection. We required users to register, create a login and answer fourteen to seventeen questions about who they worked for, their job roles, basic demographics, job characteristics and whether there were any reasons preventing them from sleeping well.

Once registered we asked users which level they would like to participate – basic, silver or gold. We asked all users to answer two questions on their sleepiness level (see question 1.1 below) and how fatigue is affecting performance at work (see question 1.2 below). We asked users to answer these two questions three times a shift - somewhere near the beginning, somewhere near the middle and somewhere near the end of their shift. Users had an option to set SMS text and / or email reminders to add data in the middle (4 or 6 hours after their first data entry) and end of their shift (8 or 12 hours after their first data entry).



Silver and gold users also undertook a 60-second alertness and cognition test at the beginning of their shift (only). The test asks users to accurately confirm the colour of the word in the top box. The results are based on the percentage accuracy (the number of correct trials / the total number of trials) and efficiency (the number of trials in the 60 seconds).



Gold users answered six questions on their sleep, wake and work times at the beginning of their shift (only):

1. Excluding time awake how long did you sleep for in your most recent main sleep period?
2. What time did you wake up prior to work?
3. How would you rate the quality of your most recent sleep period?
4. What time did you turn the lights out to go to bed?
5. What time did you start or are you expecting to start work?
6. What time are you expecting to finish work?

The data was quantitative and for the most part, other than the results of the alertness and cognition test, subjective in nature.

For this research we chose not to use wearable technology as the cost of the devices limits the size of the sample population. Our approach was designed to obtain data from hundreds of workers. A great deal of time was spent at the design stage trying to reduce the amount of time it would take for volunteers to participate, both at registration and ongoing on a daily basis. Through extensive testing and being present for the first few launches (on C1 Align – part of a similar research project in construction workers) we were able to observe how the app was being used and make adjustments accordingly. Overall, feedback on use of the app was very positive on its ease and simplicity.

As a result, we obtained thousands of data points that were specific to fatigue in real-world working populations.

Participants volunteered to take part in the study. No participant's data were excluded from analysis. A data cleanse was conducted to delete duplicate data – i.e. when the same results for sleepiness and the extent to which fatigue is likely to affect performance at work were exactly the same just minutes (or seconds) apart.

Excel was then used to undertake the analysis of how the data breaks down to each sleepiness and performance score for all the different groups.

The greatest benefit of our approach was obtaining data from a large cohort of workers in real world working environments. From a sleep and circadian science perspective our results were in line with what we would expect to find. This is probably due to the voluntary nature of the study. The interesting aspect is the nuances within the data.

Previous studies sought to obtain objective data using wearable technology. Whilst there are concerns over the total accuracy of wearables the consensus is they can tell when users are awake and asleep. This approach has yielded interesting results in other studies. However, as we alluded to above, the cost of the units makes widespread use unachievable, especially with a limited budget.

Not all workers were comfortable with using smartphones and a web application. So, we missed a few workers that might have participated if we had used paper-based entry. However, when we looked at that as an option it would have been difficult to add the time and date stamp in the system and time consuming entering the data manually.

One conclusion from studies on Crossrail and other Transport for London sites was a caution over using subjective measures within the tunnelling and construction industry. The same cautions can be applied to those who drive for work. Our two main questions – asking how you feel and the extent to which fatigue is likely to affect performance at work are both subjective. We expect there might be reluctance from some participants to give open and honest answers that reveal fatigue and we saw some evidence of that in our results. However, having gone through each line of data multiple times we feel the vast majority of our data is accurate. We further mitigate this issue by looking at the relative fatigue risk in the 'heatmaps' in this report. Additional mitigation comes from the number of participants, meaning workers who provided false data were a small percentage of the overall data set.

The two key challenges were to firstly promote the study well enough to get participants to sign up and complete registration. The second key challenge was to get participants to add data on a daily basis.
To promote the study and get participants signed up, we advertised it through a variety of channels. We frequently briefed leadership teams to explain what the study is and why we were undertaking it to obtain senior level buy-in. Senior leaders would then cascade this information to their workforce to encourage participation.

The next challenge was to obtain data from participants daily. We provided QR code stickers with the login URL which could be added to entry pass lanyards, placed in the cabs of vehicles etc. We also relied on management providing frequent reminders to participate in the study.

To overcome the challenge of obtaining data near the middle and end of shifts we created SMS text and / or email reminders. These reminders were triggered once the user had added data at the beginning of their shift. We could not set a reminder to provide data at the beginning of the shift given many of our participants were working rotating shifts and doing different shift patterns.

By obtaining thousands of data points from a wide range of workers who drive for work, we have been able to compare the relative fatigue risk in different working patterns. Understanding average sleepiness and performance impairment scores over a shift rotation allows us to rank shift patterns based on the highest / lowest scores for twenty percent brackets. As you will see in the ‘heatmaps’ the highest twenty percent of scores are highlighted in red boxes. The score at which the highest risk twenty percent scores start gives us a chance to rank the different shift patterns.

We believe our findings could be transferrable to other populations beyond those who drive for work. This would certainly be the case for any office-based population with mentally demanding job roles. Given the demographic and job characteristic questions we ask as part of registration we believe our research will be relevant to a great many job types across a wide range of industries. We are also doing some research in construction and (hopefully) in Naval operations. These data sets will allow us to test our hypothesis that the data we have collected in our research can be applied to other populations.

The results

Headline results

- Fatigue risk fluctuates over a week or shift pattern often peaking in the middle of the week
- It took 20% longer to process information on the night shift versus the day and back shift
- We see a spike in sleepiness between 13:00 and 15:00 and again towards the end of a shift
- We saw a one hour delay in an increase in sleepiness to an increase in the effect on performance
- Average sleep prior to work is 6 hours 37 minutes with 48% sleeping less than 7 hours
- 78% of participants are not meeting their sleep need over a week or shift cycle
- 36% of participants are at risk of insomnia and 26% are at risk of sleep apnoea
- 65% of workers regularly experience sleepiness at work and for 31% it interferes with work activities
- Those for whom driving is the main part of their job role compared favourably on key metrics
- Light commercial vehicle drivers were more likely to report sleepiness and performance impacts
- Those with the greatest driving experience compared poorly on key metrics
- Those with the least driving experience comparted poorly on key sleep metrics
- Those whose roles required the least physical activity compared poorly sleepiness and performance
- Female workers compared poorly on key sleep metrics, sleepiness and the impact on performance
- The chances of experiencing high levels of sleepiness declined as age increased
- Those with supervisor roles compared poorly on all key sleep metrics
- Shift and day workers compared poorly to benchmark on the percentage being overweight or obese
- Stress was the most common barrier to obtaining enough sleep – cited by 32% of all respondents
- The average time from waking up to starting work was 2 hours 31 minutes
    - This was 6:49 on the night shift and 1:32 for those starting work before 07:00
- We see a jump in sleepiness after 10 hours of wakefulness and in the impact on performance after 14 hours of wakefulness.

About the results - Participation

We launched the study with our first organisation on 27th June 2023 and obtained the final piece of data for analysis on 21st August 2024. Across the study 237 workers engaged with the study, 214 completed registration and 153 provided data that could be analysed. After a significant data cleanse, we received 2,045 separate KSS sleepiness responses and 2,004 responses to the question on fatigue affecting performance. These responses came from just over 985 separate working days.

We are grateful to all those who helped us achieve this level of engagement and participation.

Results

One of the most pleasing aspects of this research is that broadly speaking we found what we would expect to find, from a sleep and circadian science perspective. Below is a table of the responses we received to our two main questions. These were:

- How do you feel at the moment?
- At this time how is fatigue affecting or likely to affect your performance at work?

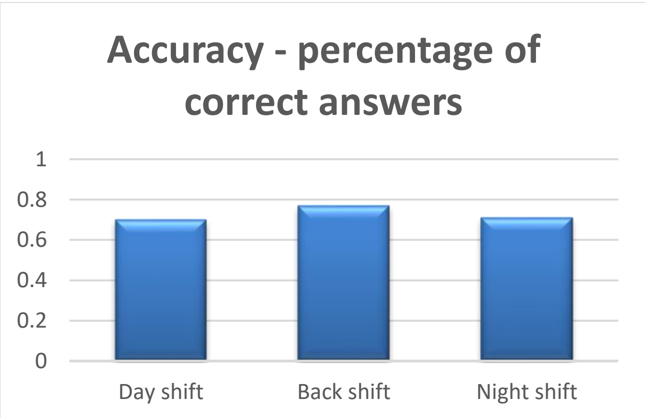
KSS responses	KSS responses				Performance responses			
Extremely Alert	1	363	18%	70%	Not at all	1145	57%	
Very alert	2	471	23%		Slightly	633	32%	
Alert	3	590	29%		Moderate	201	10%	
Rather alert	4	248	12%		Very	18	1%	1.2%
Neither sleepy or alert	5	111	5%		Extremely	7	0%	
Some signs of sleepiness	6	180	9%			2004	100%	
Sleepy, but no effort to keep awake	7	45	2%	4.0%				
Sleepy, but some effort to keep awake	8	29	1%					
Very sleepy, great effort to keep awake	9	8	0%					
		2045	100%					

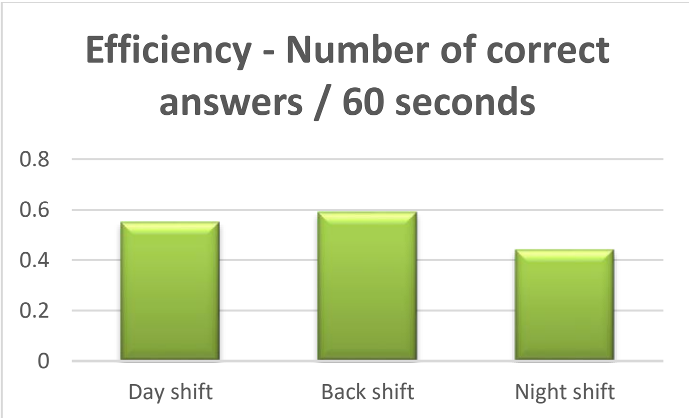
Across all responses, seventy percent of responses were in the top three 'alert' responses. Four percent of responses were in the bottom three options (scores of 7, 8 or 9) indicating high levels of sleepiness. The fatigue index, which is used extensively in UK shift working operations to predict fatigue risk in working patterns, is based on the percentage chance of the KSS response being 7 or greater over the course of a whole shift. In our research, we have where possible tried to break this down into hourly intervals for the different shift patterns operated across different organisations.

Fifty seven percent of responses indicate that fatigue was not at all likely to affect performance at work. Eleven percent of responses indicated at least a moderate effect on work performance due to fatigue. One percent of responses indicated that work performance is likely to be 'very' or 'extremely' affected by fatigue. Given it is well documented that we tend to be bad judges of how our sleepiness impacts our performance it is not a surprise to see this figure lower than those who indicated high levels of sleepiness.

Results from the alertness test

We created an alertness test, as detailed in the methodology to gain an objective measure of alertness. We then sought to understand to what extent the alertness test results are affected by whether they are undertaken at the beginning of a day shift, a back shift or a night shift. A day shift tends to be between the hours of 07:00 and 19:00. The night shift is the opposite. A back shift (or evening shift) tends to start in the late afternoon and finish late at night or in the early morning.





