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Fatal work-related motor vehicle crashes in the United States, 2011–2014: Analysis of matched data from the *Census of Fatal Occupational Injuries* and the *Fatality Analysis Reporting System*

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A R T I C L E I N F O

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A B S T R A C T

Introduction: Motor vehicle crashes (MVCs) are the leading cause of work-related fatalities in the United States. The Bureau of Labor Statistics (BLS), the National Institute for Occupational Safety and Health (NIOSH), and the National Highway Traffic Safety Administration (NHTSA) matched and analyzed the Census of Fatal Occupational Injuries (CFOI) and the Fatality Analysis Reporting System (FARS) to describe work-related MVCs. *Methods:* BLS matched CFOI and FARS data for 2011–2014. The matching algorithm used a series of iterative matches allowing for increasing levels of flexibility. Descriptive epidemiologic analysis was conducted to examine potential risk factors for MVCs. *Results: Crashes:* Information on 3,822 fatal work-related MVCs was successfully matched. A collision (n = 3,156, 82.5%) was most often the first injury- or damage-producing event. Collisions with motor vehicles in transport accounted for 1,769 (46.5%) of crashes. *Vehicles:* The match identified 3,879 vehicles. Over half (53.6%) were large trucks. In most vehicles, one fatality (n = 3,657) occurred. Multiple worker fatalities per vehicle (n = 203) were more common in heavy trucks (n = 59, 29.1%) and pick-up trucks (n = 36, 17.7%). *Persons:* The match identified 4,060 workers, 3,581 (88.2%) of whom were drivers. Workers employed in transportation, warehousing, and utilities (38.2%) and services (24.4%) accounted for most fatalities. Among passengers, the highest proportions were observed in mining, quarrying, and oil and gas extraction (28.6%) and construction (20.0%). A small number of drivers were reported as impaired by being asleep or fatigued (5.2%), under the influence of alcohol, drugs, and medications (3.0%) or blacking out (1.8%). For 755 (21.1%) of the 3,581 drivers, the investigating officer indicated that speed contributed to the crash. *Conclusions/Practical Applications*: The CFOI/FARS matched data analysis provides a fuller understanding of work-related MVCs, thus making it possible to develop focused crash prevention recommendations for workers who drive as part of their job.

1. Introduction

For over four decades motor-vehicle crashes (MVCs) have remained the leading cause of death among workers in the United States (Biddle & Marsh, 2002; Bureau of Labor Statistics, 2020a; Centers for Disease Control and Prevention, 2003, 2004; Green et al., 2011; Marsh, 2021; National Institute for Occupational Safety and Health, 2002). Analysis of Bureau of Labor Statistics (BLS) Census of Fatal Occupational Injuries (CFOI) consistently identifies MVCs as the leading cause of worker death (IIF Databases: U.S. Bureau of Labor Statistics (bls.gov), Census of Fatal Occupational Injuries (2003–2010): Multi-Screen Data Search: U.S. Bureau of Labor Statistics (bls.gov)). CFOI has shown that MVCs are the first or second leading cause of death in every major industry group and that most workers who die in crashes are vehicle occupants involved in crashes on public roadways (Centers for Disease Control and Prevention, 2003, 2004).

While CFOI continues to identify MVCs as a leading cause of worker death, it lacks specific details on risk factors for MVCs (Byler et al.,

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2016). No single source provides sufficient detail about crash circumstances and risk factors (Centers for Disease Control and Prevention, 2003), information necessary to guide the development of targeted prevention strategies. One source that can offer some of the needed detail is the publicly available Fatality Analysis Reporting System (FARS), a census of all police-reported traffic crashes involving a fatality, collected by the National Highway Traffic Safety Administration (NHTSA) (NHTSA, 2021). FARS contains detailed information on crash characteristics, vehicles, the road environment, and driver risk factors that CFOI lacks. The disadvantage of FARS is that work-related determination is based on the injury-at-work item on the death certificate, a variable that has been previously shown to result in an incomplete capture of work-related MVC fatalities (Byler et al., 2016).

Recognizing the need for a more complete source of U.S. work-related MVC data, BLS, NHTSA, and NIOSH collaborated on a study to match CFOI and FARS to address the limitations of each of these sources individually (Byler et al., 2016). Although this study confirmed that FARS systematically failed to capture certain types of cases (i.e., workers employed outside the transportation and warehousing industry, workers employed outside transportation and material moving occupations, and occupants of a vehicle other than a heavy truck), the initial attempt to match these two databases using 2010 data demonstrated that matching the two sources was feasible.

The objective of the current study is to expand on the success of the initial match of CFOI and FARS data to better describe the characteristics of workers who died in work-related MVCs as well as driver-related risk factors. This activity was reviewed by CDC, deemed not research, and was conducted consistent with applicable federal law and CDC policy.[2]

2. Materials and methods

2.1. Data sources

2.1.1. Bureau of Labor Statistics (BLS) Census of Fatal Occupational Injuries (CFOI)

CFOI data have been collected since 1992 through a Federal-State cooperative program that has resulted in comprehensive, accurate, and timely annual counts of all fatal work injuries occurring in the United States (Bureau of Labor Statistics, 2020b). Work relationship and case information about each fatal injury—including demographic and employment characteristics of the decedent and detailed circumstances of the event—are obtained by cross-referencing multiple sources, such as death certificates, workers' compensation reports, and Federal and State agency administrative reports (Bureau of Labor Statistics, 2020b). CFOI contains a single record for each fatally injured worker.

The CFOI subset used for matching consisted of "Roadway incidents involving motorized land vehicles".[3] This subset was identified using the *event* variable (code = 26*) as defined by the BLS Occupational Injury and Illness Classification System (OIICS), Version 2.01 (Bureau of Labor Statistics, 2012). Hereafter, the CFOI subset is referred to as "CFOI Roadway." While CFOI does include pedestrian-related events, the CFOI Roadway cases used in this analysis include only fatally injured drivers and passengers, not pedestrians. It is also important to note that CFOI excludes fatalities during normal commutes to and from work.

2.1.2. National Highway Traffic Safety Administration (NHTSA) Fatality Analysis Reporting System (FARS)

FARS is a yearly nationwide census of police-reported traffic crashes in the 50 U.S. states, the District of Columbia, and Puerto Rico, compiled by state-level partner agencies and transmitted to NHTSA. To be included in FARS, a crash must involve a motor vehicle traveling on a trafficway customarily open to the public and must result in the death of at least one person (occupant of a vehicle or a non-motorist) within 30 days of the crash (National Highway Traffic Safety Administration, 2020). FARS data are based on police reports of fatal traffic crashes supplemented by other documents supplied by NHTSA's state partners, including death certificates, vehicle registration files, coroner/medical examiner reports, driver licensing files, state highway department data, emergency medical service reports, and vital statistics (National Highway Traffic Safety Administration, 2021).

