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The Safety Profile of Work-Related Trucks

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The National Truck Equipment Association

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16. Abstract

This report is an investigation into the safety profile of work-related trucks which includes dump, garbage/refuse, tow/wrecker, cement mixer, utility, and many other single unit vocational trucks. Statistics are presented comparing work trucks to tractor semitrailers, straight truck vans, and passenger cars. Five years (1997-2000, 2002) of fatal crash counts are taken from the Trucks Involved in Fatal Accidents database. Fatal crash counts in 2002 for passenger cars are derived from the Fatality Analysis Reporting System data file. Vehicle miles traveled (VMT) data for trucks are taken from the 2002 Vehicle Inventory and Use Survey, while VMT data for passenger cars are derived from reports published by the Federal Highway Administration. Crash involvement rates per 100 million VMT are calculated and compared among different vehicle types. In addition, fatal crash statistics are presented comparing work trucks, straight truck vans, tractor semitrailers, and passenger cars with respect to road and environment characteristics, vehicle characteristics, and driver characteristics.

Based on VIUS VMT, the average annual crash involvement rate for all trucks (class 3 and above) was 3.54. Dump trucks had the highest crash involvement rate (5.96). The rate for garbage/refuse trucks was 5.12, while the rate for tractor semitrailers was 3.63. Straight truck vans had one of the lowest rates (2.09). While fatal crash involvement rates for some of the work trucks appear to be high, aggregated rates do not take into account the kinds of roads that work trucks typically traveled on. Dump trucks accumulated 80% of travel on local trips (50 miles or less), while semitrailers accumulated only 15.8% of travel on local trips. After stratification by trip type, it is shown that rates for many work trucks are comparable to, and in some cases lower than, the rate for semitrailers. On trips greater than 50 miles the rates for dump trucks and garbage/refuse trucks were 2.90 and 1.90, respectively, while the rate for semitrailers was 3.29

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The Safety Profile of Work-Related Trucks

1. Introduction

This study is an investigation into the safety profile of work-related trucks. Work trucks include dump, garbage/refuse, tow/wrecker, cement mixer, utility, and many other single unit vocational trucks. This investigation focuses on a comparison of work trucks, straight truck vans, tractor semitrailers, and passenger cars that were involved in fatal crashes. Comparisons are made and descriptive statistics are presented covering a broad range of topics related to the environment, the vehicle, and the driver. In addition, statistics related to accident type and injury severity are presented. One of the features of this study, that distinguishes it from other published work, is the calculation and comparison of fatal crash involvement rates between many work truck configurations, straight truck vans, tractor semitrailers, and passenger cars.

The unique resource that makes this study possible is the Trucks Involved in Fatal Accidents (TIFA) database. Descriptive statistics and crash involvement rates for all large trucks, passenger cars, and light trucks and vans appear in other documents (see, for example, [1], [2], or [3]). However, none of those publications present analyses of trucks that are broken down by body styles that are representative of work-related trucks that are specific to this study. The TIFA database contains a body style variable that permits classification of straight trucks into categories such as dump, garbage/refuse, tow/wrecker, tank, pole/logging, service/utility, straight truck van, and many other straight truck body styles. To be included in the TIFA database, owners or drivers of vehicles were actually contacted to confirm and supplement the information contained in police accident reports. No other database contains a level of information about medium and heavy trucks (class 3 and above) that were involved in fatal crashes.

The first part of the study is a comparison of work trucks, straight truck vans, tractor semitrailers, and passenger cars with respect to road and environment characteristics, vehicle characteristics, and driver characteristics. In terms of road and environment characteristics, barplots are presented that display distributions of road type, trip type, land use (rural and urban), speed limit, and time of day (day and night). For vehicle characteristics, descriptive plots are presented that compare Gross Vehicle Weight Rating (GVWR), gross weight, rollover status, and fire occurrence. For driver characteristics, graphical plots are used to compare vehicle types by restraint use, blood alcohol content (BAC), previous driver speeding convictions, and driver age.

In addition to descriptive statistics concerning the environment, the vehicle, and the driver, the accident type and injury severity are also investigated. An accident type variable is used to compare truck types based on the position and relative motion of the vehicles prior to the crash. Single-vehicle crashes are distinguished from multiple-vehicle crashes. For some accident types, fault can be inferred. For example, in head-on collisions this variable is used to identify which vehicle came across the center line. In rear-end crashes it is used to identify which vehicle was the striking vehicle and which vehicle was struck. Comparisons based on other accident types such as sideswipe and crossing paths accidents are presented.

Injury severity is compared among work trucks, straight truck vans, and tractor semitrailers. Statistics for injury severity are broken down by persons inside the truck as well as outside the truck. Occupants inside the truck include drivers and passengers. Persons outside the truck include drivers and passengers in other vehicles, and nonmotorists such as pedestrians and bicyclists.

The second part of the study focuses on the calculation of fatal crash involvement rates. Counts of trucks and passenger cars and travel data are taken from transportation-related databases. Rates are compared per 100 million vehicle miles traveled. Aggregated rates are presented by vehicle type, and then rates are calculated that are stratified by trip type (trips less than or equal to 50 miles and trips greater than 50 miles). It is shown that aggregated rates can be misleading since they do not account for the different kinds of road types that different vehicles traveled on.

In a previous study, crash rates for heavy truck-tractors in Michigan were investigated using road type, vehicle type, time of day, and land use (rural and urban) as explanatory variables [4]. In that study it was found that road type had the largest effect on the magnitude of crash rates. Depending on the road type, rates varied by a factor of up to 6.8. Land use, time of day, and vehicle type had much smaller effects. In another study, fatal crash rates were found to be substantially different based on road type and time of day [5]. These findings demonstrate the importance of adjusting accident rates for risk factors known to be associated with accident involvement.

Finally, although not as straightforward, a crash involvement rate for passenger cars is calculated and compared to rates for various work trucks, straight truck vans, and semitrailers. The reason the comparison is not as straightforward is due to the calculation of rates from different data sources. Based on available data for trucks between the two sources, an adjusted fatal crash involvement rate for passenger cars is calculated. The report concludes with a summary and discussion of the major findings of this study.

All findings and results pertaining to work trucks in this study are confined to vehicles with Gross Vehicle Weight Ratings (GVWR) greater than 10,000 lbs (class 3 and above). While much interest exists concerning the safety profile of vehicles that are produced in two or more stages (multistage vehicles) that have GVWR less than or equal to 10,000 lbs, identification and extraction of these vehicles from publicly available transportation-related databases is not straightforward. Information about GVWR is often not consistently recorded for light trucks. In fact, previous studies regarding the safety performance of multistage vehicles are difficult to find, regardless of GVWR. A search of the University of Michigan Transportation Research Institute's library on keywords such as *work trucks*, *vocational trucks*, or *multistage trucks*, resulted in zero matches. Many studies were found concerning light trucks, but these were mostly confined to pickup trucks, passenger vehicle vans, or SUVs.

As a result, inferences should only be applied to medium and heavy trucks (class 3 and above) that were identified in this study. Inference does not necessarily apply to vehicle types outside the range of the data presented here, such as multistage vehicles. Furthermore, comparisons between trucks and passenger cars do not necessarily apply to multistage vehicles for which data are not presented.

2. Description of Data

Data for this study were derived from a variety of available transportation-related data sources. The crash databases contain records of vehicles that were involved in fatal crashes. Exposure data for calculating crash involvement rates were taken from data sources in which vehicle miles traveled (VMT) information is published.

2.1 Trucks Involved in Fatal Accidents (TIFA) Files

Fatal crash data for all trucks are taken from the Trucks Involved in Fatal Accidents (TIFA) data files [6, 7]. Five years of data (1997-2000, 2002) have been accumulated to provide statistically reliable results. This database is an accident file of all medium and heavy trucks (class 3 and above) in which each record corresponds to one truck that was involved in a fatal crash in the United States. A detailed description about each truck is recorded that includes information related to the vehicle, the roadway, and the driver. Information such as cargo body type, gross vehicle weight rating (GVWR), road type, area of operation, time of day, and previous driver convictions can be determined. A fourteen level body style variable in conjunction with a text description can be used to identify various vocational trucks of interest such as dump trucks, garbage/refuse trucks, cement mixers, tow trucks, service/utility vehicles, and many other straight truck body styles.

The TIFA data files are maintained by the Center for National Truck and Bus Statistics at the University of Michigan Transportation Research Institute. These files are designed to be census files, but two years (1997, 1998) were probability samples where approximately sixty percent of all fatal crashes were sampled, and weights were assigned to permit calculation of national estimates. Years 1999, 2000, and 2002 were census years.

2.2 Vehicle Inventory and Use Survey (VIUS)

Travel data for all trucks are taken from the 2002 Vehicle Inventory and Use Survey (VIUS) [8]. The VIUS provides data on the physical and operational characteristics of the nation's truck population. This survey is conducted every five years as part of the economic census under the authority of the U.S. Census Bureau and is a sample survey of private and commercial trucks registered (or licensed) in the United States. VIUS contains information related to various straight truck body styles such as dump, garbage/refuse, cement mixers, tow/wrecker, service/utility, flatbed, tank, and pole/logging trucks. Straight truck vans and tractors with one, two, or three trailers can be identified. The travel data in VIUS (class 3 and above) can be matched to counts of fatal crashes in the TIFA database to calculate crash involvement rates.

2.3 Fatality Analysis Reporting System (FARS) Files

The Fatality Analysis Reporting System (FARS) is a collection of files documenting all qualifying fatal crashes that occurred within the United States [9]. This database is used in this study to gather information regarding passenger cars involved in fatal crashes. To be included in this census of crashes, a crash had to involve a motor vehicle traveling on a trafficway customarily open to the public, and must result in the death of a person (driver, passenger, or nonmotorist) within 30 days of the crash. This database consists of several separate files including a vehicle file, a person file, and an accident file, along with several other files that have been added to the collection over the years. The FARS crash data are collected by the National Center for Statistics and Analysis under the authority of the National Highway Traffic Safety Administration (NHTSA).

2.4 Vehicle Miles of Travel – Federal Highway Administration (FHWA)

Vehicle miles of travel data for cars and trucks are reported as part of the Highway Statistics Series and Traffic Volume Trends produced by the Federal Highway Administration (FHWA) [10]. Annual vehicle miles traveled (VMT) estimates are based on travel reported by the various states to the FHWA Highway Performance Monitoring System. The Traffic Volume Trends program makes monthly estimates of the change in the nation's highway travel using data from continuous counters operated by the states.

In this study, fatal crash involvement rates are calculated in order to compare rates between vocational trucks, other truck types, and passenger cars. This comparison is acknowledged to be less direct than the comparison among trucks using VIUS data. This is because there is no common source of travel estimates for vocational trucks, all trucks, and passenger cars. VIUS provides VMT estimates to calculate rates for vocational trucks and all trucks, but not passenger cars. Travel estimates from the FHWA can be used to calculate crash rates for all trucks and passenger cars, but not vocational trucks. A procedure is developed to compare rates across the two VMT sources, using fatal crash rates for all trucks as the link.

2.5 A Note Concerning Other Data Sources, Multistage Vehicles, and Gross Vehicle Weight Rating (GVWR)

In this study, the TIFA database is used exclusively to count numbers of trucks involved in fatal crashes (class 3 and above), and the FARS database is used to count the number of passenger cars involved in fatal crashes. In addition to the sources of data described in this study for identifying trucks involved in crashes, other sources of data exist that contain information about truck crash involvement. For example, in the FARS database, trucks can be identified, but the TIFA database is regarded as more complete and accurate since owners or drivers of vehicles were actually contacted to confirm and supplement the information contained in police accident reports. For example, based on the 2002 FARS database, the number of trucks (class 3 and above) involved in fatal crashes was 4,587 [1]. Based on the 2002 TIFA database, the number was 4,950. Therefore, based on confirmation and follow-up of cases, 363 additional trucks were identified in the TIFA file.

In addition, the TIFA database contains additional survey variables, not contained in the FARS database that are extremely important in addressing differences between work trucks, tractor semitrailers, straight truck vans, and passenger cars. Some of these variables include accident type, trip type, gross weight, and straight truck body style. In fact, this study demonstrates that many fatal involvement rates for work trucks were comparable to, and in some sense lower than, involvement rates for tractor semitrailers when rates were stratified by trip type. This analysis would not have been possible using FARS data alone. Furthermore, the GVWR variable recorded in the TIFA database was used in this study since it is regarded as more complete than the one recorded in the FARS file.

With respect to multistage trucks that are produced in two or more stages, certain vehicles such as cab chassis based trucks can be identified in the FARS database, but it is difficult to confirm whether GVWR is less than or equal to 10,000 lb since GVWR is not recorded consistently for light trucks. A body type variable is recorded making it possible to identify *candidate* multistage vehicles, but for the majority of those cases, GVWR cannot be confirmed using the GVWR variable alone. For example, three years of FARS data (2000-2002) were combined and only 41 vehicles could be identified with GVWR less than or equal to 10,000 lb using the GVWR variable. Based on body type, 175 vehicles appear to be candidate light trucks, but in the absence of additional information, it is difficult to confirm the actual GVWR. Of these 175 vehicles, 66 are cab chassis based, 20 are categorized as construction equipment, 14 are pickup trucks, and 7 are categorized as farm equipment. Moreover, 50 of the vehicles are single unit trucks with unknown GVWR and the remaining trucks are categorized as unknown light vehicles for which GVWR cannot be confirmed. While GVWR seems to be coded inconsistently for vehicles with GVWR less than or equal to 10,000 lbs, this is not the case for medium and heavy trucks. Cross-tabulations of body type and GVWR for trucks designated class 3 and above provide consistent and verifiable results.

One possible solution for identifying vehicles of interest would be to construct a list that defines the make, model, year, and possibly the VIN for vehicles to be studied. These vehicles could be identified more readily as meeting certain criteria. However, since multistage vehicles are often modified after leaving the primary manufacturer, even this method of identifying multistage vehicles with GVWR less than or equal to 10,000 lb is not straightforward.

Another publicly available database that contains records of trucks involved in crashes is the National Automotive Sampling System (NASS) General Estimates System (GES) database [11]. These data are collected by the National Center for Statistics and Analysis (NCSA) under authority of the National Highway Traffic Safety Administration (NHTSA). This survey is a complex sample survey that includes clustering (PSUs), stratification, and probability weights for calculating national estimates. Unlike TIFA and FARS, which are intended to be census files of all fatal involvements, the GES database is a probability sample that contains records for all injury severity levels.

In the GES database, which was not used in this study, a body type variable is recorded for identifying some trucks; however, there are no provisions for accurately identifying multistage vehicles. There is one category for cab chassis based trucks, which includes rescue vehicles, light stake, dump and tow trucks. However, dump trucks and tow trucks cannot be separated using this variable, for example. In addition, a category is defined in which light trucks are combined with automobiles and pickup trucks, but there appear to be no provisions for separating multistage vehicles from this category.

3. Comparison of Fatal Crash Statistics

In this section, TIFA and FARS data are used to present descriptive statistics and plots for vehicles involved in fatal crashes. TIFA data are used to present statistics and plots for three different truck configurations: work trucks, straight truck vans, and tractor semitrailers. FARS data are used to present statistics and plots for passenger cars. The goal is to determine how fatal crashes involving these four configurations differ with respect to road and environment characteristics, vehicle characteristics, and driver characteristics.

Table 1 provides frequencies and percentages of body styles classified as work trucks using five years of data taken from the TIFA survey. Dump trucks were involved in the highest percentage of fatal work truck crashes (36.9%), accounting for more than twice as many involvements as any other body style. In terms of percentages, the top five body styles (dump, flatbed, garbage/refuse, tank/dry/liquid, and tow/wrecker) accounted for 80.3% of all fatal involvements shown in Table 1. The Other category, which accounted for 108 (1.9%) work truck fatal involvements includes more than thirty different body styles, each with a count of fewer than ten.

Table 1 Frequencies and Percentages of Body Styles Classified as Work Trucks. (TIFA 1997-2000, 2002)

Body style	N	%
Dump	2,090	36.9
Flatbed	1,042	18.4
Garbage/refuse	573	10.1
Tank/dry/liquid	433	7.6
Tow/wrecker	413	7.3
Service/utility	404	7.1
Cement mix/pump	279	4.9
Auto carrier	110	1.9
Pole/logging	95	1.7
Drill Rig	29	0.5
Chassis	25	0.4
Sweeper	21	0.4
Vacuum	12	0.2
Spreader	12	0.2
Glass rack	11	0.2
Crane	10	0.2
Other	108	1.9
Total	5,667	100.0

Table 2 provides counts of all trucks involved in fatal crashes for five years. The number of involvements is fairly consistent over the years. Annually, about 5,200 medium and heavy trucks are involved in fatal crashes. As shown, tractor semitrailers accounted for approximately 3,000 per year, representing roughly 60% of all trucks involved in fatal crashes. For the five years shown, work trucks were involved in 5,667 fatal crashes, while straight truck vans were involved in 1,950. In year 2002 there appears to have been slight decreases in the numbers of involvements for work trucks, straight truck vans, and semitrailers compared to previous years, and a slight increase in the Other category. The Other category includes, for example, tractors pulling two or more trailers, and trucks of unknown configuration.

