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Accident Analysis and Prevention 36 (2004) 801–808

ACCIDENT ANALYSIS & PREVENTION

www.elsevier.com/locate/aap

Costs of large truck-involved crashes in the United States

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Received 10 February 2003; received in revised form 23 July 2003; accepted 25 July 2003

Abstract

This study provides the estimates of the costs of highway crashes involving large trucks by type of truck involved. These costs represent the present value of all costs over the victims' expected life span that result from a crash. They include medically related costs, emergency services costs, property damage costs, lost productivity, and the monetized value of the pain, suffering, and lost quality of life that a family experiences because of death or injury. Based on the latest data available, the estimated cost of police-reported crashes involving trucks with a gross weight rating of more than 10,000 pounds averaged US$ 59,153 (in 2000 dollars). Multiple combination trucks had the highest cost per crash (US$ 88,483). The crash costs per 1000 truck miles however, were US$ 157 for single unit trucks, US$ 131 for single combination trucks, and US$ 63 for multiple combinations.

Keywords: Truck; Crash; Cost; Injury

1. Introduction

Trucks with a gross weight rating of more than 10,000 pounds constitute the majority of interstate commercial vehicles. The total number of large trucks registered in the US in 2000 reached over 8 million, which represents an increase of 31% compared to 1991–1992. The vehicle-miles traveled by these vehicles increased even more (36%). These increases were accompanied by smaller increases in the number of large truck-involved crashes (28%), and the number of people injured or killed in such crashes (12%) (CRASH, 2003). Large truck involved-crashes represent a relatively small proportion of total crashes in the US—during 1991–1999, large trucks were involved only in 5.3% of crashes. However, large truck involved-crashes are more harmful than other crashes. During this period, on average, 438 people were injured or killed per 1000 large truck involved-crashes reported to the police versus 325 in other reported crashes. In 2000, 5211 people died in the US because of crashes involving large trucks (CRASH, 2003). Of these, only 14% were large truck occupants. Another 139,663 people were non-fatally injured in crashes involving large trucks. Of these, only 23% were large truck occupants.

According to 1997 Vehicle Inventory and Use Survey (VIUS) data on truck mileage (Bureau of the Census, 1999), single combination trucks are the most used trucks in the US. They drive 71% of all miles traveled by large trucks. Single unit trucks drive 26%, and multiple combinations only 3%. Currently, 16 states allow multiple combination trucks to operate.

Crashes involving large trucks impose a variety of costs on the vehicle and its driver, other drivers either directly or indirectly involved in the crash, and society as a whole. In addition to costs such as property damage, emergency services, and travel delays, injuries and fatalities impose significant costs. This study provides unit costs of large (medium and heavy) vehicle crashes, stated in 2000 dollars.

Miller et al. (1991) made a first attempt to estimate US truck crash costs. They first computed costs by threat-to-life severity measured by Maximum Abbreviated Injury Score (MAIS; Association for the Advancement of Automotive Medicine (AAAM), 1985). The Abbreviated Injury Score (AIS) scheme is a detailed medical classification developed by physicians as a basis for rating the survival threat injuries pose. It assigns a numeric rating ranging from 0 (uninjured) to 6 (maximum, generally unsurvivable). National Highway Traffic Safety Administration (NHTSA) data sets that are AIS-coded add codes for "injured, severity unknown" and "unknown if injured." MAIS is simply the maximum AIS among the multiple injuries a victim suffers. The purpose of the AIS scale is to differentiate injuries by survival threat, not the cost, functional losses, or course of recovery they involve. For example, loss of teeth is an AIS-1 injury that can involve substantial costs and lifetime pain and suffering. Conversely, timely surgery often allows complete and rapid

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0001-4575/$ – see front matter © 2003 Elsevier Ltd. All rights reserved.
doi:10.1016/j.aap.2003.07.006

recovery from ruptured spleens and other AIS-3–5 internal injuries. Nevertheless, average costs per case within a body region usually rise with MAIS (Miller, 1993).

By multiplying average costs per highway crash victim by MAIS times the MAIS distribution of victims in crashes sorted by the heaviest vehicle involved, Miller et al. (1991) estimated costs by vehicle type. Those estimates implicitly assumed that the distribution of injuries by body region within an AIS severity level did not vary with vehicle type. Only property damage and crash-related travel delay costs were tailored to truck crashes.

