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16. Abstract

Due to the emphasis on fuel economy in recent years, cars are becoming smaller and lighter while trucks are becoming larger and heavier. This study focused on the effect that this change may have on large truck accidents in Texas. Accident data consisted of rural accidents from 1976 through 1979 for combination and single unit trucks and small, midsize, and large cars.

Results showed that the majority of all accidents resulted in only property damage while less than 5% involved a fatality. From 1976 to 1979 the total number of large truck accidents increased over 50%, but fatal accidents increased over 150%. Car/truck accidents only accounted for 5% of all accidents while 93% involved only cars and 3% involved only trucks. The majority of all accidents occurred on U.S. and State Highways. For accidents in which a combination truck was involved, there was a higher risk of a fatality or injury especially in collisions with small cars. Collisions between large cars and midsize cars were the most frequent and resulted in the highest number of persons killed or injured per accident. Accidents involving combination trucks and small cars resulted in the least number of fatalities or injuries per accident.

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CAR/TRUCK ACCIDENTS IN TEXAS
1976-1979

Joanne Saunders
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Research Report 231-2F
from
Research Study 2-8-78-231

in cooperation with

Texas State Department of Highways
and Public Transportation

November 1982

Texas Transportation Institute
The Texas A&M University System
College Station, TX 77843

PREFACE

The data reported here are part of a data set prepared at the Texas Transportation Institute (TTI) to help define the magnitude of the truck accident problem in Texas. This overall inquiry proceeded under the general direction given by the State Department of Highways and Public Transportation's (SDHPT) Committee on Vehicle Sizes and Weights. The TTI work has been part of a cooperative effort, among SDHPT, TTI, and the Center for Transportation Research (CTR).

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Dock Burke
Joanne Saunders

DISCLAIMER

The findings, opinions, and interpretations presented here are solely those of the authors. This report does not contain any standards or policies endorsed by the sponsor. Clearly, all errors are the responsibility of the authors.

EXECUTIVE SUMMARY

Due to the emphasis on fuel economy in recent years, the vehicle mix on our nation's highways has been changing. Cars are becoming smaller and lighter, while commercial trucks are becoming larger and heavier. This study focused on the effect that this change may have on large truck accidents in Texas.

The Texas accident data consisted of rural accidents between 1976 and 1979 for combination and single unit trucks and three weight classes of cars: 1) small (less than 3,000 lbs.), 2) midsize (3,000-4,000 lbs), and 3) large (over 4,000 lb.). The data was evaluated according to accident severity, road type, and fatalities and injuries per accident. The data were not sorted to remove alcohol-related accidents.

Results of the accident analysis showed that an overwhelming majority of all accidents resulted in only property damage, while less that 5% resulted in a fatality. Over the four-year period, 1976-1979, the total number of accidents in which a truck was involved increased 68%, but the number of fatal accidents increased over 150%. Even with this substantial increase, car/truck accidents only accounted for 4% of all accidents while 93% involved only cars and the remaining 3% involved only trucks.

For all accidents between 1976 and 1979, the majority occurred on U. S. and State Highways followed by Farm-to-Market roads with Interstate roads having the fewest number of accidents. On all three road types, combination trucks were involved in a higher precentage of fatal accidents than single unit trucks,

Accidents involving large cars and midsize cars were the most frequent of all the vehicle weight classes and resulted in the most fatalities and injuries per accident. Results showed that for accidents in which a combination truck was involved, there was a higher risk of a fatality; however, those accidents accounted for only a very small percentage of all accidents. In accidents between vehicle weight classes, combination trucks were involved in a greater number of fatal and injury accidents with small cars than midsize and large cars, but these accidents resulted in the least number of fatalities and injuries per accident.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

Problem Statement

During recent years the vehicle mix on our nation's highways has been changing. Since 1975, more emphasis has been put on fuel economy in automobiles. The easiest way to meet fuel economy standards is to reduce the weight of the vehicle and as a result, cars are becoming smaller and lighter. Just the opposite is true for trucks, however. More and more pressure is being put on state and federal governments to increase gross vehicular weight limits for trucks in order to offset the increased fuel costs and lower speed limit associated with the energy crisis.

This results in a trend toward dividing the vehicle mix into two basic groups - the very small car and the very large truck. Another important point is that the percentage of trucks in the vehicle fleet has grown at a more rapid rate than that of passenger cars. In 1968 automobiles made up approximately 82% of the total U.S. vehicle fleet. Ten years later this percentage was reduced to 79%. Assuming this trend continues, by 1990 it is reasonable to expect that 25% of our fleet will consist of trucks and buses (Ref. 1 & 2).

Along with this trend comes certain design changes in these small cars and larger trucks that may limit vehicle and driver performance. These changes could result in an increase in the frequency and severity of car/truck accidents.

Objective

The objective of this study was to consider the possibility that the changing vehicle mix has an influence on large truck accidents on Texas highways. Specifically, the study focused on comparing accidents involving large trucks and small, midsize, and large cars between 1976 and 1979.

Data Base

The accident data for this report were obtained from the Accident Analysis Division of the Texas Transportation Institute which maintains a tape library containing detailed information on more than 3,000,000 traffic accidents which have occurred in Texas since January 1, 1974. The data recorded on these tapes were originally supplied by the Texas Department of Public Safety (DPS) and the Texas State Department of Highways and Public Transportation (SDHPT).

The analyses contained in this report are based on rural accidents of the years 1976 through 1979. During this time period, Texas experienced 252,544 rural traffic accidents, and 160,686 of these involved a commercial truck(s) and/or passenger car(s).

The Texas accident report form does not require the recording of vehicle weight, however, it does require vehicle make, model, and year of manufacture. Weight classes for accident-involved passenger cars manufactured after 1965 were derived on the basis of this information and a cross reference file of passenger car weight by make, model, and year of manufacture. Cross referencing was accomplished with the aid of Branham Automobile Reference Book (1966-1980).

For this study, passenger cars were classified into three general weight classes and six more specific weight groups:

- Small Cars
  - Mini-compact: 2,000 lbs. or less
  - Sub-Compact: 2,001 - 3,000 lbs.
- Midsize Cars
  - Compact: 3,001 - 3,500 lbs.
  - Midsize: 3,501 - 4,000 lbs.
- Large Cars
  - Full size: 4,001 - 4,500 lbs.
  - Luxury: 4,500 lbs. or more

Trucks were divided into two groups: single unit trucks - self-contained two or three axle trucks weighing up to approximately 50,000 pounds; and combination trucks - two or three axle tractors with one or more trailers or semi-trailers attached, weighting up to 80,000 pounds. Accidents were evaluated according to: severity - fatal, injury, and property damage only (PDO); road type - farm to market roads, U.S. and State highways, and interstate highways; and the number of persons killed or injured per accident.

THE CHANGING VEHICLE MIX

Trend Toward Larger Trucks and Smaller Cars

As previously mentioned, there has been a growing emphasis on fuel economy in recent years resulting in size and weight changes in cars and trucks. The trend is toward larger trucks and smaller cars and based on the availability and cost of fuel today and in the future, it seems as though the continuation of this trend is likely.

In the 1979 automobile fleet, which had already undergone a certain amount of shrinking since the Energy Policy and Conservation Act of 1975 established fuel economy standards, midsize and full size passenger cars were the dominant weight groups. However, by 1990 it is anticipated that sub-compacts will be the dominant weight group in the vehicle population. The largest reduction is expected in the full size category from 26% of the fleet in 1976 to 2% in 1990. A relatively large number of luxury cars will be retained because of the sizable segment of people who still want the comfort, luxury, or status associated with these cars (Ref. 2).

Passenger car registrations by weight for the state of Texas for the years 1975 through 1979 are presented in Figure 1. This figure shows that midsize and large cars have been the dominant weight groups in Texas. Since 1976, the precentage of cars over 4,000 pounds has steadily decreased while the percentage of cars between 3,000 and 4,000 pounds has steadily increased. The percentage of small cars in Texas has also increased, but at a slower rate; however, cars weighing between 2,000 and 3,000 pounds (sub-compacts) had the greatest

