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STATISTICAL EVALUATION OF THE EFFECTIVENESS OF FEDERAL MOTOR VEHICLE SAFETY STANDARD 207: SEAT BACK LOCKS (ONLY)

Report No. 3 of 7

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CONTRACT TECHNICAL MANAGER'S ADDENDUM

Prepared for the National Highway Traffic Safety Administration in support of a program to review existing regulations, as required by Executive Order 12044 and Department of Transportation Order 2100.5. Agency staff will perform and publish an official evaluation of Federal Motor Vehicle Safety Standard 207 based on the findings of this report as well as other information sources. The values of effectiveness and benefits found in this report may be different from those that will appear in the official Agency evaluation.

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16. Abstract

This is the final report on the statistical evaluation of Federal Motor Vehicle Safety Standard (FMVSS) 207: Seat Back Locks (Only). It is one of seven statistical evaluations conducted under this contract. The seven Standards are:

1. FMVSS 108: Side Marker Lamps (Only)
2. FMVSS 202: Head Restraints
3. FMVSS 207: Seat Back Locks (Only)
4. FMVSS 213: Child Restraints
5. FMVSS 214: Side Door Beams
6. FMVSS 222: School Bus Seating and Crash Protection
7. FMVSS 301: Fuel System Integrity

FMVSS 207 is a death-and-injury-reduction Standard which requires a self-locking restraining device for folding seats and seat backs, that must meet specified static load tests. The Standard became effective 1 January 1968.

More than 600,000 cases of driver involvement in frontal collisions were analyzed using mass accident data from Texas (1972-1974), New York (1974) and North Carolina (1973-1975). Contingency table data were subjected to log-linear modeling and adjustment to minimize potential confounding effects and allow direct comparison of injury rates between drivers of 2-door and 4-door cars. The results of the analyses do not support the hypothesis that the introduction of seat back locks in 2-door passenger cars reduces the injury risk to drivers in these cars.

While the analysis was not completely successful in removing all confounding effects, it can be inferred that the effect of seat back locks on driver injury risk, if any, is amall and very difficult to quantify, given the potential for confouncing effects from the implementation of other Standards and the possible interactive effects between vehicle body style and weight and driver characteristics.

The question of possible rear seat occupant entrapment in accidents involving fire and/or explosion or immersion was very clearly settled by the analysis of FARS data. The results successfully demonstrated that any negative effect due to entrapment is far outweighed by the beneficial effect of a rigid seat back confining rear seat passengers to the rear area during a collision.

A brief, limited study of computerized NCSS data from April 1978 through 1979 was conducted to study data on driver injury and seat failure. The data indicated that the likelihood of fatal or critical injury is about five times greater given seat failure. Conversely, the probability of escaping any injury is about three times higher with no seat failure, compared to cases of seat failure. However, the NCSS-derived seat failure rates for Post-Standard cars were not lower than those for Pre-Standard cars.

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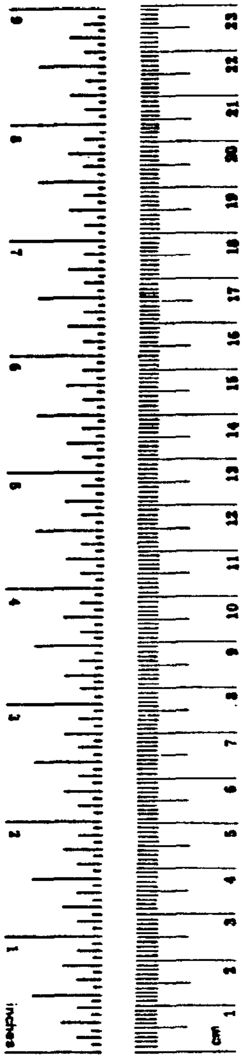
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

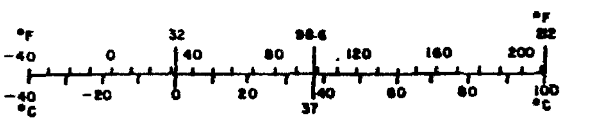
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in ≡ 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



EXECUTIVE SUMMARY

This is the Final Report of the statistical evaluation of the effectiveness of Federal Motor Vehicle Safety Standard (FMVSS) 207: Seat Back Locks (Only).

FMVSS 207 is a death-and-injury reduction Standard which requires a self-locking restraining device for folding seats and seat backs, that must meet specified static load tests. The Standard became effective 1 January 1968.

The principal objective of this analysis is to determine if the effects of seat back locks on injury avoidance can be determined from statistical analyses of existing mass accident data from Texas (1972-1974), New York (1974) and North Carolina (1973-1975). A total of over 600,000 cases of driver involvement in frontal collisions are analyzed. Only domestic vehicles of known body style, make-model and model year that were involved in single vehicle or two-vehicle accidents were included.

Other objectives are (1) to analyze the fatality rate of front and rear seat occupants using Fatal Accident Reporting System (FARS) data, to determine whether seat back locks increase the possibility of rear seat occupants being trapped and killed in panic situations where quick emergency exit from the car is required and (2) to analyze a limited computerized portion of National Crash Severity Study (NCSS) data on seat failure and injury.

The purpose of these evaluations is to provide a better understanding of the effects of seat back locks on deaths and injury severity. The basic measure of effectiveness is defined as follows:

$$\left[\begin{array}{c}\text{Effectiveness}\\ \text{of Seat Back}\\ \text{Locks}\end{array}\right] = \left[1 - \left\{\frac{\text{Injury Rate for Drivers of Post-Standard, 2-Door Cars}}{\text{Injury Rate for Drivers of Pre-Standard, 2-Door Cars}} \times \frac{\text{Injury Rate for Drivers of Pre-Standard, 4-Door Cars}}{\text{Injury Rate for Drivers of Post-Standard, 4-Door Cars}}\right\}\right] \times 100$$

Thus, effectiveness is measured by computing the percent difference between the Pre- to Post-Standard ratio of injury rates for drivers of 2-door and 4-door cars, respectively. This effectiveness measure is formulated with the realization that 4-door cars received the same modifications (which were mandated by other Standards that went into effect at about the same time as FMVSS 207) as were made in 2-door cars, except the seat back lock. Thus, by looking at the changes in injury distributions of drivers of 2-door cars before and after the implementation of the Standard and comparing this with the analogous data for drivers of 4-door models, one can expect to assess the impact of the Standard on injury reduction. In effect, the 4-door vehicles are being treated as a control group.

Before effectiveness values were computed, the data were smoothed by fitting hierarchical, log-linear models to contingency tables composed of the variables Injury, PrePost, Vehicle Body Style (2-door or 4-door) and selected control variables for each state-year of data. Three distinct injury dichotomies were used: KA vs. BCO, KAB vs. CO and KABC vs. O. Modeling served the dual purpose of smoothing the data by removing random variability due to small cell frequencies, and of revealing the strength and pattern of various interactions among the variables comprising the contingency tables.

The smoothed data were then adjusted (standardized) to allow for the direct comparison of injury rates. Adjustment of the data was necessary in order to insure that the overall effectiveness estimates were not affected by different distributions of Pre- and Post-Standard, 2-door and 4-door vehicles across different levels of control variables. On the average, the net impact of modeling and adjustment was to increase the value of effectiveness estimates by roughly two to three percent, while slightly reducing the variability of these estimates.

The results of the analyses--shown in the table below--do not support the hypothesis that the introduction of seat back locks in 2-door passenger cars reduces the injury risk to drivers in these cars. That is, the results do demonstrate that this aspect of the Standard has not been significantly effective in reducing injury on a broad basis.

OBSERVED EFFECTIVENESS* OF SEAT BACK LOCKS
IN STATE ACCIDENT DATA, FRONTAL CRASHES

State	Year	KABC vs O		KAB vs CO		KA vs BCO	
		Effectiveness	Standard Deviation	Effectiveness	Standard Deviation	Effectiveness	Standard Deviation
Texas	1972	-1.6 %	2.9 %	-1.3 %	3.5 %	4.9 %	6.1 %
	1973	-0.7	2.9	-3.5	3.6	-12.7	7.6
	1974	-8.3	3.4	-10.3	4.3	1.9	7.7
New York	1974	-7.2	3.1	-12.1	4.4	-17.9	8.9
North Carolina	1973	-7.9	6.8	-3.7	8.8	-44.4	23.5
	1974	-14.6	7.4	-19.9	10.6	-19.0	20.9
	1975	5.6	6.0	14.9	7.5	26.5	13.7

*See effectiveness formula on page v.

While the analysis was not completely successful in removing all confounding effects, it is reasonable to infer that the effect of seat back locks on driver injury risk, if any, is small and very difficult to quantify, given the potential for confounding effects from the implementation of other Standards, the steady increase in sales of 2-door cars (and the corresponding decrease in 4-door car sales) since 1966, vehicle weight differences among 2-door and 4-door cars, and potential differences of age, sex, socioeconomic and personality factors between drivers of 2-door and 4-door cars.

The question of possible rear seat occupant entrapment in accidents involving fire and/or explosion or immersion was also examined by testing the hypothesis that the presence of seat back locks increases the probability of rear seat occupants of 2-door, Post-Standard cars being killed as a result of their being trapped by the seat back lock in panic situations. Empirically, this "trapping" effect was defined as:

$$\left[\begin{array}{c}\text{Trapping}\\ \text{Effect}\end{array}\right] = \left[\left\{\frac{\text{Fatality Rate for Occupants of Post-Standard, 2-Door Cars}}{\text{Fatality Rate for Occupants of Pre-Standard, 2-Door Cars}} \times \frac{\text{Fatality Rate for Occupants of Pre-Standard, 4-Door Cars}}{\text{Fatality Rate for Occupants of Post-Standard, 4-Door Cars}}\right\} - 1\right] \times 100$$

Results obtained from 1975-1978 FARS data indicate that there is an estimated 19 percent decrease in the Pre- to Post-Standard ratio of *rear seat* occupant fatality rates corresponding to 2-door, Post-Standard vehicles. It can be speculated that any potential adverse effect due to entrapment is outweighed by the beneficial effect of a rigid seat back which acts as a restraint on the forward movement of rear seat passengers in a crash, thus reducing the likelihood of serious or fatal injury. In any event, the data do not support the hypothesis that seat back locks increase fatalities due to their trapping effect.

A brief, limited study of computerized NCSS data from April 1978 through 1979 was conducted to study data on driver injury and seat failure. Here, seat failure refers to seat deformation as well as failure of the seat adjuster, seat track or seat back locks. The data indicated that the likelihood of fatal or critical injury is about five times greater given seat failure; the probability of escaping any injury is about three times higher with no seat failure, compared to cases with seat failure. NCSS-derived seat failure rates for Post-Standard cars, however, were not lower than those for Pre-Standard cars.

ACKNOWLEDGMENTS

The work performed by CEM in statistically evaluating the effectiveness of seven Federal Motor Vehicle Safety Standards is the product of an interdisciplinary team effort.

Dr. Gaylord Northrop is the Principal Investigator of this project, and participated in the development and implementation of the approach and the analyses of the results. Mr. John Ball and Mr. Jim Knoop are the principal authors of this report. Mr. Edward Sweeton contributed to the computer processing and analysis.

Other members of the Study Team who contributed in various ways to the report include:

Ms. Kayla Costenoble
Mr. Thomas Bzik
Dr. Hans Joksch
Mr. Joseph Reidy
Dr. Michael Sutherland
Dr. Brian Hickie

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This study has benefitted throughout from the detailed reviews and constructive comments of the NHTSA Contract Technical Manager, Dr. Charles Kahane. Any errors in analysis or interpretation of data and results are, of course, solely the responsibility of the authors of this report.

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ABBREVIATIONS USED

FMVSS	Federal Motor Vehicle Safety Standard
CEM	The Center for the Environment and Man, Inc.
HSRC	Highway Safety Research Center
FARS	Fatal Accident Reporting System
NHTSA	National Highway Traffic Safety Administration
TAD	Traffic Accident Data Vehicle Damage Scale
KABCO	"K" Killed; "A", "B", "C" Injury Levels; "O" No Injury
BMDP	Biomedical Computer Programs
NCSS	National Crash Severity Study
AIS	Abbreviated Injury Scale
SAE	Society of Automotive Engineers

1.0 INTRODUCTION

1.1 Background

This report is the third in a series of Task 3 Final Reports on the statistical evaluation of the effectiveness of seven Federal Motor Vehicle Safety Standards (FMVSS). This work has been conducted under Contract DOT-HS-8-02014 by The Center for the Environment and Man, Inc. (CEM) and its subcontractor, The Highway Safety Research Center (HSRC) of the University of North Carolina. The seven FMVSS statistically evaluated are:

- FMVSS 108: Side Marker Lamps (Only)
- FMVSS 202: Head Restraints
- FMVSS 207: Seat Back Locks (Only)
- FMVSS 213: Child Seating Systems
- FMVSS 214: Side Door Beams
- FMVSS 222: School Bus Seating and Crash Prevention
- FMVSS 301: Fuel System Integrity

The statistical evaluation of the effectiveness of FMVSS 207 (Seat Back Locks only) is presented in this report. Previous work is described in [1] and [2].

FMVSS 207 originally went into effect on 1 January 1968, at which time it was applicable to passenger cars only. The Standard was basically adapted from the Society of Automotive Engineers (SAE) Recommended Practice J879 which originally appeared in November 1963. The major impact of the Standard was that it required a self-locking restraint device for folding seats and seat backs. In fact, the introduction of seat back locks was the only apparent change made by the manufacturers in response to FMVSS 207. The application of the Standard was extended to multipurpose passenger vehicles, trucks and buses as of 1 January 1972. At this time, additional requirements and specifications were added to the Standard, including the proviso that the seat remain in its adjusted track position during load application. In addition, various aspects of the Standard were clarified and restructured.

The general requirements of FMVSS 207 are listed below. They apply to passenger cars, multipurpose passenger vehicles, trucks and buses.

1. Each occupant seat, with the exception of folding auxiliary jump seats and side facing seats, must be able to withstand specified loads in forward and rearward longitudinal directions. These loads include an amount equal to 20 times the weight of the seat and a load equal to a 3300 inch pound moment about a defined seating reference point. The seat must remain in its adjusted position during the application of each force.
2. With the exception of a passenger seat in a bus or a seat having a back that is adjustable only for the comfort of its occupants, hinged or folding seats or seat backs must

be equipped with a self-locking restraining device. Each device must have a release control. The device must not release or fail when:

- A force of 20 times the weight of the seat back is applied through the center of gravity of a forward facing seat back, or
- A force of 8 times the weight of the seat back is applied through the center of gravity of a rearward facing seat back.

Additionally, the restraining device must not release or fail when subjected to an acceleration of 20 g.

3. The control for releasing the restraining device must be readily accessible to the seat occupant. It must also be readily accessible to any occupant in a seat immediately to the rear.

4. Seats that are not designated for occupancy while the motor vehicle is in motion must be conspicuously labeled to that effect.

There are two important factors related to the evaluation of the effectiveness of FMVSS 207 which should be noted:

1. Between the model years MY 66 and MY 72 there was a significant shift in sales from 4-door to 2-door cars (see Table 3-1, page 3-2). This trend must be taken into account in the evaluation of FMVSS 207. Possible implications of this market shift are discussed when appropriate in Section 3.1.

2. FMVSS 207 and many other Standards were applied nearly simultaneously during the late 1960's. It is not immediately obvious as to how to distinguish between the effects of one Standard and another; for example, FMVSS 207 (Seat Back Locks, Only) and FMVSS 202 (Head Restraints) may possibly have related effects. It is conceivable that there is a relation between these two Standards which influences possible effectiveness. In the evaluation of FMVSS 207, it is assumed that the other Standards are equally effective on 2-door and 4-door cars. FMVSS 207 (Seat Back Locks, Only) applies to 2-door passenger vehicles. Thus, in the evaluation of seat back restraints, 4-door cars may be regarded as a "control group." There is the possibility that if another Standard or industry-introduced safety measure had a significantly different effect in 2- and 4-door cars in frontal crashes, it may act as a confounding influence on the evaluation of the Standard. For example, General Motors and Chrysler introduced collapsible steering columns in 1967, and Ford modified the steering wheel in 1967 and introduced collapsible columns in 1968. The effects of collapsible columns may be different in 2-door and 4-door vehicles and also ultimately related to the presence of seat back locks in the 2-door vehicles (at least as far as driver injuries are concerned). Possible confounding factors on the evaluation of the Standard are discussed in Section 3.1.3.

1.2 Objective and Purpose

The principal objective of this analysis is to determine if any effects of seat back locks on fatalities and injury avoidance can be determined from the statistical analyses of mass accident data from:

- Texas 1972-1974
- North Carolina 1973-1975
- New York 1974.

Other objectives are (1) to analyze the fatality rate of front and rear seat occupants, using the Fatal Accident Reporting System (FARS) data, to determine whether the presence of seat back locks increases the possibility of rear seat occupants being trapped and killed in panic situations where quick exit from the car is required, and (2) to analyze National Crash Severity Study (NCSS) accident data on seat failure and driver injury.

1.3 Scope of Analysis

- The analysis of the effects of seat back locks on injury avoidance is primarily concerned with fatalities and injuries to drivers.
- In injury avoidance evaluation the statistical analyses rely on a comparison of 2-door and 4-door Pre- and Post-Standard cars.
- Mass accident data from Texas (3 years), North Carolina (3 years) and New York (1 year) are used.
- The analysis of the effects of seat back locks on rear seat occupant fatalities uses the FARS data for the years 1975 through 1978.
- The analysis of driver injury and seat failures uses NCSS computerized accident data from April 1, 1978 through 1979.

1.4 Approach

The statistical evaluation of the effects of FMVSS 207 is here limited to three specific studies:

1. Injury Analysis for Seating Systems, Using State Accident Data.
2. Rear Occupant Fatality Analysis, Using FARS Data.
3. NCSS Data on Driver Injury and Seat Failure.

The first and major study is concerned with determining if the self-locking seat back devices are an important deterrent to fatalities and injuries of drivers. The second study deals with assessing whether the seat back locks may trap rear seat passengers in severe accidents and increase the risk of death to rear passengers in 2-door cars. The third study briefly reviews limited computerized NCSS data on driver injury and seat failure.

The hypothesis investigated in the first analysis is that drivers of 2-door cars will benefit from reduced injuries in frontal collisions by having the seat back fixed, rather than free to dynamically rotate forward, thus forcing the driver and the passenger(s) into the steering wheel and/or dash panel in front of them. Because there were many other injury reducing Standards introduced at approximately the same time as FMVSS 207, as well as various changes in the vehicles and in sales trends, it is assumed that the degree to which seat back locks are effective can be determined by comparing the difference in the changes of injury rates between 2-door cars and 4-door cars before and after the implementation of FMVSS 207. Specifically, one would expect drivers in 2-door cars to have a slightly greater injury reduction than drivers in 4-door cars, if, in fact, the seat back locks are effective. However, two factors deserve mention at this point. First, the analysis is restricted to drivers in frontal collisions only. Second, if other FMVSS were differentially applied or had significantly greater effectiveness in 2-door or 4-door cars, then any difference in the reduction of injury rates could be attributed to these factors as well as to the presence of seat back locks.

The rear occupant fatality analysis considers the possibility of rear seat occupants becoming trapped due to the inability to release seat back locks in panic-producing situations such as post-crash fires or immersion, where quick exit is essential. It would appear from the analysis that trapping is not an important effect; rather, seat back locks appear to have a beneficial effect of containing rear seat occupants in the rear seat area during a collision and preventing them from being projected into the front seat area, where they might strike objects after having gained momentum.

1.5 Limitations of the Study

This study does not provide a measure of the overall effectiveness of all aspects of FMVSS 207. It is limited to a consideration of the effects of the self-locking restraining devices for folding seat backs in 2-door passenger cars.

As was pointed out previously, seat back locks were introduced in the model years 1967-1968 in 2-door cars. Seat back locks are the only requirements mandated by FMVSS 207 which do not apply to 4-door cars as well and, hence, the Pre- and Post-Standard 4-door vehicles may be regarded as a control group in the evaluation of seat back locks.

It should also be noted that the other major aspect of FMVSS 207, specifications for seating system strengths, would be difficult to evaluate for two reasons. First, it appears unlikely that the strength of seating systems has changed significantly over the past 30 years. Second, unlike seat back locks, these specifications apply equally to both 2-door and 4-door vehicles.

1.6 Outline of the Report

Section 2 of this report summarizes the analyses performed in the evaluation of the effectiveness of FMVSS 207 with regard to seat back locks. It includes a discussion of the measure of effectiveness; the estimated effectiveness of the Standard; confidence limits on the estimated effectiveness; overall success of the evaluation and the credibility of the analysis. Also included in Section 2 are various comparisons of results and the final conclusions, findings and recommendations obtained from the analysis.

In Section 3, the detailed analyses of the data are described. The Appendices include relevant data in the form of completely cross-classified tables (Appendix A), and a complete description of resultant models (Appendix B) for the Texas, New York and North Carolina accident data samples, as well as effectiveness results for observed unadjusted data (Appendix C) and a description of the effectiveness computations and error estimation procedure (Appendix D).

1.7 References for Section 1

1. Ball, J.T., J.C. Reidy and G.M. Northrop. *Final Design and Implementation Plan for Evaluating the Effectiveness of FMVSS 202: Head Restraints, and FMVSS 207: Seating Systems*, DOT HS 803 392, National Technical Information Service, Springfield, Virginia, 1977.

2. Northrop, G.M., J.T. Ball, D. Bancroft and J.C. Reidy. *Methodologies for Nine Federal Motor Vehicle Safety Standards: FMVS 105, 108, 122, 202, 207, 213, 221, 222*, DOT HS 803 388, National Technical Information Service, Springfield, Virginia, 1977.

2.0 SUMMARY OF ANALYSES PERFORMED FOR FMVSS 207

2.1 Measures of Effectiveness

The effectiveness measure used for evaluating the effects of seat back locks on driver injury is defined as follows.

$$\begin{bmatrix}\text{Effectiveness} \\ \text{of Seat Back} \\ \text{Locks}\end{bmatrix} = \left[1 - \left\{\frac{\text{Injury Rate for Drivers of Post-Standard, 2-Door Cars}}{\text{Injury Rate for Drivers of Pre-Standard, 2-Door cars}} \times \frac{\text{Injury Rate for Drivers of Pre-Standard, 4-Door Cars}}{\text{Injury Rate for Drivers of Post-Standard, 4-Door Cars}}\right\}\right] \times 100$$

The question of possible rear seat occupant entrapment in accidents involving fire and/or explosion or immersion was also examined by testing the hypothesis that the presence of seat back locks increased the probability of rear seat occupants of 2-door, Post-Standard cars being killed as a result of their being trapped by the seat back lock in panic situations. Empirically, this "trapping" effect was defined as:

$$\begin{bmatrix}\text{Trapping} \\ \text{Effect}\end{bmatrix} = \left[\left\{\frac{\text{Fatality Rate for Occupants of Post-Standard, 2-Door Cars}}{\text{Fatality Rate for Occupants of Pre-Standard, 2-Door Cars}} \times \frac{\text{Fatality Rate for Occupants of Pre-Standard, 4-Door Cars}}{\text{Fatality Rate for Occupants of Post-Standard, 4-Door Cars}}\right\} - 1\right] \times 100$$

Positive values indicates that a trapping effect may be occurring.

2.2 Estimated Effectiveness of FMVSS 207

FMVSS 207 applies to passenger cars, multipurpose passenger vehicles, trucks and buses. The main impact of the Standard was to require a self-locking restraining device for folding seats and seat backs. Other requirements relate to the strength of seats and seat track devices. Because seat back locks were installed on two-door passenger cars generally in the 1968 model year, the analysis basically focuses on the change in the frequency of injury to drivers of two-door cars between Pre-Standard and Post-Standard models. Secondary investigations (1) study the possibility of increased fatalities of rear seat passengers due to being trapped and (2) analyze NCSS data on seat failures. The major analysis springs from the hypothesis that with seat back locks in a frontal collision, (a) the front seat passenger will not have an additional load or impact from the seat back, and (b) items in the back seat, particularly passengers, will not be thrown against the front seat passengers. The second analysis stems from speculation that seat back lock releases are sometimes difficult to locate and operate, especially in panic situations, and may "trap" rear seat passengers, which would be extremely dangerous in situations where fire, explosion or immersion is a post-crash event. The third study is a very limited investigation of the association of driver injury with the failure of seat back locks and other aspects of seat failure using NCSS data.

2.2.1 Effectiveness of FMVSS 207 in Reducing Driver Injuries

The effectiveness of seat back locks for reducing the injury risk of drivers in 2-door passenger cars involved in frontal collisions was evaluated using mass accident data as summarized in Table 2-1. Thus, the effectiveness results are based on more than 600,000 cases from Texas, New York and North Carolina, covering seven state-years of accident data.

TABLE 2-1

MASS ACCIDENT DATA USED TO EVALUATE THE EFFECTIVENESS OF SEAT BACK LOCKS

State	Year	Sample Size	Total
Texas	1972	156,943	
	1973	158,897	459,228
	1974	143,388	
New York	1974	65,593	65,593
North Carolina	1973	27,345	
	1974	26,707	82,463
	1975	28,411	
Total Cases			607,284

Before effectiveness values were computed, the data were smoothed by fitting hierarchical, log-linear models to contingency tables composed of the variables Injury, PrePost, Vehicle Body Style (2-door or 4-Door) and selected control variables for each state-year of data. Three distinct injury dichotomies were used: KA/BCO, KAB/CO and KABC/O. Modeling served the dual purpose of smoothing the data by removing random variability due to small cell frequencies, and of revealing the strength and pattern of various interactions among the variables comprising the contingency tables.