Unlike CFOI, where the only unit of analysis is the fatally injured worker, FARS is a hierarchical data system that provides data at three levels of analysis (accident, vehicle, and person [that is, drivers, vehicle occupants, and non-motorists]) (Fig. 1), along with numerous supplementary files covering topics such as distracted driving and alcohol. The system is managed by the NHTSA National Center for Statistics and Analysis (NCSA) (National Highway Traffic Safety Administration, 2021).

At the "accident" or crash level, FARS provides information that applies to all vehicles, drivers, and persons involved, including the first injury- or damage-producing event of the crash, type of road, road conditions, time of day, location, and light conditions.

Vehicle-level data include details for each vehicle involved in a fatal roadway crash regardless of whether there was a fatally injured occupant in that vehicle. Vehicle-level data items include but are not limited to make, model, year, owner, trailing units, weight class, special use, and speed. For each vehicle driver, data on licensing status, driving history, distraction, and risky driving behaviors ("driver-related factors") are included.

Finally, FARS provides person-level data for occupants of each

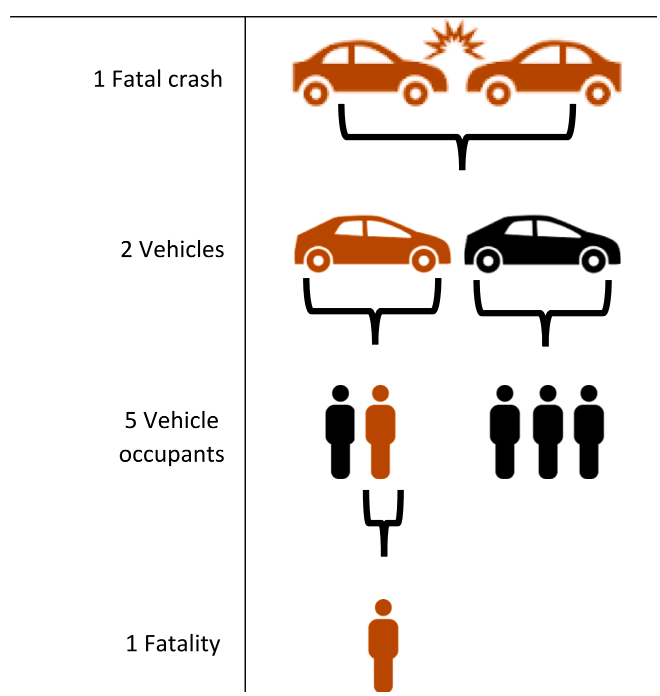

Fig. 1. Example of FARS Hierarchical Structure.

[2] See e.g., 45C.F.R. part 46.102(l)(2), 21C.F.R. part 56; 42 U.S.C. §241(d); 5 U.S.C. §552a; 44 U.S.C. §3501 et seq.

[3] "Roadway incidents involving motorized land vehicles" are defined in OIICS as incidents in which "at least one vehicle was in normal operation as a means of transportation, and the impact was caused by a traffic incident or the motion of the vehicle." The incident must also have involved "injuries to vehicle occupants occurring on that part of the public highway, street, or road normally used for travel as well as the shoulder and surrounding areas, telephone poles, bridge abutments, trees aligning roadway, etc." Bureau of Labor Statistics. (2012). Occupational Injury and Illness Classification Manual, Version 2.01. Washington, DC.

vehicle in the crash, regardless of injury status. Person-level variables include demographic characteristics, person type (whether the person was a driver, passenger, pedestrian, or other road user), injury severity, injury at work status (based on death certificates), alcohol test results, and restraint systems in use.

2.2. Data matching procedures

For this study, data from CFOI and FARS for 2011–2014 were matched following the procedures described by Byler and colleagues (2016). See Byler et. al. (2016) for more detail about the algorithm. The variables *state of incident*, *county of incident*, *age*, *sex* and *date of incident* were used to identify matches.

The matched dataset was created based on matching 4,512 CFOI Roadway fatalities to all 98,464 fatally injured vehicle occupants from FARS (that is, those assigned a *person type* of "driver" or "passenger"). Data for each of the four years were matched in separate iterations and all years were appended into one dataset containing all matches. The algorithm successfully matched 90% of CFOI roadway cases, consistent with the 90% of 2010 CFOI cases matched by Byler et. al. (2016), resulting in a dataset containing 4,060 matched cases. Twelve percent (12.2%) of FARS "at-work" cases (i.e., cases where the injury at work item was marked yes on the death certificate) were not matched to a CFOI case. Inability to match some of the cases could be due to differences in case definition between the two systems and FARS's reliance on death certificates to ascertain work relationship. Of the 19 matched cases with missing FARS vehicle data, two were confirmed false matches and removed. The other 17 were classified in FARS as being an "Occupant of a Motor Vehicle Not In-Transport." In nearly all 17 cases, the decedent was in a parked vehicle on the side or the shoulder of the road. Because these 17 cases fell within the definition of CFOI Roadway, they were included in the analysis.

2.3. Data analysis

This analysis was conducted under a memorandum of understanding (MOU) between NIOSH and BLS.[4] We conducted a descriptive analysis of the matched data and examined univariate and bivariate frequencies for variables of interest at the crash, vehicle, and person level. Data on age, sex, race, Hispanic ethnicity, occupation, and industry were obtained from CFOI. Crash, vehicle, and occupant data were extracted from FARS. We also compared work-related fatalities to those in the general population to establish differences and similarities in these events.

2.3.1. Crash-level variables

Various aspects of crash-level data were analyzed. We examined distributions of the first injury- or damage-producing event (e.g., collision with motor vehicle in transport, collision with fixed object, noncollision such as rollover), combining categories to account for small cell sizes where needed. NHTSA's classifications[5] were used to examine manner of collision (e.g., front-to-rear, front-to-front, angle) and road type (e.g., interstate, U.S. highway, state highway, county road, or local street) on trafficways where crashes occurred.

Information from FARS (time of day and day of week classifications[6]) was also used to describe temporal characteristics. The type/level of light and atmospheric conditions that existed at the time of the crash were explored to determine whether lighting or weather conditions potentially played a role in the crash. Where more than one atmospheric condition was indicated, one single condition was identified based on priority ranking.[7]

2.3.2. Vehicle-level variables

We examined the distribution of vehicles involved in work-related fatal crashes using the FARS variable *vehicle body type,* which classifies vehicles based on their general body configuration, size, shape, and number of doors among other characteristics (National Highway Traffic Safety Administration, 2021). Vehicles were grouped into larger categories per NHTSA's recommendations.[8] Distributions for vehicle body type by decedent's industry were examined.

