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The Relationship Between a Truck Driver's Performance in a Personal Vehicle and a Large Truck

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16. Abstract: The study examined the relationship between a truck driver's driving record in a personal vehicle and in a large truck, with special focus on the value of the personal record for predicting future performance in the truck. The study included a literature review, analysis of data, and an expert panel to review the findings. Driver history files from the states of Washington and North Carolina were the major data bases. In addition, special analyses were conducted on samples of owner-operators and motor carrier drivers. Motor carriers made available supplementary data. Limited information was obtained from the National Driver Register.

The findings clearly show that there is a relationship between the record in the private vehicle and that incurred in the large truck, but the prior record in the truck is a better predictor than either the record in the private vehicle or the total record including both private and commercial driving. Driver age and reported annual mileage were associated with future driver performance, but by far the strongest predictor was the prior driving record.

Because it is not known how complete the available records are, the findings must be interpreted with caution. Nevertheless, the consistency of the findings from one data base to another, and the fact that the most complete data base available to the study shows some of the strongest relationships, suggest that the findings reflect real associations between past and future records.

Recommendations are made for improving driver qualification, selection, and monitoring.

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EXECUTIVE SUMMARY

The purpose of this study was to determine the relationship, if any, between a commercial driver's violations and crashes while driving a private motor vehicle in an off-duty status and violations and crashes incurred while operating a large truck while on duty.

The increasing numbers and seriousness of truck crashes in recent years have prompted reexamination of current policies and regulations which were formulated to promote safety on the highways. More specifically, this study addressed the issue of whether past driving history in a private vehicle should be taken into account in determining whether a driver should be permitted to operate a large truck for commercial purposes.

At this time decisions concerning eligibility to drive under the Bureau of Motor Carrier Safety Regulations are limited to offenses that occur during the operation of a commercial vehicle in an on-duty status. Offenses that occur in a driver's personally owned vehicle in an off-duty status may not be used to disqualify a driver under Section 391.15 of the Motor Carrier Safety Regulations.

Nevertheless, studies based on driver records consistently show that past driving history is one of the best single indicators of future driving performance. Although the relationships are not powerful enough to provide good prediction for individual drivers, they are very consistent for groups. Few studies, however, have investigated the relationship beteen past and future driving performance of drivers of large trucks in their private and their commercial vehicles.

Drivers licenses to drive large combination vehicles from the states of North Carolina (Class A licensees) and Washington (Combination-

endorsement licensees) comprised the study populations. These states have classified licensing systems which identify drivers of large trucks. In addition, Washington state designates on the driver history file whether the driving was employment related when violations or accidents occur. North Carolina provides vehicle type for crashes on a computerized crash file and vehicle type for violations on hard copy in files maintained in the Division of Motor Vehicles in Raleigh. Subgroups of North Carolina driv --owner-operators, random sample of Class A drivers, and drivers from four motor carriers--were selected in order to obtain more complete driving histories for these groups and to analyze these groups independently.

In all, data were collected from Washington state driver history files, the North Carolina driver history, citation, crash, and vehicle registration files and motor carrier personnel files as well as the National Driver Register. Information was collected on the following variables: accidents and violations from two time periods (1981-1982, 1983-1984), vehicle type for crashes (all groups) and violations (all Washington drivers and North Carolina driver subgroups), estimated annual mileage (North Carolina only), license revocation (North Carolina only), age and sex (North Carolina and Washington), race (North Carolina), and driver type, that is, over-the-road or local (North Carolina motor carrier subgroup). Violations were classified into speeding, stop, alcohol, reckless, and moving categories.

Chi-square analyses were used to measure the association between prior and subsequent driving record in private and commercial vehicles. Linear regression models, appropriate for categorical data, were employed to analyze the correlations among the variables and to determine whether

variables from the first time period were predictors of accidents and/or violations in the subsequent period.

The findings clearly show that there is a relationship between the record in the private vehicle and that incurred in subsequent employment related driving. In addition, findings indicate that estimated annual mileage and driver age are related to subsequent crashes but these relationships are not as strong as that between prior driving record and number of subsequent crashes. Generally, the driving record in the truck is a better predictor than either the record in the private vehicle or the total record, including both private and commercial driving.

Alcohol violations from the first time period (private and commercial combined) were associated with number of crashes in the commercial vehicle in the second time period for North Carolina drivers but not for Washington drivers. Alcohol offenses in the private vehicle were not associated with crashes in the commercial vehicle in the subsequent period for Washington drivers. In any case, for both North Carolina and Washington drivers, other violation categories (reckless, moving, speeding, and stop) were more strongly related to employment related crashes than was the alcohol category.

The major reservation about the findings from this study is that the completeness of the records on which the analyses are based is not known. It is generally accepted that truck drivers hold more than one license and thus spread offenses across several records. What impact this practice may have had on the findings from this study is not clear. Nevertheless, the consistency of the findings from one data base to the next suggests that the relationships found in the study may be reflecting real associations between past and future records.

On the basis of the literature review, the results of the study analyses, and the input of an expert panel, a number of recommendations were made. These recommendations focus on licensing issues, measures to increase the completeness of driver history records and their use by prospective employers, and finally, on-the-job monitoring and incentives. More specifically, recommendations include the following.

1. There should be established an interstate file of drivers of large trucks, containing both computerized and hard copy information, which would easily identify drivers and the home state of licensure.
2. Before issuance of original or renewal license to drive a large truck, states should be required to check with the interstate file and the National Driver Register to obtain driving and licensing information for each driver. Also at both original and renewal licensure, states should require a current medical certificate for license to drive a tractor trailer.
3. License to drive a tractor trailer should cover the costs of a thorough examination by a trained examiner.
4. Recommendations to provide additional information on the driver history records are to include vehicle type in which violations and accidents occur and to report out-of-state infractions to the home state for inclusion on the records.
5. Copies of citations issued to truck drivers should be sent to the safety officers of motor carriers.
6. With the applicant's written consent, prospective employers should have speedy and affordable access to an applicant's complete driver history.

7. On-the-job monitoring of truck drivers by the motor carriers should include accident review boards of peers and annual driver review using self reports and the state driver history record.
8. Motor carriers and others responsible for vehicle fleets should consider encouraging on-the-job monitoring by the motoring public which would allow the public to report any complaints (or compliments) to motor carriers. This could occur if each truck carried an identification number and a toll free telephone number.
9. Motor carriers should encourage good driving through incentives, e.g., per mile safety bonuses and fuel economy incentives.

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INTRODUCTION

Heavy trucks are disproportionately represented in serious and fatal crashes, and truck mileage is increasing more rapidly than passenger car mileage (Eicher, Robertson & Toth, 1982). The large numbers and sizes of heavy trucks on the highways and accompanying reports of large truck accidents are likely to have increased the public's awareness of this vehicle population and related safety issues. Also, the motor carrier industry and policy makers who regulate and monitor the trucking industry have expressed concern about heavy truck safety issues.

According to a 1985 report from the Insurance Institute for Highway Safety, large truck crashes have increased by 18 percent since early 1980. In a study published in 1982, Eicher et al. indicated that large trucks had nearly twice the fatal accident rate per mile than that of cars. Additionally, trucks were three times more likely to collide with a car than another truck and occupants of cars were more likely to be killed than occupants of trucks. Eicher et al. concluded that greater competition for road space, due to increased numbers of vehicles and concomitant declines in the construction of new highway miles, will likely result in more frequent collisions in the future.

Given this situation, the need to investigate factors associated with heavy truck crashes and to formulate measures to reduce the liklihood of their occurrence has become increasingly important. Possible areas for investigation are the effectiveness of variables such as qualification, training, and performance of drivers of heavy trucks as well as licensing procedures, driver safety regulations and equipment standards and their enforcement on highway safety. Researchers have examined many driver,

vehicle, and highway environment factors in their relationship to the frequency and severity of accidents involving motor vehicles. Less frequently have studies been conducted to investigate these factors in relation to heavy truck crashes.

The focus of this study was to examine the association between past and future driving performance of drivers of heavy trucks in their privately owned vehicles and in commercial vehicles. This issue has been of particular interest to the trucking industry and those responsible for monitoring the performance of drivers of heavy trucks. At this time, offenses that disqualify a driver under the Bureau of Motor Carrier Safety Regulations are limited to offenses that occur during the operation of a commercial vehicle for commerce purposes (49 CFR, 391.15). Offenses that occur in the driver's personally owned passenger car or small truck may not be used to disqualify a driver under section 391.15 of the safety regulations. Nevertheless, studies of driver records indicate that violation history is one of the best single indicators of future driving performance, including future involvement in crashes (Lund, 1984; Peck, R. & Kuan, J., 1983: Peck, R., McBride, R, & Coppin, R., 1971). While the relationships are not strong, this finding has been consistent. The question of whether infraction experience in one type of vehicle may be indicative of performance in another type of vehicle has not been addressed in the research literature.

The overall objective of this study was to determine, through correlation analyses, the relationship between the violations and accidents an off-duty driver has while driving a private motor vehicle, and the violations and accidents the driver has while operating a commercial motor vehicle. This overall objective was divided into three parts. The first

was to describe characteristics of the truck driving population including the number and type of violations or accidents a driver receives while operating a privately owned vehicle and while operating a commercial vehicle. The second was to analyze any possible correlations between the number and type of violations or accidents, incurred in both privately owned vehicles and commercial trucks, and subsequent accident involvement in a truck. Third, based on the relationships found, the study considered possible countermeasures which included their review by a small group of knowledgeable and concerned persons representing the drivers, motor carriers, state licensing and enforcement personnel, and National Highway Traffic Safety Administration and Bureau of Motor Carrier Safety officials.

The study was based primarily on the analysis of driver histories.. A multifaceted approach was used in the project because driver history information from a number of sources was needed in order to compile driver histories which were as complete as possible and which included vehicle type information. Washington state driver history files, the North Carolina driver history, citation, crash, and vehicle registration files were the data bases for the study as well as the National Driver Register.

The driver history files identified drivers licensed to drive heavy trucks and contained information about accidents and violations which had occurred during the years of interest to the project, 1981-1984. In addition, the vehicle registration file, the crash files, and the citation file were used to identify independent owner-operators and to supply vehicle type information. Selected North Carolina motor carriers provided access to their driver files, which included both in-state and out-of-state violations and accidents, and identified vehicle types associated with

these incidents. This information supplemented the information provided by the state records for a subgroup of North Carolina drivers.

The development of the research design and the selection of variables included in the study were based on previous research focusing on various aspects of driver performance and heavy trucking. Approximately thirty diverse studies and reports were included in the literature review although nearly fifty were considered initially. Following is a synthesis of the literature review which included studies on predictive modeling, driver characteristics, and accidents and violations in relation to driver performance. Also included were studies dealing with driver selection, training, licensing, and safety. An annotated bibliography (Appendix A) provides a more detailed description and critique of studies in the literature review.

LITERATURE REVIEW

During the initial stage of the study, a literature review was conducted which consisted of studies that identified potentially useful variables, data bases, and methodology for use in the current study. The focus of the review addressed the following research question: What is the relationship between a driver's performance in a vehicle (car, van, small truck, motorcycle) for private use and a driver's performance in a commercial vehicle (heavy truck)?

This portion of the report synthesizes the studies included in the literature review. Two purposes of the synthesis were to provide a brief compilation of the results of studies about driver performance and related areas and to present justification for specific parts of the current project. Major areas of interest included analysis of the methodology incorporated in the studies, identification of variables and hypotheses tested, and disclosure of problems which needed to be addressed in future studies.

Within the thirty-one studies and reports comprising the literature review, there was variety both in the content of the reports and in the methods used to investigate the association of selected factors with driver performance. Research studies included those which included statistical analyses and those which were more descriptive in nature. Reports analyzing and describing the heavy truck system--licensing, regulations, policies--were also included in the review. Finally, a small number of accident reports, which provided descriptive information and findings from investigations of heavy truck accidents, were incorporated into the review.

One of the following three objectives was found in each of the studies reviewed. The most frequent objective was to investigate factors associated with crash involvement, the second most frequent was to identify significant predictors of crash involvement, and the third was to analyze parts of the heavy truck system to locate deficiencies which may contribute to accident involvement.

Formally stated hypotheses were generally not included in the study descriptions but variables and relationships under study were presented. Therefore, the following section concentrates on variables identified in relation to driver performance rather than on specific hypotheses generated in the literature.

Variables Related to Driver Performance

Association Between Accidents/Violations and Driving Performance

Numerous studies have addressed the relationship between accident and violation records and subsequent driver performance. The focus of these investigations has changed somewhat over time. At one time emphasis was placed on identifying a select group of individuals who were thought to be responsible for the majority of accidents. This idea has generally been supplanted by a growing recognition of the complex nature of accident causation and a broader view of accident involvement of drivers.

In 1939 Forbes challenged the notion that a relatively small number of "accident-prone" individuals was responsible for the majority of accidents. Through his analysis of accident records of Connecticut drivers over a six-year period, Forbes demonstrated that only 1.3 percent of the drivers had more than two accidents during the first three year period. These so-called "accident-prone" drivers accounted for only 3.7 percent of the accidents in the second three-year period. Forbes found that the low or

no-accident drivers (98.7%) in the first three year period accounted for 96.3 percent of the accidents in the second period. Forbes concluded that for purposes of traffic design and control the ordinary driver should be the primary focus.

Findings from more recent studies and a review of literature in this area (Lund, 1984) supported Forbes' earlier conclusion that the accident population is largely composed of different drivers from year to year. Stewart and Campbell (1972, p.i) found that "the majority of all accidents occurring in a period of time (one, two or three years) involve drivers having no accidents and violations in the previous period". In a study of drivers involved in fatal crashes, Robertson and Baker (1975) found that only three percent of the drivers had more than three convictions in the three years prior to the fatal accident and 52 percent had no convictions or violations during that time. Peck, McBride, and Coppin (1971) found that of the drivers involved in accidents in 1961 and 1962, 87 percent were accident free in 1963 and previously accident-free drivers accounted for the vast majority of accidents in 1963. Clearly research demonstrates that the responsibility for the majority of accidents does not rest with a small unique group of drivers.

Given the changing composition of the accident population from year to year, have studies shown an association between drivers' driving record and driver performance? Lund (1984) reviewed twelve studies related to driver records and crash prediction. He suggested that there was some consistency in the findings and concluded that "although there is a direct and replicable relationship between past crashes and future crashes on driver records, the level of association is quite low" (p. 1). Even though associations have been low, driver records have consistently provided those

variables which have been the most useful in exploring accident involvement relationships. Studies by Michiels and Schneider (1984), Peck and Kuan (1983), Goodsen (1972), Stewart and Campbell (1972), and Peck et al. (1971) have found associations between driver history variables and accident involvement among drivers of motor vehicles. Driver history variables used to investigate driving performance of heavy truck drivers revealed that type of conviction (Mitter & Vilardo, 1984) and total number of convictions (Furtado, Saenz & Eskin, 1983) were related to subsequent driver accident involvement. In summary, research has shown that there is a statistically significant relationship between driver record variables and accident involvement but the relationship is relatively weak.

Predictive Modeling--Accidents and Violations as Predictors

Predictive modeling which would allow policy-makers, licensing and law enforcement officials, and educators to identify individuals or groups who are likely to be accident-involved is an important purpose of accident research. In addition, predictive modeling may be useful in identifying variables which are related to drivers' accident involvement. The largest number of studies reviewed were in the area of predictive modeling.

Predicting individual accident involvement. At this time, only a small amount of variation in accidents can be explained by any identified variable or collection of variables. Peck and Kuan (1983) and Peck et al. (1971) acknowledged that traffic conviction record was the best unique predictor of accident frequency in their studies, and yet less than 8 percent of the variability in driver accident frequency could be explained by this variable. Stewart and Campbell (1972) concluded that previous violation records taken from a two-year period were not good predictors of subsequent accidents during a second two-year period because 70 percent of

the accidents were committed by drivers with no recorded violations from the earlier period. Using a similar time period for study, Michiels and Schneider (1984) determined that it was difficult to identify those drivers likely to commit offenses based on records from the preceding two years. Lund (1984) concluded that predicting individual accident involvement based on prior violations and accidents has not been successful due to the large random component in individual crash likelihood.

Predicting accident involvement for high-risk groups. Predicting accident involvement for certain groups of drivers has been more successful. Drivers with repeated traffic violations and crashes in a given time period are more likely to have subsequent crashes than the general population (Lund, 1984; Goodsen, 1972). Stewart and Campbell noted that accident records were slightly better predictors of accidents for groups of drivers considered to be at higher risk of future accident involvement than the general population of drivers. For example, approximately 36 percent of the drivers who had three accidents in the first two-year period had at least one accident in the second two-year period. Other groups of drivers that are more likely to be accident involved are drivers with alcohol-related convictions (Lacey, Stewart, & Council, 1977; Kaestner, 1973) and drivers identified by certain demographic and personal characteristics such as sex, age, and driving experience (Michiels & Schneider, 1984). Robertson and Baker (1975) noted that a high risk group, such as the one consisting of males under age twenty with traffic convictions, is much more likely to be involved in fatal crashes that the general population.

Professional Driver Studies.

There has been relatively little research in the area of professional drivers' driving performance and more specifically on predictors of heavy truck accidents. In Furtado et al.'s (1983) analysis of California's heavy vehicle operator licensing program, an investigation of conviction and accident records revealed that truck drivers with frequent heavy vehicle convictions were more prone to heavy vehicle accidents than truck drivers who had less frequent convictions. Using multiple regression analysis, Mitter and Vilardo's (1984) study of the relationship between truck driver records and crash involvement found that conviction for driving while intoxicated was the most important variable in explaining the variation in accident involvement among the drivers. Other variables which were statistically significant in the regression equation were conviction for speeding, conviction for other violations, and driving experience. Chira-Chavala and Cleveland (1985) developed causal and deductive models addressing the problem of accident involvement using Bureau of Motor Carrier Safety (BMCS) Files and the Highway Cost Allocation Study data. Independent variables used in this analysis focused on aspects of the vehicle, the road, the trip, and the type of cargo. Driver variables were number of years of driving experience and driver age. Particularly high accident involvement rates were shown by van singles, 3-axle-tractor singles and 2-axle straights in local service, and flatbed doubles in over-the-road service.

The National Transportation Safety Board's investigation (1980) of 41 heavy truck accidents provided important descriptive information about the truck drivers involved in these accidents. The 44 drivers held a total of 63 drivers licenses, had 98 license suspensions, 104 traffic accidents, and

456 traffic convictions. Fifty-one fatalities and 95 injuries resulted from the accidents investigated by the National Transportation Safety Board. Police investigators listed improper truck driver action as a causal factor in every case but one. The results from this study cannot be generalized since we have no idea how these cases were selected, but they do point to problems in a system where drivers with multiple convictions and accidents are allowed to continue to operate commercial vehicles. In addition, three Motor Carrier Accident Investigations (Bureau of Motor Carrier Safety, 1967a, 1967b, 1968) and one newspaper account (Mather, 1985) further illustrate the heavy truck accident problem.

