



## Motor vehicle fatalities among oil and gas extraction workers

Kyla D. Retzer<sup>a,\*</sup>, Ryan D. Hill<sup>b,1</sup>, Stephanie G. Pratt<sup>c,2</sup>

<sup>a</sup> National Institute for Occupational Safety and Health, Oil and Gas Extraction Safety and Health Program, Alaska Pacific Office, 4230 University Dr., Ste. 310, Anchorage, AK 99508, United States

<sup>b</sup> National Institute for Occupational Safety and Health, Oil and Gas Extraction Safety and Health Program, Western States Office, P.O. Box 25226, Denver, CO 80225, United States

<sup>c</sup> National Institute for Occupational Safety and Health, Division of Safety Research, Center for Motor Vehicle Safety, 1095 Willowdale Road, Mail Stop H-1808, Morgantown, WV 26505, United States

### ARTICLE INFO

#### Article history:

Received 28 June 2012

Received in revised form 22 October 2012

Accepted 5 November 2012

#### Keywords:

Motor vehicle crashes

Work-related fatalities

Oil and gas extraction industry

### ABSTRACT

Motor vehicle crashes are the leading cause of work-related fatality in the U.S. as well as in the oil and gas extraction industry. This study describes the characteristics of motor vehicle-related fatalities in the oil and gas extraction industry using data from the U.S. Bureau of Labor Statistics' Census of Fatal Occupational Injuries. It compares the risk of dying in a motor vehicle crash in this industry to other major industries and among different types and sizes of oil and gas extraction companies. There were 202 oil and gas extraction workers who died in a work-related motor vehicle crash from 2003 to 2009. The motor vehicle fatality rate for workers in this industry was 8.5 times that of all private wage and salary workers (7.6 vs. 0.9,  $p < .0001$ ). Workers from small oil and gas establishments (<20 workers) and workers from well-servicing companies were at greatest risk of dying in a motor vehicle crash. Pick-up trucks were the most frequent type of vehicle occupied by the fatally injured worker ( $n = 104$ , 51.5%). Safety belt non-use was identified in 38.1% ( $n = 77$ ) of the cases. Increased focus on motor vehicle safety in this industry is needed, in particular among small establishments. Extraction workers who drive light duty vehicles need to be a specific focus.

Published by Elsevier Ltd.

### 1. Introduction

Motor vehicle crashes on public highways are consistently the leading cause of work-related fatality in the U.S., accounting for 8173 fatalities during 2003–2008 (24% of all work-related fatalities for the period) and a rate of 0.94 deaths per 100,000 workers (CDC, 2011a). These events exact an economic burden in addition to a human toll. One study estimated that motor vehicle crash injuries occurring on and off the job cost employers nearly \$60 billion USD annually from 1998 to 2000 (National Highway Traffic Safety Administration, 2003). On average, each fatality cost the employer over US\$ 500,000 in direct and liability costs, and each nonfatal injury cost nearly US\$ 74,000. For work-related crashes, the cost to businesses of non-use of safety belts was estimated to be over US\$ 2 billion.

Previous reports show that compared to workers in all industries, workers in the oil and gas extraction industry experienced seven times the rate of work-related death due to all causes (CDC,

2008), and six times the rate of work-related motor vehicle-related death (5.7 deaths per 100,000 workers) (CDC, 2011a). Potential risk and exposure factors for fatal motor vehicle crashes in the oil and gas extraction industry include frequent travel between well sites, travel on rural roads which often lack firm shoulders and rumble strips, low levels of safety belt use, and long and irregular hours of work that contribute to driver fatigue. Oil and gas extraction workers often work up to 12-h shifts, and 7–14 days in a row (CDC, 2008).

The oil and gas extraction industry employed an estimated 434,488 people in the U.S. in 2010 (Bureau of Labor Statistics, 2011). While the number of oil and gas extraction workers fluctuates from year to year, there was a 48% overall increase in the number of workers from 2003 to 2010. Additional growth is expected in this industry, with shale gas production expected to increase by almost threefold by 2035 (U.S. Energy Information Administration, 2011). With this growth comes an increase in the number of workers and a need to address major causes of work-related injury and death. This study contributes to the literature by providing data on motor vehicle-related fatalities in the oil and gas extraction industry that are more detailed than published previously. Further, the study compares motor vehicle-related fatality rates for the oil and gas extraction industry with other industries and compares the risk of motor vehicle-related death by establishment type and size. This information will help to identify gaps in crash data and will

\* Corresponding author. Tel.: +1 907 271 2388; fax: +1 907 271 2390.

E-mail addresses: [kretzer@cdc.gov](mailto:kretzer@cdc.gov) (K.D. Retzer), [gii9@cdc.gov](mailto:gii9@cdc.gov) (R.D. Hill),

[sgp2@cdc.gov](mailto:sgp2@cdc.gov) (S.G. Pratt).

<sup>1</sup> Tel.: +1 303 236 0502; fax: +1 303 236 6072.

<sup>2</sup> Tel.: +1 304 285 5992; fax: +1 304 285 5774.

contribute to more targeted motor vehicle safety efforts in the oil and gas extraction industry.