2.3.3. Person-level variables

Univariate distributions by age, sex, race, and Hispanic ethnicity were generated for all fatally injured vehicle occupants. We looked at age as a continuous variable and also recoded it into larger categories for subsequent analyses.

We examined the distribution of fatalities by major industry and occupation. Industry was coded into major groups according to the 2012 North American Industry Classification System (NAICS) (U.S. Census Bureau, 2012) and occupation was coded using the 2000 Standard Occupational Classification (Bureau of Labor Statistics, 2011). We further grouped, with some exceptions, industries into National Occupational Research Agenda (NORA) industry sectors[9] using 2-digit NAICS codes. Because we used 2-digit codes, oil and gas extraction (NAICS codes 211, 213111 and 213112) and public safety (NAICS codes 92212, 92214, 92,216 and 62191) do not appear as separate sectors as they do in NORA. Also, in this analysis, the agriculture, forestry, fishing and hunting sector does not include seafood product preparation and packaging (NAICS code 311710), as is the case with NORA, and the healthcare and social assistance sector does not include veterinary services (NAICS code 54194) and pet care services (NAICS code 81291).

We used the variable *person type* to determine if occupants were drivers or other vehicle occupants. We examined blood alcohol test results among drivers and recoded numeric result values using NHTSA's definition: "Drivers are considered to be alcohol-impaired when their blood alcohol concentrations (BACs) are 0.08 g per deciliter (g/dl) or higher (U.S. Department of Transportation, 2015b)." In FARS, BAC estimates are generated using reported blood alcohol test results. If results are not reported, NHTSA assigns imputed values following procedures developed for this purpose (Rubin et al., 1998; Subramanian, 2002). We also examined BACs specifically among commercial motor-vehicle (CMV) drivers. Under federal regulations, the alcohol impairment threshold for CMV drivers is 0.04% g/dl (49 CFR 382.201). We did not analyze drug test results data because of issues in how the data is collected and interpreted, including, the lack of uniformity in drug testing and reporting across states and jurisdictions and the need for caution in assuming that drug presence indicates impairment (Berning & Smither, 2014). Finally, we examined seat belt in use by vehicle occupants at the time of the crash and recoded seat belt use as yes, no, and unknown.

Additionally, we examined FARS variables on drivers' crash risk

[4] Per the terms of the MOU, all data linkage and analysis took place at the BLS office in Washington, DC. Results were subject to BLS publication criteria to ensure reporting requirements were met.

[5] Fatality Analysis Reporting System (FARS) Analytical User's Manual, 1975–2019, Appendix C: Additional Data Element Information. NHTSA'S Manner of Collision Convention, page 484.

[6] Fatality Analysis Reporting System (FARS) Analytical User's Manual, 1975–2019, Appendix C: Additional Data Element Information. Date of Crash, Time of Day/Day of Week, page 479.

[7] Fatality Analysis Reporting System (FARS) Analytical User's Manual, 1975–2019, Appendix B: Rules for Derived Data Elements. Atmospheric conditions, page 475.

[8] Fatality Analysis Reporting System (FARS) Analytical User's Manual, 1975–2019 Appendix C: Additional Data Element Information. NHTSA's Vehicle Body Type Classification, pages 493–4.

[9] CDC – National Occupational Research Agenda (NORA): The Sector and Cross-Sector Approach | NIOSH.

factors and behaviors. Variables examined included: status of driver's license at the time of the crash; status of the driver's Commercial Driver's License (CDL), if applicable; and whether the driver was complying with CDL endorsements. We examined history of previous crashes, speeding convictions, and driving while intoxicated convictions, all within a three-year period prior to the crash. Finally, we explored whether factors such as driver distraction, fatigue, illness, or alcohol use may have contributed to the crash as identified by law enforcement.

3. Results

Matched data from 3,822 crashes, 3,879 vehicles, and 4,060 workers (3,581 of whom were drivers) were analyzed.

3.1. Crashes

3.1.1. Manner and type of collision

For the 3,822 fatal work-related crashes that were successfully matched, most instances involved a collision (n = 3,156, 82.6%) as the first injury- or damage-producing event of the crash. Collisions with motor vehicles in transport accounted for almost half (n = 1,769, 46.3%) of all work-related crashes, followed by collisions with fixed objects (33.4%) (Table 1). We further examined collisions with a motor vehicle in transport (Table 1) and observed that over a third (34.3%) of the collisions occurred at an angle followed by front-to-rear collisions (31.8%) and front-to-front collisions (21.9%).

3.1.2. Roadway classification

Of the 3,822 fatal crashes, most (n = 2,725, 71.3%) occurred on trafficways classified as rural. Most MVCs occurred on routes identified as interstates (n = 1,122, 29.4%), state highways (n = 1,083, 28.3%) and U.S. highways (n = 733, 19.2%).

3.1.3. Temporal characteristics

Fatal crashes by day of the week ranged from a low of 228 (6.0%) on Sundays to a high of 704 (18.4%) on Mondays. Crash occurrence was higher at the beginning and middle of the workweek and lowest on weekends (data not shown).

Table 1
Crash characteristics for work-related fatal MVCs, Census of Fatal Occupational Injuries (CFOI)/Fatality Analysis Reporting System (FARS) matched data,[a] 2011–2014.

		n	%
First Harmful Event[^]	Collision with a motor vehicle in transport	1,769	46.3
	Collision with a fixed object	1,276	33.4
	Non-collision[*]	647	17.0
	Collision with a non-fixed object or a person	111	3.0
	Not reported/unknown	19	0.5
	Total	3,822	
Manner of collision	Angle	606	34.3
	Front to rear	563	31.8
	Front to front	387	21.9
	Sideswipe – same direction	94	5.3
	Sideswipe – opposite direction	96	5.4
	Rear to side	5	0.3
	Not reported/unknown	18	1.0
	Total	1,769	

[a] This research was conducted with restricted access to Bureau of Labor Statistics (BLS) data. Percentages may not add up to a hundred due to rounding.
[^] Data missing for 19 crashes.
[*] This category includes single-vehicle events such as rollovers and overturns, fires and explosions, immersions, and vehicle jackknife.

3.1.4. Atmospheric and light conditions

Most crashes occurred during daytime (6:00 am-5:59 pm) hours (n = 2,643, 69.2%), in daylight (n = 2,513, 65.8%), and under no adverse weather conditions (n = 3,313, 86.7%).

