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Severity Factors for Truck Drivers' Injuries

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A study was carried out in 1995–1999 to assess severity factors for truck drivers' crashes. The authors used data from the trauma registry of road crash victims of the Rhône region, France. Several descriptive characteristics of the victims (age, place of residence) and their crashes (place, time, antagonist, seatbelt wearing) were analyzed. The injuries of 300 male truck drivers were described by body region, and their severity was measured by using the injury severity score comparing these drivers with 9,488 male car drivers (age: 18–67 years). Truck drivers were more seriously injured than car drivers; the odds ratio was 1.87 (95% confidence interval: 1.33, 2.63) for having an injury severity score of 9 or more. Limb and abdominal lesions were more frequent and more serious among truck drivers. The lack of seatbelt wearing by truck drivers was one of the factors that explained the particular severity of their injuries; the odds ratio, adjusted for seatbelt wearing, for truck drivers to be seriously injured was 1.04 (95% confidence interval: 0.73, 1.47) compared with car drivers. When all of the severity factors were taken into account, the risk was even lower, but not significantly so.

accidents; injury severity score; risk factors; seat belts

Abbreviations: AIS, Abbreviated Injury Scale; ISS, injury severity score.

Road crashes during the course of work are the primary cause of occupational fatalities in most industrialized countries. They represent 20–25 percent of fatal work accidents in the United States (1–3) and 30 percent in Canada (4), and they are associated with significant human and economic costs (5). In France, nearly 40 percent of fatal work accidents are road crashes (6, 7). Truck driving is a risky profession in terms of work-related road crashes (2, 8), and truck drivers' crashes are often linked to medical impairment and job loss (9). In a previous study about work-related road crashes (10), police data on road crash casualties were analyzed, and the particular severity of work-related road crashes associated with certain driver professions and also with the types of vehicles driven were underlined. The rate of seatbelt wearing by drivers injured in work-related crashes was analyzed: 74 percent at the wheel of a car, 61 percent at the wheel of a van, and 9 percent at the wheel of a truck. However, the percentage of missing values for this variable was high—14 percent, 22 percent, and 86 percent, respectively. For this reason, it was not possible to conclude that there was an association between crash severity and seatbelt wearing, but the low rate of seatbelt use among truck drivers might have explained the particular severity of their crashes.

Because of the human and economic stakes related to truck crashes, it is important to improve knowledge of the kinds and severity of injuries that truck drivers experience and also to identify the severity factors for these crashes. The registry of road crash victims in the Rhône region of France, which contains information about crash and victim characteristics and also includes a precise description of injuries, was appropriate for such a study. The aim of the present study was to understand the difference in crash severity previously observed between truck and car drivers and to compare their injuries and the severity factors for their crashes.

MATERIALS AND METHODS

Data used

A trauma registry of road crash victims in the Rhône region (population, 1.6 million inhabitants; main city, Lyon) has been operational since January 1995 (11). Any injury victim of a road crash that happened within the Rhône region

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is eligible for inclusion. No matter what type of vehicle is involved, every road accident is reported, including those on roads closed to public traffic. Victims are defined as all persons presenting with at least one injury of a severity level of 1 or more according to the 1990 revision of the Abbreviated Injury Scale (AIS) defined by the Association for the Advancement of Automotive Medicine (12). Data collection is based on the participation of various medical centers involved in the health care of crash victims. The network also encompasses centers that are outside but close to the Rhône region and may, nevertheless, receive eligible victims. Overall, about 100 medical services are involved from private, civil, and military centers dealing with crashes: fire and emergency services, emergency on-site medical care, and emergency and follow-up services (intensive care, surgery, and rehabilitation units). To avoid losing "dead at the scene" cases, mortuaries and forensic institutes are also in the network.

Inclusion in the registry is automatic; however, cooperation from victims and their families is directly requested by means of posters put up in the treatment centers. They are invited to familiarize themselves with the contents of the poster, which asks them to let the medical staff know the place, date, time, and circumstances of their accident and reminds them of their right to refuse to be included in the registry. However, nobody has been known to refuse. To ensure maximum exhaustiveness and quality of the data, the data collection sheet is as simple as possible. The information collected consists of the characteristics of the victim (name, gender, date of birth), the characteristics of the crash (place, date, time, type of collision, road user category), the medical assessment, and the injured person's subsequent progress.