Miller et al. (1998c) improved on Miller et al. (1991) by computing medium/heavy vehicle crash costs by vehicle type from 1982 to 1992 data on victim MAIS and body region in medium/heavy vehicle crashes. It presented a detailed analysis of crash types and etiology, and the respective differentials in costs. It also provided an analysis of vehicle-level costs for multi-vehicle crashes. Zaloshnja et al. (2000) paralleled Miller et al. (1998c) methods. It updated its estimates and substantially increased the number of cases used to estimate the injury distribution for occupants of light passenger vehicles involved in medium/heavy vehicle crashes. With the larger sample, it was able to more finely differentiate costs among heavy vehicle types and to differentiate costs of single versus multiple trailer crashes.

The present study updates and improves on unpublished estimates in Zaloshnja et al. (2000). Notably, differently from Zaloshnja et al. (2000), costs per non-fatally injured victim of a highway crash were estimated by MAIS, body part, and whether the victim suffered a fracture/dislocation. In addition to the more detailed diagnoses used in estimation, the accuracy of our estimates was increased by using current medical cost, wage, and income data. Property damage costs were updated using insurance data on commercial vehicles.

2. Methods

Estimating crash costs requires estimates of the number of people and vehicles involved in a crash, the severity of each person's injuries, and the costs of those injuries and associated vehicle damage and travel delay. The following section describes the methodology used to estimate the incidence and severity of large truck crashes. The succeeding section explains how the costs of crashes were estimated.

2.1. Incidence and severity estimation

To estimate injury incidence and severity, we followed procedures developed by Miller and Blincoe (1994) and Miller et al. (1995a), and applied in Zaloshnja et al. (2000) and Blincoe et al. (2002). Our estimates of the average number of people and vehicles involved in a medium/heavy vehicle crash by vehicle type, restraint use, crash severity, and police-reported injury severity come from NHTSA's Fatality Analysis Reporting System (FARS) and General Estimates System (GES).

Crash databases do not accurately describe the severity of large truck crashes. Accordingly, we made several adjustments to more accurately reflect the severity of crashes. These adjustments are described below.

FARS is a census of US fatal crashes but it does not describe injuries to survivors in these crashes. GES provides a sample of US crashes by police-reported severity for all crash types. GES records injury severity by crash victim on the KABCO scale (National Safety Council, 1990) from police crash reports. Police reports in almost every state use KABCO to classify crash victims as K: killed, A: disabling injury, B: evident injury, C: possible injury, or O: no apparent injury. KABCO ratings are coarse and inconsistently coded between states and over time. The codes are selected by police officers without medical training, typically without benefit of a hands-on examination. Some victims are transported from the scene before the police officer that completes the crash report even arrives. Miller et al. (1991) and Blincoe and Faigin (1992) documented the great diversity in KABCO coding across cases. O'Day (1993) more carefully quantified the great variability in use of the A (injury) code between states. Viner and Conley (1994) explained the contribution to this variability of differing state definitions of A (injury). Miller et al. (1987) found police-reported injury counts by KABCO severity systematically varied between states because of differing state crash reporting thresholds (the rules governing which crashes should be reported to the police). Miller and Blincoe (1994) found that state reporting thresholds often changed over time.

Thus, police reporting does not accurately describe injuries medically. To minimize the effects of variability in severity definitions between states, reporting thresholds, and police perception of injury severity, we turned to NHTSA data sets that included both police-reported KABCO and medical descriptions of injury in the Occupant Injury Coding system (OIC; AAAM, 1985, 1990). OIC codes include AIS score and body region, plus more detailed injury descriptors that changed from the 1985 to the 1990 edition. We used both 1993–1999 Crashworthiness Data System (CDS; National Highway Traffic Safety Administration, 2000) and 1982–1986 National Accident Sampling System (NASS; National Highway Traffic Safety Administration, 1987) data. CDS describes injuries to passenger vehicle occupants involved in tow-away crashes. The 1982–1986 NASS data provide the most recent medical description available of injuries to medium/heavy truck occupants, non-occupants, and other non-CDS crash victims. The NASS data were coded with the 1980 version of AIS, which differs slightly from the 1985 version; but NHTSA made most AIS-85 changes well before their formal adoption. The CDS data were coded in AIS-90.