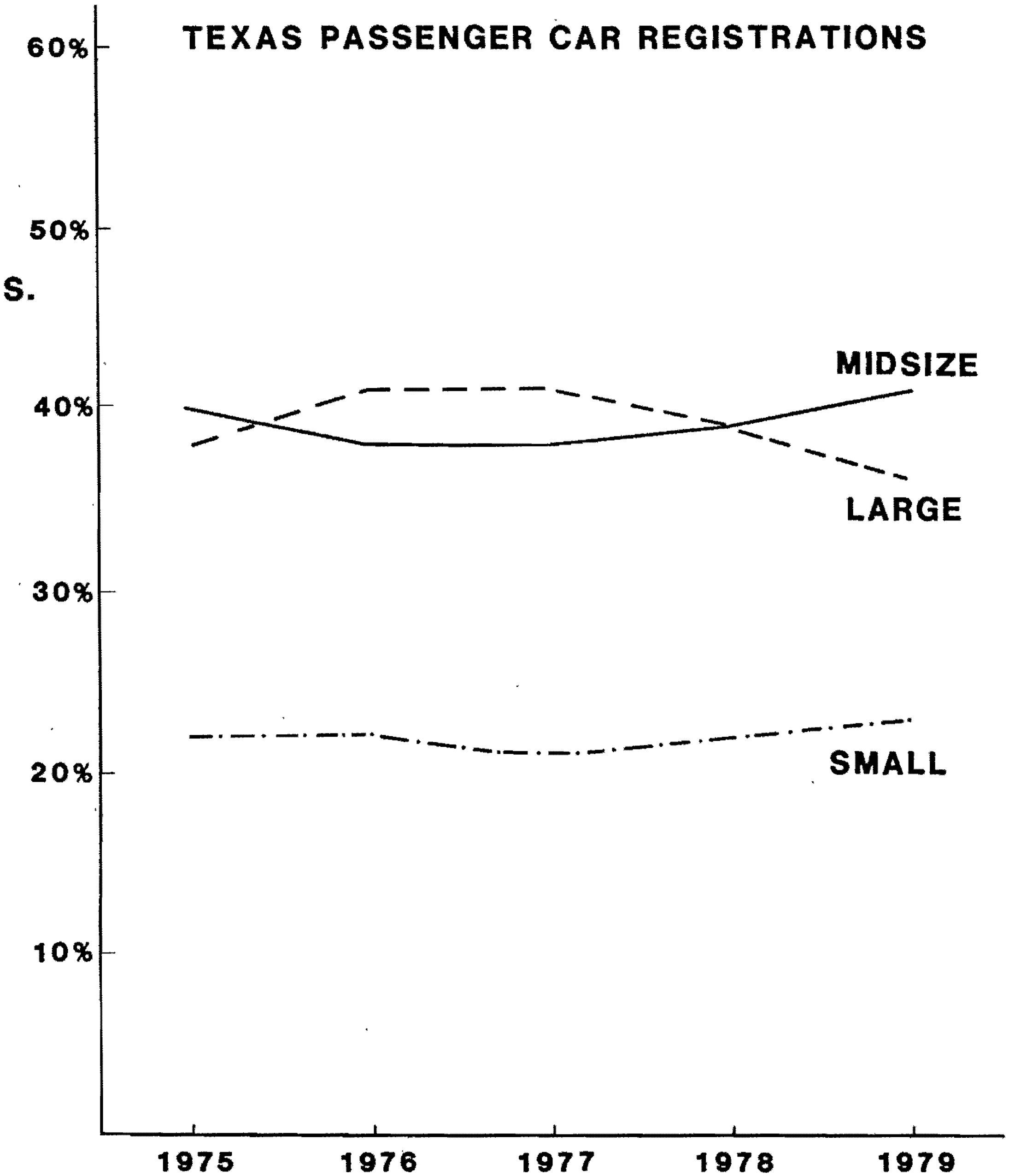
Figure 1. Passenger Cars in Texas

CAR WEIGHT CLASSES

SMALL CARS - LESS THAN 3,000 LBS.

MIDSIZE CARS - 3,000-4,000 LBS.

LARGE CARS - OVER 4,000 LBS.



Source: SDHPT

overall percentage increase during this time period.

The truck fleet can also be categorized into different weight and size classes. For this study trucks were divided into two size categories: single unit trucks and combination tractor trailer trucks. Pickup trucks were excluded from these groups.

In the Texas truck fleet the trend is toward larger and heavier trucks, some with twin trailers. These twin trailer combinations are able to haul a given amount of goods in a fewer number of trips, which results in a savings in fuel and other operating costs.

Vehicle Design Changes

Along with the changing vehicle mix, certain design changes in automobiles and trucks have improved operating efficiency. The most obvious change in the automobile is reduced size and weight. Reducing vehicle weight is accomplished mainly through downsizing as well as the substitution of lighter materials for steel components. Reduction in size and weight usually means that the vehicle will offer less protection for the occupants unless some additional safety measures are also included. Results of these changes have produced cars with some (or all) of the following characteristics: 1) reduced track width, 2) higher center of gravity, and 3) reduced horsepower. These characteristics lead to a more unstable vehicle probably with reduced acceleration ability (Ref. 1).

Another important design change is the reduction of the driver eye height distribution in smaller model cars. This can result in insufficient sight distances in certain situations. Current traffic engineering practice assumes a driver eye height of 3.75 feet. Studies have indicated, however, that driver eye heights for approximately 89% of compact and smaller passenger cars and about 73% of intermediate and full size cars are less than the present standard (Ref. 3). This implies that our streets and highways are being designed to accommodate sight distances of only a small percentage of today's automobile drivers.

These design changes in automobiles are expected to continue in the future. A study by the Midwest Research Institute (Ref. 4) projected vehicle characteristics through the year 1995. The report predicted that the average weight of vehicles on the highway will be 10% less in 1985 than in 1978 and 14% less in 1995. Weight to horsepower ratios will not likely change appreciably after 1985. This implies that, although fuel consumption characteristics will continue to improve through 1995, little change in vehicle performance after 1985 is expected.

A principal design change in the truck fleet has been reduced engine horsepower. This has resulted from a combination of the need for more fuel economy and the move to lower operating speeds on highways. But because of these lower speeds, many states have compensated by increasing the maximum gross vehicular weight limit for trucks. This results in a higher average weight to horsepower ratio which in turn leads to reduced acceleration ability and reduced performance on grades (Ref. 1).

Another design change is in the number of trailers in the truck combination itself. As mentioned previously, there is a trend toward the use of twin and also triple trailers. These combinations are able to haul more gross vehicular weight without increasing axle weights. However, additional trailers may mean less control of the vehicle in certain situations; and offtracking is often a problem with longer trucks. Twin and triple combinations might also cause problems for small car drivers in terms of visibility and passing maneuvers. Other design changes such as the cab-over-engine tractor and streamlining devices to reduce wind resistance do not have a direct impact on vehicle performance in the traffic stream.

Vehicle Operating Characteristics

To determine the impact of certain design changes it is necessary to look at the operating characteristics or performance of these new small cars and large trucks.

A TTI study by Woods and Weaver (Ref. 5) tested acceleration rates of various sized cars. They found that while the smaller vehicles accelerated adequately at low speeds, their acceleration capability at highway speed was substantially lower than the full size cars. At 50 mph, more than 200 additional feet were required for the 85th percentile small cars to pass another car. The growing trend toward higher gear ratios for highway cruise speeds and continued horsepower reductions to achieve fuel efficiency will no doubt result in continued lower performance by the smaller cars at highway speeds (Ref. 2).

This reduced power of smaller cars may cause problems in passing, road entry, and lane changing. This is especially true when small cars are in the traffic stream along with very large trucks. In a study by the Center for Transportation Research (Ref. 6) on large truck combinations, it was found that the distance required for an average car to pass a 95 foot triple trailer combination is about 330 feet more than to pass a 65 foot twin trailer combination. For a small car with reduced engine power this distance would be even greater.

Another disadvantage of the smaller car in the traffic stream is the reduced eye height. This can cause difficulty in seeing around larger vehicles for passing, road entry and lane changing as well as general visibility of traffic control devices, road hazards, etc. (Ref. 7). Cornering ability and stopping distances also appear to present some problems as far as the smaller vehicles are concerned. And, small vehicles are inherently less stable in off-road maneuvers than are large vehicles (Ref. 2).

Design changes in small cars that affect performance can be especially hazardous to drivers that are used to driving larger cars. There are many differences in the vehicle performance of a smaller car as compared to a larger size car that a driver should be aware of: (Ref. 7)

1. A small car can give a false sense of security in handling and maneuvering.

2. Brakes and tires can give a different "feel" of handling from that of a large car, especially if the car has front wheel drive.

3. A small car is more easily affected by either truck or weather - related wind blasts.

4. Drivers of small cars may feel intimidated by larger vehicles, especially large trucks.

5. Often, drivers of small cars tend to maintain shorter following distances. Trucks and other large vehicles behind may also misjudge a small car and follow too closely.

Tests have been conducted comparing truck combinations with single, double, and triple trailers concerning vehicle performance. It was found that during passing maneuvers, additional length of a vehicle significantly affects passing sight distances (Ref. 8,9,10). Passenger car drivers would require a much longer distance to pass these larger trucks. Weight must also be considered in the passing maneuver because the weight/horsepower ratio is important in determining the acceleration rate of a vehicle. With the trend toward trucks with lower horsepower and increased weight, more time and distance will be required for a truck to execute a pass (Ref. 9). These tests concluded that on multi-lane highways, bigger and heavier trucks would create little or no difficulty in the passing maneuver; however, on two-lane roads with limited passing sight distances, these trucks could present a safety hazard (Ref. 8,9).

The FHWA has done some research on large truck safety. Recent tests found that, on the whole, less than half of the randomly selected trucks tested met their respective stopping distance requirements. Results from a FHWA questionnaire showed that officials from 10 states observed that heavy trucks had problems maintaining highway speeds on upgrades and 11 states cited braking inadequacies as a safety hazard. Officals from 28 states believed that excessive truck weight increased stopping distances enough to create a safety hazard (Ref. 11).

Other tests of larger and heavier truck combinations found that an increase in truck length and weight does not result in significant increases in stopping distances as long as all equipment is operating properly (Ref. 8,9,10). In fact, on wet road surfaces, multi-axled longer combinations have advantages over vehicles with fewer axles. The front axles of a truck combination will "squeegee" much of the water out of the path of the following axles which gives a higher coefficient of friction resulting in a shorter braking distance and better stability (Ref. 8,9,10).

