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On the road again: A cross-sectional survey examining work schedules, commuting time, and driving-related outcomes among U.S. oil and gas extraction workers

Kyla Hagan-Haynes, MPH[1], **Alejandra Ramirez-Cardenas, MPH**[1], **Kaitlin C. Wingate, MPH**[1], **Stephanie Pratt, PhD**[1], **Sophie Ridl, MS**[1], **Emily Schmick, CIH, MSPH**[1], **John Snawder, PhD, DABT**[2], **Elizabeth Dalsey, MA**[1], **Christa Hale, DVM, MPH, Dipl. ACVPM (Epi)**[1]

[1]Western States Division, National Institute for Occupational Safety and Health, Lakewood, Colorado, USA

[2]Health Effects Laboratory Division, National Institute for Occupational Safety and Health, Cincinnati, Ohio, USA

Abstract

Correspondence: Kyla Hagan-Haynes, MPH, Western States Division, National Institute for Occupational Safety and Health, Lakewood, CO 80225, USA, kgz7@cdc.gov.

AUTHOR CONTRIBUTIONS

Kyla Hagan-Haynes participated in the conception of the study; acquisition and interpretation of the data; drafting and revising of the work; final approval of the version to be published; and agreement to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. Alejandra Ramirez-Cardenas participated in the acquisition and interpretation of the data; drafting and revising of the work; and final approval of the version to be published. Kaitlin C. Wingate participated in the analysis and interpretation of the data; drafting and revising the work; and final approval of the version to be published. Stephanie Pratt participated in the interpretation of the data; drafting and revising of the work; and final approval of the version to be published. Sophie Ridl participated in the acquisition of the data; revising the work; and final approval of the version to be published. Emily Schmick participated in the acquisition of the data; revising the work; and final approval of the version to be published. John Snawder participated in the acquisition of the data; revising the work; and final approval of the version to be published. Elizabeth Dalsey participated in the acquisition of the data; revising the work; and final approval of the version to be published. Christa Hale participated in revising the work and final approval of the version to be published.

CONFLICTS OF INTEREST

The authors declare that there are no conflict of interest.

DATA ACCESSIBILITY

Research data are not shared.

ETHICS APPROVAL AND INFORMED CONSENT

The study protocol and survey were approved by the NIOSH Institutional Review Board (Protocol Number: 15-WSD-01XP) and the U.S. Office of Management and Budget (Protocol Number: 0920-1195). Workers who agreed to participate were given the informed consent form, which was also explained to them verbally. The informed consent process included assurances that no personally identifiable information would be recorded or disclosed and that responses would be aggregated for presentation or publication.

DISCLAIMER

The findings and conclusions in this report are those of the authors and do not necessarily represent the official position of the Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health (NIOSH). Mention of any company or product does not constitute an endorsement by the Centers for Disease Control and Prevention, NIOSH. In addition, citations to websites external to NIOSH do not constitute NIOSH endorsement of the sponsoring organizations or their programs or products. Furthermore, NIOSH is not responsible for the content of these websites. All web addresses referenced in this document were accessible as of the publication date.

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John Meyer declares that he has no conflict of interest in the review and publication decision regarding this article.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

Background: Oil and gas extraction (OGE) workers in the United States experience high fatality rates, with motor vehicle crashes the leading cause of death. Land-based OGE workers drive frequently to remote and temporary worksites. Limited information is available on factors that may influence crash risk for this workforce.

Methods: A cross-sectional survey of 500 land-based OGE workers examined work schedules and hours, commuting, sleep, employer policies, and their relationship to potentially harmful events while driving.

Results: Over 60% of participants worked 12 or more hours per day. The mean daily roundtrip commuting time was 1.82 h. Longer daily commutes, nonstandard work schedules, less sleep on workdays, and lack of employer policies were associated with one or more risky driving-related outcomes.

Conclusions: Implementation and evaluation of OGE employer policies and programs to limit long work hours, reduce long daily commutes, promote sufficient sleep, and reduce drowsy driving among U.S. OGE workers are needed.

Keywords

commuting; drowsy driving; employer safety policies; fatigue; long work hours

1 | INTRODUCTION

As of 2019, the United States was the world's largest oil producer,[1] in part due to technological advances such as horizontal drilling and hydraulic fracturing, which allow the extraction of crude oil and natural gas from hydrocarbon-rich shale formations. In 2019, the U.S. oil and gas extraction (OGE) workforce was composed of 471,772 workers employed by operators that develop and operate properties, contractors that drill oil and gas wells, and support contractors that provide a wide range of services to bring new wells into production and service existing wells.[2] Additionally, thousands more contractors and self-employed workers from transportation, construction, and other industry sectors work at oil and gas worksites, completing tasks such as hauling water used in the hydraulic fracturing process, constructing new oil and gas well pads, and servicing existing wells.

The OGE industry is a dangerous industry. During 2003–2013, the OGE worker fatality rate was almost seven times that of all U.S. workers (average annual fatality rate of 25.1 vs. 3.7 per 100,000).[3] Transportation incidents are the leading cause of death for OGE workers, accounting for 55% of all fatalities in 2019.[4] Not using a seat belt and falling asleep at the wheel have been identified as contributing factors to driving-related fatalities in OGE.[5] Furthermore, oil and gas well sites are often located in remote areas, resulting in long daily commutes and extensive site-to-site travel on rural roads with fewer safety features such as lighting and rumble strips.[6]

Industry-wide data on commuting distances are not available. Data on commuting patterns and their association with on-the-job motor vehicle crashes or onsite injuries are also lacking, as U.S. statistics on work-related injuries and fatalities exclude incidents that occur while commuting.[7] For OGE specifically, information is needed about the extent to which

workers experience extreme commutes, defined by the U.S. government as a round-trip daily commute of more than 3 h,[8] so that recommendations for preventing commuting-related crashes can be developed. To reduce the number of long commutes, some companies provide onsite or nearby temporary lodging (often referred to as “man camps”) for workers while they are on duty.

OGE workers also face long working hours.[6] While U.S. workers work 34.5 h per week on average, oil and gas operator employees work 41–43.9 h per week,[9] and workers engaged in drilling or oil and gas support activities work 45.8–49.5 h.[10] A small pilot study among well-servicing workers found that the workers’ daily average work hours and commuting time combined was 15.4 h per day.[11]

Information about employer policies for motor vehicle safety, risky driving behaviors, work hours and schedules, miles driven, and the working environment of land-based OGE workers is limited. Furthermore, federal safety regulations covering many facets of this working environment are limited. Although the Occupational Safety and Health Administration (OSHA) regulates safety on oil and gas well sites, motor vehicle crashes on public roads are outside OSHA’s jurisdiction. Pickup trucks are widely used in the OGE industry but are typically not covered by the Federal Motor Carrier Safety Regulations that specify maximum hours of driving and other aspects of operations. In this limited regulatory environment, individual companies are left to determine the best approaches for reducing crash risk. In response, industry-wide recommendations on motor vehicle safety and fatigue management have been developed by international industry associations.[12,13] Consistent with these recommendations, OGE operators and contractors have implemented interventions such as seat belt policies, journey management, invehicle monitoring systems, mobile phone restrictions, driver safety orientations, pretrip vehicle inspections, and near-miss reporting.[14] However, the extent to which each of these has been implemented in the U.S. or among companies of varying sizes is not known.