## 2. Materials and methods

Work-related motor vehicle fatalities were identified using the Census of Fatal Occupational Injuries (CFOI), a cooperative program between the U.S. Bureau of Labor Statistics (BLS) and state governments.<sup>3</sup> CFOI is the most comprehensive surveillance system for work-related injury fatalities in the U.S. Multiple data sources are accessed to compile data, including death certificates, OSHA reports, workers' compensation reports, police reports, and media accounts. Cases are deemed to be work-related upon confirmation by two independent data sources.

The oil and gas extraction industry includes three types of companies: the oil and gas operators who control and manage leased areas, the drilling contractors who drill the wells, and the well-servicing companies who provide all other types of support operations that prepare a well for production and completion. For this study, the 2002 North American Industry Classification System (NAICS) was used to identify workers whose employers were classified by industry into the following three codes: Oil and Gas Extraction (211), Drilling Oil and Gas Wells (213111) and Support Activities for Oil and Gas Operations (213112). To be consistent with the terminology commonly used in the industry and previously published studies, employers categorized in NAICS 211 are referred to hereafter as "oil and gas operators," in NAICS 213111 as "drilling contractors" and in NAICS 213112 as "well-servicing companies." Data for other industries were grouped according to NAICS for comparison to the oil and gas extraction industry. All analyses were limited to data years 2003–2009, as NAICS categories are not comparable to the Standard Industrial Classification previously used by the BLS.

The CFOI uses the Occupational Injury and Illness Classification System (OIICS) to code characteristics of work-related fatalities (BLS, 2012). The CFOI data were subset to all cases coded per the 2007 OIICS as "highway accident" events (event code = 41). This encompasses all motor vehicle-related fatalities of vehicle occupants occurring on a public highway, street, or road or its shoulder and surrounding areas. It excludes motor vehicle fatalities that occurred on industrial, commercial, or residential premises, or that were the result of an assault or violent act. More detailed event codes within the "highway accident" category were examined. Also of interest were the source of injury (i.e., the type of vehicle occupied by the decedent), the decedent's status as a driver or passenger, the type of road on which the incident occurred, and the time of day. Motor vehicle fatalities that occurred during commuting to work are not included in CFOI.

The CFOI also provides data on the demographic and employment characteristics of the fatally injured worker, including occupation (categorized using the Standard Occupational Classification [SOC] scheme) (OMB, 2010), size of establishment,<sup>4</sup> years of service with the company, age group, gender, race, Hispanic origin, and the state in which the incident occurred. The narrative text field in CFOI was systematically examined for information on factors related to the driver, vehicle, or road environment, as well as the circumstances of the crash. Each narrative was reviewed manually by

a single coder, as the factors identified were straightforward (e.g., safety belt worn) and did not require coder interpretation. The following factors were identified: safety belt use/non-use, occupant ejection, other drivers' error, speed, fell asleep, overcorrected and lost control, lost control at curve, weather, night time, debris/holes in roadway, collisions with livestock, and faulty vehicle parts (e.g., tire blowout, brake failure). In crashes where multiple factors were listed, each factor was counted once. It should be noted that the narrative text field in CFOI is based on information obtained from the source documents, and does not contain a high level of detail for all cases. More importantly, mention of a factor in the narrative field does not imply causation.

Ideally, fatality rates should be calculated based on vehicle miles traveled (VMT) or some other measure of exposure such as hours of driving. However, no such data exist for work-related driving in general or for the oil and gas extraction industry in particular. Therefore, as is customary for most analyses of work-related injuries and fatalities, rates (and accompanying risk ratios) were calculated based on average annual employment estimates. For this study, the source of employment estimates was the BLS' Quarterly Census of Employment and Wages (QCEW), the only source that provides estimates for the detailed NAICS codes that make up the oil and gas extraction industry (BLS, 2011). QCEW estimates are calculated from monthly employer reports and include all workers covered by state unemployment insurance laws. The QCEW does not include self-employed workers,<sup>5</sup> nor does it provide estimates by age, race or gender. To ensure consistency between the numerator (fatalities identified through CFOI) and denominator (QCEW employment estimates), the CFOI data were subset to include only fatalities to individuals employed in the private sector and working for wage or salary, thereby excluding the self-employed, employees who worked in a family business, volunteers, and government workers.

Rate ratios (RR) and 95% confidence intervals (CI) were calculated for comparisons of fatality rates for the oil and gas extraction industry and other major industry groups, for comparisons between the three component NAICS codes that make up the oil and gas extraction industry, and for comparisons between large, medium and small establishments within the oil and gas extraction industry. For the first comparison, all private wage and salary workers were used as the reference group because there is no industry group that could reasonably be compared to oil and gas extraction on the basis of operational characteristics or likely exposure to motor-vehicle related risks. For the other two comparisons, the group with the lowest rate was used as the reference group. All analyses were performed using SAS version 9.2 (SAS Institute, Cary, NC, 2008).