We used 1990–1999 GES data to weight the CDS and NASS data so they represent the annual estimated GES injury victim counts in medium/heavy vehicle crashes by CDS and NASS sample strata. In applying these weights, we controlled for crash type (as defined by the truck type involved), police-reported injury severity, restraint use, and vehicle occupied (or non-occupant). Weighting the NASS data to GES restraint use levels updates the NASS injury profile to a profile reflecting contemporary belt-use levels. Again, sample size considerations drove the decision to pool all available data. At the completion of the weighting process (Fig. 1), we had a hybrid CDS/NASS file with weights that summed to the estimated annual GES incidence by police-reported injury severity and other relevant factors.

Trucks with a gross weight rating of over 10,000 pounds were grouped into the following categories: (a) straight truck, no trailer; (b) straight truck with trailer; (c) straight truck, unknown if with trailer; (d) truck tractor with no trailer (bobtail); (e) truck tractor with one trailer; (f) truck tractor with two or three trailers; (g) truck tractor with unknown number of trailers; (h) medium/heavy truck, unknown if with trailer; and (i) all large trucks.

In order to create reasonable sample sizes, two assumptions were made in the categorization of trucks. Trucks that were reported in the GES and FARS data as medium/heavy trucks and had no trailing units were assumed to be straight trucks with no trailer. Trucks that were reported as unknown medium/heavy trucks and had more than one trailing unit were assumed to be truck tractors with two or three trailers. Straight trucks with trailer and medium/heavy trucks with one trailer were grouped together.

2.2. Cost estimation

The second step required to estimate average crash costs is to generate estimates of crash costs by severity. This section describes the process used to develop these estimates. In order to estimate the average costs per crash by medium/heavy vehicle type and crash severity, costs per injury by MAIS-85 or MAIS-90 as appropriate, body part, and whether the victim suffered a fracture/dislocation were adapted from the costs in Zaloshnja et al. (2004). These costs were merged onto the GES-weighted NASS/CDS file. The costs represent the present value, computed at a 4% discount rate, of all costs over the victim's expected life span that result from a crash. We included the following major categories of costs: (a) medically related costs, (b) emergency services, (c) property damage, (d) lost productivity, and (e) monetized quality-adjusted life years (QALYs).

Medically related cost: It includes ambulance, emergency medical, physician, hospital, rehabilitation, prescription, and related treatment costs, as well as ancillary costs for crutches, physical therapy, and so forth. To estimate medical costs, we started from nationally representative samples that use International Classification of Diseases 9th Revision Clinical Modification (ICD9-CM) diagnosis codes to describe the injuries of US crash victims, namely, the 1996–1997 National Hospital Discharge Survey (NHDS) for hospital-admitted victims and the 1990–1996 National Health Interview Survey (NHIS) for non-hospitalized victims. The analysis included the following steps, some of which are explained in further detail in Miller et al. (1998a, 2000), Lawrence et al. (2000), and Zaloshnja et al. (2004): (a) assign a cause or probabilistic cause distribution for each NHDS and NHIS case; (b) estimate the costs associated with each crash case in NHDS and NHIS; (c) use ICDmap-85 and ICDmap-90 (Johns Hopkins University and Tri-Analytics, 1997) to assign 1985 and 1990 Occupant