Several characteristics of the industry present challenges for research, including high employee turnover, the temporary nature of well sites, and the movement of workers from one well site to another over time. In addition, in 2020, only 6% of workers in mining, quarrying, and OGE were union members,[15] limiting the use of unions’ organizational and communication networks to support research. Moreover, where OGE-specific data are reported, the sample size is small, leading to wide confidence intervals and less confidence in the estimates.

The purpose of this study is to better understand OGE worker schedules and hours, commuting times, self-reported sleep, and employer safety policies to determine relationships between these factors and driving-related outcomes. The study findings will serve as a launching point to better determine and evaluate strategies to mitigate crash risk for OGE workers.

2 | METHODS

2.1 | Survey design

OGE employers were recruited at industry health and safety meetings, conferences, and through informal contacts. Companies that agreed to participate were in Colorado, North Dakota, and Texas. Companies and researchers jointly identified survey sites based on logistical considerations, including the location of active well sites and the number of workers available to be surveyed on the site. The survey used in this study covered worker demographics, employer characteristics, worker health, work hours and schedules, commuting times, and employer safety policies. Workers who drove for work completed an additional module with questions about driving patterns; history of work-related near misses, motor vehicle crashes, and injuries; driving behaviors; and their employer's motor vehicle safety programs and policies. Many questions in the survey were obtained from the National Survey of U.S. Long-Haul Truck Driver Health and Injury,[16] the National Health Interview Survey (NHIS; a cross-sectional household survey that yields national estimates on the health of the U.S. civilian noninstitutionalized population), and the NHIS occupational health supplement.[17] The question on commuting was adapted from the American Community Survey. Motor vehicle safety program and policy questions were developed based on OGE literature and in consultation with subject matter experts.[14,18] Survey questions and response options can be viewed in Supporting Information: 1. The primary outcomes of interest in this study were 1) frequency of feeling very drowsy while driving at work, 2) having ever fallen asleep while driving a work vehicle, and 3) having experienced a "near miss" in the past week. A "near miss" was described in the survey as a driving incident in which "you felt lucky not to have been in a crash." The study protocol, which included the survey, was reviewed and approved by the National Institute for Occupational Safety and Health Institutional Review Board (IRB). The IRB did not require written consent because it would be the only participant identifier if recorded.

A pilot test was conducted with employees from an oil and gas company in Colorado to determine whether questions were understood as intended and to test the length of the survey. Pilot testing showed that many workers' primary language was Spanish. Based on this, all study materials were translated into Spanish, and a Spanish-speaking researcher attended all survey administrations unless informed that all participants on-site were proficient in English.

2.2 | Survey administration

Surveys were administered at sites that were being drilled, completed, or serviced; monthly contractor meetings; and company field offices. All workers on site were invited to participate, that is, contractor employees as well as employees of the participating employer.

Workers were screened verbally for eligibility based on two questions: 1) "Have you worked in OGE for at least 1 month during the past year?" and 2) "Do your work duties take you to a well site at least 2 days per week or more?" Workers with less than 1 month of experience in the OGE industry were excluded to ensure all respondents had sufficient knowledge about the work environment and their employer's policies. Workers who agreed to participate

were given the informed consent form, which was also explained to them verbally. The informed consent process included assurances that no personally identifiable information would be recorded or disclosed and that responses would be aggregated for presentation or publication. Eligibility to take the driving module was based on a "yes" response to the question "Do you drive a vehicle as part of your work duties?" Participants had the option to take the survey using a paper copy, digitally on a tablet using the Qualtrics platform, or administered verbally and recorded digitally by a member of the research team. Open-ended responses in Spanish were translated into English. Participating workers were given gift cards in nominal amounts ($10 if on-duty and $30 if off-duty) as tokens of appreciation for completing the survey.

2.3 | Data analysis

Statistical analysis was performed using R.[19] For analysis, workers whose company type was reported as "drilling contractor," "servicing company," or "other" were grouped into a "contractor" category for comparison with workers who reported working for an operator. Analyses of employer safety policies compared those who responded "yes" to those who responded "no" or "don't know." The rationale for this was that if workers were unaware of a particular policy, it would be unlikely for that policy, even if there was one, to affect driving-related outcomes.

Responses for the question on work schedule were grouped into two categories for analysis: daytime schedules and nonstandard schedules (evening shift, swing or rotating shift, on-call 24/7, and other). Responses to the question "How often do you feel very drowsy when you are driving at work?" were collapsed into two categories: "never (or almost never)" and "about once a month" combined, and all other response categories (i.e., feeling drowsy more than once a month).

Two individuals who reported having less than 1 month of experience, despite having passed the screening criteria, were removed from the dataset used for analysis. Responses of 12 h or more of daily sleep, daily work hours of 4 or less or 20 or more, and daily roundtrip commutes of 5 min or less or 6 or more hours were treated as outliers. These outliers were included in frequency distributions but excluded from the calculation of means, *t*-tests for differences between means, and logistic regression.

Descriptive statistics were calculated. *T*-tests were used to assess differences in means by company type (i.e., operator or contractor) for daily work hours, usual hours of sleep on workdays, daily commuting time, and work hours plus commuting time. Bivariate χ^2 tests were performed for all categorical variables. Multivariable logistic regression was used to assess each of three driving-related outcomes: feeling very drowsy while driving at work; having ever fallen asleep while driving a work vehicle; and having experienced a near miss in the past week. The intraclass correlation coefficient (ICC) was estimated for each outcome using the Fleiss–Cuzick kappa type estimate in the *ICCbin* package.[20,21] All three ICC estimates were less than 0.05, indicating little agreement within the 13 participating companies. Demographic and occupational variables that were significant ($p < 0.1$) in the bivariate analysis were included in the initial regression model. The STEP function in R was used to build the final model based on the Akaike information criterion.[22] Observations with

missing values for any variable were removed before performing the stepwise procedure. The STEP function performed both backward and forward search directions. Adjusted odds ratios (ORs) were calculated for all variables included in the final models.

3 | RESULTS

Surveys were conducted between October 2017 and February 2019. Of 528 workers screened and determined eligible to participate, 500 completed the survey, for a response rate of 94.7%.

3.1 | Descriptive results

A total of 498 eligible worker responses were included in the analysis. Most of the respondents were male (96.8%), and 35.7% reported Hispanic ethnicity (Table 1). The largest proportion of workers was between 25 and 34 years of age (39.9%). Overall, 80.6% of respondents worked for contractors, primarily servicing companies (55.4%). A large proportion of respondents drove as a part of their work duties (72.9%).

Over three-fourths of respondents who drove for work used a pickup truck (75.9%), with an additional 11.5% using a single-unit medium-weight truck and 7.7% using a heavy truck (Table 1). Nearly 10% drove more than 100,000 miles for work each year, and another 19.3% drove 50,001–100,000 miles. Most respondents who drove for work reported that their employer had a vehicle safety policy (93.0%) and required reporting of near miss crashes (82.0%). Considerably lower proportions reported that their employer had a journey management policy (46.7%), fatigue management policy (42.3%), or maximum work hours policy (38.5%). Notable proportions of respondents did not know whether their employer had certain policies, 19.9% for journey management and 35.1% for fatigue management (data not shown, available upon request).