In terms of accuracy (the number of correct tests / the number of completed tests) there was little difference based on the shift. We saw a slight increase in accuracy on the back shift. A number of the trials conducted before a day shift were in the early morning and soon after waking, which we know is a time of lower alertness. There was little difference between accuracy results prior to a day shift and a night shift.

There was a little more variation when we looked at the results for efficiency (the number of trials per 60 seconds). Once again, we saw the best results on the back shift – slightly ahead of the day shift. However, there was a drop of 20% from the day shift to the night shift in terms of efficiency.

This suggests that it takes longer to process information on the night shift to achieve the same result in terms of accuracy. If it takes us longer to process information, drivers will be slower to react to hazards or events and therefore more prone to accidents and incidents.

Comparing shift patterns worked in those who drive for work

In this section we want to help the industry understand where fatigue risk increases in the different shift patterns that we encountered in the organisations we worked with. The tables below show the results for sleepiness and the impact on performance for those working day, back and night shifts.

KSS responses		Overall			Day shift			Back shift			Night shift		
		n. = 153			n. = 133			n. = 24			n. = 14		
Extremely Alert	1	363	18%		278	16%		16	13%		68	56%	
Very alert	2	471	23%	70%	426	24%	70%	25	20%	55%	19	16%	80%
Alert	3	590	29%		550	31%		27	22%		11	9%	
Rather alert	4	248	12%		217	12%		20	16%		9	7%	
Neither sleepy or alert	5	111	5%		104	6%		6	5%		1	1%	
Some signs of sleepiness	6	180	9%		150	8%		21	17%		6	5%	
Sleepy, but no effort to keep awake	7	45	2%		36	2%		4	3%		4	3%	
Sleepy, but some effort to keep awake	8	29	1%	4.0%	22	1%	3.6%	4	3%	6.5%	2	2%	6.6%
Very sleepy, great effort to keep awake	9	8	0%		6	0%		0	0%		2	2%	
		2045	100%	3.1	1789	100%	3.1	123	100%	3.6	122	100%	2.3

Performance responses		Overall			Day shift			Back shift			Night shift		
Not at all	1	1145	57%		986	56%		61	51%		94	77%	
Slightly	2	633	32%		567	32%		42	35%		19	16%	
Moderately	3	201	10%		179	10%		15	13%		5	4%	
Very	4	18	1%	1.2%	15	1%	1.1%	1	1%	0.8%	2	2%	3.3%
Extremely	5	7	0%		5	0%		0	0%		2	2%	
		2004	100%	1.6	1752	100%	1.6	119	100%	1.6	122	100%	1.4

As we would expect the day shift compares well on the chances of high levels of sleepiness and the likelihood of fatigue being either very or extremely likely to affect performance at work. The chances of high levels of sleepiness were significantly elevated in the back shift and the night shift. Interestingly the night shift had the highest percentage of responses in the top three alertness scores. This is because much of the data came from one seemingly always alert individual. The back shift had the lowest levels of scores indicating higher alertness but this group also had the lowest percentage of responses indicating fatigue being very or extremely likely to impact work performance.

The Day shift

Below is a ‘heatmap’ of results for the day shift. To build the heatmaps we plotted the data by time of day. There are three columns for each day. The left-hand column is the percentage chance that the KSS sleepiness score was greater than or equal to 7. In the middle is the average KSS score for that hour of the shift pattern. The right-hand column indicates the number of data points we received for that hour of the shift pattern. The colour coding is based on 20 or 33% brackets (three or five colours) and indicates relative risk. It is not intended to be a judgement on whether that hour of the week is problematic or problem free.

Chance of being very tired (KSS >=7), Average KSS score (1 to 9), Data points

	1 to	2.7		2.8	2.9		3.0	3.2		3.3	3.4		3.5	4.8				
Time	Monday			Tuesday			Wednesday			Thursday			Friday			Overall		
6	9%	3.2	23	4%	3.2	27	0%	2.8	31	18%	3.9	22	0%	3.0	25	5%	3.2	128
7	4%	3.2	24	0%	2.5	30	0%	3.0	27	0%	2.8	31	0%	2.2	16	1%	2.7	128
8	0%	2.4	25	5%	3.5	21	3%	2.8	35	0%	2.7	18	5%	2.7	20	3%	2.8	119
9	4%	2.8	25	0%	2.9	23	4%	3.1	25	0%	2.7	17	4%	2.8	23	3%	2.8	113
10	0%	2.9	25	5%	2.9	38	0%	2.8	39	0%	2.8	35	4%	2.7	23	2%	2.8	160
11	0%	2.5	32	6%	3.6	31	0%	3.1	32	0%	3.2	30	4%	3.2	25	2%	3.1	150
12	3%	3.2	30	3%	2.9	37	13%	3.9	31	0%	2.9	29	0%	2.6	29	4%	3.1	156
13	0%	3.3	37	0%	3.0	35	8%	3.2	39	10%	3.4	30	9%	3.5	22	5%	3.3	163
14	6%	3.5	36	3%	3.2	36	0%	3.0	40	0%	3.2	36	0%	3.4	29	2%	3.3	177
15	3%	2.9	33	5%	3.0	37	3%	3.4	30	4%	3.5	26	0%	3.1	27	3%	3.2	153
16	0%	2.7	21	0%	3.3	31	4%	3.5	27	3%	3.1	32	7%	3.5	14	2%	3.2	125
17	8%	3.6	13	0%	3.6	12	26%	4.5	19	0%	2.6	10	0%	4.3	4	10%	3.7	58
18	50%	4.8	4	9%	3.6	11	0%	2.9	7	0%	3.4	5	0%	3.3	4	10%	3.6	31
FRI	3.4%	3.1	3	3.0%	3.2	4.1	4.2%	3.2	8.6	3.1%	3.1	12.2	2.7%	3.1	15.2	3.3%	3.1	1661

When we look at the hourly 'heatmap' for the day shift we can see there is little difference between the different days. We had a mix of shift patterns being operated so this heatmap is not necessarily fully representative of those working a 'standard' Monday to Friday week, albeit many of the respondents were. With this in mind we see an increase in the chances of high levels of sleepiness on a Wednesday. It has proven to be a common finding on those working Monday to Friday patterns that there is a spike in sleepiness in the middle of the week.

Irrespective of the working pattern we see a jump in sleepiness between 13:00 and 15:00. In most populations we see a spike between 14:00 and 16:00, which is when we experience a natural dip due to circadian effects. Given we had a good number of respondents starting work before 07:00 it is likely that the circadian effect will kick in earlier for those with an earlier chronotype who can deal with repeated early starts. We then see an increase in sleepiness from 17:00 for those still working.

The figure in the off-blue box is the value (chance of hitting 7 or more on the KSS over the course of a shift) the Fatigue index gives based on a 12-hour working day with two breaks (once every 3 ½ hours) totalling an hour. We assume the workload is moderately demanding with little spare capacity and that the job requires continuous attention most of the time. Our results also assume a commute of 30 minutes each way – in line with the answers given to us by respondents during registration.

Time	Monday	Tuesday	Wednesda	Thursday	Friday	Data points	Overall
6	1.4	1.5	1.5	1.7	1.4	128	1.5
7	1.5	1.5	1.6	1.3	1.4	127	1.4
8	1.2	1.4	1.6	1.3	1.5	118	1.4
9	1.3	1.3	1.6	1.4	1.3	113	1.4
10	1.4	1.5	1.4	1.5	1.4	156	1.4
11	1.4	1.8	1.7	1.5	1.6	147	1.6
12	1.3	1.4	1.8	1.6	1.2	153	1.4
13	1.4	1.5	1.5	1.5	1.7	158	1.5
14	1.5	1.6	1.8	1.8	1.7	175	1.7
15	1.6	1.7	1.8	1.8	1.7	151	1.7
16	1.8	1.8	1.8	2.0	1.7	123	1.8
17	1.8	1.7	1.9	1.5	2.0	57	1.8
18	2.0	2.0	1.6	1.6	1.7	29	1.8
	1.5	1.6	1.6	1.6	1.6	511	1.6

	Fatigue interfere with work	
1	Not at all	
2	Slightly	
3	Moderately	
4	Very	
5	Extremely	
	1	1.3
	1.4	1.5
	1.6	1.6
	1.7	1.7
	1.8	

In the table above we have plotted the responses to the question; to what extent is fatigue affecting or likely to affect your performance at work. The responses ranged from 'Not at all' (1/5) to 'Extremely' (5/5).

The findings are very similar to the sleepiness findings. The second half of a Wednesday shift looks the most difficult time. We also see a 1-hour delay from when sleepiness increases to when workers start to feel that it is affecting performance at work, which is in itself an interesting finding. The increase in impact on work performance also coincides with the natural circadian dip in the mid-afternoon.

In appendix 2 we break down the results based on those working 8 to 9 hour day shifts those working 10 to 11 hour day shifts and those working 12+ hour day shifts.

The 'Back' shift

We did not have enough data from all participants to be able to tell which shift in a series of shifts each back shift represented. It was only participants who participated at 'Gold' level that supplied us with start and end times for their shift.

Back shifts started between 11:00 and 16:00 and finished between 22:00 and 02:00. We had data covering 11:00 to 01:00. Whilst we did not have enough data to do a full 'heatmap' we have been able to get an understanding of how fatigue risk increases between the start, middle and end of a shift by bracketing the responses together.

Driving for work - the back shift

Chance of high levels of sleepiness (KSS >=7), Average KSS score (1 to 9), Number of data points

		1 to	3					3.1	3.9					4	9									
Period	Monday			Tuesday			Wednesday			Thursday			Friday			Saturday			Sunday			Overall		
Beginning	0%	1.8	4	0%	2.0	3	0%	3.3	12	17%	3.0	6	11%	3.2	9	0%	2.1	7	0%	3.3	3	5%	2.7	44
Middle	0%	2.7	6	0%	1.5	2	0%	3.2	6	0%	3.7	11	0%	4.3	12	0%	3.0	10	0%	3.8	4	0%	3.2	51
End	0%	3.0	4	33%	6.3	3	0%	4.3	3	33%	6.2	6	50%	6.2	6	0%	4.0	3	0%	3.5	2	22%	4.8	27
	0%	2.5	14	13%	3.3	8	0%	3.6	21	13%	4.3	23	15%	4.5	27	0%	3.0	20	0%	3.5	9	5%	3.5	122

Most of this data set came from respondents in the emergency services (80%). The majority drove light commercial vehicles or cars and the vast majority of responses came from those working a 10-hour shifts.

The clear trend was for fatigue risk to increase as the shift moved from the beginning, through the middle to the end. A Friday shift saw the highest levels of sleepiness, especially the end of a Friday shift – perhaps, given the job roles of those who provided the data, due to demand on their services.