The smoothed data were then adjusted (standardized) to allow for the direct comparison of injury rates. Adjustment of the data was necessary in order to insure that the overall effectiveness estimates were not affected by different distributions of Pre- and Post-Standard, 2-door and 4-door vehicles across different levels of control variables.

The effectiveness results obtained are summarized in Table 2-2 and Table 2-3 for observed, unadjusted mass accident data and smoothed, adjusted data, respectively. Effectiveness percentages are given together with an associated standard deviation and confidence interval for three injury dichotomies (KA/BCO, KAB/CO and KABC/O) for each state and year analyzed.* On the average, the net impact of modeling and adjustment was to increase the value of effectiveness estimates by roughly two to three percent.

The effectiveness values computed for the smoothed, adjusted data are most often negative. In Texas (the largest sample), effectiveness ranged from 4.9 percent to -12.7 percent for KA/BCO; -1.3 percent to -10.3 percent for KAB/CO; and -0.7 percent to -8.3 percent for KABC/O. The effectiveness values computed from the New York 1974 sample were negative for all three injury dichotomies (-7.2 percent to -17.9 percent). In North Carolina, the effectiveness was negative in 1973 and 1974 for all three injury dichotomies and positive in 1975.**

The results of the analyses are consistent with the null hypothesis that the introduction of seat back locks in 2-door passenger cars had no effect on the injury risk to drivers in these cars. That is, the results do not demonstrate that this aspect of the Standard has been effective in reducing injury.

From Tables 2-2 and 2-3, the following observations are made.

- A comparison of the effectiveness results obtained for the observed (raw) unadjusted with the smoothed (modeled) adjusted data shows that usually a greater effectiveness is obtained with the smoothed adjusted data. In the observed data, the reduction in injury rates from Pre-Standard to Post-Standard cars is greater in 4-door cars than in 2-door cars. Thus, modeling and adjustment to remove confounding effects does increase effectiveness; however, for most samples, negative values remain.

- The variability in results among years is greater in North Carolina with the small data base than in Texas with the much larger number of cases.

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*Definitions of injury levels are: K = killed; A = severely injured; B = moderately injured; C = minor injuries; 0 = no injury.

**In general, negative effectiveness values do not allow rejection of the null hypothesis that seat back locks do not reduce the incidence or severity of injuries in the broad class of frontal crashes between two passenger automobiles. Negative effectiveness values do not imply that the Standard is causing injuries.

TABLE 2-2

SUMMARY OF PERCENT EFFECTIVENESS FOR OBSERVED UNADJUSTED MASS ACCIDENT DATA FOR FRONTAL CRASHES INVOLVING ONE OR TWO VEHICLES

Injury Level	State	Year	Effectiveness	Standard Deviation	95 % Confidence Interval From	95 % Confidence Interval To
KA	Texas	1972	5.1	6.1	-4.9	15.1
		1973	-6.7	7.2	-18.5	5.1
		1974	-2.8	8.0	-16.0	10.3
	New York	1974	-27.4	9.7	-43.2	-11.5
	North Carolina	1973	-49.8	24.0	-89.8	-9.8
		1974	-29.2	22.2	-65.7	7.3
		1975	20.1	14.6	-3.8	43.9
	Texas 1965-1971 Model Year Cars	1972	4.4	7.8	-8.3	17.17
		1973	-2.5	9.0	-17.3	12.3
		1974	3.2	9.8	-12.9	19.3
KAB	Texas	1972	-3.2	3.6	-9.1	2.6
		1973	-1.0	3.5	-6.8	4.8
		1974	-16.3	4.5	-23.6	-9.0
	New York	1974	-14.6	4.5	-22.0	-7.3
	North Carolina	1973	-6.8	9.1	-21.6	8.1
		1974	-26.9	11.1	-45.0	-8.7
		1975	12.0	7.7	-0.7	24.7
	Texas 1965-1971 Model Year Cars	1972	-1.8	4.5	-9.2	5.5
		1973	3.4	4.4	-3.9	10.6
		1974	-15.4	5.7	-24.8	-6.0
KABC	Texas	1972	-2.3	2.9	-7.1	2.5
		1973	1.2	2.8	-3.4	5.9
		1974	-12.5	3.5	-18.2	-6.7
	New York	1974	-8.3	3.1	-13.4	-3.2
	North Carolina	1973	-9.7	6.9	-21.0	1.5
		1974	-18.9	7.5	-31.2	-6.5
		1975	1.2	6.2	-9.1	11.4
	Texas 1965-1971 Model Year Cars	1972	-0.7	3.6	-6.7	5.2
		1973	6.0	3.5	0.3	11.8
		1974	-10.7	4.5	-18.1	-3.4

TABLE 2-3

SUMMARY OF PERCENT EFFECTIVENESS FOR SMOOTHED ADJUSTED MASS ACCIDENT DATA FOR FRONTAL CRASHES INVOLVING ONE OR TWO VEHICLES

Injury Level	State	Year	Effectiveness	Standard Deviation	95 % Confidence Interval From	95 % Confidence Interval To
KA	Texas	1972	4.9	6.1	-5.1	14.9
		1973	-12.7	7.6	-25.0	-0.3
		1974	1.9	7.7	-10.7	14.6
	New York	1974	-17.9	8.9	-32.5	-3.3
	North Carolina	1973	-44.4	23.5	-82.9	-5.9
		1974	-19.0	20.9	-53.3	15.2
		1975	26.5	13.7	4.0	49.0
	Texas 1965-1971 Model Year Cars	1972	6.0	7.7	-6.6	18.5
		1973	-5.3	9.3	-20.5	9.9
		1974	5.0	9.7	-10.8	20.9
KAB	Texas	1972	-1.3	3.5	-7.1	4.4
		1973	-3.5	3.6	-9.4	2.5
		1974	-10.3	4.3	-17.4	-3.3
	New York	1974	-12.1	4.4	-19.4	-4.9
	North Carolina	1973	-3.7	8.8	-18.1	10.7
		1974	-19.9	10.6	-37.4	-2.5
		1975	14.9	7.5	2.6	27.1
	Texas 1965-1971 Model Year Cars	1972	-0.4	4.5	-7.7	6.9
		1973	1.3	4.5	-6.1	8.7
		1974	-10.3	6.5	-19.4	-1.3
KABC	Texas	1972	-1.6	2.9	-6.3	3.1
		1973	-0.7	2.9	-5.4	4.1
		1974	-8.3	3.4	-13.9	-2.6
	New York	1974	-7.2	3.1	-12.2	-2.1
	North Carolina	1973	-7.9	6.8	-19.0	3.3
		1974	-14.6	7.4	-26.6	-2.5
		1975	5.6	6.0	-4.2	15.4
	Texas 1965-1971 Model Year Cars	1972	0.3	3.6	-5.6	6.2
		1973	4.7	3.6	-1.2	10.5
		1974	-7.1	4.4	-14.3	0.0

- A reduced sample for Texas was created by including only 1965-1971 model year cars. This eliminates very old cars, includes only model years fairly close to the time of Standard implementation, and reduces the effects of the market shift from 4-door cars to 2-door cars which took place over an extended period. The results, however, were about the same, indicating that the inclusion of very old and very new cars in the Texas 1972-1974 sample did not confound the results.

2.2.2 Analyses for Trapping

The analysis of a potential trapping effect for rear seat occupants in Post-Standard 2-door passenger cars was conducted using fatal accidents involving fire, explosion or immersion derived from the Fatal Accident Reporting System (FARS) for 1975, 1976, 1977 and 1978. The results are summarized in Table 2-4. The results do not support the hypothesis that seat back locks increase the possibility of trapping a rear seat occupant in a panic situation, resulting in increased fatalities. If this were so, one would expect positive values for rear seat occupants and possibly negative values for front seat occupants. Contrary to this expectation, there is an estimated 19 percent decrease in the Pre- to Post-Standard ratio of rear seat occupant fatality rates corresponding to 2-door, Post-Standard vehicles while a 4 percent decrease occurs for front seat occupants. It can be speculated that the locked front seat back may act as a restraint on the forward movement of rear seat passengers during a crash, reducing the likelihood of fatal or serious injury. This beneficial effect is perhaps more important than a possible trapping effect.

TABLE 2-4

RESULTS FOR FRONT AND REAR SEAT OCCUPANTS TO EVALUATE TRAPPING IN FIRE/EXPLOSION/IMMERSION ACCIDENTS

Occupant Location	Weighted Change in Post Standard/Pre-Standard Fatality Ratio
Rear Seat	- 19 % N = 513
Front Seat	- 4 % N = 3086
Total	N = 3599

2.2.3 Occupant Injury and Seat Failures

An analysis of a limited sample of computerized National Crash Severity Study (NCSS) data indicated that the probability of avoiding injury is three times greater when no seat failure occurs. Seat failure was defined to include any seat deformation as well as failure of the seat adjuster, track and lock. Fatal or serious injury occurs about five times more often with seat failure. The NCSS seat failure rates were 2.4 percent in Pre-Standard cars and 3.7 percent in Post-Standard cars. It should be noted that seat failure occurred in only four percent of the NCSS cases. Seat failure tends to occur primarily in very violent crashes, where the failure of the seat is likely to be only one of many possible mechanisms causing or contributing to death or serious injury.

2.3 Evaluation of the Driver Injury Analysis

2.3.1 Overall Success of the Analysis

The analysis of the effects of seat back locks on driver injuries does not support the hypothesis that seat back locks reduce injury risk to drivers of 2-door passenger cars involved in frontal collisions. The observed, unadjusted data with confounding effects has an injury reduction that is greater in 4-door Post-Standard cars than in 2-door Post-Standard cars, resulting in negative effectiveness. The process of modeling and adjusting the data to remove confounding effects increases the computed effectiveness. However, with the single exception of results for one year (North Carolina 1975), the effectiveness is negative or near zero.

It is reasonable to infer that the effect of seat back locks on driver injury risk in 2-door cars is at most very small and difficult to quantify, given the potential for confounding effects from the implementation of other Standards implemented about the same time; the changing distribution of 2-door and 4-door cars in the automotive population; vehicle weight differences among 2-door and 4-door cars; and potential differences of age, sex, socioeconomic and personality factors among drivers of 2-door and 4-door cars.

2.3.2 Limitations of the Driver Injury Analysis

The analysis of the driver injury reduction effect of FMVSS 207 is limited in the following ways.

1. State mass accident data do not indicate whether injury was due to the seat back itself, or to other mechanisms. Obviously, the conclusive determination of this information would be virtually impossible in most accident situations.

2. There was a large shift from 4-door to 2-door cars during the period considered in this analysis. It is apparent that if this trend had been ignored in the analysis, any relative changes in injury rates could be attributed to the market trend rather than to seat back locks. This effect is controlled for but not entirely eliminated by the modeling and adjustment process that was used with the data.

3. Only driver injuries have been studied. Insufficient data were available to analyze the effectiveness of seat back locks for front seat passengers.

4. Mass accident data recording techniques result in missing data and the misclassification of data.

   It is known that the police assignment of injuries to the intermediate KABCO is somewhat subjective and ambiguous, particularly for the B, C, and O levels. Missing information for some variables has prevented some useful comparisons between states from being made. In some cases, certain types of information are not collected, e.g., vehicle weight in Texas. Data limiations such as this have been partially offset by using make/model/year information.

5. The analytic approach imposes some practical and theoretical constraints.

   The use of categorical data analysis techniques limits the modeling of smooth relationships between factors, e.g., relations between driver age and injury severity.

2.3.3 Credibility of the Analysis

The credibility of the analysis is quite high even considering the limitations noted in Section 2.3.2. More than 600,000 cases of driver involvement in frontal crashes were studied, and the cars were rather evenly divided among 2-door and 4-door cars and Pre-Standard and Post-Standard cars, assuring a large sample in each cell. The analysis was carried out in three states of widely divergent locations and somewhat different economic and demographic characteristics, as well as driving habits.

2.4 Evaluation of the Rear Seat Occupant Analysis

2.4.1 Overall Success of the Analysis

The question of possible rear seat occupant entrapment in accidents involving fire and/or explosion or immersion was addressed by the analysis. The results, while based on a small number of cases, suggest that any effect due to entrapment is outweighed by the beneficial effect of a rigid seat back confining rear seat passengers to the rear area during a collision, thus reducing the likelihood of serious or fatal injury.

2.4.2 Characteristics and Limitations of the Rear Seat Occupant Analysis

Two important aspects should be pointed out:

1. This analysis was carried out on the basis of the FARS data for the period 1975-1978, and FARS is a census of fatal accidents for that period.

2. Using police reported accident data, it is not possible to determine the cause of death or other factors which might indicate the importance of the seat back lock.

2.4.3 Credibility of the Analysis

The credibility of the results is as high as practicable, because the analysis is based on the entire FARS census and not on a sample. A trapping effect of -19 percent was determined, which is the opposite of what would be expected if there were an increase in trapping. From this, it would appear that seat back locks are possibly beneficial to rear seat passengers, even in fire/explosion/immersion situations, by confining them to the rear seat and keeping them from being thrown into the front seat region, where they might strike the windshield, windows and supports, the dash, and front seat occupants. Also, because of the seat back locks, the occupants of rear seats in 2-door cars are less likely to be ejected through open front windows or doors.

3.0 ANALYSIS OF MASS ACCIDENT DATA AND NCSS DATA

Overview

This section contains a detailed description of two analyses performed on mass accident data and a brief examination of NCSS data. The analyses described in this section include:

- 3.1 Analysis of Driver Injuries
- 3.2 Analysis of Rear Seat Occupant Fatalities
- 3.3 Analysis of NCSS Data on Seat Intrusion

The first analysis is the principal effort for studying the effectiveness of seat back locks in 2-door passenger cars. The analysis contains a discussion of the analytic approach; a description of the data files used and how they were derived; and a step-by-step presentation of the analysis through the determination of effectiveness and estimation of errors for FMVSS 207. More briefly, the second analysis investigates the question of trapping rear seat occupants, while the third analysis examines the relation between driver injury and seat failure as determined from a portion of NCSS accident data.

3.1 Analysis of Driver Injuries

3.1.1 Analysis Approach

The purpose of this analysis is to assess whether the requirement for seat back locks in 2-door passenger cars reduces the severity or frequency of injuries to drivers. This effect has been investigated by using state accident data to analyze the injury characteristics of drivers in passenger car frontal crashes.

As was outlined in Section 1.1, FMVSS 207 went into effect on 1 January 1968. Prior to the implementation of the Standard, only General Motors had included (in 1967) seat back locks on all their 2-door models. There also were self-locking seat back restraints on some types of foreign cars implemented over a period of years prior to 1967. However, foreign cars are excluded from the sample.

To address the question of whether seat back locks reduce the frequency or severity of injury to front seat occupants, a comparison is made between drivers of 2- and 4-door cars before (Pre) and after (Post) the Standard took effect. The 4-door cars received the same modifications (which were mandated by other Standards that went into the effect at roughly the same time as FMVSS 207) as were made in 2-door cars, except the seat back lock. Thus, by looking at the changes in injury distribution of drivers of 2-door cars before and after the implementation of the Standard and comparing this with the analogous data for drivers of 4-door models, one might hope to assess the impact of the Standard on injury reduction. In effect, the 4-door vehicles are being treated as a control group.

There is a difficulty in a straightforward approach to the analysis outlined above caused by a rather large change in the relative sales of 2 and 4-door cars. The following table presents the distribution of domestic factory sales by vehicle type.

TABLE 3-1

DOMESTIC FACTORY SALES BY VEHICLE TYPE
(Percent)

Year	Vehicle Type		
	2-Door	4-Door	Chassis/Convertibles
1966	45.3	50.0	4.7
1967	48.2	47.6	4.2
1968	50.8	46.0	3.2
1969	51.9	45.6	2.5
1970	53.6	45.0	1.4
1971	53.2	45.7	1.1
1972	54.3	45.0	0.7

Source: Automobiles Facts and Figures Compiled Annually by Motor Vehicle Manufacturers Association of U.S. [1]

It is apparent that there has been a marked shift away from 4-door cars and, unless controlled for, any relative differences in injury rates may be attributable to the market shift rather than to seat back locks.

CEM's analytic approach to evaluating FMVSS 207 has three major aspects:

- Definition of effectiveness measures.
- Smoothing of the data to remove chance variation.
- Adjustment of the data to control for differences of the injury rates that are not due to FMVSS 207.

The basic variables used in the analysis are Pre/Post, 2-door/4-door, and injury severity; other variables are selected for adjusting and/or modeling the data. Driver injury distributions between Pre- and Post-Standard 2- and 4-door cars are not directly comparable without adjustment. There are differences among the four classes in the distribution of other variables such as vehicle weight, driver age and driver sex. In order to address the question of how many (driver) injuries were avoided due to seat back locks on 2-door, Post-Standard cars, the data have to be adjusted for these differences. Once this is done, the driver injury distribution of other classes of accidents can be directly compared to the driver injury distribution for all 2-door car accidents.

With the above comments in mind, the analysis of the effectiveness of FMVSS 207 is carried out in the following steps:

1. Select the full mass accident data base. The data bases analyzed are Texas 1972-1974, North Carolina 1973-1975 and New York 1974.
2. Extract the partial data set to be directly used in evaluation of the Standard. The partial data set consists of drivers in passenger cars involved in frontal impact collisions.
3. Define variables to be considered for modeling and adjustment. In addition to Model Year Class (Pre/Post), Vehicle Body Style (Style) and Driver Injury (Injury), all available variables that might account or control for possible confounding effects and random variability of the data are considered for modeling and adjustment.
4. Apply the variable selection procedure. From the group of potential variables, at most four can be selected for modeling and adjustment. This reflects the limitation of a maximum of seven variables in the modeling procedure. The variable selection procedure consists of ranking all potential variables according to the strength of their interactions with Prepost, Style and Injury and choosing those variables with the highest degree of interaction.

5. Model the data defined by the table, Injury x Pre/Post x Style x $Variable_1$ x $Variable_2$ x ... $Variable_n$, using the log-linear modeling routine in the Biomedical Computer Programs P-Series.[2] The purpose of modeling is to remove random variability and smooth the data. Modeling also reveals the strengths of interactions among variable groups. Modeling is carried out separately for 3 injury dichotomies (KA x BCO, KAB x CO, KABC x O).

6. Adjust the smoothed data to allow for the direct comparison of injury rates. Adjustment is necessary in order to insure that the overall effectiveness estimates will not be affected by a different distribution of 2-door and 4-door vehicles across all levels of the relevant pre-crash factors identified in the variable selection procedure.

7. Compute the effectiveness of the Standard for each state-year data subset and compare results. The effectiveness measure which is used in this analysis is a ratio of the change (Pre vs. Post) in injury rates for drivers of 4-door cars relative to the change (Pre vs. Post) for drivers of 4-door cars. If P_{ij} are defined as in Table 3-2, then the effectiveness is computed as follows.

$$E = \left[1 - \left\{\frac{P_{21}}{P_{11}} x \frac{P_{12}}{P_{22}}\right\}\right] x \quad 100$$

An error estimate of each effectiveness computation is made.

TABLE 3-2

CLASSIFICATION OF DRIVER INJURY RATES

Condition	2-Door	4-Door
Pre-Standard	P_{11}	P_{12}
Post-Standard	P_{21}	P_{22}

8. Repeat Steps 5-7 for data that include only drivers in passenger cars with model years from 1965 through 1971 (i.e., close to the time of Standard implementation) and evaluate any differences in the effectiveness and error estimate.

9. If positive effectiveness is found, extrapolate the results based on Texas, North Carolina and New York to nationwide estimates of the number of injuries avoided assuming all 2-door cars have seat back locks compared with no 2-door having seat back locks.

3.1.2 Data Characteristics and Variable Selection

The data characteristics and variable selection for each state are presented separately in this subsection. The five generic tables that document each data set are:

- Relation of partial data set to full data base.
- Univariate frequency distribution of relevant variables.
- Injury rates for Pre/Post Standard x 2-door/4-door vehicle x relevant variables.
- Chi-squares of interaction terms of variables considered for modeling and adjustment.
- Completely cross-classified contingency table of data prior to modeling (Appendix A).

Texas 1972, 1973, 1974

The size of the seat back lock drivers-only data set relative to the entire 1972-1974 Texas accident data base can be characterized by noting the fraction of accidents, vehicles and fatalities contained in the data set as given in Table 3-3. The low fatality rates in the Texas partial data sample (and also in North Carolina and New York) result from the screening procedure used to establish a data set that might reflect the effects of adding seat back locks. The partial data set excluded vehicles that overturned or had run off the road. Only drivers were included. Since average occupancy is 1.6 persons per vehicle, a significant number of other occupants are excluded. Foreign cars were excluded, because many foreign manufacturers had seat back locks before 1968. Convertibles were not included as passenger cars and passenger cars towing anything were excluded. All of the above factors tend to lessen the number of fatalities and fatal accidents included in the partial data set.

TABLE 3-3

ACCIDENTS, VEHICLES AND FATALITIES IN 1972-1974 TEXAS DATA BASE

Year	Variable	Full Data Base	Partial Data Set	Percent
1972	Accidents	432,998	125,555	29.0
	Vehicles	744,699	156,943	21.1
	Fatalities	3,688	362	9.8
1973	Accidents	464,226	127,779	27.5
	Vehicles	800,545	158,897	19.9
	Fatalities	3,692	334	9.1
1974	Accidents	434,194	114,711	26.4
	Vehicles	747,834	143,388	19.2
	Fatalities	3,046	261	8.6

Specifically, the partial data set was derived by selecting cases that satisfied the following values of the screening criteria:

- Vehicle Type = Passenger Car.
- Point of Impact = Front.
- Accident Type = Frontal Collision with:
  1. another motor vehicle,
  2. a parked car, or
  3. a fixed object.
- Manner of Collision - Between Two Motor Vehicles, or Single Vehicle Striking Fixed Object.
- Number of Vehicles in Accident = 1 or 2.
- Vehicle Make and Model = "Domestic."
- Vehicle Body Style - 2-door or 4-door Passenger Car.
- Vehicle Model Year is known.
- "Drivers" of parked cars are eliminated.

The univariate frequencies of some key variables in the Texas 1972-1974 driver-only 10 percent sample are given in Table 3-4. The 10 percent random sampling yielded 49,355 cases for the three years. The univariate distributions are shown for each year and the three years combined. The table contains few surprises and only a few remarks concerning the data will be noted. Only 2.3 percent of the drivers suffered fatal or serious injury. This distribution of driver injury indicates that a KABC vs. O injury dichotomy may be required to yield interpretable results, since almost 89 percent of the drivers are listed as uninjured. The percentage of Pre-Standard cars shifts from 44 percent in 1972 to 29 percent in 1974, with an overall 36 percent for the three years. This percentage is considerably higher than in the North Carolina and New York data bases and reflects, of course, the closer overall proximity in time to the Standard implementation date in Texas. The Model Year Category variable indicates that 63 percent of the vehicles have a model year between 1965 and 1971, within reasonably close proximity of Standard implementation. The distribution of the overall sample between 2-door and 4-door cars is 56 percent and 44 percent, respectively.

Injury rates (KABC percentages) and the number of drivers on which the rates are based are given in Tables 3-5, 3-6 and 3-7 for the Texas 1972, 1973 and 1974 drivers-only 10 percent sample. The rates are given for each category of all variables considered for modeling and are depicted separately for 2-door/4-door cars and Pre/Post Standard.