Overall, 61.8% of respondents reported working 12 or more hours per day (mean = 11.87 h) (Table 2). These long workdays were more common for contractors than for operator employees (69.7% vs. 33.7%), and mean work hours for contractors were significantly higher than for operators (12.17 vs. 10.8 h, $p < 0.001$). In addition, 23.7% of respondents reported that they worked a nonstandard schedule (data not shown, available upon request).

For 14.6% of respondents, daily roundtrip commuting time was 5 min or less, primarily because they stayed on location during their work rotations (Table 2). For all other respondents, the mean daily roundtrip commuting time was 1.82 h, with 16.7% of respondents reporting a roundtrip commute of more than 3 h. Mean commuting time for contractors was significantly longer than for operator employees (1.92 vs. 1.5 h, $p < 0.01$). The mean combined daily working and commuting time was 13.52 h, with 20.5% of workers spending more than 16 h workings and commuting on a typical workday. Mean combined working and commuting time was significantly higher for contractors than for operator employees (13.97 vs. 12.34 h, $p < 0.001$).

A substantial number of workers ($n = 136$, 27.3%) reported staying in “man camps” or other types of company-provided housing during their work rotations (data not shown, available

upon request). These workers commuted a median of 7 h each way at the beginning and end of their work rotations (data not shown, available upon request).

Overall, 46.0% of workers reported less than 7 h of daily sleep on workdays (Table 2). Mean hours of sleep did not differ significantly by company type.

3.2 | Bivariate results: Driving-related outcomes

Overall, 27.2% of respondents reported having ever fallen asleep while driving a work vehicle, 26.1% reported feeling very drowsy more than once a month while driving at work, and 17.2% had experienced a "near miss" in the past week (Table 3). None of the three driving-related outcomes differed significantly by company type.

Policies significantly associated with a greater likelihood of feeling very drowsy while driving at work more than once a month were: not having a maximum work hours policy (32.7% vs. 16.3%, $p < 0.001$); not having a journey management policy (31.7% vs. 19.2%, $p < 0.01$); and not having a fatigue management policy (31.3% vs. 18.9%, $p < 0.05$) (Table 3). Mean daily roundtrip commuting time was significantly greater for workers who reported feeling very drowsy more than once a month while driving at work, compared to workers who felt drowsy less often (2.38 vs. 1.69 h, $p < 0.001$). Mean sleep hours were significantly lower for workers who reported feeling drowsy while driving more than once a month (6.24 vs. 6.85 h, $p < 0.001$).

Those who worked normal business hours or day shifts were significantly less likely to have ever fallen asleep while driving their work vehicle as compared with workers assigned to nonstandard schedules (24.1% vs. 39.4%, $p < 0.01$) (Table 3). Having fallen asleep while driving a work vehicle was also associated with not having a journey management policy (32.8% vs. 20.4%, $p < 0.01$). Workers who had fallen asleep while driving a work vehicle also had significantly greater means for number of hours worked per day (12.21 vs. 11.61 h, $p < 0.05$) and daily commuting time (2.21 vs. 1.74 h, $p < 0.01$) compared to those who had not fallen asleep, and significantly lower mean sleep hours (6.42 vs. 6.80 h, $p < 0.05$).

Finally, workers who reported a near miss in the past week had longer daily mean commuting time (2.24 vs. 1.81 h, $p < 0.05$) and fewer hours of sleep per day (6.39 vs. 6.74 h, $p < 0.05$), compared to those who had not had a near miss (Table 3).

3.3 | Regression results

The final regression models for the three driving-related outcomes are reported in Table 4. Three variables were significant predictors of feeling very drowsy more than once a month while driving at work: getting less sleep (OR = 0.66, $p < 0.01$), with each additional hour of sleep decreasing the odds by 34%; having a long daily commuting time (OR = 1.49, $p < 0.001$), with each additional hour of commuting time increasing the odds by 49%; and the employer not having a maximum work hours policy (OR = 3.35, $p < 0.01$). On the other hand, those employed by a contractor were less likely to report feeling very drowsy more than once a month while driving at work (OR = 0.48, $p < 0.05$).

Two variables were significant predictors of having fallen asleep in a work vehicle: having a nonstandard schedule (OR= 2.10, $p < 0.01$), and the employer not having a journey management policy (OR = 1.80, $p < 0.05$) (Table 4). The only significant predictor of having had a near miss crash in the past week was commuting time, with each additional hour of daily roundtrip commuting time associated with a 25% increase in the likelihood of a near miss in the past week (OR = 1.25, $p < 0.05$).

4 | DISCUSSION

This study is the first to examine land-based OGE workers' commuting times, work hours, work schedules, sleep, and employer safety policies in the context of driving-related outcomes.

Results of this study showed that a high proportion of this OGE workforce drove substantial miles for work purposes, thus increasing their exposure to traffic hazards and crash risk. Nearly 30% of workers who drove for work reported driving more than 50,000 work-related miles each year. These levels of annual driving exposure are greater than those reported elsewhere: an average of 16,447 miles for workers in multiple industries,[23] and 24,411 miles for employees of a healthcare company.[24] Yet, the driving aspects of OGE workers' jobs are largely unregulated, the driving environment is different, and motor vehicle safety risks go unmitigated unless an effective program is put in place by their employers.

4.1 | Long commuting times

This study adds to the literature by supplementing data on shift work and work hours with data on commuting time. Over 16% of survey respondents reported extreme daily commutes of greater than 3 h, compared to 2.4% of U.S. commuters in the general population in 2010.[8] For OGE workers, these extended daily commutes may be due to the remote locations of well sites. Driving home immediately after a night shift puts workers at risk of a fatigue-related crash. Night workers driving home after their work shift in a rural mining region in Australia reported significantly shorter sleep duration and higher levels of subjective sleepiness.[25] Other research has linked driving home after night shifts or extended shifts directly to increased risk of crashes or near-crashes for medical residents, interns, and nurses.[26–28] Commutes during early morning hours can also pose risks because the body's circadian rhythms are at their lowest and the body's drive or propensity for sleep is at its strongest.[29,30]

Daily commuting time was significantly associated with having a near miss in the past week. This result is consistent with a simulator study that established that risk of crashes and near-crashes after working a night shift increased as driving time increased.[30] The mean commuting time in our study was 1.82 h (about 55 min each way), a length twice that of the average round-trip commute in the U.S.[31] Thus, OGE workers in our study have more hours of crash exposure than workers in other industries, along with greater susceptibility to the dose–response pattern identified by the previous research.[28]

For 20.5% of survey respondents, work time and commuting time summed to more than 16 h. Some rural roads in oilfield regions can be extremely congested, with few alternate routes,

further inflating commuting times. For example, traffic congestion on 56 road segments in the Midland/Odessa area (i.e., the Permian Basin) led to over 6 million hours of delay in 2019.[32] Long work hours, long commutes, or a combination of these limit workers' opportunities to obtain the recommended 7–9 h of daily sleep and to attend to personal needs such as eating, hygiene, and family responsibilities.[33] In addition, long commutes have been found to adversely affect self-reported mental health status[34] and to reduce quality of life by causing workers to forego pleasurable off-work activities.[35] In this study, longer daily commuting times were also significantly associated with more frequent drowsy driving, which increases the risk of a motor vehicle crash.[36–38]

To mitigate the risks of fatigue-related crashes during commuting, interventions are needed to shorten commuting times, such as offering alternative accommodations or providing a rested driver.[39] Some employers may consider nonwork time to be outside of their scope of responsibility. Nonetheless, any motor vehicle crash involving a worker, even during nonwork hours, affects the employer. Employers bear the burden of the costs of finding and training replacements for injured workers, the repair or replacement of fleet vehicles, and the weakened morale of coworkers. Employers should explore increased use of onsite company-provided housing for workers whose daily commuting times extend beyond a specified time limit, especially when combined with working hours that result in insufficient time for sleep and other necessary activities. Some employers offer reimbursement for hotel stays or hotel vouchers to employees who determine they are too fatigued to drive safely, but hotel rooms may not be available or located where workers need a place to rest. Employers may also offer transportation between population centers and well sites. However, workers may choose not to take advantage of these options because they want to return home to the family as quickly as possible. Interventions to mitigate fatigue during commuting need to be identified and evaluated, including incentives and barriers to their effective implementation. Employers should also consider interventions for workers who sleep on-site or in nearby accommodations during their work rotations but have extended commutes home (median of 7 h each way) before and after their rotation.