Table 2 Trucks Involved in Fatal Crashes by Year. (TIFA 1997-2000, 2002)

	Number of trucks involved in fatal crashes					
Vehicle Type	1997	1998	1999	2000	2002	Total
Work truck	1,131	1,165	1,172	1,202	997	5,667
Straight truck van	395	382	417	405	351	1,950
Semitrailer	3,020	3,094	3,159	3,164	2,877	15,314
Other	584	557	485	504	725	2,855
Total	5,130	5,198	5,233	5,275	4,950	25,786

In 2002, 27,374 passenger cars were involved in fatal crashes. A passenger car is defined according to the definition published in the *FARS Analytic Reference Guide* (2002). It includes convertibles, sedans, coupes, hatchbacks, station wagons, and several other body types. Table 3 shows frequencies and percentages of passenger cars involved in fatal crashes in 2002.

Table 3 Frequencies and Percentages of Passenger Cars Involved in Fatal Crashes (FARS 2002)

Body type	N	%
Convertible	419	1.5
2 door sedan/hardtop/coupe	6,280	22.9
3 door / 2 door hatchback	1,608	5.9
4 door sedan / hardtop	17,445	63.7
5 door / 4 door hatchback	277	1.0
Station wagon	824	3.0
Hatchback / unknown doors	31	0.1
Sedan / hardtop / unknown doors	32	0.1
Other / unknown auto type	413	1.5
Auto pickup	43	0.2
Auto panel	2	0.0
Total	27,374	100.0

3.1 Road and Environment Characteristics

The National Highway System (NHS) includes the Interstate Highway System as well as other roads important to the nation’s economy, defense, and mobility. It includes other principal arterials, the Strategic Highway Network, and other intermodal connectors. The NHS was developed by the Department of Transportation (DOT) in cooperation with the states, local officials, and metropolitan planning organizations.

Figure 1 is a barplot displaying the percentages of vehicles involved in fatal crashes that occurred on the NHS. Of the four vehicle types shown, semitrailers experienced the highest percentage (62.3%) of fatal crash involvement on the NHS. In fact, it is the only vehicle type with a percentage greater than 50%. For straight truck vans the percentage was 44.2%, while the percentage for work trucks was 32.5%. The percentages for passenger cars were very similar to those shown for work trucks. The results shown in Figure 1 suggest that, compared to work-related trucks, semitrailers and straight truck vans tended to be involved in crashes on roads that are considered to be among the safest. Results such as these are taken into account when calculating crash involvement rates in Section 6.

Figure 1 Percentages of Fatal Crash Involvement on the National Highway System by Vehicle Type. (TIFA 1997-2000, 2002, FARS 2002)

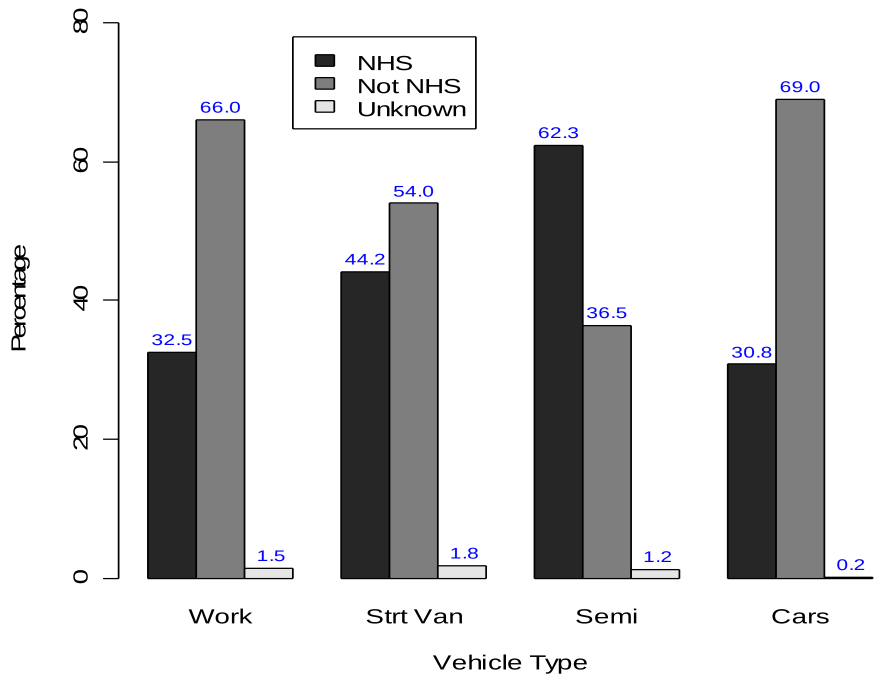
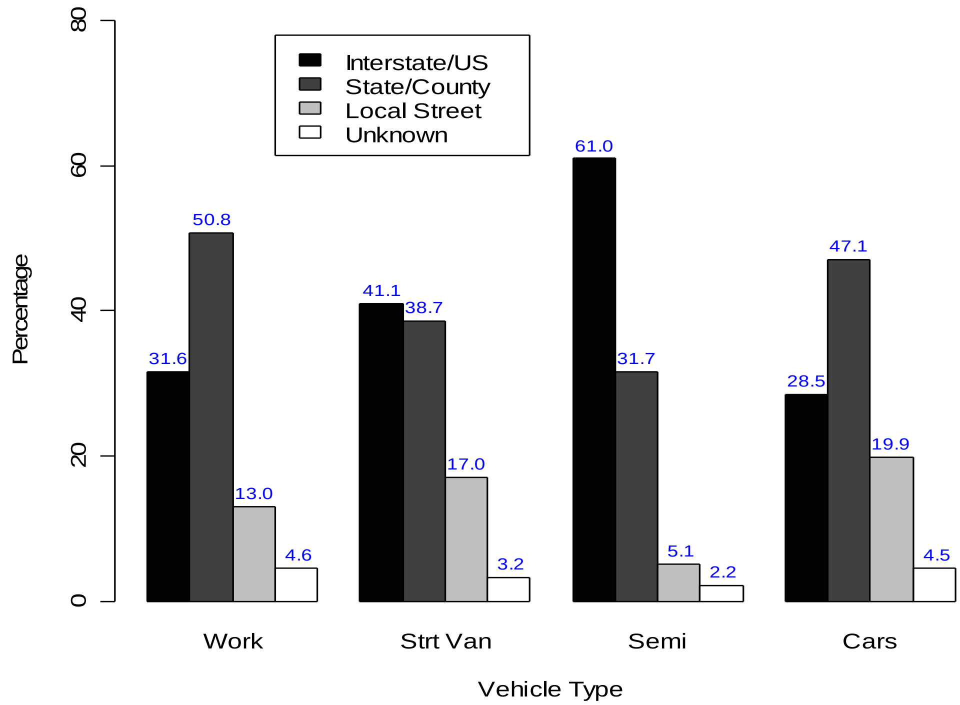


Figure 2 confirms the results shown in Figure 1, except in a little more detail. In Figure 2, fatal crash involvement for the four vehicle configurations is broken down by route signing. The interstate/US highway percentages (31.6, 41.1, 61.0, 28.5) are almost identical to the NHS percentages (32.5, 44.2, 62.3, 30.8) shown in Figure 1. However, Figure 2 is further broken down by state/county roads and local streets.

Approximately half (50.8%) of work truck fatal crash involvements occurred on state/county roads, while 13% occurred on local streets. The situation for straight truck vans appears to be intermediate between the results shown for work trucks and semitrailers. For straight truck vans, 41.1% of involvements occurred on the interstate/ US highway system, while 38.7% occurred on state/county roads. Passenger cars and straight truck vans had the highest percentages of involvement on local streets (19.9% and 17.0%, respectively). Semitrailers had the highest percentage of fatal crash involvement on interstate/US highways (61.0%), and the smallest percentage of fatal crash involvement on local streets (5.1%). The percentages for passenger cars are comparable to those of work trucks, except that passenger cars had a slightly higher percentage of involvement on local streets (19.9%).

Figure 2 Percentages of Fatal Crash Involvement by Route Signing and Vehicle Type. (TIFA 1997-2000, 2002, FARS 2002)



The trip type variable is a truck specific variable that is coded in the TIFA survey. Data for this variable are available for trucks, but not for passenger cars since it is not coded in the FARS survey. Figure 3 shows percentages of fatal crash involvement broken down by trips that were local (trips less than or equal to 50 miles), and trips that were not local (trips greater than 50 miles). The percentages are somewhat masked due to missing data (work trucks, 24.9%; straight truck vans, 32.4%; semitrailers, 17.0%), but certain patterns emerge. Work trucks were most likely to be involved in fatal crashes on local trips (62.3%), while semitrailers were most likely to be involved on trips greater than 50 miles (63.3%). Straight truck van percentages were distributed more evenly between the two categories.

One question of interest is whether work trucks were more likely than other vehicle configurations to be involved in fatal crashes at intersections. The TIFA and FARS data files contain a relation to junction variable that can be used to investigate this question. Figure 4 shows percentages of fatal crash involvement that describe where fatal crashes occurred in relation to an intersection. The largest differences appear to have occurred between work trucks and semitrailers. Work trucks were most likely to be involved at an intersection (30.6%), while semitrailers were least likely to be involved at an intersection (21.8%). The distributions for straight truck vans and passenger cars tend to be intermediate between those for work trucks and semitrailers.

Figure 3 Percentages of Fatal Crash Involvement by Trip Type and Vehicle Type. (TIFA 1997-2000, 2002)

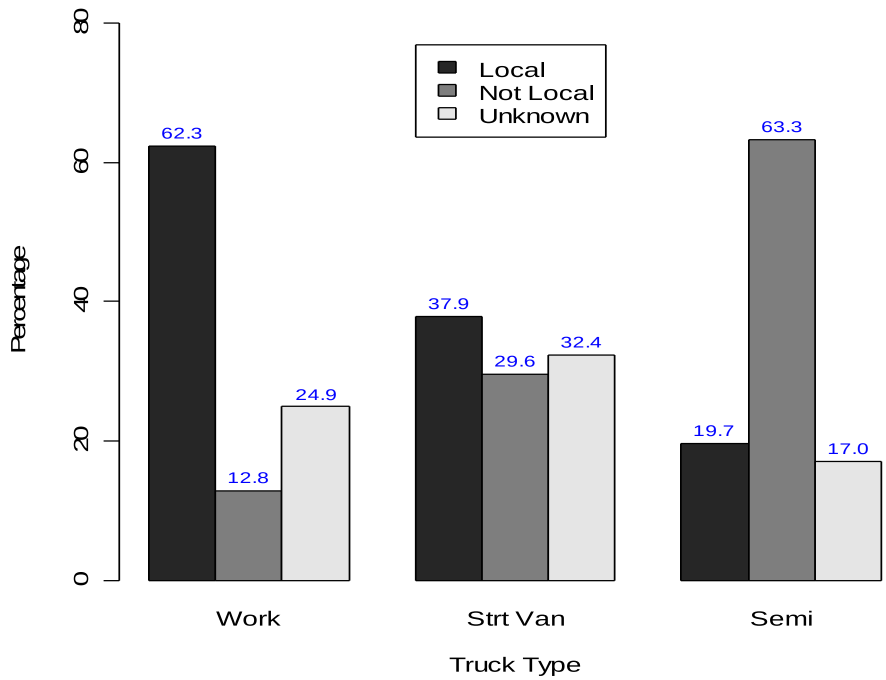
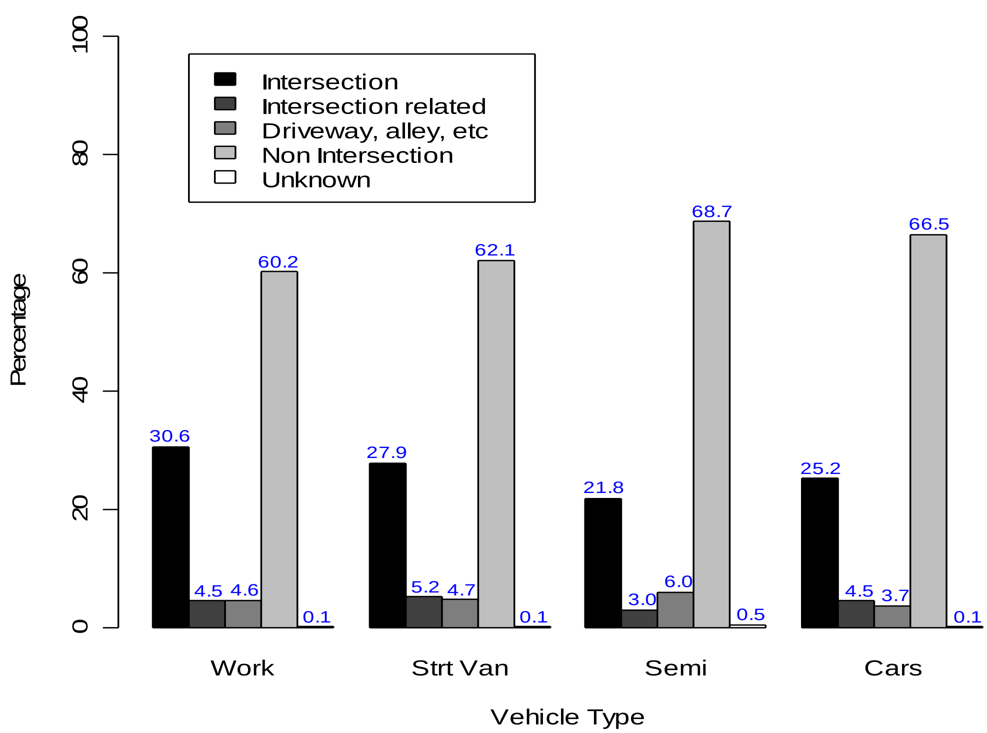
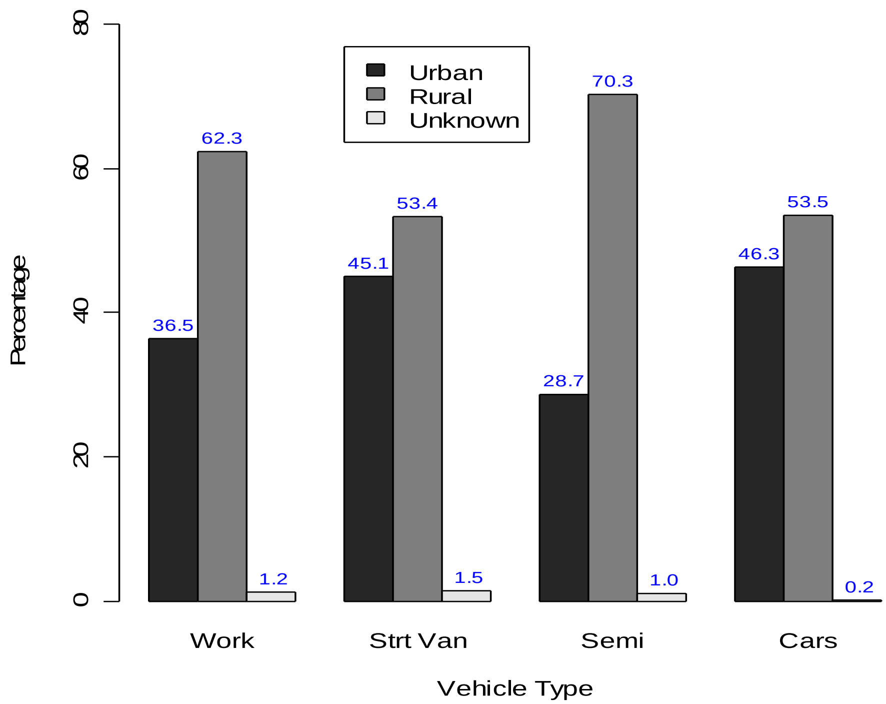


Figure 4 Percentages of Fatal Crash Involvement by Relation to Intersection and Vehicle Type. (TIFA 1997-2000, 2002, FARS 2002)



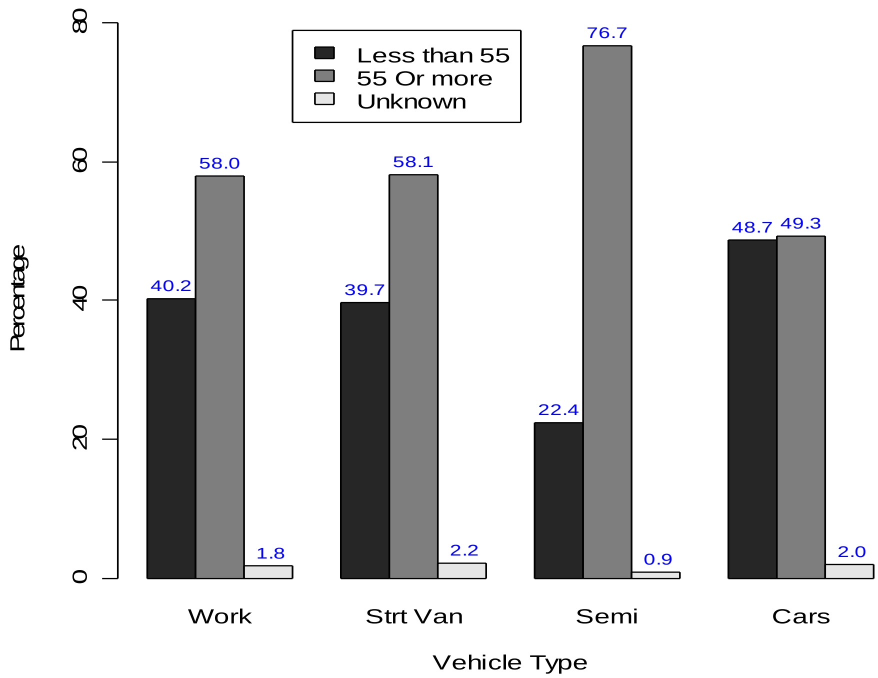
Percentages of fatal crash involvement according to land use are shown in Figure 5. While all vehicle types were involved primarily in rural areas, semitrailers had the highest percentage (70.3%), followed by work trucks (62.3%). Appendix B contains plots demonstrating that the majority of semitrailer involvement in rural areas occurred on the National Highway System (NHS), while the majority of work truck involvement in rural areas was not on the NHS. Thus, work trucks tended to be involved in rural areas not on the NHS (see Appendix B). The distributions for straight truck vans and passenger cars were comparable with respect to land use.

