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Sleepiness/fatigue and distraction/inattention as factors for fatal versus nonfatal commercial motor vehicle driver injuries

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Abstract

A retrospective population-based case–control study was conducted to determine whether driver sleepiness/fatigue and inattention/distraction increase the likelihood that a commercial motor vehicle collision (CVC) will be fatal. Cases were identified as CVC drivers who died (fatal) and controls were drivers who survived (nonfatal) an injury collision using the Kentucky Collision Report Analysis for Safer Highways (CRASH) electronic database from 1998–2002. Cases and controls were matched on unit type and roadway type. Conditional logistic regression was performed. Driver sleepiness/fatigue, distraction/inattention, age of 51 years of age and older, and nonuse of safety belts increase the odds that a CVC will be fatal. Primary safety belt law enactment and enforcement for all states, commercial vehicle driver education addressing fatigue and distraction and other approaches including decreased hours-of-service, rest breaks and policy changes, etc. may decrease the probability that a CVC will be fatal.

Keywords: Commercial vehicle; Fatigue; Inattention; Case–control; Sleepiness; Restraints

1. Introduction

Over the past 20 years, the number of large truck collision fatalities has declined while the number of large truck collision injuries has increased. In 2001, there were 4793 fatal collisions involving large trucks and approximately 90,000 injury collisions involving large trucks nationwide (Federal Motor Carrier Safety Administration [FMCSA], 2003). In Kentucky, there were 95 fatal truck collisions and 1397 injury truck collisions, resulting in 107 deaths and 1958 injuries in 2001 (the large truck collision statistics include injuries suffered by both drivers and passengers in the large truck and the other collision vehicle, if applicable) (Kentucky Fatality Assessment and Control Evaluation [FACE] Program data, 2002). The number of large trucks registered in 2001 (7,857,674) has increased by 37% in the last 20 years and large trucks travel more miles per year now than 20 years ago (Federal Motor Carrier Safety Administration [FMCSA], 2003).

Sleepiness and fatigue have long been considered risk factors for collisions in truck drivers who tend to work long hours and are likely to be sleep-deprived. When drivers lack sleep, they are less focused on the road and their surroundings, easily distracted and less alert. Nationwide, fatigue and inattention have been recorded as driver-related factors contributing to 1.4 and 5.1%, respectively, of large truck fatal crashes in 2001 (FMCSA, 2003). Many studies have examined the effects of sleepiness and fatigue in the transportation industry, (Brown, 1994; Sagberg, 1999; Braver et al., 1992; Summala and Mikkola, 1994) but few have examined both fatigue and sleepiness as well as inattention/distraction as factors for a motor vehicle collision (Petridou and Moustaki, 2000; Ferguson, 2003).

The Kentucky Fatality Assessment and Control Evaluation program conducts surveillance of all occupational deaths that occur within the state in order to identify specific worker populations at increased risk for fatal traumatic injuries. Once

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risk factors are identified, prevention recommendations and strategies are developed and disseminated to similar industries and occupations to be used in worker safety training programs. A previous study characterizing the factors for an occupational versus nonoccupational motor vehicle collision (MVC) determined that driver fatigue and driver inattention/distraction were the primary human factors involved in an occupational MVC fatality, while unsafe speed and alcohol were the primary contributing factors for a nonoccupational MVC fatality (Bunn and Struttmann, 2003). Based on those results, this case–control study was conducted to determine the increased odds of a Kentucky CVC being fatal given that the driver was reported as (a) fatigued or asleep or (b) inattentive/distracted.

2. Methods

We used a retrospective population-based case–control design for the study. Data for both cases and controls were obtained from the state police department's Kentucky Collision Report Analysis for Safer Highways (CRASH) electronic files for 1998–2002. Fatalities and injuries resulting from commercial vehicle collisions that occurred between January 1, 1998 and December 31, 2002 were included in the analysis. The electronic file received contained all MVC information but excluded personal identifiers.

The inclusion criteria for the selection of cases and controls from the CRASH database was based on:

(1) Unit type: truck and trailer, truck—single unit, truck tractor and semi-trailer, truck—other combination and truck or truck–trailer—Kentucky Accident Reporting System (KARS) with more than two axles.
(2) Person type (driver) and position in vehicle (driver's position): person type refers to whether the selected person was the driver, passenger, pedestrian, bicyclist, train engineer, witness, owner or animal-drawn.
(3) Classification of injury:
    (a) fatal injury (cases);
    (b) other injury types (controls): incapacitating injury, non-incapacitating injury, possible injury.