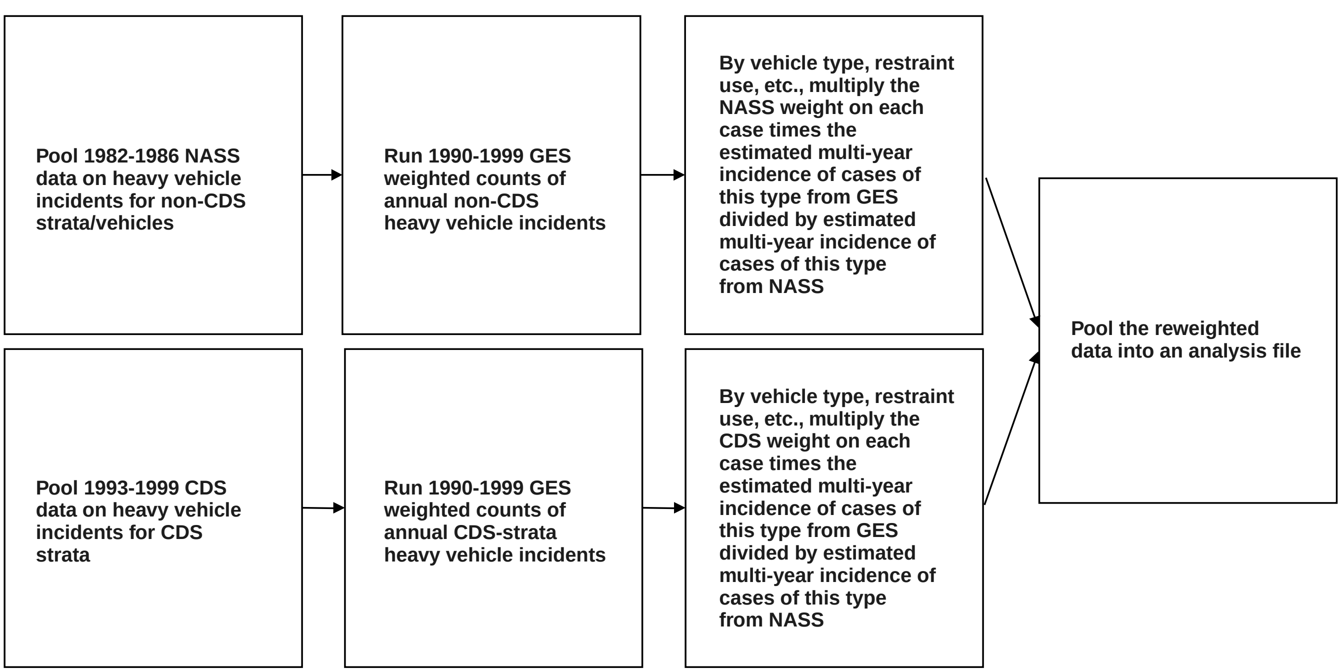

Fig. 1. The merger of NASS, CDS, and GES files.

Injury Codes (OIC) or code groups to each NHDS and NHIS case; (d) collapse the code groups to achieve adequate case counts per cell by MAIS, body part, and whether fracture/dislocation was involved; (e) tabulate ICD-based costs by MAIS, diagnosis code grouping, and whether hospital-admitted; and (f) estimate the percentage of hospital-admitted cases by diagnosis group from 1996 to 1999 CDS and apply it to collapse the cost estimates to eliminate hospital admission status as a stratifier (necessary because current admission rates are unknown for crash victims in non-CDS strata).

Six percent of AIS/body part/fracture diagnosis categories that appear in CDS crash data did not appear in the ICD-based files. Costs for these categories were assigned as follows: (a) mean costs were estimated for each AIS; (b) based on these averages, incremental cost ratios from one preferably lower AIS to another were estimated (lower AIS was preferred because it offered larger case counts); and (c) costs for empty ICD-based cells were assigned by multiplying costs from adjacent cells by this ratio. For instance, if the mean medical costs for AIS-2 and AIS-3 were US$ 500 and 1000, respectively, then the incremental ratio for AIS-2 to AIS-3 was set to: $1000/500 = 2$. Then the cost for an empty AIS-3 cell was estimated by multiplying the body part/fracture-specific cost for AIS-2 times the ratio. In the end, we were unable to assign costs through this procedure for cases in the trunk area, and where the OIC codes did not specify organ or body part. For these residual cases, a general average cost for the appropriate AIS was assigned.

Emergency services cost: It includes police and fire services. Police and fire costs were computed from assumed response patterns by crash severity and vehicle involvement, constrained by data on total responses. For fatal, injury, and property damage only (PDO) crashes, time spent per police cruiser responding came from 10 jurisdictions with automated police time-tracking systems. Based on anecdotal information, we assumed that a single officer responded to a PDO crash and one officer per injury to other crashes. Time spent per fire truck responding came from nine large fire departments. Consistent with a model developed to allocate total fire department crash responses among crash types (Miller et al., 1991), we assumed that fire personnel would respond to: (a) 90% of fatal and severe injury crashes and 95% of critical injury crashes, (b) 40% of other heavy truck crashes involving injury, and (c) 25% of police-reported heavy truck crashes involving only property damage.