Figure 5 Percentages of Fatal Crash Involvement by Land Use and Vehicle Type. (TIFA 1997-2000, 2002, FARS 2002)



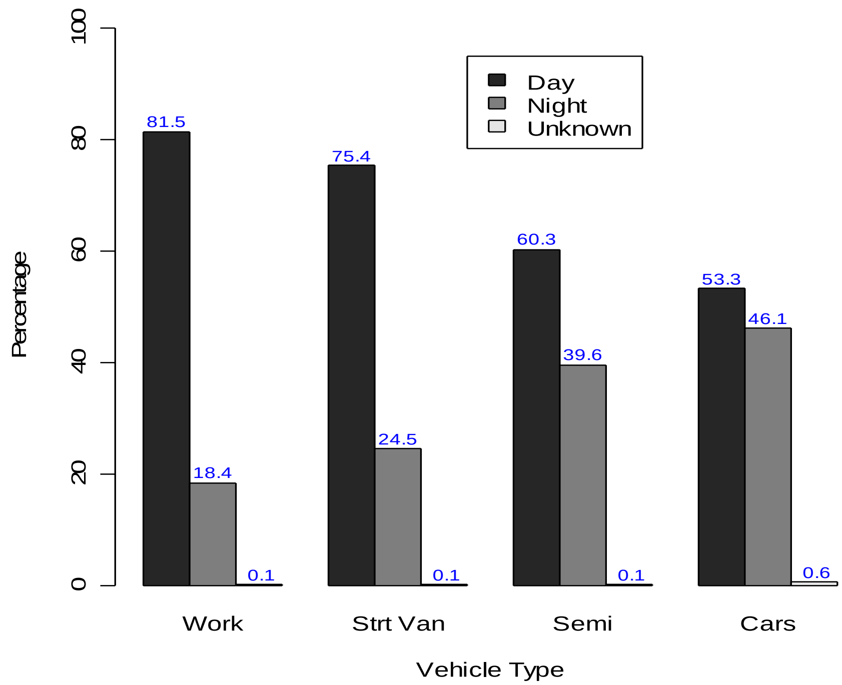
Speed limit is another variable related to road environment. Figure 6 shows fatal crash involvement percentages stratified by speed limit less than 55 mph, and speed limit greater than or equal to 55 mph. Semitrailers had the highest percentage of involvement where posted speed limits were greater than or equal to 55 mph (76.7%). This is consistent with Figure 2 that shows that semitrailers had the highest percentage of fatal crash involvement on interstate/US highways. The distributions for work trucks and straight truck vans were almost identical (approximately 40% less than 55 mph, 58% greater than or equal to 55 mph). The distribution for passenger cars was approximately equally divided between the two categories.

Figure 6 Percentages of Fatal Crash Involvement by Speed Limit and Vehicle Type. (TIFA 1997-2000, 2002, FARS 2002)



Crashes involving fatalities among the four vehicle types also differed with respect to time of day. Figure 7 is a barplot displaying the distributions of crashes. Day is defined as 7:00 am through 6:59 pm, and night is defined as 7:00 pm through 6:59 am. All vehicle types shown were more likely to be involved in fatal crashes during the day. Work trucks had the highest percentage of daytime involvement (81.5%), suggesting that these trucks tended to keep standard work schedules. Although at smaller percentages, straight truck vans also tended to be involved in the daytime (75.4%), as did semitrailers (60.3%). The distribution of fatal crash involvement by time of day for passenger cars was much more evenly distributed (53.3% day, 46.1% night).

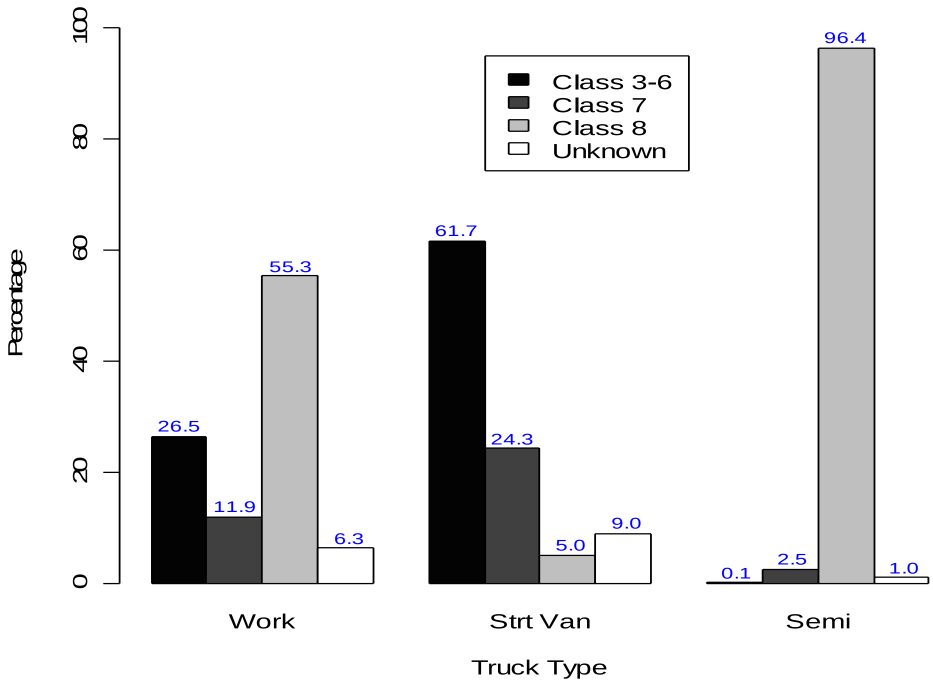
Figure 7 Percentages of Fatal Crash Involvement by Time of Day And Vehicle Type. (TIFA 1997-2000, 2002, FARS 2002)



3.2 Vehicle Characteristics

Trucks involved in fatal crashes also differed greatly with respect to Gross Vehicle Weight Rating (GVWR). Figure 8 shows percentages of involvement for the three truck types. GVWR is categorized into classes 3 through 6 (10,001-26,000 lbs), class 7 (26,001-33,000 lbs), and class 8 (greater than 33,000 lbs). Semitrailers were almost exclusively class 8 vehicles (96.4%). More than half (55.3%) of work trucks were class 8 vehicles, which is most likely attributable to the GVWR of dump trucks and cement mixers. On the other hand, straight truck vans were mostly represented by classes 3 through 6 (61.7%). Only 5 percent of straight truck vans were class 8 vehicles.

Figure 8 Percentages of Fatal Crash Involvement by Gross Vehicle Weight Rating (GVWR) and Vehicle Type. (TIFA 1997-2000, 2002)



Another weight-related variable that only applies to trucks is gross weight (GW). Figure 9 shows plots of the distributions of GW in pounds for the three truck types. The plots are normalized such that the area under each curve equals one, facilitating direct comparison in terms of proportions among the three truck types. The distribution for semitrailers is bimodal, represented by the dotted line with two peaks. This distribution demonstrates that somewhat less than half of semitrailers involved in fatal crashes were not loaded (mode at approximately 30,000 lbs), while somewhat less than half of semitrailers were loaded (mode at approximately 75,000 lbs). The distribution of GW for work trucks is concentrated mostly between 10,000 lbs and 30,000 lbs, although the long right tail suggests that for a small percentage of work trucks the GW was even greater than 60,000 or 75,000 lbs. The GW for straight truck vans was much smaller and much more concentrated than either semitrailers or work trucks. The distribution of GW for straight truck vans is centered around 15,000 lbs, with almost no trucks having GW greater than 40,000 lbs.

Figure 10 shows percentages of fatal crash involvement for the three truck types based on operating authority. There is a large contrast between semitrailers and the other two vehicle types. The operating authority for semitrailers was mostly for hire (74.6%), while the operating authority for work trucks and straight truck vans was mostly private (66.7% and 60.7%, respectively). The straight truck van was the only vehicle type with substantial operating authority classified as rental (11.6%), and the work truck was the only vehicle type with some involvement under government authority (6.7%).

Figure 9 Distributions of Gross Weight (GW) in lbs by Truck Type for Trucks Involved in Fatal Crashes. (TIFA 1997-2000, 2002)

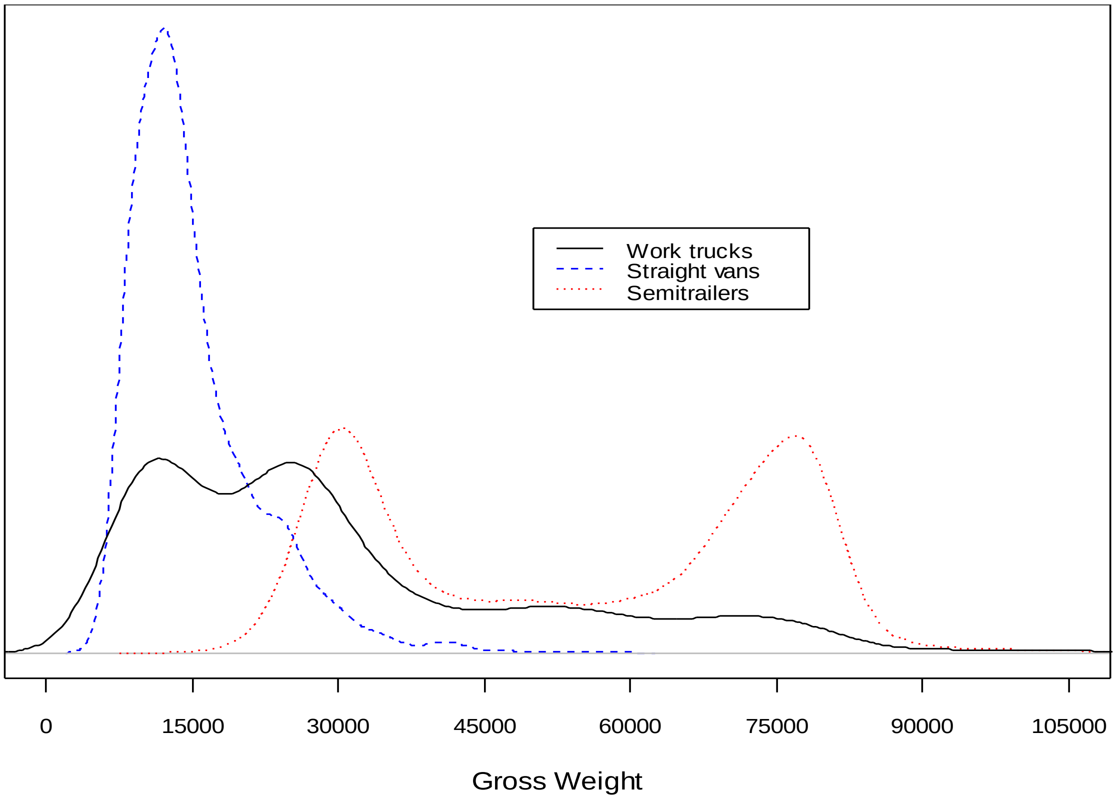
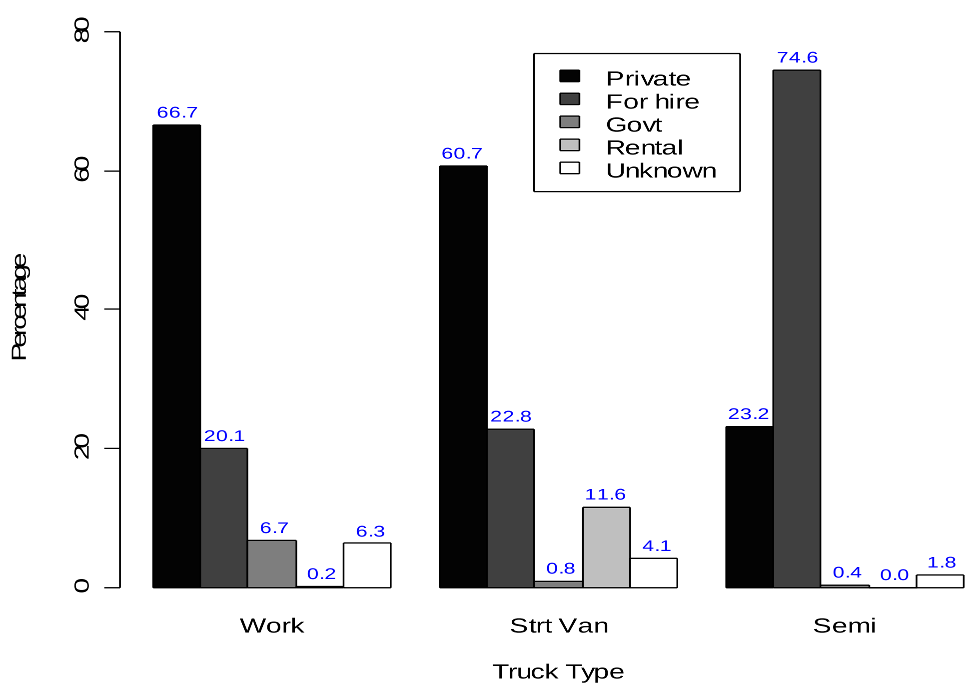


Figure 10 Percentages of Fatal Crash Involvement by Operating Authority and Truck Type. (TIFA 1997-2000, 2002)



Percentages of fatal crash involvement with respect to rollover occurrence are shown in Figure 11. The distributions for work trucks and passenger cars are almost identical. However, among truck types, work trucks experienced a slightly higher percentage of rollover events. For work trucks the combined percentage of rollover occurrence for first event and subsequent events was 16.7%. For straight truck vans this percentage was 11.9%, and for semitrailers it was 11.6%. Thus, there was about a five percent difference between work trucks and the other two truck types.