The cases ($n = 68$) were commercial motor vehicle drivers who died from a CVC (fatal). All 68 eligible cases were selected for inclusion in the study. Controls ($n = 271$) were commercial motor vehicle drivers who survived a CVC (nonfatal). The cases and controls were individually matched at a ratio of 1 case–4 controls from the CRASH file ($n = 31{,}629$). We used more than one control per case in order to increase the precision of the odds ratio estimates. Cases and controls were matched on unit type and roadway type to account for these potential confounders. In Kentucky, all interstates are full access controlled, whereas, all parkways are not. In other words, there are intersections on some parkways. Additionally, fatality rates for commercial truck occupants are different for interstates (251 deaths/100,000 persons involved in crashes), parkways (735/100,000), federal (116/100,000) and state roads (151/100,000) (based on Kentucky's Crash Outcome Data Evaluation System (CODES), 2000–2002 data).

Each matched set was considered a unique stratum. Age and gender are commonly used as stratification variables. However, the commercial vehicle drivers in our database were almost exclusively males so we did not use gender as a matching variable. Exact matching on age was not performed so that age could be included in the regression model as an exposure variable. Matching was performed using the SAS Macro (%match) developed by Bergstralh and Kosanke (1995).

There were 6 "fell asleep" and 2 "fatigue" cases compared to 10 "fell asleep" and 1 "fatigue" controls so both categories were combined for cases and controls. The human factors related to the crash included sleepiness, fatigue, distraction, inattention and not under proper control. These factors are assessed by the investigating officer. The "fell asleep" and "fatigue" cases were combined in the analysis given the relatively few cases in these categories. The combination of these two categories was previously performed by Stutts et al. (2003) when examining driver risk factor for sleep-related crashes. The definition of "fell asleep" was defined by Stutts et al. (2003) as the investigating officer's conclusion that the driver was asleep at the wheel at the time of the crash. "Fatigue" was reported when the officer believed that the driver was tired but may not have been sleepy.

A descriptive analysis was performed to characterize the factors involved in a commercial vehicle injury collision and summary statistics were generated. A McNemar's Chi-square test and conditional logistic regression were performed and adjusted odds ratios were calculated. The SAS Cox Proportional Regression Model procedure "PHREG" was used to fit a conditional logistic regression model (Vierkant et al., 2000; Stokes et al., 2000). The variables examined were: age, human factors, restraint usage, roadway condition, roadway surface, roadway character, posted speed limit, precollision vehicle action, light condition and time of day.

A bivariate analysis for association between exposure variables and outcome (fatality versus nonfatal injury) was undertaken. The odds ratios and 95% confidence intervals were calculated using the Mantel–Haenszel method. After bivariate analysis, four factors were significantly associated with the fatal injury outcome and included in the final conditional regression model: (1) *human factors* divided into five categories: sleepiness/fatigue, distraction/inattention, not under proper control, other and none detected; (2) *restraint usage* separated into two categories: non-restraint and restrained/partially restrained; (3) *age* separated into categories based on the quartiles (Hosmer and Lemeshow, 1989) of the combined distribution of age ($n = 340$)—under 32 years of age, 33–39 years of age, 40–50 years of age and 51+ years of age; (4) *posted speed* limit separated into three categories: <55, 55 or 60 and >65 miles/h. All four factors were included in the initial conditional logistic regression model, and posted speed limit was not significantly associated with a fatal injury outcome so it was not included in the final conditional logistic regression model. Nine matched case–control datasets were excluded from the final conditional logistic regression model due to missing values for the cases (including one distraction/inattention case, two fell asleep controls and four distraction/inattention controls). In the final conditional logistic regression model, 283 observations were included out of a possible 340 observations (59 matched datasets).