Driving for work - the back shift

Effect of fatigue on performance from 1 (Not at all) to 5 (Extremely). Average, Number of data points

		1 to	1.3		1.4	1.7			1.8	3.0						
Period	Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sunday		Overall	
Beginning	1.0	4	1.3	3	1.6	11	1.5	6	1.2	9	1.3	6	1.7	3	1.4	42
Middle	1.3	6	1.0	1	1.8	6	1.7	11	1.7	12	1.4	10	1.8	4	1.5	50
End	1.3	4	3.0	2	2.0	3	2.3	6	2.3	6	1.3	3	1.0	2	1.9	26
	1.2	14	1.8	6	1.8	20	1.9	23	1.7	27	1.4	19	1.5	9	1.6	118

When we looked at the response to the question; to what extent is fatigue affecting or likely to affect your performance at work we see a slightly different pattern. Thursday remains a high risk day and is when fatigue has its greatest effect on work performance. Wednesday remains a high risk day. Monday remains the lowest risk day of the week.

The Night shift

Sixty eight percent of the data we obtained from the night shift came from one individual who was seemingly constantly alert, which may have been the case but it is not so useful when we are looking at the relative risk of fatigue. We then stripped out that individual's results to see if we could find any patterns based on the time of day on the night shift.

Time	KSS scores				Performance impact	
18	0%	4.0	1		1.0	1
19						
20	0%	4.0	1		2.0	1
21	17%	4.2	6		2.0	6
22	0%	3.3	4		2.0	4
23	0%	4.3	3		2.0	3
0						
1	50%	6.5	2		2.5	2
2	50%	5.8	4		1.8	4
3	0%	3.3	3		2.0	3
4	0%	5.0	1		2.0	1
5	67%	7.0	3		3.3	3
6	33%	6.3	3		3.3	3
7	100%	9.0	1		5.0	1

Once gain the bulk of our data came from workers working 10 hours shifts. The dip in alertness at 01:00 is interesting as this is before the traditional 02:00 to 07:00 dip we would expect. This would be interesting to look at in more detail given the low level of data collected. Otherwise, the end of the night shift in the early morning is, as we would expect the most difficult part of the night shift.

Learnings from the voluntary sleep health self-assessment

As part of the study, we offered participants the chance to do the Third Pillar of Health sleep health self-assessment. This is an assessment we have run for over 10,000 (mainly) UK workers from 52 organisations in a wide variety of industries.

Once workers completed 30 working days of data, we provided them with a personalised report of their sleep health and highlight areas where they can make, often small, changes to help improve their sleep and personal energy. They have an option to download any of our ten factsheets which explain how certain factors impact sleep – mainly lifestyle factors. We know from working with organisations on multiple rounds of the assessment that workers who do the assessment and receive their report significantly improve all key metrics, sleep duration, sleep quality, daytime sleepiness and lifestyle factors on a long-term basis.

Voluntary assessment - key metrics	Overall	Day workers	Day benchmark	Shift workers	Shift benchmark
	n. = 139	n. = 58	n. = 3,757	n. = 81	n. = 6,319
Average workday sleep	6.61	6.66	6.52	6.57	6.24
The percent < 7 hours before work	48%	47%	56%	49%	70%
The percent carrying a sleep debt	78%	72%	79%	83%	87%
The percent at risk of sleep apnoea	26%	21%	20%	30%	26%
The percent at risk of insomnia	36%	32%	47%	39%	57%
Sleepiness at work (few times / month +)	65%	45%	66%	79%	86%
Sleepiness interfere with work (F/M+)	31%	22%	41%	38%	60%
Life satisfaction (score out of 10)	6.58	6.71	N/A	6.49	N/A

Across all those who participated average sleep duration prior to work is 6 hours 37 minutes, slightly below the recommended 7 to 9 hours. 48% of respondents fail to achieve seven or more hours of sleep a night. 78% of respondents are carrying a sleep debt – meaning they are not meeting their sleep need over the course of a shift cycle or working week. 26% of respondents are at risk of sleep apnoea and 36% are at risk of insomnia. 65% experience sleepiness at work at least a few times a week and for 31% sleepiness interferes with daily work activities at least a few days a month. The average life satisfaction score was 6.58 out of 10.

Whilst not being especially promising these results generally compare favourably to other populations we have assessed for both those working days and shift workers. The only noticeable negative comparison was the percentage of shift workers at risk of sleep apnoea.

The significant percentage of those at risk of sleep apnoea and insomnia provide a cause for concern given what we know from studies looking at the risk of sleep disorders in workers who drive for work.

The 2014 Sleepiness Safety and Transport study (9) said that "sleep disorders are the most common sources of excessive daytime sleepiness ("EDS") and fatigue. Several studies performed in the last twenty years show a clear relationship between sleep disorders and road accidents. Those with Obstructive Sleep Apnoea Syndrome frequently complain of EDS because of non-restorative and continuously disrupted sleep. This is also the situation with other sleep disorders such as RLS (restless leg syndrome), PLM (periodic limb movement) disorder, narcolepsy and insomnia."

The study said that "screening of sleep disorders and education of workers on proper sleep hygiene are fundamental keys to safe transport." It is important that initiatives to reduce the risk of drowsiness should be part of wider efforts to improve safety.

However, diagnosing sleep disorders in transport workers may not be easy. As the 2015 Harvard article (8) mentions: "workers in transportation industries are hesitant to seek medical evaluation and treatment for sleep problems. Perceived or real concerns about loss of employment tends to discourage those affected from seeking medical care. This results in large numbers of persons with untreated conditions working in potentially dangerous environments." The article goes on to suggest three important aspects of tackling sleep disorders. First, recognise a problem exists. Secondly, revise duty hours to be consistent with scientific evidence related to sleep deprivation and circadian misalignment. Thirdly, educate operators and workers.

Reviewing results based on job and demographic characteristics

Differences based on whether driving is the main part of their job

KSS responses		Overall			Main part			Major part			Drive a lot			Drive sometimes		
		n. = 153			n. = 38			n. = 63			n. = 42			n. = 10		
Extremely Alert	1	363	18%		101	23%		122	15%		94	16%		53	21%	
Very alert	2	471	23%	70%	72	17%	73%	181	22%	65%	149	26%	71%	79	31%	76%
Alert	3	590	29%		143	33%		232	28%		170	29%		63	25%	
Rather alert	4	248	12%		49	11%		115	14%		64	11%		26	10%	
Neither sleepy or alert	5	111	5%		28	6%		55	7%		24	4%		6	2%	
Some signs of sleepiness	6	180	9%		26	6%		90	11%		51	9%		18	7%	
Sleepy, but no effort to keep awake	7	45	2%		5	1%		26	3%		11	2%		4	2%	
Sleepy, but some effort to keep awake	8	29	1%	4.0%	5	1%	2.8%	4	0%	3.6%	13	2%	5.2%	7	3%	4.3%
Very sleepy, great effort to keep awake	9	8	0%		2	0%		0	0%		6	1%		0	0%	
		2045	100%		431	100%		825	100%		582	100%		256	100%	

Performance responses		Overall			Main part			Major part			Drive a lot			Drive sometimes		
Not at all	1	1145	57%		297	70%		437	54%		283	50%		153	60%	
Slightly	2	633	32%		90	21%		273	34%		204	36%		88	35%	
Moderately	3	201	10%		32	8%		93	11%		66	12%		12	5%	
Very	4	18	1%	1.2%	2	0%	0.9%	5	1%	0.7%	11	2%	2.6%	0	0%	0.0%
Extremely	5	7	0%		2	0%		1	0%		4	1%		0	0%	
		2004	100%		423	100%		809	100%		568	100%		253	100%	

Those for whom driving is the main part of their job had the lowest incidence of high levels of sleepiness (2.8%) and a high percentage (73%) of responses indicating high levels of alertness. This group was also slightly less likely than the overall average (0.9% vs 1.2%) to say that fatigue is very or extremely likely to impact performance at work. Those for whom driving was a major part of their job fared marginally better than the overall average in terms of responses indicating high levels of sleepiness (3.6%) and fatigue being very or extremely likely to affect work performance (0.7%). They did, however, have a lower percentage of responses indicating high levels of alertness (65%). Those who drive a lot to fulfil their job role, comfortably underperformed in both key metrics, despite having the same percentages of shift workers and emergency services workers as the overall average. Those who drive sometimes for work had the highest percentage of alert responses (76%) but also were more likely to indicate high levels of sleepiness (4.3%). However, for this group no responses indicated fatigue was very or extremely likely to impact performance at work.

Voluntary assessment - key metrics	Overall	Main	Major	A lot	Sometimes
	n. = 139	n. = 26	n. = 60	n. = 42	n. = 11
Average workday sleep	6.61	6.70	6.58	6.51	6.95
The percent < 7 hours before work	48%	46%	52%	52%	18%
The percent carrying a sleep debt	78%	73%	82%	74%	91%
The percent at risk of sleep apnoea	26%	24%	30%	22%	18%
The percent at risk of insomnia	36%	41%	29%	64%	45%
Sleepiness at work (few times / month +)	65%	73%	65%	64%	45%
Sleepiness interfere with work (F/M+)	31%	31%	31%	38%	9%
Life satisfaction (score out of 10)	6.58	6.19	6.53	6.62	7.09

Those who have to drive sometimes for work averaged 20 minutes more sleep prior to work than the average. This group also had the lowest percentage of workers obtaining less than 7 hours prior to work. However, in contrast they were also much more likely to be carrying a sleep debt and be at risk of insomnia. Those who drive sometimes for work had the lowest risk of sleep apnoea. Those for whom driving is a major part of their job performed better than all other groups in terms of insomnia risk. For all other groups over 40% of respondents were at risk of insomnia with 64% of those who drive a lot for work at risk – the highest of any worker group we analysed. Those who drive a lot for work were also the most likely to say that fatigue interferes with daily activities at least a few days a month. Those who's main role is driving, comfortably underperformed all other groups in terms of average life satisfaction scores.

Differences between the size of vehicle being driven

KSS responses		Overall			HGV			3.5t - 7.5t			Light commercial			Car		
		n. = 153			n. = 36			n. = 12			n. = 51			n. = 48		
Extremely Alert	1	363	18%		272	30%		5	5%		68	12%		21	4%	
Very alert	2	471	23%	70%	197	22%	80%	30	30%	73%	112	20%	58%	142	29%	64%
Alert	3	590	29%		261	29%		37	37%		152	27%		157	32%	
Rather alert	4	248	12%		72	8%		12	12%		99	17%		67	13%	
Neither sleepy or alert	5	111	5%		52	6%		4	4%		29	5%		27	5%	
Some signs of sleepiness	6	180	9%		48	5%		9	9%		73	13%		55	11%	
Sleepy, but no effort to keep awake	7	45	2%		9	1%		2	2%		23	4%		12	2%	
Sleepy, but some effort to keep awake	8	29	1%	4.0%	1	0%	1.3%	0	0%	2.0%	11	2%	7.0%	17	3%	5.8%
Very sleepy, great effort to keep awake	9	8	0%		2	0%		0	0%		6	1%		0	0%	
		2045	100%		914	100%		99	100%		573	100%		498	100%	

Performance responses		Overall			HGV			3.5t - 7.5t			Light commercial			Car		
Not at all	1	1145	57%		614	68%		35	35%		312	56%		202	42%	
Slightly	2	633	32%		203	22%		50	51%		189	34%		209	44%	
Moderately	3	201	10%		83	9%		13	13%		51	9%		57	12%	
Very	4	18	1%	1.2%	0	0%	0.3%	1	1%	1.0%	8	1%	1.8%	9	2%	2.3%
Extremely	5	7	0%		3	0%		0	0%		2	0%		2	0%	
		2004	100%		903	100%		99	100%		562	100%		479	100%	

We had low levels of data for those driving 3.5 to 7.5 tonne vehicles. Those driving HGVs compared favourably on sleepiness and the impact on performance at work. It should be noted that this group was less likely to work shifts (31% versus 51%) and had no emergency services workers. Those driving light commercial vehicles were much more likely to report high levels of sleepiness and fatigue affecting work performance. This is despite only a small increase in shift workers and EMS workers compared to the average. Those driving cars were much more likely to work shifts and be EMS workers. It is perhaps no surprise that they were more likely to report high levels of sleepiness and were much more likely to say that fatigue affects performance.