Figure 11 Percentages of Fatal Crash Involvement by Rollover Status and Vehicle Type. (TIFA 1997-2000, 2002, FARS 2002)

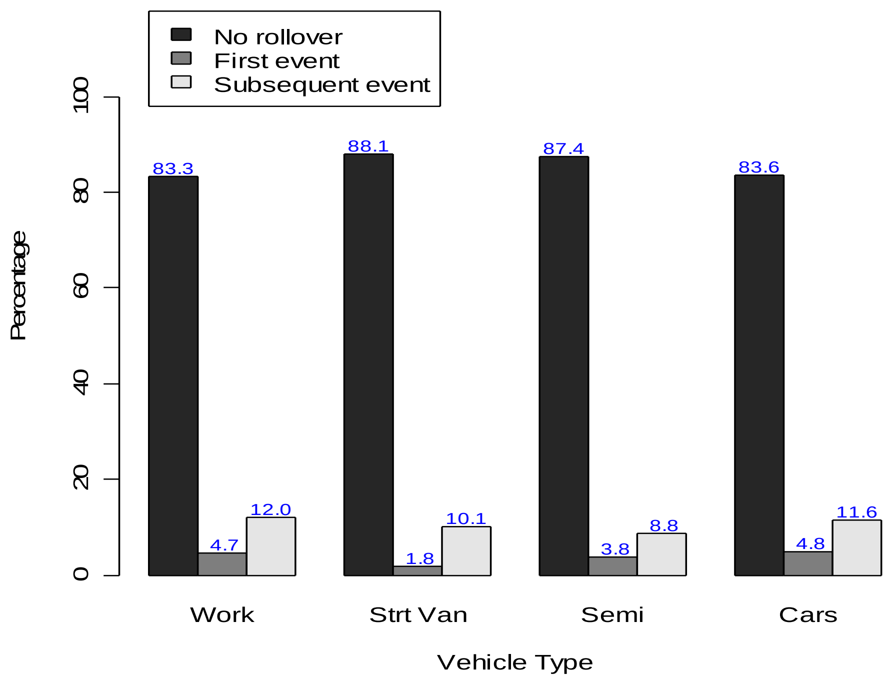
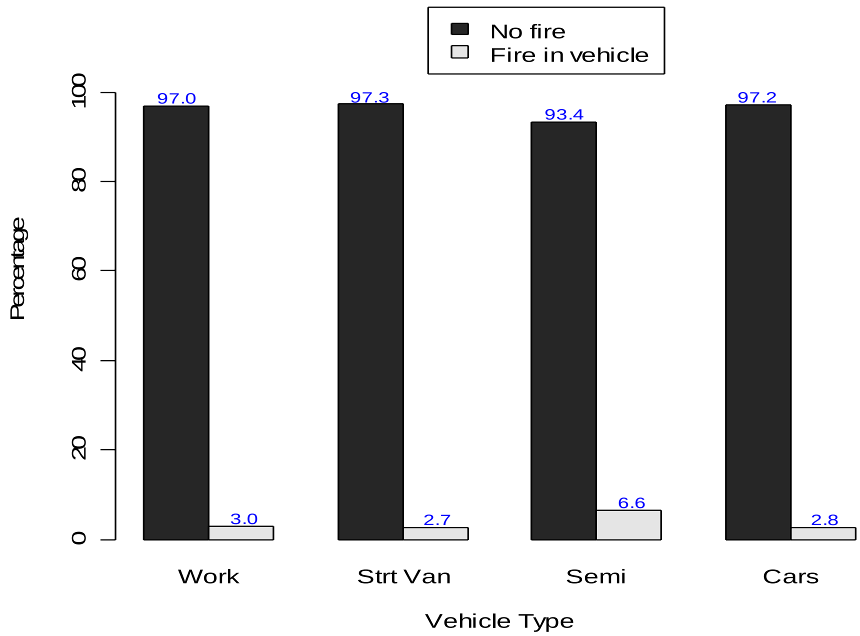


Figure 12 shows percentages of fatal crash involvement among vehicle types based on fire occurrence. Almost all involvements resulted in no fire inside the vehicle. The distributions for work trucks, straight truck vans, and passenger cars are very similar, with fire in the vehicle occurring approximately three percent of the time. Compared to the other vehicle types, semitrailers had a slightly higher occurrence of fire inside the vehicle (6.6%).

Figure 12 Percentages of Fatal Crash Involvement by Fire Occurrence and Vehicle Type. (TIFA 1997-2000, 2002, FARS 2002)



3.3 Driver Characteristics

Figure 13 shows percentages of driver restraint use for vehicles involved in fatal crashes. Restraint use has been divided into two categories to reflect whether the driver used some kind of restraint or none at all. Restraint use implies that the driver used either a shoulder belt, a lap belt, a shoulder belt and a lap belt, or that some type of restraint was used, but the type is unknown. Passenger cars had the highest percentage of unrestrained drivers (32.9%). Among truck types, work trucks had the highest percentage of unrestrained drivers (28.1%). A higher percentage of unrestrained drivers, along with the rollover results shown in Figure 11, could be an indication that injury for drivers or occupants of work trucks was more severe than for drivers or occupants of straight truck vans or semitrailers. This hypothesis is investigated in the section devoted to injury severity. Note that percentages of restraint use for straight truck vans and semitrailers were comparable.

Percentages of drivers involved in fatal crashes according to blood alcohol content (BAC) are shown in Figure 14. Blood alcohol concentration is measured in grams per deciliter (g/dl). A common level of BAC used in some states to indicate that a driver is intoxicated is 0.08 g/dl. Percentages are high for all vehicle types where either a test was refused, a test was not given, or data are missing. However, there was a large difference between trucks and passenger cars. Percentages of truck drivers with BAC greater than or equal to 0.08 g/dl were small. Among trucks, work trucks had the highest recorded percentage (1.5%). The percentages for straight

Figure 13 Percentages of Fatal Crash Involvement by Driver Restraint Use and Vehicle Type. (TIFA 1997-2000, 2002, FARS 2002)

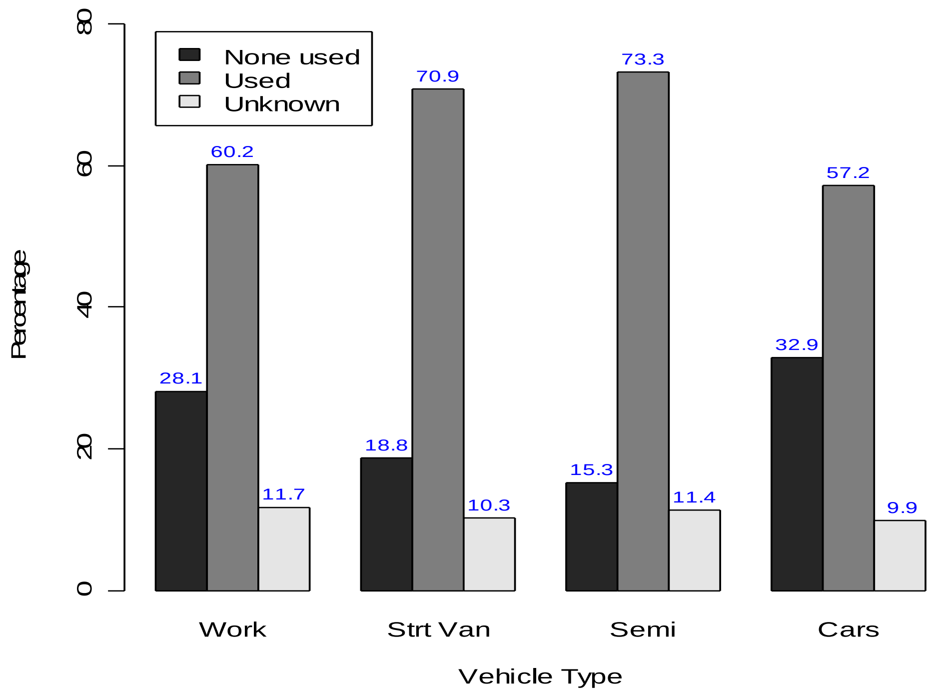
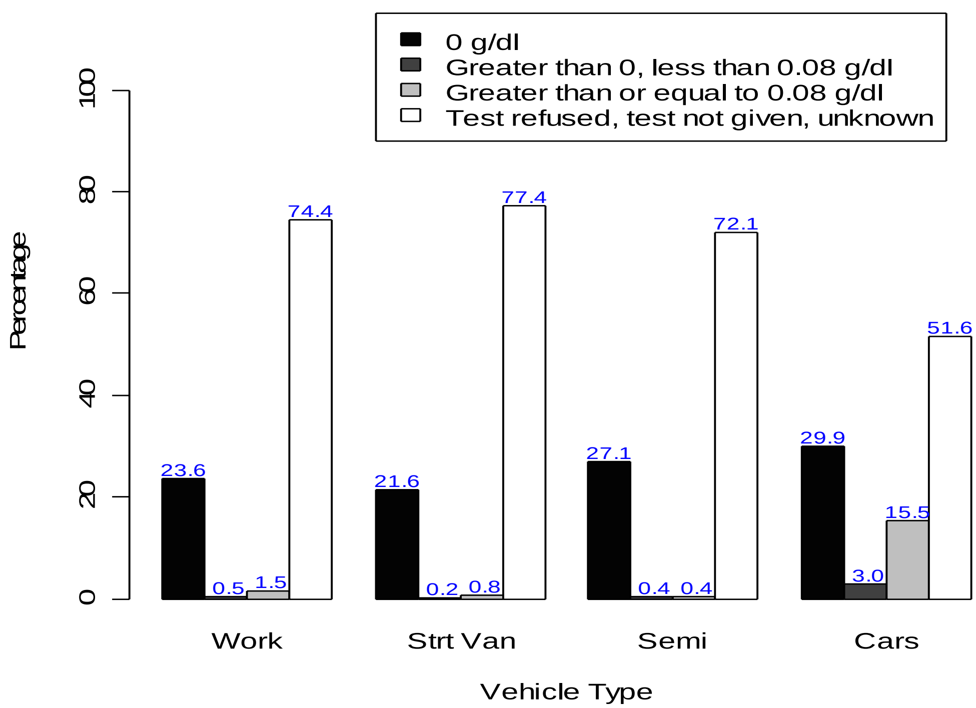


Figure 14 Percentages of Fatal Crash Involvement by Driver Blood Alcohol Content (BAC g/dl) and Vehicle Type. (TIFA 1997-2000, 2002, FARS 2002)



truck vans and semitrailers were 0.8% and 0.4%, respectively. The recorded percentage of passenger car drivers with BAC at least 0.08 g/dl was 15.5%.

The next three plots are related to the driving records of drivers in vehicles involved in fatal crashes. The results are based on convictions and accidents that occurred within three years of the crash under consideration. Figure 15 shows percentages of previous speeding convictions for drivers. Drivers of semitrailers had the highest percentage of previous speeding convictions. The percentage of drivers of semitrailers with more than one speeding conviction was 11.1%, and the total percentage of drivers of semitrailers with at least one speeding conviction was 29.8%. The total percentages for work trucks, straight truck vans, and passenger cars were comparable (21.0%, 22.4%, and 19.4%, respectively). It is important to note that on average truck drivers log many miles of travel compared to drivers of passenger cars, and are exposed to the likelihood of more traffic convictions.

Figure 15 Percentages of Fatal Crash Involvement by Driver Previous Speeding Convictions (Within 3 years of the Crash) and Vehicle Type. (TIFA 1997-2000, 2002, FARS 2002)

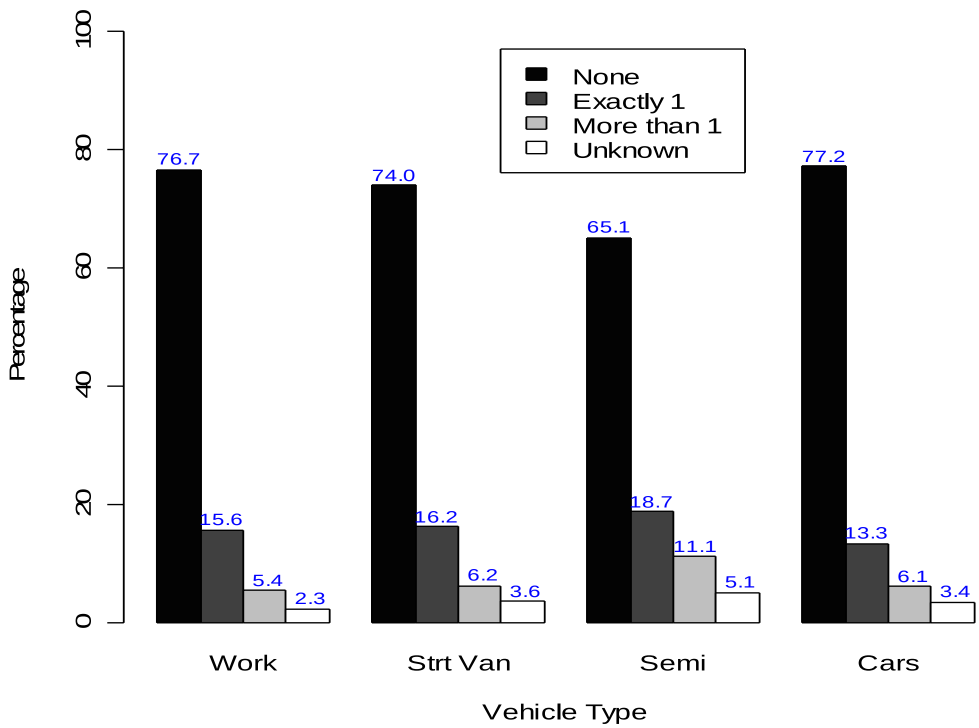


Figure 16 is a barplot of fatal crash involvement according to previous other moving convictions within three years of the crash. Although differences were not great, semitrailers had the highest percentage of total convictions (24.6%), while passenger cars had the lowest percentage (16.2%). The percentages for work trucks and straight truck vans were similar, and intermediate between semitrailers and passenger cars.

Figure 16 Percentages of Fatal Crash Involvement by Driver Previous Other Moving Convictions (Within 3 Years of the Crash) and Vehicle Type. (TIFA 1997-2000, 2002, FARS 2002)

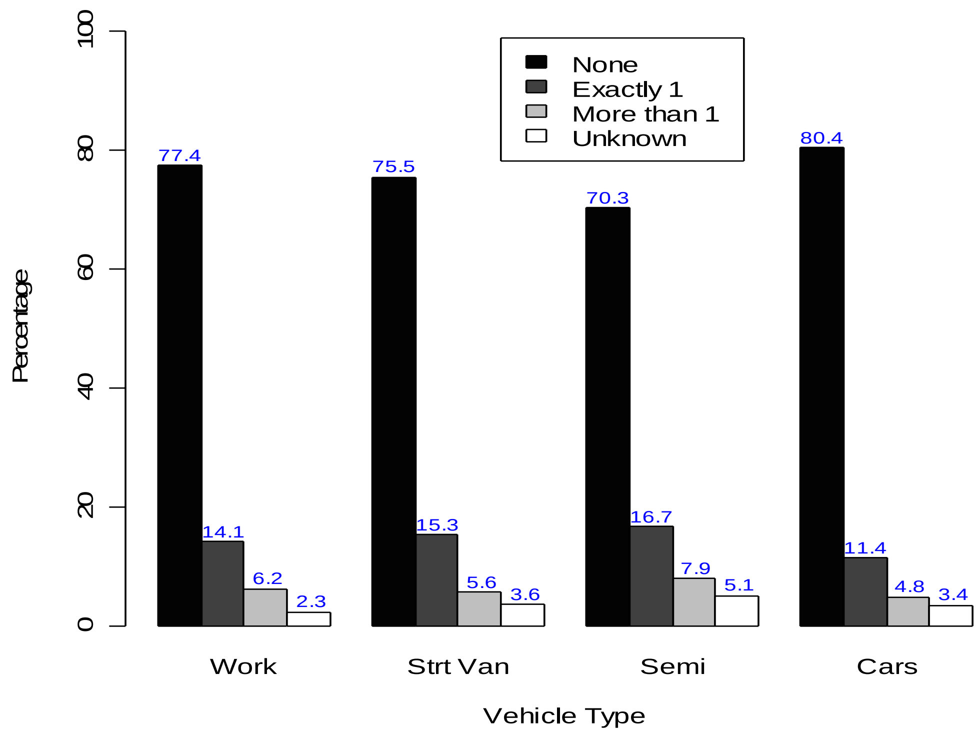


Figure 17 is a barplot of fatal crash involvement for drivers according to number of previous accidents within three years of the crash. The plot demonstrates that there were very little differences in fatal crash involvement between vehicle types. Passenger cars had a slightly lower total percentage (13.9%) than trucks, but missing data percentages were greater than 5% for each vehicle type, making a direct comparison between vehicle types somewhat difficult.

Distributions of driver age for vehicles involved in fatal crashes are shown in Figure 18 according to vehicle type. Figure 18 shows that there was a large difference between passenger cars and trucks. The distributions for work trucks, straight truck vans, and semitrailers are similar. The average age of drivers involved in fatal crashes for these truck types was approximately 40. However, for passenger cars a large percentage of drivers were young (between 16 and 30), and compared with trucks, a large percentage of drivers were old (greater than 70). Therefore, compared with trucks involved in fatal crashes, passenger cars were overrepresented by younger and older drivers.