TABLE 3-4

FREQUENCY DISTRIBUTIONS OF KEY VARIABLES IN DRIVER-ONLY TEXAS 10 PERCENT SAMPLE

Variable	Category	1972		1973		1974		Total: 1972-1974	
		Absolute Frequency	% of Known	Absolute Frequency	% of Known	Absolute Frequency	% of Known	Absolute Frequency	% of Known
Driver Injury	K	27	0.2	34	0.2	24	0.2	85	0.2
	A	432	2.5	350	2.1	248	1.6	1,030	2.1
	B	923	5.4	866	5.1	950	6.1	2,739	5.6
	C	591	3.5	599	3.5	561	3.6	1,751	3.5
	0	14,991	88.4	15,055	89.1	13,704	88.5	43,750	88.6
Model Year Class	Pre	7,442	43.9	6,004	35.5	4,441	28.7	17,887	36.2
	Post	9,522	56.1	10,900	64.5	11,046	71.3	31,468	63.8
Vehicle Body Style	2-Door	9,198	54.2	9,529	56.4	9,046	58.4	27,773	56.3
	4-Door	7,766	45.8	7,375	43.6	6,441	41.6	21,582	43.7
City Size	Rural	1,373	8.1	1,309	7.7	1,051	6.8	3,733	7.6
	LT 2,500	445	2.6	417	2.5	413	2.7	1,275	2.6
	2,500- 5,000	389	2.3	395	2.3	337	2.2	1,121	2.3
	5,000- 10,000	679	4.0	693	4.1	623	4.0	1,995	4.0
	10,000- 25,000	1,401	8.3	1,437	8.5	1,344	8.7	4,182	8.5
	25,000- 50,000	908	5.4	928	5.5	882	5.7	2,718	5.5
	50,000-100,000	2,173	12.8	2,265	13.4	2,018	13.0	6,456	13.1
	100,000-250,000	1,273	7.5	1,261	7.5	1,186	7.7	3,720	7.5
	GT 250,000	8,323	49.1	8,199	48.5	7,633	49.3	24,155	48.9
Road Classification	Interstate	1,635	9.6	1,718	10.2	1,433	9.3	4,786	9.7
	U.S. & State	5,039	29.7	4,818	28.5	4,446	28.7	14,303	29.0
	Farm to Market	710	4.2	742	4.4	663	4.3	2,115	4.3
	County Road	348	2.1	327	1.9	304	2.0	979	2.0
	City Street	9,202	54.2	9,261	54.8	8,623	55.7	27,086	54.9
	Turnpike	30	0.2	38	0.2	18	0.1	86	0.2
Weather	Clear-Cloudy	14,239	83.9	13,739	81.3	12,895	83.3	40,873	82.8
	Rain	2,549	15.0	2,929	17.3	2,415	15.6	7,893	16.0
	Snow	64	0.4	130	0.8	35	0.2	229	0.5
	Fog	108	0.6	99	0.6	135	0.9	342	0.7
	Dust/Smoke	4	0.0	7	0.0	7	0.0	18	0.0
Accident Type	Collision w MV	14,709	86.7	14,552	86.1	13,308	85.9	42,569	86.3
	Coll.w Prkd Car	870	5.1	922	5.5	859	5.5	2,651	5.4
	Coll.w Fixd Obj	1,385	8.2	1,430	8.5	1,320	8.5	4,135	8.4
Light Condition	Daylight	12,453	73.4	12,413	73.4	11,248	72.6	36,114	73.2
	Dawn	73	0.4	65	0.4	103	0.7	241	0.5
	Dark-No Lights	2,981	17.6	2,890	17.1	2,545	16.4	8,416	17.1
	Dark-Lights	1,128	6.6	1,222	7.2	1,350	8.7	3,700	7.5
	Dusk	329	1.9	314	1.9	241	1.6	884	1.8
Road Surface Condition	Dry	13,371	78.8	12,765	75.5	12,250	79.1	38,386	77.8
	Wet	3,250	19.2	3,730	22.1	3,078	19.9	10,058	20.1
	Muddy	3	0.0	9	0.1	2	0.0	14	0.0
	Snowy	31	0.2	68	0.4	14	0.1	113	0.2
	Icy	309	1.8	332	2.0	143	0.9	784	1.6
TAD	1-2	10,341	62.1	10,750	64.7	9,844	64.8	30,935	63.8
	3-5	5,758	34.6	5,437	32.7	5,010	33.0	16,205	33.4
	6-7	545	3.3	433	2.6	349	2.3	1,327	2.7
	Missing	320	-	284	-	284	-	888	-
Driver Age	15-24	6,719	40.3	6,816	41.1	6,492	42.8	20,027	41.4
	25-54	7,654	45.9	7,582	45.7	6,710	44.2	21,946	45.3
	55-98	2,298	13.8	2,177	13.1	1,968	13.0	6,443	13.3
	Missing	293	-	329	-	317	-	939	-
Driver Sex	Male	11,077	65.8	10,929	65.1	9,826	63.9	31,832	65.0
	Female	5,768	34.2	5,869	34.9	5,541	36.1	17,178	35.0
	Missing	119	-	106	-	120	-	345	-

TABLE 3-4 (Continued)

Variable	Category	1972		1973		1974		Total: 1972-1974	
		Absolute Frequency	% of Known	Absolute Frequency	% of Known	Absolute Frequency	% of Known	Absolute Frequency	% of Known
Number of Occupants	One Two or More	15,839 1,125	93.4 6.6	15,882 1,020	94.0 6.0	14,533 953	93.3 6.2	46,254 3,098	93.7 6.3
Person Behind Driver	Yes No Missing	194 16,761 9	1.1 98.9 -	182 16,712 10	1.1 98.9 -	153 15,325 9	1.0 99.0 -	529 48,798 28	1.1 98.9 -
Vehicle Weight	LT 2690 lbs 2690-4089 lbs GT 4090 lbs Missing	1,594 13,331 1,658 381	9.6 80.4 10.0 -	1,563 12,946 2,039 356	9.4 78.2 12.3 -	1,422 11,561 2,249 255	9.3 75.9 14.8 -	4,579 37,838 5,946 992	9.5 78.2 12.3 -
Number of Vehicles	One Two	2,238 14,726	13.2 86.8	2,343 14,561	13.9 86.1	2,169 13,318	14.0 86.0	6,750 42,605	13.7 86.3
Manufacturer	GM Ford Other	9,588 4,603 2,773	56.5 27.1 16.3	9,535 4,666 2,703	56.4 27.6 16.0	8,592 4,461 2,434	55.5 28.8 15.7	27,715 13,730 7,910	56.2 27.8 16.0
Model Year Category	Pre-Stnd-LT 65 Pre-Stnd-GE 65 Post-Stnd-LT 72 Post-Stnd-GE 72	3,740 3,702 7,802 1,720	22.0 21.8 46.0 10.1	2,670 3,334 7,258 3,642	15.8 19.7 42.9 21.5	1,781 2,660 6,411 4,635	11.5 17.2 41.4 29.9	8,191 9,696 21,471 9,997	16.6 19.6 43.5 20.3
Total Number of Cases		16,964	-	16,904	-	15,487	-	49,355	-

TABLE 3-5

INJURY RATES FOR TEXAS 1972 DRIVER-ONLY 10 PERCENT SAMPLE

Variable	Category	Injury Rate (Percent)				Number of Drivers			
		2-Door		4-Door		2-Door		4-Door	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
Accident Type N = 16,964	Coll.w Motor Veh	11.2	9.1	10.9	7.6	2781	5169	3421	3338
	Coll.w Parked Car	14.5	13.9	18.1	18.8	227	201	309	133
	Coll.w Fixed Obj	35.3	31.3	31.6	19.2	337	483	367	198
Driver Age N = 16,671	15-24	13.6	11.0	11.2	8.5	1700	2684	1519	816
	25-34	13.6	10.8	15.6	8.5	736	1649	712	669
	35 or Older	15.3	12.1	14.7	8.9	848	1449	1766	2123
City Size N = 16,964	LT 5,000	20.7	23.4	21.8	16.5	411	675	559	562
	5,000-249,999	12.1	10.0	10.9	7.4	1277	2104	1652	1401
	GE 250,000	13.5	9.1	12.9	7.0	1657	3074	1886	1706
Vehicle Weight N = 16,583	LT 3000 lbs	14.1	13.2	15.3	14.2	1148	1314	692	226
	3000-3599 lbs	13.5	10.3	13.3	9.9	1456	2899	1904	950
	GE 3600 lbs	14.3	10.7	12.3	7.6	601	1563	1351	2479
TAD N = 16,644	1-2	3.6	2.3	3.4	1.6	1995	3508	2465	2373
	3-4	23.1	17.9	22.5	14.9	1099	1823	1280	1006
	5-7	67.3	57.8	65.6	60.3	202	422	262	209
Light Condition N = 16,964	Daylight	11.2	9.2	10.4	7.7	2312	4291	2983	2867
	Reduced Light	19.7	16.2	21.0	11.8	1033	1562	1114	802
Driver Sex N = 16,845	Male	13.0	9.9	12.8	7.5	2380	3730	2729	2238
	Female	16.5	13.4	14.8	10.5	935	2092	1325	1416
Road Surface Condition N = 16,964)	Dry	14.7	11.3	13.9	9.0	2622	4588	3288	2873
	Other	10.8	10.3	10.8	7.0	723	1265	809	796
Number of Vehicles N = 16,964	One	26.6	25.7	25.0	19.0	560	676	671	331
	Two	11.3	9.2	11.0	7.6	2785	5177	3416	3338
Manufacturer N = 16,964	GM	13.8	9.9	12.5	7.9	1614	3462	2336	2176
	Ford	13.9	12.6	15.4	8.8	1208	1534	1011	850
	Other	13.8	13.1	12.9	10.7	523	857	750	643
Road Classification N = 16,964	US/State/Interstate Hwy	15.9	12.8	14.5	10.3	1223 2	2413	1519	1549
	County/Farm Rd	18.9	16.7	18.3	13.4	201	360	273	224
	City Street	12.0	9.1	11.9	6.6	1921	3080	2305	1896
Number of Occupants N = 16,964	One	10.1	8.5	10.1	6.1	3070	5524	3780	3465
	Two or More	56.0	54.4	51.7	51.0	275	329	317	204
Weather N = 16,964	Clear/Cloudy	14.3	11.3	13.7	8.8	2810	4872	3497	3060
	Other	11.2	10.2	10.8	7.7	535	981	600	609
Person Behind Driver N = 16,955	Yes	64.2	61.6	68.0	56.8	53	54	50	37
	No	13.0	10.6	12.6	8.1	3291	5794	4045	3631

TABLE 3-6

INJURY RATES FOR TEXAS 1973 DRIVER-ONLY 10 PERCENT SAMPLE

Variable	Category	Injury Rate (Percent)				Number of Drivers			
		2-Door		4-Door		2-Door		4-Door	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
City Size N = 16,904	LT 50,000	14.1	12.5	13.6	12.3	746	1919	1063	1451
	50,000-249,999	9.9	9.1	12.5	6.9	625	1390	703	808
	GE 250,000	13.2	9.9	11.3	8.2	1304	3545	1563	1787
Road Classification N = 16,908	US/State/Interstate Hwy	12.5	11.4	14.0	12.4	928	2700	1198	1748
	County/Farm Rd	14.9	13.8	20.2	12.1	168	413	223	265
	City Street	12.5	9.5	10.3	6.5	1579	3741	1908	2033
Driver Age N = 16,575	15-24	12.8	10.6	11.9	6.8	1370	3217	1268	961
	25-34	13.4	9.6	15.3	10.8	561	1825	577	767
	35 or Older	12.5	11.6	12.1	10.3	678	1717	1383	2251
Vehicle Weight N = 16,548	LT 3000 lbs	15.2	12.8	16.0	9.7	921	1550	582	248
	3000-3999 lbs	10.9	10.1	12.2	9.8	1445	4240	2320	2346
	GE 4000 lbs	13.8	8.4	7.7	8.8	189	960	310	1437
Manufacturer N = 16,904	GM	11.4	10.3	11.3	8.9	1276	4027	1861	2371
	Ford	14.8	10.7	14.3	10.5	1029	1846	830	961
	Other	11.1	10.7	12.5	9.8	370	981	638	714
Accident Type N = 16,904	Coll.w Motor Veh	9.7	8.6	9.5	7.8	2206	6013	2738	3595
	Coll.w Parked Car	18.6	18.8	16.7	11.5	199	271	269	182
	Coll.w Fixed Obj	32.2	26.7	32.6	30.2	270	570	322	268
Number of Occupants N = 16,904	One	9.9	8.3	9.6	6.9	2475	6494	3096	3817
	Two or More	47.0	50.3	48.5	51.5	200	360	233	229
Person Behind Driver N = 16,894	Yes	45.7	44.9	68.3	52.6	35	49	41	57
	No	12.2	10.2	11.6	8.8	2637	6800	3286	3989
TAD N = 16,620	1-2	3.2	2.7	3.2	2.1	1672	4296	2158	2624
	3-4	22.2	17.9	24.0	16.6	798	2036	939	1136
	5-7	62.2	58.7	66.5	65.7	172	409	173	207
Light Condition N = 16,904	Daylight	10.0	8.0	9.4	7.6	1892	4995	2399	3127
	Reduced Light	19.0	17.2	19.9	15.6	783	1859	930	919
Weather N = 16,904	Clear/Cloudy	13.2	10.6	12.5	9.6	2164	5555	2765	3255
	Other	10.6	9.9	11.5	8.6	511	1299	564	791
Road Surface Condition N = 16,904	Dry	13.3	10.7	13.0	9.7	1999	5163	2590	3013
	Other	10.8	9.8	10.0	8.6	676	1691	739	1033
Number of Vehicles N = 16,904	One	26.1	24.1	25.5	22.1	467	841	588	447
	Two	9.8	8.6	9.5	7.8	2208	6013	2741	3599
Driver Sex N = 16,798	Male	12.4	10.1	11.4	8.5	1885	4294	2262	2488
	Female	13.9	11.3	14.6	11.0	762	2532	1033	1542

TABLE 3-7

INJURY RATES FOR TEXAS 1974 DRIVER-ONLY 10 PERCENT SAMPLE

Variable	Category	Injury Rate (Percent)				Number of Drivers			
		2-Door		4-Door		2-Door		4-Door	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
City Size N = 15,487	LT 50,000	15.7	14.1	14.2	10.9	528	1938	801	1383
	50,000-244,999	11.6	9.7	15.5	7.0	431	1448	542	783
	GE 250,000	14.6	10.2	12.4	8.9	1005	3696	1134	1798
Accident Type N = 15,487	Coll.w Motor Veh	11.4	8.9	10.9	7.4	1611	6145	2004	3548
	Coll.wParked Car	15.0	15.6	19.0	21.5	127	353	216	163
	Coll.w Fixed Obj	34.1	32.2	31.1	30.0	226	584	257	253
TAD N = 15,203	1-2	3.7	3.0	4.1	2.0	1208	4456	1574	2606
	3-4	27.0	20.4	26.2	19.3	610	2135	744	1086
	5-7	62.5	61.4	62.0	61.7	112	363	129	180
Vehicle Weight N = 15,232	LT 3000 lbs	15.8	14.0	13.5	11.3	717	1590	474	240
	3000-3999 lbs	13.4	10.6	13.8	9.8	1027	4257	1708	2128
	GE 4000 lbs	10.9	9.9	13.0	8.6	137	1173	207	1574
Driver Age N = 15,170	15-24	13.8	11.1	13.4	10.7	1002	3451	969	1070
	25-34	13.6	10.7	13.6	9.3	411	1870	403	774
	35 or Older	16.8	12.2	14.4	9.0	493	1659	1034	2034
Road Classification N = 15,487	US/State/Interstate Hwy	14.1	12.0	15.7	9.7	687	2736	873	1601
	County/Farm Rd	18.9	14.3	22.5	13.5	122	462	138	245
	City Street	13.9	10.3	11.7	8.7	1155	3884	1466	2118
Light Condition N = 15,487	Daylight	11.4	9.0	11.2	7.3	1370	5041	1781	3056
	Reduced Light	20.9	16.6	20.0	16.3	594	2041	696	980
Number of Vehicles N = 15,487	One	27.2	25.8	25.6	26.0	353	932	472	412
	Two	11.4	9.0	10.9	7.5	1611	6150	2005	3552
Road Surface Condition N = 15,487	Dry	15.6	11.6	14.3	9.7	1575	5603	1977	3095
	Other	9.0	9.7	11.2	8.4	389	1479	500	869
Weather N = 15,487	Clear/Cloudy	15.2	11.5	14.1	9.4	1655	5893	2085	3262
	Other	9.4	9.7	11.2	9.1	309	1189	392	702
Number of Occupants N = 15,487	One	11.4	8.5	11.0	7.0	1832	6652	2301	3748
	Two or More	53.8	52.6	49.4	50.5	132	430	176	216
Person Behind Driver N = 15,478	Yes	59.3	64.2	33.3	50.0	27	67	27	32
	No	13.6	10.7	13.5	9.1	1937	7010	2448	3930
Manufacturer N = 15,487	GM	14.0	10.6	14.3	9.4	857	4177	1257	2301
	Ford	14.5	11.5	13.6	9.5	823	1927	685	1026
	Other	14.4	13.0	12.3	9.3	284	978	535	637
Driver Sex N = 15,367	Male	13.2	10.4	12.7	8.6	1360	4459	1635	2372
	Female	17.3	12.7	15.9	10.6	573	2579	816	1573

The choice of cutting points used to categorize a variable was not completely arbitrary. Whenever appropriate (and possible), several different "versions" of a given variable--each with different cutting points, and in many cases, with a different number of categories--were input into the variable selection procedure. Only one "version" of a variable, that with the highest harmonic mean of $LR\chi^2$'s, was used in subsequent analyses. Figure 3-1 illustrates a typical example of the effort involved in determining the "optimal" cutting points of the variable City Size in the Texas 1974 sample. (The 50,000 and 250,000 cutting points are chosen.)

The variables given in Tables 3-5, 3-6 and 3-7 are ranked in descending order according to the strength of their interaction terms with Driver Injury, Pre/Post Standard and Vehicle Body Style. A number of patterns are evident such as frequently higher injury rates with high values of TAD, reduced lighting, female drivers, lighter cars, and accidents in which the seat behind the driver is occupied.

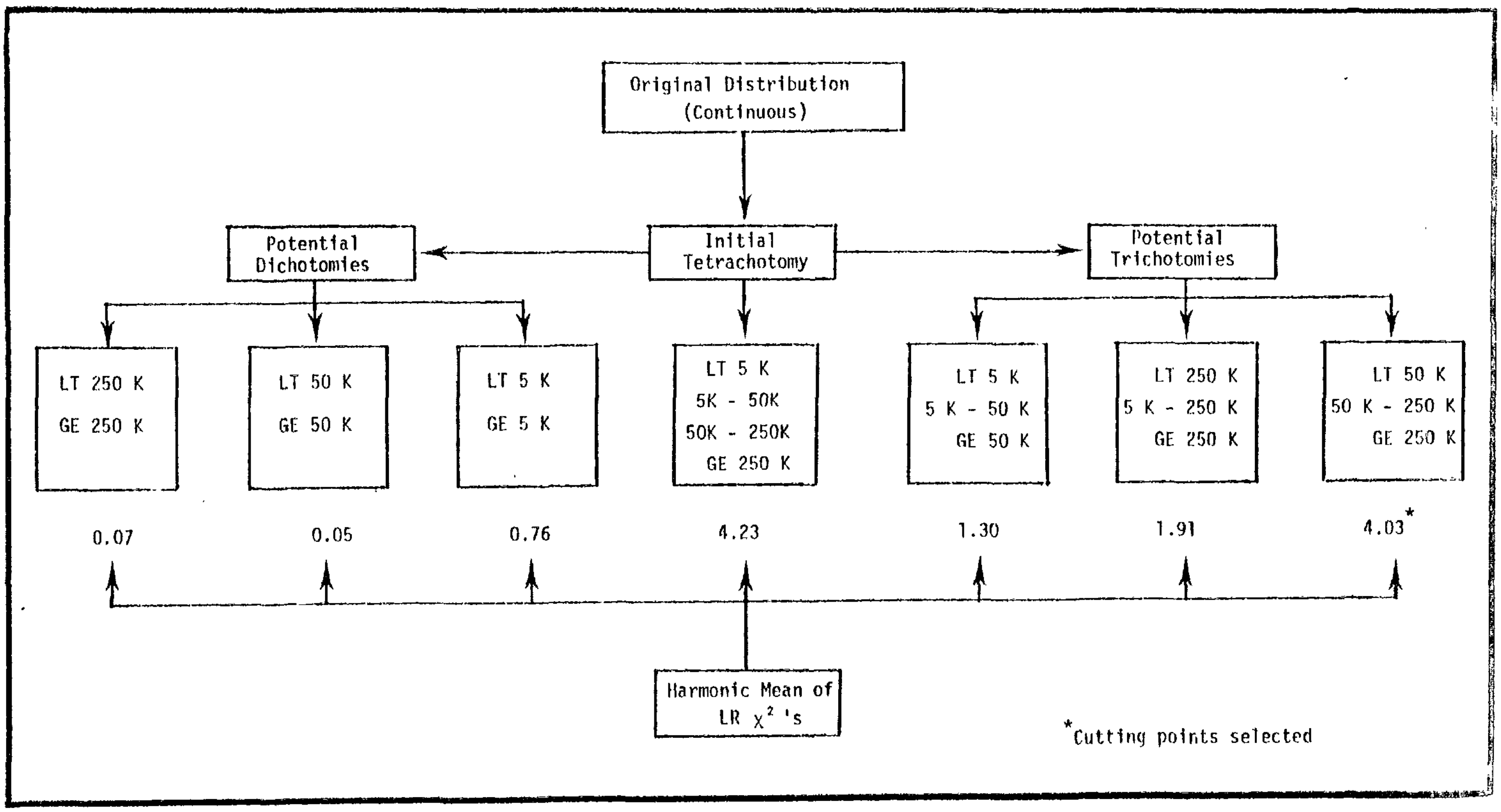

Figure 3-1. Example of determination of "optimal" cutting points of categorical variables.

The information used in the variable selection procedure to determine those variables selected for modeling in the Texas 1972, 1973 and 1974 data is given in Tables 3-8, 3-9 and 3-10. The interaction terms considered here and in all subsequent samples are the following:

- Variable x Style.
- Variable x Prepost.
- Variable x Prepost x Style.
- Variable x Injury.
- Variable x Injury x Prepost.
- Variable x Injury x Style.
- Variable x Injury x Style x Prepost.

The first three interaction terms are obtained from a saturated log-linear model of Prepost, Style and Variable while the last four interaction terms come from a saturated model containing Injury, Prepost, Style and Variable.

The variables are listed in an order determined by the nagnitude of the harmonic mean (also given in the tables) of the seven interaction terms. The use of the harmonic mean results in greater weight being given to the third and fourth order interaction terms than would be the case if the arithmetic mean was used.

Using the harmonic mean as the ordering criteria, City Size was among the three selected variables in the 1972, 1973 and 1974 data bases. Driver Age and Accident Type were selected in two of the three years. Road Classification and TAD were selected in a single year. For completeness and the convenience of the reader, the completely cross-classified tables of Injury, Prepost, Style and the three selected variables that were obtained for the full Texas Drivers-Only data sample for 1972, 1973 and 1974 prior to modeling are given in Appendix A.

TABLE 3-8

INTERACTION TERMS EVALUATED IN VARIABLE SELECTION PROCEDURE

TEXAS 1972

Variable	Interaction Terms from Saturated Model Containing Prepost, Style and Variable			Interaction Terms from Saturated Model Containing Injury, Prepost, Style and Variable				Harmonic Mean of the Interaction Terms
	Var x Style	Var x Prepost	Var x Prepost x Style	Var x Injury	Var x Injury x Prepost	Var x Injury x Style	Var x Injury x Style x Prepost	
	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	
Accident Type ≠	22.96*	154.75*	8.13*	437.19*	1.39	6.83*	1.85	4.43
Driver Age ≠	1192.01*	96.01*	95.06*	1.93	5.24	3.38	1.76	4.39
City Size ≠	52.62*	12.86*	5.42	177.44*	13.07*	1.33	1.30	3.72
Vehicle Weight ≠	1401.37*	489.94*	184.22*	30.79*	5.95	10.71*	0.59	3.51
TAD ≠	14.92*	10.20*	10.09*	2970.28*	2.46	1.21	1.82	3.42
Light Condition	27.13*	34.53*	1.38	185.32*	2.09	0.49	2.57	1.89
Driver Sex	10.97*	74.61*	1.83	26.76*	1.73	0.60	0.50	1.42
Road Surface Condition	2.26	2.81	2.38	15.94*	1.64	0.57	0.75	1.41
Number of Vehicles	1.06	128.75*	7.01*	355.58*	2.30	0.73	0.27	1.06
Manufacturer ≠	81.89*	67.58*	32.93*	16.94*	4.91	0.15	3.09	0.96
Road Classification	0.67	40.22*	0.81	67.46*	2.36	0.25	1.05	0.86
Number of Occupants	0.13	37.17*	0.18	1308.79*	4.65	0.07	2.09	0.25
Weather	2.62	6.50*	1.15	8.90*	1.22	0.15	0.02	0.12
Person Behind Driver	0.07	6.71*	1.46	293.28*	0.02	0.16	0.02	0.06

*$p < 0.05$

≠Interaction terms associated with variables marked with "≠" have two degrees of freedom. Interaction terms associated with the unmarked variables have one degree of freedom.

Note: Variables above the bold line were selected.

TABLE 3-9

INTERACTION TERMS EVALUATED IN VARIABLE SELECTION PROCEDURE

TEXAS 1973

Variable	Interaction Terms from Saturated Model Containing Prepost, Style and Variable			Interaction Terms from Saturated Model Containing Injury, Prepost, Style and Variable				Harmonic Mean of the Interaction Terms
	Var x Style	Var x Prepost	Var x Prepost x Style	Var x Injury	Var x Injury x Prepost	Var x Injury x Style	Var x Injury x Style x Prepost	
	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	
City Size ≠	77.06*	8.90*	11.51*	31.41*	3.21	1.69	4.29	5.07
Road Classification ≠	9.85*	48.20*	2.53	47.20*	3.34	13.80*	1.68	4.67
Driver Age ≠	1101.75*	75.68*	78.32*	1.42	4.13	8.38*	2.19	4.52
Vehicle Weight ≠	820.47*	614.80*	96.75*	40.33*	0.59	1.22	6.69*	2.59
Manufacturer ≠	99.48*	70.01*	39.98*	11.51*	3.03	0.78	0.79	2.32
Accident Type ≠	14.18*	125.71*	3.13	479.00*	0.27	4.64	1.97	1.45
Number of Occupants	1.09	21.77*	1.27	1050.30*	6.85*	0.73	0.30	1.06
Person Behind Driver	7.71*	3.06	6.00*	197.01*	0.18	4.43*	0.70	0.89
TAD ≠	13.41*	0.12	0.18	2792.82*	1.81	3.70	1.08	0.45
Light Condition	15.07*	18.27*	5.37*	265.24*	0.10	0.07	0.82	0.27
Weather	1.06	4.12*	4.82*	3.96*	0.22	0.02	0.51	0.12
Road Surface Condition	1.49	4.25*	7.99*	8.65*	1.58	0.45	0.01	0.07
Number of Vehicles	0.32	104.54*	2.08	417.07*	0.12	0.01	0.01	0.03
Driver Sex	0.26	91.50*	1.05	11.62*	0.14	2.30	0.01	0.001

*$p < 0.05$

≠ Interaction terms associated with variables marked with "≠" have two degrees of freedom. Interaction terms associated with the unmarked variables have one degree of freedom.