Research is needed to further quantify the types and lengths of OGE worker commutes, and how commuting contributes to fatigue levels in OGE workers. The impact of long daily commutes on the risk of injuries at the workplace also needs to be examined. Further research is also needed to validate survey questions on commuting in the OGE industry.

4.2 | Work schedules, work hours, sleep, and drowsy driving

Findings pertaining to the relationships between drowsy driving and work schedules, work hours, and hours of sleep were mixed. Some were broadly consistent with other research findings while others diverged. In a few instances, expected significant relationships were found but others that would also seem to be associated with an outcome were not.

4.2.1 | Work schedules—In this study, a total of 23.7% of respondents reported working a nonstandard work schedule. A large body of research has linked shift work in the OGE industry to psychosocial problems, impaired sleep quality and duration, declines in performance, and objective and subjective fatigue.[40–42] However, this body of research

was done in an offshore environment, primarily in the North Sea; further, very little of it addressed injuries as an outcome of interest, and none of it addressed driving-related outcomes.

Our study did not find a significant relationship between work schedule (day shifts vs. nonstandard work schedules) and feeling very drowsy while driving for work. This result is not consistent with studies done in non-OGE worker populations. For example, research based on interviews of drivers who had recently been involved in sleep- or fatigue-related crash (although not necessarily a work-related crash) were significantly more likely to work a night or "other" non-day shift,[37] and a study of fatigue-related crashes during the night shift involving police officers reported that prolonged wakefulness was a more important contributor than the circadian phase.[43] Another study showed that early-morning drivers who worked the night shift were significantly more likely to have gotten less than 5 h of daily sleep in the past 24 and 48 h, to have longer weekly work hours, and to be driving long distances, all of which may increase their crash risk.[44] In addition, a meta-analysis of 14 studies judged to be high-quality concluded that shift work has substantial negative effects on safety.[45]

On the other hand, our study did show that those who worked nonstandard shifts were significantly more likely to have fallen asleep while driving a work vehicle. It is not clear why nonstandard work schedules were significantly associated with having fallen asleep while driving a work vehicle but not with self-reported drowsiness while driving for work. These mixed results point to a need for additional research among land-based OGE workers to establish which specific work schedules are associated with drowsy driving. Because all nonstandard work schedules were grouped together for analysis and compared with day shifts, it is possible that the results reported here obscured differences between individual work-schedule types and drowsy driving. A larger survey would have allowed us to examine outstanding research questions; for example, the effects of unpredictable on-call schedules are largely unknown, even in the widely studied offshore OGE work environment.[46] A larger survey would also make it possible to identify any links between work schedules and rare outcomes such as motor vehicle crashes among OGE workers.

4.2.2 | Work hours—More than 60% of survey respondents worked 12 or more hours a day. This has safety implications for the OGE industry, as transport workers' crash risk has been shown to increase significantly as on-duty time increases beyond 12 h.[47] Long work hours have been associated with declines in performance, poorer perceived general health, increased injury rates, and increased mortality.[48,49] Other research has found that working 60 or more hours per week, which was common for workers in our study, was significantly associated with crash involvement in general and involvement in a sleep-related crash, compared to working 40–49 h per week.[37]

Respondents were more likely to report feeling very drowsy more than once a month while driving to work when their employer did not have a maximum work hours policy, or the respondent was unaware of a policy. In the U.S., workers who drive a truck weighing less than 10,000 pounds are not covered by federal hours-of-service (HOS) regulations that limit driving and on-duty hours, and in our survey, 75.9% of the respondents who drove for work

indicated that they used a pickup truck. It is important to acknowledge, however, that HOS is just one factor that contributes to the likelihood of a fatigue-related incident, and HOS regulations do not account for differences in individuals' experience of fatigue or differences in work environments.[50,51] Thus, whether or not OGE workers are covered by federal HOS regulations, employer policies on maximum work hours are a means to reinforce or exceed the levels of protection afforded by federal regulations.

4.2.3 | Sleep—Overall, 46.0% of respondents reported getting less than the recommended 7 h of sleep per day,[33] and 17.5% got less than 6 h on days they worked. Other surveys provide national or multi-state data on daily sleep hours by occupation or industry, but these data are not specific to OGE. An analysis of the 2010 NHIS estimated that 40.6% of workers in the mining sector, which includes OGE, got 6 or fewer hours of daily sleep, compared to 30.0% in all industries.[52] An analysis of BRFSS data for 2013–2014 found that 45.3% of workers in extractive occupations (which includes some occupations in OGE but also many occupations in coal and metal mining) got fewer than 7 h of daily sleep.[53] An analysis of 2018 NHIS data reported that 36.3% of workers in construction and extraction occupations got fewer than 6 h of daily sleep, a 22% increase in the prevalence of short sleep since 2014.[54] Because workers in many different occupations are found within the OGE industry, analysis by occupation does not provide the best comparison with our data. Nonetheless, the proportion of respondents to our survey getting fewer than the recommended 7 h of sleep is consistent with these larger surveys.

Among respondents who drove for work, less sleep was associated with feeling very drowsy while driving for work, falling asleep while driving a work vehicle, and experiencing a near miss in the past week. Fewer daily hours of sleep was a significant contributor to having felt drowsy while driving at work. The inverse relationship between hours of sleep and impaired driving performance and motor vehicle crashes is well-documented in the scientific literature, both in work and nonwork settings.[38,55,56] Further, the finding that a substantial proportion of respondents reported that they usually got less than 7 h of daily sleep also implies the accumulation of "sleep debt" over long periods of time in this worker population. Although one can recover fairly quickly after a few days of insufficient sleep, performance impairment increases as the period of time without adequate sleep increases[57,58] or the opportunity for sleep decreases.[59]

Nonstandard work schedules and long work hours in OGE make it difficult for workers to obtain adequate sleep. Interventions focused on commuting safety and shift work (e.g., employer-provided sleeping accommodations on or near the worksite or allowing workers to self-report fatigue and get restorative rest) may help workers obtain more sleep. This study found that despite contractor workers having longer work hours and commuting times, there were no significant differences in sleep quantity between contractor and operator workers. Therefore, creating sufficient sleep opportunities may not be enough to increase sleep among workers. Fatigue and sleep education for workers and their families may help promote adequate sleep. Other approaches to increase the total amount of daily sleep are incorporating scheduled naps during the work shift or using naps to counteract drowsy driving, both of which are recommended to increase alertness in real-time.[60–62] Although the current study did not address it, sleep quality is also important. Interventions such as

darkened, quiet sleeping areas with comfortable temperatures can improve sleep quality, whether implemented at home or at employer-provided accommodations.[63]

4.3 | Employer motor vehicle safety policies and practices

Nearly all workers who participated in the study and drove for work worked for companies with some type of vehicle safety policy (93.0%). The components of vehicle safety programs and their associated policies vary widely, but a comprehensive program integrated into an organization's overall occupational safety and health framework is critical to reducing the risk of work-related-motor vehicle crashes and associated injuries.[64,65] Small OGE companies experience the highest crash rates,[5] and they also have the fewest resources to implement multi-faceted programs that address a range of driving-related risk factors. Research is needed to identify the effectiveness of individual motor vehicle safety policies so that scalable programs based on employer resources can be suggested. The current study examined the prevalence of policies relevant to three driving-related conditions: feeling very drowsy while driving at work, falling asleep while driving a work vehicle, and experiencing a near miss.