Hakkinen conducted an initial study in 1958 of 100 bus and streetcar drivers from Helsinki and a follow-up study in 1979 of 66 drivers from the original study. Hakkinen's studies revealed that the accident behavior of the drivers, who had from 10 to 26 years driving experience, was highly consistent over time. A number of psychological test scores obtained during the initial study were more successful in predicting accident behavior over time than were the accident figures from the earlier study. Fifty to sixty-five percent of the variation in accident numbers could be explained by the psychological measures. Factor analysis and discriminant analysis revealed that seven of these measures could accurately discriminate between drivers who had been classified into safe and accident groups. This study design may not be applicable for studies of large populations, but the results do point to the possibility that accident behavior is quite consistent over time and that psychological test measures may have potential use for screening potential high accident drivers.

D. ver History Variables.

Which driver history variables have been the most successful in predicting future accident involvement? Stewart and Campbell (1972) concluded that accident records were better predictors of accident involvement than were violation records. Peck et al. (1971), Peck and Kuan (1933), and Lund (1984) in a review of studies indicate that violation records are better predictors of accident involvement than are accident records.

In the studies reviewed, have differences in the treatment of variables influenced their usefulness? Peck et al. (1971) recommended a simple summation of total conviction frequency rather than weighting of different types of violations. According to Lund (1884), point systems that weight past violations and/or crashes have not improved prediction of individual crash rates. Fu.tado et al. (1983) reports that combining violation and accident record information from both heavy trucks and other vehicles was a better predictor of heavy truck accidents than the heavy truck record only.

The relationship of prior violations and accidents with future accident involvement appears to be influenced by the length of the time periods used in studies. Michiels and Schneider (1984) noted that the frequency of offenses was not distributed at random and indicated that longer observation periods were more likely to uncover this phenomenon than shorter periods. Hakkinen's initial study (1959) and follow-up study 21 years later provided evidence to indicate that the early accident record of the bus and streetcar drivers was predictive of later accident involvement. Researchers have found that data from longer time periods are preferable

but are difficult to obtain because of limited resources and availability of data for more than a 5-year period. For example, because of the lack of computer storage space, only data for serious offenses are retained on the North Carolina Driver History Files for longer than five years.

Personal Characteristics Associated with Driving Performance

Accident proneness. Researchers continue to be interested in the influence of drivers' personal characteristics on accident involvement. A concept which has been debated for over 50 years is that of accident proneness (Forbes, 1939; Shaw & Sichel, 1971; McGuire, 1970). According to Shaw and Sichel "the most basic principle, acceded by all investigators, is that even when exposed to the same conditions some people are inherently more likely to have accidents than others--or, in other words, that people differ fundamentally in their innate propensity for accidents" (1971, p. 14). Shaw and Sichel contend that there is a subset of drivers characterized by certain personality features which make them more likely than other drivers to drive in a dangerous manner which may lead to accidents. However, Forbes (1939) found that very few drivers could be classified as accident prone, according to his definition (drivers who had more than two accidents during three years), and those drivers so classified accounted for a very small number of total accidents. McKenna (1983) has pointed to the conceptual confusion in this area of research. McKenna recommends that a more neutral term "differential accident involvement" may be more useful. McGuire (1970) also attempted to clarify the concept of accident proneness by defining two types of accident proneness--long-term and short-term.

Age, sex, and driving experience. Research findings have consistently shown that males are more likely to be involved in accidents

than females (Goodson, 1972; Robertson & Baker, 1975; Peck et al., 1971; Peck & Kuan, 1983). These studies have not taken into account the variable of exposure, and particularly quality of exposure, e.g., amount of late night driving. How much more likely men are than women to be involved in accidents when the number and type of miles driven are taken into account is uncertain.

Findings regarding the influence of driver age on accident involvement appear to be somewhat unclear. Stewart and Campbell (1971) and Hakkinen (1979) determined that the age factor had little effect on accident involvement. However, Eicher et al. (1982) indicated that young truck drivers have higher accident rates than any other driver group and truck drivers under age 25 are twice as likely to be involved in an accident compared to car drivers under age 25. In Robertson and Baker's (1975) study of drivers involved in fatal crashes, a higher rate of involvement was found for drivers under age 21 with one conviction prior to the fatal crash than was found for older drivers with two or more convictions in the same time period. On the other hand driver experience was shown to be more important than age in terms of offenses committed (Michels & Schneider, 1984) and subsequent truck driver accident involvement (Mitter & Vilardo, 1984).

Driver Selection, Training, Licensing, and Safety

In their review of driver selection research, Uhlander and Drucker (1963) concluded that selection procedures in state driver licensing programs could make only a slight contribution to reducing the numbers of accidents. However, they noted that some success, particularly in the military, has been achieved in selecting "best drivers" based on batteries of tests. According to Uhlander and Drucker, personality and adjustment

measures probably can make a significant contribution in this area. Both of Hakkinen's studies (1979) and a study conducted in Sweden in 1982 (Personlighet) have shown that psychological tests were able to identify drivers who were more likely to be involved in accidents than other drivers. A driver selection procedure developed by William Kyser was described in the periodical, School Bus Fleet (1979). This procedure consisted of levels of criteria to be considered in hiring drivers. Even if licensing procedures do not hold great promise for eliminating poor drivers from the general driving population, they may still be effective in reducing the number of unqualified drivers operating large trucks. States can be much more selective in issuing such licenses than they can be in the case of the regular operator's license.

Good estimates of the numbers of truck drivers who have received formal truck driver training are not available. Eicher et al. (1982) reported that a majority of the heavy truck drivers surveyed indicated that they had no formal truck driving training. Only 15 percent of the truck drivers involved in accidents indicated that they had received formal training. How widespread safety programs are among trucking companies and leasing firms was not learned from the literature review. One report (Fleet Owner, 1966) described a safety program conducted by two truck leasing firms which indicated that these programs resulted in improved safety records.

Waller and Li's (1979) analysis of the licensing and monitoring of heavy truck drivers has identified three main problem areas: (1) initial qualification of drivers, (2) monitoring and regulating driver performance, and (3) restricting drivers. Additional studies within the past five years have focused on problems of the heavy truck licensing systems (Furtado,

1983; Nathanson, 1983; American Association of Motor Vehicle Administration, 1981; National Transportation Safety Board, 1980). Multiple licensing among heavy truck drivers has repeatedly been acknowledged as a serious matter which thwarts the detection of problem truck drivers (American Association of Motor Vehicle Administration, 1981). Robinson's study (1977) of motor vehicle drivers whose licenses had been revoked revealed that thirty-six percent of these drivers admitted driving without a valid license. Because truck drivers rely on their ability to drive for employment, they may be more willing to use multiple or invalid licenses than the general population of drivers represented in Robinson's study.

Waller and Li (1979) and Furtado et al. (1983) recommended licensing standards which required demonstrated knowledge and behind-the-wheel skill. These researchers indicated that these measures could improve the licensing procedure and possibly reduce the number of truck accidents.

Methodological Issues Raised from the Literature Review

Issues Related to Driver History Records

Driver history records have been the source of data for many studies. These records contain information which appears to be the best predictor of accident involvement at this time. However, the use of these records as data sources is not without problems. Lund (1984) concluded that crash information on driver history records may be quite weak. Lund cited findings from a study by the All-Industry Research Advisory Council in 1984 supporting this conclusion. According to this study, a Wisconsin insurance company found that only 81 percent of the crashes that resulted in $500 or more in damage appeared on the driver records. Another weakness of driver history records is the variability of the data from state to state.

Criteria for what and how data are included in the records and how long data remain on the records differ among the states. In addition, some states regularly send violation information to states whose drivers have committed violations within their borders, while others do not. The violation information shared among the states varies depending upon individual state regulations.

Obtaining driver history records of heavy truck drivers which are as complete as possible was an important objective of this research project. This was a difficult undertaking given the already existing problems with data from driver history records. Multiple licensing of truck drivers described earlier and the resulting multiple records further complicated access to complete truck driver records.

Finally, in order to use information from driver history records for particular variables of interest, additional investigation was necessary. For this study on truck driver performance, it was necessary to be able to determine what kind of vehicle was driven when a violation or an accident occurred. Extra data analysis procedures were necessary in order to determine this from the North Carolina Driver History File. From a review of the information available on state driver history records, it was determined that only Washington State designated whether violations listed on the driver history records were employment or non-employment related and identified the class of drivers specifically licensed to operate tractor trailers.

Violations and Accidents as Variables

Using violation and accident data presents particular problems to researchers. Violations and accidents are relatively infrequent occurrences and drivers exhibit less variation than is optimal for

analytical purposes. However, researchers have found that using data from longer time periods increases the variation among the numbers of violations and accidents.

Past studies using driver history variables to explain variation in accident involvement have been able to account for only a small amount of variation. This may be understandable when taking into account the complexity of accident causation. In the investigation of accident involvement, factors related to the vehicle, characteristics of the driver, the environment, and random factors must be taken into account as well as the driver record.

Need for Measure of Exposure

The importance of an estimate of exposure regarding accident involvement has been addressed in the literature (Chira-Chavala & Clevelend, 1985; Eicher et al. 1982; Robertson & Baker, 1975). The number of miles traveled annually by drivers may explain different accident involvements more adequately than other variables. Unfortunately an estimate of exposure for truck drivers is not easily available. Motor carrier companies keep records on the annual mileage of trucks but generally do not collect this information about their drivers. North Carolina Class A drivers are asked during the license renewal process to estimate annual miles driven. This estimate was used in the study as a crude measure of exposure in analysis for drivers providing this information.

Relatively few studies have been conducted on truck driver performance. Descriptive studies have provided useful but limited information regarding accident involvement. Mulitple licenses with accompanying multiple records, confidentiality issues regarding access to

data, lack of availability of data such as exposure estimates, and the complicated procedures for collecting data present major obstacles to research on truck drivers.

Justification for Study Approach

Violation and Accident Records--Independent Variables

Public concern has been expressed about increasing numbers of heavy truck related accidents (Eicher et al., 1982). The main purpose of this study is to determine what factors may be related to accident involvement of commercial truck drivers. Past studies addressing accident involvement have determined that prior accident and violation records are the best predictors of accident involvement (Peck & Kuan, 1983; Furtado et al., 1983; Peck et al., 1971). Mitter and Vilardo's (1984) analysis of heavy truck driver records in relation to accident involvement indicated that certain types of violations, namely, driving while intoxicated, speeding, and other convictions, as well as driving experience, were associated with accident involvement. Based on prior research findings, violation and accident records were selected as independent variables which would be used to develop hypotheses examining the research question.

As has been discussed in the earlier sections on driver history records, accident and violation data from longer periods are more likely to produce greater numbers of accidents and violations and also more variation within the sample of drivers. Therefore, it would have been beneficial to the study to collect data from relatively longer periods of time, but due to limited resources and time-limited data from driver history records, this was not feasible. Based on previous findings and availability of data, a five year time period, from 1980 through 1984 was originally selected for the study. This was later adjusted to a four year period

because Washington state data were not abailable for all of 1980.

Driver Characteristics--Independent Variables

The age of driver was a variable included in the study not only to provide descriptive information but also because of its potential importance to understanding accident involvement of heavy truck drivers. Previous studies have indicated differences in the importance of age as a variable. Hakkinnen (1979) and Stewart and Campbell (1972) indicated that age had little effect on accident involvement. However, Eicher et al. (1982) and Robinson (1977) concluded from their studies that age was related to accident involvement.

Most drivers of heavy trucks are male but increasing numbers of women have entered this field in recent years. The chief reason for including sex as a variable was to determine characteristics of the driver population rather than to use as a predictor variable.

Because of access to the personnel files of the motor carriers, it was possible to obtain more information about the commercial vehicle drivers than other groups of drivers The following independent variables were included for this group of drivers: frequency of lay-offs, years of employment by the company as a truck driver, and type of driver (whether local or over-the-road).

Use of Multiple Data Sets

Obtaining complete driver history records for truck drivers has been a major problem. Truck drivers are able to secure licenses from many states and may use them in such a way as to avoid a complete listing of violations and convictions on the home-based driver history record. Variability among the states with regard to the kind of driver history information collected and retained has been described in the literature review.

Because of the difficulty in obtaining complete driver history records of heavy truck drivers from any one source, the decision was made to use a number of sources which would complement each other. The Washington state driver history file and the North Carolina driver history and crash files provided the major part of the violation and accident information for the study. The North Carolina citation file allowed us to determine whether drivers were driving private vehicles or commercial vehicles when violations were committed, while the crash file provided vehicle type for crashes. Motor carrier files provided information about in-state and out-of-state accidents and violations from motor carriers' accident files and from annual truck driver self-reports and. Finally, summary information on license revocations for the various groups of truck drivers was requested from the National Driver Register.

Washington state was the only state identified that has both a classified licensing system which identifies licensed heavy truck drivers and a driver history format which designates whether violations or accidents occurred in private or commerical driving. Washington has a truck driver population similar to North Carolina's and data which easily address the central issue of the study, namely, to compare truck driver performance in a private vehicle with driver performance in a commercial truck.

Statistical Analysis

Statistical analyses employed in the studies investigating the relationship between driver performance and accident involvement may be grouped into several categories. First, tests such as chi-square to determine differences among groups of drivers on a number of variables related to accident involvement represent one level of analysis (Waller &

Li, 1979; Robinson, 1977). Second, factor analysis (Michiels et al., 1984; Hakkinen, 1979) was used to investigate the interdependence of variables. This technique is generally used to select, from a large number of variables, a smaller number of important factors for use in subsequent analyses.

The third category of analysis examined relationships between driver performance variables and accident involvement with the following purposes: (1) to identify variables which explain statistically significant amounts of variation in accident involvement and, (2) to develop predictive models related to accident involvement. Mutliple regression techniques have been used with limited success in studies by Mitter and Vilardo (1984), Peck and Kuan (1983), and Peck et al. (1971). Log linear analysis and repeated measures analysis of variance techniques were used by Furtado et al. (1983) in their analysis of driver records of California heavy truck drivers and subsequent accident involvement.

A version of the latter procedure appeared to be potentially the most useful to this study and is described in the study, "Development of Predictive Models to Identify Persons at High Risk of Alcohol Related Crash Involvement" (Lacey et al., 1977). Much of the data for the truck driver record study are of a discrete nature or can be considered to be categorical for analytic purposes. The statistical techniques employed in the study are analogous to stepwise regression analysis of discrete or categorical data. These procedures are based on chi-square or modified Mantel-Haenszel test statistics (Somes, 1986). In addition, because this study contained an important exploratory component, the variable selection procedure was helpful for investigating driver history variables and driver performance variables.

This study examined the predictive association between a truck driver's driving record in his personal vehicle and his on-duty driving record in the heavy truck, that is, to determine if certain indicators of unsafe driving behavior in the driver's personal vehicle at some point in time are positively associated with indicators of unsafe behavior in the truck at some later point in time. To investigate these relationships, four-year segments of driver histories were obtained for drivers from the five study groups. Each of these four-year segments was divided into two consecutive two-year intervals. 1981-1982 and 1983-1984. Variables derived from the driving records in private or commercial vehicles during the first period were then correlated with variables derived from employment related driving records in the second time period. Variables derived from the driver histories were accidents, violations, and categories of violations (Appendix B) such as Speeding, Stop (e.g., running stop sign, failure to yield), Moving (e.g., improper turn, following too closely), Reckless, and Alcohol. In addition, such variables as age of the truck driver and annual estimated mileage were included in the analyses.

Panel Review

The findings of the analyses were presented to a small group of experts, including representatives of the trucking industry, owner operators, traffic law enforcement, truck safety and weight enforcement, truck driver licensing, Bureau of Motor Carrier Safety, and the National Highway Traffic Safety Administration (Appendix C). Based on the study results and the deliberations of this group, reccomendations were developed for improving truck driver records and truck driver performance.

HYPOTHESES

The primary research question in this study may be stated in a straight- forward manner: What is the relationship between a truck driver's driving performance in his private vehicle and his driving performance in a commercial truck? However, determining how this question may be investigated was more difficult. The lack of easily accessible information on driver histories regarding the type of vehicle driven (e.g., private passenger car, commercial truck) when violations occurred and the more basic problem of obtaining complete driver records for drivers of heavy trucks in the study population complicated this study. Given the limitations of the available data, an exploratory approach was taken. A number of driver history variables (accidents and violations) from two time periods (1981-1982, 1983-1984) for various heavy truck driver populations were analyzed. Hypotheses were developed which presented the various relationships to be investigated.

Listed are combinations of variables used to investigate the relationship of truck drivers' performance in their private and commercial vehicles. Various combinations of violation and crash variables from one time period (1981-1982) are presented with violation and crash variables from a second time period (1983-1984). The vehicle type driven when violations occurred was not obtained for the complete North Carolina Class A driver population shown in Set I. Privately owned vehicles are referred to as POV, commercial vehicles as (COMM).

Hypotheses

Set I

All NC Resident Class A Drivers (A1)
(Vehicle Type available for Crashes only)

	Time 1 (1981-1982)	Time 2 (1983-1984)
1.	Crashes (POV & COMM)	Crashes (POV & COMM)
2.	Crashes (POV)	Crashes (POV)
3.	Crashes (COMM)	Crashes (COMM)
4.	Violations	Violations
5.	Violations	Crashes (POV & COMM)
6.	Violations	Crashes (POV)
7.	Violations	Crashes (COMM)

Set II

Subset of NC Resident Class A Drivers (A2)
Owner-Operators (B)
Motor Carrier Truck Drivers (C)
Washington State Truck Drivers (E)
(Vehicle Type available for both Violations and Crashes)

	Time 1 (1981-1982)	Time 2 (1983-1984)
8.	Violations (POV)	Crashes (COMM)
9.	Violations (POV)	Crashes (POV)
10.	Violations (COMM)	Violations (COMM)
11.	Violations (COMM)	Crashes (COMM)
12.	Violations (POV & COMM)	Violations (POV & COMM)
13.	Violations (POV & COMM)	Violations (COMM)
14.	Violations (POV & COMM)	Crashes (COMM)
15.	Crashes (POV & COMM)	Violations (COMM)
16.	Crashes (POV & COMM)	Crashes (COMM)
17.	Crashes (POV & COMM)	Crashes (POV & COMM)
18.	Crashes (POV)	Violations (COMM)
19.	Crashes (POV)	Crashes (COMM)
20.	Crashes (COMM)	Crashes (COMM)

METHOD

Selection

Study Populations. Drivers of heavy trucks from the states of North Carolina and Washington were selected as the study populations to investigate the relationship between a truck driver's driving performance in a private vehicle and his driving performance in a commercial vehicle. Selection of drivers from these two states was based on the following criteria. First, both states have classified driver licensing systems which identify drivers of large combination vehicles on the state driver history files. Drivers holding Class A licenses from North Carolina and drivers with a combination endorsement from Washington were included in the study (See Appendix D for descriptions of license classifications). North Carolina Class A drivers who had been licensed in North Carolina for the years 1981-1984 were included in the study. Washington state drivers were included in the study if they held a license to drive a large combination vehicle in 1984.