3. Results

3.1. Demographic characteristics of cases and controls

Table 1 provides descriptive demographic statistics of fatal and nonfatal CVC injury collisions. Half (48%) of the drivers involved in a fatal CVC were wearing their safety belts at the time of death (Table 1) but safety belts were worn by the majority (84%) of commercial vehicle drivers involved in nonfatal injury crashes. Seat belt use for the nonfatally injured drivers is likely to be inflated because belt use may not be directly observed by a police officer and self-reporting by the driver could be biased. Drivers aged 50 years and older were more frequently in a fatal CVC compared with drivers in a nonfatal injury collision.

Driver distraction/inattention accounted for one-third of the reported human factors in a fatal injury CVC but was only reported in one-fifth of the nonfatal incidents. The percentage of CVCs due to driver fatigue/sleepiness as the human factor for a fatality was more than double the number for nonfatal CVCs. Alcohol use and cell phones were not contributors for fatal CVCs. All of the CVC fatalities involved males, whereas males were observed in 96% of the nonfatal CVCs. Not having the vehicle under proper control was a factor in 9% of the cases and in 5% of the controls. Exceeding the speed limit was reported among 5% of the cases and 7% of the controls.

For 7 of the cases and 21 of the controls, secondary human factors were listed in the police report. In one of the controls and in three of the cases, fatigue/fell asleep or distraction/inattention were listed as primary and secondary human factors. These factors were combined in the final analysis anyway. Speeding was not listed as a secondary factor for any of the asleep/fatigue or distraction/inattention cases or controls. Based on the low number of observations with secondary human factors listed, the potential for confounding effects on the human factor variable would be very low.

Table 1
Characteristics of fatal and nonfatal commercial vehicle collisions for truck drivers in Kentucky (1998–2002)

Demographic characteristic	Cases ($n = 68$) fatals, N (%)[a]	Controls ($n = 271$) nonfatals, N (%)[a]
Restraint use		
Shoulder/lap belt	30 (48)	212 (80)
Not used/not installed	33 (52)	52 (20)
Age (years)		
<30	12 (18)	54 (20)
30–39	12 (18)	94 (35)
40–49	18 (26)	61 (23)
50–59	17 (25)	38 (14)
≥60	9 (13)	24 (9)
Human factors		
Distraction/inattention	20 (31)	49 (18)
None detected	12 (19)	109 (41)
Fell Asleep/fatigue	8 (13)	11 (4)
Not under proper control	6 (9)	13 (5)
Other	6 (9)	24 (9)
Exceeded stated speed limit	3 (5)	19 (7)
Misjudge clearance	3 (5)	1 (<1)
Overcorrecting/oversteering	2 (3)	8 (3)
Failed to yield right of way	2 (3)	3 (1)
Alcohol involvement	1 (2)	3 (1)
Too fast for conditions	1 (2)	8 (3)
Cell phone	0	1 (<1)
Disregard traffic control	0	4 (1)
Drug involvement	0	2 (<1)
Following too close	0	6 (2)
Improper passing	0	1 (<1)
Lost consciousness/fainted	0	6 (2)
Invalid	4 (6)	4 (<1)
Gender		
Male	68 (100)	262 (96)
Female	0	10 (4)

[a] Percentages may not total to 100% due to rounding.

3.2. Collision characteristics of CVCs

When collision characteristics of the CVC injury collisions were examined, more fatal CVCs occurred at higher speed limits (Table 2). No differences were observed between fatal and nonfatal CVCs for roadway character, roadway surface, roadway condition, light condition, precollision vehicle action and time of day. Most nonfatal and fatal incidents occurred on straight and level roadways and less than one-fifth of the fatalities and nonfatalities occurred on curved roads. Approximately 70% of all collisions happened during daylight hours between 6:00 am and 6:00 pm, while one-third occurred during the night. Drivers were traveling straight down the road when the majority of incidents occurred and not backing up or turning. Only one-third of the collisions happened between the hours of 6:00 pm and 6:00 am.

