

# Economic Cost of Traffic Accidents in Relation to the Vehicle

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This paper discusses accidents in Massachusetts in which Massachusetts registered vehicles were involved and the resulting economic costs. The data were developed by the Massachusetts Department of Public Works and the Registry of Motor Vehicles in cooperation with the U. S. Bureau of Public Roads. It covers the involvements of passenger cars in traffic accidents during 1953 and the involvements of trucks in traffic accidents during 1955. The purpose is to present the cost of accidents in relation to the vehicle in a way that will be helpful both to those interested in pinpointing where prevention efforts should be centered and to those engaged in the economic analysis of highway improvements. It is not the purpose to fix the responsibility for accidents by type of vehicle but rather to show what kinds of vehicles were involved and the extent of the involvement in terms of cost.

Involvement and cost data are analyzed separately for passenger cars and trucks by age of vehicle and severity of accident. Further analyses are made of trucks involved in accidents and their direct costs in relation to the registered gross weight and type of truck. Comparisons are made throughout the report on the basis of the involvements per 100 million vehicle-miles and the accident cost per vehicle-mile.

An involvement is one vehicle in one accident. For example, in the passenger car study if a passenger car hit a pedestrian there was 1 involvement in 1 accident. If 2 passenger cars collided with each other there were 2 involvements in 1 accident. Also, in the passenger car study if a passenger car collided with a truck this was 1 passenger car involvement in 1 accident. The truck involvement was not included in the passenger car study.

## OVER-ALL ACCIDENT EXPERIENCE

● THERE WERE 1, 239, 596 passenger cars and 179, 610 trucks registered in Massachusetts during 1953 and 1955, respectively. Table 1 shows that passenger cars were driven 11.6 billion vehicle-miles and that trucks were driven about 2 billion vehicle-miles. The truck mileage was about 17 percent of the miles driven by passenger cars. The direct cost of passenger car accidents was \$50, 223, 500 as compared to a truck accident cost of \$4, 773, 590. The cost attributable to trucks was about 9.5 percent of the cost of passenger cars. These direct costs consist of the money value of damage to property, medical costs resulting from injuries to persons, value of time lost, loss of use of motor vehicle, legal and court costs, damages awarded in excess of costs,

TABLE 1  
 NUMBER OF VEHICLES REGISTERED IN MASSACHUSETTS (PASSENGER  
 CARS, 1953, AND TRUCKS, 1955) AND THEIR TRAVEL, CLASSIFIED  
 BY AGE OF VEHICLE

Age of Vehicle (yr)	Number of Vehicles	Percent of Total	Vehicle Travel		
			Total Mileage (thousands)	Percent of Total	Average Annual Mileage
(a) Passenger Cars Registered in 1953					
Under 2	257,852	20.8	3,331,000	28.6	12,918
2 - 4	333,947	26.9	3,390,000	29.2	10,151
4 - 8	356,030	28.7	3,143,000	27.0	8,828
8 and older	291,767	23.6	1,764,000	15.2	6,046
<b>Total</b>	<b>1,239,596</b>	<b>100.0</b>	<b>11,628,000</b>	<b>100.0</b>	<b>9,380</b>
(b) Trucks Registered in 1955					
Under 2	27,074	15.1	354,737	17.4	13,102
2 - 4	27,343	15.2	395,707	19.4	14,472
4 - 8	67,913	37.8	794,942	39.0	11,705
8 and older	57,280	31.9	494,710	24.2	8,637
<b>Total</b>	<b>179,610</b>	<b>100.0</b>	<b>2,040,096</b>	<b>100.0</b>	<b>11,358</b>

and miscellaneous items. All of these cost elements usually are involved in the cost of fatal or non-fatal injury accidents. In property-damage-only accidents there are no medical expenses.

In addition to the total direct costs of traffic accidents just described there were other direct costs in connection with non-traffic accidents, traffic incidents and non-traffic incidents that are not covered in this report. Non-traffic accident involvements—accidents involving motion but not occurring on a public roadway—resulted in additional direct costs of \$2,698,000 for passenger cars and \$327,000 for trucks. Traffic incidents—mishaps on public roads but not involving motion and usually involving either vandalism, fire, or Acts of God—resulted in direct costs of \$2,361,000 for passenger cars and \$276,000 for trucks. Non-traffic incidents—mishaps not on public roads and not involving motion and usually involving either vandalism, fire, or Acts of God—resulted in direct costs of \$2,327,000 for passenger cars and \$589,000 for trucks. This analysis is confined to the \$50,223,500 for passenger cars and \$4,773,590 for trucks which comprise the direct costs of motor-vehicle traffic accidents in Massachusetts.

It is evident that trucks have an appreciably lower over-all accident cost per mile. The cost per mile was 0.23 cents for trucks and 0.43 cents for cars. Comparison of the cost of accidents by severity (Fig. 1) shows that the direct cost of operating a passenger car 1 mi was 0.17 cents for property-damage-only accidents while for trucks in similar accidents it was 0.07 cent. For non-fatal injury accidents it was 0.25 cent per mile of passenger car operation and 0.14 cent per mile of truck operation. Only for the fatal-injury accidents was the rate for trucks higher, being 0.014 cent for passenger cars and 0.027 cent for trucks for each mile of vehicle operation.

It should be noted that for fatal-injury accidents, the cost per mile for cars is almost one-half that for trucks but that for non-fatal-injury accidents and property-damage-only accidents the cost per passenger car mile of travel is about  $2\frac{1}{2}$  and 2 times that for trucks. These last two classes of accidents account for by far the greater part of the cost of accidents.

Figure 2 compares the average cost per involvement of passenger cars and trucks.

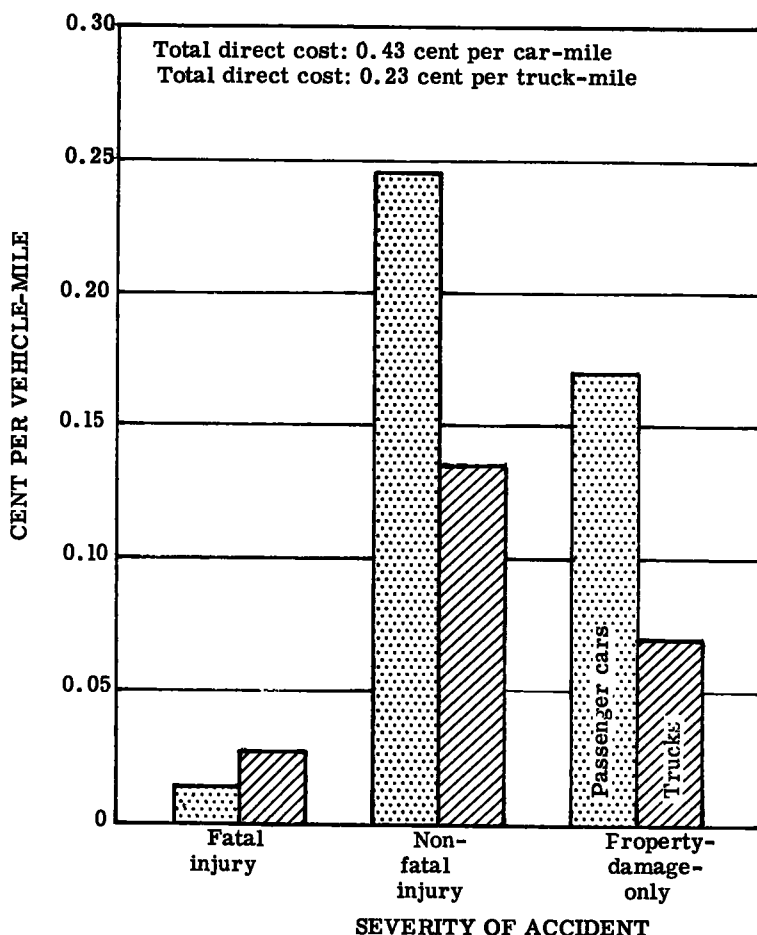


Figure 1. Direct cost of traffic accidents in Massachusetts per passenger-car-mile of travel during 1953, and per truck-mile of travel during 1955, classified by severity of accident.

The average cost per passenger car involvement was 27 percent more than the cost per truck involvement. This average cost for all involvements was heavily influenced by the fact that property-damage-only involvements account for the largest percentage of all accidents. It was because the average cost of truck involvements in property-damage-only accidents was only one-half that of passenger cars that trucks had a lower average cost per involvement in the case of all accidents. This was true even though the average cost of truck involvements was 43 percent higher for fatal-injury involvements and 16 percent higher for non-fatal-injury involvements than were the costs of similar involvements for passenger cars.

#### AGE OF VEHICLE

Table 2 summarizes the number of cars involved in accidents and the involvement rates by age of car and severity of accident. Similar data for trucks are given in Table 3. For purposes of orientation on involvements and accidents, 222,059 passenger cars were involved in 131,536 accidents. This total is comprised of 344 involvements in 315 fatal accidents, 54,260 involvements in 33,270 non-fatal-injury accidents, and 167,455 involvements in 97,951 property-damage-only accidents.