Note: Variables above the bold line were selected.

TABLE 3-10

INTERACTION TERMS EVALUATED IN VARIABLE SELECTION PROCEDURE

TEXAS 1974

Variable	Interaction Terms from Saturated Model Containing Prepost, Style and Variable			Interaction Terms from Saturated Model Containing Injury, Prepost, Style and Variable				Harmonic Mean of the Interaction Terms
	Var x Style	Var x Prepost	Var x Prepost x Style	Var x Injury	Var x Injury x Prepost	Var x Injury x Style	Var x Injury x Style x Prepost	
	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	
City Size ≠	86.85*	6.04*	1.23	22.43*	4.63	4.02	4.21	4.03
Accident Type ≠	7.12*	103.48*	14.40*	494.26*	5.63	4.95	0.75	3.62
TAD ≠	9.38*	4.21	0.85	2490.96*	4.27	1.18	3.04	2.39
Vehicle Weight ≠	751.27*	722.17*	86.26*	32.26*	3.06	2.56	0.43	2.27
Driver Age ≠	991.31*	55.68*	48.63*	1.45	2.44	5.02	0.45	1.97
Road Classification ≠	1.89	28.32*	0.97	25.50*	0.85	1.63	2.70	1.84
Light Condition	34.01*	8.72*	6.48*	201.65*	0.42	1.17	1.18	1.60
Number of Vehicles	0.73	103.23*	11.58*	422.62*	5.60*	0.44	0.93	1.40
Road Surface Condition	0.83	2.95	0.17	16.69*	2.91	0.29	1.04	0.57
Weather	0.48	4.09*	0.34	10.18*	2.44	0.76	0.16	0.52
Number of Occupants	0.11	6.33*	1.41	1029.41*	6.72*	0.06	0.66	0.25
Person Behind Driver	0.59	3.16	0.04	172.26*	6.38*	5.16*	0.82	0.24
Manufacturer ≠	62.11*	155.85*	50.46*	2.22	2.45	3.15	0.02	0.14
Driver Sex	7.92*	51.53*	0.18	17.91*	0.34	0.02	0.06	0.09

*$p < 0.05$

≠Interaction terms associated with variables marked with "≠" have two degrees of freedom. Interaction terms associated with the unmarked variables have one degree of freedom.

<u>Note</u>: Variables above the bold line were selected.

New York 1974

The size of the seat back lock drivers-only data set relative to the entire 1974 New York accident data base is characterized by noting the fraction of accidents, vehicles and fatalities contained in the data set as given in Table 3-11. The reasons for the low fatality rate are basically the same as those given in the discussion of the Texas partial data set (page 3-5).

TABLE 3-11

ACCIDENTS, VEHICLES AND FATALITIES IN 1974
NEW YORK STATE DATA BASE

Variable	Full Data Base	Partial Data Set	Percent
Accidents	377,818	52,475	13.9
Vehicles	704,477	65,593	9.3
Fatalities	2,664	208	7.8

The partial data set was derived by selecting cases that satisfied the following criteria:

- Number of Vehicles in Accident = 1 or 2.
- First Event = Collision with Motor Vehicle or Fixed Object.
- Area of Impact = Frontal, front right fender or front left fender.
- Vehicle Body Type = 2-door or 4-door Sedan.
- Vehicle Model Year is known.
- Vehicle Make and Model = "Domestic."
- Vehicle Occupant = Driver.

The univariate frequencies of some key variables in the New York drivers-only sample are given in Table 3-12. It is noted that almost 6 percent of the drivers suffered a fatal or serious injury (KA), a much higher percent than in Texas or North Carolina. The much higher incidence of serious injury is related to the fact that KABCO in New York was derived from more accurate information describing type of injury, location of injury and drivers' physical and emotional status. Perhaps the principal reason that injury rates are higher in New York is that the dollar damage reporting threshold is higher. The New York sample is tilted toward 2-door, Post-Standard cars. There are twice as many 2-door cars as 4-door cars and four times as many Post-Standard as Pre-Standard vehicles. The preference for 2-door cars is higher in New York than in Texas or North Carolina. The frequencies of associated inclement weather and surface road conditions other than dry are also higher in New York compared with the other two states analyzed.

TABLE 3-12

FREQUENCY DISTRIBUTIONS OF KEY VARIABLES IN DRIVER-ONLY NEW YORK 1974 SAMPLE

Variable	Category	Absolute Frequency	% of Known
Driver Injury	K	208	0.3
	A	3,568	5.5
	B	8,383	12.8
	C	7,714	11.8
	0	45,413	69.6
	Injured Extent - Unknown	307	-
Model Year Class	Pre	12,996	19.8
	Post	52,597	80.2
Vehicle Body Style	2-Door	43,767	66.7
	4-Door	21,826	33.3
Road Classification	State or Interstate Hwy	21,929	34.7
	County or Town Road	15,208	24.0
	City Street	22,595	35.7
	Limited Access	3,542	5.6
	Missing	2,319	-
Weather	Clear	37,227	57.0
	Cloudy	12,721	19.5
	Rain	10,272	15.7
	Snow	3,746	5.7
	Sleet/Hail/Freezing Rain	871	1.3
	Fog/Smog/Smoke	439	0.7
	Other	66	0.1
	Missing	251	-
Road Surface Condition	Dry	41,746	64.2
	Wet	16,066	24.6
	Muddy	95	0.1
	Snow-Ice	6,229	9.5
	Slush	817	1.3
	Other	166	0.3
	Missing	274	-
Vehicle Damage	None	765	1.2
	Light	19,049	29.5
	Moderate	34,280	53.1
	Severe	9,893	15.3
	Demolished	560	0.9
	Missing	1,046	-
Driver Age	15-24	23,039	35.2
	25-34	14,964	22.9
	35-49	12,991	19.8
	50+	14,453	22.1
	Missing	146	-

TABLE 3-12 (Continued)

Variable	Category	Absolute Frequency	% of Known
Driver Sex	Male Female	45,196 20,397	68.9 31.1
Number of Occupants	One Two or More Missing	36,742 23,882 4,969	60.6 39.4 -
Restraint Usage	None Used Lap Belt Harness Lap Belt and Harness Child Restraint Other Missing	34,341 11,243 533 1,372 3 113 17,988	72.1 23.6 1.1 2.9 0.0 0.2 -
Vehicle Weight	LT 3000 lbs 3000-3599 lbs 3600-4399 lbs GE 4000 lbs Missing	15,386 21,321 22,684 4,797 1,405	24.0 33.3 35.3 7.5 -
Number of Vehicles	One Two or More	9,949 55,644	15.2 84.8
Manufacturer	GM Ford Other	33,414 15,988 16,191	50.9 24.4 24.7
Total Number of Cases		65,593	-

TABLE 3-13

INJURY RATES FOR NEW YORK 1974

Variable	Category	Injury Rate (Percent)				Number of Drivers			
		2-Door		4-Door		2-Door		4-Door	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
Road Classification N = 63,274	State or Interstate Highway	38.3	31.8	35.8	28.8	2,608	14,508	2,096	6,259
	County or Town Road	40.8	33.5	38.8	30.3	1,884	8,823	1,310	3,191
	City Street	31.3	29.2	30.7	24.4	2,498	11,868	2,232	5,997
Driver Age N = 65,447	15-24	37.0	32.1	37.8	28.3	3,256	14,008	2,087	3,688
	25-49	35.9	31.0	33.2	27.4	2,730	15,751	2,449	7,025
	50 or Older	33.6	28.0	30.6	25.5	1,189	6,727	1,240	5,297
Manufacturer N = 65,593	GM	35.4	29.3	33.6	25.7	3,547	19,115	2,758	7,994
	Ford	36.7	31.7	36.8	27.6	2,262	8,969	1,202	3,555
	Other	36.3	33.4	33.5	28.8	1,399	8,475	1,828	4,489
Number of Occupants N = 60,624	One	39.2	33.8	39.3	29.8	3,830	20,995	3,014	8,903
	Two or More	33.5	27.8	29.2	24.0	2,801	12,843	2,312	5,926
Road Surface Condition N = 65,319	Dry	36.8	31.4	33.9	27.6	4,640	23,505	3,579	10,222
	Other	34.8	30.0	35.1	26.1	2,542	12,914	2,178	5,739
Point of Impact N = 65,593	Hood & Front	42.4	37.6	41.5	33.5	4,062	19,591	3,118	8,253
	Right Front	28.9	23.2	26.2	20.8	1,738	9,116	1,541	4,224
	Left Front	26.3	22.8	25.1	19.2	1,408	7,852	1,129	3,561
Towaway N = 65,593	No	21.7	17.5	20.1	15.4	4,198	21,884	3,508	10,447
	Yes	55.8	50.7	55.1	48.6	3,010	14,675	2,280	5,591
Vehicle Weight N = 64,188	LT 3,000 lbs	39.1	36.0	39.6	34.1	2,502	10,176	1,199	1,509
	3,000 lbs or More	34.3	28.8	33.3	26.4	4,705	26,205	4,347	12,545
Restraint Usage N = 47,605	No	46.0	40.5	44.5	36.3	4,599	18,179	3,701	7,978
	Yes	35.4	34.1	35.6	31.0	810	8,508	579	3,251
Number of Vehicles N = 65,593	One	76.4	65.0	77.1	64.1	1,273	5,715	985	1,976
	Two	27.3	24.5	25.4	21.8	5,935	30,844	4,803	14,062
Driver Sex N = 65,593	Male	34.2	28.6	31.7	24.8	5,293	24,627	4,142	11,134
	Female	40.8	35.6	40.6	31.9	1,915	11,932	1,646	4,904
Vehicle Damage N = 64,547	None-Light	20.9	17.5	19.7	15.3	2,050	10,732	1,756	5,276
	Moderate	35.4	30.2	34.2	27.5	3,757	19,211	2,999	8,313
	Severe-Demolished	63.3	57.4	63.6	55.6	1,285	6,070	929	2,169
Weather N = 65,342	Clear-Cloudy	36.5	30.9	34.0	27.3	5,526	27,858	4,371	12,193
	Other	34.9	31.0	35.3	26.2	1,658	8,562	1,390	3,784

TABLE 3-14

INTERACTION TERMS EVALUATED IN VARIABLE SELECTION PROCEDURE

NEW YORK 1974

Variable	Interaction Terms from Saturated Model Containing Prepost, Style and Variable			Interaction Terms from Saturated Model Containing Injury, Prepost, Style and Variable				Harmonic Mean of the Interaction Terms
	Var x Style	Var x Prepost	Var x Prepost x Style	Var x Injury	Var x Injury x Prepost	Var x Injury x Style	Var x Injury x Style x Prepost	
	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	
Road Classification	196.33*	59.74*	2.67	151.73*	8.65*	2.34	3.90	5.823
Driver Age	1818.67*	466.75*	118.89*	63.90*	1.55	1.19	4.09	3.985
Manufacturer	356.84*	66.30*	115.20*	57.76*	9.65*	0.85	1.00	3.013
Number of Occupants	18.39*	61.04*	0.75	266.10*	0.89	2.43	4.08*	2.196
Road Surface Condition	5.36*	2.44	3.99*	11.46*	0.86	0.53	2.95	1.620
Point of Impact	30.58*	38.74*	1.87	1631.16*	0.76	0.46	1.99	1.527
Towaway	130.03*	34.44*	9.64*	8100.39*	2.78	2.44	0.13	0.814
Vehicle Weight	2324.08*	431.34*	136.67*	243.04*	5.62*	0.87	0.07	0.448
Restraint Usage	35.91*	1125.01*	0.11	170.02*	5.80*	0.80	0.05	0.230
Number of Vehicles	83.48*	76.82*	18.07*	6739.11*	47.94*	5.26*	0.01	0.070
Driver Sex	9.43*	96.48*	18.08*	334.49*	0.01	1.57	0.67	0.069
Vehicle Damage	119.75*	28.74*	5.85	5141.41*	0.16	2.21	0.01	0.066
Weather	1.06	0.04	1.04	0.57	0.01	0.11	3.36	0.051

*$p < 0.05$

Note: The degrees of freedom for all interaction terms for all variables are one except for: road classification, driver age, manufacturer, point of impact and vehicle damage. For these variables, the degrees of freedom are two for all interaction terms.

Variables above the bold line were selected.

Injury rates (KABC percentages) and the number of drivers on which the rates are based are given in Table 3-13. High injury rates occur for towaway accidents, direct frontal impacts, lighter-weight vehicles, severely damaged vehicles, lack of restraint usage, female drivers and drivers age 15-24 years old. The last variable result requires comment since it appears to differ from the results for Texas and North Carolina. In Texas, Driver Age is a dichotomy and drivers 35 years and older have higher injury rates. The categories of Driver Age differ in North Carolina among years but in no case does the category 15-25 years old have the highest rates. Environmental and socioeconomic factors that differ among the three states could be important in explaining this difference. Also, it should be noted that the overall injury rate is much higher in New York (31%) compared to Texas (11%) and North Carolina (15%).

The information used in the variable selection procedure to determine those variables selected for modeling of the New York 1974 data is given in Table 3-14. Ordering the variables according to the harmonic mean of the seven interaction terms resulted in Road Classification, Driver Age and Manufacturer being the leading three variables that were selected for modeling of the New York 1974 data sample. The completely cross-classified tables of the New York Driver-Only 1974 data prior to modeling are given for Injury, Prepost, Style, Road Classification, Driver Age and Manufacturer in Appendix A. A separate table is given for each of the three injury dichotomies--KA vs BCO, KAB vs CO and KABC vs O.

North Carolina 1973, 1974, 1975

The size of the seat back lock drivers-only data set relative to the entire 1973-1975 North Carolina accident data base can be characterized by noting the fraction of accidents, vehicles and fatalities contained in the data set as given in Table 3-15. The reasons for the low fatality rate have been discussed previously (page 3-5).

TABLE 3-15

ACCIDENTS, VEHICLES AND FATALITIES IN 1973-1975
North Carolina Data Base

Year	Variable	Full Data Base	Partial Data Set	Percent
1973	Accidents	129,150	21,876	16.9
	Vehicles	232,825	27,345	11.7
	Fatalities	1,859	54	2.9
1974	Accidents	121,568	21,366	17.6
	Vehicles	218,506	26,707	12.2
	Fatalities	1,585	47	3.0
1975	Accidents	129,013	22,729	17.6
	Vehicles	232,180	28,411	12.2
	Fatalities	1,519	56	3.7

The basic data set was derived by selecting all drivers in passenger vehicles that satisfied the following criteria:

- Involved in two-car head-on collision.
- Involved in two-car collision other than head-on, and sustained front end damage.
- Involved in single-car collision with a fixed object and sustained front end damage.
- Collided with a parked car and sustained front end damage.

Thus, the data subset includes all passenger cars involved in frontal impact accidents that could indicate the effects of seat back locks. Vehicles involved in multi-vehicle accidents are excluded from the sample as are all struck vehicles. Vehicles striking non-fixed objects such as animals, bicyclists and pedestrians are similarly excluded.

The data base was screened using the following variables and conditions:

- Means of Involvement in Accident = More than 2 Vehicles Involved.
- Vehicle Type = 2-door or 4-door Sedan.
- Vehicle Body Style = 2-door Sedan or 2-door Hardtop, or 4-door Sedan or 4-door Hardtop.
- Vehicle Model Year = 1960 or later.
- Vehicle Make = Domestic.
- Region of Impact = Frontal Collision.
- Accident Type = Hit Parked Vehicle, Hit Fixed Object Head-On, Other 2-Vehicle.

The univariate frequencies of some key variables in the North Carolina drivers-only sample are given in Table 3-16. Unique features of the North Carolina sample include a high frequency of known information on Alcohol Involvement (97%) and Restraint Usage (93%). Other unique information in the North Carolina sample includes Estimated Vehicle Speed and Adjusted Vehicle Speed. Estimated Vehicle Speed refers to the speed of the vehicle prior to impact. This speed is adjusted in two-vehicle collisions to account for the speed of the other vehicle to obtain Adjusted Vehicle Speed. Note that TAD is not included in the table, as 54 percent of the data are missing.

Injury Rates (KABC percentages) and the number of drivers on which the rates are based are given in Tables 3-17, 3-18 and 3-19 for the North Carolina 1973, 1974 and 1975 drivers-only sample. Higher injury rates occur for lower vehicle weights, higher estimated and adjusted vehicle speeds, state and interstate highways, alcohol involvement, failure to use restraints, reduced light conditions and presence of an occupant seated behind the driver.

TABLE 3-16

FREQUENCY DISTRIBUTIONS OF KEY VARIABLES IN DRIVER-ONLY NORTH CAROLINA SAMPLE

Variable	Category	1973		1974		1975		Total: 1973-1975	
		Absolute Frequency	% of Known	Absolute Frequency	% of Known	Absolute Frequency	% of Known	Absolute Frequency	% of Known
KABCO	K	54	0.2	47	0.2	56	0.2	157	0.2
	A	626	2.3	564	2.1	550	1.9	1,740	2.1
	B	1,674	6.1	1,654	6.2	1,799	6.3	5,127	6.2
	C	1,713	6.3	1,791	6.7	2,029	7.1	5,533	6.7
	0	23,278	85.1	22,651	84.8	23,977	84.4	69,906	84.8
Model Year Class	Pre	8,936	32.7	7,331	27.4	6,708	23.6	22,975	27.9
	Post	18,409	67.3	19,376	72.6	21,703	76.4	59,488	72.1
Vehicle Body Style	2-Door	15,522	56.8	14,990	56.1	15,787	55.6	46,299	56.1
	4-Door	11,823	43.2	11,717	43.9	12,624	44.4	36,164	43.9
City Size	Rural	10,877	39.8	9,743	36.5	9,919	34.9	20,183	24.5
	Under 1,000	309	1.1	324	1.2	382	1.3	4,675	5.7
	1,000- 4,999	1,688	6.2	1,689	6.3	1,838	6.5	4,005	4.9
	5,000- 9,999	1,448	5.3	1,424	5.3	1,600	5.6	3,496	4.2
	10,000-14,999	1,101	4.0	1,125	4.2	1,268	4.5	2,068	2.5
	15,000-19,999	1,030	3.8	1,067	4.0	1,204	4.2	3,301	4.0
	20,000-24,999	633	2.3	665	2.5	770	2.7	3,494	4.2
	25,000-34,999	1,058	3.9	1,144	4.3	1,294	4.6	4,472	5.4
	35,000-49,999	1,407	5.1	1,333	5.0	1,265	4.5	5,215	6.3
	50,000-75,000	1,434	5.2	1,523	5.7	1,718	6.0	1,015	1.2
	GT 75,000	6,360	23.3	6,670	25.0	7,153	25.2	30,539	37.0
Road Classification	Interstate	403	1.5	255	1.0	294	1.0	952	1.2
	U.S.	4,801	17.6	4,302	16.1	4,325	15.3	13,428	16.3
	North Carolina	2,985	11.0	2,670	10.0	2,840	10.0	8,495	10.3
	Rural Paved Rd	3,987	14.6	3,695	13.9	3,850	13.6	11,532	14.0
	Rural Unpaved Rd	382	1.4	420	1.6	350	1.2	1,152	1.4
	City Street	14,661	53.9	15,300	57.4	16,678	58.9	46,639	56.7
	Missing	126	-	65	-	74	-	265	-
Weather	Clear	18,104	66.6	17,416	65.6	18,264	64.6	53,784	65.6
	Cloudy	4,816	17.7	4,792	18.0	4,992	17.7	14,600	17.8
	Rain	3,581	13.2	3,927	14.8	4,548	16.1	12,056	14.7
	Snowing	359	1.3	101	0.4	165	0.6	625	0.8
	Fog	286	1.1	270	1.0	242	0.9	798	1.0
	Sleet or Hail	44	0.2	46	0.2	41	0.1	131	0.2
	Missing	155	-	155	-	159	-	469	-
Accident Type	Coll.w Fixed Obj	1,558	5.7	1,432	5.4	1,374	4.8	4,363	5.3
	Coll.w Motor Veh	25,787	94.3	25,275	94.6	27,037	95.2	78,099	94.7
Light Condition	Daylight	20,582	75.4	19,951	74.9	21,489	75.8	62,022	75.4
	Dusk	893	3.3	863	3.2	947	3.3	2,703	3.3
	Dawn	276	1.0	270	1.0	281	1.0	827	1.0
	Dark/Lit	3,078	11.3	3,307	12.4	3,365	11.9	9,750	11.8
	Dark/Unlit	2,484	9.1	2,261	8.5	2,253	8.0	6,998	8.5
	Missing	32	-	55	-	76	-	163	-
Road Surface Condition	Dry	21,264	77.9	20,864	78.3	21,848	77.1	63,976	77.8
	Wet	4,981	18.2	5,571	20.9	6,200	21.9	16,752	20.4
	Oily	26	0.1	20	0.1	11	0.0	57	0.1
	Muddy	43	0.2	24	0.1	30	0.1	97	0.1
	Snowy	380	1.4	74	0.3	111	0.4	565	0.7
	Icy	611	2.2	100	0.4	122	0.4	833	1.0
	Missing	40	-	54	-	89	-	183	-
Investigating Agency	City Police	16,267	59.5	16,740	62.7	18,198	64.1	51,205	62.1
	Sheriff	7	0.0	11	0.0	16	0.1	34	0.0
	Rural Cnty Police	145	0.5	76	0.3	53	0.2	274	0.3
	Highway Patrol	10,919	39.9	9,869	37.0	10,126	35.6	30,914	37.5
	Other	7	0.0	11	0.0	18	0.1	36	0.0

TABLE 3-16

FREQUENCY DISTRIBUTIONS OF KEY VARIABLES IN DRIVER-ONLY NORTH CAROLINA SAMPLE (Continued)

Variable	Category	1973		1974		1975		Total: 1973-1975	
		Absolute Frequency	% of Known	Absolute Frequency	% of Known	Absolute Frequency	% of Known	Absolute Frequency	% of Known
Estimated Vehicle Speed	1-29 mph	13,834	53.1	13,863	54.1	14,765	53.9	42,462	53.7
	30-49 mph	9,313	35.8	9,287	36.2	10,118	36.9	28,718	36.3
	50+ mph	2,884	11.1	2,474	9.7	2,521	9.2	7,879	10.0
	Missing	1,314	-	1,083	-	1,007	-	3,404	-
Adjusted Vehicle Speed	1-29 mph	10,802	42.6	10,920	43.2	11,938	44.0	33,660	43.3
	30-49 mph	11,098	43.7	11,443	45.3	12,305	45.3	34,846	44.8
	50+ mph	3,474	13.7	2,891	11.4	2,882	10.6	9,248	11.9
	Missing	1,971	-	1,453	-	1,285	-	4,709	-
Driver Age	15-25	11,606	42.8	11,228	42.3	11,800	41.7	34,634	42.3
	26-55	11,846	43.7	11,466	43.2	12,294	43.4	35,606	43.4
	56+	3,671	13.5	3,826	14.4	4,211	14.9	11,708	14.3
	Missing	222	-	187	-	106	-	515	-
Driver Sex	Male	17,464	64.0	16,883	63.4	17,643	62.1	51,990	63.2
	Female	9,808	36.0	9,752	36.6	10,751	37.9	30,311	36.8
	Missing	73	-	72	-	17	-	162	-
Alcohol Involvement	No	24,838	93.5	23,926	92.4	25,601	93.1	74,365	93.0
	Drnkng-Impaired	812	3.1	1,046	4.0	1,042	3.8	2,900	3.6
	Drnkng-Imp Unk	910	3.4	915	3.5	865	3.1	2,690	3.4
	Missing	785	-	820	-	903	-	2,508	-
Restraint Usage	No Belt	21,053	85.6	21,729	85.5	23,505	87.0	66,287	86.1
	Lap Belt	3,331	13.5	3,044	12.0	2,853	10.6	9,228	12.0
	Lap & Shoulder	121	0.5	506	2.0	623	2.3	1,250	1.6
	Shoulder Only	104	0.4	129	0.5	26	0.1	259	0.3
	Missing	2,736	-	1,299	-	1,404	-	5,439	-
Number of Occupants	One	16,964	63.4	16,526	61.9	17,318	61.0	50,808	62.1
	Two or More	9,804	36.6	10,175	38.1	11,087	39.0	31,066	37.9
	Missing	577	-	6	-	6	-	589	-
Person Behind Driver	Yes	2,065	7.6	2,043	7.6	2,377	8.4	6,485	7.9
	No	25,280	92.4	24,664	92.4	26,034	91.6	75,978	92.1
Vehicle Weight	LT 3,000 lbs	5,601	20.6	5,182	19.5	5,420	19.2	16,203	19.8
	3,000-3,599 lbs	11,544	42.4	10,351	39.0	10,473	37.1	32,368	39.5
	GT 3,600 lbs	10,065	37.0	11,006	41.5	12,343	43.7	33,414	40.8
	Missing	135	-	168	-	175	-	478	-
Number of Vehicles	One	198	0.7	208	0.8	227	0.8	633	0.8
	Two	27,147	99.3	26,499	99.2	28,184	99.2	81,830	99.2
Manufacturer	GM	14,335	52.4	14,311	53.6	15,148	53.3	43,794	53.1
	Ford	8,654	31.6	8,160	30.6	8,795	31.0	25,609	31.1
	Other	4,356	15.9	4,236	15.9	4,468	15.7	13,060	15.8
Model Year Category	Early Pre-Stnd	4,689	17.1	3,584	13.4	3,130	11.0	11,403	13.8
	Late Pre-Stnd	4,247	15.5	3,747	14.0	3,578	12.6	11,572	14.0
	Early Post-Stnd	16,102	58.9	14,727	55.1	14,999	52.8	45,828	55.6
	Late Post-Stnd	2,307	8.4	4,646	17.4	6,704	23.6	13,660	16.6
Total Number of Cases		27,345	-	26,707	-	28,411	-	82,463	-