Given a report for Drivewise estimated there were 4.1m light commercial vehicles on the roads in 2019 the results for light commercial vehicles are a possible cause for concern. This is a group that would benefit from being enrolled in our second research study to test whether getting drivers to do an alertness and cognition test at the beginning of their shift and showing them their results with immediate feedback will improve key metrics, including accidents and incidents.

Voluntary assessment - key metrics	Overall	HGV	3.5t - 7.5t	LCV	Car
	n. = 139	n. = 29	n. = 12	n. = 46	n. = 44
Average workday sleep	6.61	6.61	6.88	6.55	6.62
The percent < 7 hours before work	48%	52%	25%	52%	45%
The percent carrying a sleep debt	78%	76%	67%	83%	80%
The percent at risk of sleep apnoea	26%	14%	25%	28%	32%
The percent at risk of insomnia	36%	31%	33%	37%	41%
Sleepiness at work (few times / month +)	65%	62%	67%	63%	73%
Sleepiness interfere with work (F/M+)	31%	17%	33%	39%	32%
Life satisfaction (score out of 10)	6.58	6.66	6.66	6.52	6.75

Those driving heavy goods vehicles 3.5 tonnes and above compared well in many key metrics. It was perhaps a surprise to see the low levels of sleep apnoea risk in HGV drivers. Light commercial vehicle drivers are obtaining the lowest levels of sleep prior to work and it is interfering with daily work activities. Those who drive cars for work had higher risk for sleep apnoea and insomnia and it is translating to sleepiness at work.

<u>Differences between the number of years participants have been driving for work</u>

KSS responses		Overall			< 2 years			2 to 5 years			5 to 10 years			10+ years		
		n. = 153			n. = 13			n. = 25			n. = 24			n. = 39		
Extremely Alert	1	363	18%		97	30%		42	16%		24	8%		59	18%	
Very alert	2	471	23%	70%	57	18%	73%	83	31%	76%	71	24%	71%	31	9%	53%
Alert	3	590	29%		83	26%		79	29%		115	39%		86	26%	
Rather alert	4	248	12%		43	13%		32	12%		31	10%		44	13%	
Neither sleepy or alert	5	111	5%		15	5%		8	3%		29	10%		32	10%	
Some signs of sleepiness	6	180	9%		22	7%		12	4%		18	6%		65	20%	
Sleepy, but no effort to keep awake	7	45	2%		6	2%		9	3%		6	2%		12	4%	
Sleepy, but some effort to keep awake	8	29	1%	4.0%	1	0%	2.2%	4	1%	4.8%	3	1%	3.0%	1	0%	4.5%
Very sleepy, great effort to keep awake	9	8	0%		0	0%		0	0%		0	0%		2	1%	
		2045	100%		324	100%		269	100%		297	100%		332	100%	

Performance responses		Overall			< 2 years			2 to 5 years			5 to 10 years			10+ years		
Not at all	1	1145	57%		232	72%		124	49%		170	59%		185	57%	
Slightly	2	633	32%		77	24%		105	41%		92	32%		78	24%	
Moderately	3	201	10%		12	4%		25	10%		23	8%		56	17%	
Very	4	18	1%	1.2%	0	0%	0.3%	1	0%	0.4%	2	1%	0.7%	4	1%	1.8%
Extremely	5	7	0%		1	0%		0	0%		0	0%		2	1%	
		2004	100%		322	100%		255	100%		287	100%		325	100%	

The percentage of responses in the top three alertness scores declined as driving experienced increased, with a notable drop in those who have been driving for work for over 10 years. There was no clear trend in the percentage of high levels of sleepiness. Those with the least experience (under two years) had the lowest percentage of scores indicating high levels of sleepiness. They also had a low percentage of responses indicating fatigue being very or extremely likely to impact performance at work. There was a clear trend in the likelihood of fatigue affecting performance at work increasing with driving experience.

It is interesting that those with the greatest driving experience had a comparably high likelihood of high levels of sleepiness and comfortably the highest chances of fatigue being either very or extremely likely to impact performance at work. This group were more likely to be male, in the top two age brackets, have driving as a significant part of their job and drive light commercial vehicles. This finding is counter intuitive, especially as our findings showed sleepiness decreasing as age increased. In further discussions we considered whether the stimulation the driver feels from driving diminishes with experience but we welcome further discussion.

Voluntary assessment - key metrics	Overall	< 2 years	2-5 years	5-10 years	10+ years
	n. = 139	n. = 8	n. = 21	n. = 21	n. = 36
Average workday sleep	6.61	6.19	6.39	6.62	6.84
The percent < 7 hours before work	48%	63%	62%	62%	33%
The percent carrying a sleep debt	78%	88%	81%	81%	75%
The percent at risk of sleep apnoea	26%	25%	24%	29%	31%
The percent at risk of insomnia	36%	25%	24%	33%	39%
Sleepiness at work (few times / month +)	65%	63%	67%	67%	72%
Sleepiness interfere with work (F/M+)	31%	38%	48%	24%	25%
Life satisfaction (score out of 10)	6.58	5.75	7.33	6.14	6.39

Despite seemingly positive results on levels of sleepiness and the impact on performance those with the least experience driving for work compared poorly on sleep duration, sleepiness interfering with work and on life satisfaction. Other groups showed mixed results. Those with the most diving experience are a concern in respect of the percentage at risk of sleep apnoea and experiencing sleepiness at work. In contrast this group compared well on the extent to which sleepiness interferes with work activities. We tend to be poor judges of how our alertness can be affected.

Differences based on the amount of physical activity required in their job role

KSS responses		Overall			None			Some			Moderate			Significant		
		n. = 153			n. = 12			n. = 40			n. = 74			n. = 21		
Extremely Alert	1	363	18%	70%	21	9%	73%	83	12%	66%	139	16%	70%	122	48%	76%
Very alert	2	471	23%		72	32%		149	21%		205	24%		31	12%	
Alert	3	590	29%		69	31%		232	33%		253	29%		40	16%	
Rather alert	4	248	12%		25	11%		90	13%		99	12%		30	12%	
Neither sleepy or alert	5	111	5%		7	3%		51	7%		51	6%		4	2%	
Some signs of sleepiness	6	180	9%		19	9%		74	10%		77	9%		16	6%	
Sleepy, but no effort to keep awake	7	45	2%	4.0%	6	3%	4.5%	14	2%	4.1%	20	2%	4.0%	6	2%	4.0%
Sleepy, but some effort to keep awake	8	29	1%		2	1%		10	1%		14	2%		3	1%	
Very sleepy, great effort to keep awake	9	8	0%		2	1%		5	1%		0	0%		1	0%	
		2045	100%		223	100%		708	100%		858	100%		253	100%	

Performance responses		Overall			None			Some			Moderate			Significant		
Not at all	1	1145	57%		97	44%		395	57%		472	56%		189	76%	
Slightly	2	633	32%		86	39%		230	33%		256	31%		47	19%	
Moderately	3	201	10%		30	14%		58	8%		104	12%		11	4%	
Very	4	18	1%	1.2%	5	2%	3.6%	8	1%	1.6%	4	0%	0.6%	1	0%	0.4%
Extremely	5	7	0%		3	1%		3	0%		1	0%		0	0%	
		2004	100%		221	100%		694	100%		837	100%		248	100%	

The level of physical activity involved in respondent's jobs had little affect in chances of recording high levels of sleepiness. There was a slight trend towards the incidence reducing as the amount of physical activity increased. The trend in the effect of fatigue on performance was much more pronounced. **Those whose jobs required the least physical activity were much more likely to say that fatigue is very or extremely likely to affect performance at work.**

Voluntary assessment - key metrics	Overall	None	Some	Moderate	Significant
	n. = 139	n. = 4	n. = 37	n. = 67	n. = 16
Average workday sleep	6.61	7.07	6.68	6.59	6.28
The percent < 7 hours before work	48%	18%	41%	49%	75%
The percent carrying a sleep debt	78%	91%	76%	78%	81%
The percent at risk of sleep apnoea	26%	36%	24%	24%	31%
The percent at risk of insomnia	36%	36%	41%	31%	50%
Sleepiness at work (few times / month +)	65%	64%	70%	64%	69%
Sleepiness interfere with work (F/M+)	31%	36%	27%	34%	25%
Life satisfaction (score out of 10)	6.58	5.64	6.78	6.87	6.06

The life satisfaction score for the (12) respondents whose jobs require little or no physical activity, who provided answers to the voluntary sleep health assessment is a clear cause for concern. Those whose jobs required significant physical activity compared poorly on many key metrics. The anomaly was the percentage who felt sleepiness interferes with daily work activities. We have seen similar anomalies in other groups in this study. This is surprisingly common in many of the populations we assess.

Differences between male and female workers

KSS responses		Overall			Male			Female		
		n. = 153			n. = 127			n. = 23		
Extremely Alert	1	363	18%	70%	369	19%	71%	1	1%	56%
Very alert	2	471	23%		446	23%		36	28%	
Alert	3	590	29%		574	29%		35	27%	
Rather alert	4	248	12%		240	12%		14	11%	
Neither sleepy or alert	5	111	5%		103	5%		10	8%	
Some signs of sleepiness	6	180	9%		165	8%		21	16%	
Sleepy, but no effort to keep awake	7	45	2%	4.0%	39	2%	3.7%	7	5%	8.6%
Sleepy, but some effort to keep awake	8	29	1%		25	1%		4	3%	
Very sleepy, great effort to keep awake	9	8	0%		8	0%		0	0%	
		2045	100%		1969	100%		128	100%	

Performance responses		Overall			Male			Female		
Not at all	1	1145	57%		1122	58%		49	41%	
Slightly	2	633	32%		600	31%		56	47%	
Moderately	3	201	10%		192	10%		12	10%	
Very	4	18	1%	1.2%	17	1%	1.2%	1	1%	1.7%
Extremely	5	7	0%		6	0%		1	1%	
		2004	100%		1937	100%		119	100%	

Female workers made up 15% of participants. However, it is clear to see that female respondents were much more likely to indicate high levels of sleepiness and much less likely to indicate scores in the top alertness scores. Female workers experience greater amplitude in sleepiness over a day. However, it is likely there is a level of under-reporting of sleepiness and the effect on performance in male workers.