3.2. Vehicles

3.2.1. Vehicle body type and vehicle characteristics

Fatally injured workers were driving or riding in 3,879 vehicles based on the matched data set. Over half of these vehicles (53.6%) were large trucks, followed by light trucks and vans (26.8%), and passenger cars (12.3%) (Table 2). In most vehicles, one fatality (n = 3,657) occurred. Multiple worker fatalities per vehicle (n = 203) were more commonly observed in heavy trucks (n = 59, 29.1%), pick-up trucks (n = 36, 17.7%), and vans (n = 36, 17.7%). There were 142 special use vehicles involved in fatal work-related crashes. The majority of these were police vehicles (n = 77, 54.2%) followed by taxis (n = 19, 13.4%) and vehicles used for school transport (n = 12, 8.5%) (data not shown).

Contributory vehicle-related factors were reported for only 11.1% of vehicles. The top two vehicle factors reported were tires (3.5%) and brake systems (1.2%).

3.2.2. Vehicle body type by industry

Most vehicles were operated by workers employed in the transportation, warehousing, and utilities (n = 1,521, 39.4%), services (n = 926, 24.0%), wholesale and retail trade (n = 429, 11.1%) and construction (n = 394, 10.4%) industries (data not shown).

Examination of the distribution of vehicles by industry sector revealed some distinct patterns within each group (Table 3). In the transportation, warehousing, and utilities sector the largest proportion of vehicles were heavy trucks (78.9%). The largest vehicle categories in construction were pickup trucks (36.8%), heavy trucks (23.1%), vans (14.1%), and medium trucks (12.9%). Most vehicles in mining, quarrying and oil and gas extraction industries were pickup trucks (42.6%) and heavy trucks (35.2%). Vehicle distributions for services and agriculture differed from the other sectors, which were dominated by trucks. In agriculture, forestry, fishing and hunting industries, farm and construction equipment accounted for over a third (35.6%) of all vehicles followed by heavy trucks (31.4%). In the services sector, passenger vehicles accounted for over a third of all vehicles (34.4%) followed by pickup trucks (17.3%), and vans (13.4%).

3.3. Persons

A total of 4,060 workers, 3,581 (88.2%) of whom were drivers, died in work-related MVCs.

Table 2
Distribution of vehicles by body type, Census of Fatal Occupational Injuries (CFOI)/Fatality Analysis Reporting System (FARS) matched data,[a] 2011–2014.

Vehicle Body Type[^]	Vehicle Body Type Code	N	%
Large trucks	60–64, 66–67, 71–72, 78–79	2,078	53.6
Medium trucks	*60–62, 64, 67, 71*	*317*	*8.2*
Heavy trucks	*63, 66, 72, 78–79*	*1,761*	*45.4*
Light trucks and vans	14–16, 18–22, 24–25, 28–41, 45–49	1,040	26.8
Pickup trucks	*30–39*	*555*	*14.3*
Passenger cars	01–11, 17	479	12.3
Farm or construction equipment	92–93	104	2.7
Motorcycles	80–89	73	1.9
Buses	50–59	40	1.0
Other or unknown vehicles	73, 90–91, 94–97, 98–99, –	65	1.7
Total		3,879	

[a] This research was conducted with restricted access to Bureau of Labor Statistics (BLS) data. Percentages may not add up to a hundred due to rounding.
[^] Follows FARS vehicle body type coding convention.

Table 3

Vehicle body type by selected industry sectors, Census of Fatal Occupational Injuries (CFOI)/Fatality Analysis Reporting System (FARS) matched data,[a] 2011–2014.

		Light trucks and vans										Large trucks^										
		Passenger cars		Utility vehicles		Pickup trucks		Vans		Other light trucks		Heavy trucks		Medium trucks		Farm or construction equipment		Motorcycles & buses		Other vehicles		
Industry sector*	NAICS codes	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	n	%	Total
Services	**51–56, 61, 71–72, 81, 92**	298	34.4	87	10.0	150	17.3	116	13.4			100	11.5	68	7.9			47	5.4			866
Agriculture, forestry, fishing, and hunting	**11**	7	3.0			41	17.4	6	2.5			74	31.4	8	3.4	84	35.6			16	6.8	236
Construction	**23**	21	5.4	13	3.3	143	36.8	55	14.1	6	1.5	90	23.1	50	12.9							389
Manufacturing	**31–33**	18	10.7			27	16.1	10	6.0			82	48.8	25	14.9							168
Mining, quarrying and oil and gas extraction	**21**	7	4.3			69	42.6	6	3.7			57	35.2	23	14.2							162
Transportation, warehousing and utilities	**22, 48–49**	69	4.6	24	1.6	60	4.0	65				1,189	78.9	67	4.4			27	1.8			1,507
Wholesale and retail trade	**42, 44–45**	56	13.2	18	4.3	65	15.4	50	11.8			163	38.5	65	15.4			6	1.4			423
Total		476		148		555		308		12		1,755		306		90		80		21		3,751

[a] This research was conducted with restricted access to Bureau of Labor Statistics (BLS) data. Percentages may not add up to a hundred due to rounding.

^ Following FARS coding convention, the large trucks category is the sum of medium trucks (vehicle body type = 60–62, 64, 67 and 71) and heavy trucks (vehicle body type = 63, 66, 72,78–79).

* Because of unreportable cell numbers for some industry groups, the total number of vehicles shown in this table is lower than total number of vehicles in the dataset.

3.3.1. *Demographic characteristics of all fatally injured workers*

Fatally injured workers (N = 4,060) were, on average, 47 years old. The number increased with age, peaking among those 45–54 years old (Table 4). Over 90% of fatally injured workers were male. Most fatally injured workers (72%) were White (non-Hispanic), followed by Hispanic or Latino persons of any race (13%).

3.3.2. *Employment characteristics*

3.3.2.1. Industry. Workers employed in transportation, warehousing and utilities (38.9%), services (24.4%), construction (10.8%) and wholesale and retail trade (10.8%) industries accounted for most of the fatalities (Table 5). In all industry groups, drivers accounted for most of the fatally injured workers. The highest proportions of fatally injured passengers were observed in mining, quarrying, and oil and gas extraction (28.6%), construction (20.0%) and services (17.3%) industries.

3.3.2.2. Occupation. Most fatally injured workers (57.4%) were transportation and material moving workers, followed by construction and extraction workers (9.8%) and management workers (5.6%) (Table 6). In all occupational groups, most of the fatally injured workers were drivers. About a third or more of the fatally injured workers in personal care and services (40.7%), building and grounds cleaning and maintenance (33.7%), food preparation and serving related (33.3%), and construction and extraction (30.6%) occupations were passengers. In construction, administrative and support, waste management and remediation service, and mining, quarrying, and oil and gas extraction industries, the proportion of passengers dying in MVCs was double the proportion of drivers dying in those industries.