TABLE 3-17

INJURY RATES FOR NORTH CAROLINA 1973

Variable	Category	Injury Rate (Percent)				Number of Drivers			
		2-Door		4-Door		2-Door		4-Door	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
Vehicle Weight N = 27,210	LT 3,000 lbs 3,000-3,599 lbs 3,600+ lbs	18.3 17.0 12.8	17.3 14.5 12.7	19.3 15.4 15.4	18.7 14.3 12.0	1,543 2,476 695	2,736 5,031 3,021	739 2,034 1,388	583 2,003 4,961
Manufacturer N = 27,345	GM Ford Other	16.9 17.0 16.0	13.8 15.9 15.4	15.5 16.7 17.1	12.3 13.3 15.8	1,943 2,326 462	5,682 3,165 1,944	2,168 1,458 579	4,542 1,705 1,371
Adjusted Vehicle Speed N = 25,373	1-29 MPH 30-49 MPH 50+ MPH	8.1 21.3 25.9	7.3 17.7 27.9	9.0 19.1 31.4	7.2 16.4 23.4	1,770 2,000 603	4,274 4,317 1,424	1,661 1,757 481	3,097 3,024 966
Driver Age N = 27,123	15-25 26-55 56+	15.8 18.3 17.7	14.5 15.3 13.5	14.5 17.7 16.1	11.8 13.6 13.7	2,629 1,712 351	5,837 4,239 615	1,455 1,731 983	1,685 4,164 1,722
Estimated Vehicle Speed N= 26,031	1-29 MPH 30-49 MPH 50+ MPH	9.6 22.2 28.5	8.5 18.2 29.9	11.1 20.9 32.5	8.1 18.1 25.2	2,275 1,731 513	5,215 3,788 1,262	2,269 1,400 323	4,075 2,394 786
City Size N = 27,345	LT 50,000 50,000+	17.1 16.3	15.9 13.0	16.9 13.9	13.9 11.6	3,500 1,231	7,473 3,318	3,126 1,079	5,452 2,166
Road Classification N = 27,219	State or Interstate Highway Rural Road City Street	19.3 18.0 15.1	17.9 14.4 12.9	19.1 17.7 14.0	16.3 14.0 11.2	1,335 942 2,435	3,350 1,713 5,682	1,173 673 2,333	2,331 1,041 4,212
Accident Type N = 27,345	Coll.wFixed Obj Coll.wMotor Veh	21.1 16.5	21.3 14.4	20.1 15.9	16.6 13.0	350 4,381	558 10,233	259 3,946	391 7,227
Restraint Usage N = 24,609	Yes No	13.9 17.7	12.5 15.8	12.4 17.1	12.2 14.3	267 3,984	1,604 8,152	291 3,489	1,394 5,428
Light Condition N = 27,313	Daylight Reduced Light	15.5 20.6	13.0 19.6	15.2 19.3	12.1 17.0	3,443 1,284	7,948 2,832	3,207 995	5,984 1,620

TABLE 3-17

INJURY RATES FOR NORTH CAROLINA 1973 (Continued)

Variable	Category	Injury Rate (Percent)				Number of Drivers			
		2-Door		4-Door		2-Door		4-Door	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
Road Surface Condition N = 27,305	Dry Other	16.9 16.7	15.1 13.4	16.4 15.0	13.6 11.7	3,669 1,056	8,309 2,467	3,310 891	5,976 1,627
Investigating Agency N = 27,186	City Police Highway Patrol	15.2 18.9	13.1 17.2	14.4 18.8	11.4 16.0	2,677 2,037	6,376 4,339	2,549 1,635	4,665 2,908
Weather N = 27,190	Clear-Cloudy Other	16.8 17.7	14.8 14.8	15.9 17.8	13.1 13.5	3,985 713	8,946 1,796	3,556 619	6,433 1,142
Person Behind Driver N = 27,345	No Yes	16.6 19.7	14.6 16.4	15.8 20.4	13.1 13.6	4,356 375	9,991 800	3,896 309	7,037 581
Driver Sex N = 27,272	Male Female	15.6 22.1	12.8 18.2	13.0 21.6	10.9 16.8	3,282 1,436	6,892 3,869	2,651 1,540	4,639 2,963
Number of Vehicles N = 27,345	One Two	37.8 16.6	34.9 14.6	33.3 16.0	34.9 13.0	45 4,686	86 10,705	24 4,181	43 7,575
Alcohol Involvement N = 26,560	No Yes	15.4 27.3	13.8 24.7	15.2 22.9	12.7 19.1	4,158 388	9,849 648	3,758 336	7,073 350
Number of Occupants N = 26,768	One Two or More	15.9 18.6	14.0 16.2	15.2 18.0	12.6 14.5	2,800 1,824	6,678 3,884	2,618 1,493	4,868 2,603

TABLE 3-18

INJURY RATES FOR NORTH CAROLINA 1974

Variable	Category	Injury Rate (Percent)				Number of Drivers			
		2-Door		4-Door		2-Door		4-Door	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
Vehicle Weight N = 26,539	LT 3,000 lbs	17.6	19.7	21.4	18.3	1,224	2,744	641	573
	3,000-3,599 lbs	16.8	15.1	17.3	14.3	1,886	4,768	1,754	1,943
	3,600+ lbs	16.9	13.2	13.9	12.0	592	3,724	1,176	5,514
Manufacturer N = 26,707	GM	16.2	14.4	17.3	12.4	1,492	6,105	1,968	4,746
	Ford	17.4	16.4	17.1	13.6	1,871	3,236	1,138	1,915
	Other	18.5	17.9	15.4	14.4	363	1,923	499	1,451
Adjusted Vehicle Speed N = 25,254	1-29 MPH	8.3	7.8	9.4	6.9	1,423	4,616	1,508	3,373
	30-49 MPH	19.9	18.2	20.8	15.8	1,692	4,780	1,511	3,460
	50+ MPH	31.2	32.4	33.0	25.9	398	1,269	373	851
Road Classification N = 26,642	State or Interstate Highway	19.0	18.5	20.4	15.5	968	3,082	936	2,241
	Rural Road	20.0	17.0	18.5	15.8	712	1,749	547	1,107
	City Street	15.2	13.8	15.2	11.2	2,039	6,413	2,108	4,740
Driver Age N = 26,520	15-25	15.0	15.1	15.9	12.1	2,016	5,988	1,270	1,954
	26+	19.5	16.0	17.6	13.4	1,686	5,194	2,309	6,103
Light Condition N = 26,652	Daylight	15.9	14.1	14.9	12.1	2,703	8,272	2,709	6,267
	Reduced Light	20.1	19.5	23.5	16.5	1,011	2,972	892	1,826
Restraint Usage N = 25,408	Yes	11.6	14.3	16.1	10.4	215	1,821	193	1,450
	No	17.6	16.2	17.3	13.8	3,331	8,928	3,216	6,254
Investigating Agency N = 26,609	City Police	14.9	13.7	15.2	11.2	2,229	7,022	2,294	5,195
	Highway Patrol	20.1	18.5	20.2	16.2	1,489	4,194	1,296	2,890
Estimated Vehicle Speed N = 25,624	1-29 MPH	10.3	9.2	11.1	8.2	1,855	5,550	2,007	4,451
	30-49 MPH	21.1	19.8	22.3	17.7	1,367	4,104	1,160	2,656
	50+ MPH	31.7	31.0	38.2	27.5	347	1,160	280	687
Number of Vehicles N = 26,707	One	32.0	35.1	50.0	27.1	25	111	24	48
	Two	16.9	15.4	16.8	12.9	3,701	11,153	3,581	8,064

TABLE 3-18

INJURY RATES FOR NORTH CAROLINA 1974 (Continued)

Variable	Category	Injury Rate (Percent)				Number of Drivers			
		2-Door		4-Door		2-Door		4-Door	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
City Size N = 26,707	LT 5,000 5,000+	19.1 15.2	17.4 14.1	19.3 15.1	15.4 11.3	1,745 1,981	4,936 6,328	1,598 2,007	3,477 4,635
Person Behind Driver N = 26,707	No Yes	16.7 20.5	15.4 18.1	16.9 18.5	12.8 15.6	3,428 298	10,442 822	3,291 314	7,503 609
Road Surface Condition N - 26,653	Dry Other	17.0 17.1	15.6 15.3	17.3 16.0	13.0 13.1	2,918 795	8,763 2,485	2,832 769	6,351 1,740
Alcohol Involvement N = 25,887	No Yes	15.4 26.4	14.5 26.2	15.9 25.6	12.5 19.3	3,204 390	10,181 770	3,127 344	7,414 457
Driver Sex N = 26,635	Male Female	14.8 22.2	13.2 19.7	15.1 20.4	11.2 15.8	2,604 1,110	7,085 4,146	2,337 1,259	4,857 3,237
Number of Occupants N = 26,701	One Two or More	16.6 17.7	15.1 16.3	16.2 18.4	12.5 14.0	2,199 1,525	6,956 4,307	2,240 1,365	5,131 2,978
Accident Type N = 26,707	Coll.w Fixed Obj Coll.w Motor Veh	21.6 16.7	20.4 15.3	22.9 16.6	19.3 12.7	232 3,494	565 10,699	236 3,369	399 7,713
Weather N = 26,552	Clear-Cloudy Other	17.2 16.2	15.4 16.3	17.4 15.2	13.1 12.5	3,072 625	9,361 1,843	3,022 564	6,753 1,312

TABLE 3-19
INJURY RATES FOR NORTH CAROLINA 1975

Variable	Category	Injury Rate (Percent)				Number of Drivers			
		2-Door		4-Door		2-Door		4-Door	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
Vehicle Weight N = 28,236	LT 3,000 lbs	18.2	19.8	18.8	19.8	1,200	2,908	634	678
	3,000-3,599 lbs	17.8	14.3	16.1	15.7	1,694	4,907	1,619	2,253
	3,600+ lbs	16.8	14.3	15.2	13.5	475	4,539	1,044	6,285
Driver Sex N = 28,394	Male	15.1	12.7	14.6	11.8	2,369	7,640	2,070	5,564
	Female	24.2	20.3	19.5	18.6	1,010	4,756	1,253	3,722
Manufacturer N = 28,411	GM	17.7	14.0	16.0	13.7	1,274	6,743	1,670	5,461
	Ford	17.7	18.1	17.0	16.7	1,726	3,717	1,136	2,216
	Other	18.3	16.2	16.7	14.3	382	1,945	520	1,621
Driver Age N = 28,305	15-25	15.8	15.1	15.5	13.5	1,860	6,403	1,197	2,340
	26-55	20.6	16.3	17.3	15.5	1,200	5,097	1,293	4,704
	56+	18.9	15.5	16.6	13.5	302	864	820	2,225
Estimated Vehicle Speed N = 27,404	1-29 MPH	10.3	9.1	10.4	9.0	1,668	6,180	1,859	5,058
	30-49 MPH	22.4	20.9	23.4	19.7	1,266	4,601	1,139	3,112
	50+ MPH	39.8	29.3	29.3	30.0	334	1,181	213	793
Adjusted Vehicle Speed N = 27,126	1-29 MPH	8.8	8.2	9.0	7.3	1,347	5,190	1,400	4,001
	30-49 MPH	20.6	19.1	20.5	18.0	1,517	5,398	1,448	3,942
	50+ MPH	38.8	30.0	31.1	30.1	384	1,250	305	944
City Size N = 28,411	LT 25,000	18.4	16.7	16.4	15.3	2,167	7,207	2,074	5,533
	25,000+	16.6	14.1	16.5	13.4	1,215	5,198	1,252	3,765
Road Classification N = 28,337	State & Interstate Highway	21.1	18.7	20.3	18.4	904	3,269	824	2,462
	Rural Road	19.3	18.0	16.5	16.1	611	1,851	496	1,242
	City Street	15.7	13.6	14.8	12.5	1,855	7,250	2,001	5,572
Number of Occupants N = 28,405	One	16.5	15.5	16.7	14.3	1,980	7,610	1,949	5,779
	Two or More	19.6	15.8	16.1	14.9	1,401	4,792	1,376	3,518
Number of Vehicles N = 28,411	One	36.4	38.3	64.7	35.5	33	115	17	62
	Two	17.6	15.4	16.2	14.4	3,349	12,290	3,309	9,236

TABLE 3-19

INJURY RATES FOR NORTH CAROLINA 1975 (Continued)

Variable	Category	Injury Rate (Percent)				Number of Drivers			
		2-Door		4-Door		2-Door		4-Door	
		Pre	Post	Pre	Post	Pre	Post	Pre	Post
Weather N = 28,252	Clear-Cloudy	18.2	15.3	16.1	14.2	2,766	10,120	2,751	7,619
	Other	16.0	16.9	18.3	16.1	601	2,217	563	1,615
Investigating Agency N = 28,324	City Police	15.4	13.7	14.8	12.5	2,038	7,949	2,150	6,061
	Highway Patrol	21.5	19.1	19.4	18.4	1,332	4,424	1,167	3,203
Accident Type N = 28,411	Coll.w Fixed Obj	20.5	21.7	24.2	17.2	200	572	194	408
	Coll.w Motor Veh	17.6	15.3	16.0	14.4	3,182	11,833	3,132	8,890
Light Condition N = 28,335	Daylight	16.2	14.5	15.2	13.7	2,463	9,144	2,535	7,347
	Reduced Light	22.0	18.6	20.5	17.8	908	3,233	786	1,919
Alcohol Involvement N = 27,508	No	16.2	14.7	15.5	14.2	2,954	11,165	2,891	8,591
	Yes	30.4	23.6	24.3	19.1	306	830	305	466
Restraint Usage N = 27,007	Yes	11.5	14.4	12.9	13.1	165	1,735	147	1,455
	No	18.4	16.1	17.1	15.0	3,046	10,087	3,012	7,360
Road Surface Condition N = 28,322	Dry	17.9	15.5	16.0	14.2	2,611	9,470	2,594	7,173
	Other	17.4	16.1	18.0	16.8	759	2,900	722	2,093
Person Behind Driver N = 28,411	No	17.6	15.7	16.2	14.5	3,090	11,427	3,006	8,511
	Yes	19.5	14.5	19.1	14.4	292	978	320	787

The information used in the variable selection to determine those variables selected for modeling of the North Carolina 1973-1975 data is given in Tables 3-20, 3-21 and 3-22. Ordering the variables according to the harmonic mean of the seven interaction terms resulted in the selection of variables for each year as follows:

1973	1974	1975
Vehicle Weight	Vehicle Weight	Vehicle Weight
Manufacturer	Manufacturer	Driver Sex
Estimated Vehicle Speed		Manufacturer

The completely cross-classified tables of the North Carolina driver-only 1973-1975 data samples prior to modeling are given in Appendix A.

TABLE 3-20

INTERACTION TERMS EVALUATED IN VARIABLE SELECTION PROCEDURE
NORTH CAROLINA 1973

Variable	Interaction Terms from Saturated Model Containing Prepost, Style and Variable			Interaction Terms from Saturated Model Containing Injury, Prepost, Style and Variable				Harmonic Mean of the Interaction Terms
	Var x Style	Var x Prepost	Var x Prepost x Style	Var x Injury	Var x Injury x Prepost	Var x Injury x Style	Var x Injury x Style x Prepost	
	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	
Vehicle Weight	3217.64*	1428.69*	79.29*	56.59*	1.53	2.30	4.29	5.175
Manufacturer	290.66*	778.38*	26.53*	13.03*	3.19	3.73	1.16	4,480
Estimated Vehicle Speed	88.25*	20.85*	6.97*	926.30*	1.62	1.51	6.40*	4.270
Driver Age	2933.48*	154.76*	126.03*	11.16*	1.95	1.79	1.22	3.508
Adjusted Vehicle Speed	6.66*	14.57*	1.33	943.14*	1.03	2.69	8.40*	2.877
City Size	9.14*	44.00*	2.46	20.85*	0.75	0.51	1.28	1.502
Road Classification	44.68*	55.33*	1.67	100.58*	2.04	1.29	0.24	1.152
Accident Type	2.40	30.86*	3.01	28.27*	0.65	0.80	0.37	1.110
Restraint Usage	48.80*	622.91*	0.25	22.80*	0.54	0.32	0.43	0.616
Light Condition	72.48*	7.88*	2.25	118.05*	2.61	1.23	0.05	0.322
Road Surface Condition	7.35*	0.51	0.11	8.26*	1.32	0.33	0.11	0.290
Investigating Agency	21.34*	8.01*	2.46	90.82*	0.88	0.93	0.03	0.194
Weather	7.43*	4.16*	1.73	0.79	0.70	0.24	0.03	0.171
Person Behind Driver	0.02	0.21	1.32	6.28*	1.57	0.04	0.57	0.085
Driver Sex	49.09*	42.53*	8.00*	197.90*	1.92	1.90	0.01	0.070
Number of Vehicles	7.56*	0.62	0.29	50.23*	0.18	0.01	0.15	0.060
Alcohol Involvement	12.71*	76.34*	5.48*	103.84*	0.01	3.27	0.01	0.035
Number of Occupants	15.35*	11.46*	0.81	24.94*	0.18	0.01	0.01	0.034

*$p < 0.05$

Note: The degrees of freedom for all interaction terms for all variables are one except for: vehicle weight, manufacturer, estimated vehicle speed, driver age, adjusted vehicle speed and road classification. For these variables, the degrees of freedom are two for all interaction terms.

Variables above the bold line were selected.

TABLE 3-21

INTERACTION TERMS EVALUATED IN VARIABLE SELECTION PROCEDURE
NORTH CAROLINA 1974

Variable	Interaction Terms from Saturated Model Containing Prepost, Style and Variable			Interaction Terms from Saturated Model Containing Injury, Prepost, Style and Variable				Harmonic Mean of the Interaction Terms
	Var x Style	Var x Prepost	Var x Prepost x Style	Var x Injury	Var x Injury x Prepost	Var x Injury x Style	Var x Injury x Style x Prepost	
	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	
Vehicle Weight	2897.22*	165.92*	72.51*	78.63*	5.66	2.75	3.89	8.487
Manufacturer	252.41*	586.49*	77.65*	15.23*	3.65	2.13	0.83	3.445
Adjusted Vehicle Speed	6.99*	4.79	7.47*	1034.68*	0.71	1.96	0.65	1.775
Road Classification	31.07*	28.78*	3.42	92.43*	0.38	0.59	1.64	1.320
Driver Age	1901.69*	77.36*	75.70*	12.39*	3.58	0.22	2.38	1.308
Light Condition	42.03*	5.96*	1.68	108.22*	0.17	0.94	3.56	0.873
Restraint Usage	7.96*	674.04*	3.38	18.01*	0.16	0.83	3.25	0.850
Investigating Agency	14.70*	5.57*	2.86	114.66*	0.13	0.33	0.31	0.481
Estimated Vehicle Speed	91.52*	4.65	0.27	944.89*	0.40	0.11	1.37	0.431
Number of Vehicles	7.05*	1.23	2.27	48.05*	0.23	0.10	1.79	0.429
City Size	5.14*	11.18*	1.25	70.52*	0.03	1.45	0.39	0.186
Person Behind Driver	1.14	6.46*	0.38	10.65*	0.05	0.05	0.40	0.152
Road Surface Condition	0.74	0.59	0.21	0.22	0.10	0.02	0.49	0.095
Alcohol Involvement	12.00*	107.94*	1.09	125.15*	0.01	2.18	0.42	0.068
Driver Sex	37.54*	84.63*	3.19	162.61*	0.01	1.77	0.11	0.064
Number of Occupants	10.61*	8.67*	1.32	9.94*	0.01	0.65	0.06	0.059
Accident Type	0.01	19.97*	0.40	30.97*	0.19	0.85	0.05	0.055
Weather	0.99	0.01	0.97	0.14	1.50	1.38	0.03	0.049

*$p < 0.05$

Note: The degrees of freedom for all interaction terms for all variables are one except for: vehicle weight, manufacturer, adjusted vehicle speed, road classification and estimated vehicle speed. For these variables, the degrees of freedom are two for all interaction terms.

Variables above the bold line were selected.

TABLE 3-22

INTERACTION TERMS EVALUATED IN VARIABLE SELECTION PROCEDURE
NORTH CAROLINA 1975

Variable	Interaction Terms from Saturated Model Containing Prepost, Style and Variable			Interaction Terms from Saturated Model Containing Injury, Prepost, Style and Variable				Harmonic Mean of the Interaction Terms
	Var x Style	Var x Prepost	Var x Prepost x Style	Var x Injury	Var x Injury x Prepost	Var x Injury x Style	Var x Injury x Style x Prepost	
	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	LR χ^2	
Vehicle Weight	2703.51*	2045.25*	19.53*	59.41*	9.52*	3.12	1.89	6.839
Driver Sex	30.96*	68.30*	21.92*	252.47*	0.92	1.40	1.40	2.885
Manufacturer	256.11*	591.66*	42.52*	32.09*	8.73*	0.88	0.83	2.783
Driver Age	2495.82*	156.41*	55.57*	18.32*	2.84	0.42	2.48	2.177
Estimated Vehicle Speed	78.69*	4.72	11.79*	1080.69*	2.47	0.38	4.60	1.965
Adjusted Vehicle Speed	7.12*	4.70	6.52*	1156.18*	1.27	0.24	4.58	1.233
City Size	1.27	42.89*	5.22*	20.40*	2.08	1.04	0.23	1.024
Road Classification	25.24*	22.65*	6.78*	125.68*	1.45	1.44	0.16	0.890
Number of Occupants	1.14	21.26*	0.31	1.97	0.61	0.43	3.22	0.784
Number of Vehicles	8.61*	0.14	0.91	73.69*	0.41	0.76	3.50	0.564
Weather	1.56	0.32	0.13	5.18*	2.06	1.38	1.99	0.524
Investigating Agency	11.42*	11.21*	5.28*	147.78*	0.50	0.08	0.80	0.435
Accident Type	0.54	19.98*	0.09	23.48*	0.03	0.11	3.28	0.126
Light Condition	91.84*	9.43*	3.95*	75.40*	0.69	0.03	0.02	0.083
Alcohol Involvement	18.29*	82.52*	10.33*	92.08*	3.17	4.03*	0.01	0.070
Restraint Usage	9.74*	581.03*	3.96*	11.51*	2.75	0.01	0.43	0.068
Road Surface Condition	2.71	2.20	0.01	3.81	0.23	2.21	0.21	0.064
Person Behind Driver	4.17*	5.82*	0.19	0.01	2.77	0.41	0.01	0.034

*$p < 0.05$

Note: The degrees of freedom for all interaction terms for all variables are one except for: vehicle weight, manufacturer, driver age, estimated vehicle speed, adjusted vehicle speed and road classification. For these variables, the degrees of freedom are two for all interaction terms.

Variables above the bold line were selected.

3.1.3 Analysis of Mass Accident Data

Following completion of the variable selection procedure, the analytical steps that remain are modeling, adjustment, computation of effectiveness and estimation of error. Each of these steps and the results are described in this subsection.

Modeling

The basic purpose of modeling is to attempt to control for and take into account confounding effects through smoothing the data and removing random variability. Separate log linear models were fit for each of the three injury dichotomies (KA/BCO, KAB/CO and KABC/O) for each state and year of mass accident data analyzed. Each model was fit to a table consisting of an injury dichotomy (Injury), model year related to Standard implementation (Prepost) and passenger car body style (Style) as well as those selected variables (usually 3 in number) discussed in Section 3.1.2.

A series of tables is presented that documents and summarizes the modeling process and the results obtained. Complete modeling information for Texas, New York and North Carolina is given in Appendix B. Models were fitted separately for the three years of Texas data, the single year of New York data and the three years of North Carolina data for each injury dichotomy (i.e., KA/BCO, KAB/CO and KABC/O). Specifically, the likelihood ratio (LR) chi-square values in Appendix B tables are derived from tests of marginal association of each effect (variable interaction term) in which the table is summed over all unspecified margins, after which the effect is tested to be zero. Chi-square values marked with an asterisk in the Appendix represent the actual effects specified in a given model. All other chi-square values denote specific effects included due to the hierarchical nature of the log-linear models.