Wind blast effects from large trucks are also a consideration in the passing maneuver. Tests have shown that larger trucks slightly increase wind disturbance and may affect car and driver performance. However, it was found that a truck combination with multiple trailers seemed to offset the effect of increased vehicle length because of the flow of air between the trailers. Generally, the more porous the truck combination is to a crosswind, the less disturbance it causes to a passing vehicle (Ref. 12).

Another problem with large trucks is the splash and spray created on wet surfaces. The main concern is that the truck tractor front axle tires create a large stream of water that is thrown back into the drive axle or axles. This causes a considerable amount of splash and spray thrown out at the windshield height of surrounding cars (Ref. 13). This can create a hazard by blocking the visibility of a car driver trying to pass. The effect of the trailer axles in the truck combination is much less significant. Studies have shown that the size and weight of the truck combination is not an important factor with splash and spray (Ref. 13).

A major concern with larger trucks is the general maneuverability of the vehicle. With multiple trailer truck combinations there is a danger of the trailers swerving or whipping. This could cause a possible loss of control plus, other drivers are hesitant to pass a whipping trailer (Ref. 9). It was found that swerving or whipping was not a serious problem under normal conditions, however, bad road and weather conditions have a negative effect and higher speeds seem to increase the whipping motion (Ref. 8,9,10). Also, the greater number of trailers in a truck combination, the shorter the distance the vehicle can back up without jackknifing (Ref. 8). This can cause maneuverability problems on narrow roads in the case of an obstruction.

Large trucks also have maneuverability problems on city streets that oftentimes affect surrounding vehicles. These problems include: (Ref. 9)

1. Using extra lanes when turning.
2. Failing to use left-turn pockets.
3. Needing additional time to move through intersections.
4. Running over curbs and double yellow lines.
5. Finding a large enough gap in traffic when entering or crossing a main street.
6. Having problems with merging traffic resulting in excessive speed adjustments and lane changing.

Effectiveness of Highway Appurtenances

Size and weight changes in certain vehicles may cause problems in terms of highway design. The design concept of the "forgiving highway" seeks to protect the driver that, through some error or accident, loses control of the vehicle and leaves the highway. This concept, which utilizes protective highway devices, is made much more difficult to implement with the trend toward smaller cars and larger trucks (Ref. 1).

A report by Michie at the Southwest Research Institute (Ref. 14), points out that most current roadside hardware (guardrails, median barriers, bridge railings, crash cushions, breakaway sign supports, etc.) was developed when the average passenger car was between 2000 and 4500 pounds. More recently there is concern, supported by crash tests, that current roadside hardware will not function properly with the new mini-compact cars weighing less than 2000 pounds (Ref. 14). Also, with the gradual increase in bus and truck traffic, there is further concern that this hardware will prove to be inadequate for heavy vehicles under a growing number of severe collision-impact conditions. These factors could lead to an increase in roadside collision injuries and fatalities.

This same report presented several problems associated with vehicles weighing less than 2,000 pounds: (Ref. 14)

1. Decreases in vehicle mass are accompanied by increases in the acceleration, momentum, or velocity change induced in the car during impact with roadside objects. The occupants are therefore subjected to a greater degree of risk.

2. The smaller wheel tracks and base lengths reduce the dynamic stability of the vehicle during shoulder slope encroachments and barrier redirection. More rollovers are foreseen.

3. Because of a smaller wheel diameter, the front wheels can wedge under roadside, median, and

bridge barriers of standard height, causing abrupt vehicle snagging and spinout.

4. The mass moments of inertia are less, making the vehicle more prone to upset or to violent reactions during off-center impacts with breakaway supports, barrier terminals, or crash cushions.

5. Since the ground clearance of the small car is generally less than the six inch exposed concrete base allowed for current breakaway supports, small cars will readily sway on the rigid concrete foundations.

Large heavy vehicles pose a different set of problems. Michie's report stated that at impact, a heavy vehicle may possess kinetic energy that is 40 times greater than that of a passenger car (Ref. 14). Therefore, longitudinal barriers must be substantially stronger in order to contain and redirect a heavy vehicle. These barriers must also be higher to interact properly with the larger vehicle's high center of mass. Breakaway luminaire and sign supports have not been shown to present a hazard for large heavy vehicles, with the exception of the potential of elements detached during the impact to act as projectiles.

Redesigning the entire system of roadways to accommodate both ends of the vehicle spectrum would be an overwhelming expense. One report estimated that a barrier system that would protect both very large and very small vehicles might cost 300 to 500 percent more than conventional barriers (Ref. 15). However, there are things that can be emphasized in the normal roadway rehabilitation programs until other measures are taken: (Ref. 2)

1. Provision of climbing lanes and more structurally adequate paved shoulders that can serve as "pull-over" lanes for slower traffic.

2. Provision of advanced signing to inform drivers of passing opportunities ahead. This can prevent many of the dangerous "frustration" passing maneuvers associated with long stretches of no-passing zones.

3. New and different ways of displaying information and traffic control devices in order to be more easily visible.

The interaction between very small and very large vehicles and highway structures along with design changes that adversely affect vehicle performance, can create an increased risk of accidents occurring on the highways.

Accident Rates - Related Studies

After a short decline in traffic fatalities following the 1973 gasoline shortage, the number of traffic deaths has gradually been rising since 1976. Some highway safety experts feel that much of this increase is due to the growing number of smaller cars on the nation's highways (Ref. 16).

A fact that is not usually considered in studies dealing with future accident rates of small cars is that generally, newer model cars are being designed with better safety features. Passive restraint systems in some cars will prevent many fatal injuries in car crashes. Other improvements in vehicle design such as more protective occupant compartments surrounded by better energy absorbing materials will prevent many fatal injuries by reducing peak deceleration forces on occupants during a crash (Ref. 18). Also, the basic car frame of the future will be designed better to absorb the energy of a crash; and new materials used in making the car itself will be stronger as well as lightweight (Ref. 17,18).

A report by Joksch in 1975 (Ref. 19) analyzed the effects of vehicle size on traffic deaths and injuries. Vehicle size can influence accidents in two ways: by changing the frequency of accidents and by changing the occupant injury and fatality risk in an accident. This report found no evidence that car size alone is, positively or negatively, related to accident frequency.

Joksch's report concluded that for single-car crashes the risk of fatal or serious injury is consistently about 50% higher for drivers of small cars than for drivers of large cars (Ref. 19). For two-car collisions (primary car collides with secondary car), it was found that as the weight of the primary car increases, frequency of fatal or serious driver injury of the primary car decreases. And, as the weight of the secondary car increases, frequency of fatal or serious driver injury of the primary car increases. For car/truck collisions, the weight of the primary vehicle has a quantitatively similar effect as in the two-car collisions (Ref. 19). This is only a partial conclusion however, because this report focused only on car weight and did not study the effects of truck size in a collision.

A series of three studies dealing with the relationship between vehicle size and weight and driver injury were conducted by the Highway Safety Research Center of the University of North Carolina. Each of these studies covered a different time period from 1973 through 1975. The primary data source was the North Carolina vehicle registration file and accident file.

The three reports had similar results. The first study (Ref. 20) found that particularly in two-car crashes, there was an association between lighter cars and more frequent instances of severe injury. However, the strength of association seemed to decline with newer model cars. This was probably due to the increased safety measures required in the newer models. The association between vehicle weight and injury was <u>not</u> significant for single car crashes (Ref. 20). Therefore, low weight alone does not completely rule out the possibility of providing crash protection. The type of collision itself (rear end, head-on, side swipe, etc.) was also a factor in determining the extent of driver injury.

The second study (Ref. 21) found that for two-car crashes, there was a definite trend of decreased risk of serious injury with increased vehicle weight. Accident speed, belt usage, and type of crash were all important factors that influence injury severity.

A third study presented a more detailed analysis of the make, model and year of cars involved in accidents. An examination of driver age by car size for vehicles involved in accidents showed that the mean driver age for small cars was lower than for midsize or large cars (Ref. 22). This could be a partial explanation for the higher involvement rates for small cars. Also, the accident and injury comparisons in the third study showed basically the same trends as in the two previous reports. Accident involvement rates - both overall and single vehicle - declined for newer model cars with the trend being more pronounced for large cars than for midsize or small cars. Injury rates, including driver injury and vehicle severity measures, decreased for newer models across all vehicle sizes (Ref. 22).

In contrasting accident and injury rates for vehicles in the North Carolina studies, the more recent rates were generally higher than rates in the earlier studies. A partial explanation for these higher involvement and injury rates might be the fact that more people were driving above the 55 mph speed limit in the more recent study which covered the period following the energy crisis. The more recent study used data for the period January 1975 through December 1975 whereas the initial study covered the period from October 1973 to October 1974. Also, the number of small cars in the traffic stream rapidly increased during the time period encompassing the three studies (Ref. 22).