Figure 17 Percentages of Fatal Crash Involvement by Driver Number of Previous Accidents (Within 3 Years of the Crash) and Vehicle Type. (TIFA 1997-2000, 2002, FARS 2002)

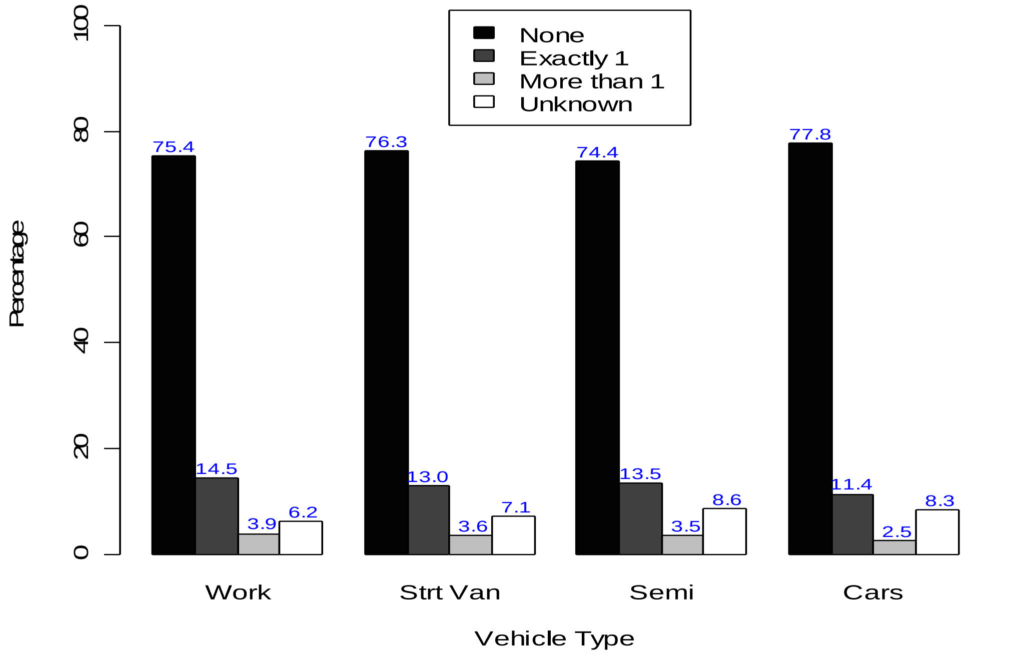
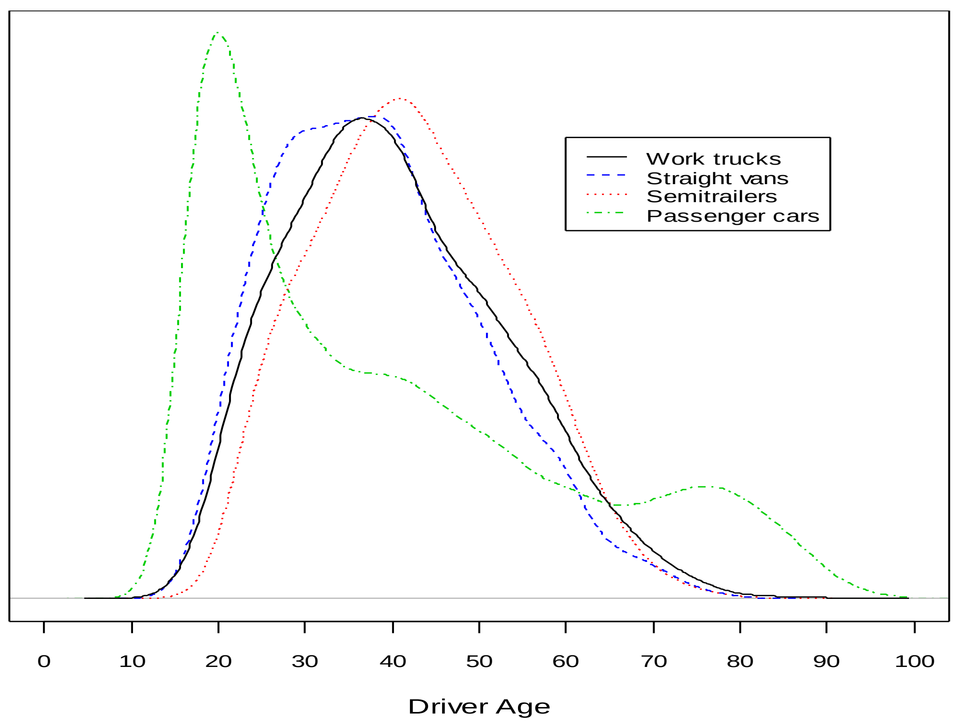


Figure 18 Distributions of Driver Age by Vehicle Type for Vehicles Involved in Fatal Crashes. (TIFA 1997-2000, 2002, FARS 2002)



4. Accident Type

An accident type variable is coded in the TIFA survey that classifies vehicles into one of more than sixty different accident types. It can be used to determine the position and relative motion of vehicles prior to the collision, and in some cases driver contribution to the crash can be inferred. For example, in head-on collisions it can be used to identify which vehicle came across the center line. In rear-end crashes it can be used to determine which vehicle was striking from behind and which vehicle was struck. In sideswipe opposite direction crashes it is possible to determine which vehicle was encroaching. Not only can single-vehicle crashes be distinguished from multiple-vehicle crashes, but information in greater detail is available in which it is possible to determine whether a vehicle ran off the road or hit an object on the road (such as a pedestrian). To reduce the number of accident types into a meaningful and manageable number, the TIFA accident types have been recoded into homogeneous groups that help to identify the types relevant to this study.

4.1 Comparison of Truck Types by Accident Type

Table 4 shows frequency distributions of crash involvement for work trucks, straight truck vans, and semitrailers. Single-vehicle crashes are denoted by truck ran off road and truck hit object in road accident types. The “all other accident types combined” category is an accumulation of eleven accident types, each with a relatively small percentage of crashes. Missing or unknown percentages for the accident type variable are relatively small.

Regardless of truck type, certain accident types had relatively large percentages of fatal crash involvement. For example, percentages of head-on crashes in which the other vehicle encroached were 12.3% for work trucks, 11.7% for straight truck vans, and 10.8% for semitrailers. It is not too surprising that fatal involvements had large percentages of these opposite direction crashes. Similarly, percentages of rear-end crashes in which the truck was struck were 10.3% for work trucks, 6.4% for straight truck vans, and 9.0% for semitrailers. Other accident types with relatively large percentages were truck hit object in road and truck straight into other vehicle.

For analysis of multiple-vehicle accidents, it is useful to group similar accident types into pairs that provide information about the role of the truck in the crash. For example, in Table 4 five multiple-vehicle accident typologies can be distinguished: rear-end, head-on, sideswipe opposite direction, turning across, and straight into. The rear-end typology pair of crashes that provide information regarding the role of the truck in the crash are *truck striking* and *truck struck*. Work trucks, vans, and semitrailers can be compared as to which vehicle types were more likely to be striking or struck. Similarly, the head-on typology consists of *truck encroaching* and *other vehicle encroaching*. The three vehicle types can be compared as to which ones were more likely to be encroaching or encroached upon. The other accident typologies can be considered similarly.

Table 4 Frequencies and Percentages of Fatal Crash Involvement by Accident Type and Truck Type. (TIFA 1997-2000, 2002)

	Work truck		Straight Van		Semitrailer	
Accident type	N	%	N	%	N	%
Truck ran off road	475	8.4	131	6.7	1,199	7.8
Truck hit object in road	517	9.1	239	12.3	1,077	7.0
Rear-end, truck striking	173	3.1	152	7.8	1,004	6.6
Rear-end, truck struck	582	10.3	124	6.4	1,372	9.0
Head-on, truck encroaching	147	2.6	55	2.8	195	1.3
Head-on, other vehicle encroaching	698	12.3	228	11.7	1,657	10.8
Sideswipe opposite direction, truck encroaching	99	1.7	33	1.7	138	0.9
Sideswipe opposite direction, other vehicle encroaching	352	6.2	120	6.2	1,165	7.6
Truck turning across other vehicle	185	3.3	75	3.8	562	3.7
Other vehicle turning across truck	452	8.0	131	6.7	867	5.7
Truck straight into other vehicle	724	12.8	216	11.1	1,304	8.5
Other vehicle straight into truck	225	4.0	66	3.4	654	4.3
All other accident types combined	926	16.3	342	17.5	3,647	23.8
Unknown	112	2.0	38	1.9	473	3.1
Total	5,667	100.0	1,950	100.0	15,314	100.0

Table 5 shows the five accident typologies cross-classified by typology pair (indicating the role of the truck in the crash) and truck type. Odds ratios and 95% confidence intervals are presented. Odds ratios are measures of association between two variables. An odds ratio of 1.00 implies independence between two variables, indicating that there is no association. If a 95% confidence interval contains 1.00, the odds ratio is said to be statistically insignificant.

Interpretation of the odds ratios presented in Table 5 proceeds as follows. In rear-end fatal crashes, work trucks were approximately 4.12 times more likely than straight truck vans, and 2.46 times more likely than semitrailers to have been the struck vehicle. Semitrailers were approximately 1.68 times more likely than straight truck vans to have been struck in rear-end fatal crashes. Note that differences could be due to operational exposure differences, since for example, rear-end crashes are more likely at signalized intersections, and Figure 4 indicates that work trucks had a higher percentage of fatal involvements at intersections.

In head-on fatal crashes, there was no statistical difference (the 95% confidence interval contains 1.00) between work trucks and straight truck vans as to whether the truck was encroaching or the other vehicle was encroaching. However, semitrailers were approximately 2.05 times more likely than straight truck vans, and 1/0.56=1.79 times more likely than work trucks to have been encroached upon in head-on crashes.

Table 5 Odds Ratios and 95% Confidence Intervals for Associations Between Accident Types and Truck Types. (TIFA 1997-2000, 2002)

Accident type								
Rear-end	Work	Van		Work	Semi		Semi	Van
Struck	582	124		582	1,372		1,372	124
Striking	173	152		173	1,004		1,004	152
Odds ratio	4.12			2.46			1.68	
95% Confidence interval	(3.08, 5.52)			(2.04, 2.97)			(1.30, 2.15)	
Head-on								
Other vehicle encroaching	698	228		698	1,657		1,657	228
Truck encroaching	147	55		147	195		195	55
Odds ratio	1.15			0.56			2.05	
95% Confidence interval	(0.81, 1.62)			(0.44, 0.70)			(1.47, 2.85)	
Sideswipe opposite direction								
Other vehicle encroaching	352	120		352	1,165		1,165	120
Truck encroaching	99	33		99	138		138	33
Odds ratio	0.98			0.42			2.32	
95% Confidence interval	(0.63, 1.53)			(0.32,0.56)			(1.52,3.55)	
Turning across								
Other vehicle turning across	452	131		452	867		867	131
Truck turning across	185	75		185	562		562	75
Odds ratio	1.40			1.58			0.88	
95% Confidence interval	(1.00, 1.95)			(1.29, 1.94)			(0.65, 1.20)	
Straight into								
Other vehicle into truck	225	66		225	654		654	66
Truck into other vehicle	724	216		724	1,304		1304	216
Odds ratio	1.02			0.62			1.64	
95% Confidence interval	(0.74, 1.39)			(0.52, 0.74)			(1.23, 2.20)	

In sideswipe opposite direction fatal crashes, there was no statistical difference (the 95% confidence interval contains 1.00) between work trucks and straight truck vans as to whether the truck was encroaching or the other vehicle was encroaching. Semitrailers were approximately 2.32 times more likely than straight truck vans, and 1/0.42=2.38 times more likely than work trucks to have been encroached upon in sideswipe opposite direction crashes.

In turning across fatal crashes, there was no statistical difference between semitrailers and straight truck vans as to which vehicle turned across in the crash. Work trucks were approximately 1.58 times more likely than semitrailers, and 1.40 times more likely than straight truck vans to have been turned across by the other vehicle. It is important to note that for this crash type, fault cannot be inferred since right of way is not known.

In straight into fatal crashes, there was no statistical difference between work trucks and straight truck vans as to which vehicle crashed straight into the other vehicle. Semitrailers were approximately 1.64 times more likely than straight truck vans, and 1/0.62=1.61 times more likely than work trucks to have been crashed straight into by the other vehicle in straight into fatal crashes. As with turning across fatal crashes, fault cannot be inferred for the straight into accident type since right of way is not known.

4.2 Comparison of Some Work-Related Trucks by Accident Type

In previous sections, descriptive statistics for work trucks as a group have been presented according to the definition given in Table 1. Many different body styles are represented in the work truck classification. Some work trucks were more likely to be involved in certain kinds of accidents than other work trucks. Table 6 and Table 7 show frequencies and percentages according to accident type for some of the more common body types that were involved in fatal crashes. Six body types are investigated: dump, garbage/refuse, tow/wrecker, tank, service/utility, and cement/mixer/pumper trucks.

The most noticeable statistic shown is the high percentage of garbage/refuse trucks involved in fatal crashes in which the truck hit an object in the road (23.0%). The object in the road was most likely a pedestrian, a bicyclist, or other nonmotorist. Garbage/refuse trucks often operate in residential neighborhoods, making frequent stops. One explanation for this high percentage is the low speed in urban areas where these vehicles operate, placing them in close proximity to workers and other nonmotorists around the vehicle while it is in transport.

Table 6 Frequencies and Percentages of Fatal Crash Involvement by Accident Types for Dump, Garbage/Refuse, and Tow/Wrecker Trucks. (TIFA 1997-2000, 2002)

	Dump		Refuse		Tow/wrecker	
Accident type	N	%	N	%	N	%
Truck ran off road	116	5.6	33	5.8	34	8.2
Truck hit object in road	145	6.9	132	23.0	49	11.9
Rear-end, truck striking	59	2.8	16	2.8	17	4.1
Rear-end, truck struck	253	12.1	58	10.1	34	8.2
Head-on, truck encroaching	61	2.9	7	1.2	8	1.9
Head-on, other vehicle encroaching	274	13.1	50	8.7	48	11.6
Sideswipe opposite direction, truck encroaching	34	1.6	11	1.9	8	1.9
Sideswipe opposite direction, other vehicle encroaching	151	7.2	13	2.3	24	5.8
Truck turning across other vehicle	69	3.3	16	2.8	16	3.9
Other vehicle turning across truck	184	8.8	45	7.9	42	10.2
Truck straight into other vehicle	313	15.0	58	10.1	37	9.0
Other vehicle straight into truck	87	4.2	24	4.2	22	5.3
All other accident types combined	302	14.4	100	17.5	70	16.9
Unknown	42	2.0	10	1.7	4	1.0
Total	2,090	100.0	573	100.0	413	100.0

Table 7 Frequencies and Percentages of Fatal Crash Involvement by Accident Types for Tank, Service/Utility, and Cement/Mixer/Pumper Trucks. (TIFA 1997-2000, 2002)

	Tank		Utility		Cement	
Accident type	N	%	N	%	N	%
Truck ran off road	66	15.2	38	9.4	27	9.7
Truck hit object in road	32	7.4	32	7.9	21	7.5
Rear-end, truck striking	3	0.7	9	2.2	1	0.4
Rear-end, truck struck	25	5.8	40	9.9	18	6.5
Head-on, truck encroaching	8	1.8	10	2.5	10	3.6
Head-on, other vehicle encroaching	53	12.2	51	12.6	31	11.1
Sideswipe opposite direction, truck encroaching	7	1.6	6	1.5	9	3.2
Sideswipe opposite direction, other vehicle encroaching	31	7.2	33	8.2	21	7.5
Truck turning across other vehicle	18	4.2	6	1.5	7	2.5
Other vehicle turning across truck	30	6.9	26	6.4	34	12.2
Truck straight into other vehicle	52	12.0	63	15.6	38	13.6
Other vehicle straight into truck	18	4.2	14	3.5	9	3.2
All other accident types combined	74	17.1	68	16.8	47	16.8
Unknown	16	3.7	8	2.0	6	2.2
Total	433	100.0	404	100.0	279	100.0

Almost all work trucks had high percentages of crashes in which the truck crashed straight into the other vehicle. Percentages for this accident type were 15.6% for service/utility trucks, 15.0% for dump trucks, 13.6% for cement/mixer/pumper trucks, and 12.0% for tank trucks. This accident type does not necessarily imply that the truck was at fault. For example, it is possible that the struck vehicle violated a traffic signal at an intersection.

Head-on crashes in which the other vehicle was encroaching also had high percentages. Some percentages for this accident type were 13.1% for dump trucks, 12.6% for service/utility trucks, and 12.2% for tank trucks. Tank trucks were involved in a high percentage of single-vehicle crashes in which the truck ran off the road (15.2%). The percentage of cement/mixer/pumper trucks involved in crashes in which the other vehicle turned across the truck was 12.2%, and the percentage of dump trucks in rear-end crashes in which the truck was struck from behind was 12.1%.

5. Injury Severity

It is possible to count the number of fatalities to drivers/passengers in trucks and cars. The FARS person file has information recorded about injury severity and person type. The person type variable can be used to identify drivers, passengers, and nonmotorists. The FARS vehicle file can be linked to the person file, making it possible to count fatalities to drivers/passengers in different vehicles.

In this section the TIFA vehicle file is linked to the FARS person file and work trucks, straight truck vans, and tractor semitrailers are compared with respect to injury severity. Statistics for injury severity are presented for persons inside the truck as well as outside the truck. Injury inside the truck involves either the driver or a passenger, while injury outside the truck involves either drivers or passengers in other vehicles in the same crash, or non-motorists such as pedestrians or bicyclists. Keep in mind that all inference for trucks is based on vehicles that are class 3 and above. There are no provisions for identifying, for example, work trucks produced in two or more stages (multistage vehicles) that have GVWR less than or equal to 10,000 lb.

Table 8 shows frequencies and percentages of injury severity for trucks involved in fatal crashes. Injury severity has five categories coded on an ordinal scale: none (O), possible (C), nonincapacitating (B), incapacitating (A), and fatal (K). Note that driver totals inside the truck do not match the totals shown in Table 2 exactly. This is due to missing data on the injury severity variable. Missing data percentages for the injury severity variable are relatively small. For example, the missing data percentage for work trucks is approximately 1.8%.