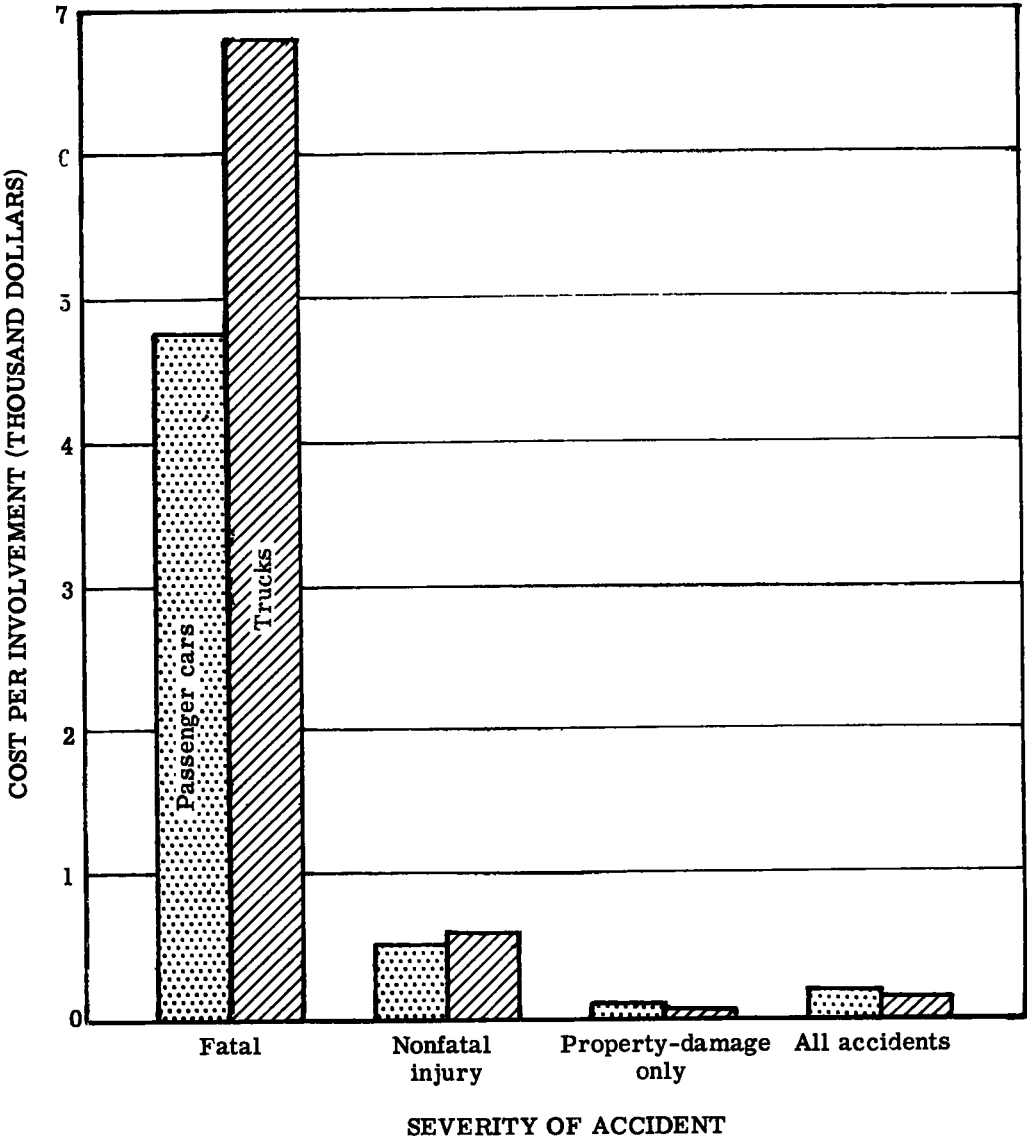


Figure 2. Comparison of the average cost of involvements for passenger cars and trucks.

TABLE 2  
NUMBER OF PASSENGER CARS INVOLVED IN MOTOR-VEHICLE TRAFFIC ACCIDENTS AND THE RATE PER 100 MILLION PASSENGER-CAR MILES, CLASSIFIED BY AGE OF CAR AND SEVERITY OF ACCIDENT

Age of Passenger Car (yr)	Passenger Cars Involved in								Number of Passenger Cars per 100 Million Passenger-Car Miles of Travel Involved in			
	Fatal-Injury Accident		Non-Fatal-Injury Accidents		Property-Damage-Only Accidents		All Accidents		Fatal-Injury Accidents	Non-Fatal-Injury Accidents	Property-Damage-Only Accidents	All Accidents
	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total				
Under 2	66	19.2	10,403	19.2	31,162	18.6	41,631	18.7	2.0	312	936	1,250
2 - 4	94	27.3	15,311	28.2	47,375	28.3	62,780	28.3	2.8	452	1,397	1,852
4 - 8	101	29.4	16,762	30.9	51,927	31.0	68,790	31.0	3.2	533	1,652	2,189
8 and older	83	24.1	11,784	21.7	36,991	22.1	48,858	22.0	4.7	668	2,097	2,770
<b>Total</b>	<b>344</b>	<b>100.0</b>	<b>54,260</b>	<b>100.0</b>	<b>167,455</b>	<b>100.0</b>	<b>222,059</b>	<b>100.0</b>	<b>3.0</b>	<b>467</b>	<b>1,440</b>	<b>1,910</b>

TABLE 3  
NUMBER OF TRUCKS INVOLVED IN MOTOR-VEHICLE TRAFFIC ACCIDENTS AND THE RATE PER 100 MILLION TRUCK-MILES,  
CLASSIFIED BY AGE OF TRUCK AND SEVERITY OF ACCIDENT

Age of Truck (yr)	Trucks Involved in:								Number of Trucks per 100 Million Truck-Miles of Travel Involved in:			
	Fatal-Injury Accidents		Non-Fatal-Injury Accidents		Property-Damage- Only Accidents		All Accidents		Fatal- Injury Accidents	Non-Fatal- Injury Accidents	Property- Damage-Only Accidents	All Accidents
	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total				
Under 2	19	23.2	705	15.6	4,080	18.9	4,804	16.7	5.4	200	1,150	1,355
2 - 4	13	15.9	959	21.3	4,749	19.6	5,721	19.9	3.3	242	1,200	1,466
4 - 8	26	34.1	1,881	41.7	9,395	38.8	11,304	39.2	3.5	237	1,182	1,442
8 and older	22	28.8	984	21.4	5,981	24.7	6,987	24.2	4.4	195	1,209	1,408
Total	82	100.0	4,509	100.0	24,205	100.0	28,796	100.0	4.0	223	1,186	1,412

In contrast, 28,796 trucks were involved in 27,041 accidents during 1955. Classified by severity there were 82 involvements in 77 fatal accidents, 4,509 involvements in 4,344 non-fatal-injury accidents, and 24,205 involvements in 22,648 property-damage-only accidents. The ratio of truck involvements to accidents is almost 1.1 to 1 (28,796 to 27,041), whereas the corresponding ratio for passenger cars was 1.7 to 1 (222,059 to 131,536).

The influence of age on the involvement rates of passenger cars and trucks is shown in Figure 3 for all accidents. In the case of passenger cars the rate increased steadily with age. The rate for passenger cars, 8 years and older, was more than twice that for cars under 2 years of age. This can be construed as a strong argument for vehicle inspection even though there are factors other than mechanical condition contributing to the situation. With respect to involvement rates, trucks appear to be ageless, there being no significant trend upward with age. Although the involvement rate for passenger

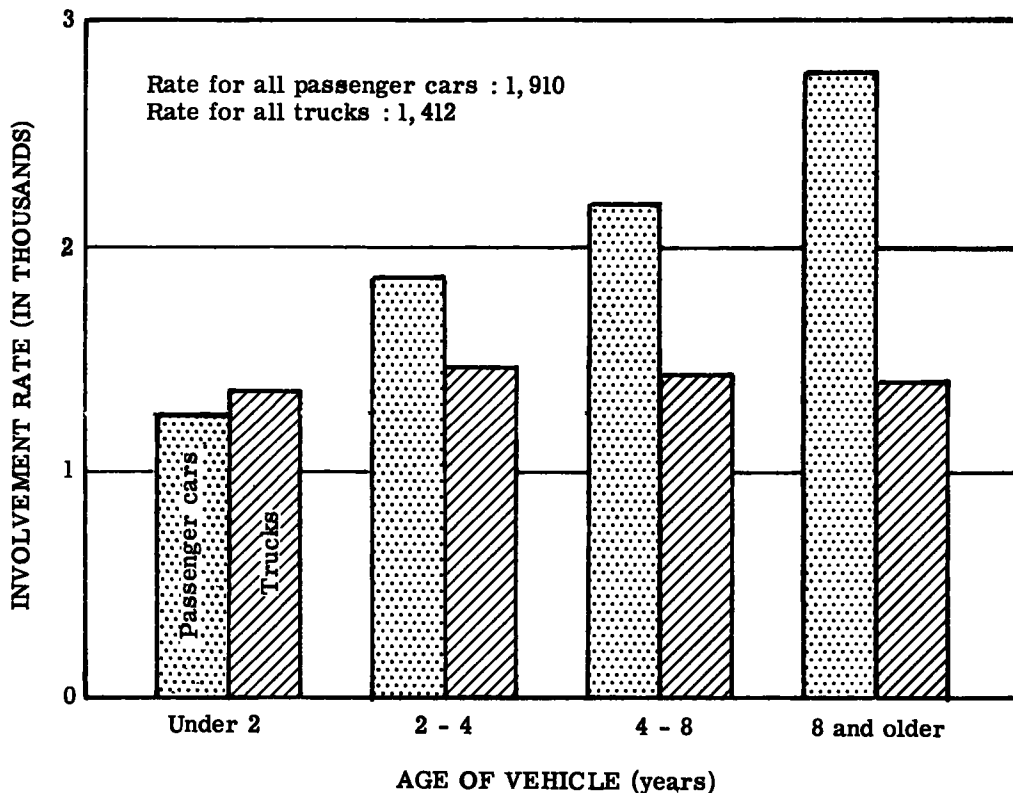


Figure 3. Comparison of involvement rates per 100 million vehicle-miles of travel for passenger cars and trucks by age of vehicle.

cars is generally higher than that for trucks, the rates are approximately the same for the group of vehicles under 2 years of age.