The strategy used to fit models can be summarized as follows:

1. As many significant effects (in terms of their marginal association) as required are first specified in an attempt to derive a model with an optimal fit. Optimal fit refers to the situation in which the magnitude of the model's LR chi-square is roughly similar to its number of degrees of freedom.
2. Effects were either deleted or added to the model in a stepwise fashion until the deletion of any one effect would result in a significant worsening of the fit, whereas the addition of any single effect would not significantly improve the model's fit.

This approach represents a compromise between the two considerations of parsimony and goodness-of-fit.

For the convenience of the reader, the complete model fitting information given in Appendix B is summarized in this section in Tables 3-23 through 3-32. In these tables, only the marginal associations of directly specified model effects (those values with an asterisk in Appendix B) are included. Tables 3-23, 3-24 and 3-25 contain the results for each year of Texas data for the injury dichotomies KA/BCO, KAB/CO and KABC/O, respectively. Only those effects that are directly specified in at least one year are included in the table. A dash in the table indicates that the particular effect was not directly specified in the model for that year. The marginal association of directly specified model effects for all three injury dichotomies for the single year of New York data is given in Table 3-26. Finally, the results for North Carolina are given in Tables 3-27, 3-28 and 3-29 in a format analogous to the Texas model results.

In each of the above analyses, a model was fit to the entire drivers-only data set for a given state and year. Additionally, a separate data set was created for each year of Texas data in which only drivers in vehicles of model years from 1965 through 1971 were included. About two-thirds of the passenger cars are within this model year range. The reduced sample has the advantage of (1) including only those vehicles having model years reasonably close to the Standard implementation date, (2) eliminating very old cars, and (3) reducing the extent of confounding effects such as the market shift from 4-door to 2-door cars which took place over an extended period of years. Tables 3-30, 3-31 and 3-32 contain the directly specified model effects for each year of Texas 1965-1971 model year derived data for the injury dichotomies KA/BCO, KAB/CO and KABC/O. The corresponding full models are given in Appendix B.

TABLE 3-23

SUMMARY OF MARGINAL ASSOCIATION OF DIRECTLY SPECIFIED MODEL EFFECTS FOR INJURY DICHOTOMY KA vs BCO TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost x Style	-	-	-	0.81	1	0.369	0.21	1	0.647
Injury x Prepost x City Size	-	-	-	26.62	2	0.000	-	-	-
Injury x Driver Age x City Size	16.67	4	0.002	-	-	-	-	-	-
Injury x City Size x Road Type	-	-	-	148.76	4	0.000	-	-	-
Injury x City Size x Accident Type	-	-	-	-	-	-	205.77	4	0.000
Injury x City Size x TAD	-	-	-	-	-	-	104.71	4	0.000
Injury x Road Type x Driver Age	-	-	-	21.35	4	0.000	-	-	-
Prepost x Style x Driver Age	-	-	-	743.34	2	0.000	-	-	-
Prepost x Style x City Size	-	-	-	16.05	2	0.000	5.32	2	0.070
Prepost x City Size x Road Type	-	-	-	27.54	4	0.000	-	-	-
Prepost x City Size x Driver Age	-	-	-	3.44	4	0.487	-	-	-
Prepost x City Size x Accident Type	-	-	-	-	-	-	59.92	4	0.000
Prepost x City Size x TAD	-	-	-	-	-	-	38.10	4	0.000
Prepost x Road Type x Driver Age	-	-	-	15.17	4	0.004	-	-	-
Style x Driver Age x City Size	61.38	4	0.000	-	-	-	-	-	-
Style x City Size x Accident Type	-	-	-	-	-	-	16.86	4	0.002
Accident Type x Driver Age x City Size	17.23	8	0.028	-	-	-	-	-	-
City Size x Accident Type x TAD	-	-	-	-	-	-	510.98	8	0.000
Injury x Style x City Size x Driver Age	-	-	-	12.33	4	0.015	-	-	-
Prepost x Style x Accident Type x Driver Age	11.07	4	0.026	-	-	-	-	-	-
Prepost x Style x Accident Type x TAD	-	-	-	-	-	-	10.60	4	0.032
Style x City Size x Road Type x Driver Age	-	-	-	18.15	8	0.020	-	-	-
Injury x Prepost x Style x Accident Type x City Size	11.59	4	0.021	-	-	-	-	-	-
SUMMARY OF MODEL	112.13	98	0.152	115.24	106	0.2537	141.42	122	00.1103

TABLE 3-24

SUMMARY OF MARGINAL ASSOCIATION OF DIRECTLY SPECIFIED MODEL EFFECTS FOR INJURY DICHOTOMY KAB vs CO TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost x Style	0.68	1	0.408	-	-	-	14.58	1	0.000
Injury x Prepost x Accident Type	-	-	-	-	-	-	26.12	2	0.000
Injury x Prepost x Driver Age	13.50	2	0.001	-	-	-	-	-	-
Injury x Style x City Size	-	-	-	-	-	-	1.10	2	0.578
Injury x Accident Type x TAD	-	-	-	-	-	-	242.48	4	0.000
Injury x City Size x Road Type	-	-	-	178.00	4	0.000	-	-	-
Injury x City Size x Accident Type	-	-	-	-	-	-	353.53	4	0.000
Injury x City Size x TAD	-	-	-	-	-	-	54.50	4	0.000
Injury x Road Type x Driver Age	-	-	-	26.35	4	0.000	-	-	-
Prepost x Style x City Size	12.39	2	0.002	16.07	2	0.000	5.32	2	0.070
Prepost x City Size x Road Type	-	-	-	27.52	4	0.000	-	-	-
Prepost x Road Type x Driver Age	-	-	-	15.17	4	0.004	-	-	-
Style x Driver Age x City Size	61.37	4	0.000	-	-	-	-	-	-
Style x City Size x Accident Type	-	-	-	-	-	-	16.86	4	0.002
City Size x Accident Type x TAD	-	-	-	-	-	-	510.98	8	0.000
Injury x Prepost x Accident Type x City Size	9.94	4	0.041	-	-	-	-	-	-
Injury x Prepost x Style x Driver Age	-	-	-	14.32	2	0.001	-	-	-
Injury x Prepost x City Size x Driver Age	-	-	-	10.34	4	0.035	-	-	-
Injury x Style x Accident Type x City Size	17.38	4	0.002	-	-	-	-	-	-
Inj. x Acc. Type x Driver Age x City Size	23.20	8	0.003	-	-	-	-	-	-
Prepost x Style x Accident Type x Driver Age	11.07	4	0.026	-	-	-	-	-	-
Prepost x Style x Accident Type x TAD	-	-	-	-	-	-	10.60	4	0.032
Style x City Size x Road Type x Driver Age	-	-	-	18.15	8	0.020	-	-	-
SUMMARY OF MODEL	91.50	96	0.6108	118.89	104	0.1508	129.82	116	0.1794

TABLE 3-25

SUMMARY OF MARGINAL ASSOCIATION OF DIRECTLY SPECIFIED MODEL EFFECTS FOR INJURY DICHOTOMY KABC vs O TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost x Style	0.46	1	0.496	0.26	1	0.608	13.40	1	0.000
Injury x Prepost x Driver Age	19.15	2	0.000	-	-	-	-	-	-
Prepost x Style x Driver Age	-	-	-	743.34	2	0.000	-	-	-
Prepost x Style x City Size	12.39	2	0.002	16.07	2	0.000	5.32	2	0.070
Prepost x City Size x Road Type	-	-	-	27.52	4	0.000	-	-	-
Prepost x Road Type x Driver Age	-	-	-	15.17	4	0.004	-	-	-
Accident Type x Driver Age x City Size	17.25	8	0.028	-	-	-	-	-	-
Injury x Prepost x Accident Type x City Size	10.13	4	0.038	-	-	-	-	-	-
Injury x Prepost x City Size x Driver Age	-	-	-	11.68	4	0.020	-	-	-
Injury x Style x Accident Type x City Size	12.66	4	0.013	-	-	-	-	-	-
Injury x Style x Driver Age x City Size	10.97	4	0.027	-	-	-	-	-	-
Prepost x Style x Accident Type x Driver Age	11.05	4	0.026	-	-	-	-	-	-
Prepost x Style x Accident Type x TAD	-	-	-	-	-	-	10.60	4	0.032
Injury x Style x City Size x Road Type x Driver Age	-	-	-	17.13	8	0.029	-	-	-
Injury x Prepost x City Size x Accident Type x TAD	-	-	-	-	-	-	17.95	8	0.022
SUMMARY OF MODEL	93.47	102	0.7149	82.05	74	0.2440	95.46	80	0.1144

TABLE 3-26

SUMMARY OF MARGINAL ASSOCIATION OF DIRECTLY SPECIFIED MODEL EFFECTS FOR THE THREE INJURY DICHOTOMIES NEW YORK 1974 DRIVERS-ONLY SAMPLE

Effect	KA vs BCO		KAB vs CO		KABC vs O	
	LR χ^2	Prob.	LR χ^2	Prob.	LR χ^2	Prob.
Injury x Rd Cl	123.51	0.000	-	-	-	-
Injury x Age	57.11	0.000	-	-	95.39	0.000
Injury x Prepost x Style	6.64	0.010	9.99	0.002	5.92	0.015
Injury x Prepost x Rd Cl	-	-	-	-	9.68	0.008
Injury x Prepost x Mfg	7.67	0.022	15.12	0.001	10.31	0.006
Injury x Style x Rd Cl	-	-	8.67	0.013	-	-
Injury x Style x Age	-	-	10.40	0.006	-	-
Injury x Rd Cl x Age	-	-	-	-	9.61	0.048
Prepost x Rd Cl x Age	17.80	0.001	17.80	0.001	17.05	0.002
Style x Rd Cl x Age	23.69	0.000	23.69	0.000	23.49	0.000
Prepost x Style x Rd Cl x Mfg	13.00	0.011	13.00	0.011	13.33	0.010
Prepost x Style x Age x Mfg	13.70	0.008	13.70	0.008	13.85	0.008
SUMMARY OF MODEL	138.49	0.3321	133.98	0.3409	141.47	0.1637

Note: The degrees of freedom for the entire model are: KA-132, KAB-128, KABC-126.

TABLE 3-27

SUMMARY OF MARGINAL ASSOCIATION OF DIRECTLY SPECIFIED MODEL EFFECTS FOR INJURY DICHOTOMY KA vs BCO NORTH CAROLINA DRIVERS-ONLY SAMPLE

Effect	North Carolina 1973			North Carolina 1974			North Carolina 1975		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Weight	-	-	-	44.87	2	0.000	17.47	2	0.000
Injury x Sex	-	-	-	-	-	-	4.00	1	0.046
Mfg x Est Speed	20.34	4	0.000	-	-	-	-	-	-
Injury x Prepost x Style	5.79	1	0.016	1.93	1	0.165	1.75	1	0.187
Injury x Weight x Est Speed	9.99	4	0.041	-	-	-	-	-	-
Prepost x Style x Est Speed	6.00	2	0.050	-	-	-	-	-	-
Prepost x Style x Sex	-	-	-	-	-	-	19.96	1	0.000
Prepost x Weight x Sex	-	-	-	-	-	-	6.25	2	0.044
Prepost x Sex x Mfg	-	-	-	-	-	-	31.07	2	0.000
Prepost x Style x Weight x Mfg	75.99	4	0.000	88.20	4	0.000	78.61	4	0.000
Style x Weight x Sex x Mfg	-	-	-	-	-	-	20.74	4	0.000
SUMMARY OF MODEL	102.56	152	0.264	34,49	30	0.262	88.83	77	0.168

TABLE 3-28

SUMMARY OF MARGINAL ASSOCIATION OF DIRECTLY SPECIFIED MODEL EFFECTS FOR INJURY DICHOTOMY KAB vs CO NORTH CAROLINA DRIVERS-ONLY SAMPLE

Effect	North Carolina 1973			North Carolina 1974			North Carolina 1975		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Style x Est Speed	88.65	2	0.000	-	-	-	-	-	-
Mfg x Est Speed	20.32	4	0.000	-	-	-	-	-	-
Injury x Prepost x Style	0.47	1	0.494	6.87	1	0.009	2.32	1	0.127
Injury x Prepost x Weight	-	-	-	-	-	-	8.81	2	0.012
Injury x Weight x Mfg	-	-	-	10.65	4	0.031	-	-	-
Prepost x Style x Sex	-	-	-	-	-	-	19.96	1	0.000
Prepost x Sex x Mfg	-	-	-	-	-	-	31.06	2	0.000
Injury x Prepost x Weight x Est Spd	11.33	4	0.023	-	-	-	-	-	-
Prepost x Style x Weight x Mfg	75.98	4	0.000	88.20	4	0.000	78.60	4	0.000
Injury x Weight x Sex x Mfg	-	-	-	-	-	-	12.34	4	0.015
Style x Weight x Sex x Mfg	-	-	-	-	-	-	20.74	4	0.000
SUMMARY OF MODEL	161.69	142	0.124	29.60	24	0.198	67.07	63	0.400

TABLE 3-29

SUMMARY OF MARGINAL ASSOCIATION OF DIRECTLY SPECIFIED MODEL EFFECTS FOR INJURY DICHOTOMY KABC vs O NORTH CAROLINA DRIVERS-ONLY SAMPLE

Effect	North Carolina 1973			North Carolina 1974			North Carolina 1975		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Weight	70.55	2	0.000	109.44	2	0.000	75.72	2	0.000
Injury x Est Speed	918.70	2	0.000	-	-	-	-	-	-
Injury x Sex	-	-	-	-	-	-	249.97	1	0.000
Weight x Est Speed	28.88	4	0.000	-	-	-	-	-	-
Mfg x Est Speed	20.32	4	0.000	-	-	-	-	-	-
Injury x Prepost x Style	2.01	1	0.157	6.97	1	0.008	0.06	1	0.811
Injury x Prepost x Mfg	-	-	-	-	-	-	7.65	2	0.022
Prepost x Style x Est Speed	6.00	2	0.050	-	-	-	-	-	-
Prepost x Style x Sex	-	-	-	-	-	-	19.96	1	0.000
Prepost x Sex x Mfg	-	-	-	-	-	-	31.06	2	0.000
Prepost x Style x Weight x Mfg	75.98	4	0.000	88.20	4	0.000	78.60	4	0.000
Style x Weight x Sex x Mfg	-	-	-	-	-	-	20.74	4	0.000
SUMMARY OF MODEL	174.60	156	0.147	29.51	30	0.491	76.34	75	0.435

TABLE 3-30

SUMMARY OF MARGINAL ASSOCIATION OF DIRECTLY SPECIFIED MODEL EFFECTS FOR INJURY DICHOTOMY KA vs BCO MODEL YEARS 1965-1971 TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Driver Age	3.59	2	0.166	-	-	-	-	-	-
Style x TAD	-	-	-				106.61	2	0.000
Injury x Prepost x Style	0.42	1	0.518	0.06	1	0.804	0.14	1	0.705
Injury x Prepost x City Size	-	-	-	17.93	2	0.000	-	-	-
Injury x Style x Accident Type	-	-	-	-	-	-	6.35	2	0.042
Injury x City Size x Road Type	-	-	-	84.48	4	0.000	-	-	-
Injury x City Size x Accident Type	-	-	-	-	-	-	123.71	4	0.000
Injury x City Size x TAD	-	-	-	-	-	-	69.86	4	0.000
Prepost x Style x Driver Age	280.18	2	0.000	132.49	2	0.000	-	-	-
Prepost x Style x City Size	7.23	2	0.267	12.57	2	0.002	6.90	2	0.032
Prepost x Accident Type x Driver Age	12.56	4	0.014	-	-	-	-	-	-
Prepost x Accident Type x City Size	17.13	4	0.002	-	-	-	13.13	4	0.011
Prepost x City Size x Road Type	-	-	-	13.10	4	0.011	-	-	-
Prepost x City Size x TAD	-	-	-	-	-	-	12.08	4	0.017
Style x Accident Type x Driver Age	20.51	4	0.000	-	-	-	-	-	-
Style x Driver Age x City Size	41.69	4	0.000	65.71	4	0.000	-	-	-
Style x City Size x Road Type	-	-	-	17.98	4	0.001	-	-	-
City Size x Road Type x Driver Age	-	-	-	41.74	8	0.000	-	-	-
City Size x Accident Type x TAD	-	-	-	-	-	-	286.51	8	0.000
Injury x Style x Accident Type x City Size	17.81	4	0.001	-	-	-	-	-	-
Injury x Prepost x Accident Type x TAD	-	-	-	-	-	-	10.94	4	0.027
SUMMARY OF MODEL	147.04	134	0.2083	148.72	144	0.3766	132.00	126	0.3393

TABLE 3-31

SUMMARY OF MARGINAL ASSOCIATION OF DIRECTLY SPECIFIED MODEL EFFECTS FOR INJURY DICHOTOMY KAB vs CO MODEL YEARS 1965-1971 TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Style x TAD	-	-	-	-	-	-	110.61	2	0.000
Injury x Prepost x Style	0.14	1	0.707	0.68	1	0.409	7.93	1	0.005
Injury x Prepost x City Size	15.99	2	0.000	19.80	2	0.000	12.41	2	0.002
Injury x Prepost x Driver Age	-	-	-	11.98	2	0.002	-	-	-
Injury x Style x Accident Type	-	-	-	-	-	-	9.15	2	0.010
Injury x Style x Driver Age	5.86	2	0.053	9.77	2	0.008	-	-	-
Injury x Accident Type x TAD	-	-	-	-	-	-	154.15	4	0.000
Injury x Driver Age x City Size	28.43	4	0.000	-	-	-	-	-	-
Injury x City Size x Road Type	-	-	-	116.13	2	0.000	-	-	-
Injury x City Size x Accident Type	-	-	-	-	-	-	195.01	4	0.000
Injury x City Size x TAD	-	-	-	-	-	-	41.52	4	0.000
Injury x Road Type x Driver Age	-	-	-	19.58	4	0.001	-	-	-
Prepost x Style x Accident Type	29.14	2	0.000	-	-	-	8.55	2	0.014
Prepost x Style x Driver Age	280.18	2	0.000	132.49	2	0.000	-	-	-
Prepost x Style x City Size	7.23	2	0.027	12.57	2	0.002	6.92	2	0.031
Prepost x Accident Type x Driver Age	12.56	4	0.014	-	-	-	-	-	-
Prepost x Accident Type x TAD	-	-	-	-	-	-	23.03	4	0.000
Prepost x City Size x Road Type	-	-	-	13.10	4	0.011	-	-	-
Prepost x City Size x Accident Type	17.13	4	0.002	-	-	-	13.12	4	0.011
Style x Accident Type x Driver Age	20.51	4	0.000	-	-	-	-	-	-
Style x Driver Age x City Size	41.69	4	0.000	65.71	4	0.000	-	-	-
Style x City Size x Road Type	-	-	-	17.98	4	0.001	-	-	-
City Size x Road Type x Driver Age	-	-	-	41.74	8	0.000	-	-	-
City Size x Accident Type x TAD	-	-	-	-	-	-	286.51	8	0.000
Injury x Style x Accident Type x City Size	12.78	4	0.012	-	-	-	-	-	-
SUMMARY OF MODEL	130.56	126	0.3722	146.17	134	0.2228	155.25	136	0.1237

TABLE 3-32

SUMMARY OF MARGINAL ASSOCIATION OF DIRECTLY SPECIFIED MODEL EFFECTS FOR INJURY DICHOTOMY KABC vs O MODEL YEARS 1965-1971 TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Style x TAD	-	-	-	-	-	-	110.61	2	0.000
Injury x Prepost x Style	-	-	-	3.09	1	0.079	6.02	1	0.014
Injury x Prepost x City Size	-	-	-	13.06	2	0.002	-	-	-
Injury x Style x Accident Type	-	-	-	-	-	-	7.35	2	0.025
Injury x Style x Driver Age	9.51	2	0.009	-	-	-	-	-	-
Injury x Accident Type x TAD	-	-	-	-	-	-	149.11	4	0.000
Injury x Driver Age x City Size	23.88	4	0.000	-	-	-	-	-	-
Injury x City Size x Accident Type	-	-	-	-	-	-	150.86	4	0.000
Injury x City Size x TAD	-	-	-	-	-	-	32.97	4	0.000
Prepost x Style x Accident Type	-	-	-	-	-	-	8.55	2	0.014
Prepost x Style x Driver Age	280.18	2	0.000	132.49	2	0.000	-	-	-
Prepost x Style x City Size	-	-	-	12.57	2	0.002	6.90	2	0.032
Prepost x Accident Type x Driver Age	12.56	4	0.014	-	-	-	-	-	-
Prepost x Accident Type x TAD	-	-	-	-	-	-	23.03	4	0.000
Prepost x City Size x Road Type	-	-	-	13.09	4	0.011	-	-	-
Prepost x City Size x Accident Type	-	-	-	-	-	-	13.12	4	0.011
Style x Accident Type x Driver Age	20.51	4	0.000	-	-	-	-	-	-
Style x Driver Age x City Size	41.69	4	0.000	-	-	-	-	-	-
City Size x Accident Type x TAD	-	-	-	-	-	-	286.51	8	0.000
Inj.x Prepost x Style x Acc.Type x City Size	10.81	4	0.029	-	-	-	-	-	-
Inj.x Style x City Size x Rd. Type x Dr.Age	-	-	-	20.33	8	0.009	-	-	-
SUMMARY OF MODEL	119.69	108	0.2079	92.81	88	0.3422	148.45	138	0.2566

Adjustment of Data

Prior to computing the actual effectiveness values, the smoothed data were adjusted so as to allow for the direct comparison of injury rates. Such adjustment is necessary in order to insure that the overall effectiveness estimate will not be affected by a potentially different distribution of 2-door and 4-door vehicles across all levels of the relevant pre-crash factors identified through the variable selection procedure (described in Section 3.1.2). The data were adjusted so that the following constraints were satisfied (notation is explained in Figure 3-2).

Constraint 1. The Pre-Post Standard mix of 2-door cars shall be the same for all pre-crash conditions:

$$\frac{n'_{.11\ell}}{n'_{.12\ell}} = \frac{n_{.11.}}{n_{.12.}}$$

Constraint 2. The distribution of 2-door cars over all pre-crash conditions shall remain unchanged:

$$n'_{.1.\ell} = n_{.1.\ell}$$

Constraint 3. The Pre-Post Standard mix of 4-door cars shall be the same for all pre-crash conditions:

$$\frac{n'_{.21\ell}}{n'_{.22\ell}} = \frac{n_{.21.}}{n_{.22.}}$$

Constraint 4. The distribution of 4-door cars over all pre-crash conditions shall remain unchanged:

$$n'_{.2.\ell} = n_{.2.\ell}$$

Constraints 5-8. For each Pre-Post/2-4 door combination within each pre-crash condition, the injury risk shall not be changed:

$$\frac{n'_{1jk\ell}}{n'_{.jk\ell}} = \frac{n_{1jk\ell}}{n_{.jk\ell}}$$

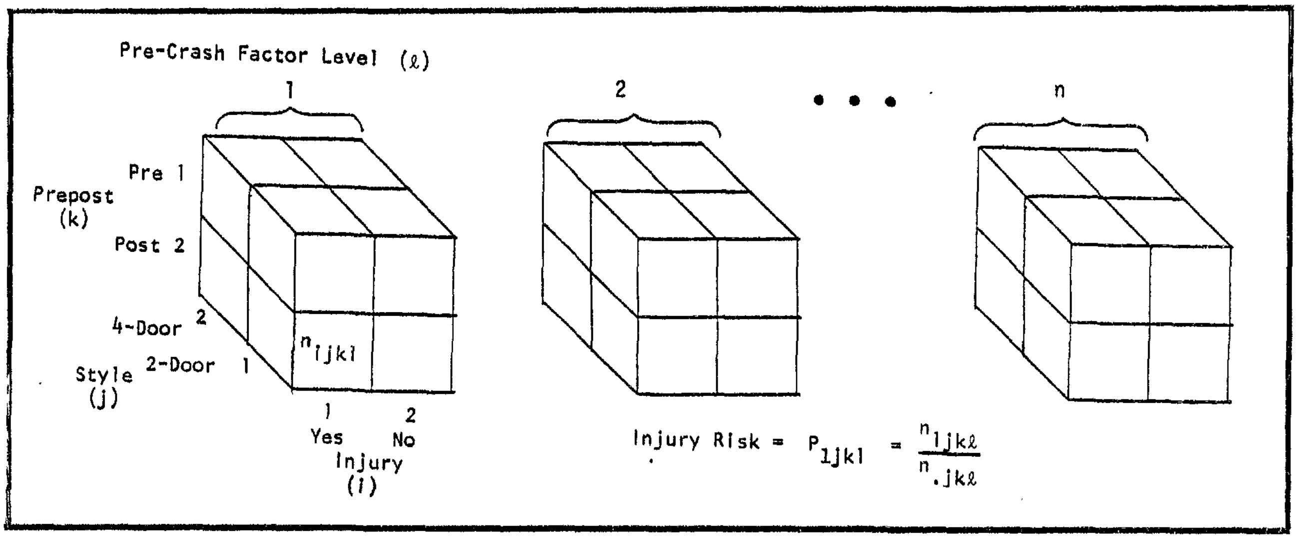

Figure 3-2. Summary of notation used in description of adjustment procedures.