3.3.3. *Driver factors*

3.3.3.1. Driver's license status, CMV license status, and CDL endorsements and compliance. Almost all (97.9%) drivers who died in a MVC had a valid driver's license at the time of the crash. Less than 1% of drivers had a suspended, revoked, or cancelled CDL or had not complied with required CDL endorsements (data not shown).

Table 4

Demographic characteristics of work-related MVC fatalities, Census of Fatal Occupational Injuries (CFOI)/Fatality Analysis Reporting System (FARS) matched cases,[a] 2011–2014.

		n	%
Age^	≤17	12	0.1
	18–24	325	8.2
	25–34	627	15.4
	35–44	775	19.1
	45–54	1,022	25.2
	55–64	866	21.3
	65+	433	10.7
Sex^	Male	3,752	92.4
	Female	308	7.6
Race/ ethnicity^*	White (non-Hispanic)	2,916	71.8
	Black (non-Hispanic)	481	11.8
	Hispanic or Latino*	530	13.1
	American Indian, Alaska Native or Pacific Islander (non-Hispanic)	107	2.6
	Other/multiple (non-Hispanic)	26	0.6
Total fatalities		4,060	

[a] This research was conducted with restricted access to Bureau of Labor Statistics (BLS) data. Percentages may not add up to a hundred due to rounding.

^ Counts by sex, age, race, and ethnic origin are based on CFOI frequencies.

* Persons identified as Hispanic or Latino may be of any race.

Table 5
Work-related MVC fatalities by industry sectors and person type, Census of Fatal Occupational Injuries (CFOI)/Fatality Analysis Reporting System (FARS) matched data,[a] 2011–2014.

Industry[ˆ]	NAICS codes	Drivers		Passengers		Total	
		n	%	n	%	n	%
Transportation, warehousing and utilities	22, 48–49	1,473	93.6	101	6.4	1,574	38.9
Services	51–56, 61, 71–72, 81, 92	815	82.7	170	17.3	985	24.4
Wholesale and retail trade	42, 44–45	406	92.7	32	7.3	438	10.8
Construction	23	348	80.0	87	20.0	435	10.8
Agriculture, forestry, fishing, and hunting	11	228	97.0	7	3.0	235	5.8
Mining, quarrying and oil and gas extraction	21	140	71.4	56	28.6	196	4.8
Manufacturing	31–33	171	95.5	8	4.5	179	4.4
Total		**3,581**		**461**		**4,042**	

[a] This research was conducted with restricted access to Bureau of Labor Statistics (BLS) data. Percentages may not add up to a hundred due to rounding.
[ˆ] Missing data on industry for 18 workers.

Table 6
Work-related MVC fatalities by occupation and person type, Census of Fatal Occupational Injuries (CFOI)/Fatality Analysis Reporting System (FARS) matched data,[a] 2011–2014.

Occupation[*]	Drivers		Passengers		All fatalities	
	n	%	n	%	n	%
Transportation and material moving	2,165	92.9	165	7.1	2,330	57.4
Construction and extraction	275	69.4	121	30.6	396	9.8
Management	214	93.9	14	6.1	228	5.6
Installation, maintenance and repair	171	87.7	24	12.3	195	4.8
Protective occupations	173	92.0	15	8.0	188	4.6
Sales and related	111	91.7	10	8.3	121	3.0
Farming, forestry and fishing	75	78.9	20	21.1	95	2.3
Office and admin support	80	90.9	8	9.1	88	2.2
Building and grounds cleaning and maintenance	55	66.3	28	33.7	83	2.0
Healthcare practitioners and technical	36	73.5	13	26.5	49	1.2
Production	33	71.7	13	28.3	46	1.1
Architecture and engineering	31	88.6				
Community and social service	28	80.0	7	20.0	35	0.9
Business and financial	31	91.2				
Personal care and service	16	59.3	11	40.7	27	0.7
Arts, design, entertainment, sports and media	17	77.3	5	22.7	22	0.5
Healthcare support	17	94.4				
Food preparation and serving related	12	66.7	6	33.3	18	0.4
Life, physical and social science	13	81.3				
Education, training and library	9	69.2				
Legal	7	87.5				
Military	5	62.5				
Computer and math	7	100.0			7	0.2
Total	3,581		479		4,060	

[a] This research was conducted with restricted access to Bureau of Labor Statistics (BLS) data. Percentages may not add up to a hundred due to rounding.
[*] Data not meeting BLS' publication requirements were suppressed.

3.3.3.2. Previous history of a crash and traffic violations. More than three-fourths (77%) of all drivers had no crash recorded within the past three years. Of those who had a previous crash, most (n = 408, 82.6%) had one crash. In addition, 671 (18.8%) drivers had a speeding conviction within the past three years (data not shown).

3.3.3.3. Leading driver-related factors. The largest proportions of driver-related factors identified in the police report were improper lane usage (10.8%) and overcorrecting (8.6%) (Table 7). Fifty-seven percent (57%) of drivers were classified as not impaired at the time of the crash (Table 7). A small number of drivers were reported as impaired by being asleep or fatigued (5.2%), under the influence of alcohol, drugs, and medications (3.0%), or blacked out (1.8%). For 755 (21.1%) of all drivers, the investigating officer indicated that speed contributed to the crash. Driver distraction was noted by investigating officers for 348 (9.7%) of drivers (Table 7). For most of those drivers, the distraction source was unknown (n = 226, 65.0%) followed by cell phone use (n = 48, 13.8%) (data not shown).

Of the 2,500 drivers for whom BAC test results were reported, 92.1% had a BAC of 0.00 g/dl, 2.9% had a BAC between 0.01 g/dl – 0.07 g/dl, and 5.0% had a BAC at or above the legal limit of 0.08 g/dl (Table 7). We observed unknown BAC values among tested drivers, those represented a small proportion of the drivers that died in a work-related motor vehicle crash (data not shown).

3.3.4. Seat belt use

Data on seat belt use at the time of crash was available for 3,826 (94%) of all cases. Our study found that 46% were restrained (Table 8). Data were available for 3,455 (96%) of all drivers. Of those, 47% were restrained. We observed that, among passengers, seat belt use decreased as passengers were seated further away from the front seat (data not shown). We also observed fatalities (n = 95) that involved passengers seated in vehicle areas meant for cargo.