The characteristic of age established in Figure 3 for all accidents holds for all the severity classes except for the fatal-injury accidents. Throughout the report it will be seen that this class of accident has distinct characteristics in relation to the other two classes. Because of the difference, the fatal-injury class is considered separately in Figure 4. Just as for all accidents, the fatal involvement rate for passenger cars also increased with age. The difference was that the fatal involvement rate for trucks also increased with age, if the vehicles under 2 years of age are ignored. An important point is that the fatal rate for trucks is almost 3 times that for passenger cars for the vehicles less than 2 years of age. For other than the newest age group, the great difference in involvement rate between passenger cars and trucks observed in Figure 3 for all accidents is not evident for the fatal involvement. It is to be kept in mind that the number of fatal-injury accidents in proportion to the total is so small that their effect on the involvement rate or costs per mile for all accidents is very insignificant.

The relationship between accident cost per vehicle-mile and age of vehicle for each severity class of accident and for all accidents is shown in Figure 5 for passenger cars, and in Figure 6 for trucks. A comparison of the two figures which are drawn to the

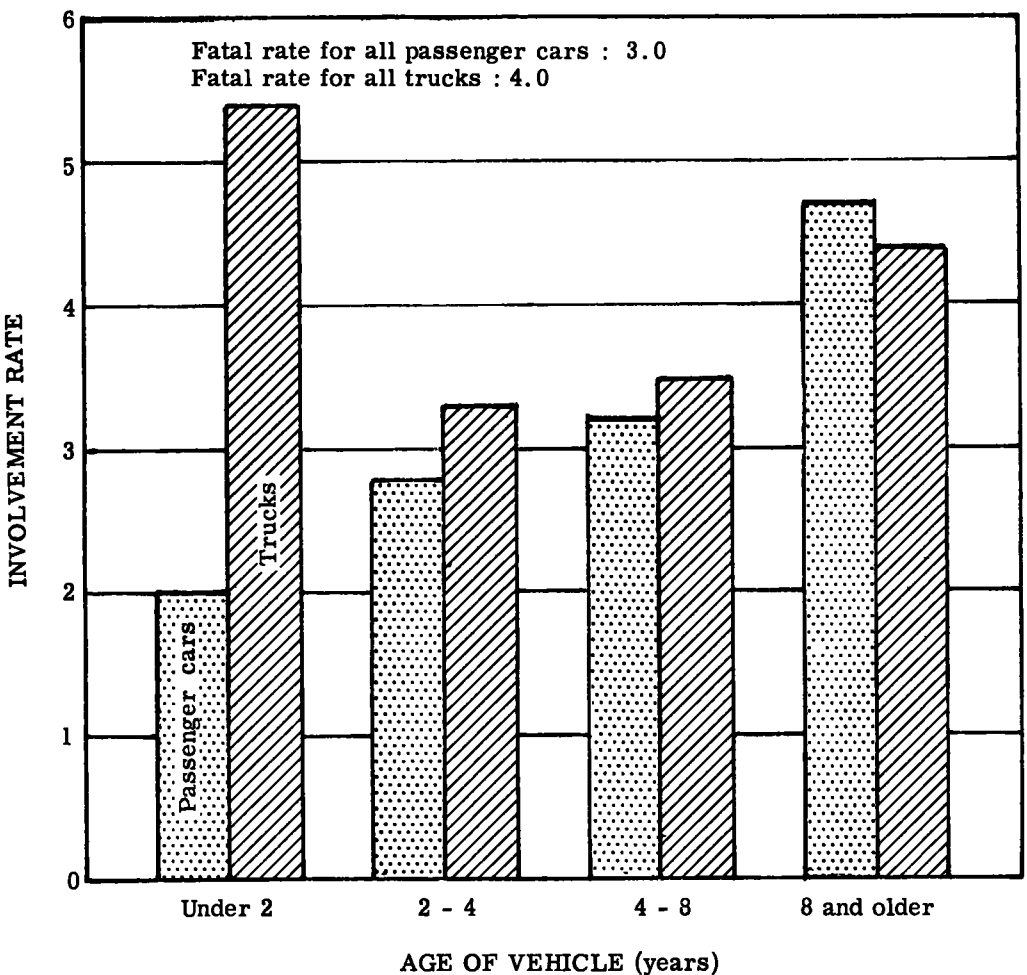


Figure 4. Comparison of fatal-injury accident involvement rates per 100 million vehicle-miles of travel for passenger cars and trucks by age of vehicle.

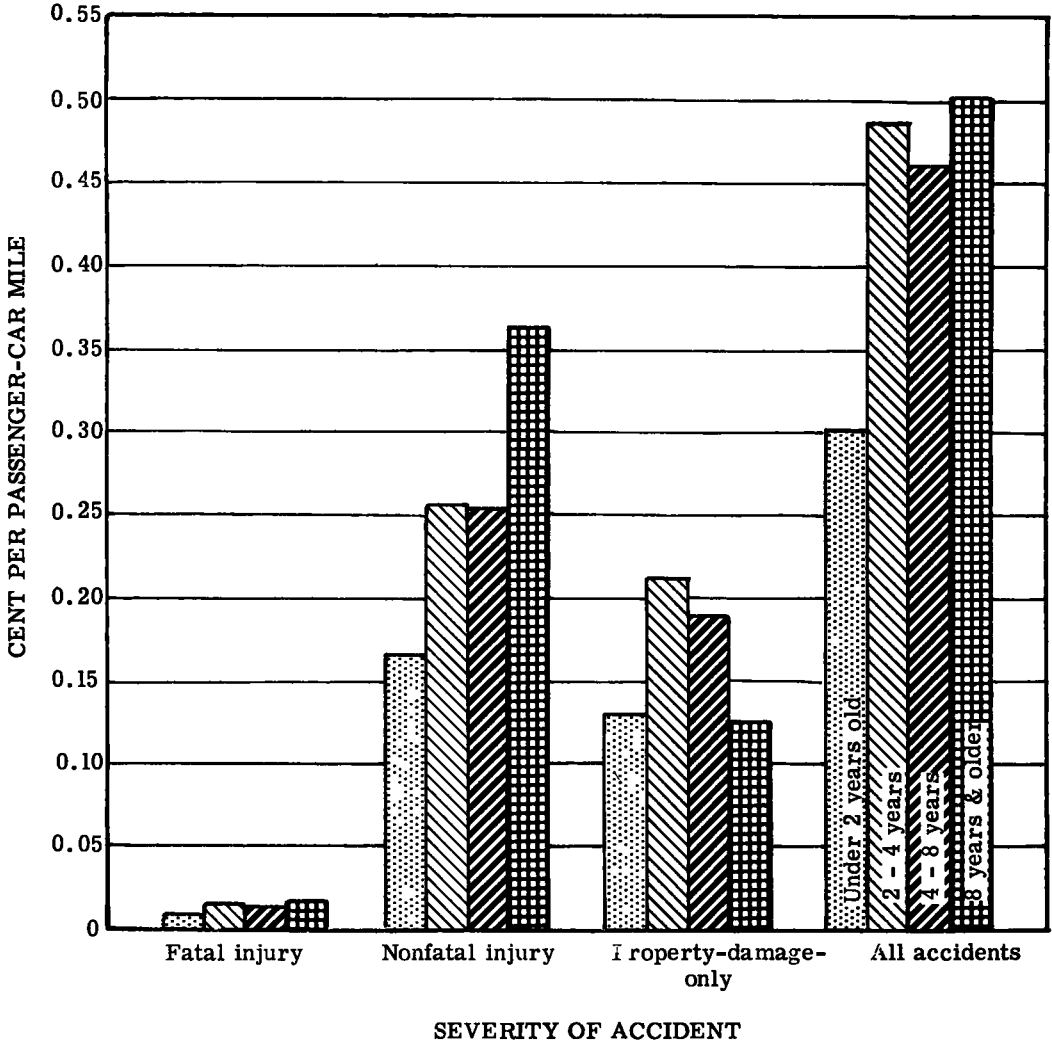


Figure 5. Comparison of cost per mile for passenger cars by severity of accident and age of car.