As a first step in the adjustment procedure, the above constraints were satisfied by computing adjusted values (n') of the cell frequencies for the marginal sub-table representing the joint classification of the variables Pre-Post and Vehicle Body Style (2-door/4-door) within each level (ℓ) of the pre-crash conditions, as follows:

$$n'_{.11\ell} = \frac{(n_{.11.})(n_{.1.\ell})}{n_{.1..}}$$

$$n'_{.12\ell} = n_{.1.\ell} - n'_{.11\ell}$$

$$n'_{.21\ell} = \frac{(n_{.21.})(n_{.2.\ell})}{n_{.2..}}$$

$$n'_{.22\ell} = n_{.2.\ell} - n'_{.21\ell}$$

Next, in order to generate a complete table of adjusted values in which the variable Injury is explicitly represented, the adjusted marginal sub-totals computed in the previous step are decomposed into Injured/Uninjured categories by applying the original injury risk to the appropriate newly-adjusted marginal total, as follows:

$$n'_{111\ell} = \frac{n_{111\ell}}{n_{.11\ell}} (n'_{.11\ell})$$

$$n'_{211\ell} = \frac{n_{211\ell}}{n_{.11\ell}} (n'_{.11\ell})$$

$$n'_{121\ell} = \frac{n_{121\ell}}{n_{.21\ell}} (n'_{.21\ell})$$

$$n'_{221\ell} = \frac{n_{221\ell}}{n_{.21\ell}} (n'_{.21\ell})$$

$$n'_{112\ell} = \frac{n_{112\ell}}{n_{.12\ell}} (n'_{.12\ell})$$

$$n'_{212\ell} = \frac{n_{212\ell}}{n_{.12\ell}} (n'_{.12\ell})$$

$$n'_{122\ell} = \frac{n_{122\ell}}{n_{.22\ell}} (n'_{.22\ell})$$

$$n'_{222\ell} = \frac{n_{222\ell}}{n_{.22\ell}} (n'_{.22\ell})$$

After the cell frequencies were adjusted within each factor level, the data were aggregated over all factor levels, resulting in a single Injury x Prepost x Style table for each year of each state's data base. These latter tables of smoothed, adjusted data served as the basis for all subsequent effectiveness estimates.

As noted previously, proper adjustment of the data is necessary in order to allow for the direct comparison of injury rates. By following the procedure outlined in this section, such comparisons are not only possible, but the total number of drivers does not change, the effectiveness value within each factor level is not altered (nor is the corresponding odds ratio), but the various injury risks remain unchanged across all levels of pre-crash conditions. Table 3-33 contains the various pre-crash factors for each state and data year which served as the basis for the adjustment of the smoothed cell frequencies.

TABLE 3-33

VARIABLES USED IN ADJUSTMENT PROCEDURE

State	Year	Variables
Texas	1972	Accident Type Driver Age City Size
	1973	City Size Road Classification Driver Age
	1974	City Size Accident Type TAD
New York	1974	Road Classification Driver Age Manufacturer
North Carolina	1973	Vehicle Weight Manufacturer Estimated Vehicle Speed
	1974	Vehicle Weight Manufacturer
	1975	Vehicle Weight Driver Sex Manufacturer

Effectiveness and Error Estimation

Given the stochastic nature of the phenomenon under study, it is necessary to estimate the possible range of error for the results obtained. Using the notation depicted in Figure 3-3, the effectiveness of seat back locks in reducing driver injuries can be expressed as:

$$E = \left[1 - \left(\frac{p_{111}}{p_{121}} \times \frac{p_{122}}{p_{112}} \right) \right] \times 100$$

where $p_{ijk} = n_{ijk}/n_{.jk}$. Therefore, the problem at hand is one of deriving confidence limits for a double ratio of probabilities.

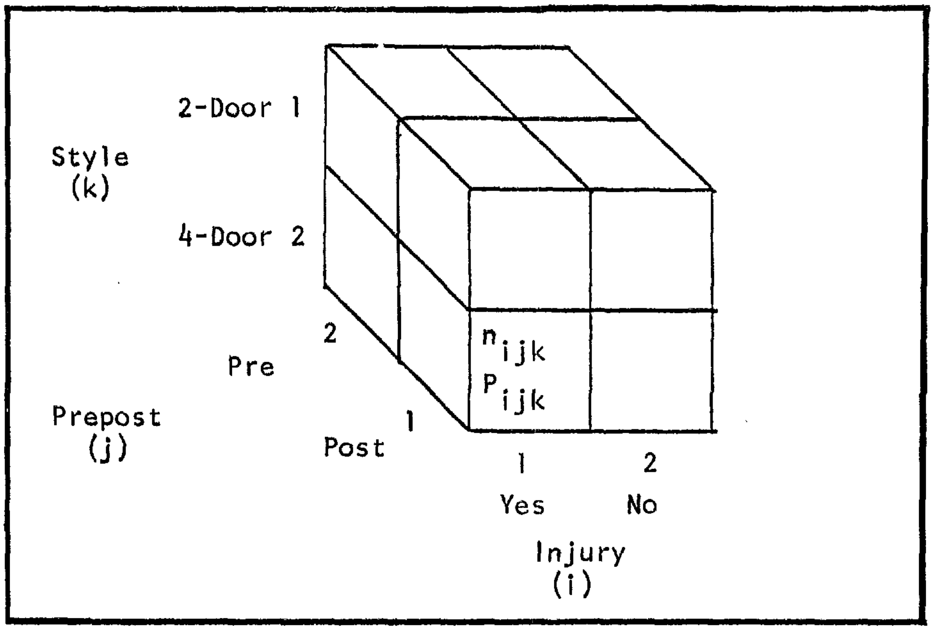

Figure 3-3. Basic contingency table for effectiveness computation and error estimation.

To estimate a confidence interval for R, where $R = \frac{p_{111}}{p_{121}} : \frac{p_{112}}{p_{122}} = \frac{p_{111}\, p_{122}}{p_{121}\, p_{112}}$,

it is assumed that both the p_{ijk} and n_{ijk} terms are binomially distributed random

variables. By defining $R = \frac{\pi_{111}\, \pi_{122}}{\pi_{121}\, \pi_{112}} \times \frac{(1 + \varepsilon_{111})(1 + \varepsilon_{122})}{(1 + \varepsilon_{121})(1 + \varepsilon_{112})}$ where the π_{ijk}'s are the expected values of the p_{ijk}'s, one can study the $\frac{(1 + \varepsilon_{111})(1 + \varepsilon_{122})}{(1 + \varepsilon_{121})(1 + \varepsilon_{112})}$ term by expanding the fraction in power series in ε_{121} and ε_{112}. These series expressions hold only if $|\varepsilon_{ijk}| < 1$. Hence, p_{1jk} should be restricted to the range $0 \ldots 2\pi_{1jk}$, or n_{1jk} to the range $0 \ldots 2n_{1jk}\pi_{1jk}$. Since $\sigma(n_{1jk}) = \sqrt{n_{.jk}\pi_{1jk}(1 - \pi_{1jk})}$, there is a $\pm$ 2σ range for $n_{.jk}\pi_{1jk} = 4(1 - \pi_{1jk})$. Since $n_{.jk}\pi_{1jk}$ is always much larger than 4 in the analyses reported here, this restriction is never violated in this study.

Since in all cases the $n_{.ij}p_{1ij}$ terms are well over 100, a second order approximation to the first and second moments, using a normal distribution to estimate the "true" mean and variance of R, was employed in CEM's error estimation procedure. Furthermore, since the expected value of R overestimates the effectiveness 1 - R, the bias in R was corrected, however small it may have been. A more detailed description of the error estimation procedure used, along with its rationale, is summarized in Appendix D. The actual formulas used in the present study are outlined below, using the notation depicted in Figure 3-2:

$$\text{Var (E)} = \left(\frac{p_{111}\,p_{122}}{p_{121}\,p_{112}}\right)^2 \left(\frac{1 - p_{111}}{n_{.11}\,p_{111}} + \frac{1 - p_{121}}{n_{.21}\,p_{121}} + \frac{1 - p_{112}}{n_{.12}\,p_{112}} + \frac{1 - p_{122}}{n_{.22}\,p_{122}}\right)$$

$$\text{unbiased (E)} = [1 - (r'xy)] \cdot 100,$$

$$\text{where } r' = \frac{p_{111}\,p_{122}}{p_{121}\,p_{112}},$$

$$x = 1 + \frac{1 - p_{121}}{n_{.21}\,p_{121}} - \frac{(1 - p_{121})(1 - 2p_{121})}{(n_{.21}\,p_{121})^2} + \left[\frac{3(1 - p_{121})^2}{n_{.21}\,p_{121}} + \frac{(1 - p_{121})(1 - 6p_{121}(1 - p_{121}))}{(n_{.21}\,p_{121})^3}\right]$$

$$y = 1 + \frac{1 - p_{112}}{n_{.12}\,p_{112}} - \frac{(1 - p_{112})(1 - 2p_{112})}{(n_{.12}\,p_{112})^2} + \left[\frac{3(1 - p_{112})^2}{n_{.12}\,p_{112}} + \frac{(1 - p_{112})(1 - 6p_{112}(1 - p_{112}))}{(n_{.12}\,p_{112})^3}\right]$$

In all cases, a 95 percent probability level ($\alpha = 0.05$) was used in constructing confidence intervals.

With the above discussion of the effectiveness computation and error estimation procedure in mind, we can now discuss the effectiveness results obtained. The results are presented in a series of computer-generated tables that provide the injury distributions for 2-door/4-door cars both Pre- and Post-Standard, the injury probabilities for these categories and the effectiveness with an associated standard deviation and confidence interval. These statistics are presented for the KA/BCO, KAB/CO and KABC/O injury dichotomies.* All of the effectiveness results presented in this section are obtained from either observed, unadjusted contingency table data or from smoothed (modeled) adjusted contingency table data. Only a summary of effectiveness values computed for observed, unadjusted data is given in this section; more detail is provided in Appendix C.

The effectiveness results for smoothed,adjusted data for Texas are presented in Tables 3-34, 3-35 and 3-36. The results for New York are in Table 3-37, and those for North Carolina are shown in Tables 3-38, 3-39 and 3-40. Finally, the effectiveness results for the Texas 1965-1971 model year sample are in Tables 3-41, 3-42 and 3-43. While a number of qualifying comments and interpretations need to be made, the results do not support the hypothesis that the introduction of seat back locks in 2-door cars reduces the injury risk to drivers in these cars. That is, the results do not demonstrate that this aspect of the Standard has been effective in reducing injury.

The effectiveness results obtained are summarized in Table 3-44 and Table 3-45 for observed, unadjusted mass accident data and smoothed, adjusted data, respectively. On the average, the net impact of modeling and adjustment was to increase the value of effectiveness estimates by roughly two to three percent.

The effectiveness values computed for the smoothed, adjusted data are most often negative. In Texas, the largest sample, effectiveness ranged from 4.9 percent to -12.7 percent for KA/BCO; -1.3 percent to -10.3 percent for KAB/CO; and -0.7 percent to -8.3 percent for KABC/O. The effectiveness values computed from the New York 1974 sample were negative for all three injury dichotomies (-7.2 percent to -17.9 percent). In North Carolina, the effectiveness was negative in 1973 and 1974 for all three injury dichotomies and positive in 1975.

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*Definitions of injury levels are: K = killed; A = severely injured; B = moderately injured; C = minor injuries; 0 = no injury.

TABLE 3-34

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1972 TEXAS
EXPECTED, ADJUSTED
TOTAL CASES = 159700

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	977	0.6	1145	0.7	1149	0.7	698	0.4	3969	2.5
B+C+O	30026	18.8	54504	34.1	37655	23.6	33546	21.0	155731	97.5
K+A+B	3001	1.9	4065	2.5	3509	2.2	2308	1.4	12883	8.1
C+O	28002	17.5	51583	32.3	35295	22.1	31937	20.0	146817	91.9
K+A+B+C	4181	2.6	6025	3.8	4866	3.0	3395	2.1	18467	11.6
O	26821	16.8	49628	31.1	33938	21.3	30847	19.3	141234	88.4
K+A+B+C+O	31003	19.4	55649	34.8	38804	24.3	34244	21.4	159700	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	4.92	6.09	-5.06	14.91
K+A+B	-1.33	3.50	-7.07	4.42
K+A+B+C	-1.58	2.87	-6.29	3.14

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	3.15	2.06	2.96	2.04	2.49
K+A+B	9.68	7.30	9.04	6.74	8.07
K+A+B+C	13.49	10.83	12.54	9.91	11.56

TABLE 3-35

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1973 TEXAS
EXPECTED, ADJUSTED
TOTAL CASES = 161915

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	752	0.5	1299	0.8	942	0.6	694	0.4	3687	2.3
B+C+O	24297	15.0	64755	40.0	30342	18.7	38834	24.0	158228	97.7
K+A+B	2607	1.6	4784	3.0	2951	1.8	2509	1.5	12851	7.9
C+O	22440	13.9	61272	37.8	28333	17.5	37019	22.9	149064	92.1
K+A+B+C	3560	2.2	7153	4.4	4034	2.5	3860	2.4	18607	11.5
O	21485	13.3	58904	36.4	27247	16.8	35667	22.0	143303	88.5
K+A+B+C+O	25049	15.5	66054	40.8	31284	19.3	39528	24.4	161915	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	-12.65	7.56	-25.04	-0.26
K+A+B	-3.48	3.62	-9.41	2.45
K+A+B+C	-0.65	2.87	-5.35	4.06

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	3.00	1.97	3.01	1.76	2.28
K+A+B	10.41	7.24	9.43	6.35	7.94
K+A+B+C	14.21	10.83	12.90	9.77	11.49

TABLE 3-36

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1974 TEXAS
EXPECTED, ADJUSTED
TOTAL CASES = 146451

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	492	0.3	1199	0.8	548	0.4	618	0.4	2857	2.0
B+C+O	17777	12.1	65892	45.0	22413	15.3	37512	25.6	143594	98.0
K+A+B	1762	1.2	5065	3.5	2114	1.4	2493	1.7	11434	7.8
C+O	16511	11.3	62026	42.4	20846	14.2	35634	24.3	135017	92.2
K+A+B+C	2404	1.6	7651	5.2	2962	2.0	3940	2.7	16957	11.6
O	15867	10.8	59437	40.6	20004	13.7	34189	23.3	129497	88.4
K+A+B+C+O	18269	12.5	67091	45.8	22961	15.7	38130	26.0	146451	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	1.93	7.71	-10.70	14.57
K+A+B	-10.34	4.28	-17.36	-3.33
K+A+B+C	-8.25	3.42	-13.86	-2.63

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.69	1.79	2.39	1.62	1.95
K+A+B	9.64	7.55	9.21	6.54	7.81
K+A+B+C	13.16	11.40	12.90	10.33	11.58

TABLE 3-37

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1974 NEW YORK
EXPECTED, ADJUSTED
TOTAL CASES = 62850

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	563	0.9	2056	3.3	411	0.7	693	1.1	3723	5.9
B+C+O	6360	10.1	32917	52.4	5188	8.3	14662	23.3	59127	94.1
K+A+B	1668	2.7	6594	10.5	1252	2.0	2401	3.8	11915	19.0
C+O	5257	8.4	28377	45.2	4343	6.9	12952	20.6	50929	81.0
K+A+B+C	2532	4.0	11025	17.5	1926	3.1	4250	6.7	19733	31.3
O	4425	7.0	24106	38.2	3700	5.9	11171	17.7	43402	68.7
K+A+B+C+O	6923	11.0	34973	55.6	5599	8.9	15355	24.4	62850	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	-17.93	8.93	-32.57	-3.29
K+A+B	-12.10	4.42	-19.35	-4.86
K+A+B+C	-7.15	3.08	-12.20	-2.11

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	8.13	5.88	7.34	4.51	5.92
K+A+B	24.09	18.86	22.38	15.64	18.96
K+A+B+C	36.39	31.38	34.23	27.56	31.26

TABLE 3-38

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1973 N. CAROLINA
EXPECTED,ADJUSTED
TOTAL CASES = 25898

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	2 - DOOR %	2 - DOOR POST	2 - DOOR %	4 - DOOR PRE	4 - DOOR %	4 - DOOR POST	4 - DOOR %	ROW TOTAL	ROW PCT
K+A	126	0.5	253	1.0	125	0.5	141	0.5	645	2.5
B+C+O	4377	16.9	10007	38.6	3822	14.8	7047	27.2	25253	97.5
K+A+B	473	1.8	876	3.4	365	1.4	523	2.0	2237	8.6
C+O	4035	15.6	9387	36.2	3584	13.8	6664	25.7	23670	91.4
K+A+B+C	733	2.8	1520	5.9	625	2.4	962	3.7	3840	14.8
O	3771	14.6	8743	33.8	3324	12.8	6227	24.0	22065	85.2
K+A+B+C+O	4503	17.4	10260	39.6	3947	15.2	7188	27.8	25898	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	-44.38	23.47	-82.87	-5.89
K+A+B	-3.70	8.81	-18.14	10.74
K+A+B+C	-7.85	6.78	-18.98	3.27

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.80	2.47	3.17	1.96	2.49
K+A+B	10.49	8.54	9.24	7.28	8.63
K+A+B+C	16.27	14.81	15.83	13.38	14.82

TABLE 3-39

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1974 N. CAROLINA
EXPECTED, ADJUSTED
TOTAL CASES = 26539

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	95	0.4	258	1.0	92	0.3	158	0.6	603	2.3
B+C+O	3607	13.6	10978	41.4	3480	13.1	7871	29.7	25936	97.7
K+A+B	368	1.4	1002	3.8	324	1.2	547	2.1	2241	8.4
C+O	3335	12.6	10233	38.6	3249	12.2	7481	28.2	24298	91.6
K+A+B+C	612	2.3	1768	6.7	573	2.2	1073	4.0	4026	15.2
O	3091	11.6	9465	35.7	2998	11.3	6956	26.2	22510	84.8
K+A+B+C+O	3702	13.9	11236	42.3	3572	13.5	8029	30.3	26539	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	-19.04	20.90	-53.32	15.23
K+A+B	-19.93	10.64	-37.38	-2.48
K+A+B+C	-14.59	7.35	-26.64	-2.54

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.57	2.30	2.58	1.97	2.27
K+A+B	9.94	8.92	9.07	6.81	8.44
K+A+B+C	16.53	15.74	16.05	13.36	15.17

TABLE 3-40

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1975 N. CAROLINA
EXPECTED, ADJUSTED
TOTAL CASES = 28233

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	93	0.3	255	0.9	64	0.2	185	0.7	597	2.1
B+C+O	3276	11.6	12097	42.8	3232	11.4	9031	32.0	27636	97.9
K+A+B	366	1.3	1020	3.6	293	1.0	734	2.6	2413	8.5
C+O	3003	10.6	11332	40.1	3004	10.6	8483	30.0	25822	91.5
K+A+B+C	609	2.2	1934	6.8	527	1.9	1355	4.8	4425	15.7
O	2762	9.8	10421	36.9	2770	9.8	7865	27.8	23818	84.3
K+A+B+C+O	3369	11.9	12352	43.8	3296	11.7	9216	32.6	28233	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	26.52	13.73	4.00	49.03
K+A+B	14.86	7.47	2.61	27.11
K+A+B+C	5.57	5.98	-4.23	15.38

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.76	2.06	1.94	2.01	2.11
K+A+B	10.66	8.26	8.89	7.96	8.55
K+A+B+C	18.07	15.65	15.98	14.70	15.67

TABLE 3-41

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1972 TEXAS 65-71
EXPECTED,ADJUSTED
TOTAL CASES = 109146

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	534	0.5	928	0.9	458	0.4	593	0.5	2513	2.3
B+C+O	17898	16.4	44226	40.5	16350	15.0	28159	25.8	106633	97.7
K+A+B	1639	1.5	3278	3.0	1395	1.3	1943	1.8	8255	7.6
C+O	16795	15.4	41877	38.4	15411	14.1	26806	24.6	100889	92.4
K+A+B+C	2348	2.2	4838	4.4	1989	1.8	2872	2.6	12047	11.0
O	16085	14.7	40315	36.9	14819	13.6	25874	23.7	97093	89.0
K+A+B+C+O	18432	16.9	45154	41.4	16808	15.4	28752	26.3	109146	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	5.95	7.68	-6.64	18.54
K+A+B	-0.38	4.47	-7.70	6.94
K+A+B+C	0.30	3.62	-5.63	6.23

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.90	2.06	2.72	2.06	2.30
K+A+B	8.89	7.26	8.30	6.76	7.56
K+A+B+C	12.74	10.71	11.83	9.99	11.04

TABLE 3-42

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1973 TEXAS 65-71
EXPECTED,ADJUSTED
TOTAL CASES = 101848

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	425	0.4	857	0.8	404	0.4	527	0.5	2213	2.2
B+C+O	15456	15.2	41759	41.0	14965	14.7	27455	27.0	99635	97.8
K+A+B	1561	1.5	3130	3.1	1323	1.3	1826	1.8	7840	7.7
C+O	14318	14.1	39486	38.8	14043	13.8	26154	25.7	94001	92.3
K+A+B+C	2167	2.1	4648	4.6	1846	1.8	2819	2.8	11480	11.3
O	13712	13.5	37967	37.3	13525	13.3	25159	24.7	90363	88.7
K+A+B+C+O	15881	15.6	42616	41.8	15369	15.1	27982	27.5	101848	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	-5.32	9.25	-20.49	9.85
K+A+B	1.32	4.50	-6.06	8.71
K+A+B+C	4.67	3.55	-1.15	10.49

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.68	2.01	2.63	1.88	2.17
K+A+B	9.83	7.34	8.61	6.53	7.70
K+A+B+C	13.65	10.91	12.01	10.08	11.27

TABLE 3-43

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1974 TEXAS 65-71
EXPECTED,ADJUSTED
TOTAL CASES = 85110

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	320	0.4	656	0.8	284	0.3	414	0.5	1674	2.0
B+C+O	11937	14.0	35706	42.0	11909	14.0	23884	28.1	83436	98.0
K+A+B	1163	1.4	2847	3.3	1105	1.3	1649	1.9	6764	7.9
C+O	11093	13.0	33519	39.4	11086	13.0	22648	26.6	78346	92.1
K+A+B+C	1610	1.9	4271	5.0	1553	1.8	2585	3.0	10019	11.8
O	10643	12.5	32091	37.7	10642	12.5	21715	25.5	75091	88.2
K+A+B+C+O	12257	14.4	36362	42.7	12193	14.3	24298	28.5	85110	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	5.02	9.67	-10.84	20.89
K+A+B	-10.33	5.51	-19.36	-1.30
K+A+B+C	-7.11	4.36	-14.26	0.04

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.61	1.80	2.33	1.70	1.97
K+A+B	9.49	7.83	9.06	6.79	7.95
K+A+B+C	13.14	11.75	12.73	10.64	11.77

TABLE 3-44

SUMMARY OF PERCENT EFFECTIVENESS FOR OBSERVED UNADJUSTED MASS ACCIDENT DATA FOR FRONTAL CRASHES INVOLVING ONE OR TWO VEHICLES

Injury Level	State	Year	Effectiveness	Standard Deviation	95 % Confidence Interval	
					From	To
KA	Texas	1972	5.1	6.1	-4.9	15.1
		1973	-6.7	7.2	-18.5	5.1
		1974	-2.8	8.0	-16.0	10.3
	New York	1974	-27.4	9.7	-43.2	-11.5
	North Carolina	1973	-49.8	24.0	-89.8	-9.8
		1974	-29.2	22.2	-65.7	7.3
		1975	20.1	14.6	-3.8	43.9
	Texas 1965-1971 Model Year Cars	1972	4.4	7.8	-8.3	17.17
		1973	-2.5	9.0	-17.3	12.3
		1974	3.2	9.8	-12.9	19.3
KAB	Texas	1972	-3.2	3.6	-9.1	2.6
		1973	-1.0	3.5	-6.8	4.8
		1974	-16.3	4.5	-23.6	-9.0
	New York	1974	-14.6	4.5	-22.0	-7.3
	North Carolina	1973	-6.8	9.1	-21.6	8.1
		1974	-26.9	11.1	-45.0	-8.7
		1975	12.0	7.7	-0.7	24.7
	Texas 1965-1971 Model Year Cars	1972	-1.8	4.5	-9.2	5.5
		1973	3.4	4.4	-3.9	10.6
		1974	-15.4	5.7	-24.8	-6.0
KABC	Texas	1972	-2.3	2.9	-7.1	2.5
		1973	1.2	2.8	-3.4	5.9
		1974	-12.5	3.5	-18.2	-6.7
	New York	1974	-8.3	3.1	-13.4	-3.2
	North Carolina	1973	-9.7	6.9	-21.0	1.5
		1974	-18.9	7.5	-31.2	-6.5
		1975	1.2	6.2	-9.1	11.4
	Texas 1965-1971 Model Year Cars	1972	-0.7	3.6	-6.7	5.2
		1973	6.0	3.5	0.3	11.8
		1974	-10.7	4.5	-18.1	-3.4

TABLE 3-45

SUMMARY OF PERCENT EFFECTIVENESS FOR SMOOTHED ADJUSTED MASS ACCIDENT DATA FOR FRONTAL CRASHES INVOLVING ONE OR TWO VEHICLES

Injury Level	State	Year	Effectiveness	Standard Deviation	95 % Confidence Interval	
					From	To
KA	Texas	1972	4.9	6.1	-5.1	14.9
		1973	-12.7	7.6	-25.0	-0.3
		1974	1.9	7.7	-10.7	14.6
	New York	1974	-17.9	8.9	-32.5	-3.3
	North Carolina	1973	-44.4	23.5	-82.9	-5.9
		1974	-19.0	20.9	-53.3	15.2
		1975	26.5	13.7	4.0	49.0
	Texas 1965-1971 Model Year Cars	1972	6.0	7.7	-6.6	18.5
		1973	-5.3	9.3	-20.5	9.9
		1974	5.0	9.7	-10.8	20.9
KAB	Texas	1972	-1.3	3.5	-7.1	4.4
		1973	-3.5	3.6	-9.4	2.5
		1974	-10.3	4.3	-17.4	-3.3
	New York	1974	-12.1	4.4	-19.4	-4.9
	North Carolina	1973	-3.7	8.8	-18.1	10.7
		1974	-19.9	10.6	-37.4	-2.5
		1975	14.9	7.5	2.6	27.1
	Texas 1965-1971 Model Year Cars	1972	-0.4	4.5	-7.7	6.9
		1973	1.3	4.5	-6.1	8.7
		1974	-10.3	6.5	-19.4	-1.3
KABC	Texas	1972	-1.6	2.9	-6.3	3.1
		1973	-0.7	2.9	-5.4	4.1
		1974	-8.3	3.4	-13.9	-2.6
	New York	1974	-7.2	3.1	-12.2	-2.1
	North Carolina	1973	-7.9	6.8	-19.0	3.3
		1974	-14.6	7.4	-26.6	-2.5
		1975	5.6	6.0	-4.2	15.4
	Texas 1965-1971 Model Year Cars	1972	0.3	3.6	-5.6	6.2
		1973	4.7	3.6	-1.2	10.5
		1974	-7.1	4.4	-14.3	0.0

The results of the analyses are consistent with the null hypothesis that the introduction of seat back locks in 2-door passenger cars had no effect on the injury risk to drivers in these cars. That is, the results do not demonstrate that this aspect of the Standard has been effective in reducing injury. In conjunction with this basic conclusiosn, the following observations are made.