After the data are cross-checked from one source to another, they are coded by a physician in accordance with the 1990 revision of the AIS. All crash data and medical data are computerized for statistical analysis, and all precautions are taken to preserve victim anonymity and confidentiality.

Study design

Data collected in the Rhône registry for crashes occurring from 1995 to 1999 were analyzed with the aim of understanding the difference previously observed between the severity of truck drivers' injuries and those of car drivers. In this article, "truck crashes" are those in which a driver of a truck weighing 3.5 tons or more is injured; "car crashes" refer to those in which a car driver is injured.

Truck crashes and car crashes were described in terms of the following:

1. The drivers' characteristics (age, place of residence).

2. Their crash characteristics (place, time, antagonist, seatbelt wearing). An "antagonist" is the third party involved in the harmful event. It can be another vehicle with which the driver had the collision, or it can be a fixed object. There also might have been no antagonist, which means that no collision occurred (e.g., overturned vehicle).

3. Victims' injuries, described by body region, and their severity measured by using the injury severity score (ISS): the total of the squares of the highest AIS scores for the three body regions injured most severely (12).

Chi-square tests (or Fisher's exact tests when expected frequencies were below 5) were performed to compare truck and car crashes. Only significant differences over a threshold of 5 percent were indicated.

Classic severity factors such as victims' and crash characteristics (age, time and place of the crash, antagonist, seatbelt wearing) were assessed for truck and car drivers. A multivariate analysis using logistic regression was then conducted to point out the predominance of the severity factors identified. For this analysis, quantitative variables were transformed into dummy variables. In this paper, results are shown as odds ratios comparing drivers with an ISS score of 9 or more (case group) with drivers who had an ISS score of less than 9 (control group).

RESULTS

Of the 52,315 road crash victims included in the Rhône registry from 1995 to 1999 who sustained at least one AIS injury (or who died, and no lesion description was included), 368 (0.7 percent) were injured in a truck. Of these 368 victims, 310 (84 percent) were at the wheel of the truck (47 were passengers, and the position in the vehicle was unknown for 11 persons). Of the truck drivers, 300 were males aged 18–67 years. Because of the low number of female truck drivers, the following analysis compared male truck drivers' characteristics with those of the 9,488 male car drivers aged 18–67 years.

Victims and crash characteristics

Age of the victims. Most of the truck drivers were in the age group 25–44 years (table 1). Car drivers differed greatly in their age distribution, 30 percent of the total being aged 18–24 years. The mean age was 36.6 (standard deviation, 10.7) years for truck drivers and 33.3 (standard deviation, 12.3) years for car drivers.

Place of residence. Of the 300 males injured at the wheel of a truck, 57 percent lived in the Rhône region, 19 percent in an adjacent region, 19 percent in another area of France, and 5 percent in a foreign country. In contrast, 87 percent of car drivers lived in the Rhône region, and less than 1 percent of them came from a foreign country.

Crash characteristics. The time of the crash was unknown for only 18 percent of all crashes. When the information was available, 87 percent of truck crashes occurred between 4 a.m. and 6 p.m. versus 70 percent of car crashes. Car crashes were more uniformly distributed during the whole day, whereas truck crashes were distributed with peaks between 8 a.m. and 9 a.m., between 10 a.m. and 11 a.m. (9 percent and 10 percent, respectively), and between 3 p.m. and 4 p.m. (8 percent). No more than 9 percent of truck crashes occurred between 9 p.m. and 4 a.m. compared with 19 percent of car crashes.