Voluntary assessment - key metrics	Overall	Male	Female
	n. = 139	n. = 120	n. = 18
Average workday sleep	6.61	6.64	6.33
The percent < 7 hours before work	48%	46%	61%
The percent carrying a sleep debt	78%	78%	83%
The percent at risk of sleep apnoea	26%	26%	28%
The percent at risk of insomnia	36%	34%	50%
Sleepiness at work (few times / month +)	65%	66%	67%
Sleepiness interfere with work (F/M+)	31%	30%	44%
Life satisfaction (score out of 10)	6.58	6.57	6.61

Female workers obtained less sleep before work, were much more likely to be at risk of insomnia and more likely to say that fatigue interferes with daily work activities. It is no surprise to see the results above in respect of alertness and the effect on performance.

Differences based on age

KSS responses		0 to 25			26 to 35			36 to 45			46 to 55			56 to 65		
		n. = 9			n. = 39			n. = 42			n. = 35			26		
Extremely Alert	1	5	10%		69	15%		151	21%		110	25%		38	9%	
Very alert	2	9	18%	57%	133	28%	67%	150	21%	73%	72	16%	74%	119	28%	63%
Alert	3	15	29%		115	24%		222	31%		143	33%		108	26%	
Rather alert	4	9	18%		57	12%		79	11%		43	10%		65	15%	
Neither sleepy or alert	5	1	2%		32	7%		31	4%		26	6%		26	6%	
Some signs of sleepiness	6	8	16%		42	9%		52	7%		28	6%		55	13%	
Sleepy, but no effort to keep awake	7	3	6%		16	3%		11	2%		9	2%		7	2%	
Sleepy, but some effort to keep awake	8	1	2%	7.8%	9	2%	5.3%	9	1%	3.9%	7	2%	3.7%	3	1%	2.4%
Very sleepy, great effort to keep awake	9	0	0%		0	0%		8	1%		0	0%		0	0%	
		51	100%		473	100%		713	100%		438	100%		421	100%	

Performance responses		0 to 25			26 to 35			36 to 45			46 to 55			56 to 65		
Not at all	1	27	55%		220	48%		387	55%		341	79%		199	48%	
Slightly	2	17	35%		190	41%		245	35%		67	16%		135	32%	
Moderately	3	4	8%		46	10%		58	8%		21	5%		74	18%	
Very	4	1	2%	2.0%	3	1%	0.9%	8	1%	1.7%	1	0%	0.2%	5	1%	1.9%
Extremely	5	0	0%		1	0%		4	1%		0	0%		3	1%	
		49	100%		460	100%		702	100%		430	100%		416	100%	

As we often find, the youngest age groups have the highest levels of sleepiness and the oldest group the lowest levels. There was no clear trend in the likelihood of fatigue being very or extremely likely to affect performance at work by age bracket. The youngest, middle and oldest age brackets were more likely to indicate a performance impact.

Voluntary assessment - key metrics	Overall	0 to 25	26 to 35	36 to 45	46 to 55	56 to 65
	n. = 139	n. = 8	n. = 34	n. = 41	n. = 31	n. = 22
Average workday sleep	6.61	6.69	6.47	6.33	6.51	7.05
The percent < 7 hours before work	48%	38%	56%	56%	45%	27%
The percent carrying a sleep debt	78%	88%	82%	80%	74%	73%
The percent at risk of sleep apnoea	26%	13%	35%	29%	23%	18%
The percent at risk of insomnia	36%	25%	41%	27%	45%	41%
Sleepiness at work (few times / month +)	65%	63%	79%	56%	68%	64%
Sleepiness interfere with work (F/M+)	31%	38%	58%	37%	26%	50%
Life satisfaction (score out of 10)	6.58	7.13	6.24	6.88	6.32	6.82

The youngest age group came out broadly in line with overall averages. The oldest age group compared favourably on many metrics other than the percentage at risk of insomnia. This appeared to translate to sleepiness interfering with daily work activities. **The group of greatest concern in terms of sleep duration, sleep quality as well as the impact on work and life satisfaction is those (39) respondents between 26 and 35.** There is another clear anomaly in terms of the percentage of responses saying that fatigue is very or extremely likely to affect performance at work for those 26 to 35 given the results of key sleep metrics.

Differences based on job seniority

KSS responses		Overall			Operative			Supervisor			Manager			Professional		
Extremely Alert	1	363	18%		275	19%		32	11%		45	29%		7	6%	
Very alert	2	471	23%	70%	313	22%	71%	88	30%	69%	37	24%	80%	23	19%	61%
Alert	3	590	29%		421	30%		85	29%		44	28%		44	36%	
Rather alert	4	248	12%		162	11%		38	13%		9	6%		19	16%	
Neither sleepy or alert	5	111	5%		82	6%		10	3%		7	4%		7	6%	
Some signs of sleepiness	6	180	9%		109	8%		25	8%		11	7%		13	11%	
Sleepy, but no effort to keep awake	7	45	2%		29	2%		8	3%		3	2%		4	3%	
Sleepy, but some effort to keep awake	8	29	1%	4.0%	14	1%	3.6%	11	4%	6.4%	1	1%	2.5%	4	3%	6.6%
Very sleepy, great effort to keep awake	9	8	0%		8	1%		0	0%		0	0%		0	0%	
		2045	100%		1413	100%		297	100%		157	100%		121	100%	

Performance responses		Overall			Operative			Supervisor			Manager			Professional		
Not at all	1	1145	57%		825	59%		142	49%		100	65%		36	31%	
Slightly	2	633	32%		420	30%		106	37%		44	29%		54	46%	
Moderately	3	201	10%		129	9%		37	13%		6	4%		25	21%	
Very	4	18	1%	1.2%	9	1%	1.1%	3	1%	1.0%	3	2%	2.6%	2	2%	1.7%
Extremely	5	7	0%		6	0%		0	0%		1	1%		0	0%	
		2004	100%		1389	100%		288	100%		154	100%		117	100%	

We did not have enough data to provide meaningful results for senior managers or board directors. Supervisors and professionals had the lowest percentage of alert scores and the highest percentage of results indicating high levels of sleepiness. Managers had the lowest percentage of scores indicating high levels of sleepiness but the highest chance of saying fatigue is very or extremely likely to affect performance at work.

Voluntary assessment - key metrics	Overall	Operative	Supervisor	Manager	Professional
	n. = 139	n. = 87	n. = 15	n. = 16	n. = 10
Average workday sleep	6.61	6.66	6.28	6.63	6.80
The percent < 7 hours before work	48%	47%	60%	44%	30%
The percent carrying a sleep debt	78%	78%	100%	75%	60%
The percent at risk of sleep apnoea	26%	16%	40%	38%	20%
The percent at risk of insomnia	36%	36%	40%	38%	30%
Sleepiness at work (few times / month +)	65%	66%	73%	63%	60%
Sleepiness interfere with work (F/M+)	31%	34%	40%	6%	40%
Life satisfaction (score out of 10)	6.58	6.60	6.33	6.81	6.80

Whilst professionals compared favourably on almost all sleep metrics, they experienced some of the highest levels of sleepiness regularly interfering with daily work activities, which ties into the results we saw above. This group had a relatively high percentage of emergency services respondents. Supervisors compared unfavourably on all key sleep metrics, including sleepiness interfering with work activities. However, in terms of the data collected during shifts there is an anomaly with the percentage of responses saying fatigue is either very or extremely likely to affect performance at work.

How do respondents compare on lifestyle factors that can inhibit good sleep and against equivalent benchmark data

Those who chose to undertake the (voluntary) sleep health self-assessment also answered a number of questions on their lifestyle habits. In their report they were given ‘traffic light’ coloured feedback. Each lifestyle factor was accompanied by a factsheet participants could download to understand how that factor can impact sleep, as well as tips on how to reduce the impact of that lifestyle habit on their sleep.

We have split the workers for each section into day and shift workers to compare results for lifestyle factors that can inhibit our ability to obtain sufficient good quality sleep. We have then compared the results to benchmark data from 3,757 day workers and 6,319 shift workers from a wide variety of companies and industries.

	Day workers			Shift workers	
	Benchmark	Study respondents		Benchmark	Study respondents
Use alcohol as a sleep aid	8%	5%		10%	6%
5+ caffeinated drinks a day	23%	33%		36%	26%
Last caffeine 6+ hours before bed	45%	22%		21%	23%
Last caffeine within 2 hours of bed	13%	28%		20%	32%
Smoke tobacco	11%	14%		10%	6%
Use any form of nicotine		17%			15%
< 150 minutes of exercise a week	48%	55%		43%	57%
Make healthy food choices		86%			77%
Use gadgets before bed	92%	88%		90%	91%
Use gadgets in bed	65%	60%		69%	74%
Life satisfaction		6.71			6.49
BMI 25 to 29.9	33%	38%		42%	35%
BMI 30+	25%	31%		24%	41%
Overweight or obese	64%	69%		66%	75%

Key highlights from lifestyle questions asked in the voluntary assessment

- All worker groups compare well on the percentage of respondents using alcohol as a sleep aid
- Day workers compare well on the percentage of respondents using gadgets in bed
- Shift workers compared well on drinking 5+ caffeinated drinks and on smoking
- All respondents compare poorly on the percentage drinking caffeine within two hours of bed
- All respondents compare poorly on the percentage who exercise for more than 150 minutes a week
- The vast majority of workers make healthy food choices
- Shift workers compared poorly on using gadgets in bed
- Shift worker life satisfaction scores are below those of day workers, which is in line with other populations
- 69% of day workers are overweight or obese. This is the case for 75% of shift workers. These figures compare poorly to their respective benchmark figures.

<u>Reasons stopping respondents from getting enough sleep</u>

As part of registration, we asked all participants: Other than work reasons are there any other reasons stopping you from getting good sleep? We received 214 responses. 73 (34%) indicated there were no reasons. 52 (24%) indicated one reason. 89 (42%) of the 214 responses indicated more than one reason prevents them from getting good sleep.

Reasons for not sleeping enough	% of those indicating a problem	% of all respondents
Accomodation away from home	13%	8%
Sleep in vehicle away from home	1%	0%
Pain condition	9%	6%
I don't sleep well	43%	29%
Children or partner	28%	18%
Noise disturbance	28%	19%
Light disturbance	22%	14%
Stress	48%	32%
Medications	1%	1%
Frequent need to use bathroom	9%	6%
Other	14%	9%

Stress was the top reason cited by respondents preventing them from obtaining sufficient good quality sleep (32% of all respondents). 29% of respondents said they simply don’t sleep well. Noise (19%), disturbance by children or partners (18%) and light (14%) were other common barriers cited by respondents.