Information on accidents involving large trucks and passenger cars was presented by the American Automobile Association (AAA) to the Subcommittee on Transportation of the State Committee on Environment and Public Works. The AAA selected safety statistics from the Fatal Accident Reporting System comparing the years 1975 and 1978 (Ref. 23). These data show that between 1975 and 1978, fatal accidents involving heavy trucks (over 26,000 lbs.) increased 47.6%; those involving combination trucks (a truck tractor with one or more semi-trailers or trailers) increased 43.1%; those involving all vehicles increased 13.2%; and those involving passenger cars increased 7.2%. Fatalities occurring in accidents involving heavy trucks increased 43.4%, and a 39.3% increase was recorded for combination trucks. There was a 12.8% increase in fatalities for all vehicles and a 7% increase for passenger cars. There was also a 39% increase in the number of fatalities to occupants of passenger cars in collisions with heavy trucks and a 33.7% increase in passenger car occupant fatalities in collisions with combination trucks. Fatality rates (fatalities/100 million vehicle miles traveled) for combination trucks increased 11% from 5.98 to 6.64 between 1975 and 1977, while the rate for passenger cars decreased 4.2% from 3.39 to 3.25 (Ref. 23).

Other statistics from the Fatal Accident Reporting System's 1978 annual report (Ref. 24) show that the collision of two passenger cars was the most frequent two-vehicle fatal accident, more than double the next most frequent. It also shows that in fatal collisions involving a large truck and another vehicle, over 90% of the deaths were in the other vehicle. Of all passenger car fatal accidents in 1978, sub-compact, compact, midsize and full size car classes each had approximately 25% of all fatalities.

More recent data on fatalities in small cars were presented in the Transportation Safety Information Report (Ref. 16 p.8). The report stated that:

> "The increasing number of subcompact cars has had a direct effect on the fatality mix. The proportion of passenger car deaths in subcompact cars has risen from 22% in 1975 to 30% in 1979. During the same period, deaths in full size cars declined from 33% to 24% of passenger car deaths. In two-vehicle crashes between subcompacts and full size cars, more than eight times as many fatalities occurred in the subcompact car as in the full size car."

In summary, it is evident from the preceeding data that decreased vehicle size and weight results in an increased risk of serious injury in the case of a collision. However, there are many factors that influence accident severity besides the weight of the vehicles involved. The type of collision, accident speed, and seat belt usage are all variables that affect accident severity. Also, newer model cars equipped with better safety devices help to offset the negative effects of reduced weight.

Another point to be considered in dealing with car/truck accidents is the basic purpose of truck travel. Trucks are used to transport goods from place to place. If large trucks were prohibited on the highways, it would take a greater number of small trucks to perform the required service. For example, consider whether it would be safer to transport a given amount of goods in one large truck or two smaller trucks. If an accident occurred, data indicate more likelihood of a death if the larger truck was used; however, there would be twice as much opportunity for an accident, in terms of vehicle miles traveled, with the smaller trucks (Ref. 25).

There is also the fact that because of the vast weight difference between a large truck and a small car, additional weight to the truck may be insignificant in a collision (Ref. 25). For instance, consider the impact of a 50,000 pound truck on a 2,000 pound car. Because of the great disparity in weight it is doubtful that the impact of an 80,000 pound truck would be much different. The outcome would most likely be the same.

TEXAS ACCIDENTS

Introduction

Data were analyzed for rural accidents in Texas from 1976 through 1979. The data were separated into accidents involving large trucks and all cars, and accidents involving large trucks and cars of different weight classes. The accidents of large trucks and all cars included multiple and single vehicle accidents and were analyzed by accident severity, road type, and persons killed or injured per accident. Large truck accidents involving car weight classes included; multiple vehicle accidents, analyzed by severity and road type, and multiple vehicle accidents between vehicle weight classes, analyzed by severity and persons killed or injured per accident. This study did not include exposure rates from vehicle miles of travel data. Also, in the data dealing with the number of persons killed or injured per accident, the number of passengers per vehicle was not determined. Data were not sorted to remove alcohol-related accidents.

Large Trucks and All Car Weights Combined

Rural accidents involving single unit or combination trucks and all weights of cars combined were analyzed. These accidents include both multiple and single vehicle accidents. The data were categorized into three degrees of accident severity, three road types on which the accident occurred, and the number of persons killed or injured per accident.

Accident Severity

The degrees of accident severity examined in this study are: 1) fatal - an accident in which a fatality occurred, 2) injury - an accident in which an injury occurred, and 3) property damage only (PDO) - an accident in which no injury or fatality occurred. Table 1 divides the accident data into three categories: Trucks(s) Only - single and multi-vehicle accidents that involve only trucks, Car/Truck - multi-vehicle accidents involving car(s) and truck(s), and Cars and Other Vehicles - single and multi-vehicle accidents involving cars and other vehicles besides trucks. This table shows that a full 93% of all accidents over the four-year period involved cars and other vehicles while just 4% involved cars(s) and truck(s) and 3% involved only trucks. Only 3% of all accidents resulted in a fatality while 31% resulted in an injury and 66% in property damage only. One might expect that the Car/Truck category would have a substantial percentage of fatal accidents; however, this table shows that only 4% of all car/truck accidents resulted in a fatality compared to 3% each for cars and other vehicles and truck only accidents.

Between 1976 and 1979, fatal accidents involving only trucks increased over 200%, car/truck fatal accidents increased over 150% and those involving cars and other vehicles increased less than 20%. For property damage only accidents, both the Truck(s) Only and Car/Truck categories increased about 50% while car and other vehicle accidents decreased about 10%. Details are illustrated in Tables A-1, 2, and 3 in the Appendix.

Table 1. Number of Rural Accidents by Accident Severity and Type of Vehicle(s) Involved, Texas 1976-1979

ACCIDENT SEVERITY	VEHICLE TYPE			
Frequency Column % Row %	Truck(s) Only	Car/Truck	Cars & Other Vehicles	All
Fatal	217 3% 4%	350 4% 6%	5092 3% 90%	5659 3% 100%
Injury	2673 34% 4%	2568 28% 3%	66664 31% 93%	71905 31% 100%
Property Damage Only	4918 63% 3%	6327 68% 4%	140559 66% 93%	151804 66% 100%
All	7808 100% 3%	9245 100% 4%	212315 100% 93%	229368 100% 100%

Table 2 shows rural multi-vehicle accidents involving collisions between single unit or combination truck(s) and car(s) from 1976 through 1979. Both truck types show an overwhelming majority of accidents in which no injury or fatality occurred; 71% for single unit trucks and 64% for combination trucks. However, combination trucks were involved in about twice as many fatal accidents as single unit trucks. While combination trucks were only involved in 39% of all accidents, they were involved in 67% of all fatal accidents. The opposite is true for single unit trucks. Single unit trucks were involved in 61% of all accidents and 33% of all fatal accidents. Table 1 shows that 3% of all accidents were fatal whereas, Table 2 shows that for all accidents involving a combination truck, 6% were fatal and for those involving a single unit truck, only 2% were fatal.

Table 3 shows the number of injury accidents for single unit and combination trucks and cars. The injuries are divided into incapacitating (severe) and other injury (less severe). Only 25% of all injury accidents resulted in an incapacitating injury. Combination trucks were involved in a slightly higher percentage of severe injury accidents and a lower percentage of other injury accidents than single unit trucks. For all truck injury accidents, single unit truck accidents accounted for 58% and combination truck accidents 42%.

Over the four-year period, incapacitating accidents increased 77% while other injury accidents increased over 100%. The number of injury accidents for combination trucks increased over 150% and those for single trucks increased approximately 60%.

Table 2. Car/Truck Rural Multi-Vehicle Accidents by Accident Severity and Truck Type, Texas 1976-1979

ACCIDENT SEVERITY	TRUCK TYPE		
Frequency Column % Row %	Single Unit Truck	Combination Truck	All
Fatal	116 2% 33%	234 6% 67%	350 4% 100%
Injury	1477 27% 58%	1091 30% 42%	2568 28% 100%
Property Damage Only	4002 71% 63%	2325 64% 37%	6327 68% 100%
All	5595 100% 61%	3650 100% 39%	9245 100% 100%

Table 3. Car/Truck Rural Multi-Vehicle Accidents by Injury and Truck Type, Texas 1976-1979

ACCIDENT SEVERITY	TRUCK TYPE		
Frequency Column % Row %	Single Unit Truck	Combination Truck	All
Incapacitating (Severe)	319 22% 49%	327 30% 51%	646 25% 100%
Other Injury	1158 78% 60%	764 70% 40%	1922 75% 100%
All	1477 100% 58%	1091 100% 42%	2568 100% 100%

Figure 2 shows the increase and decrease of accidents involving car(s) and truck(s) by accident severity over the four year period. The total number of car/truck accidents has gone up approximately 68% from 1976 to 1979. For single unit trucks, the total number of accidents increased about 30% over this time period while accidents involving combination trucks increased 140%. The only category that decreased in numbers of accidents was the Property Damage Only category for single unit trucks. It decreased 6% from 1977 to 1979. For both truck types the total number of property damage accidents increased 53% over the four-year period while injury accidents increased approximately 100% and fatal accidents increased over 150%. While the total number of fatal accidents for single unit trucks increased 61%, the number for combination trucks increased 225%.