Truck crashes were more frequent during the first 5 days of the week, uniformly distributed among the different days. Only 7 percent occurred on Saturdays and 3 percent on Sundays. On the contrary, car crashes occurred more often

TABLE 1. Ages of truck drivers and car drivers injured in a crash, trauma registry of road crash victims in the Rhône region of France, 1995–1999

Age (years)	ISS* < 9		ISS ≥ 9 (or dead)		Total	
	No.	%	No.	%	No.	%
18–24						
Truck drivers	36	92	3	8	39	13
Car drivers	2,606	93	210	7	2,816	30
25–34						
Truck drivers	95	91	9	9	104	35
Car drivers	2,908	94	202	6	3,110	33
35–44						
Truck drivers	71	85	13	15	84	28
Car drivers	1,505	92	132	8	1,637	17
45–54						
Truck drivers	45	82	10	18	55	18
Car drivers	1,065	91	109	9	1,174	12
55–67						
Truck drivers	13	72	5	28	18	6
Car drivers	682	91	69	9	751	8
Total						
Truck drivers	260	87	40	13	300	100
Car drivers	8,766	92	722	8	9,488	100

* ISS, injury severity score.

during weekends. Indeed, 47 percent of them occurred between Friday and Sunday. Crash incidences vary greatly depending on the time of year; 60 percent of the truck crashes occurred between July and December, and a peak occurred during July that accounted for 13 percent of the total versus, for car crashes, 52 percent in July and 8 percent in December.

Truck crashes took place more frequently on highways (expressways included) than car crashes did: 37 percent and 15 percent, respectively. Eighteen percent of truck crashes and 14 percent of car crashes occurred on main or secondary roads, and, respectively, 25 percent and 51 percent took place on streets.

Truck and car crashes differed greatly when we compared their antagonist. In 39 percent of the instances, the truck crash occurred with no antagonist compared with 14 percent for car crashes. The antagonist was also more often a heavy vehicle in truck crashes than in car crashes, 19 percent compared with 6 percent, and less often a car, 28 percent compared with 66 percent.

A seatbelt was worn by only 14 percent of truck drivers compared with 72 percent of car drivers. Moreover, 51 percent of truck drivers did not wear one compared with 15 percent of car drivers. For the other cases, the information on seatbelt wearing was unknown.

General severity and types of injuries

All in all, truck drivers were more seriously injured than car drivers. Indeed, 13.3 percent of them had an ISS score of 9 or more compared with 7.6 percent of car drivers (odds ratio = 1.87, 95 percent confidence interval: 1.33, 2.63). The same was true for their mortality rate: 3.3 percent for truck drivers and 1.5 percent for car drivers. For truck drivers, the most frequent injuries involved the limbs (table 2), followed by the cranium and brain and then the thorax.

Limb lesions were more frequent and more severe in truck drivers than in car drivers. Compared with 5.6 percent of car drivers, 9.3 percent of truck drivers had one or more lesion with an AIS score of 2 or more for lower limbs. Upper limb injuries were more frequent in truck drivers; however, the difference observed in their severity was not significant. Abdominal lesions were more frequent and more severe in truck drivers, 2.7 percent versus 1.2 percent for car drivers, with an AIS score of 2 or more. No significant difference was observed for thoracic injuries between the two groups of drivers. Neck and spine injuries were less frequent in truck drivers.

Severity factors

Univariate analysis. No matter what type of vehicle was driven, a car or a truck, a positive link was found between drivers' ages divided into three age classes (18–34, 35–54, and 55–67 years) and injury severity (table 1).

No difference was observed in the severity of truck drivers' injuries when the place of the crash was considered. Whatever the road category—motorway, road, or urban area—the rate of seriously injured drivers was the same (14–15 percent). On the contrary, for car crashes, a growing

TABLE 2. Abbreviated Injury Scale severity score* for 300 truck drivers and 9,476 car drivers,† trauma registry of road crash victims in the Rhône region of France, 1995–1999

