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## Case Study

# Characterization of Fatal Occupational Versus Nonoccupational Motor Vehicle Collisions in Kentucky (1998-2000)

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*Motor vehicle collisions (MVCs) are the leading cause of occupational fatalities in Kentucky as well as in the nation. The characteristics of and contributing factors for occupational versus nonoccupational MVC fatalities in the Commonwealth of Kentucky were examined from 1998 to 2000. Semi trucks were most frequently involved in fatal occupational MVCs, and passenger cars were most frequently involved in nonoccupational MVCs. More than half of the decedent drivers resided outside of Kentucky. The percentage of occupational fatalities occurring on a four-lane highway was double the percentage observed for nonoccupational MVC fatalities. In addition, an increased proportion of occupational MVC deaths occurred on limited access highways compared to nonoccupational fatalities. When human factors contributing to these fatal incidents were examined, the two primary human factors involved in occupational motor vehicle fatalities were driver distraction/inattention and falling asleep, whereas unsafe speed and alcohol were the primary human factors contributing to a nonoccupational fatality. These results suggest that semi drivers traveling on four-lane highways are more at risk for a fatal occupational injury in Kentucky. Therefore, additional epidemiological studies are needed to further examine human factors, the nature of the Kentucky highway system, and trucking controls (e.g., weigh station hours of operation) within the Kentucky transportation industry.*

**Keywords** Driver Distraction; Driver Fatigue; Human Factors; Motor Vehicle Collisions; Occupational Fatalities; Semi Trucks

It is estimated that three workers die every day in the United States as a result of a motor vehicle collision (MVC) (NIOSH, 1998), and MVC fatalities account for the majority of occupational deaths occurring nationwide for both males and females. In the year 2000 a total of 5,915 fatal occupational injuries was recorded (Bureau of Labor Statistics, 2001), and almost one-quarter of these fatalities were the result of MVCs. The Kentucky Fatality Assessment and Control Evaluation (FACE) Program has recorded occupational fatalities since 1994, and MVCs have been the leading cause of worker death every year.

In 2001 there were 22 worker deaths attributed to MVCs, and MVCs were the leading cause of death in three industries: transportation/communications and public utilities; mining; and the wholesale/retail trade industries.

While a few studies have shown MVCs to be the leading cause of death from occupational injuries in minors (Castillo & Malit, 1997; Cooper et al., 1999), retail industry workers (Peek-Asa et al., 1999), agricultural industry workers (Gerberich et al., 1996), and construction industry workers (Ore & Fosbroke, 1997), there is a paucity of research characterizing occupational motor vehicle fatalities by industry and occupation (Loomis, 1991; NIOSH, 1998). The purpose of this study was to characterize the factors associated with motor vehicle occupational fatalities in Kentucky compared to Kentucky nonoccupational motor vehicle fatalities, and to identify workers and work situations at risk for a fatal MVC in order to target and develop prevention strategies.

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## METHODS

The FACE system conducts surveillance of all occupational fatalities within the state. MVC data were selected from the FACE database based on external cause of injury (e-code) (*International Classification of Diseases (ICD-9)*) and were analyzed from January 1998 to December 2000.

To enhance the surveillance system, Kentucky Uniform Police Traffic Collision Reports (KUPTCR) were received from the Kentucky State Police Records Section. Cases were deemed work related if a commercial-type vehicle was driven (based on NCIC vehicle type), type of cargo was listed, or if the owner of a vehicle was a company instead of an individual. All Kentucky law enforcement agencies are required to submit original traffic collision reports within 10 days after the MVC to the Kentucky State Police Records Section. In compliance with Kentucky regulations, if a death results from an MVC within 30 days of the incident date, the death is classified as a traffic fatality. Definitions of MVCs were based on the ANSI D16.1 *Manual on Classification of Motor Vehicle Accidents*. Selected variables from the paper KUPTCR were used to create a separate electronic file for data analysis.

In addition, cases were obtained from media reports of fatal collisions indicating that a decedent was working at the time of the fatal incident. Death certificates were obtained from the Kentucky Office of Vital Statistics and the deaths deemed work related if the box for "injury at work" was checked and the cause of death was listed as a MVC. Questionable cases were confirmed through conversations with local coroners.