The impact of continued wakefulness on KSS sleepiness scores

Hours awake / KSS	1		2		3		4		5		6		7		8		9		Total
<=1	19	7%	35	8%	84	16%	30	14%	8	13%	19	13%	6	19%	3	13%	0	0%	204
	9%		17%		41%	68%	15%		4%		9%	28%	3%		1%		0%	4%	3.3
<=2	21	7%	31	7%	34	7%	21	10%	4	6%	5	4%	0	0%	2	9%	0	0%	118
	18%		26%		29%	73%	18%		3%		4%	25%	0%		2%		0%	2%	2.8
<=3	22	8%	23	5%	23	4%	9	4%	1	2%	8	6%	0	0%	1	4%	1	14%	88
	25%		26%		26%	77%	10%		1%		9%	20%	0%		1%		1%	2%	2.8
<=4	20	7%	31	7%	27	5%	4	2%	0	0%	1	1%	0	0%	1	4%	0	0%	84
	24%		37%		32%	93%	5%		0%		1%	6%	0%		1%		0%	1%	2.3
<=5	32	11%	28	7%	43	8%	11	5%	4	6%	5	4%	1	3%	0	0%	0	0%	124
	26%		23%		35%	83%	9%		3%		4%	16%	1%		0%		0%	1%	2.6
<=6	31	11%	41	10%	34	7%	15	7%	7	11%	4	3%	0	0%	2	9%	3	43%	137
	23%		30%		25%	77%	11%		5%		3%	19%	0%		1%		2%	4%	2.8
<=7	15	5%	33	8%	33	6%	13	6%	6	9%	10	7%	3	10%	0	0%	0	0%	113
	13%		29%		29%	72%	12%		5%		9%	26%	3%		0%		0%	3%	3.0
<=8	23	8%	45	10%	33	6%	6	3%	3	5%	6	4%	2	6%	2	9%	1	14%	121
	19%		37%		27%	83%	5%		2%		5%	12%	2%		2%		1%	4%	2.7
<=9	24	8%	32	7%	37	7%	13	6%	4	6%	4	3%	2	6%	3	13%	2	29%	121
	20%		26%		31%	77%	11%		3%		3%	17%	2%		2%		2%	6%	2.9
<=10	18	6%	32	7%	44	9%	19	9%	2	3%	13	9%	1	3%	0	0%	0	0%	129
	14%		25%		34%	73%	15%		2%		10%	26%	1%		0%		0%	1%	3.0
<=11	19	7%	28	7%	20	4%	19	9%	8	13%	21	15%	3	10%	4	17%	0	0%	122
	16%		23%		16%	55%	16%		7%		17%	39%	2%		3%		0%	6%	3.5
<=12	6	2%	25	6%	26	5%	15	7%	4	6%	6	4%	3	10%	0	0%	0	0%	85
	7%		29%		31%	67%	18%		5%		7%	29%	4%		0%		0%	4%	3.2
<=13	10	4%	12	3%	26	5%	8	4%	5	8%	14	10%	5	16%	0	0%	0	0%	80
	13%		15%		33%	60%	10%		6%		18%	34%	6%		0%		0%	6%	3.6
<=14	10	4%	13	3%	10	2%	10	5%	2	3%	6	4%	2	6%	0	0%	0	0%	53
	19%		25%		19%	62%	19%		4%		11%	34%	4%		0%		0%	4%	3.1
<=15	3	1%	7	2%	18	3%	12	6%	2	3%	8	6%	0	0%	3	13%	0	0%	53
	6%		13%		34%	53%	23%		4%		15%	42%	0%		6%		0%	6%	3.8
<=16	6	2%	7	2%	7	1%	4	2%	3	5%	7	5%	2	6%	0	0%	0	0%	36
	17%		19%		19%	56%	11%		8%		19%	39%	6%		0%		0%	6%	3.6
<=17	2	1%	3	1%	10	2%	4	2%	1	2%	3	2%	0	0%	0	0%	0	0%	23
	9%		13%		43%	65%	17%		4%		13%	35%	0%		0%		0%	0%	3.3
<=18	3	1%	2	0%	1	0%	3	1%	0	0%	0	0%	0	0%	0	0%	0	0%	9
	33%		22%		11%	67%	33%		0%		0%	33%	0%		0%		0%	0%	2.4
<=19	1	0%	1	0%	3	1%	1	0%	0	0%	1	1%	1	3%	2	9%	0	0%	10
	10%		10%		30%	50%	10%		0%		10%	20%	10%		20%		0%	30%	4.5
<=20	0	0%	1	0%	2	0%	0	0%	0	0%	0	0%	0	0%	0	0%	0	0%	3
	0%		33%		67%	100%	0%		0%		0%	0%	0%		0%		0%	0%	2.7
Total	285	100%	430	100%	515	100%	217	100%	64	100%	141	100%	31	100%	23	100%	7	100%	1713
	17%		25%		30%	72%	13%		4%		8%	25%	2%		1%		0%	4%	3.0

We looked at KSS sleepiness scores based on the number of hours of continued wakefulness. These scores were collected from gold users who provided us with their wake time. There were some interesting results:

- The average time from waking to starting work was 2 hours and 31 minutes on the day shift, 5 hours 30 minutes on the back shift and 6 hours 49 minutes on the night shift. This figure was 1 hour 32 minutes for those working days shifts that consistently started before 7 o'clock in the morning
- The percentage chance of recording a 7, 8 or 9 score jumps after 10 hours of continued wakefulness
- We know from research that our alertness is impaired after 17 hours of wakefulness to an equivalent BAC of 0.05%, after 20 hours 0.08% (England's drink drive limit) and after 24 hours 0.10% (14)
- Seventy-seven percent of 'normal' shift lengths were 10 hours or less
- Average total commute was 63 minutes – 32 minutes each way.

The impact of continued wakefulness on the effect on work performance

Hours awake / KSS	Not at all		Slightly		Moderately		Very		Extremely		Total
<=1	99	11%	82	14%	19	9%	4	22%	0	0%	204
	49%		40%		9%		2%		0%	2%	1.6
<=2	74	8%	37	6%	7	3%	0	0%	0	0%	118
	63%		31%		6%		0%		0%	0%	1.4
<=3	64	7%	15	3%	6	3%	1	6%	1	25%	87
	74%		17%		7%		1%		1%	2%	1.4
<=4	55	6%	26	4%	1	0%	1	6%	0	0%	83
	66%		31%		1%		1%		0%	1%	1.4
<=5	81	9%	34	6%	8	4%	0	0%	0	0%	123
	66%		28%		7%		0%		0%	0%	1.4
<=6	72	8%	50	9%	10	5%	0	0%	2	50%	134
	54%		37%		7%		0%		1%	1%	1.6
<=7	61	7%	35	6%	13	6%	2	11%	0	0%	111
	55%		32%		12%		2%		0%	2%	1.6
<=8	75	8%	34	6%	10	5%	1	6%	0	0%	120
	63%		28%		8%		1%		0%	1%	1.5
<=9	58	7%	50	9%	9	4%	3	17%	0	0%	120
	48%		42%		8%		3%		0%	3%	1.6
<=10	58	7%	50	9%	21	10%	0	0%	0	0%	129
	45%		39%		16%		0%		0%	0%	1.7
<=11	54	6%	40	7%	23	11%	2	11%	0	0%	119
	45%		34%		19%		2%		0%	2%	1.8
<=12	35	4%	30	5%	18	9%	1	6%	0	0%	84
	42%		36%		21%		1%		0%	1%	1.8
<=13	31	3%	33	6%	14	7%	1	6%	0	0%	79
	39%		42%		18%		1%		0%	1%	1.8
<=14	26	3%	20	3%	12	6%	0	0%	0	0%	58
	45%		34%		21%		0%		0%	0%	1.8
<=15	15	2%	24	4%	12	6%	0	0%	1	25%	52
	29%		46%		23%		0%		2%	2%	2.0
<=16	13	1%	12	2%	8	4%	2	11%	0	0%	35
	37%		34%		23%		6%		0%	6%	2.0
<=17	9	1%	7	1%	7	3%	0	0%	0	0%	23
	39%		30%		30%		0%		0%	0%	1.9
<=18	6	1%	1	0%	2	1%	0	0%	0	0%	9
	67%		11%		22%		0%		0%	0%	1.6
<=19	2	0%	6	1%	2	1%	0	0%	0	0%	10
	20%		60%		20%		0%		0%	0%	2.0
<=20	3	0%	0	0%	0	0%	0	0%	0	0%	3
	100%		0%		0%		0%		0%	0%	1.0
Total	891	100%	586	100%	202	100%	18	100%	4	100%	1701
	52%		34%		12%		1%		0%		1.6

We also looked at the effect of fatigue at work based on the number of hours of continued wakefulness. There were a couple of interesting results:

- In the first three hours of wakefulness fatigue is more likely to affect performance at work, which is interesting given the results from waking to starting work for those with early shifts (before 07:00)
- We see a sustained increase in the chance of fatigue being very or extremely likely to affect performance at work after 14 hours of continued wakefulness
- Somone working a 12 hour night shift will start work roughly seven hours after waking. After 14 hours of wakefulness – 7 hours into a shift, they will start to feel more tired. After 17 hours of wakefulness, 10 hours into a shift, performance will be equivalent to a BAC impairment of 0.05% (the drink drive limit in Scotland). They will still have 2 more hours of their shift and their commute home still to navigate.

Discussion and recommendations

At the start of this research project, we set out to try and gain a greater insight in to fatigue in those who drive for work. We now have some answers to the questions we posed at the beginning of our research. These were:

- Do longer shift result in higher levels of sleepiness and a greater impact on performance at work?
- Is sleepiness and the impact on performance greater where driving is the main part of a worker's job?
- Does sleepiness and the impact on performance reduce with more years spent driving for work?
- Does the type of vehicle being driven have any effect on sleepiness and performance at work?
- Does the level of seniority with an organisation have any effect on sleepiness and performance at work?
- Do jobs requiring physical activity increase the likelihood of fatigue?
- Does sleepiness and the impact on performance reduce as age increases?
- Does (biological) sex impact on sleepiness and performance at work?

Our data, as we outline in appendix 2, suggests that longer shifts reduce the risk of high levels of sleepiness, albeit there was no difference when looking at the impact of fatigue on performance at work. This is at odds with findings in other populations. We did not have a huge cohort of data from the night shift. It is however something that would be interesting to investigate further.

The greater the importance of driving to someone's job role the less we saw high levels of sleepiness. We also saw lower than average impact on performance at work. Given driving is a sedentary activity this finding is slightly counter intuitive. This group did have a lower percentage of respondents driving cars or light commercial vehicles and a higher percentage working permanent day shifts. It would be interesting to discuss whether, where driving is the main part of the job role, drivers might be more reluctant to report high levels of sleepiness or an effect on performance, given the potential severity of the consequences.

There was a clear trend in the data we collected showing that as the number of years driving for work increased the greater the effect of fatigue on performance at work. This was broadly seen in the risk of experiencing high levels of sleepiness too. It was interesting that those who have been driving for less than two years compared poorly on many of the key sleep and sleepiness metrics we asked as part of the voluntary assessment, yet compared well on the likelihood of high levels of sleepiness and the impact on performance at work.