## 3. Results

Between 2003 and 2009, 202 oil and gas extraction workers died as a result of a motor vehicle crash. Motor vehicle-related fatalities accounted for 28% of all oil and gas extraction work-related fatalities during this 7-year period and were the leading cause of death.

Decedents were predominantly white males and 21% were Hispanic ( $n = 44$ ) (data not shown). Forty percent of the decedents were younger than 35 years of age (Table 1). Thirty-one percent of the deaths were to workers who had worked for their employer for 1 year or less ( $n = 63$ ). Those workers fatally injured in a motor vehicle crash were most often employed as extraction workers

<sup>3</sup> This research was conducted with restricted access BLS data. The views expressed here do not necessarily reflect the views of the BLS.

<sup>4</sup> An establishment is defined as "an economic unit, such as a farm, mine, factory, or store that produces goods or provides services. It is typically at a single physical location and engaged in one, or predominantly one, type of economic activity for which a single industrial classification may be applied" (Bureau of Labor Statistics, 2011). As discussed in 4.8, there are potential inconsistencies in the use of this concept for the oil and gas extraction industry.

<sup>5</sup> Self-employed worker is defined as carrying on a business as a sole proprietor or an independent contractor.

**Table 1**  
Motor vehicle fatalities by selected characteristics, Oil and Gas Extraction Industry, United States, 2003–2009.

	Number	Percentage (%)
<i>Age group</i>		
16–24	24	11.4
25–34	60	28.6
35–44	45	21.4
45–54	39	18.6
55–64	25	11.9
≥65	9	4.3
<i>Length of service (years)</i>		
≤1	63	31.2
1 year 1 day–3	24	11.9
4–5	15	7.4
6–7	6	3.0
≥8	14	6.9
Not reported	80	39.6
<i>Occupation</i>		
Extraction workers	96	47.5
Motor vehicle operators	66	32.7
Maintenance/repair workers	14	6.9
Assemblers/welders/operators/inspectors	8	4.0
Engineers	6	3.0
Other	12	6.0
<i>Worker activity</i>		
Driver	165	81.7
Passenger	37	18.3
<i>Type of motor vehicle</i>		
Pickup truck	104	51.5
Semi-trailer, tractor trailer, trailer truck	54	26.7
Unknown or other type of truck	25	12.4
Automobile	12	5.9
Other types of vehicles	7	3.5
<i>Crash type</i>		
Highway collisions between vehicles, mobile equipment		
Moving in opposite directions, oncoming	42	20.8
Moving in intersection	18	8.9
Moving in same direction	16	7.9
Subtotal	76	37.6
Non-collision highway incidents		
Jack-knifed or overturned—no collision	78	38.6
Vehicle struck object on side of road	35	17.3
Subtotal	113	55.9
Other types of crashes	13	6.4
<i>Road type</i>		
State or U.S. highway	131	64.9
Local road or street	41	20.3
Interstate, freeway, or expressway	19	9.4
Street, highway, or road, unspecified or not elsewhere classified	11	5.4
<i>Safety belt status<sup>a</sup></i>		
Safety belt not used	77	38.1
Ejected (no safety belt info)	24	11.9
Safety belt worn	24	11.9
Unknown	77	38.1
<i>State of incident</i>		
Texas	76	37.6
Oklahoma	28	13.9
Wyoming	21	9.9
New Mexico	19	9.4
Kansas	13	6.4
Louisiana	11	5.4
Colorado	9	4.5
Utah	6	3.0
Other states	19	9.4
Total	202	100.0

Source: Data were generated by NIOSH Alaska Pacific Regional Office with restricted access to BLS CFI microdata.

Note: Ethnicity, gender and race was not reported in the table because it did not meet BLS publication criteria.

<sup>a</sup> This variable was created based on narrative text.

( $n=96$ , 47.5%), followed by motor vehicle operators ( $n=66$ , 32.7%) (Table 1).

Pickup trucks were the most common type of vehicle occupied by the decedent (51.5%), followed by semi-trucks (26.7%) (Table 1). Over half ( $n=113$ , 55.9%) of oil and gas extraction worker fatalities were the result of non-collision incidents (those involving a single vehicle); these were either the result of the vehicle jack-knifing or overturning ( $n=78$ , 38.6%) or the vehicle striking an object on the side of the road ( $n=35$ , 17.3%). When crash type was analyzed by vehicle type, the most frequent type of crash for pickup truck occupants (drivers and passengers) was a 'collision with oncoming traffic' (31.7%) and for semi-truck occupants was 'jack-knifing or overturning-no collision' (62.9%) (data not shown). Crashes occurred most frequently on a state or U.S. highway ( $n=131$ , 64.9%) (Table 1). The majority of the crashes occurred between the hours of 5 a.m. and 5 p.m. ( $n=162$ , 80.2%) (data not shown).

Based on case narratives, 38.1% of fatally injured oil and gas extraction workers were not wearing a safety belt at the time of the incident (belt-use status was ascertained for 50% of the workers). Another 11.9% of workers were reportedly ejected from the vehicle, thus it is likely that most of these individuals were also unbelted (National Highway Traffic Safety Administration, 2005). The largest proportion of unbelted workers was pick-up truck occupants (59.8%) (data not shown). Sixteen to 24 year olds had the highest proportion of unbelted workers of any age group (58.3%).