Second, good data bases were available from both states. North Carolina's crash and driver history files are known to be relatively complete. In addition, they are computerized and easily accessible. The Washington driver history files also are computerized and compatible with the computer facilities and programming capabilities of the University of North Carolina Highway Safety Research Center.

Third, and most importantly, it was possible to differentiate with some degree of certainty between violations and crashes which occurred in private vehicles and those which occurred in commercial vehicles in records

from both states. Since the middle of 1980 the Washington state driver history file has designated whether crashes and violations are employment or non-employment related. For purposes of this study, a Washington driver licensed to drive a tractor trailer was assumed to be driving a truck if the record indicated a crash or violation involved employment related driving. North Carolina does not have such a designation on the driver history record. To obtain this type of information for special subgroups of drivers, the citation file was used to identify vehicle type for violations, and for all drivers the crash file was used to identify vehicle type for accidents.

Fourth, both states have sizable numbers of drivers registered to drive heavy trucks. North Carolina has approximately 140,000 drivers licensed to operate heavy trucks whereas Washington has approximately 136,000. Finally, North Carolina is home base for a large number of motor carriers, a sample of which were included in the study.

In addition to the large study populations from North Carolina and Washington, three subgroups of drivers from North Carolina were selected for separate investigation. One group consisted of owner-operators who were identified by linking truck drivers' names and addresses with the names of owners of heavy trucks listed in the North Carolina vehicle registration file. The second group were truck drivers from four motor carriers based in North Carolina. These groups were included separately in the study for the purposes of comparing various truck driver groups on variables of interest. Also the driver files from the motor carriers provided additional driving information about motor carrier drivers which when combined with the state driver history records provided a more complete driving record for this group of drivers than was possible to

obtain for the other driver groups. Finally, a sample of 1000 drivers of heavy trucks (Class A licensees) was selected for the purpose of determining vehicle type associated with violations for this group of drivers. A sample, rather than the total group of Class A drivers, was used because of the time and labor involved in determining vehicle type for each citation.

Motor Carriers The process for selecting the motor carriers to be included in the study began with the review of a list of ninety-nine members provided by the North Carolina Trucking Association Inc. From this list, fourteen were chosen and contacted regarding the project. Of these, nine were willing to provide access to their driver files, three were unable to provide access because of the need to release identifying information about the drivers, and two were noncommittal. Because of resources available to the project, it was necessary to limit the number of companies included in the study to four. The motor carriers were included in the study based on whether they employed both over-the-road and local drivers, whether the motor carrier files contained the needed data and were easily usable, and whether collection of the data could take place during the designated data collection period. Finally, companies of varying sizes were selected to provide a balance of both larger and smaller companies.

Data Collection

Washington State File. Identification was made of states that had classified licensing systems and sizeable numbers of drivers licensed to operate tractor trailers. These states were contacted to determine which, if any, identified on their driver history file the vehicle type in which violations and crashes occurred. The state of Washington was the only state identified that met these criteria.

A preliminary investigation was initiated to determine the feasibility of using the Washington state driver history file. First, the driver history format was obtained and examined. This examination revealed that the variables of interest were listed and the file could be transferred by disc directly to the Highway Safety Research Center's computer facilities. Next, a sample of 2000 records of drivers of heavy trucks was obtained in order to determine the completeness of the records on the study variables. Analysis of these records indicated that beginning in 1980 most violations and crashes were designated as employment or non-employment. The remainder of the Washington histories for drivers of heavy trucks from the years 1980-1984 was requested and received in October, 1985.

North Carolina Motor Carrier Driver Files. Data were collected from the four motor carriers in approximately three one-week periods during the summer of 1985. All of the motor carriers visited were helpful and supportive of the project. Most of the data were obtained directly from the individual truck driver files located in the personnel departments of each company. Personnel files were arranged alphabetically and researchers systematically pulled by hand the driver files working from the beginning of the files. This process assured a representative sample of drivers from each company. Information was obtained for approximately two-thirds of the total population of North Carolina drivers from the four motor carriers. Pertinent information from the files was transferred to the data collection form (Appendix E). This form was developed, tested at a motor carrier, and revised prior to the formal data collection. In addition, it was reviewed by the Federal Highway Administration before the major data collection.

Information was gathered on variables in three general areas: descriptive, work-related, and driver record. Descriptive data included

the driver's name, age, sex, address, employment, and social security number. Work-related variables were the date of initial employment, lay-off status, drivers license number, and whether the driver was an over-the-road or local driver. Driver record data consisted of the locations, dates, and types of accidents or violations for each driver. Also included was the type of vehicle driven when accidents and/or violations occurred and, if available, a judgment by the company as to whether an accident was preventable or non-preventable.

Minor differences existed among the companies in the data collection procedures. Two companies had accident summaries on computer printouts which were made available to the project. One company did not have driver license numbers on file. Names, birth dates, and addresses from the motor carrier files for drivers of this company were later used to obtain the driver license numbers. Drivers licenses were needed for identification purposes in the process of linking files.

North Carolina Division of Motor Vehicles Files. The state driver history file, crash file, and vehicle registration file were directly accessible to the project. The only state file needed for the study which was not computerized was the citation file. This file, maintained on microfilm in the Division of Motor Vehicles in Raleigh, was available to the project during specific week-end times. Citation numbers listed on driver history files were used to locate specific citations on microfilm. Citation information was pulled for three special samples of North Carolina drivers: motor carrier drivers, owner-operators, and a random sample of 1004 class A drivers, that is, drivers licensed to operate large combination trucks. Researchers located and examined citations of these drivers for the years 1981 through 1984 to determine whether violations

occurred in private or commercial vehicles. There were approximately 2020 such violations.

National Driver Register A request was made to the National Driver Register to obtain summaries regarding the revocation of driver licenses of groups of drivers of heavy trucks from North Carolina. These groups were: all class A license holders, subset of class A license holders, owner-operators, and motor carrier drivers. No identifying information about the drivers was to be included in the summaries requested.

Data Entry and Data Sets

Data from the driver forms from the four companies and data from the citation file indicating vehicle type were entered into the computer to create separate data sets. All raw data entered onto the computer were either proof read or entered twice and checked for accuracy. Detected errors were subsequently corrected.

The Washington state driver history file and the North Carolina driver history, crash, and registration files exist as computerized data files. From these files special data sets were created for this project.

Five major data sets (Appendix F) were created as follows:

1. Washington state file of drivers licensed to operate large combination vehicles with identification of vehicle type for violations and crashes. Driver histories for the years from 1981-1984 were available for all but approximately 5 percent of this population, N=135,735. (Study Population E).
2. North Carolina drivers licensed to operate large combination vehicles, with identification of vehicle type for crashes but

not violations, N=108,765. Driver histories for the years from 1981-1984 were available for these drivers. (Study Population A1).

3. Random sample of North Carolina drivers licensed to operate heavy combination vehicles, with identification of vehicle type for violations and crashes, N=791. (Study Population A2).
4. Subset of North Carolina drivers identified as owner-operators in that they held a license to operate a heavy combination vehicle and also had a truck tractor registered in the same name, with vehicle type identified for violations and crashes,N=578. (Study Population B).
5. Sample of drivers obtained from motor carrier records, with identification of vehicle type identified for violations and crashes on the state driver history file, plus some additional data from personnel files, N=861. This group was further subdivided into Over-The-Road Drivers (N=438) and Local drivers (N=421). (Study Population C).

RESULTS

Descriptive Characteristics of Heavy Truck Driver Groups

In 1984 there were approximately 140,000 Class A drivers in North Carolina licensed to drive a tractor trailer. The number of drivers used in the study decreased to 108,765 when drivers with less than four year driver records were eliminated. Washington state had approximately 136,000 drivers licensed to drive large combination vehicles (combination endorsement license).

Generally the truck driver populations for the two states were quite similar (see Table 1). Driving heavy trucks appears to be a predominantly white male occupation. While no information on race was available from Washington state, all North Carolina groups had 84 percent or more white drivers. For both Washington state and North Carolina the proportion of drivers who were male was 96 percent or higher. The median age for truck drivers in both states was 39, which incidentally is the median age of all licensed drivers in North Carolina in 1985. However, the owner-operator and motor carrier samples from North Carolina were older, with median ages of 45 and 47, respectively.

Table 1. Characteristics of Drivers of Heavy Trucks in Study Populations

Population	Number	Median Age	Race		Sex	
			White	Other	M	F
North Carolina Class A	108,765	39	84.0%	16.0%	97.7%	2.3%
NC Subset Class A	791	40	85.5%	14.5%	97.3%	2.7%
NC Owner-Operators	578	45	85.0%	15.0%	99.8%	0.2%
NC Motor Carrier	861	47	91.0%	8.0%	100.0%	0.0%
Washington State	135,735	39	NA	NA	96.2%	3.8%

Estimated mileage was available for the North Carolina drivers (see Table 2). Again, the owner-operator and motor carrier samples differed from the larger population and the random sample of Class A drivers. Forty percent of the owner-operators and 42 percent of the motor carrier drivers fell into the highest mileage category (>80,000 miles annually), compared to only 17 percent for each of the other groups.

Table 2. NC Driver Estimated Annual Mileage

Driver Group	Not Stated	<20,000	21,000 to 50,000	51,000 to 80,000	>80,000
NC Class A	28,876 (27%)	18,766 (17%)	32,704 (30%)	9,630 (9%)	18,789 (17%)
Subset NC Class A	206 (26%)	196 (25%)	185 (23%)	67 (9%)	137 (17%)
Owner-Operators	104 (18%)	61 (11%)	86 (15%)	96 (16%)	231 (40%)
Mot. Carr. Drivers	113 (13%)	74 (9%)	206 (24%)	105 (12%)	363 (42%)

Predictive Relationships of Driver Records

Separate analyses were conducted on the five driver groups, namely, Washington state truck drivers, total North Carolina Class A drivers, random sample of North Carolina Class A drivers, North Carolina owner-operator sample, and North Carolina motor carrier sample. The latter group was further subdivided into Over-the-Road (OTR) or interstate and Local, usually short haul drivers. The results are reported by driver group.

Washington State Tractor Trailer Drivers. Table 3 shows results from contingency table analyses of pairs of variables. Infractions in the private vehicle in the first time period included total crashes, total violations, speeding violations, stopped violations, moving violations,

reckless driving violations, and alcohol related violations. Total violations and total accidents were each classified as 0, 1, or 2+, while

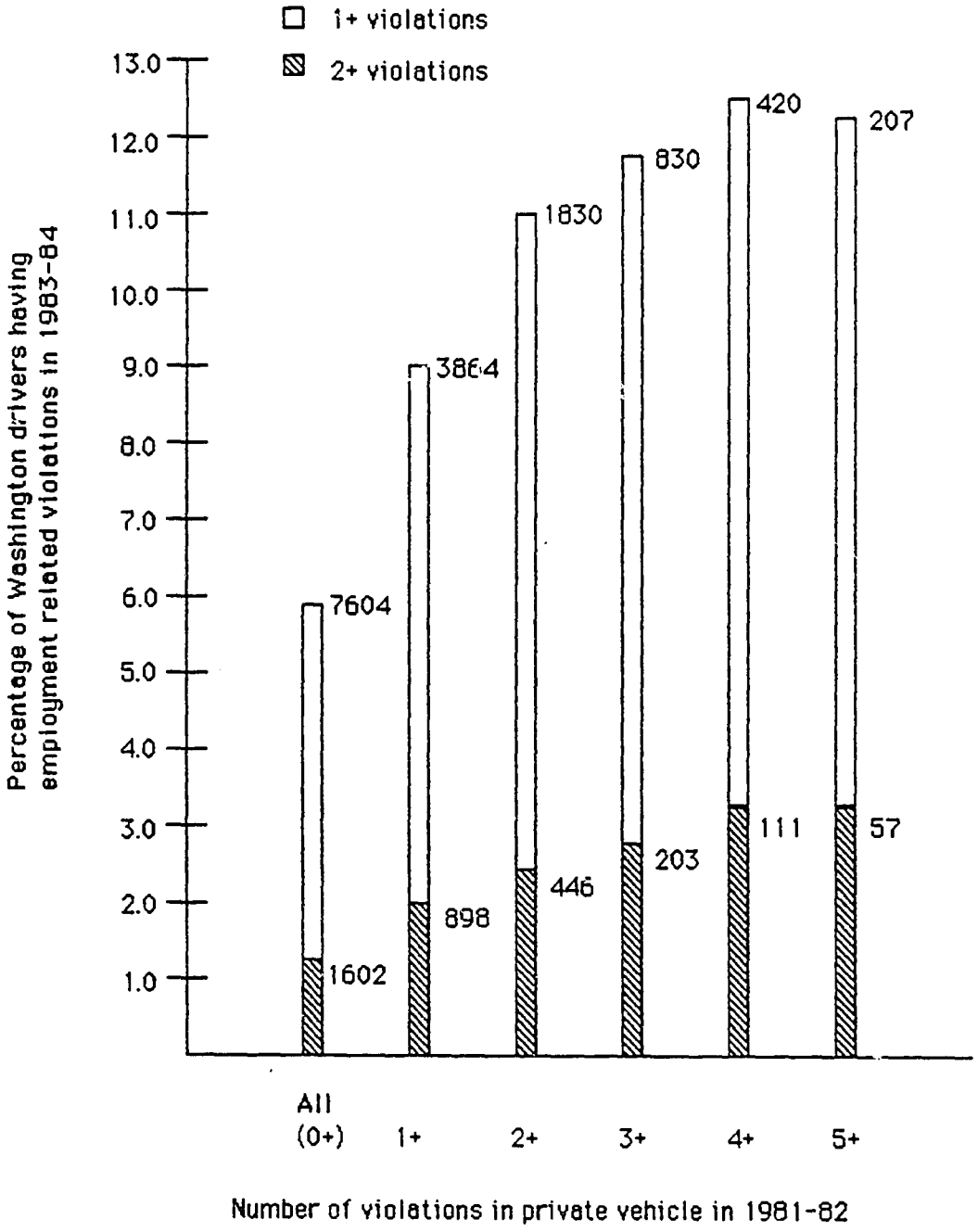
Table 3. Association Between Private and Employment Related Crashes and Violations, Washington State

Private Records 1981-1982	Employment Violations 1983-1984			Employment Crashes 1983-1984		
	X^2	d.f.	P	X^2	d.f.	P
Total Crashes	1466	4	.000	113	4	.000
Total Violations	135	4	.000	65	4	.000
Speeding Violations	1097	2	.000	85	2	.000
Stopped Violations	125	2	.000	36	2	.000
Moving Violations	228	2	.000	23	2	.000
Reckless Violations	63	2	.000	3	2	.226
Alcohol Violations	6	2	.056	1	2	.544

the specific types of violations were classified simply as 0 or 1+. The employment related infractions in the second period included total crashes and total violations, each subdivided into 0, 1, or 2+. The table shows that in most instances the statistical association between variables is highly significant. Only the alcohol violations failed to show any significant relationships (using $p = 0.05$ as the cutoff point for statistical significance), while reckless violations were significant in predicting future employment related violations but not crashes. However, because of the large numbers involved, the true correlation could be quite small and the results still significant. The question of whether the relationship is large enough to be useful with respect to changes in policy is really a separate issue.

Figure 1 illustrates some of the problems in considering practical applications based on these relationships. The upper portions of the bars in this figure give the percentage of drivers who had one or more employment related violations in 1983-1984 as a function of the number of private vehicle violations in 1981-1982. The first bar shows that overall

Figure 1. Employment related violations (83-84) as a function of prior private violations (81-82), Washington 1981-84, N=135735



(0 or more private violations) 5.6 percent of the drivers had one or more employment related violations in 1983-1984. The number beside the point (7604) is the number of drivers involved. The lower portions of the bars give the percentage of drivers who had at least two employment related violations in 1983-1984. Thus, we see that as the 1981-1982 driving record in private vehicles gets worse, the percentage having employment related violations increases but tends to level off at a fairly low level. We also see that the number of drivers involved decreases rapidly as the private driving records become worse. This means that if we were to select a group of drivers with very poor private vehicle driving records, the number of drivers would be quite small and the likelihood that they will have poor future employment related records will not be very high (although higher than for those with better private driving records).

The prediction of employment related crashes is even more difficult. Overall only about 2.3 percent of the Washington drivers had employment related crashes in 1983-1984. This rate increases up to 3.03 percent for drivers having two or more private violations in 1981-1982, but then decreases as private driving records get even worse. It should be noted that at this point the accident sample sizes become quite small and the percentages relatively unstable.