4. Discussion

To date, large-scale surveillance research on fatal work-related MVCs has been limited to analyzing and drawing conclusions from data that have complete counts of work-related fatal injuries but lack crash, vehicle, and occupant details (CFOI); or data that provide details for crashes that involved at least one fatality but lack complete information on whether fatalities occurred during work activities (FARS). The CFOI/FARS matched data analysis allowed us to explore detailed characteristics of MVCs that occurred while at work to increase our understanding of these events. It also allowed us to gain new insights into fatal work-related MVCs that can lead to more targeted prevention strategies.

4.1. Vehicle body type

Overall, almost half the vehicles occupied by fatally injured workers

Table 7
Driver history and crash-related factors for work-related MVC fatalities, Census of Fatal Occupational Injuries (CFOI)/Fatality Analysis Reporting System (FARS) matched data,[a] 2011–2014.

		n	%
Leading[^] driver related factors	Improper lane usage	388	10.8
	Overcorrecting	308	8.6
	Careless driving	154	4.3
	Failure to yield right-of-way	139	3.9
	Following improperly	124	3.5
	Failure to obey traffic sign, traffic control devices or traffic officers; failure to obey safety zone traffic laws	122	3.4
	Skidding, swerving or sliding due to ice, snow, slush, water, sand, dirt, oil, wet leaves on road	113	3.2
	Operating vehicle in an erratic, reckless or negligent manner	98	2.7
	Driving on wrong side of two-way trafficway (Intentional or Unintentional)	85	2.4
	Making other improper turn	83	2.3
Vehicle with driver speeding	Yes	755	20.0
	No	2,848	75.7
Driver distracted	Yes	348	9.7
	No	2,411	67.3
	Unknown	822	23.0
Driver BAC test result*	.00 g/dl	2,303	92.1
	0.01-.07 g/dl	73	2.9
	0.08 or more g/dl	124	5.0
Other driver impairment	No	2,039	56.9
	Asleep or fatigued	185	5.2
	Blacked out/ill	65	1.8
	Physical impairment	41	1.1
	Not reported/unknown	1,146	30.4
All Drivers		3,581	

[*] Results reported for 2,500 drivers.
[a] This research was conducted with restricted access to Bureau of Labor Statistics (BLS) data. Percentages may not add up to a hundred due to rounding.
[^] Top ten factors. Categories are not mutually exclusive, as up to four factors may be coded for each driver.

Table 8
Seat belt use for all vehicle occupants and drivers only, Census of Fatal Occupational Injuries (CFOI)/Fatality Analysis Reporting System (FARS) matched data,[a] 2011–2014.

Seat belt use[^]	All Fatalities		Drivers only	
	n	%	N	%
Restrained	1,749	45.7	1,615	46.7
Unrestrained	1,467	38.3	1,279	37.0
Unknown	610	15.9	561	16.2
Total	3,826		3,455	

[a] This research was conducted with restricted access to Bureau of Labor Statistics (BLS) data. Percentages may not add up to a hundred due to rounding.
[^] Excludes not applicable (i.e., driving or riding in a motorcycle or in vehicle cargo area).

were heavy trucks, with pickup trucks and passenger cars together accounting for more than one-fourth. This distribution differed substantially by industry. In transportation, warehousing and utilities, nearly 80% of vehicles were heavy trucks, with much of the remaining 20% found in manufacturing, mining, and wholesale and retail trade. Regardless of industry, all heavy trucks operating in interstate commerce in the United States are covered by the Federal Motor Carrier Safety Regulations (FMCSRs) (49 CFR Parts 300–399). The FMCSRs cover a wide range of operational elements, including hours of service, drug and alcohol testing, driver fitness for duty, cargo securement, licensing, driver training, use of electronic devices, and vehicle inspection.

In contrast to heavy trucks, light trucks, those with a Gross Vehicle Weight Rating of 10,000 lb or less, including many models of pickup trucks, are not covered by safety regulations set by the Federal Motor Carrier Safety Administration (FMCSA). As a result, individual companies develop their own frameworks for managing risks associated with these vehicles. Pickup trucks were over-represented in the construction and mining industries, making up two to three times the proportion of pickup truck fatalities in the overall dataset. In these work settings, pickup trucks are generally used to transport workers and supplies between worksites, and workers in these vehicles do not operate a motor vehicle as their primary job. Companies in the oil and gas extraction component of the mining industry have worked together for many years to develop voluntary standards to manage road risk for their employees and contractors (International Association of Oil and Gas Producers, 2020; IPIECA/International Association of Oil & Gas Producers, 2019). It is not clear that the construction industry or other parts of the mining sector have taken similar steps. Although there are voluntary fleet safety standards for the United States and globally (American National Standards Institute, 2017; International Organization for Standarization, 2012), employers may be more likely to adopt industry-specific guidance if it were available.

The services sector accounted for the greatest proportion of passenger cars involved in fatal MVCs. The total for this sector was nearly three times the proportion of passenger cars in the total dataset. Although service sector workers who drive passenger cars are usually not employed as motor vehicle operators, the sector includes many industries that involve regular travel to visit clients or work locations, including health care, real estate, telecommunication, repair service, law firms, and engineering companies. In most of these, operating a vehicle is seen as a necessary but incidental part of the job. Employers who view vehicle operation as incidental may not devote attention to managing road risk, even if workers spend a substantial amount of work time driving. Companies in these industries may benefit from the guidance provided by voluntary fleet safety standards (American National Standards Institute, 2017; International Organization for Standarization, 2012). In addition, in-vehicle monitoring systems (IVMS) in conjunction with driver coaching have been shown to significantly improve situational awareness, thereby reducing behaviors such as hard braking and lane departures (Bell et al., 2017; Bui et al., 2019; Hickman & Hanowski, 2011; National Highway Traffic Safety Administration, 2021; Toledo & Shiftan, 2016).

In this analysis, the services sector also included law enforcement, firefighting, and emergency medical response; among these, passenger vehicles are most used in law enforcement. Crashes are a leading cause of workplace fatalities among law enforcement officers (Tiesman et al., 2010; Tiesman et al., 2013). Law enforcement agencies are not covered by federal safety regulations, so managing road risk is the responsibility of individual agencies. A comprehensive crash prevention program was shown to significantly reduce crash and injury rates for one large law enforcement agency, but further work is needed to develop evidence-based programs that can be implemented by a wide range of agencies including smaller agencies with fewer resources (Tiesman et al., 2019).

4.2. Alcohol

In the matched dataset, alcohol testing showed that 5.0% of fatally injured drivers had a BAC at or above 0.08 g/dl, the legal threshold for impairment in all 50 U.S. states at the time these data were collected. This proportion is much lower than what is reported for the general population. For 2011–2014, 32.1% of all drivers killed in MVCs had a

BAC at or above 0.08 g/dl (U.S. Department of Transportation, 2013a, 2014a, 2015a, 2016b). For several reasons, the low percentage of alcohol impairment among fatally injured workers is not a surprising finding.