Seventy-one MVC cases were deemed work related and used for this analysis. Two cases were excluded from the analysis because they were recorded in the FACE database as being motor vehicle related but were not accompanied by a matching paper KUPTCR report. Therefore, no collision report variables were available for analysis for those two cases.

For comparison purposes, a Collision Report Analysis for Safer Highways (CRASH) system electronic file of fatal MVCs was obtained from the Kentucky State Police Records Section for 1998–2000 ( $n = 2,516$ ). The electronic file contains all MVC information, but excludes personal identifiers. The file was deemed nonoccupational after the 71 work-related cases were removed from the electronic file ( $n = 2,445$ ). A descriptive analysis was performed and frequencies were determined for each variable examined using Statistical Product and Service Solutions (SPSS) for Windows, Release 10.0.5 (SPSS Inc., Chicago, Illinois, USA). A Kolmogorov-Smirnov one-sample chi-square test was utilized to analyze proportions in each category and to generate confidence intervals for each proportion using Programs for Epidemiologists (PEPI v.4.0) (J. H. Abramson and Paul M. Gahlinger, Sagebrush Press, Salt Lake City, Utah, USA). Data for nationwide occupational fatal MVCs were used for discussion when available. Since not all nationwide occupational data variables examined were available for analysis, the Kentucky nonoccupational fatality data were used for comparison.

Kentucky's nonoccupational MVC deaths and occupational-only fatality rates were calculated for 1998–2000 for both licensed drivers and employed persons (data not shown). Fatality rates remained constant for the 3-year period.

## RESULTS

Most of the fatalities occurred in the transportation industry (61%), and the most common occupation was that of the operators/fabricators/laborers comprising 83% of fatal MVCs (data not shown). Managers/professionals, farmers, and technical/sales/support occupations were rarely represented with an average of two to three deaths for the 3-year period.

Vehicle types were compared for differences between Kentucky's occupational fatalities and nonoccupational fatalities (Table I). Commercial vehicles constituted the majority of vehicles involved in occupationally related MVC deaths. Tractor-trailer trucks (semi trucks) were the vehicles most frequently involved in Kentucky fatal occupational MVCs (45%). Other trucks (i.e., dump, flatbed, concrete, utility vehicle) were involved 14 times more often in occupational fatalities when compared to nonoccupational fatalities. Only 4% of occupational motor vehicle deaths were in passenger cars, whereas 60% of the nonoccupational MVC deaths in Kentucky were in passenger cars. Fatalities involving pickup trucks and vans as vehicle types were the same for both nonoccupational and occupational-only MVCs.

Seat belts were worn more frequently by workers (46% occupational fatalities vs. 32% nonoccupational) at the time of death. It should be noted that 12% of Kentucky nonoccupational MVC decedents were of unknown or uninstalled seat belt status at the time of the fatal MVC (Table I).

Demographic characteristics of occupational versus nonoccupational MVC fatalities were examined. Workers who died

**Table I** Vehicle characteristics of Kentucky occupational and nonoccupational motor vehicle fatalities (1998–2000)

	Kentucky occupational fatalities		Kentucky nonoccupational fatalities	
	No. (%)	(95% CI) <sup>c</sup>	No. (%)	(95% CI) <sup>c</sup>
Vehicle type <sup>a</sup>				
Bus	1 (1)	(0.1–6.7)	0 (0)	
Car	3 (4)	(0.1–11.1)	1,461 (60)	(57.8–61.7)
Pickup/Van	15 (21)	(12.8–31.8)	578 (24)	(22.0–25.4)
Semi	32 (45)	(33.8–56.7)	4 (0)	(0.1–0.4)
Truck	20 (28)	(18.6–39.4)	42 (2)	(1.3–2.3)
Other/Invalid	0 (0)		360 (15)	(13.4–16.2)
Use of restraints <sup>b</sup>				
Shoulder/Lap	33 (46)	(35.1–58.1)	642 (32)	(28.9–32.9)
None	34 (48)	(36.5–59.5)	1,317 (66)	(61.2–65.3)
Not installed	4 (6)	(1.8–13.0)	51 (3)	(1.8–3.2)
Invalid	0		295	

<sup>a</sup>  $p < .01$ .