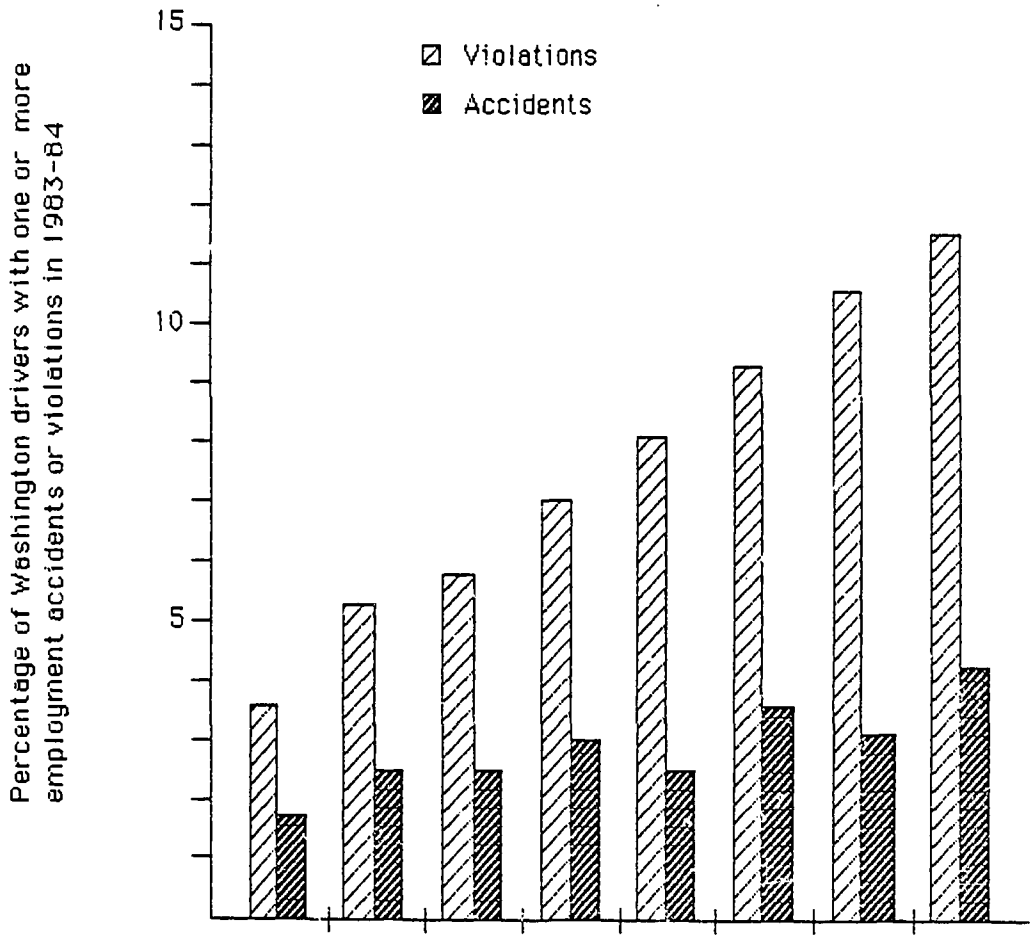
Another question of interest is whether or not some combination of variables from private driving records might yield better predictions of future employment related problems than do single variables. To investigate this question several multiway contingency tables were analyzed. Total private violations, private accidents, and driver age were among the variables which seemed potentially most useful, and these variables were included in categorical data models to predict future

employment related accidents and violations. The results of these models are shown in Figure 2 which gives predicted percentages of drivers having one or more employment related violations and one or more employment related accidents (separately) in 1983-1984 for each of eight subpopulations defined by the levels of the three variables--driver age, number of previous private accidents, and number of previous private violations--each with the two levels shown. The last two lines on the figure give the number of violation and accident involved drivers, respectively.

The results of Figure 2 seem to be quite similar to those of Figure 1. The multiple variable models (Figure 2) seem to yield slightly better predictions of accidents, while the single variable--total violations--with more levels (Figure 1) seems to give slightly better predictions of future employment related violations.

Table 4 contains the results of comparing the combined private and employment related driving records for the 1981-1982 period with employment related driving records in the 1983-1984 period. The last two lines in the table refer to only employment related violations and accidents in both time periods. Examination of chi-squares from this table and comparison with chi-squares from Table 3 suggest that relationships between employment related records in the two time periods are considerably stronger than those between records in private vehicles in the first period and employment related records in the second period. This effect can be seen clearly from Tables 5 and 6.

Figure 2. Employment related events (one or more accidents or violations in 83-84) as a function of private accidents (81-82) or violations (81-82), by driver age, Washington 1981-84, N=135735



Driver Age	>30	>30	≤30	≤30	>30	>30	≤30	≤30
Number of private Accidents in 81-82	0	1+	0	1+	0	1+	0	1+
Number of private Violations in 81-82	0	0	0	0	1+	1+	1+	1+
N (Violations)	2666	276	714	84	2106	423	1061	274
N (Accidents)	1384	171	302	35	701	151	355	97

Table 4. Association between employment related violations and accidents and prior driver history, Washington state, 1981-1984.

Driver Record 1981-1982	Employment related violations (83-84)			Employment related accidents (83-84)		
	χ^2	d.f.	p	χ^2	d.f.	p
Total Violations Private & Employment	3427.3	6	.000	307.4	6	.000
Total Accidents Private & Employment	374.3	4	.000	266.2	4	.000
Speeding Violations Private & Employment	2973.5	4	.000	240.3	4	.000
Stopped Violations Private & Employment	307.2	2	.000	94.0	2	.000
Moving Violations Private & Employment	485.1	2	.000	76.7	2	.000
Reckless Violations Private & Employment	69.6	2	.000	6.3	2	.042
Alcohol Violations Private & Employment	6.4	2	.041	1.2	2	.559
Total Violations Employment Only	5089.3	2	.000	711.7	2	.000
Total Accidents Employment Only	549.6	2	.000	581.7	2	.000

Table 5. Drivers with employment related violations (1983-1984) as a function of prior violations (1981-1982) by vehicle type, Washington, 1981-1984

Vehicle Type	Violations 1981-1982	Percentage with one or more employment violations in 1983-1984
Private Vehicle	0	4.07%
	1+	9.00%
Employment Vehicle	0	4.40%
	1+	21.80%

Table 5 shows that private vehicle violations are related to subsequent employment violations, with those having violations in the first period more than twice as likely to have employment violations in the second period (9.00% versus 4.07%). However, if examination is confined to employment related violations in the first period, the prediction is much more powerful, with those drivers having violations in the first time period almost five times as likely to have employment violations in the second period (21.80% versus 4.40%).

Table 6 shows similar relationships for crashes, with drivers having a private crash in the first time period almost one and a half times as likely to have employment crashes in the second. However, again the employment record in the first time period is a more powerful predictor, with drivers having employment crashes in the first time period over four times as likely to have them in the second period compared to drivers with no employment crashes in the first time period.

Table 6. Percentage of drivers with employment related accidents (1983-1984) as a function of prior accidents (1981-1982), by vehicle type, Washington 1981-1984

Vehicle Type	Accidents 1981-1982	Percentage with one or more employment accidents in 1983-1984
Private Vehicle	0	2.25%
	1+	3.30%
Employment Vehicle	0	2.22%
	1+	9.02%

North Carolina Class A Drivers. The initial analyses of North Carolina data examined associations over time of several data elements derived from the overall driving records of North Carolina Class A license holders. By overall is meant that for this file no distinction could be

made between violations involving private passenger vehicles and those involving trucks. In the case of crashes, however, crash report numbers from the driver history file were linked to the crash files to obtain vehicle type information. If a crash occurred in a large truck (>10,00 lbs GWV), it was considered to be employment related; a crash in a passenger car or pickup truck was considered to be private.

Table 7 compares North Carolina and Washington state data on the proportions of drivers having violations and crashes. Crash frequencies

Table 7. Accident and Violation Involvement of Truck Drivers, Washington and North Carolina, 1981-1982, 1983-1984

	Washington				North Carolina			
	1981-1982		1983-1984		1981-1982		1983-1984	
Accidents	Drivers	%	Drivers	%	Drivers	%	Drivers	%
0	119753	88.2	120281	88.6	92302	84.9	93519	86.0
1	14108	10.4	13555	10.0	14320	13.2	13449	12.4
2+	1874	1.4	1899	1.4	2143	2.0	1797	1.7
Totals	135735	100.0	135735	100.0	108765	100.0	108765	100.0
Violations								
0	87582	64.5	92727	68.3	82859	76.2	85803	79.0
1	27228	20.1	25092	18.5	17981	16.5	16829	15.5
2+	20925	15.4	17916	13.2	7925	7.3	6133	5.6
Totals	135735	100.0	135735	100.0	108765	100.0	108765	100.0

are somewhat higher in North Carolina, but inquiry to Washington state revealed no systematic differences in recording criteria. In contrast, violation rates are higher for Washington state, although the differences are not great.

In Table 8 the checked boxes indicate the specific relationships that were investigated by contingency table analysis. In every case there was a positive association significant at the .001 level, with the single exception of the relationship between alcohol violations and total

violations, which was significant at .008.

Since at least a portion of these relationships may be attributable to driver age and differences in driving exposure, and since estimates of

Table 8. Relationships over time of North Carolina Class A Truck Driver Driving Records, N=108765

1981-1982 Driving Records	1983-1984 Driving Records: Emp. Acc.	Total Vio.	Total Acc.	Vio. Acc.	Speed. Vio.	Stop. Vio.	Move. Vio.	Reck. Vio.	Alco Vio.
Private Acc.	X	X	X	X					
Total Vio.	X	X	X	X					
Total Acc.	X	X	X	X					
Vio. Acc.	X	X	X	X					
Speeding Vio.	X	X	X	X	X				
Stopped Vio.	X	X	X	X		X			
Moving Vio.	X	X	X	X			X		
Reckless Vio.	X	X	X	X				X	
Alcohol Vio.	X	X	X*	X					X

* Significant at .008 level of significance.
All others significant at .001 level.

annual miles driven are available on the North Carolina driver history file, some further analyses were conducted to investigate the effects of past driver history variables taken together with annual mileage estimates and driver age. For these analyses categorical data models were fit to the frequencies of the multiway tables of driver performance in the 1983-1984 period cross-classified by annual mileage (categorized), driver age, and past performance in the 1981-1982 period.

Models of total violations, total accidents, and employment related accidents were developed. The association between employment related accidents and prior private accidents, taking driver age and mileage into

account, is shown in Figure 3. On the whole, drivers with prior private accidents are more likely to have subsequent employment related accidents, but the relationships are not marked in the higher mileage drivers.

Figure 4 shows the predicted proportions of drivers having at least two violations (including both private and employment) as a function of prior violations, taking age and mileage into account. The proportions vary much more dramatically with number of prior violations than either age or mileage, even though both the latter show consistent relationships.

Figure 5 shows similar relationships between total violations in the first time period and truck accidents in the second time period. Although age and mileage again show consistent relationships to crash experience, the prior record appears to be the strongest predictor.

In this figure drivers age 58 and over were considered separately. It can be seen that in every case there is a slight increase in crash probability for this age group in comparison to the age 41-57 group. However, it is also the case that the drivers age 58 and over do better than the two younger age groups. Whether there is any further increase in crash probability as age increases cannot be determined from these analyses.

North Carolina Random Sample Class A Drivers. Table 9 shows the relationships between certain prior driver history variables and employment accidents and violations for the random sample of North Carolina Class A drivers. It can be seen that in most instances the relationships are not significant. However, total accidents predict employment accidents, and total accidents, total violations, employment violations, and private violations are related to employment violations in the subsequent time period.

Figure 3. Predicted employment related accident probability (one or more in 83-84) as a function of prior private accidents (81-82), by driver age and annual mileage, North Carolina 1981-84, N=108765

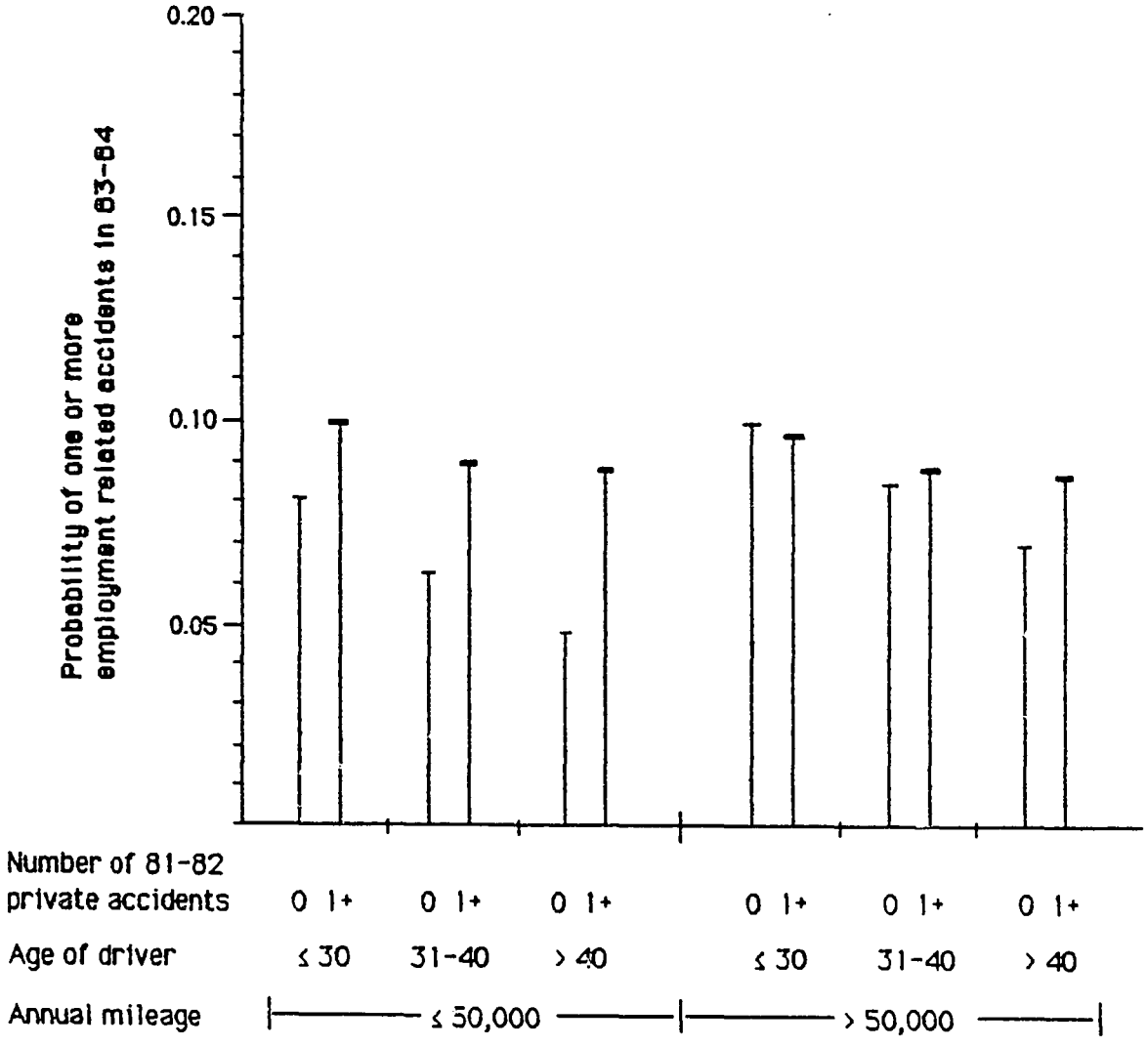


Figure 4. Predicted violation probability (two or more in 83-84) as a function of prior violations (81-82), by driver age and annual mileage, North Carolina 1981-84

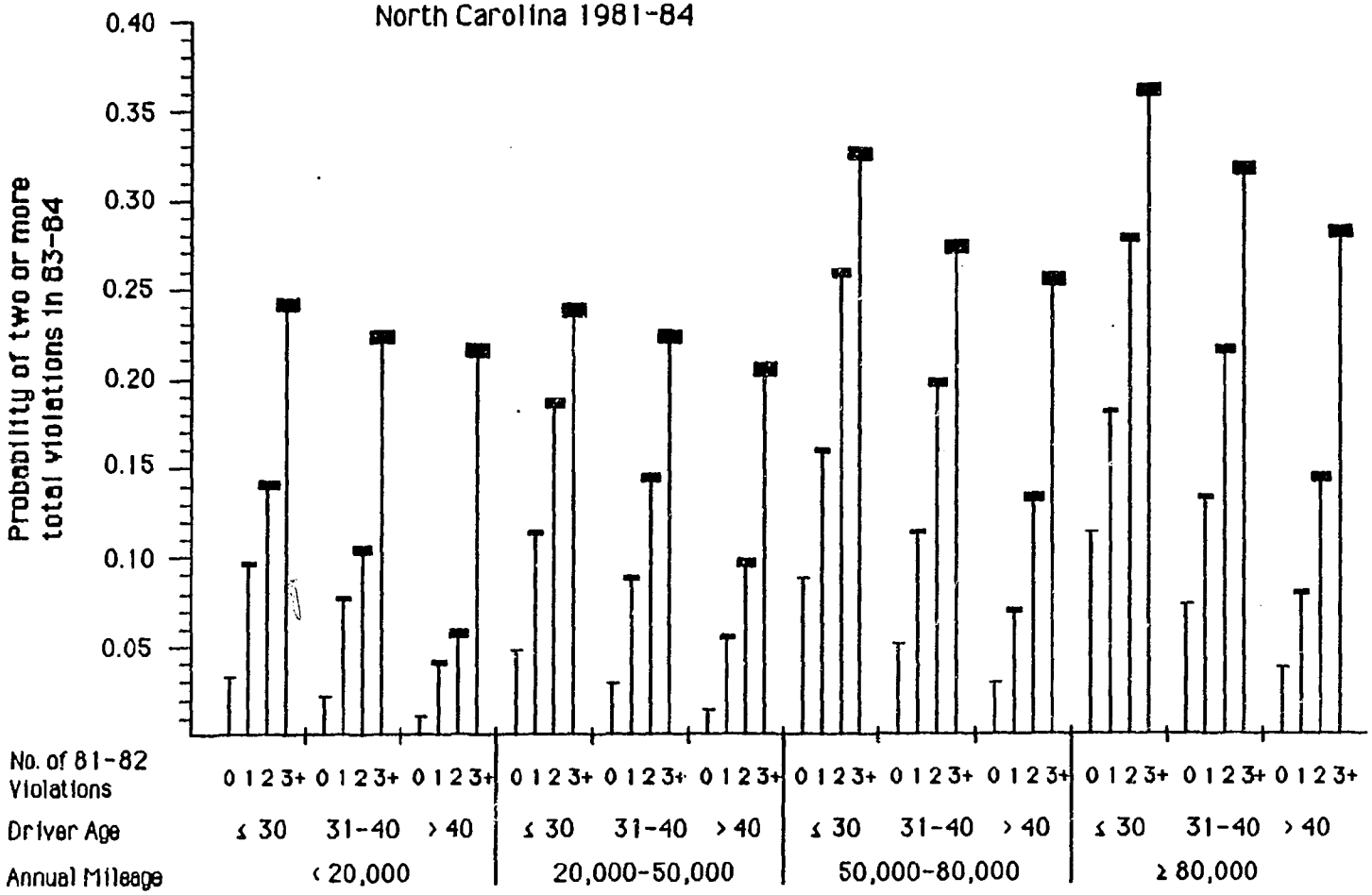


Figure 5. Predicted employment related accident probability (one or more in 83-84) as a function of prior violations (81-82), by driver age and annual mileage, North Carolina 1981-84, N=108765