Other crash-related factors noted in case narratives included other drivers' errors (13.9%), speed (9.4%), losing control after over-correcting (9.9%) or on a curve (8.4%), weather conditions (9.9%), and falling asleep at the wheel (6.9%). There were no crash-related factors noted in the narrative in 17.3% of cases. Over 60% of oil and gas extraction workers who died in a motor-vehicle crash were employed by well-servicing companies (61.9%) (Table 2). More than one-quarter of all workers who died (27.1%) were employed by well-servicing companies with fewer than 20 employees (data not shown). Workers employed by well-servicing companies and drilling contractors were significantly more likely to die as a result of a highway crash than those employed by oil and gas operators (RR = 3.4, 3.0 respectively,  $p < .0001$ ) (Table 2). Workers from small and medium sized establishments were also significantly more likely to die in a highway crash while at work than were workers from large establishments (RR = 4.2, 2.0 respectively,  $p < .01$ ).

The motor vehicle-related fatality rate for the oil and gas extraction industry was 7.6/100,000 workers. Among all other major industry groups, only transportation and warehousing had a higher rate (9.3/100,000 workers) (Table 3). Using all private wage and salary workers as the reference group, the RR for the oil and gas extraction industry was 8.5 ( $p < .0001$ ), second only to the transportation and warehousing industry (RR = 10.4,  $p < .0001$ ).

## 4. Discussion

### 4.1. Pickup trucks and the absence of regulations

Over half of the fatalities in this worker population were either the driver or passenger of a pickup truck. These vehicles are not covered by Federal Motor Carrier Safety Regulations (FMCSRs), unless they are placarded for carrying hazardous materials [49 CFR 383.91 (a)] (Federal Motor Carrier Safety Administration, 2011a). In general, the FMCSRs cover only the operation of large motor vehicles that transport freight or passengers. In addition, drivers of pickup trucks generally are not required to have a Commercial Driver's License (CDL).

**Table 2**  
Number and rate of motor vehicle fatalities by Oil and Gas Extraction Industry Establishment Size and Company Type, 2003–2009.

	Number	Percentage	Average annual employment	Deaths per 100,000 workers per year	RR (95% CI)
<i>Establishment size (no. of employees)</i>					
Small (<20)	64	31.7	65,109	14.0	4.2 <sup>a</sup> (2.9–6.3)
Medium (20–99)	50	24.8	107,544	6.6	2.0 <sup>a</sup> (1.3–3.0)
Large (≥100)	41	20.3	179,921	3.3	1.0
Not reported	47	23.3	–	–	–
<i>Company type</i>					
Well-servicing company	125	61.9	168,609	10.6	3.4 <sup>b</sup> (2.3–5.1)
Drilling contractor	47	23.3	71,482	9.4	3.0 <sup>b</sup> (1.9–4.8)
Oil and gas operator	30	14.9	138,453	3.1	1.0
Total	202	100.0	378,545 <sup>c</sup>	7.6	

Sources: Data were generated by NIOSH Alaska Pacific Regional Office with restricted access to BLS CFOI microdata; and Quarterly Census of Employment and Wages.

<sup>a</sup> Rate ratio significantly different from reference group (large [100+]) ( $p < .01$ ).

<sup>b</sup> Rate ratio significantly different from reference group (oil and gas operator) ( $p < .0001$ ).

<sup>c</sup> Total reflects a slightly higher number due to rounding.

**Table 3**  
Work-related motor vehicle fatalities, private wage and salary workers,<sup>a</sup> United States, 2003–2009.

Industry	NAICS code(s)	Highway transportation fatalities	Deaths per 100,000 workers per year	RR (95% CI)
Transportation and warehousing	48–49	2692	9.3	10.4 (9.9–10.8) <sup>b</sup>
Oil and gas extraction	211, 213111, 213112	202	7.6	8.5 (7.4–9.7) <sup>b</sup>
Agriculture, forestry, fishing, and hunting	11	325	4.0	4.5 (4.0–5.0) <sup>b</sup>
Mining, excl. oil and gas extraction	21, Excl. 211, 213111, and 213112	36	2.3	2.6 (1.8–3.6) <sup>b</sup>
Construction	23	837	1.7	1.9 (1.8–2.0) <sup>b</sup>
Wholesale trade	42	524	1.3	1.4 (1.3–1.6) <sup>b</sup>
Utilities	22	37	1.0	1.1 (0.8–1.5)
Manufacturing	31–33	413	0.4	0.5 (0.4–0.5) <sup>b</sup>
Retail trade	44–45	404	0.4	0.4 (0.4–0.5) <sup>b</sup>
Services, excl. public administration	51–56, 61–62, 71–72, 81	1483	0.3	0.4 (0.4–0.4) <sup>b</sup>
All private wage and salary workers		6953 <sup>a</sup>	0.9	1.0

Sources: Counts of highway transportation fatalities were generated by the NIOSH Division of Safety Research with restricted access to BLS CFOI microdata. Employment data for calculation of fatality rates were obtained from the Quarterly Census of Employment and Wages.