In a previous section it was shown that work trucks involved in fatal crashes had a slightly higher percentage of rollover occurrence than either straight truck vans or semitrailers (approximately 5%, see Figure 11). In addition, it was shown that drivers of work trucks were less likely to use some form of safety restraint than drivers of either straight truck vans or semitrailers (see Figure 13). These factors are generally associated with greater injury severity to drivers or passengers inside the truck. Another consideration is the massive weight and size of semitrailers, which could be a protective factor in terms of injury severity to occupants of these trucks relative to work trucks and straight truck vans (see Figures 8 and 9).

The combined percentages of fatal and incapacitating injuries to truck drivers were 21.1% for work trucks, 22.4% for straight truck vans, and 17.1% for semitrailers. Truck drivers of semitrailers appear to have had slightly less injury severity, but there appears to have been little or no difference between work trucks and straight truck vans. Similarly, the combined percentages of fatal and incapacitating injuries to passengers inside the truck were 27.1% for work trucks, 26.7% for straight truck vans, and 18.5% for semitrailers. Passengers in semitrailers appear to have had less injury severity, and there appears to have been little or no difference between work trucks and straight truck vans.

For drivers in other vehicles (outside the truck), combined percentages of fatal and incapacitating injuries were 70.5% for work trucks, 58.1% for straight truck vans, and 63.7% for semitrailers. For passengers in other vehicles, combined percentages of fatal and incapacitating injuries were 62.3% for work trucks, 54.5% for straight truck vans, and 59.0% for semitrailers. Therefore, injury severity to occupants outside the truck appears to have been slightly higher for work trucks.

Combined percentages of fatal and incapacitating injuries to nonmotorists for semitrailers involved in fatal crashes was 73.1%, about 10% less than for either work trucks (84.3%) or straight truck vans (84.2%). This could partially be attributable to semitrailers being involved in fewer single-vehicle crashes in which nonmotorists were struck (see Table 4).

Table 8 Frequencies and Percentages of Fatal Crash Involvement by Injury Severity for Work Trucks, Straight Truck Vans, and Semitrailers. (TIFA 1997-2000, 2002)

Work Truck	Injury severity										
Person type	None (O)		Possible (C)		Nonincapac (B)		Incapac (A)		Fatal (K)		
Inside truck	N	%	N	%	N	%	N	%	N	%	total
Driver	2,998	53.9	765	13.7	628	11.3	355	6.4	819	14.7	5,565
Passenger	566	49.5	131	11.5	137	12.0	130	11.4	179	15.7	1,143
Truck total	3,564	53.1	896	13.4	765	11.4	485	7.2	998	14.9	6,708
Outside truck											
Drivers	918	15.1	361	5.9	519	8.5	620	10.2	3,670	60.3	6,088
Passengers	421	13.1	337	10.5	458	14.2	756	23.5	1,250	38.8	3,222
Nonmotorist	24	3.8	11	1.7	32	5.0	33	5.2	536	84.3	636
Outside total	1,363	13.7	709	7.1	1,009	10.1	1,409	14.2	5,456	54.9	9,946

Straight van	Injury severity										
Person type	None (O)		Possible (C)		Nonincapac (B)		Incapac (A)		Fatal (K)		
Inside truck	N	%	N	%	N	%	N	%	N	%	total
Driver	946	49.3	242	12.6	300	15.6	185	9.6	245	12.8	1,918
Passenger	263	43.0	71	11.6	114	18.7	83	13.6	80	13.1	611
Truck total	1,209	47.8	313	12.4	414	16.4	268	10.6	325	12.9	2,529
Outside truck											
Drivers	561	22.5	208	8.3	275	11.0	238	9.5	1,211	48.6	2,493
Passengers	255	18.6	139	10.2	229	16.7	291	21.3	454	33.2	1,368
Nonmotorist	1	0.3	4	1.2	25	7.6	22	6.7	278	84.2	330
Outside total	817	19.5	351	8.4	529	12.6	551	13.1	1,943	46.4	4,191

Semitrailers	Injury severity										
Person type	None (O)		Possible (C)		Nonincapac (B)		Incapac (A)		Fatal (K)		
Inside truck	N	%	N	%	N	%	N	%	N	%	total
Driver	9,552	63.2	1,625	10.7	1,364	9.0	662	4.4	1,919	12.7	15,122
Passenger	1,341	61.3	239	10.9	204	9.3	150	6.9	255	11.6	2,189
Truck total	10,893	62.9	1,864	10.8	1,568	9.1	812	4.7	2,174	12.6	17,311
Outside truck											
Drivers	3,955	19.6	1,507	7.5	1,869	9.3	2,076	10.3	10,797	53.4	20,204
Passengers	1,828	14.8	1,233	10.0	2,005	16.2	2,853	23.1	4,430	35.9	12,349
Nonmotorist	40	2.4	57	3.5	165	10.0	181	11.0	1,203	73.1	1,646
Outside total	5,823	17.0	2,797	8.2	4,039	11.8	5,110	14.9	16,430	48.0	34,199

6. Comparison of Crash Involvement Rates

In this section, fatal crash counts in the TIFA data file are matched to exposure data in the VIUS survey in order to calculate crash involvement rates. Rates are provided for semitrailers, straight truck vans, and work trucks for which data are available from both sources. Vehicle miles traveled (VMT) has traditionally been used as a measure of exposure to risk, and can be used to calculate crash involvement rates. Although rates provide a means for comparing risk among different vehicle configurations, they should be judged with caution since other factors are known to be associated with crash involvement.

For example, comparison of rates between semitrailers and work trucks is not straightforward. Semitrailers travel at higher speeds on predominantly interstate highways, and therefore accumulate travel at high rates of speed on the safest roads. Work trucks, on the other hand, tend to travel at comparatively slower speeds on predominantly local trips, and therefore accumulate travel at lower rates of speed on roads considered to be less safe. On local trips, work trucks are more likely to travel through intersections, exposing them to turning traffic, crossing traffic, and stopped traffic. Therefore, the exposure to risk experienced by semitrailers traveling on predominantly interstate highways is very different from the exposure to risk experienced by work trucks traveling on predominantly local trips.

To some extent, Figures 1 through 4 that describe fatal crash involvements for work trucks, straight vans, and semitrailers confirm claims about the different road types traveled on, and the different environments in which these vehicle types operate. In this section, the trip type variable that is available in both the TIFA and VIUS data files also confirms these claims, and is used to help account for these differences.

6.1 Aggregated Rates

Table 9 is a display of average annual rates of involvement by vehicle type. The rates are calculated by dividing the number of trucks in fatal crashes by VMT. Since the numbers of trucks in fatal crashes are accumulated over five years, and VMT are taken from the 2002 VIUS file, the rates presented are *average annual rates*. Vehicle miles traveled are shown in millions of miles and the average annual rates are shown per 100 million VMT. For example, the average annual rate for dump trucks is calculated using the formula (2090/(5 * 7017.9)) x 100 = 5.96.

The rates in Table 9 are sorted in decreasing order. The total number of involvements in five years for all vehicle types shown was 22,637 and VMT in millions was 132,124.3, resulting in an overall average annual rate of 3.43. Semitrailers accounted for the majority of involvements (15,314, 67.7%) and VMT (84,305.2, 63.8%). Thus, the overall rate of 3.43 is largely influenced by the semitrailer rate (3.63). The normalized average annual rate shown in Table 9 is calculated by dividing the average annual rate by 3.43.

Relative to the overall rate, it appears that some of the work trucks were over-involved in fatal crashes. Examination of Table 9 suggests that on average, dump trucks were involved in approximately six fatal crashes per 100 million VMT. The rates for sweeper and garbage/refuse trucks are greater than five, although the rate for sweepers is based on a small number of crashes and small VMT, making it subject to random variation which could be due to chance alone. The rates for pole/logging, cement mixer/pumper, and tow/wrecker trucks range from 4.25 to 4.86, and appear to be slightly over involved relative to the overall rate (3.43).

Table 9 Frequencies, Vehicle Miles Traveled (VMT), Fatal Average Annual Crash Rates, and Normalized Rates by Truck Type. (TIFA 1997-2000, 2002, VIUS 2002)

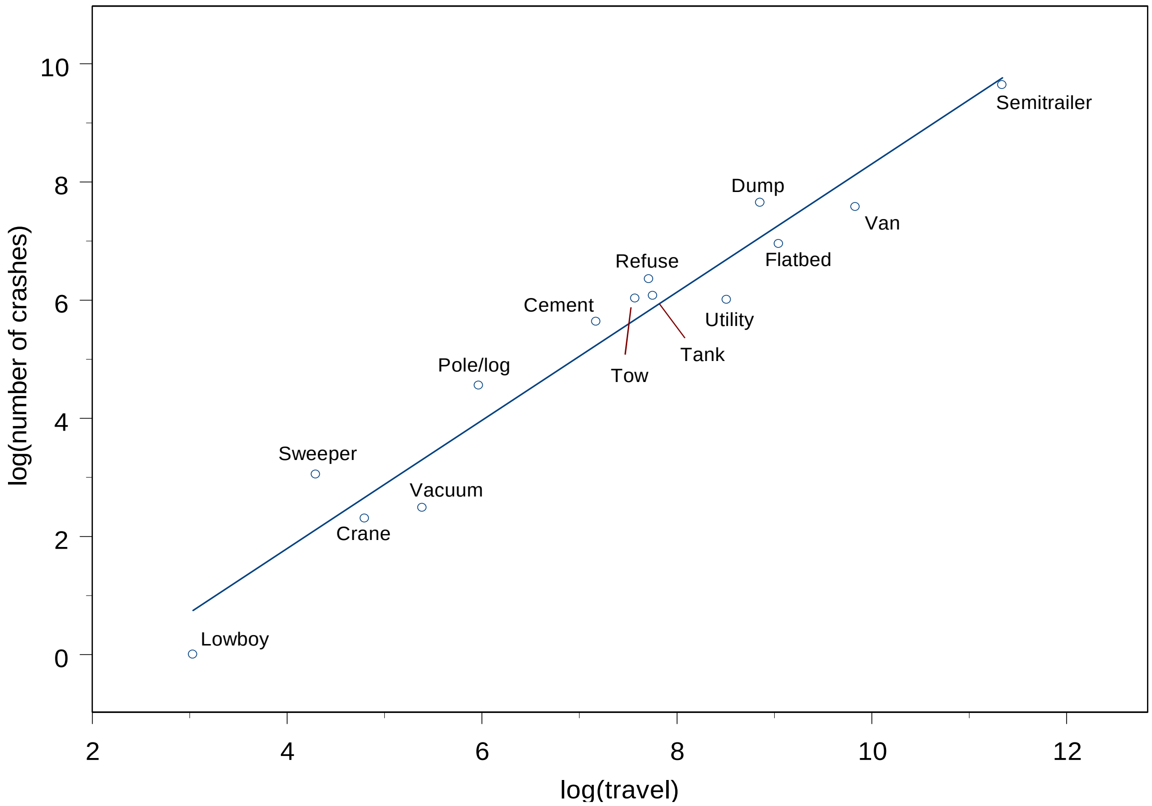
Vehicle type	Number of trucks in fatal crashes	Vehicle miles traveled (millions)	Average annual rate per 100 million VMT	Normalized average annual rate
Dump	2,090	7,017.9	5.96	1.74
Sweeper	21	73.5	5.72	1.67
Garbage/refuse	573	2,239.6	5.12	1.49
Pole/logging	95	390.6	4.86	1.42
Cement mix/pump	279	1,302.8	4.28	1.25
Tow/wrecker	413	1,944.1	4.25	1.24
Tank/dry/liquid	433	2,332.7	3.71	1.08
Semitrailer	15,314	84,305.2	3.63	1.06
Flatbed	1,042	8,503.9	2.45	0.71
Straight truck van	1,950	18,671.2	2.09	0.61
Crane	10	121.2	1.65	0.48
Service/utility	404	4,982.1	1.62	0.47
Vacuum	12	218.7	1.10	0.32
Lowboy	1	20.8	0.96	0.28
Total	22,637	132,124.3	3.43	1.00

Some of the vehicle types that appear to have been under involved relative to the overall rate are flatbed (2.45), straight truck van* (2.09), and service/utility (1.62) trucks. Crane, vacuum, and lowboy trucks also have comparatively small rates, but the calculations for these vehicle types are based on relatively small amounts of crashes and VMT.

An interesting feature of rate analysis is that a straight line relationship often exists between number of crashes and travel on the (natural) log scale. Figure 19 is a scatter plot of the data shown in Table 9 along with the fitted straight line. Vehicle types are labeled for identification. The semitrailer, which had the largest number of fatal crashes and the largest amount of travel is at one extreme, while the lowboy, which had the fewest number of fatal crashes and the smallest amount of travel is at the other extreme. Vehicle types that tend to have larger rates, such as dump, garbage/refuse, cement mixer, pole/logging, and sweeper trucks, lie above the straight line. Vehicle types that tend to have smaller rates, such as straight truck van, flatbed, and service/utility trucks, lie below the straight line.

* Calculation of the rate for straight truck vans required matching three van types in the TIFA file (van, open top, refrigerated) to six van types in the VIUS file (basic enclosed, insulated non-refrigerated, insulated refrigerated, open top, step, walk-in, multistop).

Figure 19 Plot of Log Travel versus Log Crashes. (TIFA 1997-2000, 2002, VIUS 2002)



6.2 Rates by Trip Type

The rates presented in the previous subsection are aggregated rates that do not take into account the different kinds of road types that work trucks and semitrailers traveled on. The TIFA data file contains very detailed information about fatal crashes that occurred on different road types. However, in the VIUS data file it is not possible to categorize travel based on road type. Instead, a trip type variable is coded that can be used to allocate exposure data among local trips (trips up to and including 50 miles) and longer trips (trips greater than 50 miles). The idea is that long trips are generally associated with travel on interstate and primary arterials, while local trips are generally associated with travel on local roads.

The trip type variable is available in both the TIFA and VIUS files, which permits matching of fatal counts with exposure data for calculating crash involvement rates. Table 10 shows crash involvement rates stratified by trip type[†]. The results confirm prior beliefs that work trucks tended to accumulate travel on local trips, while semitrailers tended to accumulate travel on

[†] The trip type variable is subject to missing data in both the TIFA and VIUS data files (see, for example, Figure 3). The overall missing data percentages for the vehicle types shown in Figure 10 are 20.3% in the TIFA file, and 19.5% in the VIUS file. Missing data has been allocated into the local and not local categories according to the percentages of available data in those categories.

Table 10 Frequencies, Vehicle Miles Traveled (VMT), Fatal Average Annual Crash Rates, and Normalized Rates by Truck Type and Trip Type. (TIFA 1997-2000, 2002, VIUS 2002

Vehicle type	Trip type	Number of trucks in fatal crashes	Vehicle miles traveled (millions)	Average annual rate per 100 million VMT	Normalized average annual rate
Dump	Local	1,886	5,611.5	6.72	1.96
	Not local	204	1,406.4	2.90	0.85
Sweeper	Local	20	52.6	7.61	2.22
	Not local	1	20.9	0.96	0.28
Garbage/refuse	Local	516	1,639.0	6.30	1.84
	Not local	57	600.7	1.90	0.55
Pole/logging	Local	67	197.6	6.78	1.98
	Not local	29	193.0	3.01	0.88
Cement mix/pump	Local	268	1,236.6	4.33	1.26
	Not local	11	66.3	3.32	0.97
Tow/wrecker	Local	336	1,553.2	4.33	1.26
	Not local	77	390.9	3.94	1.15
Tank/dry/liquid	Local	319	1,753.4	3.64	1.06
	Not local	114	579.3	3.94	1.15
Semitrailer	Local	3,638	13,318.4	5.46	1.59
	Not local	11,675	70,986.8	3.29	0.96
Flatbed	Local	781	5,727.8	2.73	0.80
	Not local	261	2,776.1	1.88	0.55
Straight truck van	Local	1,095	10,871.4	2.01	0.59
	Not local	855	7,799.8	2.19	0.64
Crane	Local	7	65.0	2.15	0.63
	Not local	3	56.2	1.07	0.31
Service/utility	Local	347	3,495.2	1.99	0.58
	Not local	57	1,486.9	0.77	0.22
Vacuum	Local	5	140.6	0.71	0.21
	Not local	7	78.0	1.79	0.52
Lowboy	Local	1	15.6	1.28	0.37
	Not local	0	5.2	0.00	0.00
Total		22,637	132,124.3	3.43	1.00

longer trips. For example, dump trucks traveled an estimated total of 7,017.9 million miles, 5,611.5 (80.0%) of which were on local trips. Semitrailers, on the other hand, traveled an estimated total of 84,305.2 million miles, 13,318.4 (15.8%) of which were on local trips. Other work trucks that accumulated a majority of travel on local trips include cement mixer/pumper (94.9%), tow/wrecker (79.9%), garbage/refuse (73.2%), and service/utility (70.2%) trucks.