Property damage: It is the cost to repair or replace damaged vehicles, cargo, and other property, including the costs of damage compensation. To estimate property damage in heavy vehicle crashes, we first purchased aggregated Insurance Services Office (ISO) data detailing coverage and claims experience with 28.9% of all motor vehicle insurance premiums collected for commercial vehicles. We assumed the percentage covered does not vary by vehicle type. The insurance data included payments per insurance claim and aggregate payments for damage to the insured vehicle, and separately, for damage it inflicted on other vehicles in at-fault crashes. We used GES data to estimate the vehicles involved per crash, which let us estimate costs per crash. The data distinguished medium trucks, but imperfectly differentiated tractor-trailers from other heavy trucks. Separate property damage costs for trailers insured separately allowed us to compute cost differentials for multi-trailer vehicles (we assumed that 10% were triples and the remainder doubles). Net of the insurance deductible of an estimated US$ 1000 per crash, costs per crash-involved vehicle averaged US$ 4341 in medium/heavy straight truck crashes, US$ 6872 in single-trailer combination truck crashes, and US$ 18,132 in multi-trailer truck crashes.

Lost productivity: It includes wages, fringe benefits, and household work lost by the injured, as well as the costs of processing productivity loss compensation claims. It also includes productivity loss by those stuck in crash-related traffic jams and by co-workers and supervisors investigating crashes, recruiting and training replacements for disabled workers, and repairing damaged company vehicles. Excluded are earnings lost by family and friends caring for the injured and the value of schoolwork lost. The productivity loss resulting from traffic delay is tabulated separately and as part of total productivity lost.

Future work loss costs were estimated using methods that parallel the Consumer Product Safety Commission (CPSC) Injury Cost Model. These methods are summarized below and documented in detail in Miller et al. (1998b, 2000), Lawrence et al. (2000), Blincoe et al. (2002), and Zaloshnja et al. (2004). For nonfatal injuries, the work loss cost is the sum of the lifetime loss due to permanent disability (averaged across permanently disabling and non-disabling cases) plus the loss due to temporary disability. We first computed lifetime wage and household work losses due to a death or permanent total disability and discounted them to present value with the standard age-earnings model described in Rice et al. (1989) and Miller et al. (1998b). The inputs to this model were for 1997–2000. They include, by age group and sex, survival probabilities from National Vital Statistics Reports (National Center for Health Statistics, 1999); weighted estimates of annual earnings tabulated from the 2001 Current Population Survey, a nationally representative sample; and the value of household work performed from Expectancy Data (1999).

For survivors, we applied National Council on Compensation Insurance (NCCI) probabilities that an occupational injury will result in permanent partial or total disability and the NCCI percentage of earning power lost to partial disability to compute both the number of permanently disabled victims and the percentage of lifetime work lost. These data are by diagnosis group and whether hospital-admitted. We used the ICD maps to assign 1985 and 1990 OIC injury codes or code groups to each category.

Diagnosis-specific probabilities of injuries to employed people causing wage work loss came from CDS 1993 to 1999. The days of work loss per person losing work were estimated from the 1999 Survey of Occupational Injury and Illness of the US Bureau of Labor Statistics; this survey contains employer reports of work losses for more than 600,000 workplace injuries coded in a system akin to the OIC but with less diagnostic detail. According to a survey of 10,000 households, injured people lose housework on 90% of the days they lose wage work (S. Marquis, The RAND Corporation, Personal Communication, 1992). Thus, we were able to compute the days of household work lost from the days of wage work lost. Household work was valued based on the cost of hiring people to perform household tasks (e.g. cooking, cleaning, yard work) and the hours typically devoted to each task from Expectancy Data (1999). Lost productivity for repairing vehicles involved in crashes was updated from Miller et al. (1991) and included in the lost household productivity.

For temporary disability, we assumed that an adult caregiver would lose the same number of days of wage work or housework because of a child's temporarily disabling injury as an adult would lose when suffering the same injury. Since the adult with the lowest salary often stays home as the caregiver, we estimated caregiver wages as the mean hourly earnings for non-supervisory employees in private non-agricultural industries. These assumptions may overestimate slightly because the caregiver may be able to do some work at home. Conversely, we may underestimate the losses because we ignored (a) the work loss of other individuals who visit a hospitalized child or rush to the child's bedside shortly after an injury and (b) any temporary wage work or household work loss by adolescents.

Legal and insurance administration costs per crash victim were derived from the medical and work loss costs, using models developed by Miller (1997). Legal costs include the legal fees and court costs associated with civil litigation resulting from motor vehicle crashes. The estimates used data on the probability of losing work, the percentage of victims who claimed, the percentage of claimers who hired an attorney, estimated plaintiff's attorney fees, and the ratio of legal costs over plaintiff's attorney fees. Insurance administration costs include the administrative costs associated with processing insurance claims resulting from motor vehicle crashes and defense attorney fees. These estimates used data on medical expense claims, liability claims, disability insurance, Worker's Compensation, welfare payments, sick leave, property damage, and life insurance.