<sup>a</sup> Excludes self-employed, workers in a family business, volunteers, and government workers. Also excludes six fatalities of private wage and salary workers 2003–2009 who were not classified by industry.

<sup>b</sup> Rate ratio significantly different from reference group (all private wage and salary workers) ( $p < .0001$ ).

The FMCSRs contain hours-of-service regulations which limit consecutive hours of driving by drivers of commercial motor vehicles<sup>6</sup> and specify minimum numbers of off-duty hours. However, these regulations do not apply to most pickup trucks. Many oil and gas extraction workers work 8–12 h shifts for 7–14 consecutive days (CDC, 2008). These work schedules may place them at an elevated risk of a fatigue-related crash (Williamson et al., 2011; Caruso, 2006; Dembe and Erickson, 2005). In addition, oil and gas workers often commute long distances to get to the worksite where they will spend their week(s) on duty. In some locations, workers may commute to and from a distant work site in a single day.

For vehicles specifically constructed to service oil wells, drivers' waiting time at drilling sites does not count toward total on-duty hours [49 CFR 395.1 (d) (2)] (Federal Motor Carrier Safety Administration, 2011b). The result is that although these workers

may not be exceeding the maximum number of driving hours, the length of their work shifts may be extended, thereby contributing to fatigue.

In the absence of applicable regulations, it is important for employers to target prevention efforts toward drivers of lighter vehicles such as pickup trucks through comprehensive management of vehicles and drivers. These efforts should place priority on fatigue management and the use of safety belts.

#### 4.2. Lack of safety belts

Half of the workers who died were either not wearing a safety belt or were ejected from the vehicle and presumably, not belted. Using a safety belt is the single most effective measure for preventing motor-vehicle crash fatalities and serious injuries. Lap/shoulder belts, when used correctly by light-truck occupants, reduce the risk of fatal injury by 60% and moderate-to-severe injury by 65% (National Highway Traffic Safety Administration, 2007). In the U.S., the use of safety belts saved the lives of an estimated 12,713 persons aged 5 and older in 2009; another 3688 lives would have been saved if all vehicle occupants had been belted (National Highway Traffic Safety Administration, 2010).

Low levels of belt use in the oil and gas extraction industry may be in part related to the culture of the work environment. A qualitative study of worker perceptions of safety in the oil industry in Alberta, Canada found that risk taking was a fundamental characteristic of the worker and the work environment (Rothe, 2008). These workers perceived the use of a safety belt as a behavior that was dictated by the situation, such as when driving in inclement

<sup>6</sup> For regulatory purposes, commercial motor vehicles are defined as follows: (1) Combination vehicle (group A)—any combination of vehicles with a gross combination weight rating (GCWR) of 11,794 kg or more (26,001 pounds or more) provided the GVWR of the vehicle(s) being towed is in excess of 4536 kg (10,000 pounds). (2) Heavy straight vehicle (group B)—any single vehicle with a GVWR of 11,794 kg or more (26,001 pounds or more), or any such vehicle towing a vehicle not in excess of 4536 kg (10,000 pounds) GVWR. (3) Small vehicle (group C)—any single vehicle, or combination of vehicles, that meets neither the definition of group A nor that of group B as contained in this section, but that either is designed to transport 16 or more passengers including the driver, or is used in the transportation of materials found to be hazardous for the purposes of the Hazardous Materials Transportation Act and which require the motor vehicle to be placarded under the Hazardous Materials Regulations (49 CFR part 172, subpart F) [49 CFR 383.91 (a)] (Federal Motor Carrier Safety Administration, 2011a).

weather or when there were other hazardous vehicles on the road. Authors suggested that seat-belt wearing initiatives for oil workers driving on and off-work should be led by the oil industries in collaboration with local communities.

Several types of management and educational strategies have proven effective in increasing belt use in the workplace, with multiple-strategy interventions leading to greater and longer-lasting increases in use (Segui-Gomez, 2000). Successful strategies include mandatory belt-use policies, education through lecture or discussion groups, obtrusive observations (e.g., observers wearing bright-colored vests and clearly visible to drivers), individual or group incentives and pledge cards. These strategies must be supported by company leadership in order to be successful. Technology-based strategies may also hold promise for application in work settings. A small pilot test of a device that prevented drivers from shifting vehicles into gear until the safety belt was buckled led to a 40% increase in belt use among U.S. drivers of service vehicles (Van Houten et al., 2011).

Although employer policies are important for promoting belt use, patterns of use by workers may also be influenced by state specific belt-use laws. U.S. states with primary safety belt enforcement laws (i.e., where a law enforcement officer may issue a ticket for failure to use a safety belt in the absence of any other apparent traffic infraction) have higher reported rates of safety belt use than states with secondary safety belt enforcement laws. Among the states with the highest frequencies of crash fatalities among oil and gas extraction workers, Wyoming, Colorado, and Utah lacked primary enforcement laws as of December 2011, and Wyoming had the fourth-lowest percentage of belt use among all states in 2008 (67.4%) (Insurance Institute for Highway Safety, 2011; CDC, 2011b).