4.3.1 | Journey management—Journey management, an approach to managing crash risk by systematically evaluating the necessity of road travel, is widely implemented internationally in the OGE industry.[12] When necessary trips are taken, employers select the safest method, route, vehicle, and driver.[66] In this analysis, workers whose employers did not have journey management policies were more likely to report feeling drowsy more than once a month while driving at work (only in bivariate analysis) or having fallen asleep while driving at work. There is some evidence that journey management combined with other road safety approaches reduces miles driven and crash exposure.[14,64] A deeper analysis of the individual components of journey management in reducing miles driven and crashes is needed to further assess the effectiveness of this approach.

4.3.2 | Fatigue risk management—Our study found a relationship between employer fatigue management policies and self-reported drowsy driving, but this relationship was not statistically significant in the regression analysis. Other research using data from 70 companies from a variety of industries found that companies using fatigue mitigation practices experienced significantly lower rates of collisions and injuries, especially for light-vehicle fleets.[23] In that study, practices such as fatigue training for new hires, medical screenings for fatigue, and restrictions on night driving were all associated with significantly lower percentages of collision-involved fleet vehicles and rates of collisions and injuries per million miles driven.

4.4 | Company type

A previous analysis found that contractor employees accounted for 85% of OGE worker fatalities and that fatal crash rates for contractors were three times greater than for operators.[5] In the descriptive results reported here, the three driving-related outcomes did not differ significantly by company type, although contractor employees had significantly longer daily work hours and roundtrip commuting times than operators. In addition, contractor employees were significantly less likely to report drowsiness while driving at

work, even after the data were adjusted for daily sleep hours and the presence of several employer safety policies. It is unclear why contractors in this study did not show poorer driving-related outcomes than operators, in light of the higher crash fatality rates for contractors reported elsewhere.[5] Differences between contractors' and operators' driving patterns (e.g., solitary vs. crew driving) or other work practices not examined in this study might have contributed to differences in drowsiness while driving. This finding suggests the need for research to explore differences in driving patterns and other factors that might account for differences in motor vehicle crash risk, such as speed, by company type.

4.5 | Strengths and limitations

This study was the first to gather preliminary information about work schedules and hours, sleep, commuting, and driving-related outcomes for the land-based OGE workforce in the United States. Despite the barriers to recruiting OGE workers as study participants, this study achieved a high (94%) response rate, suggesting that the methodology used is a viable approach for successfully collecting safety and health data for workers in this industry. Further, workers who spoke only Spanish, a substantial part of the OGE workforce, were able to participate fully.

Several limitations must be acknowledged. Companies that agreed to participate in the study invited the research team to their sites to administer the survey. Although worker participation was strictly voluntary, employers may have encouraged their teams to participate. Thus, potential respondents were not selected randomly, and it is not possible to generalize the results to the industry or the United States as a whole. Although the states in which data were collected have high levels of OGE work activity, other areas with similarly high activity were not included in the survey. Lastly, most data collection occurred during daylight hours, limiting the number of workers with non standard work schedules who were available to participate.

Because respondents were asked to self-report driving-related outcomes, it is possible that they may have been reluctant to report undesirable outcomes. Responses may also have been subject to social desirability bias. These potential biases were mitigated by using tablets and paper to administer surveys, collecting no personally identifiable information, and assuring participants that their responses would be aggregated with other participants' data. Recall bias may have also affected the accuracy of some responses.

Another limitation of our study is that because crashes are a relatively rare event, our survey was not large enough to assess crashes as an outcome of interest. Instead, the survey ascertained driving-related outcomes that are associated with crash risks, such as having felt very drowsy while driving and having experienced a near miss in the past week. This limitation is common in many studies of drowsy driving. In addition, sample sizes are often too small to detect significant relationships. As a result, researchers often use drowsiness as an endpoint instead of a risk factor and focus on ascertaining conditions and behaviors known to be associated with it. Thus, the role of drowsy driving as an antecedent to outcomes such as crashes or injuries is not adequately addressed in research projects. This lack of outcome-focused research could be addressed through in-depth assessments of individual crashes. Such assessments would allow other factors known to be associated with

drowsiness- and sleep-related crashes to be considered (e.g., time on task, time on shift, time of day, amount of sleep in the past 24 h, sleep quality).[38,47]

5 | CONCLUSION

This study of land-based OGE workers found that a substantial portion drove as a part of their work duties, worked long shifts, experienced long daily commutes, and did not get sufficient sleep. OGE employers should implement and evaluate interventions to limit long work hours, reduce long daily commutes, and promote quality sleep. Promising interventions include providing on-site sleeping accommodations or a rested driver, incorporating scheduled naps during long work shifts, and training workers about the importance of sufficient and quality sleep. Further evaluation of the influence of employer safety interventions such as fatigue management, journey management, and maximum work hours policies on motor vehicle crash risk is needed.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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REFERENCES

1. U.S. Energy Information Administration. Oil and petroleum products explained: where our oil comes from Accessed August 14, 2020. https://www.eia.gov/energyexplained/oil-and-petroleum-products/where-our-oil-comes-from.php
2. Bureau of Labor Statistics. Quarterly Census of Employment and Wages, annual averages 2019. Accessed April 11, 2022. https://data.bls.gov/cew/apps/table_maker/v4/table_maker.htm#type=11&year=2019&qtr=A&own=5&area=US000&supp=1
3. Mason KL, Retzer KD, Hill RD, Lincoln JM. Occupational fatalities during the oil and gas boom—United States, 2003-2013. Morb Mortal Wkly Rep 2015;64(20):551–554.
4. Bureau of Labor Statistics. Table A-1. Fatal occupational injuries by industry and event or exposure, all United States, 2019. 2020. Accessed December 29, 2020. https://stats.bls.gov/iif/oshwc/cfoi/cftb0331.htm
5. Retzer KD, Hill RD, Pratt SG. Motor vehicle fatalities among oil and gas extraction workers. Accid Anal Prev 2013;51:168–174. doi:10.1016/j.aap.2012.11.005 [PubMed: 23246709]
6. CDC. Fatalities among oil and gas extraction workers—United States, 2003–2006. Morb Mortal Wkly Rep 2008;57(16):429–431.
7. Bureau of Labor Statistics. Occupational injury and illness classification manual (version 2.01) 2012. January 2012. Accessed April 11, 2022. https://www.bls.gov/iif/oiics_manual_2010.pdf
8. American Association of State Highway and Transportation Officials. Commuting in America 2013: the national report on commuting patterns and trends 2015. Accessed April 11, 2022. https://traveltrends.transportation.org/