Following Blincoe et al. (2002) and Zaloshnja et al. (2004), travel delay was computed similarly to Zaloshnja et al. (2000), but with three refinements. First, using a newer and broader survey of five police departments, the hours-of-delay ratio was updated to 49:86:233 for the delays due to PDO, injury, and fatal crashes, respectively. Second, to extract delay-per-person from delay-per-crash we used data on the average number of people killed or injured in a heavy vehicle crash. Finally, we conservatively assumed that only police-reported crashes delay traffic. This is based on the premise that any substantial impact on traffic would attract the attention of the police.

Monetized quality-adjusted life years (QALYs): Monetary losses associated with medical care, other resources used, and lost work do not fully capture the burden of injuries. Injuries also cost victims and families by reducing their quality of life. The good health lost when someone suffers a health problem or dies can be accounted for by estimating QALYs lost. A QALY is a health outcome measure that assigns a value of 1 to a year of perfect health and 0 to death (Gold et al., 1996). QALY loss is determined by the duration and severity of the health problem. To compute it, following Miller (1993), we used diagnosis and age-group specific estimates from Miller et al. (1995b) of the fraction of perfect health lost during each year that a victim is recovering from a health problem or living with a residual disability. Such an impairment fraction was estimated by body part, AIS-85, and fracture/dislocation. The resulting estimates in AIS-85 were applied to NHDS and NHIS cases. The monetary value of a QALY (US$ 98,527) was derived by dividing the value of statistical life (VSL) net of lost productivity by the number of years in the person's life span, with future years discounted to present value at a 4% discount rate (Gold et al., 1996; Cropper et al., 1991; Viscusi and Moore, 1989). We followed the guidance of the Office of the Secretary of Transportation, setting the VSL at US$ 3 million (US Department of Transportation, 2002).

3. Results

During the last decade of the 20th century only 5.8% of large truck-involved crashes in the United States caused incapacitating or fatal injuries (Table 1); 69% of the crashes did not cause any injury. Around 60% of truck crash victims were involved in tractor–trailer crashes. The estimated cost of police-reported crashes involving trucks with a gross weight rating of more than 10,000 pounds averaged US$ 59,153 (Table 2). These costs represent the present value, computed at a 4% discount rate, of all costs over the victims' expected life span that result from a crash. They include medically-related costs, emergency services costs, property damage costs, lost productivity, and the monetized value of the pain, suffering, and quality of life that the family loses because of a death or injury.

The cost of crashes in which truck–tractors with two or three trailers were involved was the highest among all crashes—US$ 88,483 per crash. The costs-per-crash with injuries averaged US$ 164,730 for large truck crashes. (Detailed cost-per-crash estimates for different truck configurations and crash severity are available upon request.) Computed with 1997 Vehicle Inventory and Use Survey (VIUS) data on truck mileage (Bureau of the Census, 1999), the crash costs per 1000 truck miles are US$ 157 for single unit trucks, US$ 131 for single combination trucks, and US$ 63 for multiple combinations.

Table 1
The annual number of truck-involved crashes, by crash severity (1990–1999)

Truck crash type	Maximum severity in crash							Total
	No injury	Possible injury	Non-incapacitating	Incapacitating	Fatal injury	Unknown severity	Unknown if injured	
Straight truck, no trailer	89388	16046	9418	5392	763	435	6586	128028
Straight truck with trailer	8253	1258	877	599	116	17	1110	12229
Straight truck, unknown if with trailer	126	2	5	4	3	0	34	173
Bobtail	6730	1164	666	415	194	49	655	9873
Truck–tractor, 1 trailer	120640	18187	13186	8790	2698	376	11323	175200
Truck–tractor, 2 or 3 trailers	3450	597	361	261	160	0	382	5212
Truck–tractor, with unknown # of trailers	775	39	13	33	35	0	275	1170
Medium/heavy truck, unknown if with trailer	2295	389	175	63	7	5	1473	4406
All large trucks	231656	37683	24702	15556	3974	883	21837	336292

Source: GES and FARS.