<sup>b</sup>  $0.1 > p > .05$ .

<sup>c</sup> Mid- $p$  confidence interval determined for each proportion.

**Table II** Demographics of Kentucky occupational versus nonoccupational motor vehicle fatalities (1998–2000)

	Kentucky occupational fatalities <sup>a</sup>		Kentucky nonoccupational fatalities	
	No. (%)	(95% CI) <sup>c</sup>	No. (%)	(95% CI) <sup>c</sup>
Age <sup>b</sup> (yr)				
<20	1 (1)	(0.1–6.7)	488 (20)	(18.4–21.6)
20–29	8 (11)	(5.4–20.3)	513 (21)	(19.4–22.6)
30–39	20 (28)	(18.6–39.4)	397 (16)	(14.8–17.7)
40–49	19 (27)	(17.5–37.9)	333 (14)	(12.3–15.0)
50–59	14 (20)	(11.7–30.2)	220 (9)	(7.9–10.2)
60–69	7 (10)	(4.4–18.5)	173 (7)	(6.1–8.1)
70–79	1 (1)	(0.1–6.7)	181 (7)	(6.4–8.5)
80–89	1 (1)	(0.1–6.7)	122 (5)	(4.2–5.9)
Missing value	0 (0)		18 (1)	(0.5–1.1)
Gender <sup>b</sup>				
Male	68 (96)	(88.9–98.9)	1,645 (67)	(65.4–69.1)
Female	3 (4)	(1.1–11.1)	800 (33)	(71.8–75.3)
State of residence <sup>b</sup>				
Kentucky	34 (48)	(36.5–59.5)	1,383 (90)	(88.2–91.2)
Out of State	37 (52)	(40.5–63.5)	158 (10)	(8.8–11.8)
Invalid/missing	0		904	

Note: Race information not available on Collision Report Analysis for Safer Highways (CRASH) database.

<sup>a</sup>Based on death certificates, Cabinet for Health Services, Office of Vital Statistics, Frankfort, Kentucky.

<sup>b</sup> $p < .01$ .

<sup>c</sup>Mid- $p$  confidence interval determined for each proportion.

in MVCs were most often between age 30 and 49 (Table II). Teenagers and workers over age 59 were least likely to be involved in a fatal collision while working (1.4%) in Kentucky. These proportions correspond to the national pattern of employed worker ages in the workforce (Bureau of Labor Statistics, 1999). A significantly higher number of nonoccupational MVCs involved persons under age 20 compared to occupational MVC deaths. Almost all of the occupational deaths were in male workers (96%). The majority of work-related deaths occurred in whites (75%) (data not shown). Less than one-half of the occupational MVC decedents resided in Kentucky (48%), whereas 90% of nonoccupational MVC fatalities involved Kentucky residents. For 904 of the 2,445 fatalities, an invalid or missing variable for state of residence was recorded.

Collision characteristics of occupational fatalities and nonoccupational fatalities for Kentucky are shown in Table III. MVCs against a nonfixed object (e.g., another motor vehicle, a pedestrian, a bicyclist, an animal, a train) constituted half of the occupational and nonoccupational fatalities. Collisions with other motor vehicles accounted for 42% of worker MVC deaths compared to 46% for nonoccupational fatal MVCs. When collisions with a fixed object (e.g., light pole, guardrail, signpost, tree, wall, fence) were analyzed separately, there was a significant difference in the number of collisions against a guardrail. Fifteen percent of occupational MVC fatalities involved a collision against a guardrail, whereas only 5% of nonoccupational Kentucky fatalities involved guardrails.