9. Bureau of Labor Statistics. Current employment statistics, average weekly hours of all employees, 2018, oil and gas extraction (annual averages) 2020. Accessed April 13, 2022. https://data.bls.gov/timeseries/CEU1021100002?amp%253bdata_tool=XGtable&output_view=data&include_graphs=true
10. Bureau of Labor Statistics. Current employment statistics, average weekly hours of all employees, 2018, support activities for mining (annual averages) 2020. Accessed April 13, 2022. https://data.bls.gov/timeseries/CEU1021300002?amp%253bdata_tool=XGtable&output_view=data&include_graphs=true
11. Krum A, Miller A, Soccolich S. Evaluation of an in-vehicle monitoring system among an oil and gas well servicing fleet (#20-UI-083) 2020. Accessed April 13, 2022. https://vtechworks.lib.vt.edu/bitstream/handle/10919/97959/NSTSCE_OilGas_Final.pdf?sequence=1&isAllowed=y
12. International Association of Oil & Gas Producers. Land transportation safety recommended practice (OGP 365), version 4.0 (August 2020). 2020 Accessed April 13, 2022. www.ogp.org.uk/pubs/365.pdf
13. IPIECA/OGP. Managing fatigue in the workplace: a guide for the oil and gas industry (IOGP Report 626) 2019.
14. Retzer K, Hill R, Burton J. A review of the literature: motor vehicle safety initiatives in the oil and gas extraction industry presented at: SPE Americas E&P Health, Safety, Security, and Environmental Conference; 2013; Galveston, TX. doi:10.2118/163738-MSSPE
15. Bureau of Labor Statistics. Economic news release: Table 3. Union affiliation of employed wage and salary workers by occupation and industry Accessed May 26, 2021. https://www.bls.gov/news.release/union2.t03.htm
16. Sieber WK, Robinson CF, Birdsey J, et al. Obesity and other risk factors: the National Survey of U.S. Long-Haul Truck Driver Health and Injury. Am J Ind Med 2014;57(6):615–626. doi:10.1002/ajim.22293 [PubMed: 24390804]
17. National Center for Health Statistics. About the National Health Interview Survey Accessed December 4, 2020. https://www.cdc.gov/nchs/nhis/about_nhis.htm
18. U.S. Census Bureau. About the American Community Survey Accessed April 12, 2022. https://www.census.gov/programs-surveys/acs/about.html
19. R Core Team. R: A language and environment for statistical computing 2020. Accessed April 13, 2022. https://www.R-project.org/
20. Chakraborty H, Hossain A. R package to estimate intracluster correlation coefficient with confidence interval for binary data. Comput Methods Programs Biomed 2018;155:85–92. doi:10.1016/j.cmpb.2017.10.023 [PubMed: 29512507]
21. Fleiss JL, Cuzick J. The reliability of dichotomous judgments: unequal numbers of judges per subject. Appl Psychol Meas 1979;3(4): 537–542. doi:10.1177/014662167900300410
22. Yamashita T, Yamashita K, Kamimura R. A stepwise AIC method for variable selection in linear regression. Commun Stat - Theory Methods 2007;36(13):2395–2403. doi:10.1080/03610920701215639
23. Vivoda JM, Pratt SG, Gillies SJ. The relationships among roadway safety management practices, collision rates, and injury rates within company fleets. Saf Sci 2019;120:589–602. doi:10.1016/j.ssci.2019.07.033
24. Pratt SG, Bell JL. Analytical observational study of nonfatal motor vehicle collisions and incidents in a light-vehicle sales and service fleet. Accid Anal Prev 2019;129:126–135. doi:10.1016/j.aap.2019.05.009 [PubMed: 31150919]
25. Di Milia L, Rogers NL, Akerstedt T. Sleepiness, long distance commuting and night work as predictors of driving performance. PLoS One 2012;7(9):e45856. doi:10.1371/journal.pone.0045856 [PubMed: 23029278]
26. Barger LK, Cade BE, Ayas NT, et al. Extended work shifts and the risk of motor vehicle crashes among interns. N Engl J Med 2005;352(2):125–134. [PubMed: 15647575]
27. Ftouni S, Sletten TL, Howard M, et al. Objective and subjective measures of sleepiness, and their associations with on-road driving events in shift workers. J Sleep Res 2013;22(1):58–69. [PubMed: 22861524]

28. Akerstedt T Consensus statement: fatigue and accidents in transport operations. J Sleep Res 2000;9(4):395. doi:10.1046/j.1365-2869.2000.00228.x [PubMed: 11123524]
29. Liang Y, Horrey WJ, Howard ME, et al. Prediction of drowsiness events in night shift workers during morning driving. Accid Anal Prev 2017;126:105–114. doi:10.1016/j.aap.2017.11.004 [PubMed: 29126462]
30. Lee ML, Howard ME, Horrey WJ, et al. High risk of near-crash driving events following night-shift work. Proc Natl Acad Sci USA 2016;113(1):176–181. doi:10.1073/pnas.1510383112 [PubMed: 26699470]
31. Burd C, Burrows M, McKenzie B. Travel time to work in the United States: 2019 (ACS-47) 2021. Accessed April 13, 2022. https://www.census.gov/content/dam/Census/library/publications/2021/acs/acs-47.pdf
32. Texas A&M Transportation Institute. Texas' most congested road-ways Accessed May 5, 2021. https://mobility.tamu.edu/texas-most-congested-roadways/
33. Hirshkowitz M, Whiton K, Albert SM, et al. National Sleep Foundation's sleep time duration recommendations: methodology and results summary. Sleep Health 2015;1(1):40–43. [PubMed: 29073412]
34. Milner A, Badland H, Kavanagh A, LaMontagne AD. Time spent commuting to work and mental health: evidence from 13 waves of an Australian cohort study. Am J Epidemiol 2017;186(6):659–667. doi:10.1093/aje/kww243 [PubMed: 28453601]
35. Morris EA, Ettema D, Zhou Y. Which activities do those with long commutes forego, and should we care? Transp Res Interdiscip Persp 2020;5:100119. doi:10.1016/j.trip.2020.100119
36. Bioulac S, Micoulaud-Franchi JA, Arnaud M, et al. Risk of motor vehicle accidents related to sleepiness at the wheel: a systematic review and meta-analysis. Sleep 2017;40(10):zsx134. doi:10.1093/sleep/zsx134
37. Stutts JC, Wilkins JW, Scott Osberg J, Vaughn BV. Driver risk factors for sleep-related crashes. Accid Anal Prev 2003;35(3):321–331. doi:10.1016/S0001-4575(02)00007-6 [PubMed: 12643949]
38. Williamson A, Lombardi DA, Folkard S, Stutts J, Courtney TK, Connor JL. The link between fatigue and safety. Accid Anal Prev 2011;43(2):498–515. doi:10.1016/j.aap.2009.11.011 [PubMed: 21130213]
39. National Institute for Occupational Safety and Health. Oil and gas employers: how to prevent fatigued driving at work (NIOSH Publication No. 2018-125). 2018 Accessed April 13, 2022. 10.26616/NIOSHPUB2018125
40. Fossum IN, Bjorvatn B, Waage S, Pallesen S. Effects of shift and night work in the offshore petroleum industry: a systematic review. Ind Health 2013;51(5):530–544. doi:10.2486/indhealth.2013-0054 [PubMed: 23803497]
41. Kannan P, Mannan MS, Mehta RM. The state of fatigue assessment and management in offshore oil and gas industry: a systematic review. Proc Human Factors Ergonomics Soc Annu Meet 2018;62(1): 886–887. doi:10.1177/1541931218621203
42. Parkes KR. Shift schedules on North Sea oil/gas installations: a systematic review of their impact on performance, safety and health. Saf Sci 2012;50(7):1636–1651. doi:10.1016/j.ssci.2012.01.010
43. Garbarino S, Mascialino B, Penco MA, et al. Professional shift-work drivers who adopt prophylactic naps can reduce the risk of car accidents during night work. Sleep 2004;27(7):1295–1302. doi:10.1093/sleep/27.7.1295 [PubMed: 15586782]
44. Di Milia L, Kecklund G. The distribution of sleepiness, sleep and work hours during a long distance morning trip: a comparison between night- and non-night workers. Accid Anal Prev 2013;53(1): 17–22. doi:10.1016/j.aap.2013.01.003 [PubMed: 23357032]
45. Wagstaff AS, Sigstad Lie J- A. Shift and night work and long working hours—a systematic review of safety implications. Scand J Work Environ Health 2011;37(3):173–185. doi:10.5271/sjweh.3146 [PubMed: 21290083]
46. Ziebertz CM, van Hooff MLM, Beckers DGJ, Hooftman WE, Kompier MAJ, Geurts SAE. The relationship of on-call work with fatigue, work-home interference, and perceived performance difficulties. BioMed Res Int 2015;2015:643413. doi:10.1155/2015/643413 [PubMed: 26558276]
47. Folkard S Black times: temporal determinants of transport safety. Accid Anal Prev 1997;29(4):417–430. doi:10.1016/S0001-4575(97)00021-3 [PubMed: 9248500]