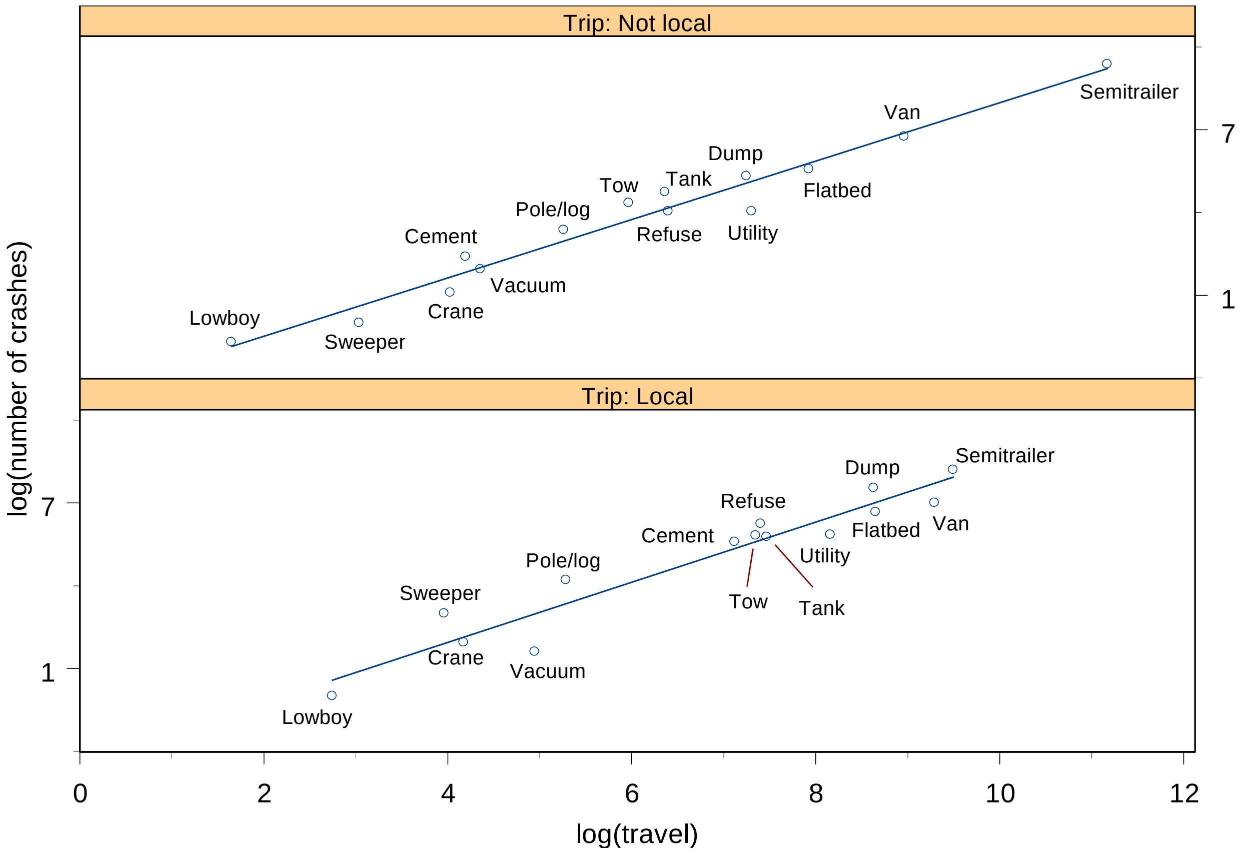
The important feature revealed by Table 10 is that the involvement rates for many work trucks are comparable to rates for semitrailers after stratification by trip type is taken into account. In some cases, the rates for work trucks are even smaller than the rates for semitrailers on longer trips. For example, results presented in Table 9 suggest that dump trucks had the highest crash involvement rate (5.96). After stratification by trip type, results in Table 10 indicate that the rate for dump trucks on local trips was 6.72, while on longer trips the rate was 2.90. Since dump trucks traveled primarily on local trips, the rate of 6.72 is relatively close to the aggregated value 5.96. However, if attention is restricted to longer trips, where semitrailers accumulated the vast majority of travel at higher speeds on predominantly interstate and U.S. highways, the rate for dump trucks (2.90) is comparable to, and is in some sense smaller than, the rate for semitrailers (3.29). It is also shown in Table 10 that when semitrailers traveled on local trips, where they were exposed to similar conditions encountered by many work trucks, the semitrailer rate (5.46) is comparable to the rate for dump trucks (6.72).

The pattern of higher rates on local trips and lower rates on longer trips is evident for other vehicle types as well. The rate for garbage/refuse trucks was 6.30 on local trips and 1.90 on longer trips, resulting in one of the largest differences between the two rates for which sufficient data are available. Differences in rates between short and long trips are also apparent for sweeper and pole/logging trucks, although the results are based on smaller amounts of data. For cement mixer/pumper and tow/wrecker trucks, the declines in rates from short to long trips were modest.

Among vehicle types for which sufficient data are available, flatbed, straight truck van, and service/utility trucks have comparatively small rates. Straight truck vans do not show large differences in rates between local and longer trips. However, the declines for flatbed trucks (2.73 to 1.88) and service/utility trucks (1.99 to 0.77) are apparent.

Figure 20 is a plot of log travel against log crashes by trip type based on the results shown in Table 10. Of the vehicle types shown, only semitrailers had less travel on local trips. Pole/logging trucks had similar amounts of travel on local and longer trips, as did straight truck vans, to some degree. In order to calculate the log of the number of crashes for the lowboy vehicle type on longer trips, a small constant (0.5) was added to the zero cell count.

Figure 20 Plot of Log Travel versus Log Crashes by Trip Type. (TIFA 1997-2000, 2002, VIUS 2002)



6.3 Rates by Gross Vehicle Weight Rating (GVWR)

Gross Vehicle Weight Rating (GVWR) is a variable that is coded in both the TIFA and VIUS files. Table 11 shows crash involvement rates stratified by GVWR. Since vehicle types tend to be of one GVWR, the categories have been divided into two classes: classes 3-7, and class 8[‡].

Although there were some exceptions, trucks with GVWR in class 8 tended to have higher crash involvement rates. In some cases the differences were large. Work trucks involved in fatal crashes that were predominantly class 8 vehicles included dump, garbage/refuse, pole/logging, and cement mixer/pumper trucks. The rate for dump trucks in class 8 was 7.77, but drops to 2.81 in classes 3-7. Similarly, the rate for garbage/refuse trucks in class 8 was 5.49, but in classes 3-7 it was 3.37. Note that all cement mixer/pumper trucks involved in fatal crashes were class 8 vehicles.

[‡] The GVWR variable is subject to small percentages of missing data in the TIFA file, and is not subject to missing data in the VIUS file (see, for example, Figure 8). Missing data in the TIFA file has been allocated into the class3-7 and class 8 categories according to the percentages of available data in those categories.

Trucks involved in fatal crashes that were predominantly in classes 3-7 included tow/wrecker, flatbed, straight truck van, and service/utility trucks. Except for tow/wrecker trucks, these trucks display some of the lowest rates of all vehicles shown. Class 8 rates for straight truck van and service/utility trucks were extremely low, but data are very sparse in those cases.

There were approximately an equal number of fatal involvements for tank trucks in classes 3-7 and class 8 (217 and 216, respectively). Yet, the rate in classes 3-7 was 2.89 and the rate in class 8 was 5.20. For semitrailers the rate in classes 3-7 was 1.63, while the rate in class 8 was 3.76.

Table 11 Frequencies, Vehicle Miles Traveled (VMT), Fatal Average Annual Crash Rates, and Normalized Rates by Truck Type and Gross Vehicle Weight Rating (GVWR). (TIFA 1997-2000, 2002, VIUS 2002)

Vehicle type	GVWR	Number of trucks in fatal crashes	Vehicle miles traveled (millions)	Average annual rate per 100 million VMT	Normalized average annual rate
Dump	3-7	361	2,569.0	2.81	0.82
	8	1,729	4,448.8	7.77	2.27
Sweeper	3-7	21	17.9	23.48	6.85
	8	0	55.6	0.00	0.00
Garbage/refuse	3-7	67	397.2	3.37	0.98
	8	506	1,842.4	5.49	1.60
Pole/logging	3-7	6	38.8	3.09	0.90
	8	89	351.8	5.06	1.48
Cement mix/pump	3-7	0	30.8	0.00	0.00
	8	279	1,272.0	4.39	1.28
Tow/wrecker	3-7	367	1,760.4	4.17	1.22
	8	46	183.7	5.01	1.46
Tank/dry/liquid	3-7	217	1,501.6	2.89	0.84
	8	216	831.1	5.20	1.52
Semitrailer	3-7	405	4,972.0	1.63	0.47
	8	14,909	79,333.2	3.76	1.10
Flatbed	3-7	828	6,839.6	2.42	0.71
	8	214	1,664.2	2.57	0.75
Straight truck van	3-7	1,843	14,853.6	2.48	0.72
	8	107	3,817.6	0.56	0.16
Crane	3-7	0	77.9	0.00	0.00
	8	10	43.3	4.62	1.35
Service/utility	3-7	389	4,584.8	1.70	0.49
	8	15	397.3	0.76	0.22
Vacuum	3-7	2	67.5	0.59	0.17
	8	10	151.2	1.32	0.39
Lowboy	3-7	1	6.9	2.88	0.84
	8	0	13.8	0.00	0.00
Total		22,637	132,124.3	3.43	1.00

7. Linkage of Travel Data and Passenger Vehicles

A direct comparison of fatal crash involvement rates between passenger cars, work trucks, semitrailers, and straight truck vans is not straightforward. This is because a common source of travel is not available for all vehicle types. The Federal Highway Administration publishes annual VMT data for passenger cars, single unit trucks or truck tractors without a trailer, and combination trucks. The VIUS survey provides VMT data for all trucks, but not passenger cars.

Table 12 shows numbers of vehicles involved in fatal crashes, vehicle miles traveled based on both FHWA travel and VIUS travel estimates, and crash involvement rates. The truck tractor with single trailer vehicle type includes tractor semitrailers and a few other tractors with one cargo-carrying trailer, such as a tractor and a full trailer or a tractor and a nonsemitrailer. Therefore, the total of 15,398 is slightly larger than the semitrailer total given in Table 2 (15,314). In addition, due to a small percentage of missing data on the vehicle type variable, the truck total of 25,088 is slightly less than the total given in Table 2 (25,786).

Examination of Table 12 suggests that overall, single unit trucks with at least one trailer had the highest fatal crash involvement rate (5.05). The rate for truck tractors with a single trailer (3.65) was comparable to the rate for single unit trucks or truck tractors without a trailer (3.26), while the rate for truck tractors with a double trailer was slightly less (3.02). Truck tractors with a triple trailer had the smallest rate (0.90), but data are sparse for this configuration. Note that the rates presented in Table 12 are aggregated rates, and are not adjusted for other factors associated with exposure to risk (see, for example, Table 10).

Rates for a particular vehicle type can be compared in cases where travel data are available from both FHWA and VIUS sources. Travel data are available from both the FHWA and VIUS surveys for two vehicle configurations: single unit trucks or truck tractors without a trailer, and all combination trucks. The total VMT for trucks is the sum of the travel for these two vehicle configurations. In both cases the FHWA travel estimates are greater than the VIUS estimates. Therefore, rates based on VIUS travel are greater than rates based on FHWA travel.

The last column in Table 12 is a travel inflation factor, which represents the multiple of the rate based on FHWA travel that produces the rate based on VIUS travel. For example, the rate based on VIUS travel for single unit trucks or truck tractors without a trailer (3.26), is 1.60 times greater than the rate based on FHWA travel. Similarly, the rate based on VIUS travel for all combination trucks (3.67), is 1.47 times greater than the rate based on FHWA travel. The inflation factors for the two vehicle types are fairly consistent. Since most travel was accumulated by combination trucks, the inflation factor for all trucks (1.51) is close to 1.47.

The rate for passenger cars is calculated using the 2002 FHWA VMT estimate. Since FHWA VMT estimates are consistently greater than VIUS VMT estimates for trucks, an argument can be made that in order to compare rates between passenger cars and trucks, the travel inflation factor should be taken into account. Based on the assumption that the inflation factor for trucks can be applied to passenger cars, an adjusted fatal crash involvement rate for passenger cars is 1.65 x 1.51 = 2.49. In relation to Table 9, the magnitude of the adjusted rate for passenger cars places it intermediate between the rates for flatbed trucks (2.45) and semitrailers (3.63).

Table 12 Comparison of Passenger Car and Truck Fatal Crash Involvement Rates Based on FHWA and VIUS Travel (FARS 2002, TIFA (1997-2000, 2002), FHWA 2002, VIUS 2002)

Vehicle type	Number of vehicles in fatal crashes	FHWA vehicle miles traveled†	VIUS vehicle miles traveled†	Rate based on FHWA travel	Rate based on VIUS travel	FHWA/VIUS travel inflation factor
Passenger cars	27,374*	1,658,640	NA	1.65	NA	NA
Single unit truck or truck tractor without a trailer ‡	7,720	75,887	47,306.2	2.03	3.26	1.60
Combination trucks						
Single unit truck with at least one trailer	1,112	NA	4,404.7	NA	5.05	NA
Truck tractor with single trailer	15,398	NA	84,305.2	NA	3.65	NA
Truck tractor with double trailer	847	NA	5,617.4	NA	3.02	NA
Truck tractor with triple trailer	11	NA	245.1	NA	0.90	NA
Combination truck total	17,368	138,643	94,572.4	2.51	3.67	1.47
Truck total	25,088	214,530	141,878.6	2.34	3.54	1.51

* Passenger number of fatal crashes from FARS 2002. Truck number of fatal crashes from TIFA (1997-2000, 2002).
† FHWA travel (2002) and VIUS travel (2002) in millions of miles. Rates are per 100 million miles traveled.
‡ FHWA designation is trucks on a single frame with at least 2 axles and 6 tires (not combination).
NA=Not available.

8. Summary and Discussion

This report is an investigation into the safety profile of work-related trucks. Fatal crash statistics have been presented comparing work trucks to other vehicle types such as tractor semitrailers, straight truck vans, and passenger cars. Counts of fatal truck crashes were taken from five years (1997-2000, 2002) of the Trucks Involved in Fatal Accidents (TIFA) database. Counts of fatal passenger car crashes were taken from the Fatality Analysis Reporting System (FARS 2002) database. Two sources of data were used to estimate vehicle miles traveled (VMT). The Vehicle Inventory and Use Survey (VIUS 2002) provides VMT estimates for work trucks, straight truck vans, and semitrailers, but not passenger cars. The Federal Highway Administration (FHWA) data provides VMT estimates for passenger cars and VMT totals for all trucks, but not work trucks.

A series of plots were presented to determine how fatal crashes involving work trucks, straight truck vans, semitrailers, and passenger cars differ with respect to road and environment characteristics, vehicle characteristics, and driver characteristics. An important difference between work trucks and semitrailers is that work trucks were most likely to be involved in fatal crashes on state or county roads (50.8%), while semitrailers were most likely involved on interstate or U.S. highways (61.0%). The distribution for passenger cars with respect to road use was similar to the distribution for work trucks (see Figure 2). The distribution for straight truck vans was distributed more evenly between fatal involvement on interstate/US highway and state/county roads.

Work trucks were more likely to be involved in fatal crashes on trips 50 miles or less (62.3%), while semitrailers were more likely involved on trips greater than 50 miles (63.3%). Straight truck van percentages were distributed more evenly between the two categories. Semitrailers had the highest percentage of fatal crash involvement where posted speed limits were 55 mph or more (76.7%). Work trucks had the highest percentage of fatal crash involvement during the day (81.5%, day defined as 7:00 am to 6:59 pm).

Vehicle characteristics differed greatly between truck types. Semitrailers involved in fatal crashes were almost exclusively class 8 vehicles (96.4%). Since dump trucks and cement mixer/pumper trucks are classified as work trucks, 55.3% of work trucks were class 8 vehicles. Straight truck vans involved in fatal crashes were mostly class 3-6 vehicles (61.7%). With respect to gross weight (GW) in pounds, the distribution for semitrailers is bimodal. Somewhat less than half of semitrailers involved in fatal crashes were not loaded (mode at approximately 30,000 lbs), and somewhat less than half were loaded (mode at approximately 75,000 lbs). The distribution of GW for work trucks is concentrated mostly between 10,000 and 30,000 lbs, but the GW for a small percentage was greater than 60,000 lbs. The distribution of GW for straight truck vans is centered around 15,000 lbs.

In fatal crashes, the percentage of rollover occurrence for work trucks was 16.7%, compared to 11.9% for straight truck vans, and 11.6% for semitrailers. In addition, among trucks, work trucks had the highest percentage of unrestrained drivers (28.1%), followed by straight truck vans (18.8%), and semitrailers (15.3%). Passenger cars had the highest percentage of unrestrained drivers (32.9%). With respect to blood alcohol content (BAC g/dl), the percentage of all truck types involved in fatal crashes with driver BAC 0.08 g/dl or greater was less than 2%. On the other hand, the percentage for passenger cars was greater than 15%.

Of the four vehicle types compared, semitrailers had the highest percentage of drivers with at least one speeding conviction within three years prior to the crash (29.8%), and the highest percentage of drivers with at least one other moving conviction within three years prior to the crash (24.6%). In terms of driver age, the distributions for truck types are similar. The average age for truck drivers, regardless of truck type, was approximately 40. However, passenger cars involved in fatal crashes were over represented by younger drivers between ages 16 and 30, and older drivers more than 70 years old.