TABLE 4  
TOTAL DIRECT COST OF MOTOR-VEHICLE TRAFFIC ACCIDENTS INVOLVING PASSENGER CARS AND THE ACCIDENT COST PER MILLION PASSENGER CAR-MILES, CLASSIFIED BY AGE OF CAR AND SEVERITY OF ACCIDENT

Age of Passenger Car (yr)	Cost of								Cost per Million Passenger Car-Miles of Travel of:			
	Fatal-Injury Accidents		Non-Fatal-Injury Accidents		Property-Damage-Only Accidents		All Accidents		Fatal-Injury Accidents	Non-Fatal-Injury Accidents	Property Damage-Only Accidents	All Accidents
	Amount (\$)	Percent of Total	Amount (\$)	Percent of Total	Amount (\$)	Percent of Total	Amount (\$)	Percent of Total	(\$)	(\$)	(\$)	(\$)
Under 2	343,730	20.9	5,572,710	19.4	4,388,040	22.0	10,304,480	20.5	103	1,873	1,317	3,083
2 - 4	507,170	30.9	8,895,640	30.3	7,284,870	36.5	16,467,680	32.8	150	2,565	2,143	4,858
4 - 8	462,820	28.2	8,015,350	28.0	6,001,250	30.2	14,479,420	28.8	147	2,550	1,910	4,807
8 and older	328,030	20.0	6,403,750	22.3	2,240,140	11.3	8,971,920	17.9	186	3,631	1,270	5,087
<b>Total</b>	<b>1,641,750</b>	<b>100.0</b>	<b>28,687,450</b>	<b>100.0</b>	<b>19,894,300</b>	<b>100.0</b>	<b>50,223,500</b>	<b>100.0</b>	<b>141</b>	<b>2,467</b>	<b>1,711</b>	<b>4,319</b>

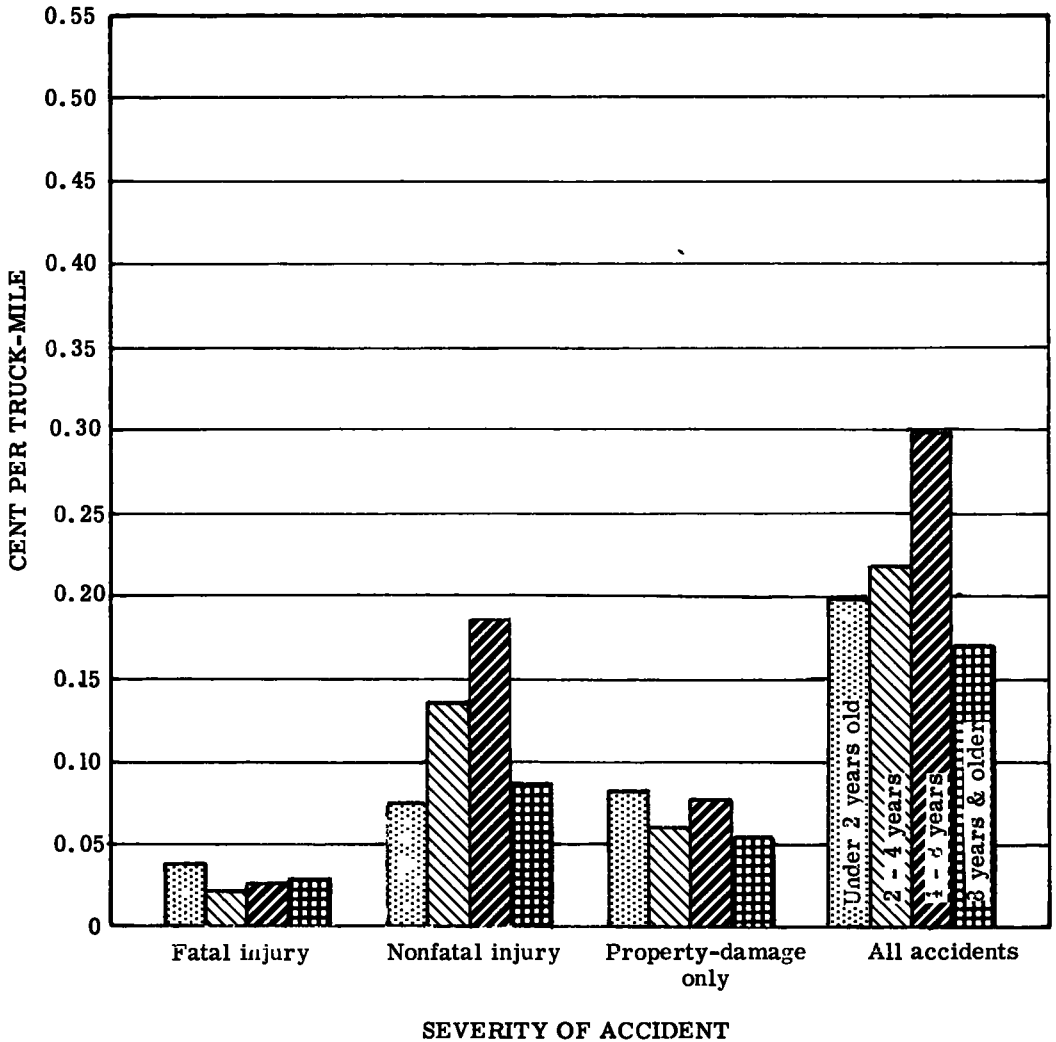


Figure 6. Comparisons of cost per mile for trucks by severity of accident and age of truck.

TABLE 5  
TOTAL DIRECT COST OF MOTOR-VEHICLE TRAFFIC ACCIDENTS INVOLVING TRUCKS AND THE ACCIDENT COST PER MILLION TRUCK-MILES, CLASSIFIED BY AGE OF TRUCK AND SEVERITY OF ACCIDENT

Age of Truck (yr)	Cost of:								Cost per Million Truck-Miles of Travel of:			
	Fatal-Injury Accidents		Non-Fatal-Injury Accidents		Property-Damage-Only Accidents		All Accidents		Fatal-Injury Accidents (\$)	Non-Fatal-Injury Accidents (\$)	Property-Damage-Only Accidents (\$)	All Accidents (\$)
	Amount (\$)	Percent of Total	Amount (\$)	Percent of Total	Amount (\$)	Percent of Total	Amount (\$)	Percent of Total				
Under 2	136,700	24.5	266,300	9.6	290,580	20.1	693,560	14.5	385	751	819	1,955
2 - 4	81,820	14.6	541,170	19.6	273,330	18.9	806,320	18.8	207	1,368	691	2,265
4 - 8	206,370	36.9	1,536,680	55.1	812,510	42.4	2,345,560	49.1	260	1,920	771	2,951
8 and older	133,950	24.0	435,020	15.7	269,180	18.6	838,150	17.6	271	879	544	1,694
<b>Total</b>	<b>558,840</b>	<b>100.0</b>	<b>2,769,170</b>	<b>100.0</b>	<b>1,445,580</b>	<b>100.0</b>	<b>4,773,590</b>	<b>100.0</b>	<b>274</b>	<b>1,357</b>	<b>709</b>	<b>2,340</b>



same scale vividly demonstrates the greater cost per mile of passenger car accidents.

Although not as pronounced as for involvement rates the cost per mile for passenger cars tends to increase with age for all accidents, for the fatal-injury, and for the non-fatal-injury. The cost per mile for property-damage-only accidents drops off for the older vehicles for both passenger cars and trucks. This undoubtedly reflects the reduced value of the older vehicles involved. Also the cost rate for the oldest group of trucks drops off sharply for the non-fatal-injury class.

The fact that the total direct cost of non-fatal-injury accidents was almost 60 percent of the total cost of all accidents for both passenger cars and trucks, of course influences greatly the pattern of cost per mile for all the accidents.

#### TYPE OF TRUCK

It was not practical to classify passenger cars by different body types. However, trucks were classified into 5 groups: 2-axle, 4-tire panel and pickup trucks; all other 2-axle, 4-tire trucks; 2-axle, 6-tire trucks; 3-axle trucks; and truck-tractor semitrailer combinations. The truck-tractor semitrailer combinations ranged from 3- to 5-axle units. Because there appeared to be no significant difference in the accident experience of these combination units due to axle arrangement they were treated as a single classification. Truck and full trailer combinations are illegal in Massachusetts and therefore were not represented in the sample.