3.3. Matched variables for cases and controls

Table 3 shows the frequencies for the matched variables between the cases and controls. Cases and controls were exactly matched for unit type and roadway type in this study. Over half of the vehicles involved in CVCs were semi trucks. Approximately one-quarter of the vehicles were single unit trucks. Very few collisions occurred in other trucks and trailers or in other combination trucks. The roadways where the majority of the CVCs occurred were state roads. Other roads accounted for approximately one-quarter each of the roadway types. The percentage of fatalities on county roads was very

Table 2
Collision characteristics of commercial vehicle collisions

Collision characteristic	Cases ($n = 68$) fatals, N (%)[a]	Controls ($n = 271$) nonfatals, N (%)
Posted speed limit		
<55	6 (9)	51 (19)
55–64	33 (51)	138 (51)
≥65	26 (40)	81 (30)
Roadway character		
Curve and grade/hillcrest	13 (19)	54 (20)
Curve and level	11 (16)	44 (16)
Straight and grade/hillcrest	19 (28)	78 (29)
Straight and level	24 (36)	96 (35)
Roadway surface		
Asphalt	59 (87)	243 (89)
Other	9 (13)	29 (11)
Roadway condition		
Dry	56 (82)	212 (78)
Other	12 (18)	60 (22)
Light condition		
Dawn/dusk	2 (3)	12 (4)
Daylight	44 (65)	188 (69)
Dark—highway not lighted	15 (22)	59 (22)
Dark—highway lighted	5 (7)	13 (5)
Invalid	2 (3)	0
Precollision vehicle action		
Avoiding object in roadway	0	5 (2)
Backing	1 (1)	1
Changing lanes	0	1
Going straight ahead	60 (90)	220 (81)
Leaving traffic lane	0	1
Making left/right turn	3 (4)	13 (5)
Merging	0	4
Parked/slowing or stopped/stopped in traffic	0	21
Other/unknown	2	3
Time of day		
12:01 am–6:00 am	13 (20)	41 (15)
6:01 am–12:00 pm	24 (36)	97 (36)
12:01 pm–6:00 pm	23 (35)	101 (37)
6:01 pm–12:00 am	6 (9)	31 (11)

[a] Percentages may not total to 100% due to rounding.

low compared to state and federal roads reflecting relatively low utilization of these roads by commercial trucking.

3.4. Factors associated with fatal CVCs

Four variables were found to be associated with the injury outcome: human factors, restraint usage, age and posted speed limit and included in the initial conditional logistic regression model. Posted speed limit was not significantly associated with a fatal injury outcome when controlling for other variables in the initial model so was not included in the final conditional regression model. The adjusted odds ratios for a fatal CVC outcome in the final model are shown in Table 4. There was no interaction between the predictor variables in this model; therefore, the contribution of each variable was independent of the others.

Table 3
Logistic regression analysis for fatal commercial vehicle collisions among male truck drivers in Kentucky (1998–2002)

Matching variable	Cases ($n = 68$) fatals, N (%)[a]	Controls ($n = 271$) nonfatals, N (%)
Unit type		
Truck and trailer	3 (4)	12 (4)
Truck—single unit	15 (22)	60 (22)
Truck—tractor and semi-trailer	40 (59)	160 (59)
Truck—other combination	8 (12)	32 (12)
Truck or truck–tractor	2 (3)	8 (3)
Roadway type		
County road	2 (3)	8 (3)
Federal	14 (21)	56 (21)
Interstate	18 (26)	72 (26)
Parkway	7 (10)	28 (10)
State	25 (37)	100 (37)
None of the above	2 (3)	8 (3)

[a] Percentages may not total to 100% due to rounding.

When the other contributing variables (age, restraint) were controlled for, driver fatigue/falling asleep and driver inattention/distraction were significantly associated with a fatal CVC. Drivers who were fatigued or fell asleep were 21 times as likely and drivers who were distracted/inattentive were 3 times as likely to be involved in a fatal CVC. The reference group was drivers with other human factors listed as a cause of the collision. A collision due to the vehicle not under proper control was not a significant factor for a CVC fatality.

In addition, lack of safety belt usage increased the likelihood of a fatal crash (OR = 8.22, CI = 3.51–19.21). Not surprisingly, the use of a shoulder belt, a lap belt, or both was protective against a fatal CVC. When age was examined as a contributing factor, the odds of incurring a fatal outcome were increased by 3 for drivers who were older than 51 years

Table 4
Adjusted odds ratios for fatal commercial vehicle collisions: final logistic regression model

Collision characteristic	Adjusted odds ratio[a]	95% CI[b]
Human factor		
Fatigue/fell asleep	21.03	4.17–106.07**
Distraction/inattention	3.16	1.22–8.24*
Not under proper control	1.93	0.43–8.63
None detected	0.66	0.25–1.75
All Others	Ref.	
Restraint usage		
Not used	8.21	3.51–19.21**
Shoulder/lap belt	Ref.	
Age (years)		
18–32	Ref.	
33–39	0.64	0.2–1.92
40–50	1.30	0.51–3.34
>51	2.94	1.08–7.99*

[a] Adjusted odds ratios indicate the probability of a collision characteristic in fatal collision compared to a nonfatal collision.
[b] 95% Confidence interval.
* Significant at $p < 0.05$.
** Significant at $p < 0.01$.