First, employer policies and federal regulations might serve as strong deterrents against on-the-job alcohol use. A voluntary fleet safety standard for the United States calls for employers to set alcohol policies with strong consequences for DUI convictions or refusal to submit to BAC testing, including revocation of driving privileges (American National Standards Institute, 2017).

In addition, U.S. standards for alcohol use and testing for motor carriers and drivers of large trucks and buses (the majority of fatally-injured drivers in this study) (49 CFR Part 382; 49 CFR Subtitle A, Part 40, Subpart O) are much stricter than those that apply to the general population, setting 0.04 g/dl as the legal limit and requiring pre-employment and routine testing.

4.3. Fatigue

In the matched dataset, 5.2% of fatally injured drivers were reported as either drowsy, asleep, or fatigued, compared to 2.8% reported in FARS data for the general population for 2011–2014 (U.S. Department of Transportation, 2013a, 2014a, 2015a, 2016b). These data are not directly comparable, as the FARS data include all crash-involved drivers, as well as drivers who were ill or blacked out. Thus, the discrepancy between the proportion of workers and other motorists who were fatigued may be even greater than what this comparison suggests. Further, because there is no objective measure of fatigue, attribution of fatigue depends on the judgment of the investigating officer, and guidance on how to determine fatigue is limited. The proportion of fatigue-related fatal crashes in the general population has been estimated to be 21% (Tefft, 2014), far higher than what FARS indicates.

Some employers have implemented fatigue risk management systems (FRMS), which are far more comprehensive than the hours-of-service regulations (49 CFR Part 395) that apply to drivers of large trucks and buses (Lerman et al., 2012). FRMS include elements such as improved scheduling, fatigue detection technology, maximum hours of driving, fitness-for-duty assessments, stop-work authority, fatigue awareness training, and restrictions on night driving (IPIECA/International Association of Oil & Gas Producers, 2019; Wong et al., 2019). Many FRMS elements have been shown to be associated with lower rates of work-related collisions and injuries (Vivoda et al., 2019).

4.4. Distraction

In the matched dataset, 9.7% of fatally injured workers were judged to have been distracted at the time of the crash, compared to 6.8% of drivers in the general population involved in fatal crashes 2011–2014 (U.S. Department of Transportation, 2013a, 2014a, 2015a, 2016b). As defined by NHTSA, a "distraction-affected crash" might be linked to factors such as cell phone use, inattention, reaching for an object, adjusting vehicle controls, and "looked but did not see" (U.S. Department of Transportation, 2014b). Again, the FARS data for the general population include all involved drivers, while the matched dataset includes only fatally injured workers who were driving. Looking only at cell phone use as a proportion of all distraction-affected crashes, we see a closer correspondence between the two groups: 13.0% for all drivers involved in fatal crashes and 13.8% for fatally injured workers. This suggests that being at work does not necessarily come with an elevated risk of a fatal cell phone-related crash compared to normal driving. However, the significant proportion of distraction-affected drivers among fatally injured workers points to the need for employers to adopt broad measures to minimize distracted driving. Several prevention measures have been found to be associated with lower crash risk or lower levels of cell phone use: total bans on cell phone use, checking cell phone records when there is a crash, using IVMS, scheduling work to allow adequate break time, and providing distraction awareness training (Claveria et al., 2019; Vivoda et al., 2019). Because most distraction-affected crashes are not associated with cell phone use, distraction awareness training can emphasize the full range of potential distractions and also stress that while workers are behind the wheel, driving is their primary job (National Safety Council, 2022).

4.5. Manner of collision

Among fatal work-related crashes that were collisions with another motor vehicle in transport, vehicles most often contacted each other at an angle (34.3%) or front-to-rear (31.8%). In contrast, data for the general population for 2011–2014 indicate that 48.8% occurred at an angle and 17.0% front-to-rear. The reason for the unexpectedly high proportion of front-to-rear crashes among fatal work-related crashes is not clear. However, a study of nonfatal work-related crashes reported a similar result: that injury-producing crashes were equally as likely to be front-to-rear as at an angle (Pratt & Bell, 2019). In contrast, research for the general population corroborates the U.S. national statistics, reporting high risk of injury or fatality for angle collisions, particularly right-angle collisions likely to have taken place at an intersection (Choi, 2010; Laberge-Nadeau et al., 2009).

It is important to note that this analysis did not examine whether the fatally injured worker was in the striking vehicle or the struck vehicle. However, research has suggested that in front-to-rear collisions, occupants of the leading vehicle (the struck vehicle) are more likely to be seriously injured than occupants of the striking vehicle (Khattak, 2001). Further research is needed to determine the reasons for high proportions of front-to-rear crashes among fatal work-related crashes, but there are known strategies that can be adopted to reduce the risk of both angle and front-to-rear collisions. Automatic emergency braking (AEB), when combined with forward collision warning, has been shown to reduce front-to-rear crashes by 50% overall and those involving large trucks by 41% (Cicchino, 2017). Also, AEB in heavy vehicles may have the potential to mitigate the frequency and severity of rear-end collisions with vehicles (Teoh, 2021). IVMS data and driver training and coaching can help workers reduce driving behaviors associated with front-to-rear crashes, including harsh braking or acceleration or following too closely (Bell et al., 2017; Hickman & Hanowski, 2011; Toledo & Shiftan, 2016). In addition, prevention messaging and hands-on driver training can emphasize the importance of maintaining a safe following distance, avoiding harsh braking or acceleration, observing traffic signals, yielding the right of way, and minimizing left turns at intersections.

4.6. Speeding

In the matched dataset, the proportion of vehicles whose speed contributed to the fatal crash was identical to the proportion in the general population for 2011–2014: 20.0% (U.S. Department of Transportation, 2013a, 2014a, 2015a, 2016b). As speed increases, the driver has less time to react to road hazards or to maneuver quickly enough to stop the vehicle or avoid a crash. Moreover, the higher the speed, the more deadly the crash (Aarts & van Schagen, 2006; Forum, 2018). Several speed management strategies for company fleets have been suggested: choosing fleet vehicles with intelligent speed adaptation, which alerts drivers they are exceeding the speed limit; using IVMS data to counsel drivers to maintain safe speeds and to assess the need to alter work schedules such that drivers can maintain safer speeds; setting maximum fleet speeds; and using speed governors on commercial motor vehicles to prevent acceleration past a set threshold (American National Standards Institute, 2017; International Organization for Standardization, 2012). Although most new trucks manufactured for use in the United States are equipped with speed governors, this equipment is not yet mandatory under the FMCSA regulations. U.S. rulemaking on speed governors is in the early stages (Federal Motor Carrier Safety Administration, 2022). Other speed management strategies applicable to all fleet drivers include mandatory reporting of speeding violations, regular motor-vehicle records checks, and the inclusion of information about the dangers of speeding in driver training (American National Standards Institute, 2017). From the data used in this analysis, it was not possible to determine whether fatally injured workers' vehicles were equipped with speed governors or other safety features or whether their employers had policies to manage speed.