Table 6 gives the number and travel characteristics of the types of trucks under consideration. During 1955 there were 179,610 trucks registered in Massachusetts. The largest single class of trucks in the Commonwealth was 2-axle, 4-tire panel and pickup trucks, of which there were 77,180 or 43.0 percent of the total truck population. These

TABLE 6  
NUMBER OF TRUCKS REGISTERED IN MASSACHUSETTS DURING 1955  
AND THEIR TRAVEL CLASSIFIED BY TYPE OF TRUCK

Truck Type	Number of Trucks	Percent of Total	Vehicle Travel		
			Total Mileage (thousands)	Percent of Total	Average Annual Mileage
Single unit trucks:					
Panels and pickups	77,180	43.0	758,139	37.2	9,823
Other 2-axle, 4-tire	18,350	10.2	165,866	8.1	9,039
2-axle, 6-tire	70,670	39.3	727,412	35.6	10,293
3-axle	3,220	1.8	52,206	2.6	16,213
Truck-tractor, semitrailer	10,190	5.7	336,473	16.5	33,020
<b>Total</b>	<b>179,610</b>	<b>100.0</b>	<b>2,040,096</b>	<b>100.0</b>	<b>11,358</b>

panels and pickups were driven 758,139,000 mi or 37.2 percent of the total-truck-miles of travel. Of almost equal magnitude were the 2-axle, 6-tire single unit trucks. Together these two constitute 82.3 percent of the total number and 72.8 of the vehicle travel. The combination units, although only 5.7 percent of the number of trucks, travel 16.5 percent of the truck-miles.

The usual summary data for the total number and direct costs of accidents by truck type are contained in Tables 7 and 8, respectively. Involvement rates are shown in Figures 7 and 8 and costs per mile in Figure 9. The rate for fatal-injury accidents is again treated separately in Figure 8.

The second classification of trucks, all other 2-axle, 4-tire trucks, have a disproportionate share of the involvements and costs compared to the vehicles registered

TABLE 7  
NUMBER OF TRUCKS INVOLVED IN MOTOR-VEHICLE TRAFFIC ACCIDENTS AND THE RATE PER 100 MILLION TRUCK-MILES, CLASSIFIED BY TRUCK TYPE AND SEVERITY OF ACCIDENT

Truck Type	Trucks Involved in						Number of Trucks per 100 Million Truck-Miles of Travel Involved in.					
	Fatal-Injury Accidents		Non-Fatal-Injury Accidents		Property-Damage-Only Accidents		All Accidents		Fatal-Injury Accidents	Non-Fatal-Injury Accidents	Property-Damage-Only Accidents	All Accidents
	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total				
Single unit trucks:												
Panels and pickups	19	23.2	1,982	43.9	8,946	36.9	10,947	38.0	2.5	261	1,180	1,444
Other 2-axle, 4-tire	14	17.1	395	8.8	3,097	12.8	3,506	12.2	8.4	238	1,867	2,114
2-axle, 6-tire	30	36.6	1,683	37.3	8,691	35.9	10,404	36.1	4.1	231	1,195	1,430
3-axle	1	1.2	45	1.0	472	2.0	518	1.8	1.9	88	904	992
Truck-tractor-semi-trailer	18	21.9	404	9.0	2,999	12.4	3,421	11.9	5.3	120	891	1,017
Total	82	100.0	4,509	100.0	24,205	100.0	28,796	100.0	4.0	221	1,186	1,412

TABLE 8  
TOTAL DIRECT COST OF MOTOR-VEHICLE TRAFFIC ACCIDENTS INVOLVING TRUCKS AND THE ACCIDENT COST PER MILLION TRUCK-MILES CLASSIFIED BY TRUCK TYPE AND SEVERITY OF ACCIDENT

Truck Type	Cost of:						Cost per Million Truck-Miles of Travel of.					
	Fatal-Injury Accidents		Non-Fatal-Injury Accidents		Property-Damage-Only Accidents		All Accidents		Fatal-Injury Accidents (\$)	Non-Fatal-Injury Accidents (\$)	Property-Damage-Only Accidents (\$)	All Accidents (\$)
	Amount (\$)	Percent of Total	Amount (\$)	Percent of Total	Amount (\$)	Percent of Total	Amount (\$)	Percent of Total				
Single unit trucks:												
Panels and pickups	114,510	20.5	1,050,880	37.9	767,860	53.1	1,933,250	40.5	151	1,386	1,013	2,550
Other 2-axle, 4-tire	88,320	15.8	315,710	11.4	107,340	7.4	511,370	10.7	532	1,903	647	3,083
2-axle, 6-tire	210,260	37.6	1,256,550	45.4	414,470	28.7	1,881,280	39.4	289	1,727	570	2,586
3-axle	-	-	13,410	0.5	6,360	0.5	19,770	0.4	-	257	122	379
Truck-tractor-semi-trailer	145,750	26.1	132,620	4.8	149,550	10.3	427,920	9.0	433	394	444	1,272
Total	558,840	100.0	2,769,170	100.0	1,445,580	100.0	4,773,590	100.0	274	1,357	709	2,340

and miles traveled by this class. They generally have the highest involvement and cost rates of any type of truck. There were 18,350 vehicles of this type registered in Massachusetts during 1955. This 10.2 percent of the total registered trucks accounted for 8.1 percent of the total truck mileage, 12.2 percent of the involvements, and 10.7 percent of the direct costs.

The involvement rate per 100 million miles of travel for this class of truck was 8.4 for fatal, 238 for non-fatal-injury, and 1,867 for property-damage-only accidents. The involvement rate for all accidents was 2,114, which was 50 percent greater than the average rate of 1,412 for trucks of all types. The fatal-injury involvement rate was more than 3 times that of 2-axle panels and pickups.

From Figure 9 the accident cost per mile for all other 2-axle, 4-tire trucks was 0.053 cent for fatal injury, 0.190 cent, for non-fatal-injury, and 0.065 cent for property-damage-only accidents or a total cost of 0.308 cent per mile. The rate for the fatal-injury class is more than 3 times that for panels and pickups and twice the average cost rate of 0.027 cent for fatal-injury accidents for all trucks. The non-fatal-injury rate is 40 percent greater than the average non-fatal-injury cost rate of 0.136 for all trucks. Only for property-damage-only involvements was the cost rate less than the average for all trucks. The total cost rate for this truck type was 32 percent greater than the average cost rate of 0.234 cent for all trucks. The average cost rates for all trucks are given in the totals in Table 8.

In the order of appearance in Figures 7, 8, and 9 the first type (panels and pickups) and the third type (2-axle, 6-tire) appear generally to have about the same involvement rate and cost per mile. For all accidents the involvement rates (Fig. 7) were 1,444 and 1,430, respectively. From Figure 9 the cost in cents per mile was 0.255 for panels and pickups and 0.259 for 2-axle, 6-tire trucks; these two groups of vehicles which constituted 82.3 percent of the total registration accounted for 79.9 percent of the total direct cost of truck accidents.

Considering the fatal-injury class of accidents shown in Figure 8, the involvement rate for the panel and pickups was 2.5 which was considerably less than the average rate of 4.0 for all trucks. The same rate for the 2-axle trucks (6-tire) was 4.1 and is the third highest of the five vehicle types.

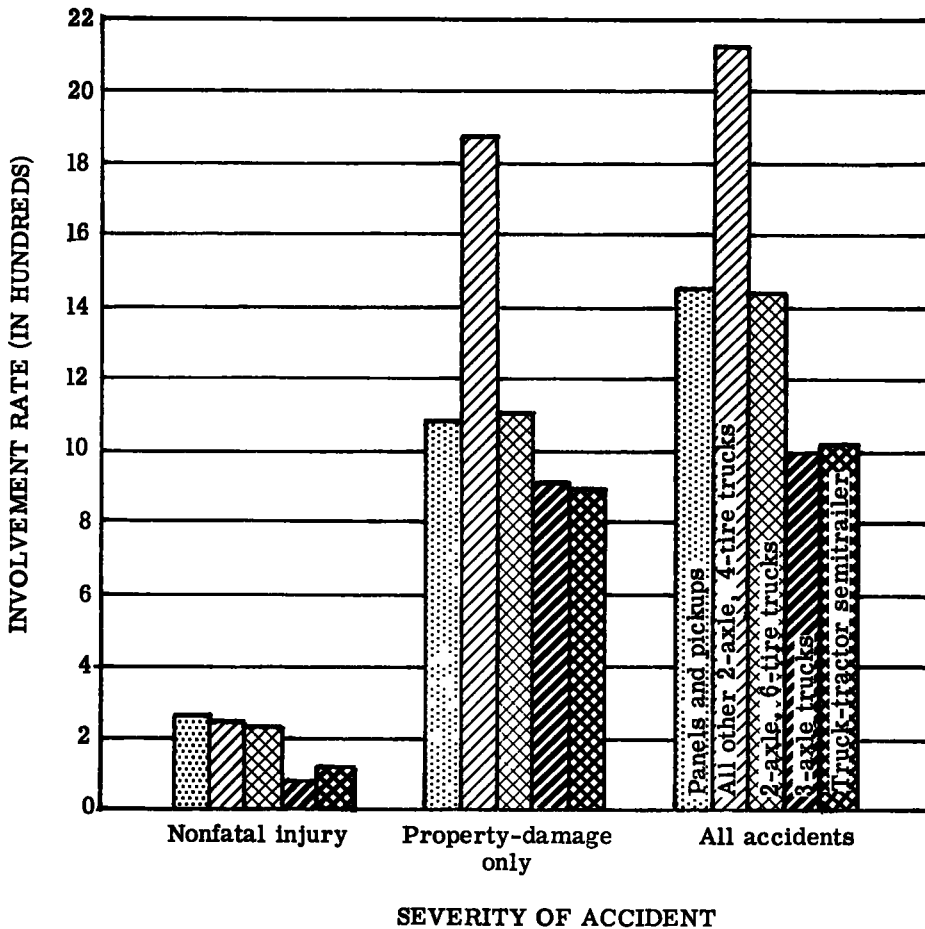


Figure 7. Comparison of non-fatal injury, property-damage-only, and all accident involvement rates per 100 million truck-miles of travel by type of truck.