From the data we gathered we saw significantly lower risk of high levels of sleepiness in those driving heavy good vehicles, compared to cars and light commercial vehicles. Those driving cars and even more so light commercial vehicles ("LCVs"), were also more likely to report fatigue being very or extremely likely to impact performance at work. This group of drivers also compared poorly on many of the key sleep and sleepiness metrics as well as self-reported life satisfaction. Drivers of LCVs are a group we feel would benefit from any effort aimed at reducing fatigue whilst driving. This finding could align with the lack of drivers' hours regulations for those driving lighter vehicles and the potential for longer shifts.

Supervisors and those in 'professional' roles were more likely to experience high levels of sleepiness with operatives and managers less likely to. Supervisors were less likely to say that fatigue will impact on work performance than the overall average. This was also the case for operatives. Professionals and managers, managers especially, were more likely to say that fatigue is very or extremely likely to impact performance at work. Supervisors compared poorly on all key sleep metrics and were more likely to cite stress as a barrier to achieving sufficient good quality sleep than the average.

Those whose jobs require little or no physical activity were more likely to report high levels of sleepiness and were much more likely to report fatigue as being very or extremely likely to impact performance at work. Those whose roles required some physical activity slightly underperformed the average on both metrics. Those whose roles required significant physical activity were broadly in line with average on the likelihood of high levels of sleepiness but compared very favourably on the impact on work performance. This was slightly at odds with unfavourable comparisons on key sleep metrics.

There was a clear trend in the likelihood of high levels of sleepiness decreasing as age increased. There was no clear trend when looking at the impact of fatigue on performance at work. The youngest age bracket (up to 25) was most likely to say that fatigue was affecting or likely to affect performance at work.

Female workers compared unfavourably on all key sleep metrics, which is not uncommon in populations we assess. This translated into much greater risk of high levels of sleepiness and an increased risk of fatigue impacting performance at work. Another reason why this might be the case is it is well known in sleep science literature that the circadian amplitude in cognition is stronger in females than males.

It is clear from our results that a significant proportion of those who drive for work are not obtaining sufficient good quality sleep before work and that this is translating into tiredness and fatigue, which in many cases is affecting their performance at work.

We know that sleepiness and fatigue in driving has negative consequences. This is not just in terms of accidents and incidents but there are economic costs too. We know from the statistics, alluded to in the introduction, that there are tens of thousand of incidents each year, resulting in thousands of deaths and serious injuries, involving those who drive for work. Often the person driving for work survives a fatal accident and must live with the consequences. However, the number of non-injury collisions will dwarf the number or serious injury or fatal collisions and the economic costs to drivers and organisations from non-injury collisions will be significant, even just in repairs and insurance.

Two areas where we feel organisations will get significant immediate return on investment, time and / or money are in staff and supervisor / manager training, as well as sleep disorder screening for drivers, with a clear programme of next steps to follow.

As the 2014 Sleepiness, Safety and Transport study (9) said, "screening of sleep disorders and education of workers on proper sleep hygiene are fundamental keys to safe transport." The 2015 Harvard article we alluded to in the introduction (8) alludes to an interesting study done in Australia in 2015 which noted that crash rates are higher amongst truck drivers who had not completed a fatigue management education programme."

There are some issues associated with diagnosing sleep disorders in transportation workers. As we alluded to in the results there are a number of reasons why those who drive for work may be hesitant to undergo sleep disorder screening.

In the UK, we would welcome greater clarity on when someone with a recent diagnosis for a sleep disorder – especially sleep apnoea – can and cannot drive, when it is fundamental to their job. We acknowledge there is a difficult and delicate balance. A policy that gave those with new diagnosis sufficient time to seek treatment, reach a point where they were comfortable with the treatment and then be compliant with directives on treatment, thereby allowing them to continue to drive as normal, would make it much more attractive for drivers and their employers to run sleep disorder screening programmes. This would ultimately significantly reduce the risk of accidents and incidents and improve individual and public health outcomes. However, on the other hand, can society accept that there will be drivers on the road with a known sleep disorder diagnosis, who will on occasion cause accidents, some of which may be serious.

The 2014 study (9) also suggested another potential intervention. "Continuous blue light exposure during nocturnal driving resulted in significantly reduced involuntary lane changes compared to a caffeine placebo." We are of the view that light interventions will become commonplace in workplaces, especially on night shifts before long. This is an intervention we are starting to explore with a number of clients from a wide range of industries.

Another option would be to run regular sleep health assessments for drivers to help them understand areas they can make improvements and for organisations to see what their risk levels are and how best to plan to mitigate them.

As well as education and training, sleep disorder screening, light therapy and sleep health assessment, other potential interventions include saliva testing for fatigue biomarkers, focus groups and shift planning.

Conclusion

It is clear from our research that fatigue is an issue in driving operations. A significant part of the reason for that is insufficient and poor quality sleep. We also found that certain job characteristics increased the risk of sleepiness and impacted drivers' performance at work. These characteristics included where driving is not the main part of their job role, as the number of years driving for work increases, those who drive cars or light commercial vehicles, those whose roles require little physical activity, younger and female workers.

As we explored in the introduction tiredness and fatigue has negative outcomes for safety and productivity in those who drive for work. As we also explored, there are significant productivity and health costs associated with tiredness and fatigue. It logically follows that anything the industry can do to reduce the impact of fatigue will be beneficial to the industry, employers and of course, the workers.

Running education initiatives is the low hanging fruit with well-documented benefits and improvements in accident metrics – as we have detailed in this report.

As we mentioned in the discussion, we would welcome a full debate as how best to diagnose and treat the great number of drivers with undiagnosed sleep disorders, that pose a significantly increased risk to all road users, whilst remaining undiagnosed, without curtailing their ability to work and earn themselves and their employers an income.

Out next steps are:

- To launch our second study in conjunction with National Highways. This study is to test a simple hypothesis. We will ask participants to do a 60-second alertness and cognition test at the beginning of a shift and provide them with their results and show how the result today compares to their (rolling) baseline, high and low scores with a simple message about driver fatigue. We then want to work with participating organisations to monitor if being aware of their alertness levels leads to better driving behaviours and improvements in key metrics. All participants also get the opportunity to undertake a shortened version of our sleep health self-assessment and obtain immediate feedback via a personalised report. We hope to launch this study in early 2025 and we welcome any fleet that would like to participate.

- In addition we will use the data we have collected in this research project to create a new accident and investigation tool so those who investigate incidents have an app they can use to ask the right questions and get a series of (red, amber or green) flags indicating whether fatigue may have been a contributory factor in any incidents.

If you are interested in participating in the second research project, in the new accident investigation tool or any of the interventions mentioned above, please contact Third Pillar of Health via our website: https://www.thirdpillarofhealth.com/contact.

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Appendix 1 – Questions asked at registration

The following questions were asked of all participants in the study. We wanted to understand how demographic and job-specific job characteristics influenced fatigue risk.

SECTION 1 – JOB TYPE	☐ Please tick one box unless asked to tick all that apply.
1.1 Which organisation do you work for?	☐ List of organisations
1.1 ai What is your role at Cadent?	☐ List of departments / job roles / divisions – each organisation had one option
1.2 What is your job role?	[Free text box]
1.3 In your role is driving?	☐ The main part of my job [Also 1.3a] ☐ A major part of my job (e.g. making multiple deliveries / journeys) [Also 1.3a] ☐ Not my main job but I drive a lot to fulfil my role [Go to 1.4] ☐ Something I have to do sometimes [Go to 1.4]
1.3a How many years has driving been a major part of your job role?	☐ Less than 6 months ☐ 6 months to 2 years ☐ 2 years to 5 years ☐ 5 years to 10 years ☐ 10 year or more
1.4 What type of vehicle do you drive?	☐ Heavy Goods Vehicle (over 7.5t) ☐ Heavy Goods Vehicle (between 3.5t and 7.5t) ☐ Van or light commercial vehicle (3.5t or less) ☐ Car
1.5 What level do you work at?	☐ Driver / Operative ☐ Supervisor ☐ Professional / support staff ☐ Manages and / or supervises a team

	☐ Senior manager ☐ Board Director
1.6 Does your job require you to be physically active?	☐ None or very little physical activity ☐ Some or light levels of physical activity ☐ Moderate levels of physical activity ☐ Significant levels of physical activity
SECTION 2 – DEMOGRAPHICS	Please tick one box unless asked to tick all that apply.
2.1 Please tell us your age.	Years [Drop down box starting at 16].
2.2 Please tell us the sex assigned to you at birth. The sex assigned to us at birth influences our circadian rhythm and how we respond to sleep deprivation. This is why we have not listed more options for gender.	☐ Female ☐ Male ☐ Prefer not to say
SECTION 3 – WORK PATTERN	☐ Please tick one box unless asked to tick all that apply.
3.1 What shifts do you work?	☐ Permanent night [Also 3.1a] ☐ Permanent day [Go to 3.2] ☐ Mixed night and day [Also 3.1a]
3.1a How many years have you been working shifts?	☐ Less than 6 months ☐ 6 months to 2 years ☐ 2 years to 5 years ☐ 5 years to 10 years ☐ 10 year or more
3.2 Normally how many consecutive shifts do you work before days off?	☐ 1 to 2 ☐ 3 to 4 ☐ 5 to 6 ☐ 7 to 8 ☐ 9 or more

3.3 On average how long is your workday / shift?	Hours:_____________? Minutes:____________?
SECTION 4 – COMMUTING	☐ Please tick one box unless asked to tick all that apply.
4.1 On average how many minutes do you spend commuting in total to AND from work on a daily basis?	Minutes:____________? [To nearest 15 minutes]
SECTION 5 – SLEEPING	☐ Please tick as many boxes that apply. If the list doesn't include your issue, then please complete the free text box
5.1 Are there any reasons that stop you from getting good sleep?	☐ Not applicable, I sleep quite well ☐ I sleep away from home in my vehicle ☐ I sleep away from home in accommodation ☐ Pain condition ☐ I don't sleep well ☐ Child / children or partner ☐ Noise disturbances ☐ Light disturbances ☐ Stress ☐ Medications ☐ Frequent need to use the bathroom ☐ Other (please state) [Free text box appears

Appendix 2 – Comparing the day shift based on length of shift

To start our analysis of the day shift based on the length of the shift we first looked at those working **8 to 9 hour shifts** (anything under 10 hours). Below is a 'heatmap' of the results of our findings.