Road Type

The accidents reported herein occurred on three types of roads: 1) Interstate highways, 2) U.S. and State highways, and 3) Farm to Market roads. Table 4 shows accidents by road type for truck only, car/truck, and car and other vehicle accidents. Over half of the total number of accidents occurred on U.S. and State highways with the least number of occurring on Interstate roads. Comparing the three vehicle categories, for both the Car/Truck and Cars and Other Vehicles categories, accidents occurring on the Interstate were the least frequent. But, the Truck Only category had a higher percentage of accidents on Interstate roads and a lower percentage on Farm to Market roads than the other two vehicle categories. Also, for all accidents, 3% involved

Figure 2. Car/Truck Rural Multi-Vehicle Accidents by Accident Severity, Texas 1976-1979

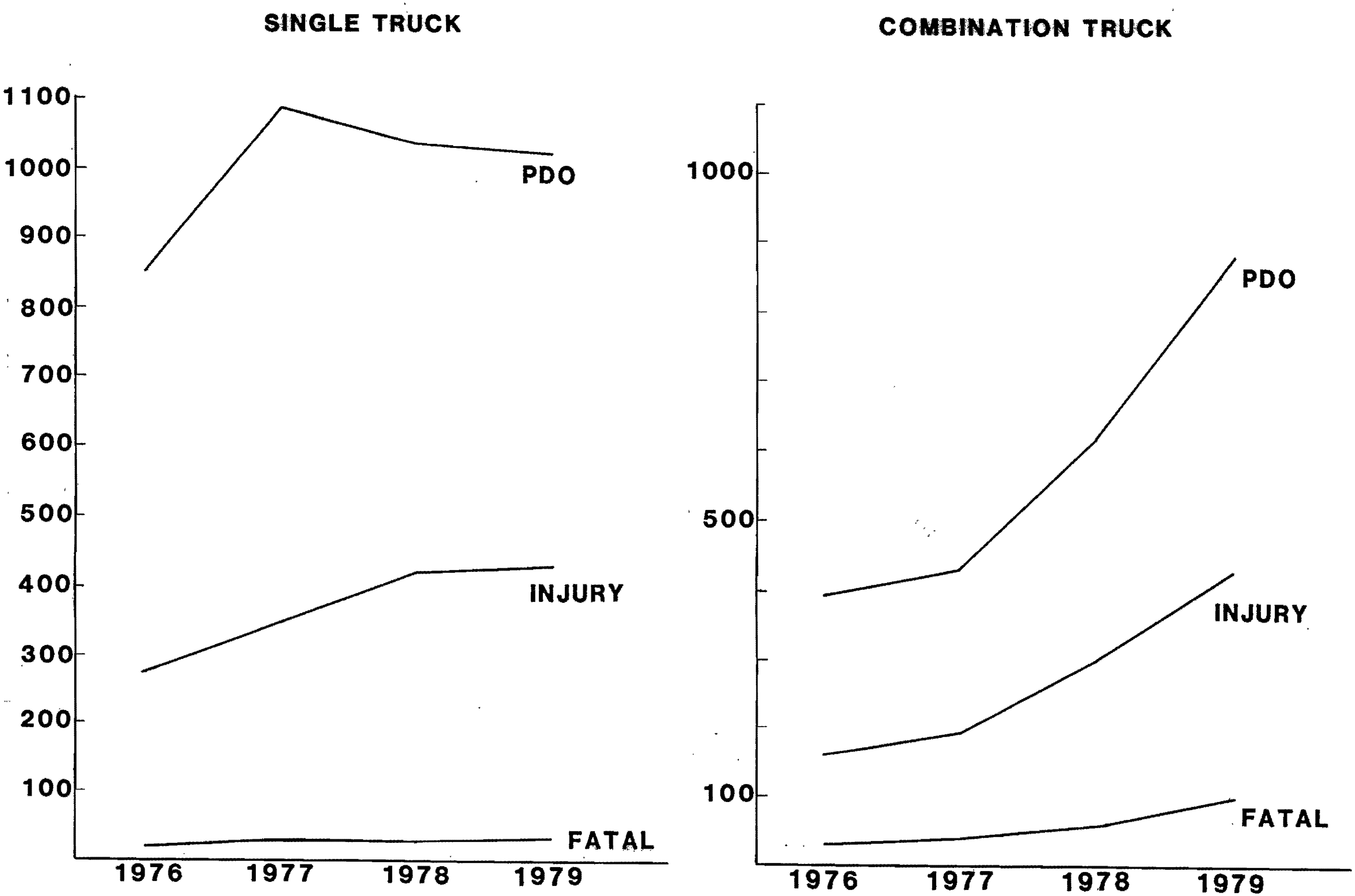


Table 4. Number of Rural Accidents by Road Class and Type of Vehicle(s) Involved, Texas, 1976-1979

ROAD CLASS	VEHICLE TYPE			
Frequency Column % Row %	Truck(s) Only	Car/Truck	Cars & Other Vehicles	All
Interstate	1584 20% 6%	1326 14% 5%	23800 11% 89%	26710 12% 100%
U.S. & State Highway	4646 60% 3%	5936 64% 4%	127923 60% 93%	138505 60% 100%
Farm to Market	1578 20% 3%	1983 22% 3%	60592 29% 94%	64153 28% 100%
All	7808 100% 3%	9245 100% 4%	212315 100% 93%	229368 100% 100%

only trucks, but for all accidents on the Interstate, 6% involved only trucks. This shows that accidents involving only trucks had a higher than expected number of accidents on the Interstate.

Table 5 shows that the majority of accidents involving single unit and combination trucks occurred on U.S. and State highways (64%). The percentage of accidents on Interstate and Farm to Market roads were fairly close at 14% and 22%, respectively. Both truck types had the highest percentage of accidents on U.S. and State highways; however, combination trucks had more accidents on Interstate roads than on Farm to Market roads while the opposite was true for single unit trucks. In fact, single unit trucks had more than three times as many accidents on Farm to Market roads than did combination trucks. For all car/truck accidents, 61% involved single unit trucks, but for all car/truck accidents on Farm to Market roads, 76% involved single unit trucks.

Person Killed or Injured

Table 6 shows the number of persons killed or injured per accident for truck only, car/truck, and cars and other vehicles accidents. The data show that there is a greater chance of a fatality or injury occurring in accidents involving car(s) and truck(s). However, in all fatal accidents, there is a greater chance of a severe injury in accidents involving cars and other vehicles. Overall, accidents involving only trucks resulted in the least number of fatalities and injuries per accident.

Table 5. Car/Truck Rural Multi-Vehicle Accidents by Road Class and Truck Type, Texas, 1976-1979

ACCIDENT SEVERITY	TRUCK TYPE		
Frequency Column % Row %	Single Unit Truck	Combination Truck	All
Interstate	637 11% 48%	689 19% 52%	1326 14% 100%
U.S. & State Highway	3458 62% 58%	2478 68% 42%	5936 64% 100%
Farm to Market	1500 27% 76%	483 13% 24%	1983 22% 100%
All	5595 100% 61%	3650 100% 39%	9245 100% 100%

Table 6. Number of Persons Killed or Injured Per Accident by Severity and Type of Vehicle(s) Involved, Texas, 1976-1979

ACCIDENT TYPE	VEHICLE TYPE			
	Truck(s) Only	Car/Truck	Cars & Other Vehicles	All
FATAL				
Fatalities	1.04	1.32	1.21	1.21
Severe Injuries	.25	.45	.61	.59
Other Injuries	.29	.66	.55	.55
INJURY				
Fatalities	--	--	--	--
Severe Injuries	.28	.35	.32	.32
Other Injuries	.99	1.43	1.30	1.30
ALL				
Injured and Killed	.48	.59	.57	.56