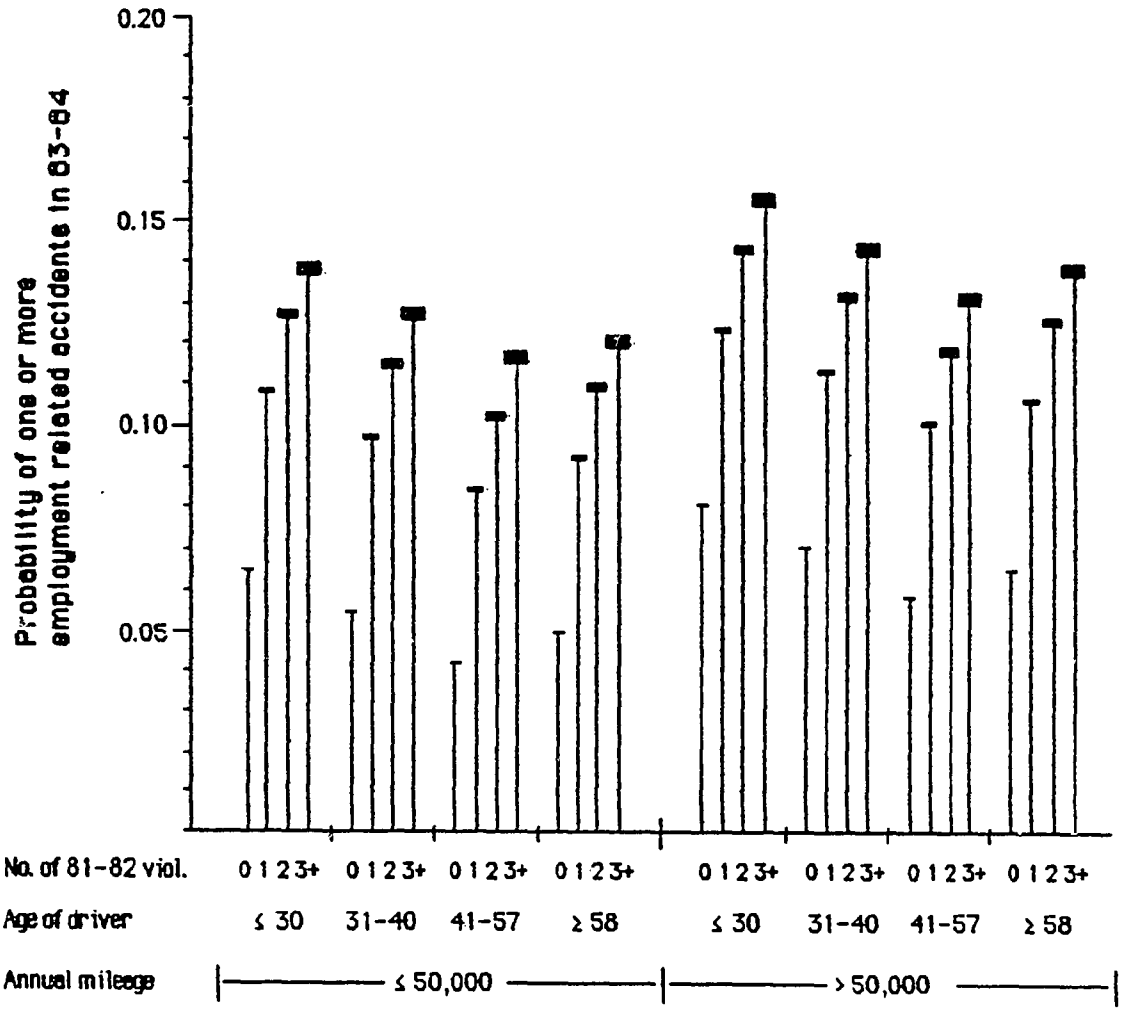


Table 9. Associations between employment accidents and violations and prior driver history, North Carolina Random Sample, 1981-1984

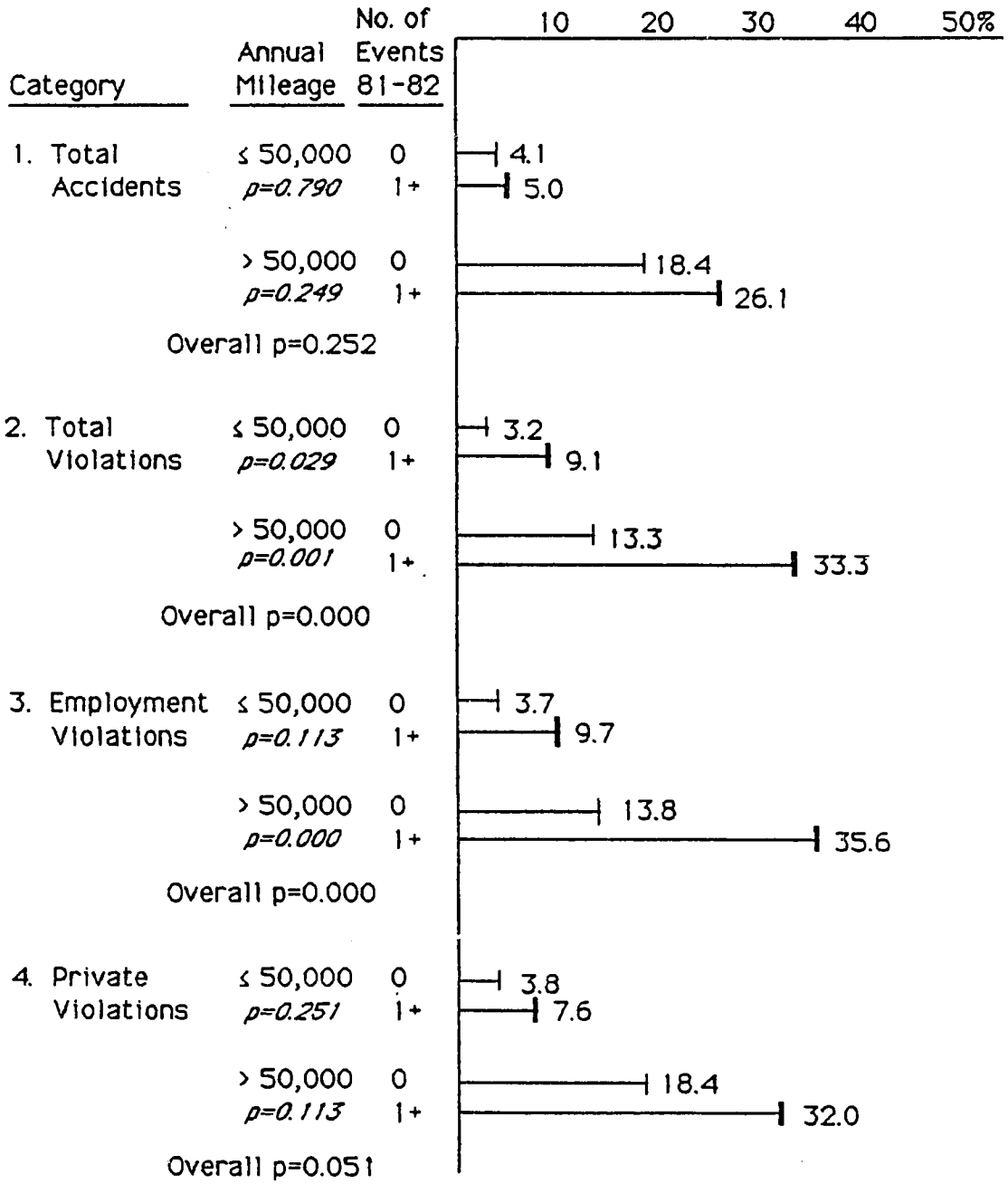
Prior Driving 1981-1982	Employment Accidents 1983-1984	Employment Violations 1983-1984
Total Accidents	*	#
Employment Accidents	-	-
Private Accidents	-	-
Total Violations	-	*
Employment Violations	-	*
Private Violations	-	#

* =p< .001
# =<.001 <p< .05
- = .05<p

Figure 6 shows the predictive relationships between crashes and violations in the first time period and employment violations in the second time period while taking into account mileage category. Total accidents were not significantly related to subsequent employment violations, nor were private violations. However, total violations and employment violations showed significant relationships, with drivers who had previous violations more likely to experience subsequent employment violations. It is particularly noteworthy that these relationships were identified, in that the total numbers of subjects in these analyses were quite small.

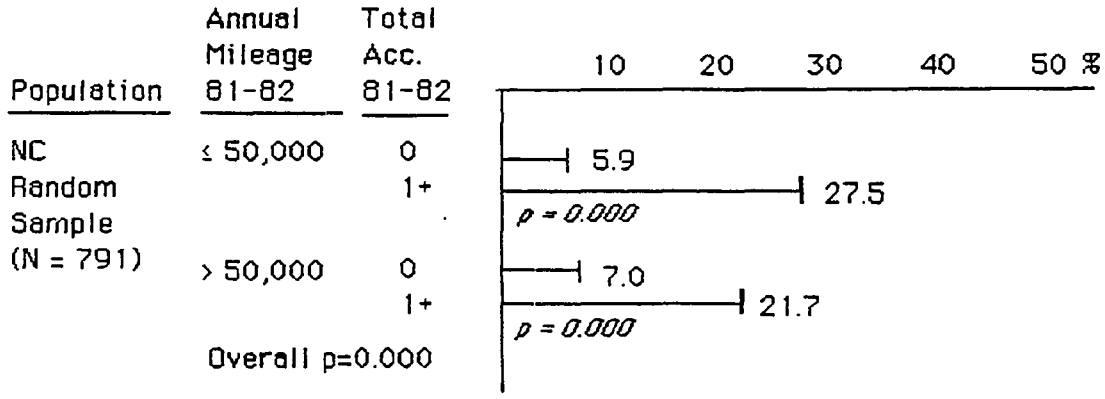
Figure 7 examined employment related crashes in relation to prior crashes. When taking mileage category into account, drivers with prior crashes have a much higher probability of subsequent employment related crashes. The differences are more than four-fold for the lower mileage group and three-fold for the higher mileage drivers.

Figure 6. Employment related violations (percent with one or more in 83-84) as a function of prior driver history (81-82), by annual mileage, North Carolina 1981-84, random sample Class A



Note: Sample sizes by mileage class
≤ 50,000, N = 381
> 50,000, N = 204

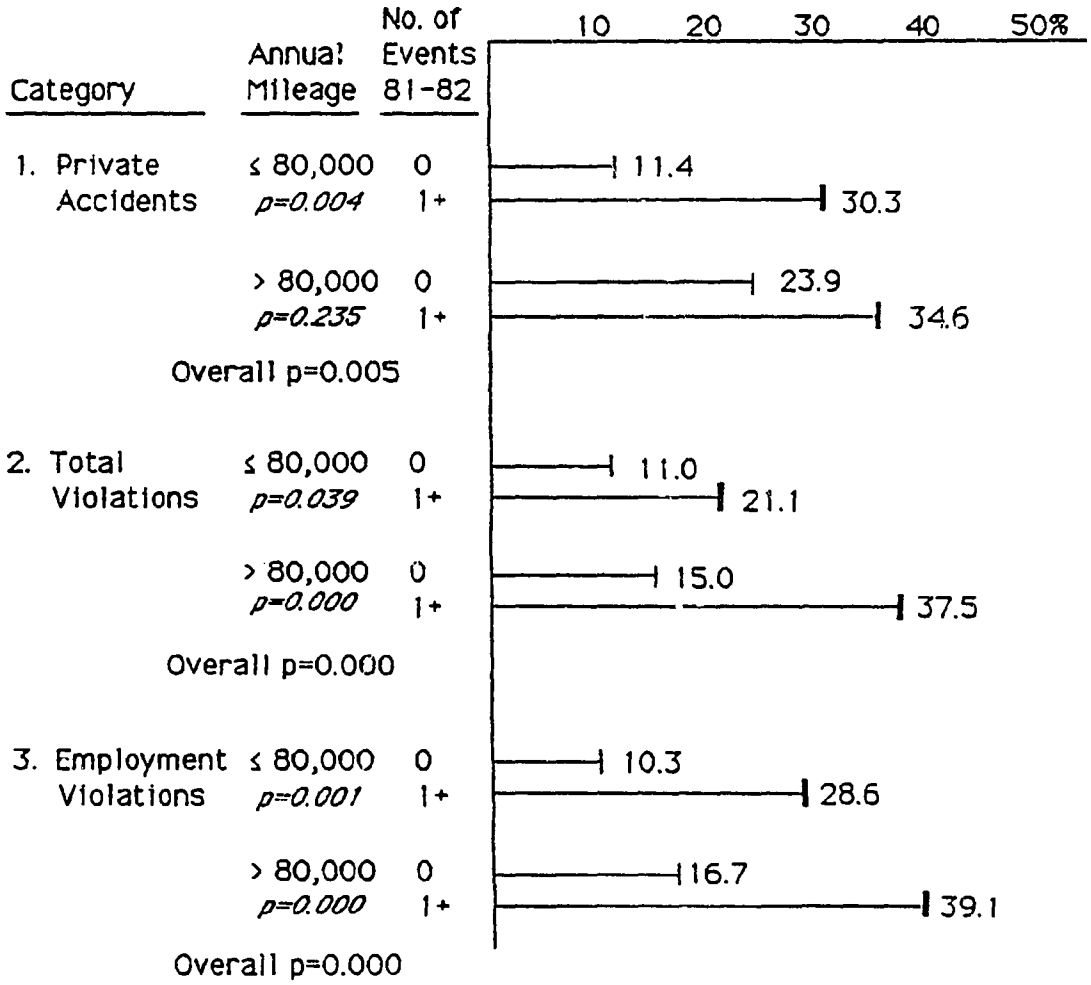
Figure 7. Employment related accidents (percent with one or more in (83-84) as a function of prior accidents (81-82), by annual mileage, North Carolina 1981-84, random sample Class A



North Carolina Owner-Operators. Table 10 shows the relationships between accidents and violations in a first time period and employment accidents and violations in a second time period. Total accidents were significantly related to subsequent employment accidents, while private accidents, total violations, and employment violations were related to subsequent employment violations.

Figure 8 shows the relationships between private accidents, total violations, and employment violations in the first time period and employment violations in the second time period while taking mileage category into account. Private accidents were significantly related to subsequent employment related violations for the lower mileage group but

Figure 8. Employment related violations (percent with one or more in 83-84) as a function of prior driver history (81-82), by annual mileage, North Carolina 1981-84, owner-operator



Note: Annual mileage categories of under and over 80,000 miles were chosen for owner/operators. Sample sizes in the two categories were 243 and 231 respectively.

Table 10. Associations between employment accidents and violations and prior driver history, North Carolina Owner-Operators, 1981-1984

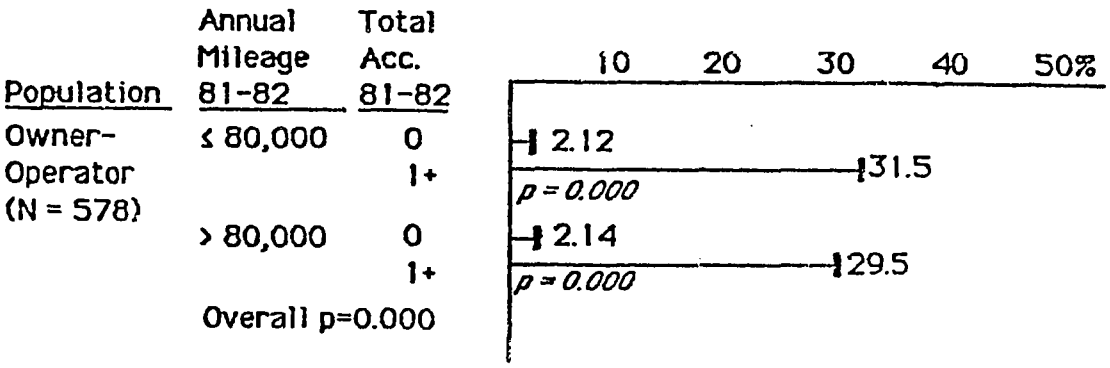
Prior Driving 1981-1982	Employment Accidents 1983-1984	Employment Violations 1983-1984
Total Accidents	*	-
Employment Accidents	-	-
Private Accidents	-	#
Total Violations	-	*
Employment Violations	-	*
Private Violations	-	-

* p< .001
\# .001 <p<.05
\- .05<p

not for the drivers in the high mileage group. Total violations were predictive for both mileage categories, as were employment violations.

Figure 9 shows the relationships between crashes in the first time period and employment related crashes in the second time period, taking mileage category into account. The relationships examined were highly significant for both mileage groups, with drivers with crashes in the first

Figure 9. Employment related accidents (percent with one or more in 83-84) as a function of prior accidents (81-82), by annual mileage, North Carolina 1981-84, owner-operator



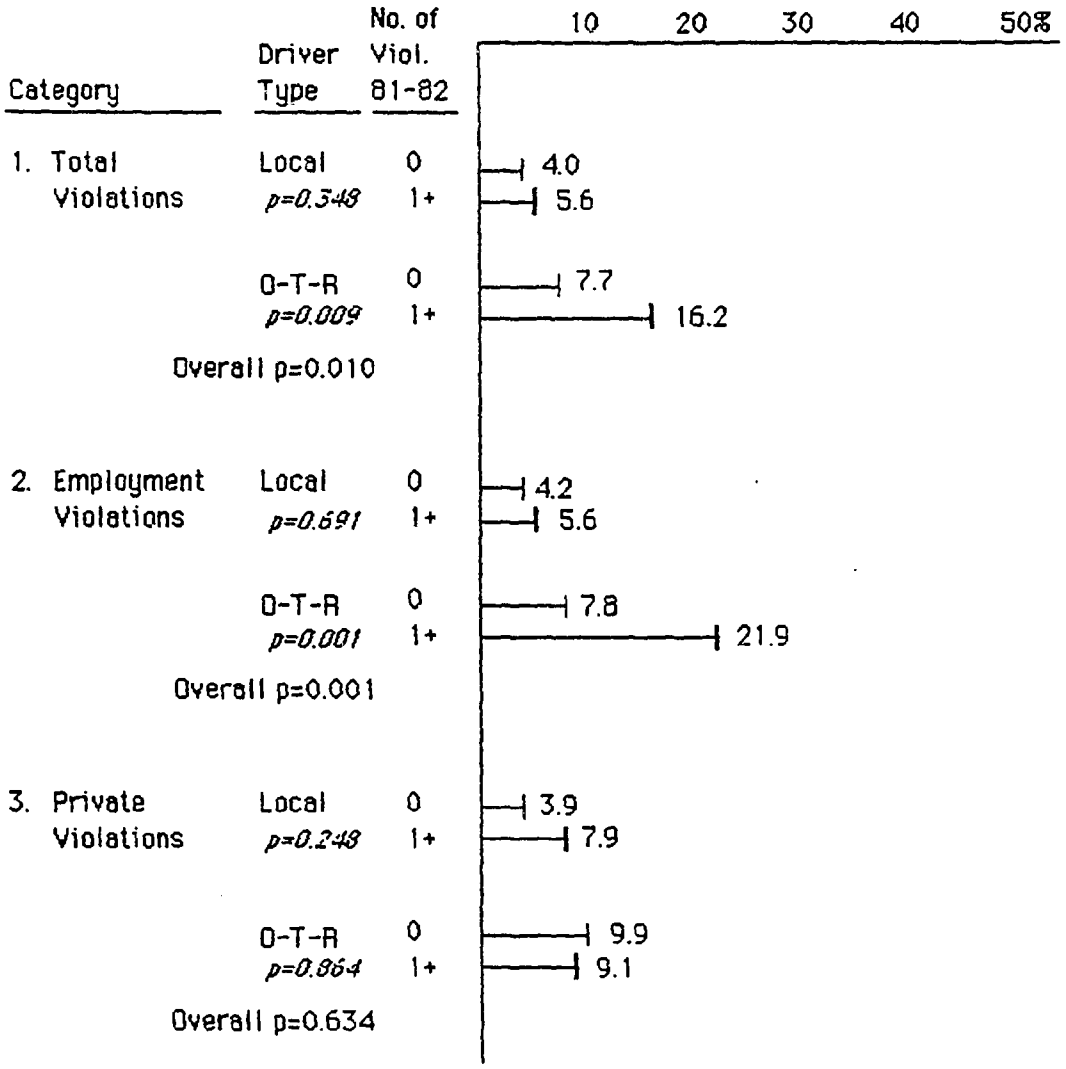
time period 13 to 15 times as likely to have employment crashes in the second time period.