Body region	Severity score (%)						Total		*p* value
	1	2	3	4	5	6	No.	%	
Cranium and brain									
Truck drivers	19.3	6.3	1.3	0.7	0.3	1.0	87	29.0	NS‡
Car drivers	14.7	8.4	1.0	0.7	0.3	0.3	2,410	25.4	
Face									
Truck drivers	17.3	1.0	0.3				56	18.7	NS
Car drivers	18.7	1.7	0.1	0.1			1,945	20.5	
Neck									
Truck drivers	7.7		0.3				24	8.0	<0.01
Car drivers	14.5	0.1				<0.1	1,379	14.5	
Thorax									
Truck drivers	16.3	1.7	2.0	1.0	0.7	0.3	66	22.0	NS
Car drivers	17.1	2.5	1.1	0.7	0.3	0.4	2,079	21.9	
Abdomen									
Truck drivers	9.7	1.0	0.7	1.0			37	12.3	<0.01
Car drivers	4.8	0.5	0.3	0.2	0.1	<0.1	563	5.9	
Spine									
Truck drivers	16.0	3.0	1.3				61	20.3	<0.01
Car drivers	26.5	2.2	0.2	<0.1	0.1	<0.1	2,747	29.0	
Upper limbs									
Truck drivers	26.3	7.0	1.3				104	34.7	<0.01
Car drivers	18.8	5.3	1.0				2,374	25.0	
Lower limbs									
Truck drivers	28.3	4.7	4.7				113	37.7	<0.01
Car drivers	16.6	3.6	1.9	0.1	<0.1		2,102	22.2	
External region§									
Truck drivers	8.3						25	8.3	<0.01
Car drivers	2.4				<0.1	0.1	238	2.5	

* Highest score for each body region.
† Information on body lesions was unknown for 12 car drivers.
‡ NS, not significant.
§ Specific Abbreviated Injury Scale term that includes several regions, especially the skin.

severity was observed among urban areas, motorways, and main roads: 5 percent, 10 percent, and 17 percent, respectively.

Seatbelt use is a protective factor. None of the 41 belted truck drivers was seriously injured, whereas 14 percent of the nonbelted drivers were. When this information was unknown, 18 percent had an ISS score higher than 9. For car drivers' crashes, the figures were 5 percent, 14 percent, and 15 percent, respectively. The most critically injured seatbelted truck driver had an ISS score of 6.

When the antagonist of the truck was a car, 8 percent of truck drivers were seriously injured compared with 10 percent when there was no antagonist, 14 percent when the other vehicle was a heavy vehicle, 32 percent when the antagonist was a fixed object, and 29 percent when the antagonist was unknown. When the antagonist of the car was another car, 6 percent of car drivers were seriously injured compared with 8 percent when there was no antagonist, 16 percent when the other vehicle was a heavy vehicle, 17 percent when the antagonist was a fixed object, and 11 percent when the antagonist was unknown.

All of the crashes were more serious between 12 a.m. and 6 a.m. (24 percent of serious crashes compared with 14 percent during the rest of the day for truck drivers; 14 percent and 8 percent, respectively, for car drivers). However, the difference was significant for car drivers' but not for truck drivers' crashes, probably because of the low frequencies of crashes during these hours.

Multivariate analysis. When the type of vehicle and seatbelt wearing were included in the model, the odds ratio for truck drivers, compared with car drivers, being seriously injured was 1.04 (95 percent confidence interval: 0.73, 1.47).

TABLE 3. Injury severity* associated with truck drivers' and car drivers' crashes determined by logistic regression analysis, trauma registry of road crash victims in the Rhône region of France, 1995–1999

	Odds ratio	95% confidence interval
Age (years)		
55– 67	1.71	1.30, 2.25
35–54	1.46	1.23, 1.73
18–34	1	
Seatbelt use		
No	2.81	2.31, 3.41
Unknown	3.18	2.62, 3.86
Yes	1	
Antagonist†		
Fixed obstacle	3.03	2.47, 3.74
Heavy vehicle‡	3.04	2.35, 3.94
Other/unknown	1.75	1.21, 2.51
No antagonist	1.16	0.93, 1.46
Light vehicle	1	
Road category		
Highway	1.70	1.38, 2.59
Road	3.51	2.91, 4.22
Urban area		
Time of crash		
12 a.m.–5:59 a.m.	1.83	1.49, 2.25
6 a.m.–11:59 p.m.	1	
Driver vehicle		
Truck	0.74	0.51, 1.07
Light vehicle	1	

* Injury severity score of ≥9.
† The third party involved in the harmful event.
‡ Truck weighing ≥3.5 tons, bus, tractor.