Large Trucks and Car Weight Classes

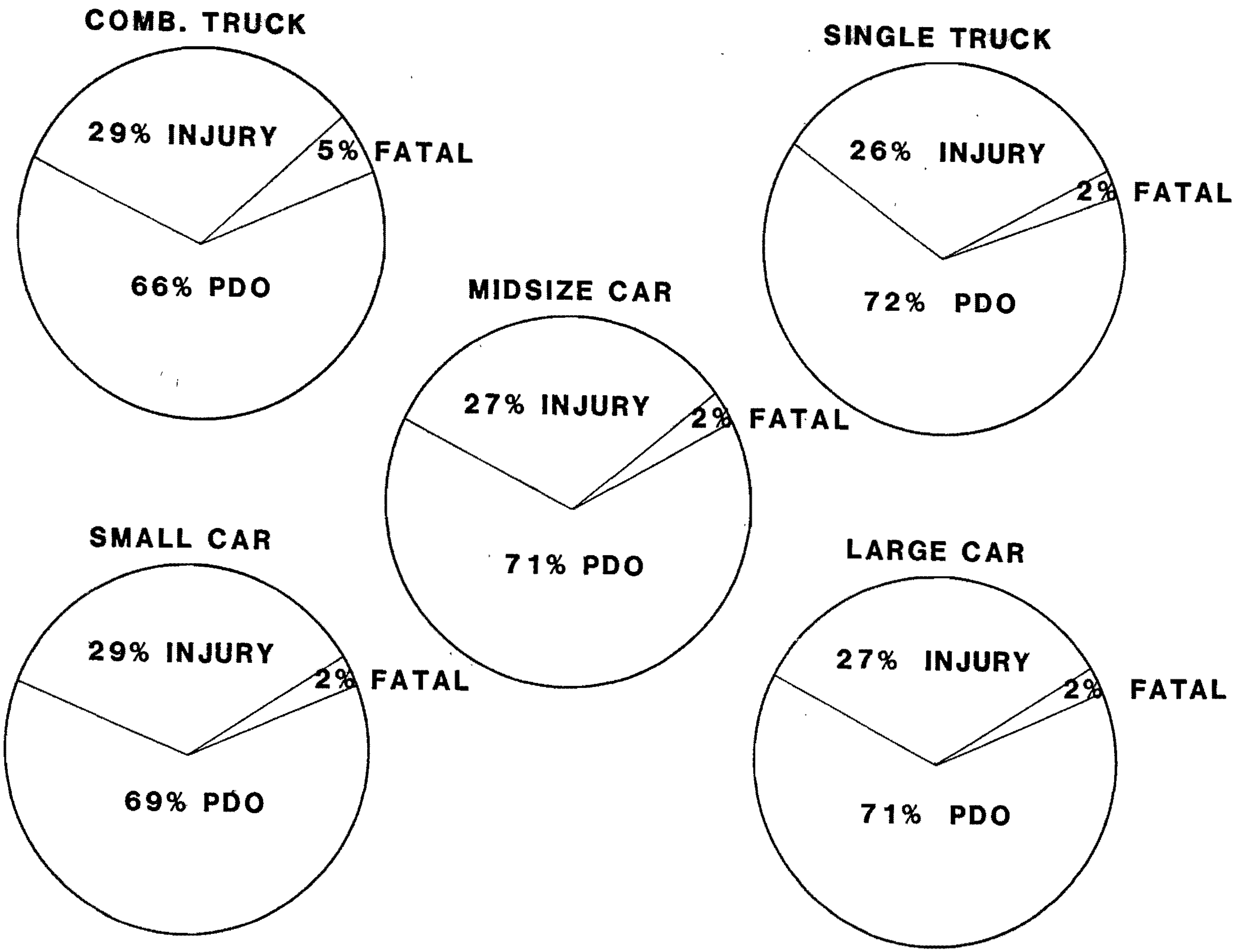
The accident data for Texas was also broken down into specific weight classes of cars: 1) small cars (less than 3,000 lbs.), 2) midsize cars (3,000-4,000 lbs.), and 3) large cars (over 4,000 lbs.). The accidents counted were only those in which a car was involved. The data were also divided into all multiple vehicle accidents and those between vehicle weight classes.

Multiple Vehicle Accidents

Multiple Vehicle accidents are those in which two or more vehicles are involved. In the tables dealing with multi-vehicle accidents, the total number of accidents is not the sum of each row, but the true total number of accidents. Every accident is counted in each column in which that type of vehicle was involved. Therefore, accidents are counted more than once and a sum of the number of accidents in each row would not be a true total. Because of this, the row percentages also do not add to 100%.

For all multiple vehicle accidents involving heavy trucks and car weight classes, only 2% resulted in a fatality, 27% involved an injury, and 71% were only property damage accidents. Combination and single unit trucks had a very small percentage of total accidents while midsize cars had the highest percentage. Figure 3 illustrates the percentage of multiple vehicle accidents by severity for combination and single unit trucks and small, midsize, and large cars. Fatal accidents accounted for 2% of all multi-vehicle accidents in each

Figure 3. Percentage of Multi-Vehicle Accidents by Severity



vehicle class except for combination trucks at 5%. This shows the slightly higher risk of a fatality occurring when a combination truck is involved. Table A-4 in the appendix gives more detailed data.

The majority of multiple vehicle accidents occurred on U.S. and State highways followed by Farm to Market roads with the least number occurring on Interstate highways. Combination trucks were the only vehicle class that had more accidents on Interstate highways than on Farm to Market roads. Table 7 shows multi-vehicle fatal accidents by vehicle class and road type. The table shows that 69% of all fatal accidents occurred on U.S. and State highways. For all fatal accidents, 19% involved a combination truck, but for all fatal accidents on Interstate highways, 29% involved combination trucks. This illustrates that combination trucks were involved in a higher than expected number of fatal accidents on Interstate highways. Conversely, only 7% of all fatal accidents on Farm to Market roads involved combination trucks. The table also shows that small cars were involved in a higher percentage of fatal accidents on Farm to Market roads than expected. Tables A-5, 6, and 7 in the appendix give more detail.

Multiple Vehicle Accidents Between Vehicle Weight Classes

Multiple vehicle accidents were further classified into accidents between different vehicle weight classes. These included only accidents involving vehicles of two weight classes (i.e. combination trucks and small cars). Due to rounding, some percentages in the following tables may not add to 100%.

Table 7. Multiple Vehicle Fatal Accidents by Weight Class and Road Type, Texas, 1976-1979

	VEHICLE TYPE							
Frequency Column % Row %	Combination Truck	Single Unit Truck	Pickup	Small Car	Midsize Car	Large Car	Other Vehicle	Total Accidents
Interstate Highways	60 15% 29%	14 9% 7%	32 6% 16%	53 10% 26%	110 10% 53%	81 10% 39%	27 8% 13%	206 10% --
U.S. and State Highways	312 78% 22%	112 68% 8%	343 67% 24%	365 66% 25%	815 70% 56%	571 71% 39%	234 66% 16%	1450 69% --
Farm to Market Roads	30 7% 7%	38 23% 9%	139 27% 32%	134 24% 31%	236 20% 54%	158 20% 36%	92 26% 21%	435 21% --
All	402 100% 19%	164 100% 8%	514 100% 25%	552 100% 26%	1161 100% 56%	810 100% 39%	353 100% 17%	2091 100% --

Tables 8-12 represent accidents between car and truck weight classes. Table 8 shows accidents in which a small car and another vehicle were involved. Only 2% of all accidents resulted in a fatality, 28% involved an injury, and 70% were property damage only accidents. Midsize and large cars were slightly under-involved in fatal accidents. Combination trucks were very much over-involved in fatal accidents. For all accidents involving small cars, 5% were collisions with combination trucks, but for all fatal accidents, 16% involved small cars and combination trucks. To illustrate it another way, 2% of all small car accidents were fatal, but 6% of all small car/combination truck accidents were fatal.

The results of accidents between midsize cars and other vehicle classes (Table 9) are similar to small cars except that the majority of accidents involved pickup trucks. Overall, midsize cars were involved in a lower percentage of injury accidents and a higher percentage of property damage accidents than small cars. Combination trucks were over-involved in fatal accidents with midsize cars.

Table 10 illustrates accidents involving large cars. The results are also similar to those of small and midsize cars. Accidents involving large cars and midsize cars were the most frequent and those involving single unit trucks were the least frequent.

Of all accidents between single unit trucks and cars (Table 11), almost 50% involved midsize cars. The same is true for those accidents involving combination trucks and cars (Table 12). Fatal accidents accounted for only 2% of all single unit truck accidents compared to 5% for combination trucks. Table 12 also illustrates the high

Table 8. Multiple Vehicle Accidents Between Small Cars and Vehicle Weight Classes, Texas, 1976-1979

ACCIDENT SEVERITY	VEHICLE TYPE							
Frequency Column % Row %	Combination Truck	Single Unit Truck	Pickup	Small Car	Midsize Car	Large Car	Other	All
Fatal	81 6% 16%	30 2% 6%	108 2% 21%	38 2% 7%	125 2% 24%	80 2% 15%	59 2% 11%	521 2% 100%
Injury	425 31% 6%	408 27% 6%	1504 27% 21%	606 32% 8%	2032 28% 28%	1335 29% 18%	965 27% 13%	7275 28% 100%
Property Damage Only	859 63% 5%	1076 71% 6%	4017 71% 22%	1271 66% 7%	5030 70% 28%	3150 69% 18%	2584 72% 14%	17987 70% 100%
All	1365 100% 5%	1514 100% 6%	5629 100% 22%	1915 100% 7%	7187 100% 28%	4565 100% 18%	3608 100% 14%	25783 100% 100%

Table 9. Multiple Vehicle Accidents Between Midsize Cars and Vehicle Weight Classes, Texas, 1976-1979

ACCIDENT SEVERITY	VEHICLE TYPE							
Frequency Column % Row %	Combination Truck	Single Unit Truck	Pickup	Small Car	Midsize Car	Large Car	Other	All
Fatal	185 5% 17%	73 2% 7%	216 1% 19%	125 2% 11%	180 2% 16%	184 1% 17%	155 2% 14%	1118 2% 100%
Injury	1182 29% 7%	1036 26% 6%	4151 25% 24%	2032 28% 12%	3170 26% 18%	3581 27% 20%	2492 27% 14%	17644 27% 100%
Property Damage Only	2695 66% 6%	2925 73% 6%	11975 73% 25%	5030 70% 10%	8872 73% 19%	9511 72% 20%	6442 71% 14%	47450 72% 100%
All	4962 100% 6%	4034 100% 6%	16342 100% 25%	7187 100% 11%	12222 100% 19%	13276 100% 20%	9809 100% 14%	66212 100% 100%

Table 10. Multiple Vehicle Accidents Between Large Cars and Vehicle Weight Classes, Texas, 1976-1979