Most occupational MVCs occurred between the normal working hours (Table III) of 6 A.M. and 6 P.M. Only 11% of

**Table III** Collision characteristics of Kentucky occupational motor vehicle fatalities compared to nonoccupational motor vehicle fatalities (1998–2000)

	Kentucky occupational fatalities		Kentucky nonoccupational fatalities	
	No. (%)	(95% CI) <sup>d</sup>	No. (%)	(95% CI) <sup>d</sup>
Type of accident <sup>a</sup>				
Nonfixed object				
Other motor vehicle	30 (42)	(31.2–53.9)	640 (46)	(43.5–48.7)
Train	1 (1)	(0.1–6.7)	7 (1)	(0.2–1.0)
Overturn	5 (7)	(2.6–4.9)	57 (4)	(3.2–5.2)
Other nonfixed object	0 (0)		24 (2)	(1.1–2.5)
Fixed object <sup>b</sup>				
Bridge abutment	1 (1)	(0.1–6.7)	15 (1)	(0.6–1.7)
Earth embankment/rock cut/ditch	12 (17)	(9.5–27.0)	179 (13)	(11.2–14.7)
Guardrail	11 (15)	(8.5–25.3)	65 (5)	(3.7–5.9)
Signpost/pole	2 (3)	(0.5–9.0)	49 (4)	(2.6–4.6)
Tree	6 (8)	(3.5–16.7)	175 (13)	(10.9–14.4)
Other fixed object	2 (3)	(0.5–9.0)	117 (8)	(7.0–10.0)
Other	1 (1)	(0.1–6.7)	61 (4)	(3.4–5.6)
Invalid	0		1056	
Time of day (military time) <sup>c</sup>				
0:00–06:00	15 (21)	(12.8–31.8)	410 (17)	(15.3–18.3)
6:01–12:00	22 (31)	(21.1–42.4)	525 (21)	(19.9–23.1)
12:01–18:00	26 (37)	(26.0–48.3)	861 (35)	(33.3–37.1)
18:01–24:00	8 (11)	(5.4–20.3)	643 (26)	(24.6–28.1)
Unknown/invalid	0 (0)		6 (0)	

<sup>a</sup>Not significant when both nonfixed and fixed object categories combined for analysis.

<sup>b</sup> $p < .05$  when only fixed object category analyzed.

<sup>c</sup> $0.1 > p > .05$ .

<sup>d</sup>Mid- $p$  confidence interval determined for each proportion.

fatal worker MVCs occurred during the evening hours, whereas 26% of Kentucky nonoccupational fatal MVCs happened between 6 P.M. and 12 A.M. Weather, highway grade, or straightness were not remarkable (data not shown).

The human factors (those listed on the KUPTCR form) contributing most frequently to Kentucky worker MVC deaths were driver distraction/inattention and driver fatigue (Table IV).

**Table IV** Human factors contributing to Kentucky fatal occupational and nonoccupational motor vehicle collisions (1998–2000)

Human factors <sup>a</sup>	Kentucky occupational fatalities		Kentucky nonoccupational fatalities	
	No. (%)	(95% CI) <sup>b</sup>	No. (%)	(95% CI) <sup>b</sup>
Disregard traffic controls	2 (3)	(0.5–9.0)	48 (2)	(1.7–2.9)
Distraction/driver inattention	18 (25)	(16.3–36.4)	273 (13)	(11.3–14.1)
Failure to yield right of way	3 (4)	(1.1–11.1)	210 (9)	(8.5–11.0)
Fell asleep	11 (15)	(8.4–25.3)	61 (3)	(2.2–3.6)
Overcorrecting/oversteering	2 (3)	(0.5–9.0)	31 (1)	(1.0–2.0)
Unsafe speed	4 (6)	(1.8–13.0)	323 (15)	(13.5–16.5)
Not under proper control	5 (7)	(2.6–14.9)	46 (2)	(1.6–2.8)
Alcohol	2 (3)	(0.5–9.0)	431 (20)	(18.3–21.6)
Other	2 (3)	(0.5–9.0)	286 (13)	(11.8–14.7)
None	22 (31)	(21.1–42.4)	457 (21)	(19.4–22.9)
Invalid	0		279	

<sup>a</sup> $p < .01$ .

<sup>b</sup>Mid- $p$  confidence interval determined for each proportion.