Interestingly, when all of the different severity factors identified were taken into account (age, antagonist, time and place of the crash, and seatbelt wearing), the difference observed between the two vehicle types was even lower but not significant. Indeed, the odds ratio for truck drivers compared with car drivers was 0.74 (95 percent confidence interval: 0.51, 1.07) (table 3). In this last model, the interactions between vehicle type and the other variables were tested and were found not to be significant.

DISCUSSION

The qualities of the Rhône registry have been demonstrated in previous analyses; indeed, this registry is almost exhaustive (11, 13, 14). Information on the crash is provided by the patients or their families. However, it would not be possible to complete the medical information by using the police data corresponding to the crash because police data on road crash casualties are less exhaustive than the Rhône registry data. Actually, a study comparing the Rhône registry data with the police data on road crash casualties for the year 1996 showed important selection bias in the police data as a result of underreporting (14). In that year, the police data reported 4,572 victims and the registry 10,202. Following the police data and registry linkage process, 2,994 victims were determined to be common to both databases. From these numbers, evaluation of the completeness of the data sources could be attempted by means of the capture-recapture method, but a number of requirements for this method cannot be achieved, especially the independence. Given that data are collected not only in all hospitals but also by all of the health care organization chain, we are quite confident that we collected data on all road fatalities and severely injured people. In other words, people missing from the registry and recorded by the police are mainly those whom the police consider slightly injured, which can mean that these people either are under the severity threshold of AIS 1 required to be included in the registry or have been taken care of by their general practitioner (or other health care people). A specific study concerning this item is currently in progress and has not yet been published. This severity criterion is, at any rate, the only bias we identified to explain the fact that these persons were recorded by the police and not by the registry. On the contrary, three biases were identified to explain why they were recorded by the registry and not by the police: underestimation is significantly dependent on injury severity and on the type of road user (maximum for pedal cyclists), and it is higher when there is no third party. Overrepresentation of severely injured persons described in other trauma registries, focused mainly on inpatients, is not a bias observed in the Rhône registry, which also includes outpatients (15).

Information on seatbelt wearing is usually difficult to collect. For example, in the police data on road crash casualties, the information is often missing, making any analysis of the link between crash severity and seatbelt wearing more difficult (10). In the present study, this information was known for 65 percent of the truck drivers and 87 percent of the car drivers, enabling us to perform a multivariate analysis. The difference observed in missing information between truck and car drivers may be explained by the lack of seatbelt equipment in many trucks.

In the analysis, missing data on seatbelt wearing were given the value "unknown" so we could assess the severity of this category of crashes and compare it with the others. In fact, the risk of serious injury was very similar for this unknown group and the group of unbelted drivers. This study based on an exhaustive census of victims of road crash injuries permitted us to assess the effect of seatbelt wearing on injury severity, but, because no uninjured drivers were included, it was impossible to assess the effect on preventing injuries. The aim of the study was to understand the difference previously observed between the severity of truck drivers' injuries and those of car drivers, that is, to find factors to explain the greater severity of truck drivers' injuries (when they are injured). For this reason, we did not study safety factors such as drivers' medical condition, driver fatigue, or other items known to be risk factors for being involved in a crash. To be included in the registry, the main

criterion is to have been injured (AIS score of 1 or more), and the type of user is not considered. Thus, the probability of being included is not linked with the type of vehicle driven, ruling out this type of selection bias. However, because no uninjured drivers are in the registry, we could not assess the ability of the truck to protect the driver. The same is true for car drivers, for whom type and weight of the vehicle can also influence injury severity, including the absence of any injuries.

Because of the large proportion of workers who were truck drivers, most of the truck drivers included in this study were aged 25–44 years, and car drivers were younger (mean ages, 36.6 and 33.3 years, respectively). For the same reason, truck crashes took place during working hours and were proportionally less frequent than car crashes at night.