Although the greatest numbers of motor vehicle-related deaths of oil and gas extraction workers occurred in Texas and Wyoming, the current development of the oil fields in North Dakota and the eastern U.S. make these areas a priority for motor vehicle safety interventions as well. North Dakota has a secondary enforcement law and the lowest belt use of any state in the U.S. (59.2%), and Pennsylvania, West Virginia and Ohio (in the Marcellus Shale) have secondary enforcement laws and belt use below 80% (Insurance Institute for Highway Safety, 2011; CDC, 2011b). Public health professionals and others should continue to work toward advocating for primary enforcement laws in these states. Employer policies requiring the use of safety belts support compliance in states with and without primary enforcement laws.

In addition, rural areas, where the majority of oil and gas drilling takes place, have significantly lower reported seat belt use than do urban/suburban areas (CDC, 2011b). Moreover, for all crash fatalities in the U.S., the proportion of unbelted occupants was highest among occupants of light trucks (57.8%), the category that includes pickup trucks, the vehicle type associated with over half of oil and gas extraction worker fatalities identified in this analysis (National Highway Traffic Safety Administration, 2010).

Beginning in data year 2011, the CFOI will record information on safety belt use in its own unique data field. For the present analysis however, almost 40% of case narratives did not contain information on safety belt use. The addition of this variable to the standard CFOI data fields will be an important step toward better quantifying belt use among workers in various occupations, industries, and demographic groups.

#### 4.3. Well-servicing companies, drilling contractors and small establishments

Within the oil and gas extraction industry, workers at small establishments, particularly those with fewer than 20 employees, were at higher risk than those employed at establishments with 100 or more workers. Although motor vehicle safety is usually

addressed within the health, safety and environmental (HSE) units of large oil and gas companies, it is the small establishments, where fatality risk is highest, that likely do not have a dedicated HSE program or staff. Workers from well-servicing companies and drilling contractors were also at an increased risk, which may partially be accounted for by the large number of miles driven by workers in these types of companies. Government and industry organizations should work together to provide small companies, well-servicing companies, and drilling contractors with evidence-based tools and products (e.g., model fleet safety policies, educational materials) they can use to reduce highway crashes among their workers. Guidelines to assist with the development of appropriate materials are available (ANSI/ASSE, 2012; International Association of Oil and Gas Producers, 2005, 2007; NIOSH, 2004; OSHA). A few are described below.

#### 4.4. Addressing motor vehicle fatalities using industry guidelines

Overall, oil and gas extraction workers were at higher risk of work-related crash fatalities than workers in any major industry group other than transportation and warehousing. A number of general and industry-specific guidelines have been developed to help oil and gas employers to manage road risk for workers, especially those not covered by truck and bus safety regulations or other occupational safety regulations. The National Institute for Occupational Safety and Health published *Work-Related Roadway Crashes: Prevention Strategies for Employers*, which presents statistics on work-related motor vehicle fatality and the steps for employers to take to protect their employees (NIOSH, 2004).

In addition, general road safety guidance for U.S. employers is provided by the American National Standards Institute (ANSI)/American Society of Safety Engineers (ASSE) Z15.1 standard, a national consensus standard titled *Safe Practices for Motor Vehicle Operations* (ANSI/ASSE, 2012). The extent to which Z15.1 has been adopted in the U.S. oil and gas extraction industry is unknown.

The International Association of Oil and Gas Producers (OGP) has released a *Land Transportation Safety Recommended Practice* for the oil and gas exploration and production industry (2005), which is based on best practices for the industry and provides tools to support implementation. The OGP recommendations advise that oil and gas operators address motor vehicle crash risk for their employees on and off drilling sites, and road safety policies cover all movement of passenger, freight and specialized vehicles operated on the company's behalf. It also advises oil and gas operators to hold their contractors to the same high level of road safety performance. The OGP recommendations are divided into the following sections: seat belts, driver trainer and qualification, in-vehicle monitoring systems, cellular telephones and communication devices, journey management plans, driving under the influence, driver fitness and alertness, vehicle specifications, and management systems. The OGP has also published a tool that assists workers in this industry to understand, recognize, and manage fatigue in the workplace (2007).

#### 4.5. Study limitations

The QCEW provides estimates of average annual employment. Estimates based on full-time-equivalent employment, had they been available for the oil and gas extraction industry, would have allowed better comparisons of crash risks for oil and gas extraction workers with risk in other industries where the average employee may work fewer hours per week. In addition, calculating crash fatality rates based on the number of workers does not consider differences in exposure to motor vehicles for different worker groups. Ideally, fatality rates would be calculated using VMT. Although such estimates are available for the general population, they do not

distinguish between work and non-work VMT. If it were possible to control for exposure by calculating VMT-based rates, other modifiable factors associated with fatality risk could be better identified.

The QCEW does not provide employment estimates by age group, race, sex, occupation or length of service with the employer; therefore, presentation of these data items was limited to frequency distributions. Because QCEW estimates exclude the self-employed, family workers, and government workers, eight CFOI cases were excluded from this analysis.