Table 2
Costs per crash, by type of truck involved (in 2000 dollars)

Truck crash type	Medical costs	Emergency services	Property damage	Lost productivity from delays	Total lost productivity	Monetized QALYs based on VSL from DOT	Total
Straight truck, no trailer	2286	177	4341	4887	15514	18690	41008
Straight truck with trailer	4569	204	6793	5116	24018	39220	74804
Straight truck, unknown if with trailer	2775	142	4548	4279	7685	6047	21196
Bobtail	1976	168	5961	5988	16554	18508	43167
Truck–tractor, 1 trailer	3854	186	6872	4677	23039	38509	72459
Truck–tractor, 2 or 3 trailers	3816	184	18132	4447	24302	42048	88483
Truck–tractor, with unknown # of trailers	1901	130	7296	4232	10778	11399	31505
Medium/heavy truck, unknown if with trailer	2051	157	5873	4184	8624	8835	25540
All large trucks	3195	182	6035	4800	19794	29945	59153

Table 3
Average annual crash costs, by type of truck involved: 1997–1999 (in millions of 2000 dollars)

Truck crash type	Medical costs	Emergency services	Property damage	Lost productivity from delays	Total lost productivity	Monetized QALYs based on VSL from DOT	Total
Straight truck, no trailer	300	24	608	692	1946	2089	4966
Straight truck with trailer	92	3	107	78	397	659	1259
Straight truck, unknown if with trailer	0	0	0	0	0	0	0
Bobtail	13	1	49	51	91	47	201
Truck–tractor, 1 trailer	697	35	1289	884	4015	6529	12564
Truck–tractor, 2 or 3 trailers	24	1	109	26	155	268	557
Truck–tractor, with unknown # of trailers	2	0	6	3	6	3	16
Medium/heavy truck, unknown if with trailer	5	1	23	17	26	12	66
All large trucks	1133	65	2190	1752	6636	9606	19630

The average annual cost of large truck-involved crashes in 1997–1999 exceeded US$ 19.6 billion, or 5.9% of the total cost of highway crashes. That cost included US$ 6.6 billion in productivity losses, US$ 3.4 billion in resource costs, and US$ 9.6 billion in quality of life losses (Table 3).

4. Discussion

Safety analysts can use these crash cost data for a variety of purposes, from analyzing the effectiveness of a particular roadway enhancement to measuring the impact of safety programs. Crash costs are used to compare the relative efficacy of various crash countermeasures, which are expected to have a differential impact on crashes of different truck types. These figures are also used to calculate and compare the cost-effectiveness of proposed safety regulations. Efficient allocation of research, enforcement, and analysis resources requires reliable data on crash costs.

Within the constraints of available data, this study provides economically sophisticated, reliable estimates of the average costs of medium/heavy vehicle crashes. Because of the changes in methodology and the use of newer sources of cost data, there are noticeable differences between the unit costs presented in this report and those in Zaloshnja et al. (2000). The monetary costs reported here represent a major improvement on Zaloshnja et al. (2000), because they are based on costs per injury by MAIS, body part, and whether the victim suffered a fracture/dislocation. Previously, costs per injury were estimated only by MAIS and body region. In addition, QALYs are now more accurately estimated because they are diagnosis, age, and sex specific. Previously, they were group-diagnosis, group-age, and sex specific. In estimating the productivity loss due to travel delays, we assumed that only police reported crashes delay traffic. This was based on the premise that any substantial impact on traffic would attract the attention of police. The property damage costs also are much better as they differentiate truck type. Due to lack of data, these cost estimates exclude mental health care costs for crash victims, roadside furniture repair costs, cargo delays, earnings lost by family and friends caring for the injured, and the value of schoolwork lost.

Our analysis finds that multiple combination truck crashes cost more than any other crash. However, on a per truck-mile basis, these crashes have by far the lowest cost. The cost differential would be even larger if computed per ton-mile of freight moved. This finding merits probing. It is unclear whether it results, for example, from a greater tendency for multiple combinations to travel on interstate highways, which are the nation's safest, from assignment of the best drivers to these top-end rigs, or from an inherently safer way to move goods. Future research should also focus on roadway classification, speed, and surrounding land use and environment.

Acknowledgements

This work was funded in part by Federal Motor Carrier Safety Administration Contract DTMC75-01-P-00046 and NIOSH Grant R01 OH03750. All errors and opinions are solely the authors.

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