An accident type variable is coded in the TIFA database that describes the position and relative motion of vehicles prior to the collision. Work trucks, straight truck vans, and semitrailers were compared with regard to the kinds of fatal accidents that these vehicles were involved in. Accident typologies were created, and odds ratios and 95% confidence intervals were calculated to compare associations between truck types and accident types. In rear-end crashes, work trucks were approximately 4.12 times more likely than straight truck vans, and 2.46 times more likely than semitrailers to be the struck vehicle. In head-on crashes, semitrailers were approximately 2.05 times more likely than straight truck vans, and 1.79 times more likely than work trucks to have been encroached upon. In sideswipe opposite direction crashes semitrailers were approximately 2.38 times more likely than work trucks, and 2.32 times more likely than straight truck vans to have been encroached upon.

Garbage/refuse trucks were involved in a high percentage of single-vehicle fatal crashes in which the truck hit an object in the road (23.0%). These trucks often operate in residential neighborhoods, making frequent stops. Poor visibility could be a contributing factor, but it is not clear why the percentage for this accident type was so high.

Injury severity based on the KABCO injury scale was compared between truck types for drivers and passengers inside the truck, as well as drivers and passengers outside the truck. In terms of combined percentages of fatal and incapacitating injuries, truck drivers of semitrailers had less injury severity than drivers of work trucks or straight truck vans by approximately 5%. Furthermore, passengers in semitrailers had less injury severity than passengers in work trucks or straight truck vans by approximately 8.5%. For drivers in other vehicles (outside the truck), combined percentages of fatal and incapacitating injuries were 70.5% for work trucks, 58.1% for straight truck vans, and 63.7% for semitrailers. For passengers in other vehicles the percentages were 62.3% for work trucks, 54.5% for straight truck vans, and 59.0% for semitrailers.

Crash involvement rates were calculated for work trucks, straight truck vans, semitrailers, and passenger cars. All truck rates are average annual rates since five years of TIFA data were combined. The numerator in the rate for passenger cars was calculated from 2002 FARS data. The VIUS survey provides VMT for calculation of all truck rates, while FHWA provides VMT for calculation of the passenger car rate. Since two different sources of travel were used for trucks and passenger cars, a method to adjust the passenger car rate for comparison to trucks was developed through the use of a travel inflation factor.

Three different types of rates are presented: aggregated rates, rates by trip type, and rates by GVWR. Aggregated rates can be misleading since other factors associated with crash involvement are not taken into account. For example, relative to work trucks, semitrailers travel at higher speeds on predominantly interstate highways, accumulating travel on the safest roads. Work trucks tend to travel at comparatively slower speeds on local roads, exposing them to turning traffic, crossing traffic, stopped traffic, and nonmotorists (pedestrians, bicyclists, and workers). Stratification of rates by trip type (trips less than or equal to 50 miles and trips greater than 50 miles) helps to account for these differences.

Examination of aggregated rates suggests that some work trucks were over involved in fatal crashes. Dump trucks had the highest average annual rate per 100 million VMT (5.96). The rates for garbage/refuse trucks and cement/mixer/pumper trucks were 5.12 and 4.28, respectively. In comparison, the aggregated rate for semitrailers was 3.63, and the rate for straight truck vans was 2.09. Of all truck types for which sufficient data were available, service/utility trucks had the lowest rate (1.62).

It was shown that involvement rates for many work trucks were comparable to, and in some cases smaller than, rates for semitrailers after stratification by trip type. For example, the rate for dump trucks on local trips was 6.72, while on longer trips the rate was 2.90. The rate for garbage/refuse trucks on local trips was 6.30, while on longer trips the rate was 1.90. In comparison, the rate for semitrailers on local trips was 5.46, while on longer trips the rate was 3.29. Therefore, when these two work trucks traveled on longer trips, where semitrailers accumulated the majority of travel, the work truck rates were comparable, and in some sense smaller than the semitrailer rate. In addition, on local trips, where work trucks accumulated the majority of travel, the semitrailer rate was comparable (although slightly smaller) to the work truck rates (see Figure 10 for comparison of other work truck rates).

The overall fatal crash involvement rate for passenger cars in 2002 was estimated at 1.65. The numerator for this rate was derived from 2002 FARS data. The VMT was taken from 2002 FHWA data. A direct comparison of rates between passenger cars and trucks is not straightforward since VMT for trucks was estimated from the 2002 VIUS survey. Based on a comparison of truck VMT that is available from both sources, it is acknowledged that FHWA estimates of VMT were consistently greater than VIUS estimates of VMT (see Table 12). The result is that truck rates based on VIUS VMT were greater than truck rates based on FHWA VMT by a factor of approximately 1.51. If this factor is applied to passenger cars, an adjusted rate for passenger cars is 1.65 x 1.51 = 2.49.

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Appendix A: Supporting Data for Barplots

The tables that appear below contain supporting data for all barplots that appear in this report.

Figure 1

National Highway System

	Work		Strt Van		Semi		Cars	
	N	%	N	%	N	%	N	%
NHS	1,843	32.5	862	44.2	9,542	62.3	8,433	30.8
Not NHS	3,738	66.0	1,053	54.0	5,584	36.5	18,884	69.0
Unknown	86	1.5	35	1.8	188	1.2	57	0.2
Total	5,667	100.0	1,950	100.0	15,314	100.0	27,374	100.0

Figure 2

Route Signing

	Work		Strt Van		Semi		Cars	
	N	%	N	%	N	%	N	%
Interstate/US	1,790	31.6	802	41.1	9,339	61.0	7,791	28.5
State/County	2,879	50.8	755	38.7	4,860	31.7	12,889	47.1
Local Street	739	13.0	331	17.0	782	5.1	5,469	20.0
Unknown	259	4.6	62	3.2	333	2.2	1,225	4.5
Total	5,667	100.0	1,950	100.0	15,314	100.0	27,374	100.0

Figure 3

Trip Type

	Work		Strt Van		Semi	
	N	%	N	%	N	%
Local	3,528	62.3	740	37.9	3,018	19.7
Not Local	727	12.8	578	29.6	9,686	63.2
Unknown	1,412	24.9	632	32.4	2,610	17.0
Total	5,667	100.0	1,950	100.0	15,314	100.0

Figure 4

Relation to Intersection

	Work		Strt Van		Semi		Cars	
	N	%	N	%	N	%	N	%
Intersection	1,733	30.6	545	27.9	3,340	21.8	6,893	25.2
Intersection related	256	4.5	101	5.2	456	3.0	1,226	4.5
Driveway, alley, etc.	261	4.6	91	4.7	918	6.0	1,006	3.7
Non intersection	3,411	60.2	1,211	62.1	10,530	68.8	18,224	66.6
Unnown	6	0.1	2	0.1	70	0.5	25	0.1
Total	5,667	100.0	1,950	100.0	15,314	100.0	27,374	100.0

Figure 5

Land Use

	Work		Strt Van		Semi		Cars	
	N	%	N	%	N	%	N	%
Urban	2,065	36.4	880	45.1	4,394	28.7	12,684	46.3
Rural	3,533	62.3	1,041	53.4	10,770	70.3	14,635	53.5
Unknown	69	1.2	29	1.5	150	1.0	55	0.2
Total	5,667	100.0	1,950	100.0	15,314	100.0	27,374	100.0

Figure 6

Speed Limit

	Work		Strt Van		Semi		Cars	
	N	%	N	%	N	%	N	%
< 55	2,278	40.2	775	39.7	3,433	22.4	13,315	48.6
>= 55	3,286	58.0	1,133	58.1	11,751	76.7	13,501	49.3
Unknown	103	1.8	42	2.2	130	0.8	558	2.0
Total	5,667	100.0	1,950	100.0	15,314	100.0	27,374	100.0

Figure 7

Time of Day

	Work		Strt Van		Semi		Cars	
	N	%	N	%	N	%	N	%
Day	4,621	81.5	1,471	75.4	9,240	60.3	14,596	53.3
Night	1,041	18.4	478	24.5	6,061	39.6	12,621	46.1
Unknown	5	0.1	1	0.1	13	0.1	157	0.6
Total	5,667	100.0	1,950	100.0	15,314	100.0	27,374	100.0

Figure 8

Gross Vehicle Weight Rating

	Work		Strt Van		Semi	
	N	%	N	%	N	%
Class 3-6	1,502	26.5	1,204	61.7	16	0.1
Class 7	676	11.9	474	24.3	385	2.5
Class 8	3,134	55.3	97	5.0	14,768	96.4
Unknown	355	6.3	175	9.0	145	0.9
Total	5,667	100.0	1,950	100.0	15,314	100.0

Figure 10

Operating Authority

	Work		Strt Van		Semi	
	N	%	N	%	N	%
Private	3,778	66.7	1,183	60.7	3,551	23.2
For hire	1,137	20.1	444	22.8	11,425	74.6
Govt	379	6.7	16	0.8	58	0.4
Rental	11	0.2	226	11.6	5	0.0
Unnown	362	6.4	81	4.2	275	1.8
Total	5,667	100.0	1,950	100.0	15,314	100.0

Figure 11

Rollover Status

	Work		Strt Van		Semi		Cars	
	N	%	N	%	N	%	N	%
No rollover	4,718	83.3	1,717	88.1	13,386	87.4	22,883	83.6
First event	270	4.8	35	1.8	587	3.8	1,326	4.8
Subsequent event	679	12.0	198	10.2	1,341	8.8	3,165	11.6
Total	5,667	100.0	1,950	100.0	15,314	100.0	27,374	100.0

Figure 12

Fire Occurrence

	Work		Strt Van		Semi		Cars	
	N	%	N	%	N	%	N	%
No fire	5,500	97.1	1,898	97.3	14,309	93.4	26,609	97.2
Fire in vehicle	167	2.9	52	2.7	1,005	6.6	765	2.8
Total	5,667	100.0	1,950	100.0	15,314	100.0	27,374	100.0

Figure 13

Driver Restraint Use

	Work		Strt Van		Semi		Cars	
	N	%	N	%	N	%	N	%
None used	1,595	28.1	367	18.8	2,339	15.3	9,004	32.9
Used	3,411	60.2	1,382	70.9	11,227	73.3	15,658	57.2
Unknown	661	11.7	201	10.3	1,748	11.4	2,712	9.9
Total	5,667	100.0	1,950	100.0	15,314	100.0	27,374	100.0

Figure 14

Driver Blood Alcohol Content

	Work		Strt Van		Semi		Cars	
	N	%	N	%	N	%	N	%
0 g/dl	1,339	23.6	422	21.6	4,146	27.1	8,193	29.9
greater than 0, less than 0.08	27	0.5	4	0.2	58	0.4	823	3.0
Greater than or equal to 0.08	83	1.5	15	0.8	67	0.4	4,243	15.5
Test refused, test not given, unknown	4,218	74.4	1,509	77.4	11,043	72.1	14,115	51.6
Total	5,667	100.0	1,950	100.0	15,314	100.0	27,374	100.0

Figure 15

Driver Previous Speeding Convictions

	Work		Strt Van		Semi		Cars	
	N	%	N	%	N	%	N	%
None	4,334	76.5	1,443	74.0	9,962	65.1	21,134	77.2
Exactly 1	886	15.6	315	16.2	2,864	18.7	3,640	13.3
More than 1	306	5.4	122	6.3	1,712	11.2	1,671	6.1
Unknown	131	2.3	70	3.6	776	5.1	929	3.4
Total	5,667	100.0	1,950	100.0	15,314	100.0	27,374	100.0

Figure 16

Driver Previous Other Moving Convictions

	Work		Strt Van		Semi		Cars	
	N	%	N	%	N	%	N	%
None	4,386	77.4	1,472	75.5	10,763	70.3	22,017	80.4
Exactly 1	797	14.1	298	15.3	2,558	16.7	3,128	11.4
More than 1	353	6.2	110	5.6	1,216	7.9	1,300	4.7
Unknown	131	2.3	70	3.6	777	5.1	929	3.4
Total	5,667	100.0	1,950	100.0	15,314	100.0	27,374	100.0

Figure 17

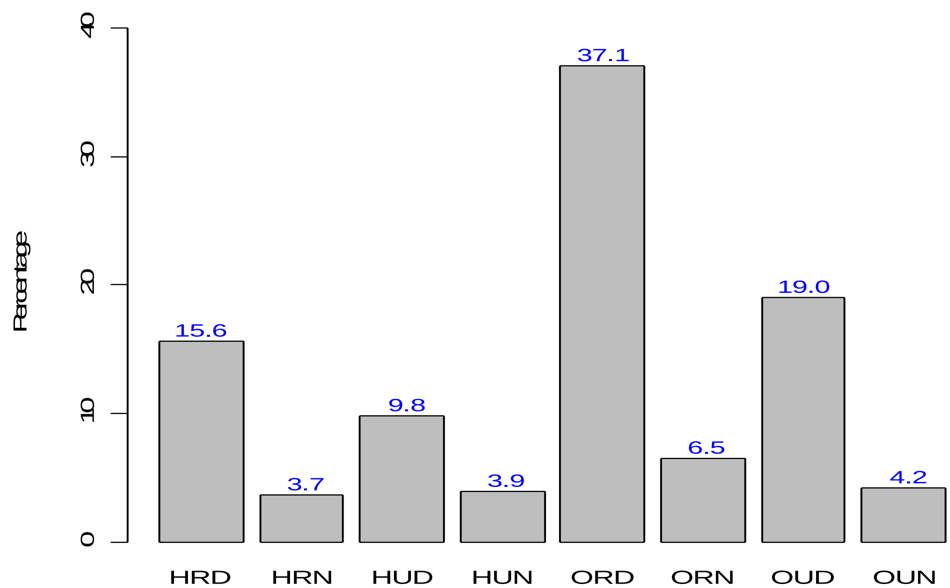
Driver Previuos Accidents

	Work		Strt Van		Semi		Cars	
	N	%	N	%	N	%	N	%
None	4,274	75.4	1,487	76.3	11,400	74.4	21,297	77.8
Exactly 1	819	14.5	253	13.0	2,067	13.5	3,108	11.4
More than 1	219	3.9	71	3.6	535	3.5	679	2.5
Unknown	355	6.3	139	7.1	1,312	8.6	2,290	8.4
Total	5,667	100.0	1,950	100.0	15,314	100.0	27,374	100.0

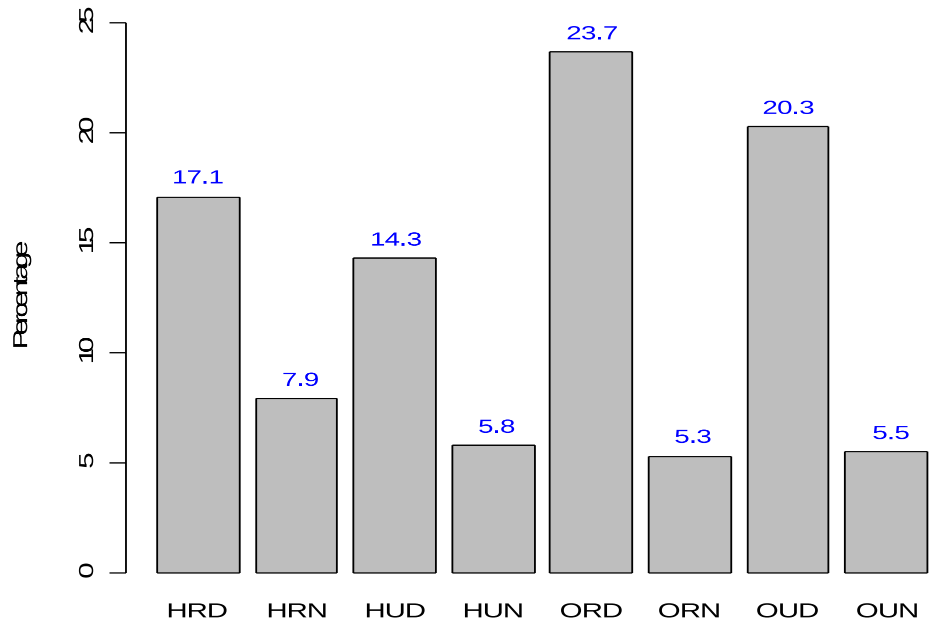
Appendix B: Percentages of Fatal Crash Involvement According to the National Highway System, Land Use, and Time of Day for Three Truck Configurations

Each bar represents the percentage of fatal crash involvement according to a combination of three variables: national highway system, land use, and time of day. For example, HRD represents the percentage of fatal crash involvement on the national highway system, in rural areas, during the day. The combination OUN represents the percentage of fatal crash involvement not on the national highway system, in urban areas, during the night. Three plots are presented. The first plot shows percentages for work trucks, the second plot shows percentages for straight truck vans, and the third plot shows percentages for semitrailers.

Percentages for Work Trucks



Percentages for Straight Truck Vans



Percentages for Semitrailers