The fourth class of trucks, 3-axle trucks, constituted only 1.8 percent or 3,220 of all trucks registered in Massachusetts during 1955, and accounted for exactly the same percentage of the total number of accidents. The total cost of accidents for this group was only 0.4 percent of the total cost of accidents for all trucks.

The number of 3-axle trucks involved in accidents per 100 million miles of travel by this group was 992. Classified by severity, this involvement rate was 1.9 of these trucks in fatal-injury accidents, 86 in non-fatal-injury accidents, and 904 in accidents resulting in property-damage-only. These were, in general, the lowest rates for any of the five truck classifications under consideration. Similarly, the cost in cents per mile (Fig. 9) was the lowest by far for any of the five types of trucks in all severity classes. These cent-per-mile rates were 0.026 for non-fatal-injury, 0.012 for property-damage-only, and 0.038 for all accidents. There were no costs connected with the single reported involvement in a fatal accident.

The data for the fifth and final type of truck, the truck-tractor semitrailers, offered a study of contrasts. Although only 5.7 percent of the trucks registered, these vehicles were responsible for 11.9 percent of all trucks involved in traffic accidents, and 9.0 percent of the total direct cost of all truck accidents. On the other hand, the rates of involvement and cost per mile for all except the fatal-injury accidents were below the average values for all trucks.

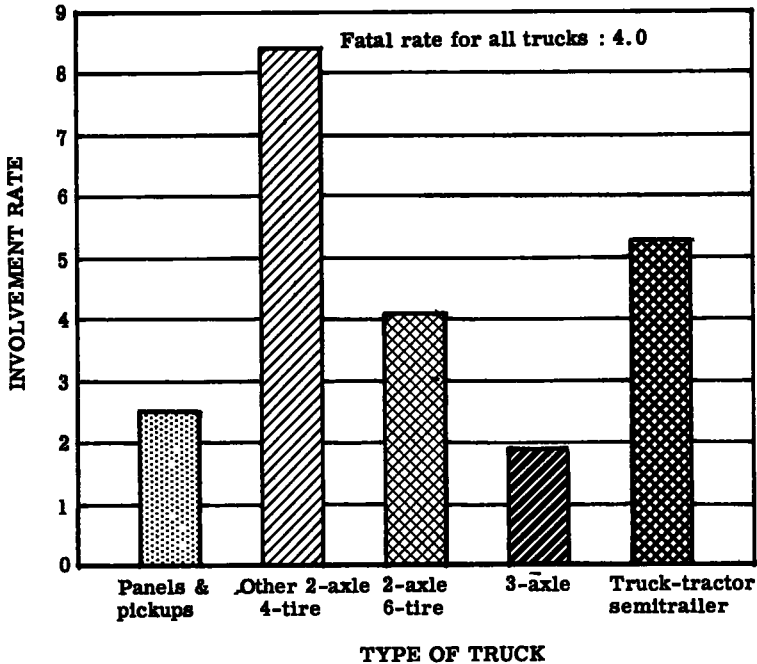


Figure 8. Comparison of truck involvement rate per 100 million truck-miles of travel in fatal accidents.

A study of the total cost of accidents for truck-tractor semitrailers by severity class indicates that fatal-injury accidents account for 34.1 percent, non-fatal-injury accidents for 31.0 percent, and property-damage-only accidents for 34.9 percent of the total costs incurred. In contrast, considering the total direct cost for all truck accidents, fatal-injury accidents account for only 11.7 percent of the total cost, where non-fatal-injury accidents and property-damage-only accidents account for 58.0 percent and 30.3 percent, respectively.

In this connection, it is of interest to note that the combined cost of fatal and non-fatal-injury accidents of truck-tractor semitrailers was 65.1 percent of the total cost of accidents for this class of vehicle, whereas for all single-unit trucks the combined fatal and non-fatal-injury cost was 70.2 percent of the cost of all single-unit truck accidents. The difference results from the different proportion of fatal and non-fatal-injury accidents and cost experience of such accidents for these classes of trucks.

This disproportionate cost of the fatal-injury accidents of truck-tractor semitrailers is accentuated by the fact that the average cost of a fatal-injury accident for this group was \$8,100 as compared to an average cost of \$6,450 for a fatal-injury accident of a single-unit truck. In addition to higher cost for fatal-injury accidents, one out of every 190 truck-tractor, semitrailer involvements was fatal whereas only 1 in every 409 involvements for single-unit trucks was fatal.

When viewed with consideration given to exposure in truck-miles of travel, these higher percentages of truck-tractor semitrailer involvements and costs are somewhat modified. The involvement rate for all accidents was 1,017 per 100 million miles of travel for truck-tractor, semitrailer combinations. Classified by severity this rate was 5.3 fatal-injury, 120 non-fatal-injury, and 891 property-damage-only involvements per 100 million miles of travel. The cost of all accidents per mile of travel was 0.127 cent. By severity class this cost rate was 0.043 cent for fatal-injury, 0.039 cent for non-fatal-injury, and 0.044 cent for property-damage-only accidents. It is evident from Figures 7 and 9 that these vehicles have involvement and cost rates well below

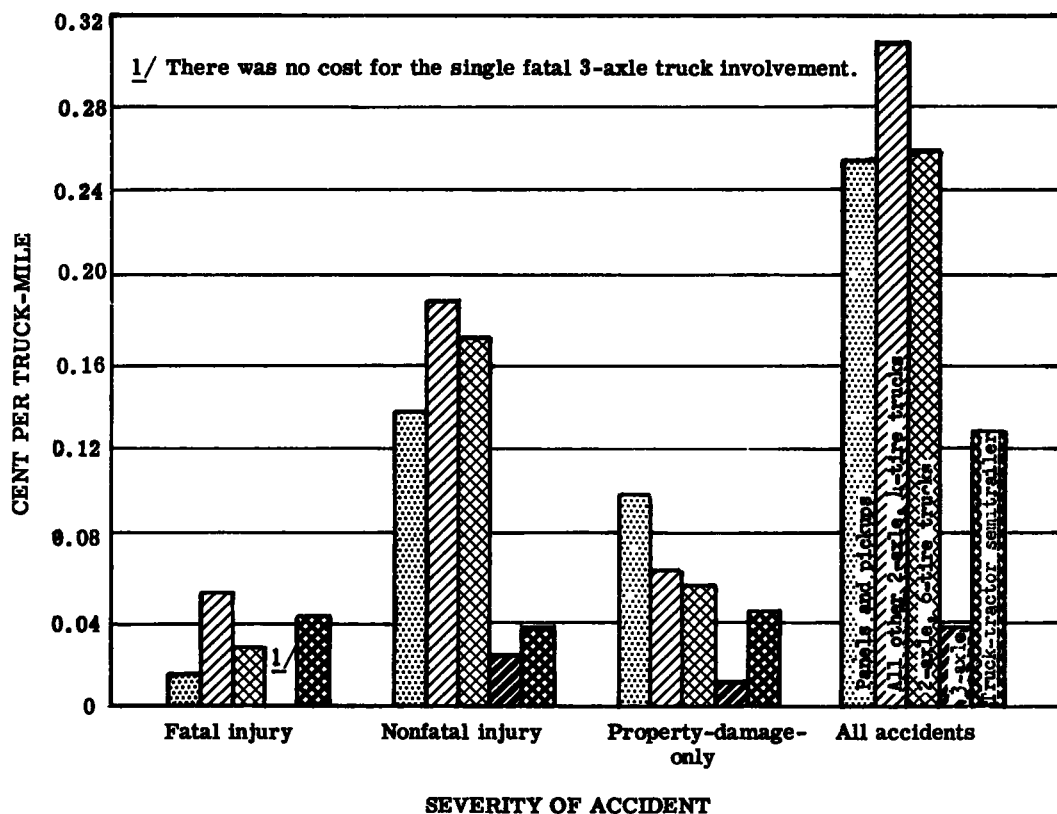


Figure 9. Comparison of the accident cost per mile of travel by type of truck and severity of accident.

those of single unit trucks for non-fatal-injury and property-damage-only accidents. This is also true for the involvement and cost rates for all accidents which were lower than those of any other type except 3-axle trucks.

However, this is not so with regard to the fatal involvement and cost rates, as these rates for the combinations are considerably higher than those of single-unit trucks. The fatal involvement rate per 100 million miles was 5.3 for truck-tractor, semi-trailer combinations, and 3.8 for all single-unit trucks. The cost of fatal accidents per mile of travel was 0.043 cent for the combinations compared to 0.024 cent for all single-unit trucks.