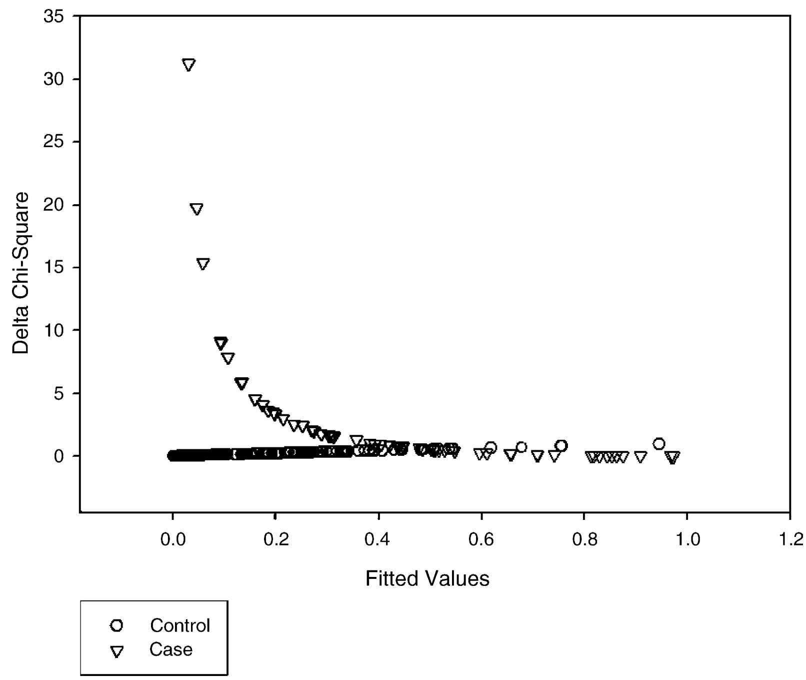

Fig. 1. Delta Chi-square by fitted values, cases and controls.

of age. Of interest, there was no decreased fatality risk for younger drivers (<39 years old).

To assess the model fit, we used some established diagnostics for the conditional regression model (Hosmer and Lemeshow, 1989). After refitting the final logistic regression model (human factors, restraint, age), the estimated coefficients for the significant exposure variables changed very slightly (less than 10%) which indicated that there were no confounding problems. Possible interactions were also tested in the model, and no significant interactions were found. The generalized r^2 proposed by Cox and Snell was 0.19 (Allison, 1995). The residual Chi-square test gave a p-value of 0.7 supporting goodness-of-fit.

Fig. 1 shows the plot of delta Chi-square versus the model's fitted values (i.e., the estimated probability a driver will have a fatal injury). There were three poorly fit cases with delta Chi-square values higher than 10 based on a delta Chi-square diagnostic as discussed by Hosmer and Lemeshow