Motor Carrier Drivers. The motor carrier drivers were divided into Local drivers and Over-the-Road (OTR) drivers. The initial analyses considered only data from the North Carolina Driver History File so that comparisons could be made with the other subgroups of drivers. Figure 10 depicts the predicted proportions of drivers having one or more employment related violations in the second time period as a function of total violations, employment violations, and private violations. Total violations and employment violations are significantly related to subsequent employment violations for the OTR drivers but not for the local drivers. OTR drivers with prior employment related violations were almost three times as likely to have subsequent employment related violations as OTR drivers with no prior employment violations. Violations in the private vehicle were not related to subsequent employment related violations.

In Figure 11 the relationships between prior accidents and subsequent employment related accidents are shown. Total accidents are significantly related for both local and OTR drivers. Drivers with prior crashes are five to six times as likely to have subsequent employment related crashes. The proportion of drivers involved is not trivial in that 30 percent or more of drivers with crashes have at least one crash in the second time period, compared to only four to five percent of those with no crashes.

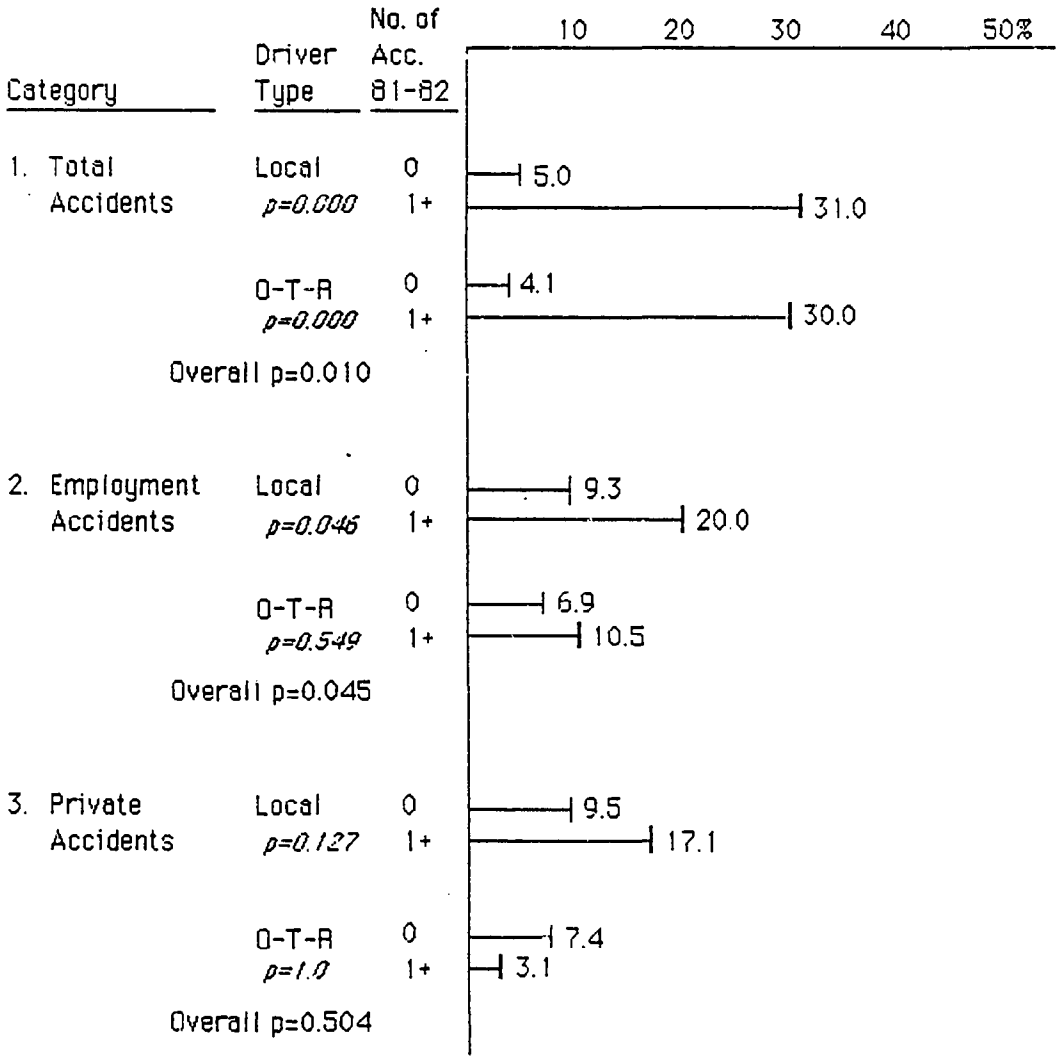
Overall employment related crashes are also related to subsequent employment crashes, although this relationship is not as strong as prior total accidents related to subsequent employment crashes. Crashes in the private vehicle do not appear to be related to subsequent employment crashes.

Figure 10. Employment related violations (percent with one or more in 83-84) as a function of prior driver history (81-82), by driver type, North Carolina, 1981-1984, motor carrier, state records



Note: Sample sizes by driver type
Local, N= 421
O-T-R (Over-the-road), N= 438

Figure 11. Employment related accidents (percent with one or more in 83-84) as a function of prior driver history (81-82), by driver type, North Carolina 1981-84, motor carrier, state driver records



Note: Sample sizes by driver type
Local, N= 421
O-T-R (Over-the-road), N= 438

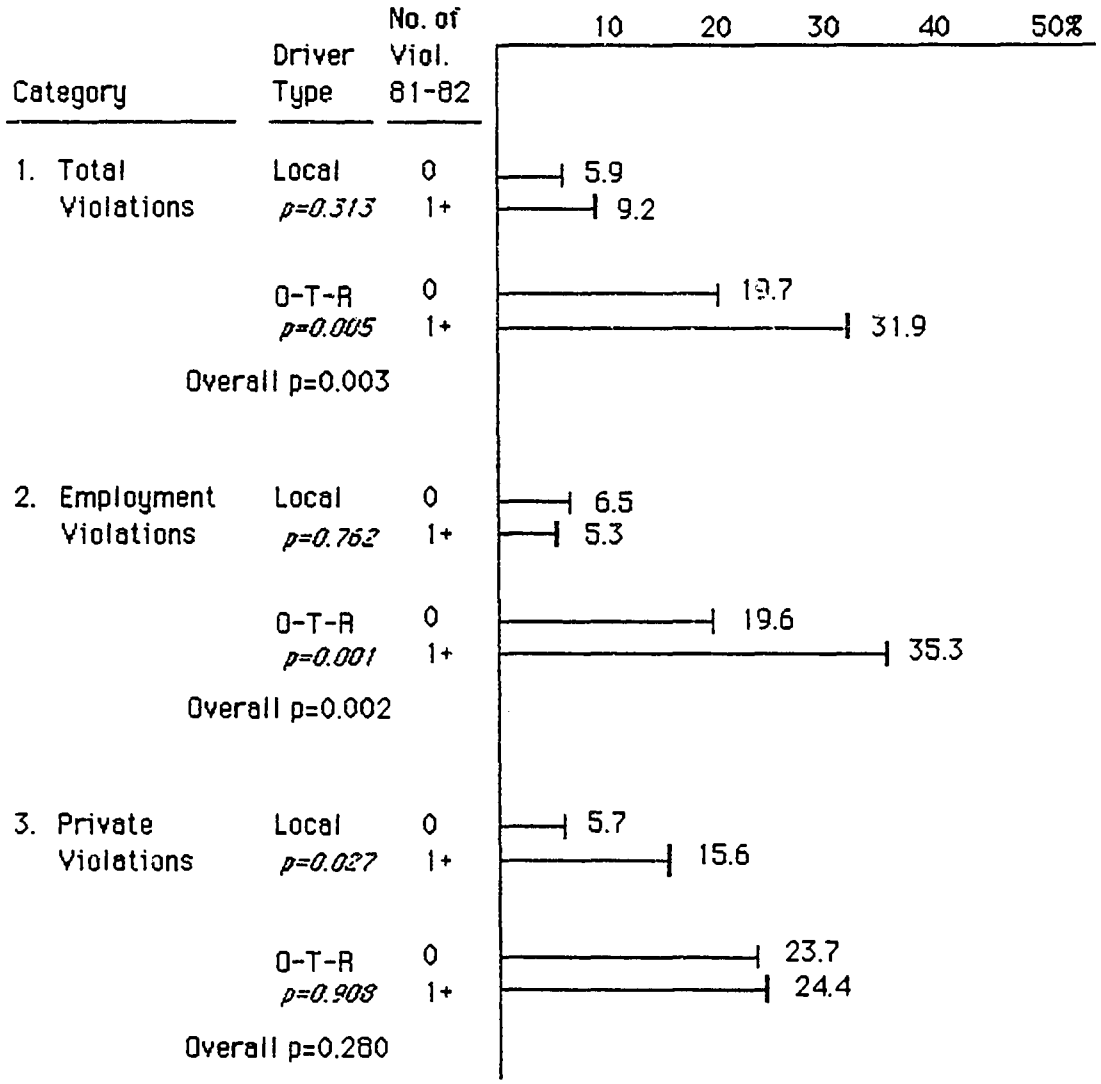
For the motor carrier driver sample, there were additional data available from the company files, thus creating the most complete files of any in the study. This fact should be kept in mind when considering the high violation and crash rates in the subsequent figures.

The relationships between violations in the first time period and employment violations in the second time period are shown in Figure 12. Total violations and employment violations are significantly related to later employment violations for OTR drivers. Violations in the private vehicle show a significant relationship to subsequent employment violations for local drivers but not for OTR drivers.

The relationships between accidents and violations and subsequent employment accidents are shown in Figure 13. Total accidents and employment accidents are highly predictive. Drivers with accidents in the first time period are more than three times as likely to have employment related accidents in the second time period. Accidents in the private vehicle are also significantly related to subsequent employment accidents, but they are not nearly so strong a predictor as are employment related accidents alone. Violations in the first time period do not show any significant relationships to employment related accidents in the second time period.

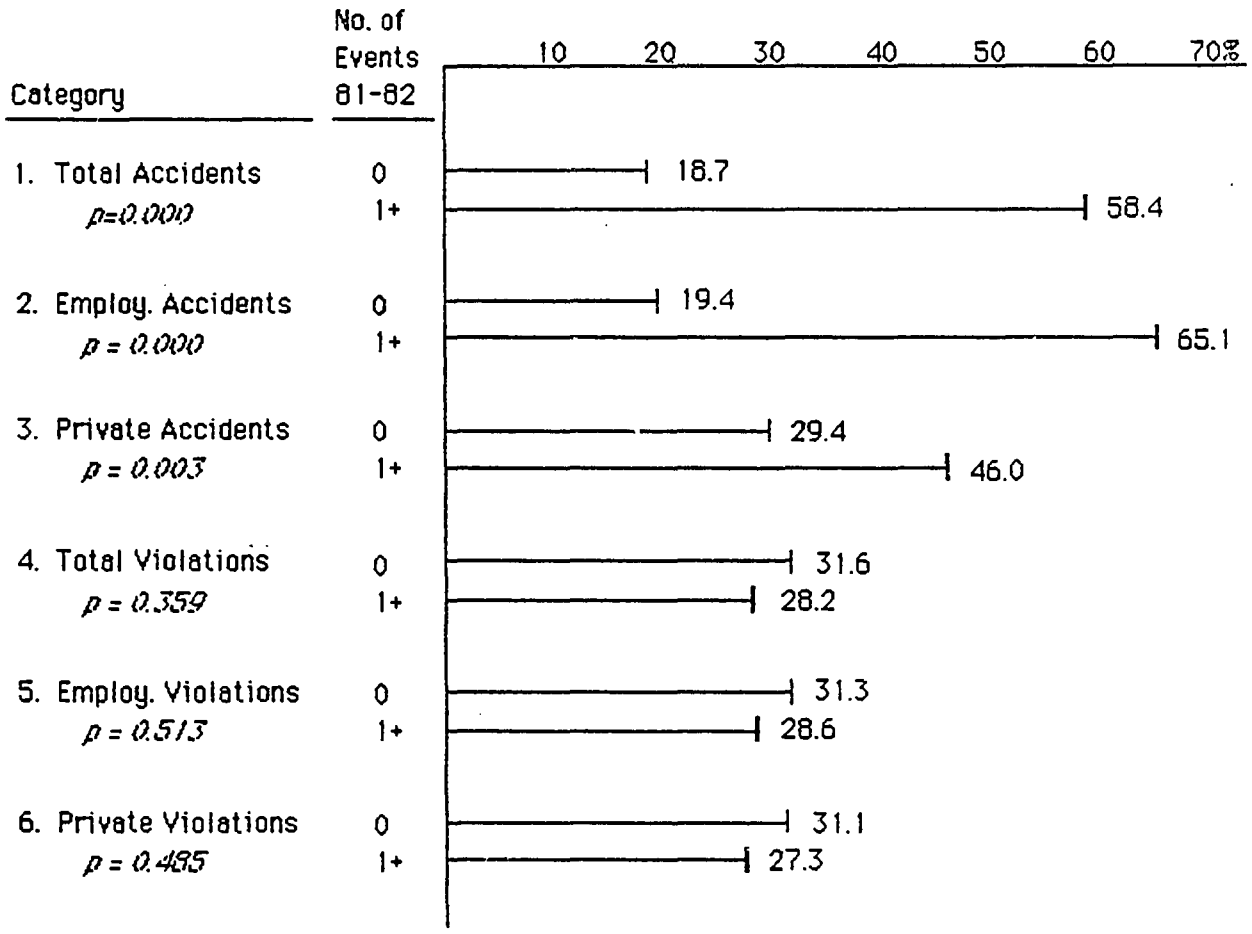
Figure 14 also examines accidents in the first time period and subsequent employment related accidents but divides drivers into Local and OTR. Both total accidents and employment accidents are predictive for both Local and OTR drivers, with drivers having prior accidents being two and a half to three times as likely to have subsequent employment crashes. For local drivers, of those with one or more prior employment crashes, 70 percent are predicted will have subsequent crashes, compared to 27 percent

Figure 12. Employment related violations (percent with one or more in 83-84) as a function of prior driver history (81-82), by driver type, North Carolina 1981-84, motor carrier, combined state and motor carrier driver records



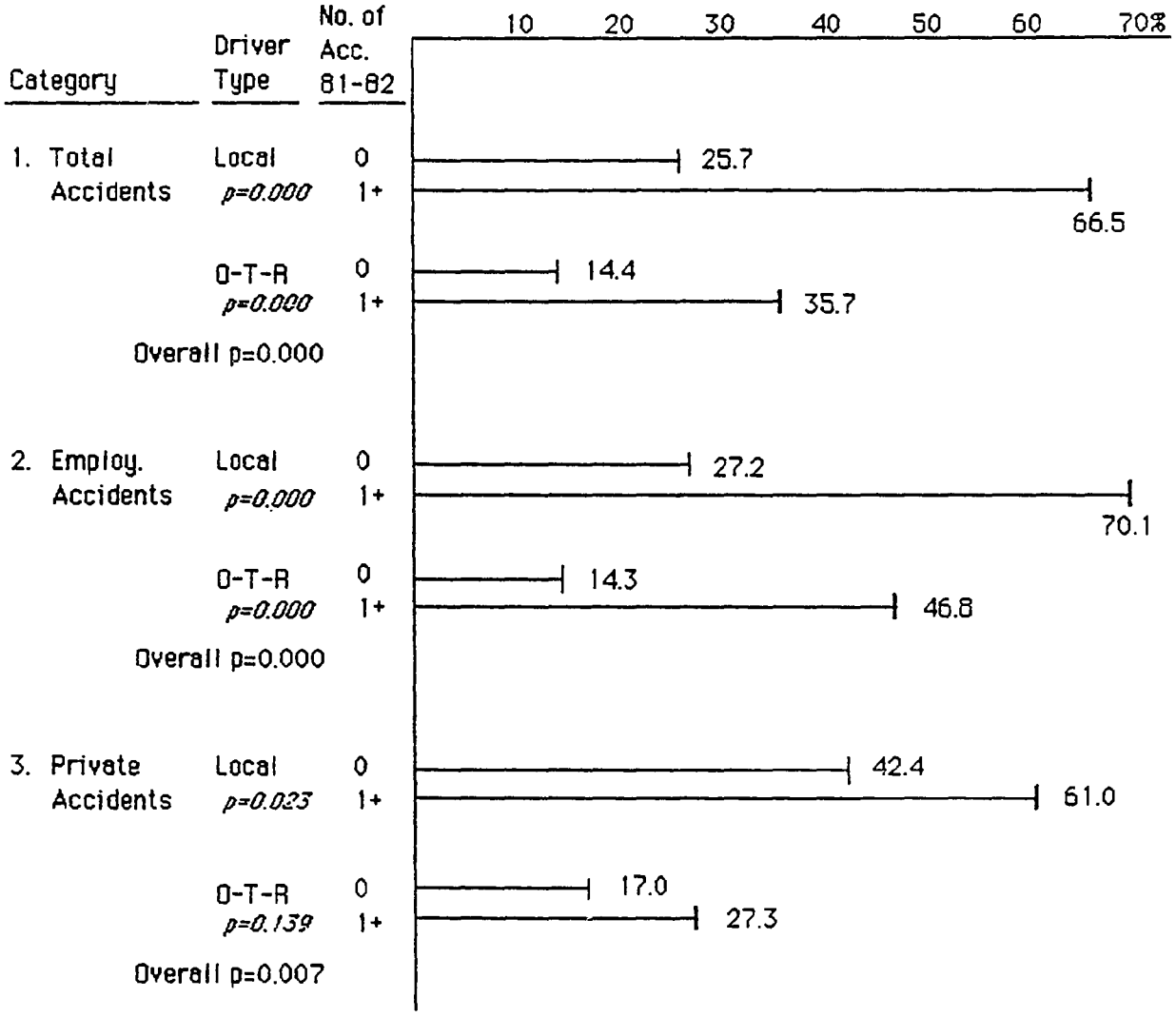
Note: Sample sizes by driver type
Local, N= 421
O-T-R (Over-the-road), N= 438

Figure 13. Employment related accidents (percent with one or more in 83-84) as a function of prior driver history (81-82), North Carolina 1981-1984, motor carrier, combined state and motor carrier driver records



Note: Motor carrier drivers, N=859

Figure 14. Employment related accidents (percent with one or more in 83-84) as a function of prior driver history (81-82), by driver type, North Carolina 1981-84, motor carrier, combined state and motor carrier driver records



Note: Sample sizes by driver type
Local, N= 421
0-T-R (Over-the-road), N= 438

of those with no prior crashes. It is rare that proportions of that magnitude are identified in predictive studies concerning motor vehicle crashes.