For several reasons, data presented here on motor-vehicle related fatalities by establishment size should be interpreted with caution. First, establishment size was not reported for nearly a quarter of decedents; therefore, not all cases were available for the calculation of fatality rates and rate ratios by establishment size. Further, there may be some inconsistency in the reporting of establishment size in CFOI. The BLS defines an establishment as being “. . . typically at a single physical location and engaged in one, or predominantly one, type of economic activity” (Bureau of Labor Statistics, 2011). This definition may create ambiguity for the classification of some oil and gas extraction establishments where the establishment may not be a single location, but a regional office from which workers are assigned to multiple worksites across a fairly wide geographic area. In CFOI, it is possible that a worker may be coded in a smaller establishment size category based on the information available on the number of workers at a single location. It is also possible that CFOI data may not differentiate between employees of the various contractors at a single worksite and thus report the total number of workers present at the site, not the number of persons working for the decedent’s employer. As a result, there are potential biases in the CFOI data that might lead to a worker being assigned to the wrong establishment size category. The extent to which these potential biases are present in the data is unknown.

Another study limitation is the absence of data on commuting-related fatalities. In the United States, a commuting-related crash is not included in the case definition of a work-related crash. Because of this, CFOI does not collect data on these events. Moreover, commuting-related crashes are not identified in any crash data system, including the National Highway Traffic Safety Administration’s Fatality Analysis Reporting System (FARS). If commuting-related crashes were within the scope of CFOI or could be identified in FARS, and if commuting-related VMT data were available, it would be possible to ascertain the combined risks of commuting-related driving and work-related driving. These limitations are especially relevant for oil and gas extraction workers, whose work schedules may combine long hours with long commuting times. It is possible that if data on commuting-related crashes were available, there would be a greater differential between fatality rates for oil and gas extraction and other industries.

As noted earlier, information abstracted from the CFOI narrative text field should also be interpreted with caution (McKenzie et al., 2010). The CFOI narrative is based on information obtained from source documents, therefore the level of detail and quality of narrative information may vary widely from case to case. A narrative may exclude important information if it was not included in the source documents used to develop the CFOI case record. Conversely, mention of a given factor in the CFOI case record does not necessarily mean that the factor caused or contributed to the incident. It implies only that a particular factor was noted in a source document.

The length of service of the worker with their current employer was not reported in nearly 40% of the fatalities (39.6%), preventing the authors from drawing any meaningful conclusions about this subset of workers as a whole in terms of their length of service.

More data are needed to understand the factors that contribute to fatal work-related crashes in the oil and gas extraction industry

as well as in other industries. Using CFOI alone, the extent to which fatigue, distraction and other behavioral factors were involved cannot be determined. National surveillance systems based on police crash reports provide more detailed information on the circumstances and contributing factors for motor vehicle crashes. FARS collects comprehensive data on the crash, the vehicle, the driver and other persons involved. However, FARS identifies work-related fatalities only through the death certificate, which often does not fully ascertain work-related fatalities (Stout and Bell, 1991). Nor does FARS categorize fatally injured workers by industry or occupation. Linkage of datasets such as CFOI and FARS would make it possible to identify crash-specific contributing factors and more effectively target prevention programs to workers in high-risk industries.

## 5. Conclusions

Pick-up trucks are a very common type of vehicle driven by oil and gas workers. These trucks and their drivers are largely unregulated. Because they are the most common type of vehicle involved in worker deaths in the oil and gas extraction industry, efforts should be focused on increased safety for occupants of these vehicles, both through increased oversight and targeted prevention initiatives.

A large proportion of oil and gas extraction workers who died at work were not wearing their safety belts. Increasing the use of safety belts needs to be a priority for employers and industry partners as it is the most effective measure for preventing motor-vehicle crash fatality and injury. This can be accomplished through the implementation and enforcement of company policies, primary safety belt enforcement legislation, and educational methods.

Workers from small establishments, well-servicing companies, and drilling contractors are at the greatest risk for motor vehicle-related fatality. Government and industry partners should work closely with these types of companies to develop relevant educational and managerial tools that will improve motor vehicle safety for their workers.

This study demonstrates the need for increased motor vehicle safety initiatives to protect workers within the oil and gas extraction industry. Guidelines to help oil and gas extraction employers implement successful motor vehicle safety programs are available, such as the OGP’s *Land Transportation Safety Recommended Practice*. OGP’s recommended tools, such as in-vehicle monitoring systems and journey management programs, may help to reduce motor vehicle-related fatalities in the industry; their effectiveness in reducing risk, managing fatigue, and improving driver behavior should be further evaluated. The ANSI Z15.1 standard, *Safe Practices for Motor Vehicle Operations*, OSHA’s *Guidelines for Employers to Reduce Motor Vehicle Crashes*, and NIOSH’s *Work-related Roadway Crashes: Prevention Strategies for Employers* are additional tools.