4.7. Seat belt use and seating position

During the study period, annual seat belt use percentages in the United States ranged from 83.8% to 87.2% (U.S. Department of Transportation, 2021). However, only 46% of fatally injured workers were wearing a seat belt at the time of the crash, identical to the percentage for all persons who died in MVCs in the United States between 2011 and 2014 (U.S. Department of Transportation, 2013b, 2014c, 2015c, 2016c). These results strongly suggest that not using a seat belt continues to be a contributor to MVC fatality risk for workers. Our results indicate the importance of worker compliance with state seat belt laws, reinforced by employer policies (American National Standards Institute, 2017).

Research has demonstrated that in the event of a crash, adult seat belt use is the single most effective way to save lives and reduce injury severity. Buckling up in the front seat of a passenger car can reduce the risk of a fatal injury by 45% (Kahane, 2015) and of moderate-to-critical injury by 50% (National Highway Traffic Safety Administration, 1984), with even greater reductions for light trucks. Several organizations provide guidance for employers to set policies addressing seat belt use (American National Standards Institute, 2017; National Safety Council, 2022; American Petroleum Institute, 2018). As recommended in these resources, employers may develop and implement comprehensive company seat belt policies that cover all occupants, even if state laws do not require the use of seat belts by persons in all seating positions. The latter is particularly important, as we observed that seat belt use decreased as passengers were seated further away from the front seat. Finally, the fact that we observed fatalities among passengers seated in vehicle areas meant for cargo suggests the need for policies calling for all workers riding in motor vehicles to have a seat and a seat belt available for their use.

4.8. Industry

Our results indicate the need to move beyond the common assumption that work-related MVCs occur exclusively among workers in transportation and warehousing industries and involve only large trucks. Although a high proportion of workers and vehicles in fatal crashes were in these groups, results from this study show the contribution of other industries and vehicle types to fatal work-related MVCs. Observed differences by vehicle type within major industry groups further support the need for motor vehicle safety programs, policies and strategies aimed at those who drive and ride in lighter vehicles (e.g., pick-up trucks, passenger cars, SUVs) and even farming and construction equipment.

Our analysis by industry also highlights the importance of closely examining fatal MVCs in industries other than transportation and warehousing, as we observed key differences by occupant and vehicle type. In construction, administrative and support, waste management and remediation service, and mining, quarrying, and oil and gas extraction industries, the percentages of fatally injured workers who were passengers were disproportionately high. These industries also accounted for higher proportions of vehicles able to accommodate multiple occupants. A key feature these industry groups have in common is that much of the work is done by crews who frequently travel in the same vehicle from one worksite to another. Higher proportions of fatally injured passengers are not an unexpected finding, and suggests the need to develop or strengthen work-related passenger safety programs specifically when multiple workers travel in the same vehicle (Appalachian State University, 2022; The University of Tennessee System, 2022). Employers can consider reinforcing basic safety measures such as compliance with seat belt use by all occupants and providing safe seating for all vehicle occupants (Appalachian State University, 2022; Kahane, 2015; National Highway Traffic Safety Administration, 1984; The University of Tennessee System, 2022).

5. Limitations

We acknowledge that definitional differences in CFOI and FARS make it impossible to achieve complete matches. In addition, the use of police report data by FARS means that some driver-related factors such as fatigue and distraction are based solely on the judgment of the investigating officer at the scene. Follow-up data collection on a sample of work-related fatalities using methodologies such as those used in Trucks Involved in Fatal Accidents (University of Michigan Transportation Research Institute, 2008) and the Large Truck Crash Causation Study (Blower & Campbell, 2005; Federal Motor Carrier Safety Administration, 2005), would allow better ascertainment of some driver-related factors. It may also allow us to assess the role of employment and work organization characteristics (e.g., employer policies, regulatory requirements, non-standard employment arrangements) in fatal work-related MVCs. Another limitation is that the current analysis excluded pedestrian fatalities on public roads, which are likely distributed differently by industry, occupation, and other characteristics. This analysis also excluded deaths of pedestrians and vehicle occupants in crashes that occurred off public roads, which are not included in FARS. It is also likely that the distributions of these deaths differ from those occurring on public roads.

Lack of adequate worker exposure data limited our ability to calculate rates. Although employment estimates by industry and occupation are available (U.S. Bureau of Labor Statistics, 2022) and customarily used to calculate work-related fatality rates, in this study those estimates may have led to inaccurate rates since we would be assuming that all included in the denominator were equally "exposed" to driving or riding in a motor vehicle. We acknowledge that it is possible to calculate rates using available data but using all workers during the study period as the denominator would have likely yielded inaccurate risk estimates (Biddle & Kisner, 1998; Pratt & Bell, 2019; Richardson et al., 2004; Ruser, 1998). Although vehicle miles traveled data for large trucks are available (United States Department of Transportation, 2016a), for consistency, we opted not to calculate any rates as we could not make comparisons with other groups. Finally, since the dataset included only worker fatalities, this study was not able to address the impact of fatal work-related MVCs on other road users who were not working when the crash occurred.

6. Conclusions and practical applications

Both FARS and CFOI are censuses, thus increasing confidence that the matched dataset represents complete ascertainment of work-related crash fatalities. Our analysis shows the value of matching CFOI/FARS in advancing our knowledge and understanding of work-related MVCs by combining information on worker demographics from CFOI with information on crash risk factors and characteristics from FARS. The matched data make it possible to develop more focused prevention recommendations for workers who drive as part of their job. Our results will help in generating research questions for further investigation using this, other data sources, or, through original data collection.

Submission declaration

This paper is not being considered for publication by any other journal.

Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent the views of the National Institute for Occupational Safety and Health. The findings and conclusions in this report were generated with restricted access to the CFOI research file and do not necessarily represent the views of the Bureau of Labor Statistics.

CRediT authorship contribution statement

Rosa L. Rodríguez-Acosta: Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Christen G. Byler:** Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Stephanie G. Pratt:** Writing – review & editing, Writing – original draft, Formal analysis, Conceptualization.

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