**Table V** Roadway characteristics of occupational versus nonoccupational motor vehicle fatalities (1998–2000)

	Kentucky occupational fatalities		Kentucky nonoccupational fatalities	
	No. (%)	(95% CI) <sup>b</sup>	No. (%)	(95% CI) <sup>b</sup>
Number of lanes <sup>a</sup>				
1	1 (1)	(0.1–6.7)	40 (2)	(1.2–2.2)
2	34 (48)	(36.5–59.5)	1,701 (70)	(67.7–74.0)
3	2 (3)	(0.5–9.0)	73 (3)	(2.4–3.7)
4	31 (44)	(32.5–55.3)	516 (21)	(19.5–22.8)
>4	3 (4)	(1.1–11.1)	188 (4)	(6.7–8.8)
Unknown	0		27 (1)	(0.7–1.6)
Land use <sup>a</sup>				
Business	4 (6)	(1.8–13.0)	278 (11)	(10.2–12.7)
Industrial	1 (1)	(0.1–6.7)	16 (1)	(0.4–1.0)
Limited access	27 (38)	(27.3–49.7)	239 (10)	(8.6–11.0)
Residential	2 (3)	(0.5–9.0)	257 (11)	(9.3–11.8)
Rural	37 (52)	(40.5–63.5)	1,607 (66)	(63.8–67.6)
Other/invalid	0 (0)		48 (2)	

<sup>a</sup> $p < 0.01$ .

<sup>b</sup>Mid- $p$  confidence interval determined for each proportion.

Driver distraction/inattention was identified as a factor in 25% of worker deaths. However, driver distraction/inattention was a factor in only 13% of the nonoccupational fatal crashes in Kentucky. Furthermore driver fatigue was a factor in 15% of the occupational MVCs, but in only 3% of the nonoccupational fatal crashes. In contrast, unsafe speed contributed to 15% of nonoccupational collision deaths, but only 6% of occupational fatalities were due to unsafe speed. In addition, alcohol was involved in 20% of Kentucky nonoccupational MVC deaths and in only 3% of occupational MVC deaths.

Roadway characteristics are shown in Table V. Whereas 70% of nonoccupational MVC fatalities occurred on two-lane highways, two-lane highways accounted for only 48% of occupational MVC fatalities. In contrast, a large proportion of Kentucky worker deaths occurred on four-lane highways (44%) compared to only 21% of state nonoccupational fatal MVCs. A higher percentage of Kentucky occupational MVC fatalities occurred on limited access highways compared to nonoccupational MVC fatalities (38% occupational vs. 10% Kentucky nonoccupational). More nonoccupational MVC deaths occurred in rural and residential areas compared to the number of occupational MVC deaths.

## DISCUSSION

While a number of studies have examined the characteristics of fatal MVCs, few studies have characterized fatal MVCs with regard to working individuals. Transportation deaths are the most frequent cause of occupational fatalities nationwide (Fatal Occupational Injuries, 2001; Loomis, 1991; NIOSH, 1998; Personick & Mushinski, 1997). The present study has examined the characteristics of work-related MVC fatalities in Kentucky where they have been the leading cause of work related deaths

(Struttman et al., 1996). We found that semi trucks were the most frequent vehicle involved in an occupational fatality, with an increased proportion occurring on four-lane highways. Also, the major contributing human factors were either driver distraction/driver inattention or falling asleep. In addition, more than half of the occupational MVC decedents resided outside of Kentucky.

The highway system in the Commonwealth of Kentucky forms a major corridor for transport between the north and south (U.S. I-75 and I-65) as well as from the east to west (U.S. I-64). The average number of trucks using the Kentucky highway system annually is 4,853,770,000 and there are 2,403 four-lane paved miles in Kentucky (Roberts, 2002). In Kentucky we found 45% of worker MVC deaths involved semis, whereas nationwide NIOSH (1998) reported that semi trucks accounted for 35% of occupational MVC fatalities. Therefore the increased number of occupational MVC fatalities that occur in trucks, and in particular in semis, compared with passenger cars may be due in part to the high truck volume driving through the state. Traffic density has been associated with multiple-vehicle and single-vehicle MVC rates of commercial vehicles (Braver et al., 2002).