ACCIDENT SEVERITY	VEHICLE TYPE							
Frequency Column % Row %	Combination Truck	Single Unit Truck	Pickup	Small Car	Midsize Car	Large Car	Other	All
Fatal	111 4% 14%	51 2% 7%	159 2% 21%	80 2% 10%	184 1% 24%	78 1% 10%	110 2% 14%	773 2% 100%
Injury	792 27% 7%	676 24% 6%	2596 24% 21%	1335 29% 11%	3581 27% 30%	1484 27% 12%	1675 28% 14%	12139 27% 100%
Property Damage Only	2042 69% 6%	2041 74% 6%	8105 75% 25%	3150 69% 10%	9511 72% 29%	4025 72% 12%	4107 70% 13%	32981 72% 100%
All	2945 100% 6%	2768 100% 6%	10860 100% 24%	4565 100% 10%	13276 100% 29%	5587 100% 12%	5892 100% 13%	45893 100% 100%

Table 11. Multiple Vehicle Accidents Between Single Unit Trucks and Car Weight Classes, Texas, 1976-1979

ACCIDENT SEVERITY	VEHICLE TYPE			
Frequency Column % Row %	Small Car	Midsize Car	Large Car	All
Fatal	30 2% 20%	73 2% 47%	51 2% 33%	154 2% 100%
Injury	408 27% 19%	1036 26% 49%	676 24% 32%	2120 26% 100%
Property Damage Only	1087 71% 18%	2925 73% 48%	2041 74% 34%	6042 73% 100%
All	1514 100% 18%	4034 100% 49%	2768 100% 33%	8316 100% 100%

Table 12. Multiple Vehicle Accidents Between Combination Trucks and Car Weight Classes, Texas, 1976-1979

ACCIDENT SEVERITY	VEHICLE TYPE			
Frequency Column % Row %	Small Car	Midsize Car	Large Car	All
Fatal	81 6% 22%	185 5% 49%	111 4% 29%	377 5% 100%
Injury	425 31% 18%	1182 29% 49%	792 27% 33%	2399 29% 100%
Property Damage Only	859 63% 15%	2695 66% 48%	2042 69% 37%	5596 67% 100%
All	1365 100% 16%	4062 100% 49%	2945 100% 35%	8372 100% 100%

percentage of fatal accidents between combination trucks and small cars. For all combination truck accidents, 16% involved small cars, but for all combination truck fatal accidents, 22% involved small cars. The opposite is true for accidents between combination trucks and large cars.

Tables 13-17 represent the number of persons killed or injured per accident in collisions between the various weight class vehicles. The accidents are classified into fatal accidents, in which fatalities or injuries occur, and injury accidents in which only injuries occur. The data is limited by the fact that exposure rates (i.e. number of people per vehicle) were not available.

Table 13 shows the number of persons killed or injured per accident in collisions between small cars and other vehicle weight classes. The table shows that collisions involving small and midsize cars resulted in the greatest number of persons killed or injured per accident overall. The Other vehicle category had the highest number of injuries per accident in fatal accidents, while collisions between small cars and pickups had the most fatalities. Small car/combination truck collisions resulted in the least number of injuries and fatalities per accident.

Table 14 and 15 illustrate that collisions between midsize and large cars resulted in the highest number of injuries and fatalities per accident. Combination trucks again had the fewest number. Overall, accidents involving large cars resulted in the most fatalities and injuries per accident at 1.99. This may be due to the fact that large cars can carry more passengers than other vehicles, therefore, there

Table 13. Number of Persons Killed or Injured Per Accident in Collisions Between Small Cars and Vehicle Weight Classes, Texas, 1976-1979

ACCIDENT SEVERITY	VEHICLE TYPE							
	Combination Truck	Single Unit Truck	Pickup	Small Car	Midsize Car	Large Car	Other	All
FATAL								
Fatalities	1.12	1.10	1.40	1.32	1.30	1.35	1.25	1.28
Injuries	0.62	1.13	1.94	1.08	2.13	2.08	2.56	1.76
INJURY								
Fatalities	--	--	--	--	--	--	--	--
Injuries	1.53	1.74	1.72	1.77	1.87	1.86	1.66	1.77
ALL	1.57	1.77	1.82	1.81	1.96	1.95	1.79	1.86

Table 14. Number of Persons Killed or Injured Per Accident in Collisions Between Midsize Cars and Vehicle Weight Classes, Texas, 1976-1979

ACCIDENT SEVERITY	VEHICLE TYPE							
	Combination Truck	Single Unit Truck	Pickup	Small Car	Midsize Car	Large Car	Other	All
FATAL								
Fatalities	1.28	1.44	1.37	1.30	1.34	1.54	1.29	1.36
Injuries	0.89	1.86	1.99	2.13	1.81	2.48	1.88	1.85
INJURY								
Fatalities	--	--	--	--	--	--	--	--
Injuries	1.57	1.86	1.94	1.87	1.91	1.99	1.78	1.89
ALL	1.65	1.95	2.01	1.96	1.98	2.09	1.86	1.97

Table 15. Number of Persons Killed or Injured Per Accident in Collisions Between Large Cars and Vehicle Weight Classes, Texas, 1976-1979

ACCIDENT SEVERITY	VEHICLE TYPE							
	Combination Truck	Single Unit Truck	Pickup	Small Car	Midsize Car	Large Car	Other	All
FATAL								
Fatalities	1.41	1.18	1.35	1.35	1.54	1.45	1.46	1.42
Injuries	1.09	1.63	2.31	2.08	2.48	2.12	1.94	2.03
INJURY								
Fatalities	--	--	--	--	--	--	--	--
Injuries	1.63	1.89	1.94	1.86	1.99	1.94	1.75	1.90
ALL	1.74	1.95	2.04	1.95	2.09	2.02	1.85	1.99

is a greater chance for more people to be killed or injured.

Table 16 shows the number of person killed or injured per accident for single unit trucks. Midsize and large cars both had 1.95 persons killed or injured per accident overall. Midsize cars had more fatalities and injuries in fatal accidents than large cars and large cars had more injuries in injury accidents. Collisions involving single unit trucks and small cars resulted in the least number of fatalities and injuries.

Collisions between combination trucks and vehicle weight classes are shown in Table 17. The table shows that accidents between combination trucks and large cars resulted in a higher number of fatalities and injuries than either small or midsize cars. The total of 1.66 persons killed or injured per accident was the lowest of the vehicle weight classes. Also, collisions between combination trucks and small cars resulted in the least fatalities and injuries per accident than any other of the vehicle weight classes.

Conclusions

From the preceeding data it is apparent that the number of rural car/truck accidents in Texas has increased over the study period, 1976-1979. The number of fatal accidents involving combination trucks has especially had a dramatic increase.

The data showed that over 90% of all accidents involved only cars; while car/truck accidents accounted for less than 5%. An overwhelming majority of these accidents resulted in property damage only with a very small percentage resulting in a fatality.

Table 16. Number of Persons Killed or Injured Per Accident in Collisions Between Single Unit Trucks and Car Weight Classes, Texas, 1976-1979

ACCIDENT SEVERITY	VEHICLE TYPE			
	Small Car	Midsize Car	Large Car	All
FATAL				
Fatalities	1.10	1.44	1.18	1.29
Injuries	1.13	1.86	1.63	1.64
INJURY				
Fatalities	--	--	--	--
Injuries	1.74	1.86	1.89	1.84
All	1.77	1.95	1.95	1.92

Table 17. Number of Persons Killed or Injured Per Accident in Collisions Between Combination Trucks and Car Weight Classes, Texas, 1976-1979

ACCIDENT SEVERITY	VEHICLE TYPE			
	Small Car	Midsize Car	Large Car	All
FATAL				
Fatalities	1.12	1.28	1.41	1.28
Injuries	0.62	0.89	1.09	0.89
INJURY				
Fatalities	--	--	--	--
Injuries	1.53	1.57	1.63	1.58
All	1.57	1.65	1.74	1.66

The study showed that the majority of rural accidents are more likely to occur on U.S. and State highways rather than Interstate highways or Farm to Market roads. Combination trucks, however, were the only vehicle class that had more accident : on Interstate highways than Farm to Market roads.

It can be concluded from the results of this report that vehicle size and weight can definitely affect accidents severity; however, there are many other factors such as the type of collision, speed, seat belt usage, etc. that can also influence the severity of an accident. The data showed that there was a greater chance of a fatality or injury occurring in car/truck accidents than in car/car or truck/truck accidents. Combination trucks were involved in more fatal accidents than single unit trucks, and combination trucks were over-involved in fatal accidents with small cars.

Combination and single unit trucks were involved in only a small percentage of all accidents, while midsize cars were involved in the highest percentage. Collisions between large and midsize cars were the most frequent and had the highest number of persons killed or injured per accident.

SUMMARY

The vehicle mix on our nation's highways has been changing in recent years due to the emphasis on fuel economy. Cars are becoming smaller and lighter while commercial trucks are becoming larger and heavier. The objective of this report was to consider what effects that the changing vehicle mix has had on large truck accidents in Texas.

Accident data for this report were obtained from the Accident Analysis Division of the Texas Transportation Institute which was originally supplied by the Texas Department of Public Safety and the Texas State Department of Highways and Public Transportation. The data consisted of only rural accidents for the period 1976 through 1979 for three weight classes of cars (small, midsize, and large) and two truck classes (single unit and combination).

Although midsize and large cars have been the dominant weight groups in Texas as well as the rest of the country, the number of large cars has been decreasing while the number of small cars has been increasing. In the truck fleet the trend is toward larger, heavier trucks, some with twin and triple trailers.