Truck crashes and car crashes differed greatly when their antagonists were compared. Truck crashes more often were associated with no antagonist or occurred with another heavy vehicle. Few studies have been published on truck drivers' injuries. A comparison can be made with a study by Bylund et al. (9) in Sweden of workers with a medical impairment injured in a road crash during work time. Nearly a third of those traveling in heavy trucks were injured in a collision with another heavy vehicle. Single crashes accounted for more than one quarter of all injuries.

In the present study, limb injuries were more frequent in injured truck drivers than in car drivers. Indeed, 34.6 percent of truck drivers had upper limb injuries, and 37.7 percent had lower limb injuries. On the contrary, injuries involving the neck, face, and external region (specific AIS term that includes several regions, especially the skin) were less frequent in drivers of heavy vehicles than in car drivers. In the Bylund et al. study (9), similar results were observed: 23 percent of the single lesions were lower limb injuries in drivers of heavy vehicles versus 14 percent in car drivers. For upper limb injuries, the figures were 20 percent and 10 percent, respectively.

In our study, injuries were more severe for victims injured while driving a truck. In the Bylund et al. study (9), the proportion of persons who sustained moderate or severe injuries (M(maximal)AIS ≥ 2) was also lower for those driving cars compared with heavy vehicles—40 percent and 63 percent, respectively. The authors pointed out a low frequency of seatbelt use among truck drivers and also among other occupational drivers, all exempt from the seatbelt law. Eighty percent of the car drivers wore their seatbelts compared with very few of the truck drivers. For Bylund et al., the low rate of seatbelt use could explain the great severity of injury in truck crashes. A truck's cabin design places drivers near the front, which could also contribute to the particular severity of truck drivers' injuries, especially if they do not wear a seatbelt. In fact, we identified the highest severity of truck crashes when drivers did not wear their seatbelts. The most severely injured belted truck driver had an ISS score of 6; none of the drivers who were belted died. Many studies have focused on the effectiveness of seatbelts regarding severe injuries or death from traffic crashes (16–18). However, few of them distinguished the rate of seatbelt wearing among truck drivers. Evans (17) reported recruitment biases in the analysis of crash severity; unbelted drivers may be involved in more severe crashes because of other risky habits such as speeding. This finding suggests that the association between lack of seatbelt use and injury severity might be confounded by drivers' behaviors. The behavioral factor also could have influenced the present study results. Even if we took into account several factors that influenced injury severity, such as driver age and type of collision, risky behavior by unbelted truck drivers was not distinguished in this analysis.

The impact that large trucks have on crash severity has been shown in the crash analysis literature (19), but the authors did not focus on the specific severity of truck drivers' injuries. When the results concerning the severity of injuries were analyzed, the Rhône registry showed the particular severity of truck drivers' crashes. However, our study demonstrated that the main part of the difference regarding the severity of the injuries of car and truck drivers can be explained by seatbelt wearing. Furthermore, when we adjusted on age, antagonist, time and place of the crash, and seatbelt use, the odds ratio of truck versus car drivers for severe injury patterns was less than one, but not significantly so. This finding could mean that a belted truck driver could be less vulnerable than a belted car driver given the same crash conditions.

The low rate of seatbelt use could be a factor in explaining the difference in the injuries suffered by truck drivers compared with car drivers resulting in a higher rate of limb and abdominal injuries. For a long time, French legislation has imposed seatbelt wearing for drivers of vehicles weighing up to 3.5 tons. Until now, drivers of trucks weighing more than 3.5 tons were allowed to drive without wearing a seatbelt. In May 2003, French legislation changed; these drivers will now have to wear a seatbelt. However, because seatbelt equipment was not obligatory for new heavy trucks and buses until 1997, when a European law required seatbelt equipment for heavy vehicles (all new ones were required to be equipped beginning in 2002), old vehicles still have no seatbelts.

Conclusion

Trucks have been identified as being dangerous for other road users (19, 20); moreover, professional driving is also a high-risk occupation. This study confirmed the particular severity of truck drivers' road injuries and identified specific severity factors: driver age, type of antagonist, and lack of wearing seatbelts. These severity factors enabled us to explain the greater severity of truck drivers' injuries compared with those of car drivers. Safety devices have been recommended for a long time (21) but are still misused, and more could be done to improve truck drivers' safety.

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