Chance of being very tired (KSS >=7), Average KSS score (1 to 9), Data points

1 to	2.9	3.0	3.1	3.2	3.3	3.4	3.8	3.9	7.0

Time	Monday			Tuesday			Wednesday			Thursday			Friday			Overall		
6	17%	3.6	12	0%	3.3	19	0%	2.8	22	31%	4.5	13	0%	3.1	17	8%	3.5	83
7	8%	3.4	13	0%	3.0	16	0%	3.1	16	0%	3.1	19	0%	2.6	5	1%	3.0	69
8	0%	2.3	14	8%	4.3	12	6%	3.1	18	0%	3.1	7	0%	2.5	12	3%	3.1	63
9	0%	2.7	17	0%	3.5	16	5%	3.3	19	0%	2.7	10	7%	3.2	14	3%	3.1	76
10	0%	2.8	16	0%	2.6	30	0%	2.7	29	0%	2.7	23	5%	2.6	19	1%	2.7	117
11	0%	2.9	20	11%	4.0	19	0%	3.1	23	0%	3.3	24	0%	3.1	14	2%	3.3	100
12	6%	3.3	16	4%	3.1	24	13%	4.4	15	0%	3.1	18	0%	2.9	17	4%	3.3	90
13	0%	3.6	28	0%	3.5	22	5%	3.0	21	15%	4.1	20	13%	4.2	15	6%	3.7	106
14	8%	3.7	26	3%	3.1	30	0%	2.9	24	3%	3.1	31	0%	3.0	22	3%	3.2	133
15	8%	3.1	13	14%	3.8	14	6%	3.7	17	10%	4.3	10	0%	3.3	12	8%	3.6	66
16	0%	3.0	9	0%	3.8	12	8%	3.8	12	0%	3.3	17	0%	3.4	8	2%	3.4	58
17	13%	3.8	8	0%	4.7	6	22%	3.9	9	0%	3.2	5	0%	5.0	1	10%	4.1	29
18	100%	7.0	1	0%	3.0	2	0%	3.7	3	0%	3.0	1	0%	3.5	2	11%	4.0	9
FRI	4.7%	3.5	2	3.2%	3.5	2.6	3.9%	3.3	4.1	4.5%	3.3	5.9	2.5%	3.3	7.6	3.9%	3.4	999

Highlights from those working an 8-hour day shift include:

- The start of the week sees the highest average KSS (sleepiness) scores for the shift
- There is elevated sleepiness in the first two hours of a Monday shift
- Despite a low average KSS score Thursday had the highest chances of high levels of sleepiness
- We saw a spike in sleepiness at 13:00, which sustained for the rest of the shift. Normally we would expect to see a circadian effect between 14:00 and 16:00. However, many of this group started work early in the morning, meaning the circadian effect may well have been brought forward.
- Those working at 17:00 and 18:00 showed the highest sleepiness despite working the same shift length.

Time	Monday	Tuesday	Wednesda	Thursday	Friday	Data points	Overall
6	1.4	1.4	1.4	1.9	1.3	83	1.5
7	1.7	1.7	1.6	1.5	1.4	68	1.6
8	1.3	1.6	1.8	1.3	1.3	62	1.4
9	1.1	1.4	1.6	1.4	1.3	76	1.4
10	1.2	1.4	1.4	1.5	1.5	114	1.4
11	1.6	2.0	1.7	1.5	1.5	100	1.6
12	1.3	1.5	1.9	1.3	1.2	88	1.4
13	1.4	1.7	1.5	1.6	1.9	105	1.6
14	1.4	1.6	1.7	1.7	1.5	132	1.6
15	1.7	1.7	2.2	2.1	1.6	66	1.9
16	1.9	1.9	2.3	1.7	1.5	57	1.8
17	1.6	2.2	1.8	1.4	1.0	29	1.6
18		2.0	1.0	2.0	3.0	8	2.0
	1.5	1.7	1.7	1.6	1.5	988	1.6

Fatigue interfere with work	
1	Not at all
2	Slightly
3	Moderately
4	Very
5	Extremely

1	1.2
1.3	1.4
1.5	1.6
1.7	1.8
1.9 +	

- Tuesday, especially the end of the Tuesday shift is the most difficult in terms of the affect of fatigue on performance at work. Tuesday is closely followed by Wednesday and Thursday.
- In this instance the spike in the effect of fatigue on performance at work occurs at 15:00, which is in line with the circadian dip we experience in the mid-afternoon.

Below is a ‘heatmap’ of the results of our findings for those working **10 to 11** hour shifts.

Chance of being very tired (KSS >=7), Average KSS score (1 to 9), Data points

		1 to	2.3		2.4	2.6		2.7	3		3.1	3.5		3.6	5.4			
Time	Monday			Tuesday			Wednesday			Thursday			Friday			Overall		
6	0%	2.6	5	0%	2.0	2	0%	1.7	3	0%	4.5	4	0%	2.7	3	0%	2.7	17
7	0%	3.0	11	0%	1.9	12	0%	3.0	11	0%	2.2	9	0%	2.0	10	0%	2.4	53
8	0%	2.6	11	0%	2.4	8	0%	2.6	15	0%	2.5	11	14%	3.1	7	2%	2.7	52
9	13%	2.9	8	0%	1.5	6	0%	2.4	5	0%	2.8	6	0%	2.1	7	3%	2.4	32
10	0%	3.3	8	29%	4.6	7	0%	3.6	8	0%	3.5	8	0%	2.5	2	6%	3.5	33
11	0%	1.9	11	0%	2.8	11	0%	3.3	8	0%	2.0	6	0%	3.4	7	0%	2.7	43
12	0%	3.1	13	0%	2.5	11	17%	3.9	12	0%	2.9	8	0%	2.4	11	4%	2.9	55
13	0%	2.4	7	0%	2.1	10	13%	3.6	16	0%	2.6	5	0%	1.8	6	5%	2.5	44
14	0%	3.0	8	0%	4.7	3	0%	3.8	10	0%	4.3	4	0%	4.7	7	0%	4.1	32
15	0%	2.8	16	0%	2.8	16	0%	3.1	10	0%	3.2	13	0%	2.8	11	0%	2.9	66
16	0%	2.5	12	0%	3.1	16	0%	3.3	13	8%	3.0	13	17%	3.7	6	3%	3.1	60
17	0%	3.2	5	0%	2.5	4	29%	5.4	7	0%	2.0	3	0%	3.5	2	10%	3.3	21
18	0%	2.5	2	14%	4.0	7	0%	2.3	4	0%	4.0	3	0%	3.0	2	6%	3.2	18
FRI	0.9%	2.7	2	2.7%	2.8	3.2	4.9%	3.2	4.7	1.1%	3.0	6.5	2.5%	2.9	8.2	2.5%	2.9	526

The majority of our data came from Monday to Friday. Highlights for a 10-hour day shift include:

- Wednesday sees the highest average KSS scores and highest chances of high levels of sleepiness
- There is almost a parabola effect in terms of shift risk from Monday to Friday
- We saw a spike in sleepiness at 14:00, and a sustained increase from 16:00.

Time	Monday	Tuesday	Wednesda	Thursday	Friday		Data points	Overall
6	1.2	2.0	1.3	1.8	1.7		17	1.6
7	1.2	1.1	1.5	1.1	1.4		53	1.3
8	1.2	1.1	1.5	1.3	1.7		52	1.4
9	1.6	1.0	1.6	1.5	1.4		32	1.4
10	1.8	1.8	1.8	1.6	1.0		32	1.6
11	1.3	1.5	1.7	1.0	2.0		40	1.5
12	1.4	1.5	1.8	1.4	1.2		55	1.4
13	1.0	1.3	1.5	1.4	1.0		41	1.2
14	1.8	2.3	1.9	2.3	2.3		32	2.1
15	1.6	1.5	1.5	1.8	1.6		64	1.6
16	1.7	1.7	1.5	1.7	2.0		59	1.7
17	2.0	1.3	2.1	1.7	2.0		20	1.8
18	1.5	2.1	2.0	1.7	1.0		18	1.7
	1.5	1.6	1.7	1.6	1.6		515	1.6

	Fatigue interfere with work	
1	Not at all	
2	Slightly	
3	Moderately	
4	Very	
5	Extremely	
	1	1.2
	1.3	1.4
	1.5	1.6
	1.7	1.8
	1.9 +	

The results for the question we ask about the extent to which fatigue affects participants’ performance at work mirror the findings of the KSS sleepiness scores. Performance is most affected on Wednesdays. We see the same parabola effect over the working week. The biggest spike in the impact of performance on work also occurs at 14:00 with a sustained increase from 16:00.

<u>Comparing the 8 hour day shift to the 10 hour day shift</u>

On the face of it the 10-hour day shift looks like a less fatiguing shift compared to an 8-hour day shift when we look at sleepiness scores. The 10-hour shift had a lower average KSS score (2.9 versus 3.4). There was also less chance of hitting high levels of sleepiness (KSS score of 7, 8 or 9) on the 10-hour day shift 2.5% versus 3.9% on the 8-hour shift. An interesting observation is that the peak sleepiness on the 10-hour shift occurs during the shift (at 14:00) whereas sleepiness increases as the 8-hour shift progresses.

Below is a ‘heatmap’ of the results of our findings for those working **12+ hour shifts**. We did not have enough data to do a full heatmap so we broke the results down to the beginning, middle and final 5 hours from 06:00 to 20:00.

Driving for work - 12-hour days shift

Chance of high levels of sleepiness (KSS >=7), Average KSS score (1 to 9), Number of data points

		1 to	2.3					2.4	2.7					2.8	7						
Period	Monday			Tuesday			Wednesday			Thursday			Friday			Saturday			Overall		
Beginning (06-10)	0%	2.8	8	9%	2.7	11	0%	2.7	11	0%	2.0	13	0%	2.7	11	0%	2.3	3	2%	2.5	57
Middle (11-15)	0%	2.0	10	0%	2.1	16	0%	2.3	14	0%	2.3	16	10%	2.8	10	0%	2.6	7	1%	2.3	73
End (16-20)	100%	7.0	1	0%	2.7	9	13%	3.5	8	0%	2.0	5	33%	5.3	3	0%	3.7	3	10%	4.0	29
	0%	3.9	19	13%	2.5	36	0%	2.8	33	9%	2.1	34	17%	3.6	24	0%	2.9	13	5%	3.0	159

The one piece of data at the end of a Monday shift skews the data slightly. It was interesting that the Thursday shift appears to be the most alert shift of the week for those working 12-hour day shifts. The most difficult shift appears to be a Friday. The caveat to this is that much of this data came from ambulance workers who will not be working ‘standard’ working weeks. It is clear however, from the data that the final third of the shift is the most difficult.

The eightieth percentile KSS score would equate to 3.1, which is comfortably lower than the 8-hour or 10-hour shift pattern results (3.9 and 3.6 respectively). However, we need more data to make a conclusion that is at odds with the data we have collected from a number of night working populations.

Driving for work - 12-hour day shift

Effect of fatigue on performance from 1 (Not at all) to 5 (Extremely). Average, Number of data points

		1 to	1.4			1.5	1.7			1.8	3.0			
Period	Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Overall	
Beginning (06-10)	1.5	8	1.7	11	1.7	11	1.1	13	1.5	11	1.0	3	1.4	57
Middle (11-15)	1.3	10	1.5	16	1.4	15	1.2	17	1.8	10	1.4	7	1.4	75
End (16-20)	3.0	1	1.6	9	1.8	8	1.4	5	2.5	2	2.0	3	2.0	28
	1.9	19	1.6	36	1.6	34	1.2	35	1.9	23	1.5	13	1.6	160

We observed similar patterns when we asked to what extend fatigue is affecting or likely to affect performance at work. Again, the main conclusion is that the final third of the shift appears to be the most difficult.

The eightieth percentile KSS score would equate to 1.9, which is in line with both the 8-hour and 10-hour patterns.