Crashes in the private vehicle are not as good predictors, although in the case of Local drivers the differences are statistically significant. The ratio of crash risk for those with prior crashes compared to those without crashes is 1.44. Private crashes are not predictive for OTR drivers.

National Driver Register

The National Driver Register (NDR), maintained in the National Highway Traffic Safety Administration (NHTSA), records information provided by the states on drivers who have had their licenses suspended or revoked. States vary in the minimum length of suspension which is reported to the NDR, with some states reporting suspensions as short as ten days and others reporting nothing shorter than a year (Waller et al., 1984). This register was queried because of the widespread contention that drivers of large trucks are more likely to carry multiple licenses.

Originally it was hoped that information from the NDR could be collated with information from state driver histories in such a way that all identifying information could be removed. In this way it would have been possible to conduct analyses based on total infractions within specified units of time (but not specific dates of infractions) to determine whether there were greater predictive relationships based on the more complete records. It was also hoped that the different driver groups could be compared on the basis of such analyses. A system was developed for linking the state data with the NDR and organizing the records into units that could be analyzed while deleting all identifying information.

However, because of the legal constraints under which the NDR operates, and possibly because of programming limitations, it was not possible to pursue this line of inquiry.

The information that was provided by the NDR consisted of a brief summary which appears in Table 11. It is difficult to say much about these data in the absence of more definitive information.

It should be noted that there is the potential for utilizing the NDR to address some of the pressing issues with which BMCS must contend while at the same time observing the important privacy restraints placed on the use of NDR information. However, for purposes of this study the NDR information needed to assist in evaluating the findings could not be made available.

Expert Panel Review

It was felt that it would be extremely useful to review the project findings with a small group of persons possessing firsthand knowledge of various facets of licensing and monitoring drivers of heavy trucks. A special review panel was convened, including representation from the Office of the Commissioner, the Driver License Section, and the Enforcement Section of the North Carolina Division of Motor Vehicles; the State Highway Patrol; owner-operators; the motor carrier industry; the Teamsters Union; the Bureau of Motor Carrier Safety; and the National Highway Traffic Safety Administration, as well as the UNC Highway Safety Research Center. Appendix F lists the participants in this one day meeting.

The findings from the project were reviewed briefly using a handout that summarized the study results. Possible countermeasures were then

discussed and modified, and additional recommendations were recorded from the participants. The discussion section of this report includes these recommendations.

Table 11. Driver License Revocation Information for Groups of North Carolina Class A Truck Drivers from the National Driver Register.

Group		Records Matched	%	Individuals Matched	%
NC Class A	N=140,693	3,475	2.47%	2,280	1.62%
Random Sample	N=1,004	26	2.59%	16	1.59%
Owner-Operator	N=672	14	2.08%	11	1.64%
Motor Carriers	N=893	6	0.67%	2	0.22%
Totals	143,262	3,521	2.46%	2,309	1.61%

Distribution of Matches by Violation

Reason for Withdrawl	Number of Matches	%
Driving While Intoxicated	1,500	42.60%
Blank Reason	475	13.49%
Repeated Violations	355	10.08%
Required Reports	298	8.46%
Violation of Responsibility	272	7.73%
Financial Responsibility	229	6.50%
Habitual Violators	169	4.80%
Misrepresentation	161	4.58%
Miscellaneous	20	.57%
Hit and Run	12	.34%
Reckless	11	.31%
Speeding	9	.26%
Disability	7	.20%
Fatality	1	.03%
Felony	1	.03%
Equipment misuse	1	.03%
Total	3,521	100.00%

SUMMARY AND RECOMMENDATIONS

This study examined the relationships between a driver's record in his private vehicle and his record driving a large truck. Its purpose was to determine whether and to what extent violations and crashes incurred while driving for private purposes are related to violations and crashes while driving for commercial purposes.

State driver history data from Washington state and North Carolina were analyzed. In addition, data on small groups of owner-operators and motor carrier drivers were examined.

The findings clearly show that there is a relationship between the record in the private vehicle and that incurred in employment related driving. However, the prior record in the commercial vehicle is a better predictor than either the record in the private vehicle or the total record including both private and commercial driving. It should be recalled that the relationships show, for example, that as the drivers' private vehicle driving record gets worse the corresponding employment related driving records also get worse, but very few drivers have very poor records in either case, as was shown in Figure 1. Thus, these relationships will generally not lead to the identification of a large groups of drivers having a high likelihoood of poor employment related driving.

Also of interest is the fact that, while reported annual mileage was associated with the occurrence of truck crashes, this relationship was not as strong as that between prior driving record and number of crashes. Drivers with clean records, regardless of mileage driven, have a much lower probability of having a truck crash than drivers with prior violations.

Driver age was related to driver record, with younger drivers having more truck crashes than older drivers. However, as in the case of mileage,

age was of less importance than prior record. Drivers with prior violations had a much higher probability of truck crashes than drivers with clean records regardless of age.

Because both labor and management report that after age 57 drivers are encouraged to discontinue over-the-road driving, some analyses focused on drivers age 58 and older. It was found that these drivers had a slight increase in probability of crash compared to drivers age 41-57, taking mileage and prior violations into account. However, the group age 58 and over had a lower probability of crash than the two younger age groups, namely, 30 and 31-40. Whether the record would have become progressively worse with increasing age cannot be determined from these analyses.

The major reservation about the findings from this study is the question of completeness of the records on which the analyses are based. It is generally accepted that truck drivers hold more than one license and thus spread offenses across several records. To the extent that this occurs, the relationships obtained could be a function of that practice. A driver with a single license would have all his violations and crashes on the one record, while a driver with several licenses would spread them across several records. Hence, the North Carolina record for the first driver would have many infractions for both time periods, while the North Carolina record for the second driver would have few. Analyses of the North Carolina records alone would show consistent relationships between the first and second time periods but would be based on incomplete data.

Hypothetical situations can similarly be presented which could cause spurious correlations between private and employment related driving records. For example, consider drivers who do most of their employment-related driving out of state and spend very little time in

their private vehicles in state. If accidents/violations occur at random then their private vehicle records should be relatively clean. Moreover, suppose most of their employment-related accidents/violations occur out of state and are not shown on the home state driver history file. As a result, their employment related records would appear to be relatively clean. These drivers then would tend to have positive correlations betweeen private and employment related records based on the incomplete data available on the home state record. Complete records, on the other hand, may not show any correlation.

Nevertheless, the consistency of the findings from one data base to the next suggests that the relationships may be reflecting real associations between past and future records. The fact that similar relationships have been found for drivers in general supports this interpretation. The motor carrier file with the supplemental data from the motor carrier records is probably the most complete file available for analysis, and the relationships found from the analysis are among the stongest in the the study.

A comparison of figures 10 and 12 shows that for local drivers the percent of drivers having one or more employment related violation in 1983-1984 was increased slightly when company records were combined with state records, but there was only one significant relationship with prior violations in either case. For OTR drivers the percent having employment related violations roughly doubled when company records were included. The significant relationships between these violations and prior employment and total violations remained about the same with a difference of about 10 to 15 percentage points between drivers with prior violations and those with none.

Thus, the inclusion of additional violation information (quite likely out of state violations for OTR drivers) did not produce any additional correlations but preserved and slightly strengthened those found using state data alone.

The situation was quite different with respect to employment related accidents included in motor carrier files but not on the state data tape. A comparison of figure 11 with figure 14 shows that many of the percentages increased dramatically when motor carrier data were included. This was especially true for local drivers. It is believed that many of the accidents contained in the motor carrier files but not on the state records involve relatively minor amounts of damage. Using the combined data stronger relationships between employment related accidents and prior accident are found, but the type of accidents being considered are not really the same as when state data alone are used.

In general, we see no evidence that weaker or no relationships would be found if the data were more complete. Indeed, there is some indication that the reverse may be true.

On the basis of the literature review, the results of the study analyses, and the input of the expert panel, the following recommendations are made:

1. There should be an interstate file of drivers of large trucks that includes computerized information on name, address, social security number, date of birth, race, and sex, as well as additional information in hard copy, e.g., photograph, thumb print, signature. The file should also include the home state of licensure where the complete driver history is maintained.

2. All states should report infractions of out-of-state drivers to the home state which in turn should make them a part of the driver record.

3. All states should check the interstate file before issuing a license to drive a large truck.

4. With the applicant's written consent, before hiring a driver the prospective employer should have speedy and affordable access to a complete driver record.

5. States should record on the driver history file the vehicle type in which violations and crashes occur so that performance in the private vehicle may be distinguished from performance in the truck.

6. A current medical certificate similar to that currently required by BMCS should be required for license to drive a tractor trailer, and this certification should be routinely checked upon state license issuance and renewal. The licensing program offers the best routine opportunity for checking medical certification of all tractor trailer drivers. Nebraska follows this practice with no apparent problems.

7. Routine renewal of license to drive a tractor trailer should be accompanied by a check of the National Driver Register (NDR). At the present time a driver may lose one license and be recorded on the NDR but still routinely renew license in another state with no inquiry of the NDR.

8. License to drive a tractor trailer should cost enough to cover the costs of administering a thorough license examination administered by a well trained examiner. Inquiry to the State of

North Carolina revealed that the cost of routine licensure to function as a plumber, electrician, real estate salesman, or photographer is considerably higher than that required to operate a tractor trailer or twin trailers. Table 12 includes a representation of such licenses and their corresponding costs.

9. State and local jurisdictions issuing citations to truck drivers should send a copy of the citation to the safety officer in the motor carrier for whom the driver works as well as to the home state. Current barriers to such a practice should be explored and, if possible, resolved.

A number of the recommendations were related to on-the-job monitoring. Although not all of these are directly related to the focus of this study, it was felt the information should not be lost so they are summarized below.

10. On-the-job monitoring can occur by the motoring public if each truck carries an identifying number and a toll free telephone number to call to report any complaints (or compliments). If drivers know they can be identified and held accountable for their on road performance whether or not official enforcement is present, it may encourage more consistent, conscientious, and courteous, as well as safe, driving.

11. On-the-job monitoring can occur through annual motor carrier review, with the driver, of both self reports and records from states in which the driver admits to holding license. At the present time, BMCS regulations require that the motor carrier annually review with the driver his record for the previous year. However, this review is usually achieved through self reports

from the drivers. Routine checking with the states should also be required. If warranted, a warning letter should be used as a backup to the review.

Table 12. Comparison of North Carolina Class A Driver license fee with other state licensing fees.

A. Selected license taxes from a "Partial List of State Privilege Licenses Due July 1st, 1985", Form KB-209 (Rev. 5-85).

License	Annual Fee	
Auto Dealers	$25.00 to $200.00	Based on town population
Bicycle Dealers	10.00 to 25.00	Based on town population
Undertakers	10.00 to 100.00	Based on town population
Plumbers, Electricians	7.50 to 40.00	Based on town population
Private Investigator	25.00	
Real Estate Salesman	25.00	
Peddlers		
On foot	10.00	
Fruits and vegtables not produced by seller	25.00	
Photographers	25.00	

From State Privilege Licenses for Year 1985
State of North Caolina
Department of Revenue
Raleigh, North Carolina

B. Driver license fee for issuance or reissuance of four year Class A license to operate large combination vehicles--$15.00, or $3.75 per year.

From Motor Vehicle Laws of North Carolina
State Division of Motor Vehicles
Revised througn Session Laws of 1983
Raleigh, North Carolina

2. On-the-job monitoring can occur through the establishment of driver councils (accident review boards) that routinely review

driver crashes to determine the degree of crash preventibility and take appropriate remedial actions. Peer review is probably not feasible in small companies that operate nationwide, but can be an effective tool in larger companies in which such councils have an opportunity to meet.

Some attention was also given to the potential benefits of using incentives, leading to the following recommendation:

13. Good driving could be encouraged through incentives, e.g., per mile safety bonus to be paid each quarter, increasing with increased quarters and doubled for the whole year. Fuel economy incentives, which likewise promote safety, could also be included.

Table 13 indicates whether the driver, motor carrier, or other (state or federal government) would likely be responsible for the costs associated with the recommendations presented.

Other issues addressed in the study include whether certain offenses, e.g., DWI, in the private vehicle should automatically disqualify a driver from driving interstate; whether BMCS should institute a point system whereby a driver reaching a certain threshhold is disqualified; what information a motor carrier should request from a driver applicant's former employer; and whether an employer should be required to conduct an annual check of state driver history records on each employee.

First, should certain offenses, such as DWI in a <u>private vehicle,</u> automatically disqualify a driver from driving under BMCS authority? Only the Washington data could address this question since vehicle type information was not available for the large North Carolina data base.

Table 13. Responsibility for Costs Associated with Recommendations

Recommendation	Responsibility for cost
Establishment and management of interstate file of drivers of large trucks. (1)	Other
Report infractions of out-of-state drivers to home state. (2)	Other
Record on driver history file vehicle type in which violations and crashes occur. (5)	Other
Check interstate file before issuance of license to drive a large truck. (3)	Other
Require check of the National Driver Register prior to renewal of license to drive a large truck. (7)	Other
Copies of citations issued to truck drivers (local and state) should be sent to safety officers of motor carriers. (9)	Other
Require current medical certificate for issuance and renewal of state license to drive a tractor trailer. (6)	Driver
License to driver a tractor trailer should cover costs of through examination by trained examiner.(8)	Driver
Prospective employer should have speedy and affordable access to complete driver history with applicant's written consent. (4)	Motor Carrier
On-the-job monitoring by the motoring public--truck carries identifying number and toll free number of motor carrier. (10)	Motor Carrier
On-the-job monitoring by motor carriers-- annual review using self reports and state driver history . (11)	Motor Carrier
On-the-job monitoring through accident review boards of peers (12)	Motor Carrier
Good driving encouraged through incentives --e.g., safety bonuses, fuel economy incentives. (13)	Motor Carrier

Washington data indicated that alcohol violations in the private vehicle in the first time period were not associated with crashes in the commercial vehicle in the second time period (Table 3). Data from North Carolina driver records indicated that total DWI violations (private and commercial) were positively correlated with commercial accident involvement (Table 8), but Washington driver records did not show this association (Table 4). The DWI offense was not as good a predictor of future crashes as were other violation types, e.g., speeding, possibly because of their larger numbers. Even so, because of the potential damage that a large truck can inflict, and because DWI clearly implies impaired performance, there are grounds for attaching more significance to this offense. It should be clearly stated, however that the data available to this study do not support the contention that if a driver is convicted of DWI in his private vehicle, he is likely to have a crash in a commercial vehicle.

Second, should BMCS institute a point system whereby drivers reaching a certain threshhold lose their right to drive under BMCS authority? The data clearly show that prior driving record is the best predictor of future driving record, independent of driver age or mileage driven. However, there is no clear cutoff point at which drivers become much worse. By far the largest differences are found between drivers with no prior convictions and those with one or more. The difference between zero convictions and one conviction is much greater than the difference between one conviction and two convictions. Likewise, the difference between one and two convictions is greater than the differences between two and three. It would not be feasible to disqualify drivers after one conviction, yet it should be remembered that any threshhold beyond one will not be greatly different from the threshhold just above or just below it.

This does not mean that a point system should not be invoked. Drivers with more prior convictions have more subsequent violations and crashes, but the increase in probability of future violations and crashes becomes smaller as the prior record becomes worse.

Third, what information should a motor carrier request from a driver applicant's former employer? A major difficulty in obtaining this kind of information is that prospective employees do not always divulge information on their former employers. However, when such information is provided, it would seem appropriate that the prospective employer at least check the reason for the employee leaving his former position. Other information that should be requested of course includes the driver's driving performance. However, the analyses in this study did not actually address the type of information prospective employers should seek from former employers.

Finally, should an employer be required to conduct an annual check on state records for each employee? Because it appears that driver records are related to future driving performance, it would be worthwhile for employers to conduct routine annual checks of the driver history records from all states in which an employee holds a license. Convictions should be reviewed with the driver with an eye toward identifying circumstances contributing to the infraction and possible ways to avoid their repetition in the future.