48. Caruso CC, Hitchcock EM, Dick RB, Russo JM, Schmit JM. Overtime and extended work shifts: recent findings on illnesses, injuries, and health behaviors (DHHS (NIOSH) Pub. No. 2004-143) 2004. Accessed April 13, 2022. 10.26616/NIOSHPUB2004143
49. Lombardi DA, Folkard S, Willetts JL, Smith GS. Daily sleep, weekly working hours, and risk of work-related injury: US National Health Interview Survey (2004–2008). Chronobiol Int 2010;27(5): 1013–1030. doi:10.3109/07420528.2010.489466 [PubMed: 20636213]
50. Dawson D, Sprajcer M, Thomas M. How much sleep do you need? A comprehensive review of fatigue related impairment and the capacity to work or drive safely. Accid Anal Prev 2021;151:105955. doi:10.1016/j.aap.2020.105955 [PubMed: 33383522]
51. Satterfield BC, Van Dongen HPA. Occupational fatigue, underlying sleep and circadian mechanisms, and approaches to fatigue risk management. Fatigue: Biomed, Health Behav 2013;1(3):118–136. doi:10.1080/21641846.2013.798923
52. Luckhaupt SE. Short sleep duration among workers—United States, 2010. Morb Mortal Wkly Rep 2012;61(16):281–285.
53. Shockey TM, Wheaton AG. Short sleep duration by occupation group—29 states, 2013–2014. Morb Mortal Wkly Rep 2017;66(8): 207–213.
54. Khubchandani J, Price JH. Short sleep duration in working American adults, 2010–2018. journal article. J Community Health 2020;45: 219–227. doi:10.1007/s10900-019-00731-9 [PubMed: 31489537]
55. Connor J, Norton R, Ameratunga S, et al. Driver sleepiness and risk of serious injury to car occupants: population based case control study. BMJ 2002;324(7346):1125. [PubMed: 12003884]
56. Hanowski RJ, Hickman J, Fumero MC, Olson RL, Dingus TA. The sleep of commercial vehicle drivers under the 2003 hours-of-service regulations. Accid Anal Prev 2007;39(6):1140–1145. doi:10.1016/j.aap.2007.02.011 [PubMed: 17920836]
57. Dawson D, McCulloch K. Managing fatigue: it's about sleep. Sleep Med Rev 2005;9:365–380. [PubMed: 16099184]
58. Van Dongen HPA, Maislin G, Mullington JM, Dinges DF. The cumulative cost of additional wakefulness: dose-response effects on neurobehavioral functions and sleep physiology from chronic sleep restriction and total sleep deprivation. Sleep 2003;26(2):117–126. doi:10.1093/sleep/26.2.117 [PubMed: 12683469]
59. Belenky G, Wesensten NJ, Thorne DR, et al. Patterns of performance degradation and restoration during sleep restriction and subsequent recovery: a sleep dose-response study. J Sleep Res 2003;12(1):1–12. doi:10.1046/j.1365-2869.2003.00337.x [PubMed: 12603781]
60. Martin-Gill C, Barger LK, Moore CG, et al. Effects of napping during shift work on sleepiness and performance in emergency medical services personnel and similar shift workers: a systematic review and meta-analysis. Prehosp Emerg Care 2018;22(suppl 1):47–57. doi:10.1080/10903127.2017.1376136 [PubMed: 29324083]
61. Purnell MT, Feyer AM, Herbison GP. The impact of a nap opportunity during the night shift on the performance and alertness of 12-h shift workers. J Sleep Res 2002;11(3):219–227. doi:10.1046/j.1365-2869.2002.00309.x [PubMed: 12220318]
62. Reyner LA, Horne JA. Suppression of sleepiness in drivers: combination of caffeine with a short nap. Psychophysiology 1997;34(6):721–725. doi:10.1111/j.1469-8986.1997.tb02148.x [PubMed: 9401427]
63. Lerman SE, Eskin E, Flower DJ, et al. Fatigue risk management in the workplace. J Occup Environ Med 2012;54(2):231–258. [PubMed: 22269988]
64. Wallington D, Murray W, Darby P, Raeside R, Ison S. Work-related road safety: case study of British telecommunications (BT). Transp Policy 2014;32:194–202.
65. Warmerdam A, Newnam S, Sheppard D, Griffin M, Stevenson M. Workplace road safety risk management: an investigation into Australian practices. Accid Anal Prev 2017;98:64–73. doi:10.1016/j.aap.2016.09.014 [PubMed: 27701023]
66. Retzer KD, Tate D, Hill RD. Journey management: a strategic approach to reducing your workers' greatest risk presented at: SPE International Conference on Health, Safety, and Environment, March 17–19, 2014; Long Beach, CA.