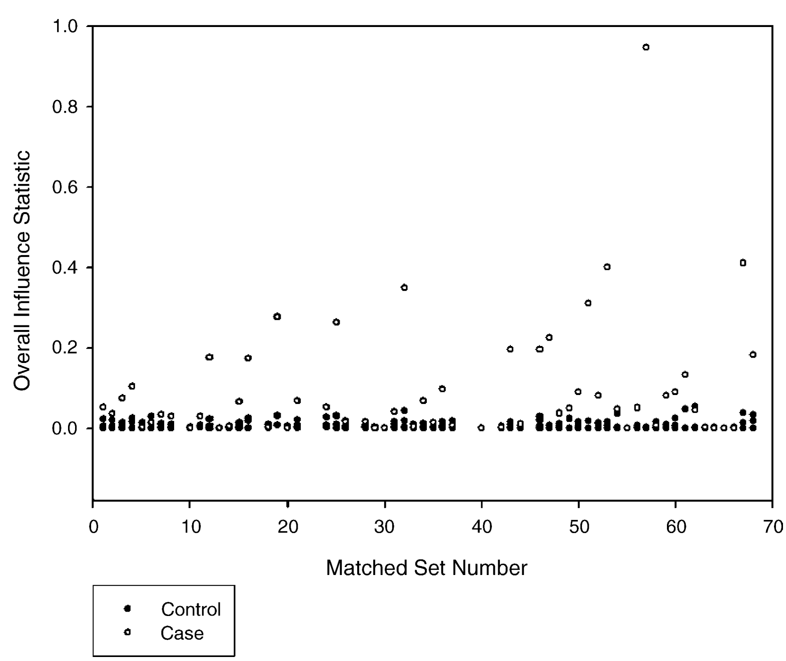

Fig. 2. Overall influence statistic for each matched data set.

(1989). The first case was a driver who was 39 years old, restrained and who was identified as distracted just before death. The second and third cases were 32- and 34-year old drivers who were restrained and had no detected human factors that contributed to their collision.

We assessed the influence of each matched data set (1 case + 4 controls) with the influence diagnostic. A plot of the overall influence statistic versus the number of matched data sets is shown in Fig. 2. The value with the largest influence statistic belongs to a case where the driver was 39 years old, was restrained, was distracted and died. In this matched data set, the first control was a driver who fell asleep, was restrained, was 53 years old but did not die. We deleted this first control and refit the model. Without this control, the adjusted odds ratios increased for fatigue/fell asleep, age of 51 years and older, and restraint usage by 100, 21 and 23%, respectively. When we deleted the entire matched data set, the results were almost the same. We decided to include this case and its matched controls because the matched set, although it did not fit the model, was still plausible. For the purposes of this study, the inclusion of this matched data set did not change the final set of predictor variables that increased the odds of a fatal commercial vehicle collision because our goal was to identify the exposure variables to be targeted for prevention programs.

4. Discussion

The present study examined human factors and other possible collision predictor variables and found that falling asleep/fatigue (13%; adjusted OR = 21.03, CI = 4.17–106.07) and distraction/inattention (31%; adjusted OR = 3.16, CI = 1.22–8.24) were both strongly associated with a fatal CVC outcome. This is in agreement with a NIOSH hazard review on work-related roadway crashes in which, Pratt (2003) reported that the Federal Highway Administration estimates that 15–33% of fatal truck crashes involving the occupant are due to driver fatigue. In addition, truck drivers over 51 years of age and not wearing a safety belt were at increased risk for a CVC fatality.

Sleepiness has historically been a concern for long-haul drivers but has also been reported in short-haul drivers (Hanowski et al., 2003). Hakkanen and Summala (2000) reported that about 40% of Finnish long-haul drivers and 20% of short-haul drivers had trouble remaining alert on at least 20% of their drives. All commercial vehicles (both long-haul and short-haul trucks) were examined in the present study. Semi-trucks, typically used for long hauls, accounted for approximately 60% of case and control commercial vehicle crashes (data not shown).

Motor vehicle collisions due to falling asleep have been estimated to account for 20% of crashes (MacLean et al., 2003) and we found that almost 15% of commercial vehicle fatalities were due to falling asleep or fatigue. When 593 New York long-distance truck drivers were randomly selected and interviewed, 47.1% reported falling asleep at the wheel at some time and 25.4% said they had fallen asleep at the wheel in the past year (McCartt et al., 2000). In another survey of 1249 truck drivers in Connecticut, Florida, Oklahoma and Oregon, 19% responded that they had fallen asleep at the wheel in the preceding month (Braver et al., 1992). Therefore, commercial vehicle driver education should include countermeasures for sleepiness (napping, consuming caffeine, limiting nighttime driving) for both local short-haul and long-distance drivers.

Driver inattention, tiredness and boredom are all symptoms of driver fatigue (Nelson, 1997) but may not be recognized as such by commercial vehicle drivers since fatigue may relieved by time away from the task as well as by sleep. While drivers may be aware of fatigue as a general problem in the transportation industry, they may fail to acknowledge it personally (Arnold et al., 1997; Hakkanen and Summala, 2001). Fatigue is indeed a problem for commercial vehicle drivers and a driver's perception of fatigue as a risk factor for a fatal collision should be addressed in training.