Certain design changes associated with these smaller cars and larger trucks may have adverse effects on vehicle performance resulting in an increased risk of an accident. Some of these effects are:

Cars

1. Reduced acceleration
2. Reduced visibility
3. More easily affected by wind blasts and splash and spray
4. Reduced handling ability

Trucks

1. Reduced acceleration
2. Increased stopping distances
3. Less maneuverability

Size and weight changes in cars and trucks may also cause problems in terms of highway design. Protective highway devices (guardrails, medians, bridge railings, etc.) were designed many years ago, and now there is concern that these devices will not function properly with the new small cars and large trucks and may affect accident severity.

The accidents in this study were evaluated according to severity, road type, and the number of persons killed or injured per accident. The study first analyzed accidents involving single unit or combination trucks and all cars in multiple and single vehicle accidents combined.

The results showed that an overwhelming majority of these accidents resulted in property damage only while only 4% resulted in a fatality. However, combination trucks were involved in about twice as many fatal accidents as single trucks. Over the four year period, the total number of truck accidents increased 68%; but the number of fatal accidents increased over 150%.

Even with the substantial increase in accidents involving cars and trucks, those accidents only accounted for 4% of all accidents over the four year period. A full 93% of all accidents involved only cars; while 3% involved only trucks.

Results showed that for all accidents, the majority occurred on U.S. and State highways followed by Farm to Market roads with Interstate roads having the fewest number of accidents. Accidents involving combination trucks were the only ones which occurred more frequently on Interstate highways than Farm to Market roads.

The data showed that the greatest number of fatalities per accident occurred in accidents involving cars and trucks. Also, in all injury accidents, car/truck collisions resulted in the highest number of persons injured per accident.

The Texas accident data were also analyzed according to specific car weight classes: 1) small cars (less than 3,000 lbs.), 2) midsize cars (3,000 -4,000 lbs.) and 3) large cars (over 4,000 lbs.). The data was separated into all multiple vehicle accidents and those between vehicle weight classes.

For multiple vehicle accidents, only 2% resulted in a fatality, 27% involved an injury, and 71% were only property damage accidents. Results showed that for multi-vehicle accidents in which a combination truck was involved, there was a higher risk of a fatality; however, combination and single unit truck accidents accounted for only a very small percentage of the total number of accidents. Midsize cars were involved in the highest percentage of all accidents followed by large cars, pickups, small cars, and other vehicles in that order.

For multiple vehicle accidents by road type, the majority of accidents occurred on U.S. and State highways followed by Farm to Market roads then Interstate highways. On all three road types, combination trucks were over-involved in fatal accidents. On Farm to Market roads and U.S. and State highways, small cars were over-involved in fatal accidents; while midsize and large cars were slightly under-involved.

In accidents involving large trucks and car weight classes, combination trucks were over-involved in fatal and injury accidents with small cars. Collisions between large cars and midsize cars were the most frequent, and those involving single unit trucks and any size car were the least frequent.

For accidents between vehicle weight classes, those involving midsize and large cars resulted in the highest number of persons killed or injured per accident overall, while those involving combination trucks and small cars resulted in the lowest number. For all accidents between vehicle weight classes, those involving combination trucks resulted in the least number of injuries and fatalities of the vehicle weight classes.

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APPENDIX

Table A-1. Number of Fatal Accidents in Texas by Year and Type of Vehicle(s) Involved

YEAR	VEHICLE TYPE							
	Truck(s) Only		Car/Truck		Cars & Other Vehicles		All	
	Acci-dents	Row %	Acci-dents	Row %	Acci-dents	Row %	Acci-dents	Row %
1976	25	2%	54	5%	1126	93%	1205	100%
1977	58	4%	71	5%	1266	91%	1395	100%
1978	55	3%	87	6%	1382	91%	1524	100%
1979	79	5%	138	9%	1318	86%	1535	100%
ALL	217	4%	350	6%	5092	90%	5659	100%

Table A-2. Number of Injury Accidents in Texas by Year and Type of Vehicle(s) Involved

YEAR	VEHICLE TYPE							
	Truck(s) Only		Car/Truck		Cars & Other Vehicles		All	
	Accidents	Row %	Accidents	Row %	Accidents	Row %	Accidents	Row %
1976	452	3%	434	3%	14644	94%	15530	100%
1977	606	3%	548	3%	16466	94%	17620	100%
1978	758	4%	723	4%	17788	92%	19269	100%
1979	857	4%	863	5%	17766	91%	19486	100%
ALL	2673	4%	2568	3%	66664	93%	71905	100%

Table A-3. Number of Property Damage Only Accidents in Texas by Year and Type of Vehicle(s) Involved

YEAR	VEHICLE TYPE							
	Truck(s) Only		Car/Truck		Cars & Other Vehicles		All	
	Acci-dents	Row %	Acci-dents	Row %	Acci-dents	Row %	Acci-dents	Row %
1976	1002	3%	1246	3%	36471	94%	38719	100%
1977	1187	3%	1519	4%	38354	93%	41060	100%
1978	1280	3%	1657	5%	33139	92%	36076	100%
1979	1449	4%	1905	5%	32595	91%	35949	100%
ALL	4918	3%	6327	4%	140559	93%	151804	100%

Table A-4. Multiple Vehicle Accidents by Weight Class, Texas 1976-1979

ACCIDENT SEVERITY	VEHICLE TYPE							
Frequency Column % Row %	Combination Truck	Single Unit Truck	Pickup	Small Car	Midsize Car	Large Car	Other Vehicle	Total Accidents
Fatal	402 5% 19%	164 2% 8%	514 2% 25%	552 2% 26%	1161 2% 56%	810 2% 39%	353 2% 17%	2091 2% --
Injury	2522 30% 8%	2238 27% 7%	8565 26% 28%	7463 29% 24%	18039 27% 59%	12464 27% 41%	5330 28% 17%	30656 27% --
Property Damage Only	5596 66% 7%	6042 72% 8%	24097 73% 30%	17987 69% 22%	47450 71% 59%	32981 71% 41%	13133 70% 16%	80727 71% --
All	8520 -- 8%	8444 -- 7%	33176 -- 29%	26002 -- 23%	66650 -- 59%	46255 -- 41%	18816 -- 17%	113474 -- --

Table A-5. Multiple Vehicle Accidents by Weight Class on Interstate Roads, Texas, 1976-1979

ACCIDENT SEVERITY	VEHICLE TYPE							
Frequency Column % Row %	Combination Truck	Single Unit Truck	Pickup	Small Car	Midsize Car	Large Car	Other Vehicle	Total Accidents
Fatal	60 3% 29%	14 1% 7%	32 1% 16%	53 2% 26%	110 2% 53%	81 2% 39%	27 1% 13%	206 2% --
Injury	570 28% 17%	285 26% 8%	676 26% 20%	935 28% 27%	1957 28% 57%	1300 27% 38%	562 26% 16%	3424 27% --
Property Damage Only	1420 69% 16%	819 73% 9%	1925 73% 21%	2301 70% 25%	5052 71% 56%	3515 72% 39%	1569 73% 17%	9055 71% --
All	2050 -- 16%	1118 -- 9%	2633 -- 21%	3289 -- 26%	7119 -- 56%	4896 -- 39%	2158 -- 17%	12685 -- --

Table A-6. Multiple Vehicle Accidents by Weight Class on U.S. and State Highways, Texas 1976-1979

ACCIDENT SEVERITY	VEHICLE TYPE							
Frequency Column % Row %	Combination Truck	Single Unit Truck	Pickup	Small Car	Midsize Car	Large Car	Other Vehicle	Total Accidents
Fatal	312 6% 22%	112 2% 8%	343 2% 24%	365 2% 25%	815 2% 56%	571 2% 39%	234 2% 16%	1450 2% --
Injury	1680 30% 9%	1386 26% 7%	5563 25% 28%	4596 29% 23%	11658 27% 59%	8250 27% 42%	3338 28% 17%	19739 27% --
Property Damage Only	3547 64% 7%	3761 72% 7%	15990 73% 30%	11157 69% 21%	31084 71% 59%	21883 71% 42%	8493 70% 16%	52573 71% --
All	5539 -- 8%	5259 -- 7%	21896 -- 30%	16118 -- 22%	43557 -- 59%	30704 -- 42%	12065 -- 16%	73762 -- --

Table A-7. Multiple Vehicle Accidents by Weight Class on Farm to Market Roads, Texas, 1976-1979

ACCIDENT SEVERITY	VEHICLE TYPE							
Frequency Column % Row %	Combination Truck	Single Unit Truck	Pickup	Small Car	Midsize Car	Large Car	Other Vehicle	Total Accidents
Fatal	30 3% 7%	38 2% 9%	139 2% 32%	134 2% 31%	236 2% 54%	158 2% 36%	92 2% 21%	435 2% --
Injury	272 29% 4%	567 27% 8%	2326 27% 31%	1932 29% 26%	4424 28% 59%	2914 27% 39%	1430 31% 19%	7493 28% --
Property Damage Only	629 68% 3%	1462 71% 8%	6182 72% 32%	4529 69% 24%	11314 71% 59%	7583 71% 40%	3071 67% 16%	19099 71% --
All	931 -- 3%	2067 -- 8%	8647 -- 32%	6595 -- 24%	15974 -- 59%	10655 -- 39%	4593 -- 17%	27027 -- --