TABLE 1

Demographic and employment characteristics, vehicle use, and employer safety policies, for all respondents and those who drive for work

	All respondents (n = 498)	%[a]	Drive for work (n = 363)	%[a]
Gender				
Male	482	96.8	349	96.1
Female	16	3.2	14	3.9
Ethnicity				
Hispanic	176	35.7	107	29.6
Age group				
<25 years	56	11.3	33	9.1
25–34 years	197	39.9	143	39.6
35–44 years	120	24.3	89	24.7
45–54 years	66	13.4	50	13.9
55+ years	55	11.1	46	12.7
Company type				
Contractor	394	80.6	266	74.5
Servicing company	271	55.4	195	54.7
Drilling contractor	106	21.7	56	15.7
Other	17	3.5	15	4.2
Operator	95	19.4	91	25.5
Years of oilfield experience				
1 month to 1 year	70	14.2	40	11.1
>1–5 years	104	21.1	70	19.5
>5–10 years	134	27.2	104	29.0
>10 years	184	37.4	145	40.4
Type of vehicle driven for work				
Pickup truck (<10,000 lbs.)	n/a		265	75.9
Single-unit medium truck (10,000– 26,000 lbs.)			40	11.5
Heavy truck, single-unit, or semitrailer (>26,000 lbs.)			27	7.7
Passenger car			10	2.9
Single-unit truck (unknown weight) or van			7	2.0
Annual miles driven				
25,000 or less miles	n/a		117	33.2
>25,000–50,000 miles			133	37.8
>50,000–100,000 miles			68	19.3
>100,000 miles			34	9.7
Employer safety policies				
Has maximum work hours policy	n/a		138	38.5
Has vehicle safety policy			330	93.0
Has journey management policy			164	46.7
Has fatigue management policy			148	42.3

	All respondents (n = 498)	%[a]	Drive for work (n = 363)	%[a]
Requires reporting of near miss crash			287	82.0

Abbreviation: n/a, not applicable.

[a]Missing or don't know responses were removed from the denominator for percent calculations.

TABLE 2

Hours worked, commuting time, and sleep hours by company type

	Total (n = 498)	%[a]	Company type Contractor[b] (n = 394)	%[a]	Operator (n = 95)	%[a]
Number of hours worked per day[c]						
Mean	11.87		12.17***		10.80***	
8 or fewer hours	14	3.2	8	2.4	6	6.5
9–11 h	153	35.0	95	28.0	55	59.8
12–14 h	219	50.1	189	55.8	28	30.4
15 or more hours	51	11.7	47	13.9	3	3.3
Daily roundtrip commuting time[c]						
Mean	1.82		1.92**		1.50**	
5 min or less	68	14.6	65	17.7	3	3.2
>5 min to 1 h	157	33.7	107	29.2	47	50.0
>1–3 h	163	35.0	126	34.3	36	38.3
>3 h	78	16.7	69	18.8	8	8.5
Hours worked plus commuting time[c]						
Mean	13.52		13.97***		12.34***	
10 h or less	23	5.6	8	2.5	14	15.2
>10–12 h	112	27.3	77	24.5	34	37.0
>12–14 h	131	32.0	105	33.4	25	27.2
>14–16 h	60	14.6	47	15.0	12	13.0
>16 h	84	20.5	77	24.5	7	7.6
Usual hours of sleep on workdays[c]						
Mean	6.67		6.66		6.73	
<5 h	12	2.5	11	2.9	1	1.1
5–<6 h	72	15.0	63	16.6	8	8.5
6–<7 h	137	28.5	103	27.2	31	33.0
7–<8 h	154	32.1	113	29.8	38	40.4
>8 h	105	21.9	89	23.5	16	17.0

[a]Missing or don't know responses were removed from the denominator for percent calculations.

[b]Contractors are workers who reported company type as a drilling contractor, servicing company, or other.

[c]Reported frequencies include outliers. Means were calculated with outliers removed.

[*]$p < 0.05$, based on *t*-tests for company type.

[**]$p < 0.01$, based on *t*-tests for company type.

[***]$p < 0.001$, based on *t*-tests for company type.

TABLE 3

Driving-related outcomes by work schedule and hours, commuting time, sleep hours, and employer safety policies among respondents who drive for work (n = 363)

	Feeling very drowsy while driving at work (more than once a month)		Ever fallen asleep while driving a work vehicle		Near miss in the past week	
	No	**Yes**	**No**	**Yes**	**No**	**Yes**
Total (%)	73.9	26.1	72.8	27.2	82.8	17.2
Company type (%)						
Operator	67.4	32.6	75.6	24.4	86.0	14.0
Contractor	77.2	22.8	72.5	27.5	82.0	18.0
Work schedule and hours, commuting, and sleep						
Work schedule (%)						
Daytime (day shift/ normal business hours)	74.2	25.8	75.9	24.1**	82.2	17.8
Nonstandard (evening shift, swing or rotating shift, on-call 24/7, and other)	74.3	25.7	60.6	39.4**	84.1	15.9
Mean number of hours worked per day						
	11.73	11.86	11.61	12.21*	11.72	12.18
Mean daily roundtrip commuting time (hours)						
	1.69	2.38***	1.74	2.21**	1.81	2.24*
Mean usual hours of sleep on workdays						
	6.85	6.24***	6.80	6.42*	6.74	6.39*
Employer safety policies						
Has maximum work hours policy (%)						
Yes	83.7	16.3***	75.8	24.2	82.7	17.3
No or don't know	67.3	32.7***	71.3	28.7	82.6	17.4
Has vehicle safety policy (%)						
Yes	74.5	25.5	73.7	26.3	82.1	17.9
No or don't know	64.0	36.0	68.0	32.0	91.7	8.3[a]
Has journey management policy (%)						
Yes	80.8	19.2**	79.6	20.4**	84.1	15.9
No or don't know	68.3	31.7**	67.2	32.8**	81.1	18.9
Has fatigue management policy (%)						
Yes	81.1	18.9*	72.8	27.2	81.9	18.1
No or don't know	68.7	31.3*	73.6	26.4	82.8	17.2
Requires reporting of near miss crash (%)						
Yes	74.4	25.6	73.8	26.2	83.8	16.2
No or don't know	71.0	29.0	72.6	27.4	76.7	23.3

[a] χ^2 tests results for expected cell sizes <5 in these cells may be unreliable.

* $p < 0.05$, based on χ^2 tests and t-tests.

** $p < 0.01$, based on χ^2 tests and *t*-tests.

*** $p < 0.001$, based on χ^2 tests and *t*-tests.

TABLE 4

Multivariable logistic regression results assessing driving-related outcomes

Outcome	Predictor[a]	SE	z-value	OR (95% CI)
Feeling very drowsy while driving at work (more than once a month)	Usual hours of sleep on workdays	0.15	−2.74**	**0.66 (0.49, 0.89)**
	Daily roundtrip commuting time	0.12	3.49***	**1.49 (1.19, 1.87)**
	No maximum work hours policy[b]	0.37	3.27**	**3.35 (1.62, 6.90)**
	Company type: Contractor	0.32	−2.27*	**0.48 (0.26, 0.91)**
Ever fallen asleep while driving a work vehicle	Nonstandard work schedule: Evening shift, swing or rotating shifts, on-call 24/7, and other	0.29	2.58**	**2.10 (1.20, 3.68)**
	No journey management policy[b]	0.25	2.30*	**1.80 (1.09, 2.96)**
Near miss in the past week	Daily roundtrip commuting time	0.11	2.02*	**1.25 (1.01, 1.54)**

Abbreviations: CI, confidence interval; OR, odds ratio; SE, standard error.

[a]Reference groups for the categorical variables are day shift/normal business hours for work schedule, operator for company type, and having the policy for the employer safety policy variables. The following are continuous variables: usual hours of sleep on workdays, daily roundtrip commuting time, and the number of hours worked per day.

[b]For employer safety policies, the category “No” includes those who responded no or don’t know.

*p <0.05, based on multivariable logistic regression.

**p < 0.01, based on multivariable logistic regression.

***p < 0.001, based on multivariable logistic regression.