It is apparent from the foregoing discussion that any total view of trucks involved in accidents and their costs is predominately weighted by the number of 2-axle, 4-tire panel and pickup trucks and 2-axle, 6-tire trucks, which comprised 82.3 percent of the vehicles registered, 72.8 percent of the total truck-miles of travel, 74.1 percent of the total number of involvements, and 79.9 percent of the total direct costs. Thus, these two classes of trucks dominate the total involvement and total cost rates on any basis. The combinations play a rather important part in the total cost in relation to the number registered, but the large average annual mileage of this group tends to offset their disproportionate costs when viewed on an exposure basis.

#### REGISTERED GROSS WEIGHT

The analysis to this point has considered the relationship of truck and passenger-car accident costs, and the variation of truck accident costs with age of vehicle and type of vehicle classified by axle arrangement. Another relationship of interest

particularly for economic analysis is that which exists between accident cost and registered gross weight.

Of the 179,610 trucks registered in Massachusetts during 1955, 100,940 or 56.2 percent were registered under 8,500 lb gross vehicle weight. The remainder were distributed 36,340 or 20.2 percent between 8,500 and 16,499 lb, 19,050 or 10.6 percent were between 16,500 and 24,499 lb, 9,540 or 5.3 percent were between 24,500 and 36,499 lb, and the 13,740 or 7.7 percent were 36,500 lb and over.

In addition to the registration data, Table 9 gives the vehicle travel for each group

TABLE 9  
NUMBER OF TRUCKS REGISTERED IN MASSACHUSETTS DURING 1955 AND THEIR TRAVEL CLASSIFIED BY REGISTERED GROSS VEHICLE WEIGHT

Gross Vehicle Weight (lb)	Number of Trucks	Percent of Total	Vehicle Travel		
			Total Mileage (thousands)	Percent of Total	Average Annual Mileage
8,499 and under	100,940	56.2	949,636	46.5	9,408
8,500 - 16,499	36,340	20.2	333,960	16.4	9,190
16,500 - 24,499	19,050	10.6	224,139	11.0	11,766
24,500 - 36,499	9,540	5.3	132,603	6.5	13,900
36,500 and over	13,740	7.7	399,758	19.6	29,094
<b>Total</b>	<b>179,610</b>	<b>100.0</b>	<b>2,040,096</b>	<b>100.0</b>	<b>11,358</b>

of registered gross vehicle weight. It is important to notice for future consideration of involvement and cost rates that the annual average mileage increases with registered weight. The increase between the last two weight groups is particularly significant. Trucks in the heaviest weight group traveled more miles in a year than those in any

TABLE 10  
NUMBER OF TRUCKS INVOLVED IN MOTOR-VEHICLE TRAFFIC ACCIDENTS AND THE RATE PER 100 MILLION TRUCK-MILES, CLASSIFIED BY REGISTERED GROSS VEHICLE WEIGHT AND SEVERITY OF ACCIDENT

Gross Vehicle Weight (lb)	Trucks Involved In:								Number of Trucks per 100 Million Truck-Miles of Travel Involved In			
	Fatal-Injury Accidents		Non-Fatal-Injury Accidents		Property-Damage-Only Accidents		All Accidents		Fatal-Injury Accidents	Non-Fatal-Injury Accidents	Property-Damage-Only Accidents	All Accidents
	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total	Number	Percent of Total				
8,499 and under	41	50.0	2,662	59.1	11,001	45.5	13,704	47.6	4.3	280	1,156	1,443
8,500 - 16,499	13	15.8	722	16.0	4,998	20.6	5,733	19.8	3.9	216	1,467	1,711
16,500 - 24,499	7	8.5	416	9.2	3,269	13.6	3,712	12.9	3.1	186	1,467	1,656
24,500 - 36,499	4	4.9	245	5.4	2,084	8.6	2,333	8.1	3.0	185	1,572	1,759
36,500 and over	13	15.9	387	8.6	2,562	10.6	2,962	10.3	3.3	97	641	741
Unknown	4	4.9	77	1.7	271	1.1	352	1.2	-	-	-	-
<b>Total</b>	<b>82</b>	<b>100.0</b>	<b>4,506</b>	<b>100.0</b>	<b>24,205</b>	<b>100.0</b>	<b>26,796</b>	<b>100.0</b>	<b>4.0</b>	<b>221</b>	<b>1,186</b>	<b>1,412</b>

TABLE 11  
TOTAL DIRECT COST OF MOTOR-VEHICLE TRAFFIC ACCIDENTS INVOLVING TRUCKS AND THE ACCIDENT COST PER MILLION TRUCK-MILES, CLASSIFIED BY REGISTERED GROSS VEHICLE WEIGHT AND SEVERITY OF ACCIDENT

Gross Vehicle Weight (lb)	Cost of								Cost per Million Truck-Miles of Travel of			
	Fatal-Injury Accidents		Non-Fatal-Injury Accidents		Property-Damage-Only Accidents		All Accidents		Fatal-Injury Accidents	Non-Fatal-Injury Accidents	Property-Damage-Only Accidents	All Accidents
	Amount (\$)	Percent of Total	Amount (\$)	Percent of Total	Amount (\$)	Percent of Total	Amount (\$)	Percent of Total				
8,499 and under	268,040	48.0	1,915,460	69.1	872,060	60.3	3,055,560	64.0	282	2,017	918	3,218
8,500 - 16,499	130,990	23.4	378,530	13.7	242,910	16.8	752,430	15.8	392	1,133	727	2,253
16,500 - 24,499	19,990	3.6	209,950	7.6	126,920	8.8	356,890	7.5	89	937	566	1,592
24,500 - 36,499	46,900	8.4	71,600	2.6	73,110	5.0	191,610	4.0	354	540	551	1,445
36,500 and over	78,310	14.0	143,270	5.2	122,160	8.5	343,740	7.2	196	358	306	860
Unknown	14,610	2.6	50,380	1.8	8,420	0.6	73,390	1.5	-	-	-	-
<b>Total</b>	<b>558,840</b>	<b>100.0</b>	<b>2,769,170</b>	<b>100.0</b>	<b>1,445,580</b>	<b>100.0</b>	<b>4,773,590</b>	<b>100.0</b>	<b>274</b>	<b>1,357</b>	<b>709</b>	<b>2,340</b>

other group except those registered under 8,500 lb. Light trucks have often been compared to passenger cars because of many similar vehicle characteristics. One of these similarities is average annual travel per vehicle. The average annual travel of passenger cars and that of light trucks are approximately equal. Passenger cars averaged 9,380 mi of travel annually and light trucks averaged 9,408 mi of travel annually. By comparing the involvement rate of 1,910 per 100 million vehicle-miles of passenger cars with the involvement rate of 1,443 for light trucks it may be seen that passenger cars are involved in 32 percent more accidents on a mileage basis.

Table 10 gives the total number of trucks involved in accidents and the involvement rate in number per 100 million miles of travel for each gross weight group by severity of accident. When the proportion of heavy trucks involved in accidents is compared with the proportion of heavy trucks in the total truck registration, the comparison presents a somewhat unfavorable picture for heavy trucks. For example, in the 36,500 lb and over group, the percentage registered was 7.7, and the percentage involved in accidents was 10.3. Data on the costs of accidents, arranged in a similar manner in Table 11, show that the reverse is true. Here the percentage of the total accident cost was 7.2 for the heaviest weight group.

The involvement rates for fatal-injury accidents are shown separately from the other severity class in Figure 10, and appear to decrease with registered weight over the range covered by the first three groups and then tend to level off. In Table 10 it was seen that the proportion of the total vehicles in the heaviest group involved in fatal-injury accident was high in comparison to the proportion of vehicles in the other groups so involved. This group had one vehicle in fatal accident for every 30 vehicles in non-fatal accident where the average rate for the other trucks was 1 in 62. On an exposure basis, the vehicles registered in the heaviest group have a favorable involvement rate. It was 3.3 per 100 million miles of travel as compared to a rate of 4.0 for the remainder of the trucks.

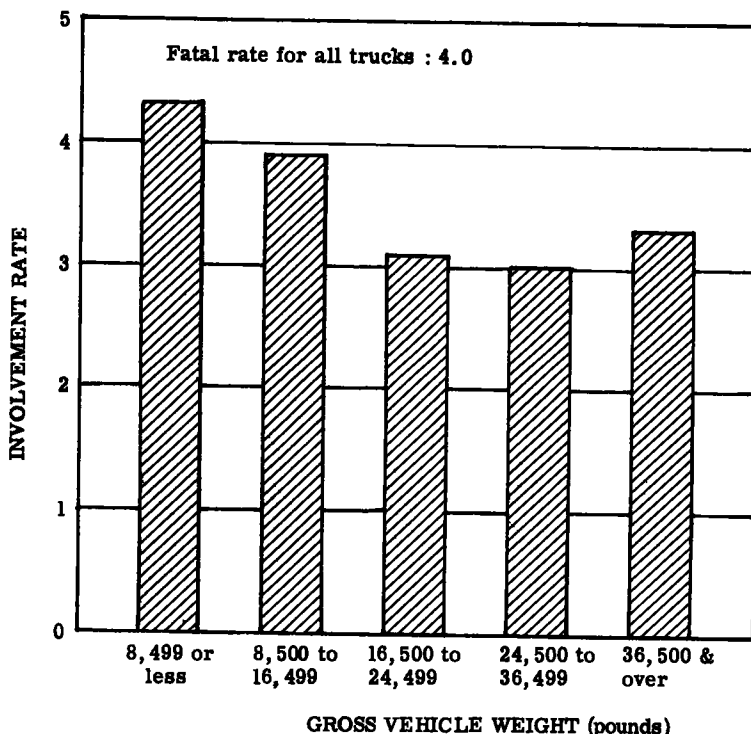


Figure 10. Comparison of truck involvement rate per 100 million truck-miles of travel in fatal accidents by gross vehicle weight.