The percentage of fatal occupational MVCs in Kentucky occurring on four-lane highways (44%) was significantly higher compared to the state nonoccupational MVCs (22%). In addition, there was a significant increase in the number of limited access roads involved in Kentucky occupational MVC deaths compared to the nonoccupational number of MVC deaths in Kentucky. The increased number of occupational truck MVC fatalities on four-lane limited access highways could be associated with land use and traffic density. In a study conducted by Karlaftis and Golias (2002), access control, as a risk factor for accident rates, increased with heavier traffic on rural multilane roads while a median was the most important factor for accident rates with low traffic flow on rural multilane highways. Advocates for Highway and Auto Safety (2001) found that the majority of large truck MVC fatalities occurred in rural areas (67%). Rural land use comprised 52% of the associated land use for work-related fatal MVCs in Kentucky. In addition, land use as well as traffic density has been determined to have an effect on crash rates for both single- and multiple-vehicle crashes on two-lane highways (Ivan et al., 2000).

Our results show the majority of fatal occupational MVCs in Kentucky was collisions with another motor vehicle (42%). When only collisions against a fixed object were analyzed, there was a significant difference in the number of collisions against guardrails in fatal occupational MVCs compared to nonoccupational fatalities (15% vs. 5%). These results are in general agreement with NIOSH (1998) findings, which showed 36% of nationwide occupational MVC deaths involved other motor vehicles and 14% involved guardrails.

Driver distraction/inattention and driver fatigue were the primary human factors contributing to fatal occupational MVCs in Kentucky, whereas alcohol and unsafe speed were the human factors most frequently contributing to a nonoccupational MVC fatality. Both driver distraction and driver fatigue may

be interrelated. Driver inattention has been cited as one of the predisposing signs of cognitive fatigue, which has been defined as “the point reached in continuous performance of a particular task where the subject asserts they are unfit to stay in action and must disengage from further performance” (Nelson, 1997, p. 412). Driver fatigue and alertness are now being recognized as a cause for concern in safety issues concerning the long-haul commercial motor vehicle driver. In a study conducted by the Federal Motor Carrier Safety Administration (1996), the single most causative factor for fatigue in truck drivers was time of day. Mid-afternoon and nighttime driving were both associated with an increased risk of crashes (Pack et al., 1995). In this study, the majority of collisions occurred during the afternoon. Also, prolonged working hours (Brown, 1994) and the length of the trip (Sagberg, 1999) were found to be risk factors for driver fatigue.

It is possible that all occupational MVC fatalities over the time period were not identified in this study. KUPTCR records are reviewed for occupational fatalities by assessing vehicle type, cargo type, vehicle ownership, and vehicle insurer. Cross-checking with KUPTCR reports that ultimately are submitted to the national Fatality Analysis Reporting System (FARS) results in increased capture of occupational fatality cases (Struttman, 1994). In this study alone 73% of all occupational fatalities occurred in semi trucks and other trucks, and both of these types of fatalities would be considered working. Because all of the truck fatality KUPTCR reports we received were recorded in the FACE database we consider our method of capture and identification of occupational fatality cases as representative of the true number of work-related deaths. The FACE program does not rely on death certificates alone because 25–30% of occupational fatalities are underestimated when used as a sole source of case identification (Rubens et al., 1995).

The primary purpose of the FACE program is to prevent occupational fatalities through the identification of risk factors in the work setting that contribute to a work-related death (Higgins et al., 2001). Following risk factor identification, prevention strategies and interventions are devised to prevent similar occurrences. With these types of data, workplace driver education programs can be developed or enhanced within companies which address, among other risk factors, human factors (i.e., driver inattention and driver fatigue) contributing to occupational MVCs. Included in training and continuing education should be recognition of symptoms of fatigue as well as tips for prevention such as short napping periods and termination of driving when feeling drowsy (NHTSA, 2001). Current practical FACE prevention materials such as hazard alerts that include the number of fatalities associated with the specific cause of death (e.g., MVCs), examples of individual cases including the specific circumstances and contributors for each incident, and tips for prevention and precautions to be undertaken while working (e.g., as occupational drivers) are distributed to employees by employers and utilized by the employees. Case study results such as those in the present one will be incorporated into hazard alerts to be used as supplemental information for discussion in company safety talks.

Our study identifies truck drivers as being at increased risk for an occupational MVC fatality in Kentucky. Additionally, driver

inattention/fatigue may increase the likelihood of a fatal MVC occurrence. Further research is needed to understand the factors that contribute to trucking fatalities in Kentucky so that effective preventive measures can be developed and formulated. A case control study of commercial vehicle crashes is recommended.

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