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APPENDIX A

Annotated Bibliography for

"The Relationship Between a Truck Driver's Performance in a Personal Vehicle and in a Large Truck"

Available Under Separate Cover

APPENDIX B

Categories of Violations

Speeding

DR below MIN speed
DR too fast Conditions
Fail Reduce Speed
Speeding
Speeding Truck
Speeding City Limits
Impeding Traffic

Moving

DR Left Lane
DR Yellow Line
Fail to Give Sign
Fail to Sound Horn
Fail to Dim Lights
Follow Fire Truck
Improper Turn
One-Way Street
Safe Movement Violation
Scratching Off
Improper Backing
Violation MV Law
Improper Signal
Safety Zone Violation
Following Too Closely
Improper Use Lane

Alcohol

Trans Intoxicants
DR while Intox
DUI-Warrant Served
BAC 0.10 or More
DUI of Drugs
DUI second offense

Stop

Fail Stop Siren
Fail Yield R/W
Running Red Light
Running Stop Sign
Stop Light Violation
Stop Sign Violation
Pass Stop School Bus

Reckless

Negligent Driving
Pass Yellow Line
Driving Wrong Side of Road
Hit/Run Prop Dam
Illegal Pass Curve
Illegal Pass Hill
Illegal Pass Inter
Reckless Driving
Illegal Passing
Hit and Run
Racing
Hit/Run Pers Inj
Invol Manslaughter
Manslaughter
Prearranged Racing
Conv. Death by Vehicle
Sp. to Elude Arrest
Assault with MV

APPENDIX C

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March 12, 1986

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APPENDIX D

Definitions of Requirements for License to Operate a Tractor Trailer in North Carolina and in Washington State

North Carolina

Class A Driver License. Entitles a licensee to drive any vehicle or combination of vehicles, exept motorcycles, including all vehicles under Classes "B" and "C". These include vehicles weighing over 30,000 pounds gross vehicle weight.

Washington state

WAC 308-100-020. Combination Motor Vehicles Requiring an Endorsement for their Operation. The director of the department of licensing hereby finds that all motor trucks and truck-tractors operated in combination with any semi-trailers or trailers, when such trailers are in excess of 5,000 pounts gross weight, require special operating skills by the drivers of those combination vehicles. All persons driving such combination vehicles must secure from the department of licensing an endorsement on their driver's licenses designated as Combination.

APPENDIX E
Motor Carrier Data Collection Form

Coder _____ (initials) Company _____ Date _____ (Month Day)

Name _____ (Last) (First) (Middle)

Employee identification number _____

Address _____

City _____ State _____ ZIP _____

DOB ___ ___ ___ (MM DD YY) SSN ___-___-____ Race ___ Sex ___

Drivers license: State ___ Number _____

Date of initial employment _____

Truck driver type _____ **RD**: road driver, **LD**: local

Layoff _____ **I**nfrequent: 0-6 months **F**requent: over 6 months

No.	Event Type	Date (MMDDYY)	STate	Vehicle Type	Crash Type	Preventibility	Violation
1							
2							
3							
4							
5							
6							
7							
8							
9							
10							
11							
12							

Crash
Violation
Both

Large Truck
Small truck
Company veh
Personal
Other

Single
Multiveh
Not appl.
Unknown

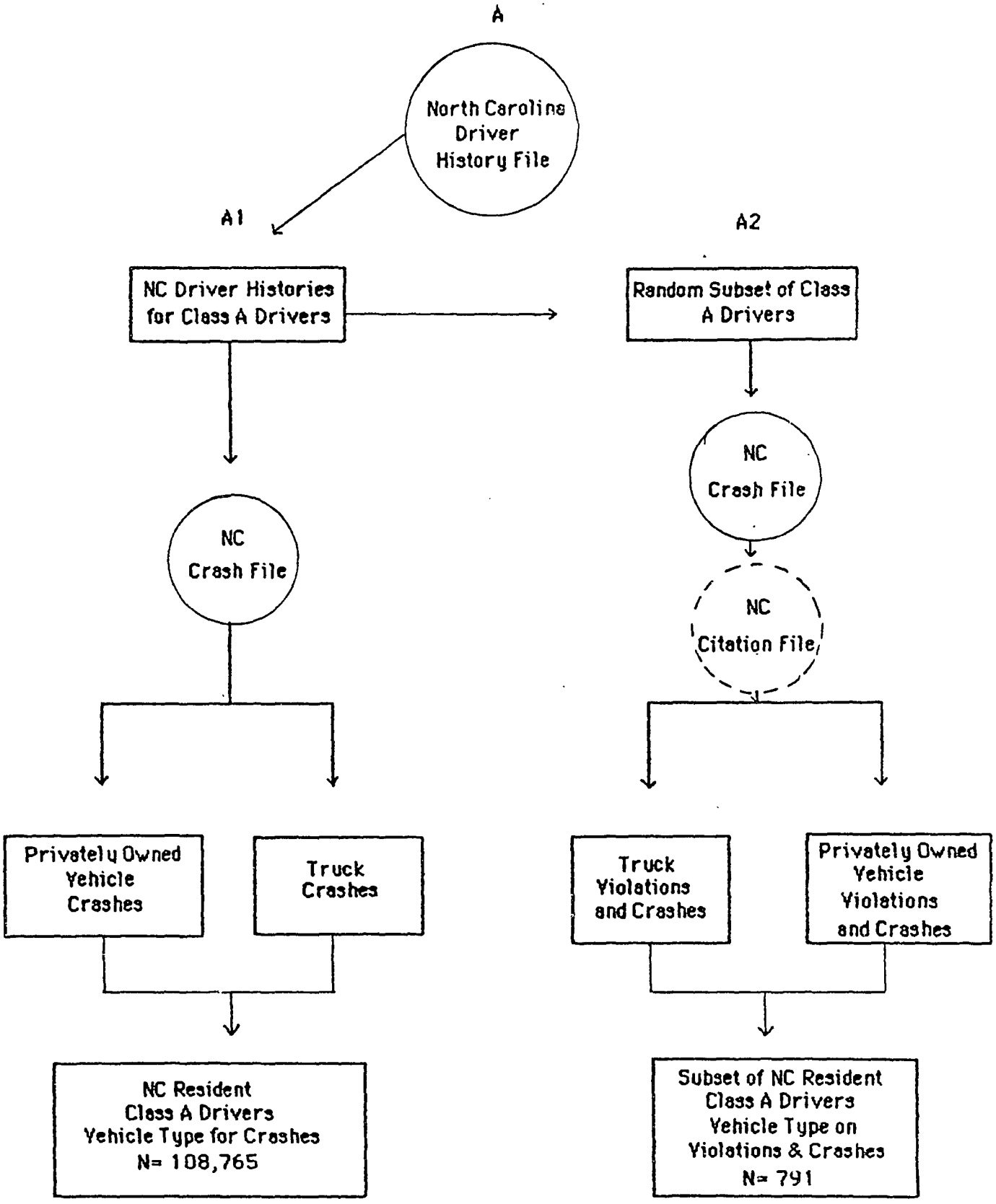
Preventable
Not preventable
Unknown

NA Not appl.
UNknown

SP eeding
MO ving
ST opped
RE ckless
AL cohol
SA fe movement
YI eld
AD ministrative
OTher (explain)

Comments

APPENDIX F
Study Populations



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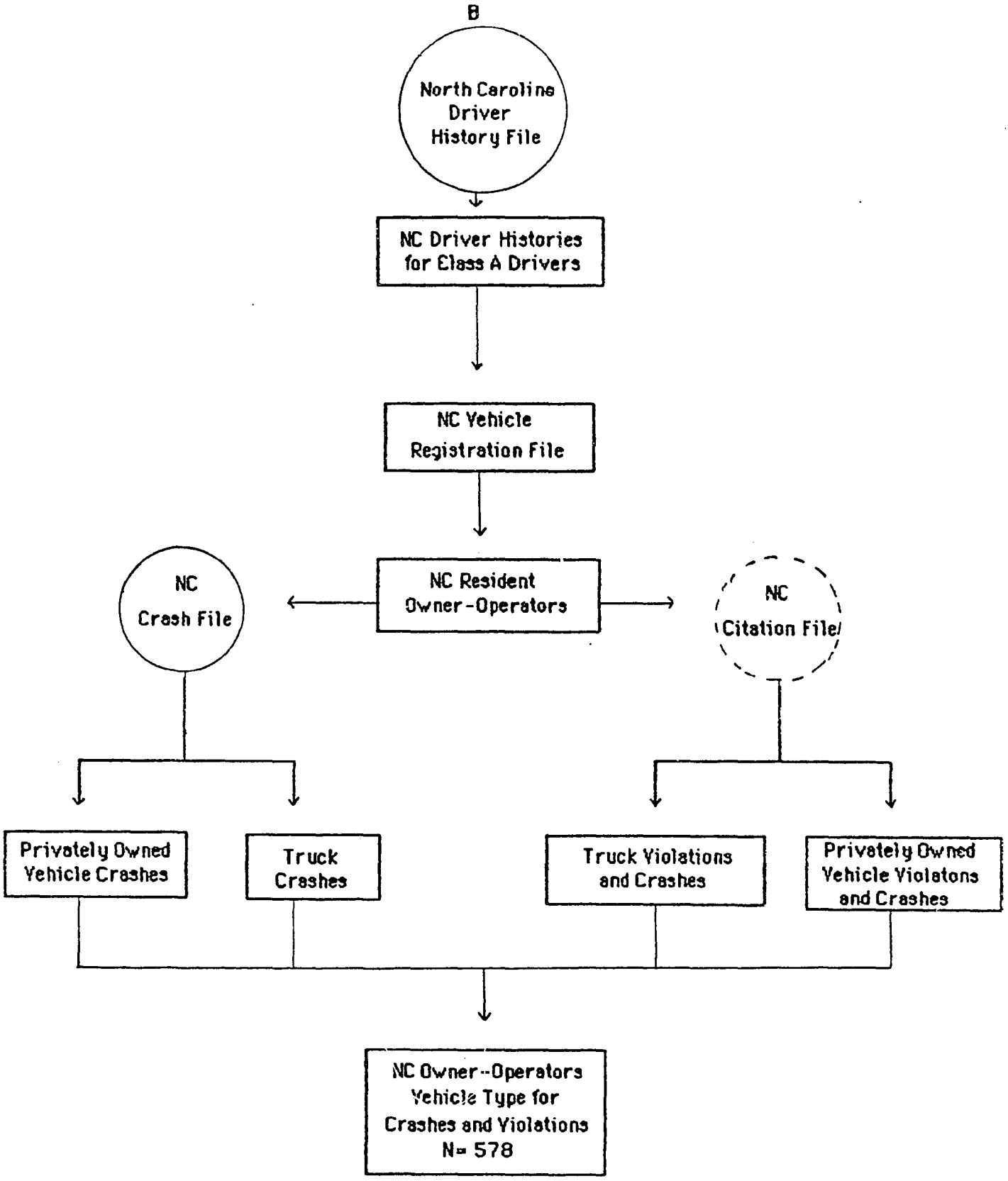
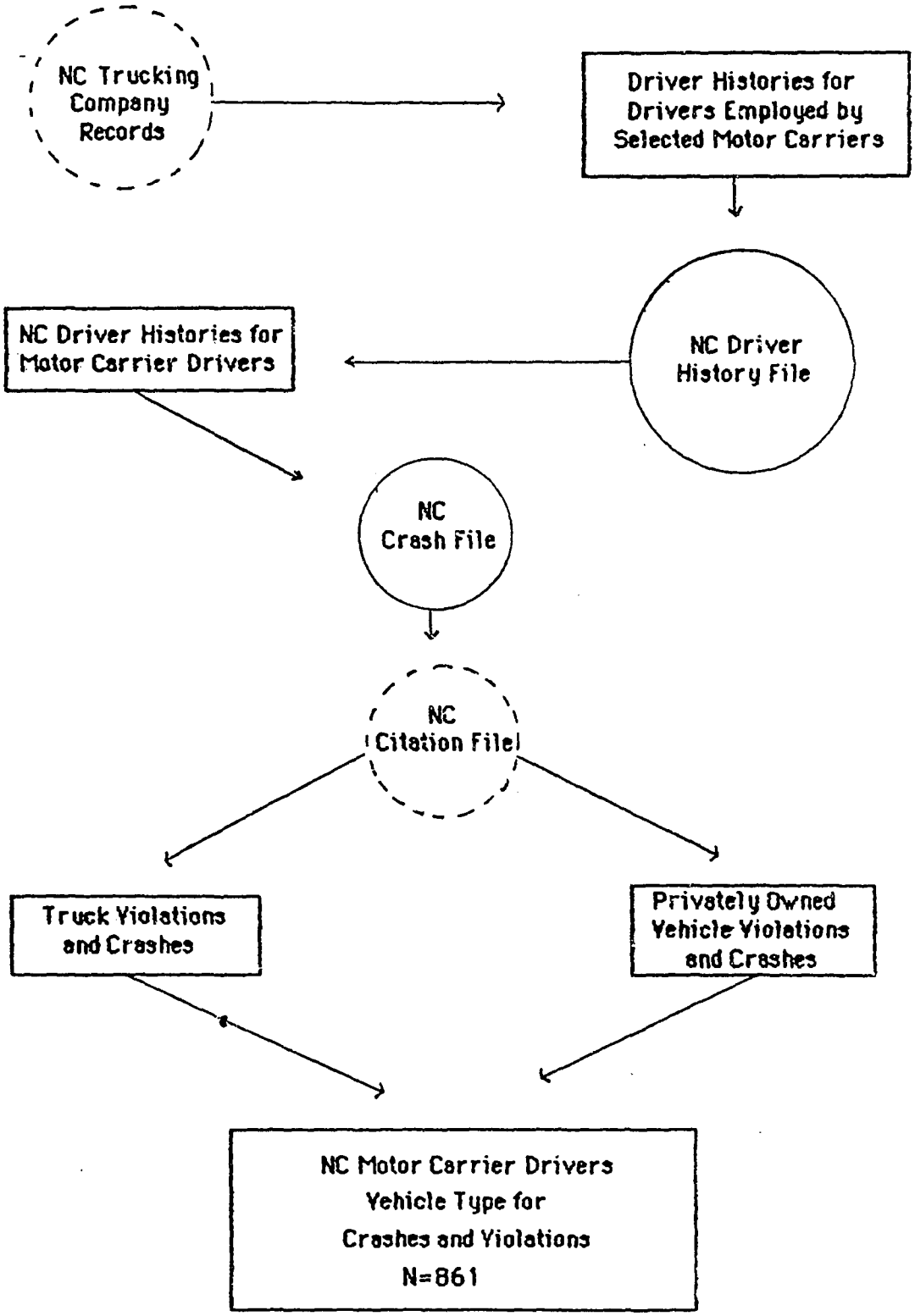

B
North Caroline Driver History File
NC Driver Histories for Class A Drivers
NC Vehicle Registration File
NC Crash File
NC Resident Owner-Operators
NC Citation File
Privately Owned Vehicle Crashes
Truck Crashes
Truck Violations and Crashes
Privately Owned Vehicle Violatons and Crashes
NC Owner--Operators Vehicle Type for Crashes and Violations N= 578

C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Driver Histories for Drivers Employed by Selected Motor Carriers
NC Driver History File
NC Driver Histories for Motor Carrier Drivers
NC Crash File
NC Citation File
Truck Violations and Crashes
Privately Owned Vehicle Violations and Crashes
NC Motor Carrier Drivers
Vehicle Type for
Crashes and Violations
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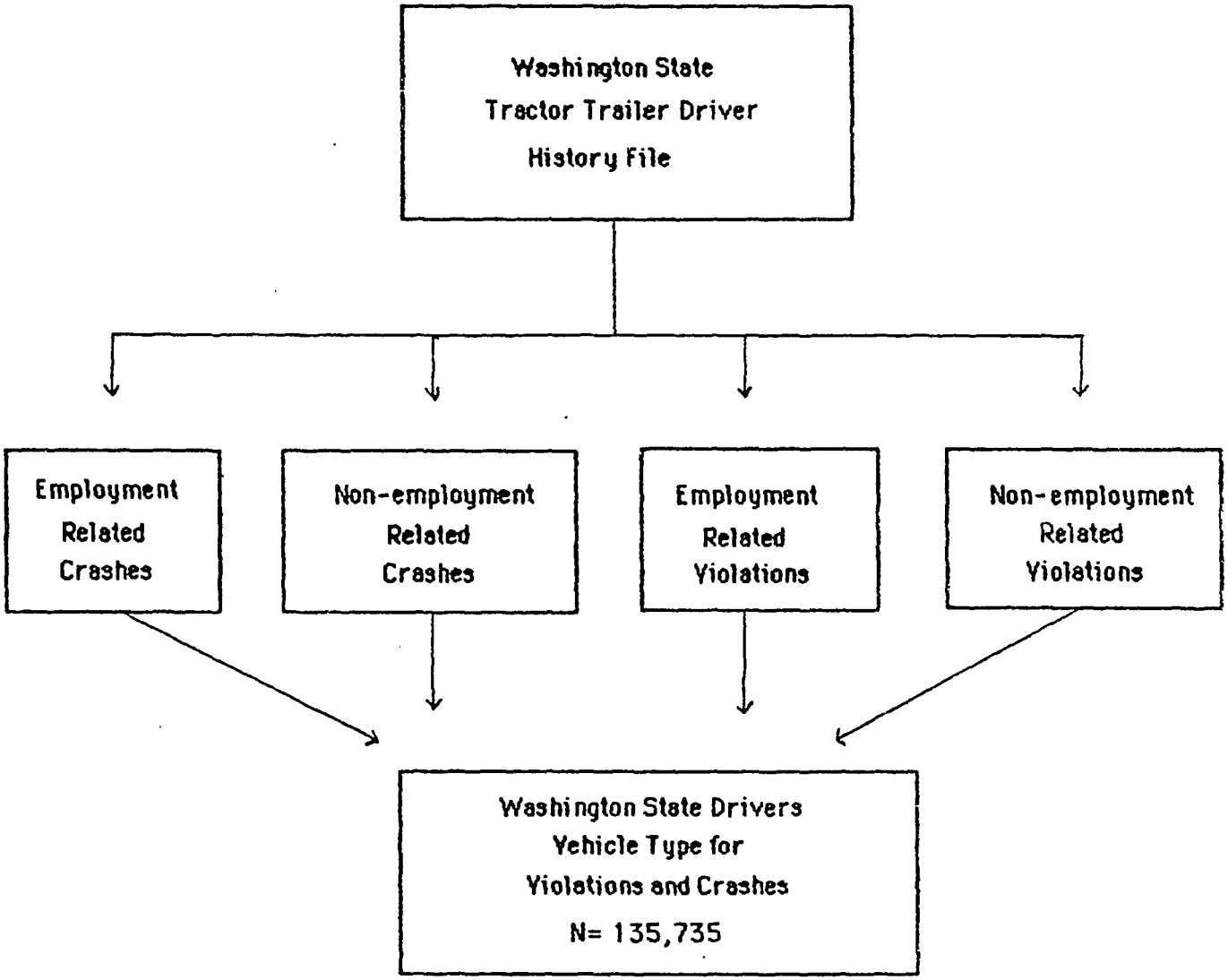
Washington State
Tractor Trailer Driver
History File
Employment
Related
Crashes
Non-employment
Related
Crashes
Employment
Related
Violations
Non-employment
Related
Violations
Washington State Drivers
Vehicle Type for
Violations and Crashes
N= 135,735