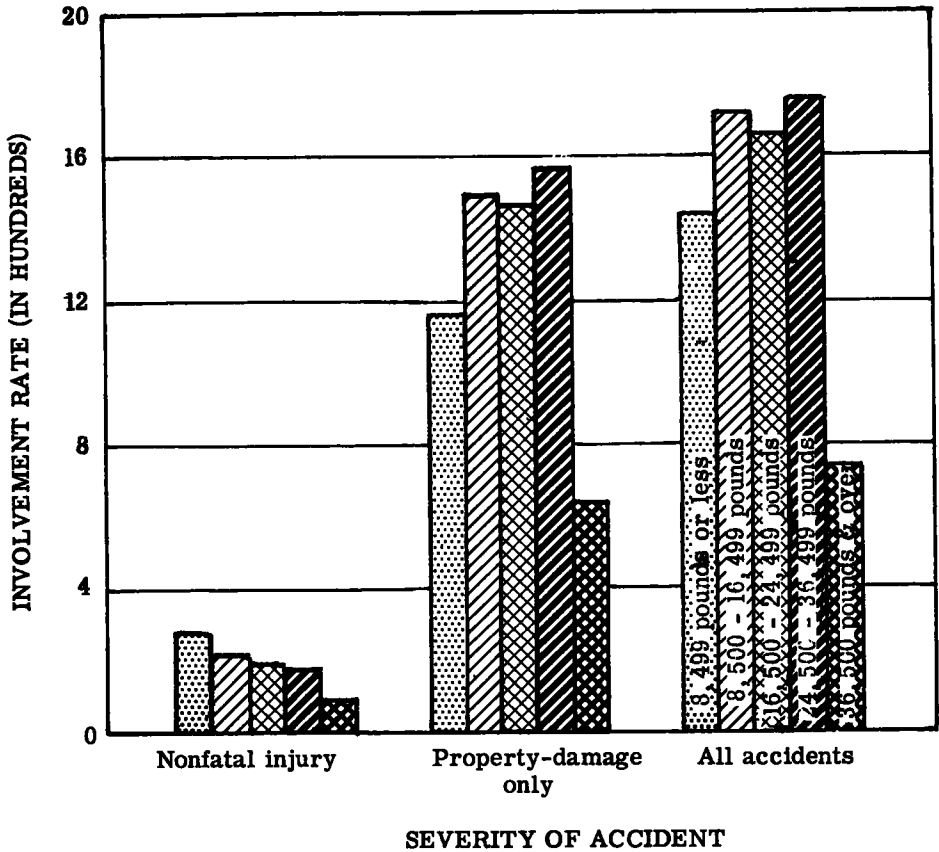


Figure 11. Comparison of non-fatal injury, property-damage-only and all accident involvement rates per 100 million truck-miles of travel by gross vehicle weight.

The involvement rates for the other two severity classes and for all the accidents are shown in Figure 11. In the case of non-fatal-injury accidents, the rates decrease with registered weight. However, for the property-damage-only accidents the tendency is for an increase with weight excepting the last group of heavier vehicles for which the rate drops off sharply to less than one-half that for the other groups. The property-damage only involvement rate was 641 for heavy trucks and 1,303 for all other trucks. The rate for all accidents, regardless of severity, is 741 for heavy trucks and is 1,554 for all other trucks, which is clearly twice as bad as the record of the heaviest trucks on the basis of exposure.

A look at accident cost rates per mile of travel (Fig. 12) will show similar favorable rates for the heaviest trucks in contrast to the cost rates for the trucks in the other weight groups. For non-fatal-injury accidents the cost rate of 0.036 cent per mile for heavy trucks was about one-fourth of the cost rate of 0.157 for all other trucks in accidents of comparable severity. The property damage-only cost rate was 0.031 cent per mile for heavy trucks and 0.080 for all other trucks. The cost rate for all accidents was 0.086 cent per mile for heavy trucks, which was about one-third of the cost rate of 0.266 for all other trucks.

A most significant result of the report is the very definite decrease of accident cost per mile of travel with increase of registered gross vehicle weight. This is the first time such data has become available. With reference to the results for all accidents in Figure 12, the cost rate ranges from 0.322 cent per mile for the lightest group to 0.086 cent per mile for the heaviest group.



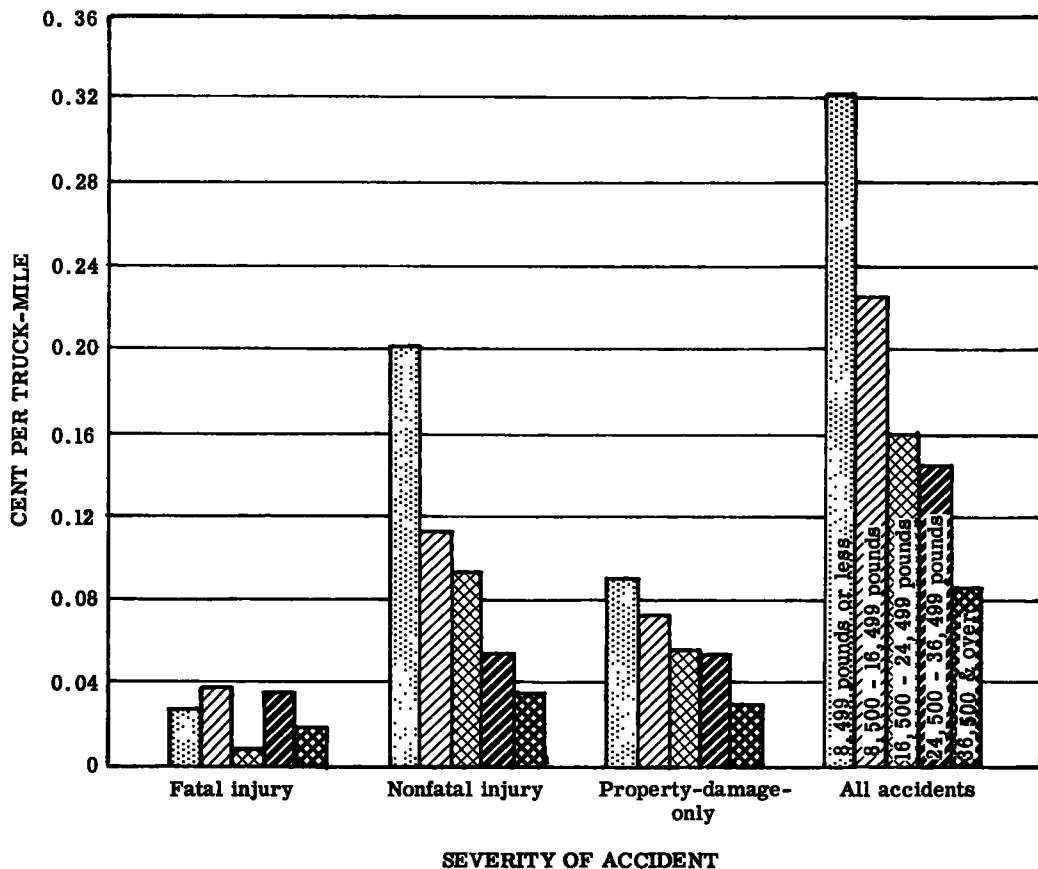


Figure 12. Comparison of the accident cost per mile of travel by gross vehicle weight and severity of accident.

### SUMMARY OF FINDINGS

It should be clearly understood in considering the reported results that they are based only on data for Massachusetts. Whether or not the same patterns and trends will hold for other states will be determined by studies now under way and planned for the future.

1. The cost of accidents per mile of travel for passenger cars is nearly double that of trucks, with the exception of cost per mile for fatal accidents.
2. Both the involvement rate and accident cost per mile for passenger cars increases with the age of the car. The same is not true of trucks.
3. Panels and pickups, together with 2-axle, 6-tire trucks, constitute 5 out of every 6 trucks registered and thus dominate the involvement and accident cost picture.
4. Truck-tractor semitrailers had the best accident record when viewed from exposure with the sole exception of a high fatal involvement rate and fatal cost per mile.
5. The most important of all the relationships discovered with regard to registered gross weight from the standpoint of economic analysis of accidents was the decrease of accident cost per mile as the gross weight increased.
6. The involvement rate and cost per mile of the heaviest group of trucks were favorable when compared to those of all other trucks. This may well be the most significant finding of this report.