Many studies have assessed strategies for coping with driver fatigue and sleepiness. The most effective strategies may be to nap or to take appropriate breaks (Adams-Guppy and Guppy, 2003) when fatigued. Simulated driving following a 3-h nap demonstrated significant improvement in alertness and performance of professional long-haul drivers (Macchi et al., 2002). Also, Filiatrault et al. (2002) determined that rest-oriented drivers had better sleep quality on the road than drivers who were schedule-oriented. Napping, appropriate breaks and other strategies to reduce fatigue and sleepiness should be also emphasized in driver training programs. It has been suggested that the best method to recognize sleepiness is to increase self-awareness of sleep onset and increase alertness (MacLean et al., 2003).

Our findings show that those drivers who do not use a seat belt increase their odds of a fatal CVC by eight-fold. Based on these results, we recommend that primary safety belt usage laws should be enacted in states that currently have only secondary laws. Safety belt use is increased in those states with primary safety belts laws (CDC, 2004).

States with secondary safety belt laws such as Kentucky typically have lower safety belt usage rates than states with primary safety belt laws (69% versus 80%) (National Center for Statistics and Analysis, 2002). The reported safety belt usage rates of 80% for nonfatally injured commercial drivers may be inflated in this study. In a safety belt usage survey performed by the Kentucky Transportation Center in 2003, the statewide seat belt rate for drivers was 65.2%. In a survey of commercial light-vehicle front seat occupants, the occupant safety belt usage rate was recorded as 55.8% in Michigan, a primary safety belt law state (Eby et al., 2002). In our study, 50% of the drivers involved in a CVC fatality were not wearing their safety belt, which corresponds with the Michigan survey.

Older drivers are at increased risk of a fatal CVC. This finding is consistent with other studies (Bedard et al., 2002;

Janicak, 2003), which examined fatal occupational motor vehicle collisions and single vehicle collisions with fixed objects. We and Bedard et al. (2002) found that drivers over 50 years of age were more likely to be involved in a fatal collision. Decreased reaction time may be one factor responsible for the decreased survival of older drivers. Philip et al. (1999) showed that older drivers (>30 years of age) have decreased simple reaction times relative to those of younger drivers who drove longer hours and were more sleep-deprived than older drivers.

Limitations of this study include the validity of the fatigue and sleep and distraction/inattention variables. In the majority of nonfatal CVCs, these human factors are reported based on the statement of the driver and the judgment of the reporting officer (personal communication, Kentucky State Police), so there could be self-report bias and underreporting. Fatal CVCs are more likely to be fully investigated by a crash reconstructionist who is a police officer, and a final report is submitted based on the impressions of both the investigating officer and the reconstructionist. According to a former Kentucky State Police crash reconstructionist, officers check evidence at the scene of a crash for braking, skid marks, steering, etc. If a crash is fatal and investigated by a reconstructionist, the 24-h history of the driver is reviewed as well. Based on all these data, collision causation factors are recorded. In a study by Stutts et al. (2003), that examined driver risk factors for crashes due to sleepiness, the authors were confident in using the sleepiness variable as identified on collision reports by the investigating officer. Therefore, we are confident in using the human cause variable for analysis of both fatal and nonfatal incidents since both case and control collision reports rely on the judgment of the investigating officer.

Another limitation of the study is the large confidence interval estimate for the fatigue/fell asleep variable. The sample sizes were small in this study so larger studies may obtain a more precise determination of the confidence interval. In a larger case–control study with 467 cases and equivalent numbers of controls, similar confidence intervals were determined by Stutts et al. (2003), when examining the number of hours a driver was awake before a motor vehicle crash, the number of times the driver drove drowsy in the past year, and how sleepy the driver was during the daytime. With these limitations, this case–control study has identified fatigue/sleepiness, distraction/inattention, older age and seat belt usage as factors that increase the odds of a commercial vehicle collision being fatal.

In conclusion, driver fatigue and driver distraction/inattention are primary contributing factors to fatal CVCs in Kentucky. Safety recommendations to address this problem include incorporating recognition and management of fatigue, sleepiness and inattention/distraction into driver safety training, and maintaining alertness on roadways. Strict enforcement of safety belt usage by commercial vehicle drivers is recommended for companies involved in transportation.

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