## Acknowledgements

The authors would like to thank Matt Gunter and the staff at the Bureau of Labor Statistics, Census of Fatal Occupational Injuries Program for providing the data for this analysis. The authors would also like to thank Jason Burton, NIOSH, for his assistance in developing earlier drafts of this paper; and James Helmkamp, Hope Tiesman, Jennifer Lincoln, and Tim Pizatella (NIOSH), and Terry Bunn, Kentucky Injury Prevention and Research Center, for their assistance in reviewing the manuscript.

## References

- ANSI/ASSE, 2012. ANSI/ASSE Z15.1-2012, *Safe Practices for Motor Vehicle Operations*. American National Standards Institute and American Society of Safety Engineers, New York/Des Plaines.

- Bureau of Labor Statistics (BLS), 2011. Quarterly Census of Employment and Wages, Annual Averages. Department of Labor, Bureau of Labor Statistics, Washington, DC.
- Bureau of Labor Statistics (BLS), 2012. Occupational Injury and Illness Classification Manual. Department of Labor, Washington, DC.
- Caruso, C.C., 2006. Possible broad impacts of long work hours. *Industrial Health* 44 (4), 531–536.
- CDC, 2008. Fatalities among oil and gas extraction workers—United States, 2003–2006. *Morbidity and Mortality Weekly Report* 57 (16), 429–431.
- CDC, 2011a. Occupational highway transportation deaths—United States, 2003–2008. *Morbidity and Mortality Weekly Report* 60 (16), 497–502.
- CDC, 2011b. Vital signs: Nonfatal, motor vehicle—occupant injuries (2009) and seat belt use (2008) among adults—United States. *Morbidity and Mortality Weekly Report* 59 (51), 1681–1686.
- Dembe, A.E., Erickson, J.B., et al., 2005. The impact of overtime and long work hours on occupational injuries and illnesses: new evidence from the United States. *Occupational and Environmental Medicine* 62 (9), 588–597.
- Federal Motor Carrier Safety Administration, 2011a. Commercial driver's license standards; requirements and penalties [49 CFR 383].
- Federal Motor Carrier Safety Administration, 2011b. Hours of service of drivers [49 CFR 395].
- Insurance Institute for Highway Safety, 2011. Safety Belt and Child Restraint Laws. Insurance Institute for Highway Safety, Arlington.
- International Association of Oil and Gas Producers, 2005. Land Transportation Safety Recommended Practice, revision 1.1. International Association of Oil and Gas Producers, Land Transportation Safety Task Force, London.
- International Association of Oil, Gas Producers, 2007. Fatigue Management in the Workplace. International Association of Oil and Gas Producers, London.
- McKenzie, K., Scott, D.A., Campbell, M.A., McClure, R.J., 2010. The use of narrative text for injury surveillance research: a systematic review. *Accident Analysis and Prevention* 42, 354–363.
- National Highway Traffic Safety Administration, 2003. The Economic Burden of Traffic Crashes on Employers: Costs by State and Industry and by Alcohol and Restraint Use. Department of Transportation, National Highway Traffic Safety Administration, Washington, DC.
- National Highway Traffic Safety Administration, 2005. Traffic Safety Facts—2004 Data. Department of Transportation, National Highway Traffic Safety Administration, Washington, DC.
- National Highway Traffic Safety Administration, 2007. Traffic Safety Facts—2006 Data. Department of Transportation, National Highway Traffic Safety Administration, Washington, DC.
- National Highway Traffic Safety Administration, 2010. Traffic Safety Facts—2009 Data. Department of Transportation, National Highway Traffic Safety Administration, Washington, DC.
- National Institute for Occupational Safety and Health, 2004. Work-Related Roadway Crashes: Prevention Strategies for Employers. Department of Health and Human Services, Centers for Disease Control and Prevention, Atlanta, GA.
- Office of Management and Budget (OMB), 2010. Standard Occupational Classification Manual. National Technical Information Service, Washington, DC.
- Occupational Safety and Health Administration (OSHA), Guidelines for Employers to Reduce Motor Vehicle Crashes. U.S. Department of Labor, Washington, DC.
- Rothe, J.P., 2008. Oil workers and seat belt wearing behavior: the Northern Alberta context. *International Journal of Circumpolar Health* 67 (2–3), 226–234.
- Segui-Gomez, M., 2000. Evaluating worksite-based interventions that promote safety belt use. *American Journal of Preventive Medicine* 18 (4S), 11–22.
- Stout, N., Bell, C., 1991. Effectiveness of source documents for identifying fatal occupational injuries: a synthesis of studies. *American Journal of Public Health* 81, 725–728.
- U.S. Energy Information Administration, 2011. Annual Energy Outlook 2011. Department of Energy, Washington, DC.
- Van Houten, R., Hilton, B., Schulman, R., Reagan, I., 2011. Using Haptic Feedback to Increase Seat Belt Use of Service Vehicle Drivers. National Highway Traffic Safety Administration, Washington, DC.
- Williamson, A., Lombardi, D.A., Folkard, S., Stutts, J., Courtney, T.K., Connor, J.L., 2011. The link between fatigue and safety. *Accident Analysis and Prevention* 43 (2), 498–515.