- A comparison of the effectiveness results obtained for the observed (raw) unadjusted data with the smoothed (modeled) adjusted data shows that usually a greater effectiveness is obtained with the smoothed adjusted data. In the observed data, the reduction in injury rates from Pre-Standard to Post-Standard cars is greater for 4-door cars than for 2-door cars. Thus, modeling and adjustment to remove confounding effects does increase effectiveness; however, in most cases, negative values remain, implying that not all confounding effects have been removed (presuming that the introduction of seat back locks does not, in fact, increase injury risk).
- The variability in results among years is greater in North Carolina with the small data base than in Texas with its much larger number of cases.
- The attempt to reduce or eliminate unexplained confounding effects by restricting the sample of cases to drivers occupying passenger cars with model years from 1965 to 1971 yielded results that are very similar when compared with the full Texas sample.

The failure to find positive effectiveness for injury reduction to drivers of 2-door cars precludes the carrying out of the final step in the analysis, which would have been to extrapolate the results based on Texas, North Carolina and New York analyses to nationwide estimates of the number of injuries avoided.

It is recognized that the above analyses may have been adversely affected by unidentified or unreported confounding effects. Certainly the possibility exists that other Standards being implemented during the late Sixties and early Seventies were differentially applied or had significantly greater effectiveness in 2-door or 4-door cars. Then, differences in the reduction of injury rates might be more directly related to these factors than the introduction of seat back locks. Additionally, the pronounced increase in preference for 2-door cars during the late Sixties and early Seventies may vary significantly among the buying and driving population. While driver age, driver sex, vehicle weight and manufacturer are all variables chosen for modeling and adjustment, it is by no means certain that all potential confounding effects can be accounted for. For example, the profile of driver characteristics for drivers of 2-door subcompact cars compared to drivers of 4-door full size cars may reflect socioeconomic and personality factors that are not adequately accounted for by the variables analyzed to remove confounding effects.

3.2 Analysis of Rear Seat Occupant Fatalities

3.2.1 Background

The purpose of this analysis is to assess whether the requirement for seat back locks for folding front seat backs in 2-door passenger cars increases the number of fatalities among rear seat occupants in crashes which involve fire/explosion or immersion. It has been suggested that the difficulty of finding and/or operating a seat back lock release in a panic situation, such as post-crash fire or immersion, could lead to increased rear seat occupant fatalities.

3.2.2 Data

The data were derived from the Fatal Accident Reporting System (FARS) for 1975, 1976, 1977 and 1978. Table 3-46 shows that there were 3601 passengers in fire/explosion and immersion accidents in FARS, and that 89 percent of the passengers were in vehicles involving fire/explosion, while 11 percent of the passengers were in immersed vehicles. Also, the frequency of front seat and rear seat passengers was essentially identical in both types of accidents (86 percent and 14 percent, respectively).*

TABLE 3-46

SEATING POSITION OF PASSENGERS IN FIRE/EXPLOSION AND IMMERSION ACCIDENTS

(Source: FARS 1975, 1976, 1977, 1978)

Passenger Location	Fire/Explosion		Immersion		Total	
	Number	%	Number	%	Number	%
Front Seat	2741	85.7	347	85.9	3088	85.8
Rear Seat	456	14.3	57	14.1	513	14.2
Total Passengers	3197	100	404	100	3601	100
Percent	88.8		11.2		100	

*The rear seat occupancy levels in these FARS cases are about 50 percent higher than those encountered in all accidents, based on North Carolina data for 1973, 1974, 1975, 1976 [3].

Table 3-47 shows the injury distributions for 513 rear seat passengers in fire/explosion and immersion FARS cases. The fatality rate for this biased set of data is 44 percent for both fire/explosion and immersion. In contrast, Table 3-48 indicates that the fatality rate for 3088 front seat passengers in fire/explosion and immersion in FARS cases is much greater than for rear seat passengers: 50 percent higher in fire/explosion and 75 percent higher in immersion.

TABLE 3-47

INJURY DISTRIBUTIONS FOR REAR SEAT PASSENGERS IN FIRE/EXPLOSION AND IMMERSION ACCIDENTS

(Source: FARS 1975, 1976, 1977, 1978)

Injury Status	Fire/Explosion		Immersion		Total	
	Number	%	Number	%	Number	%
Not Injured	15	3.3	11	19.3	26	5.1
Killed	202	44.3	25	43.8	227	44.2
A	143	31.4	7	12.3	150	29.2
B	79	17.3	7	12.3	86	16.8
C	17	3.7	7	12.3	24	4.7
Total Occupants	456	100	57	100	513	100

TABLE 3-48

INJURY DISTRIBUTIONS FOR FRONT SEAT PASSENGERS IN FIRE/EXPLOSION AND IMMERSION ACCIDENTS

(Source: FARS 1975, 1976, 1977, 1978)

Injury Status	Fire/Explosion		Immersion		Total	
	Number	%	Number	%	Number	%
Not Injured	91	3.3	24	6.9	115	3.7
Killed	1825	66.6	268	77.5	2093	67.8
A	544	19.9	17	4.9	561	18.2
B	222	8.1	27	7.8	249	8.1
C	58	2.1	10	2.9	68	2.2
Unknown	1		1		2	
Total Occupants	2741	100	347	100	3088	100

3.2.3 Analysis of FARS Data

The analysis of a potential trapping effect for rear seat occupants in Post-Standard 2-door passenger cars was conducted for accidents involving post-crash fire or explosion and accidents involving immersion. The hypothesis tested in this particular analysis is that the presence of seat back locks increases the likelihood of rear seat occupants of Post-Standard 2-door cars being killed as a result of being trapped in a panic situation. Empirical measures of any potential trapping effect that might be attributed to the presence of seat back locks were obtained by contrasting the Pre- to Post-Standard ratios of occupant fatality rates for 2 and 4-door cars as follows.

$$\begin{bmatrix}\text{Trapping}\\ \text{Effect}\\ \text{(T)}\end{bmatrix} = \left[\left\{\frac{\text{Fatality Rate for Occupants of Post-Standard, 2-Door Cars}}{\text{Fatality Rate for Occupants of Pre-Standard, 2-Door Cars}} \times \frac{\text{Fatality Rate for Occupants of Pre-Standard, 4-Door Cars}}{\text{Fatality Rate for Occupants of Post-Standard, 4-Door Cars}}\right\} - 1\right] \times 100$$

where values of T are computed separately for front and rear seat occupants. Therefore, if the presence of seat back locks increases the possibility of rear seat occupants of 2-door cars being trapped,computed values of T for rear seat occupants will be positive, representing the precent increase in rear seat occupant fatality rates due, by inference, to trapping.

The distribution of fatalities among 3086 front seat occupants and 513 rear seat occupants in fire/explosion and immersion accidents is shown in Table 3-49 for 2-door and 4-door cars, Pre- and Post-Standard. The results of the trapping effect analysis are given in Table 3-50.

These results do not support the hypothesis that seat back locks may inincrease the possibility of rear seat occupants being trapped in panic situations. Contrary to expectations, a negative value of T (-19 percent) was computed for 513 rear seat occupants contrasted with a -4 percent value for front seat occupants. In other words, the data indicate that there is an estimated 19 percent decrease in the Pre- to Post-Standard ratios of rear seat occupant fatality rates corresponding to 2-door, Post-Standard vehicles. It can be speculated that the locked seat back may act as a restraint on the forward movement of rear seat passengers during a crash, and hence reduce the likelihood of serious or fatal injury. Such an effect is perhaps much more important than a possible trapping effect, and could be particularly important in more violent accidents involving fatalities and fire or explosion.

TABLE 3-49

FATALITY DISTRIBUTION IN FIRE/EXPLOSION AND IMMERSION ACCIDENTS

Front Seat Occupants

Injury Status	2-Door Cars				4-Door Cars				Total	
	Pre		Post		Pre		Post			
	No.	%	No.	%	No.	%	No.	%	No.	%
Killed	176	*61.5*	1316	*68.5*	122	*58.4*	456	*68.2*	2070	*67.1*
Not Killed	110	*38.5*	606	*31.5*	87	*41.6*	213	*31.8*	1016	*32.9*
Total Occupants	286	*100*	1922	*100*	209	*100*	669	*100*	3086	*100*

Rear Seat Occupants

Injury Status	2-Door Cars				4-Door Cars				Total	
	Pre		Post		Pre		Post			
	No.	%	No.	%	No.	%	No.	%	No.	%
Killed	20	*51.3*	150	*45.3*	10	*37*	47	*40.5*	227	*44.2*
Not Killed	19	*48.7*	181	*54.7*	17	*63*	69	*59.5*	286	*55.8*
Total Occupants	39	*100*	331	*100*	27	*100*	116	*100*	513	*100*

TABLE 3-50

DATA USED TO EVALUATE TRAPPING EFFECT

Condition	Occupant Location	Percent Killed in 2-Door Pre (P_{11})	Percent Killed in 2-Door Post (P_{21})	Percent Killed in 4-Door Pre (P_{12})	Percent Killed in 4-Door Post (P_{22})	Trapping Effect $T = \left[\left\{\frac{P_{12}}{P_{22}} \times \frac{P_{21}}{P_{11}}\right\} -1\right] \times 100$	Standard Deviation
Fire/ Explosion/ Immersion	Rear Seat (N= 513)	51.3	45.3	37.0	40.5	- 19 Percent	27.3
	Front Seat (N=3086)	61.5	68.8	58.4	68.2	- 4 Percent	7.7

3.3 Analysis of NCSS Data on Seat Intrusion

3.3.1 Background

In an effort to obtain more information on seating system failure and associated injuries, available data from NCSS were examined. Unfortunately, the computerized information available is quite limited. Relevant information is contained in NCSS from 1 April 1978 onward regarding seat failure, although it is incomplete. A serious limitation to the data is that impact intrusion direction (forward or rearward) is not given when seat failure does not occur. It is given only for cases of seat failure. The variables of interest are:

- Pre/Post Standard
- 2-Door/4-Door Car
- Impact Intrusion Direction (Forward/Rearward)
- Seat Failure
  - No failure
  - Seat adjuster failure
  - Track failure
  - Seat back lock failure
  - Other failure
- AIS Injury Level

In the NCSS subsample studied here, the distribution of cases by seat failure is shown in Table 3-51. Less than four percent of the cases involved seat failure.

TABLE 3-51

DISTRIBUTION OF NCSS CASES BY SEAT FAILURE

Condition	Number of Cases	Percent
No Seat Failure	31,114	96.0
Seat Failure	1,226	3.8
Unknown	52	0.2
Total	32,392	100.0

3.3.2 Data Analysis

An initial review of the NCSS data produced the following ovservations and conclusions.

- The seat failure variable indicates there are 2383 Pre-Standard cases with seat failure occurring in 2.4 percent of the cases, as compared to 24,459 Post-Standard cases with seat failure occurring in 3.7 percent of them. Of course, seat failures involving the seat back lock are possible only in Post-Standard cars.

- It is not possible to analyze seating system failure/no failure as a function of impact intrusion direction because this variable is not reported in the case of no seat failure.
- The seat failure information is categorized as follows:

  a) Failure of seat adjuster.
  b) Failure of seat track.
  c) Failure of seat back locks.
  d) Other failures.

  Other failures generally refers to seat deformation resulting from passenger impact, inertial forces due to seat mass or deformation by intrusion of passenger compartment. Of the 961 cases of seat failure, 89 percent are in the "Other" category. Seat track failure and seat adjuster failure each account for 2-3 percent of the failure cases with seat back locks accounting for about 8 percent of the failure cases (i.e., 90 cases).

The distribution of AIS injury level by seat failure occurrence and non-occurrence is given in Table 3-52. The differences are very marked. There is no injury in 77 percent of the no seat failure cases in contrast to only 26 percent of the seat failure cases. A fatal or critical injury occurs in 2.9 percent of the seat failure cases in contrast to only 0.5 percent of the no seat failure cases. The limited sample size (only 32 cases) of known AIS level with seat back lock failure precludes estimating the AIS distribution separately for seat back lock failure (oddly, AIS level was unknown in 58 seat back lock failure cases).

TABLE 3-52

INJURY LEVEL DISTRIBUTION FOR SEAT FAILURE AND NO FAILURE

AIS Level	Seat Failure		No Seat Failure	
	Percent All	Percent (Unknowns Excluded)	Percent All	Percent (Unknowns Excluded)
0	17.7	(25.6)	56.5	(77.3)
1	27.5	(39.8)	12.0	(16.4)
2	10.4	(15.0)	2.8	(3.9)
3	8.8	(12.8)	1.1	(1.5)
4	2.7	(3.9)	0.3	(0.4)
5	1.4	(2.0)	0.3	(0.3)
6	0.7	(0.9)	0.1	(0.2)
Unknown	30.8	(--)	26.9	(--)
Total %	100.0	(100.0)	100.0	(100.0)
Total Cases	1226	(847)	31,114	(22,742)

The distribution of AIS injuries is given in Table 3-53 for rearward-directed forces and forward-directed forces in seat failure cases only. A forward-directed force is due to a rear impact and a rearward-directed force is due to a frontal impact. The distributions are fairly similar and it would be speculative to attempt to draw inferences from the small differences, given the limited number of cases upon which the distributions are based.

TABLE 3-53

INJURY LEVEL DISTRIBUTION BY INTRUSION FORCE DIRECTION FOR CASES OF SEAT FAILURE

AIS Level	Forward-Directed Force (%)	Rearward-Directed Force (%)
0	17.3	22.1
1	25.4	26.6
2	10.1	9.7
3	8.9	7.4
4	2.4	2.7
5	1.5	1.4
6	1.0	0.5
Unknown	33.4	29.6
Total %	100.0	100.0
Total Cases	682	444

The distribution of seat failure type by rearward-directed and forward-directed forces is given in Table 3-54. Of greatest interest in the comparative distributions is the greater frequency of occurrence of seat back lock failure with a rearward-directed force (i.e., a force due to a frontal impact).

TABLE 3-54

FREQUENCY OF SEAT FAILURE BY INTRUSION FORCE DIRECTION

Seat Failure Type	Forward-Directed Force (%)	Rearward-Directed Force (%)
Seat Adjuster	2.8	2.0
Track	3.4	2.5
Lock	5.4	11.9
Other	85.2	77.3
Unknown	3.2	6.3
Total %	100.0	100.0
Total Cases	682	444

In summary, the NCSS data sample contains limited computerized information on seat failure and injury for cases after April 1, 1978. Seat failure occurred in 2.4 percent of 2,383 Pre-Standard cases as compared with 3.7 percent of 24,459 Post-Standard cases. Only 90 cases of seat back lock failure are available and the AIS level is unknown for 58 of these cases. Based on 847 cases of all types of seat failure and 22,742 cases without failure with known AIS, the probability of escaping any injury is three times greater when no seat failure occurs, and the probability of a fatal or critical injury is about five times greater with seat failure. Seat failure/no failure comparisons are restricted by the lack of information on impact intrusion direction (forward or rearward) for no failure cases.

3.4 References for Section 3

1. Motor Vehicle Manufacturers Association of the U.S., Inc. *Automotive Facts and Figures*, 1967-1973, MVMA, Detroit, Michigan.

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3. Clark, V.J. *Single Variable Tabulations for 1973-1976 North Carolina Accidents*, Highway Safety Research Center, University of North Carolina, Chapel Hill, North Carolina, 1977.

APPENDIX A

FULLY CROSS CLASSIFIED TABLES OF OBSERVED STATE MASS ACCIDENT DATA

TABLE A-1

FULLY CROSS CLASSIFIED TABLE OF TEXAS 1972
RAW DATA FOR KA/BCO INJURY DICHOTOMY

				City Size: Less than 5,000		City Size: 5,000-250,000	
DRVAGE D	ACCTYPE A	STYLE S	PREPOST P	INJURY (I) K+A	B+C+D	INJURY (I) K+A	B+C+D
15-24	OTHER MV	2-DOOR	PRE	74	1461	69	5473
			POST	129	2610	63	8995
		4-DOOR	PRE	83	1484	45	5297
			POST	35	923	16	2880
	PRKD CAR	2-DOOR	PRE	3	90	10	481
			POST	5	83	4	494
		4-DOOR	PRE	2	109	9	530
			POST	0	32	5	215
	OBJECT	2-DOOR	PRE	42	274	48	596
			POST	48	497	56	872
		4-DOOR	PRE	32	239	35	591
			POST	19	118	9	230
25-34	OTHER MV	2-DOOR	PRE	42	544	25	1927
			POST	64	1355	38	4365
		4-DOOR	PRE	43	643	36	2094
			POST	44	750	15	2010
	PRKD CAR	2-DOOR	PRE	4	29	5	135
			POST	3	28	2	173
		4-DOOR	PRE	0	37	3	173
			POST	0	21	1	94
	OBJECT	2-DOOR	PRE	17	84	13	189
			POST	19	216	24	358
		4-DOOR	PRE	17	88	16	216
			POST	5	95	6	115
35 +	OTHER MV	2-DOOR	PRE	69	754	41	2476
			POST	83	1439	35	4187
		4-DOOR	PRE	137	1938	85	6038
			POST	176	2663	76	7089
	PRKD CAR	2-DOOR	PRE	1	29	9	193
			POST	1	32	8	194
		4-DOOR	PRE	4	99	15	578
			POST	3	58	2	294
	OBJECT	2-DOOR	PRE	23	112	21	175
			POST	19	169	31	259
		4-DOOR	PRE	42	219	45	414
			POST	32	269	15	359

TABLE A-1 (Continued)

City Size: Over 250,000

DRVAGE D	ACCTYPE A	STYLE S	PREPOST P	INJURY (I) K+A	B+C+O
15-24	OTHER MV	2-DOOR	PRE	118	5854
			POST	139	10647
		4-DOOR	PRE	77	5032
			POST	25	2790
	PRKD CAR	2-DOOR	PRE	11	451
			POST	13	505
		4-DOOR	PRE	8	458
			POST	2	139
	OBJECT	2-DOOR	PRE	89	684
			POST	59	982
		4-DOOR	PRE	86	556
			POST	20	213
25-34	OTHER MV	2-DOOR	PRE	67	3179
			POST	100	7647
		4-DOOR	PRE	64	2809
			POST	19	2833
	PRKD CAR	2-DOOR	PRE	14	212
			POST	11	253
		4-DOOR	PRE	11	242
			POST	2	83
	OBJECT	2-DOOR	PRE	49	277
			POST	50	531
		4-DOOR	PRE	48	256
			POST	21	150
35 +	OTHER MV	2-DOOR	PRE	79	3794
			POST	78	6940
		4-DOOR	PRE	129	6533
			POST	88	8513
	PRKD CAR	2-DOOR	PRE	10	288
			POST	10	297
		4-DOOR	PRE	24	494
			POST	9	280
	OBJECT	2-DOOR	PRE	43	244
			POST	39	389
		4-DOOR	PRE	69	471
			POST	42	338

THE TOTAL FREQUENCY IS 159693

TABLR A-2

FULLY CROSS CLASSIFIED TABLE OF TEXAS 1972
RAW DATA FOR KAB/CO INJURY DICHOTOMY

DRVAGE D	ACCTYPE A	STYLE S	PREPOST P	City Size: Less than 5,000 INJURY (I) K+A+B	City Size: Less than 5,000 INJURY (I) C+O	City Size: 5,000-250,000 INJURY (I) K+A+B	City Size: 5,000-250,000 INJURY (I) C+O
15-24	OTHER MV	2-DOOR	PRE	198	1337	326	5216
			POST	355	2384	382	8676
		4-DOOR	PRE	211	1356	259	5083
			POST	88	870	113	2783
	PRKD CAR	2-DOOR	PRE	12	81	57	434
			POST	9	79	42	456
		4-DOOR	PRE	9	102	57	462
			POST	2	30	16	204
	OBJECT	2-DOOR	PRE	81	235	152	492
			POST	121	424	195	733
		4-DOOR	PRE	81	190	135	491
			POST	35	102	47	192
25-34	OTHER MV	2-DOOR	PRE	85	501	143	1809
			POST	175	1244	199	4204
		4-DOOR	PRE	101	585	139	1991
			POST	99	695	87	1938
	PRKD CAR	2-DOOR	PRE	8	25	24	116
			POST	6	25	21	154
		4-DOOR	PRE	6	31	17	159
			POST	5	16	9	86
	OBJECT	2-DOOR	PRE	32	69	58	144
			POST	51	184	80	302
		4-DOOR	PRE	33	72	53	179
			POST	20	80	23	98
35 +	OTHER MV	2-DOOR	PRE	135	688	167	2350
			POST	215	1307	207	4015
		4-DOOR	PRE	357	1718	366	5757
			POST	413	2426	319	6846
	PRKD CAR	2-DOOR	PRE	7	23	28	174
			POST	9	24	34	168
		4-DOOR	PRE	15	88	58	535
			POST	10	51	22	274
	OBJECT	2-DOOR	PRE	36	99	59	137
			POST	42	146	76	214
		4-DOOR	PRE	86	175	143	316
			POST	68	233	90	284

TABLE A-2 (Continued)

City Size: Over 250,000

DRVAGE D	ACCTYPE A	STYLE S	PREPOST P	INJURY (I) K+A+B	C+O
15-24	OTHER MV	2-DOOR	PRE	399	5573
			POST	514	10272
		4-DOOR	PRE	263	4846
			POST	87	2728
	PRKD CAR	2-DOOR	PRE	61	401
			POST	64	454
		4-DOOR	PRE	56	410
			POST	12	129
	OBJECT	2-DOOR	PRE	222	551
			POST	228	813
		4-DOOR	PRE	190	452
			POST	59	174
25-34	OTHER MV	2-DOOR	PRE	209	3037
			POST	319	7428
		4-DOOR	PRE	182	2691
			POST	93	2759
	PRKD CAR	2-DOOR	PRE	30	196
			POST	35	229
		4-DOOR	PRE	43	210
			POST	12	73
	OBJECT	2-DOOR	PRE	109	217
			POST	137	444
		4-DOOR	PRE	106	198
			POST	56	115
35 +	OTHER MV	2-DOOR	PRE	294	3579
			POST	314	6704
		4-DOOR	PRE	381	6281
			POST	296	8305
	PRKD CAR	2-DOOR	PRE	47	251
			POST	42	265
		4-DOOR	PRE	83	435
			POST	40	249
	OBJECT	2-DOOR	PRE	97	190
			POST	113	315
		4-DOOR	PRE	166	374
			POST	99	281

THE TOTAL FREQUENCY IS 159693

TABLE A-3

FULLY CROSS CLASSIFIED TABLE OF TEXAS 1972
RAW DATA FOR KABC/O INJURY DICHOTOMY

DRVAGE D	ACCTYPE A	STYLE S	PREPOST P	City Size: Less than 5,000 — INJURY (I) K+A+B+C	City Size: Less than 5,000 — INJURY (I) O	City Size: 5,000-250,000 — INJURY (I) K+A+B+C	City Size: 5,000-250,000 — INJURY (I) O
15-24	OTHER MV	2-DOOR	PRE	262	1273	495	5047
			POST	446	2293	639	8419
		4-DOOR	PRE	264	1303	400	4942
			POST	130	828	180	2716
	PRKD CAR	2-DOOR	PRE	17	76	71	420
			POST	11	77	68	430
		4-DOOR	PRE	11	100	68	471
			POST	5	27	29	191
	OBJECT	2-DOOR	PRE	94	222	195	449
			POST	143	402	256	672
		4-DOOR	PRE	97	174	174	452
			POST	41	96	64	175
25-34	OTHER MV	2-DOOR	PRE	107	479	231	1721
			POST	232	1187	326	4077
		4-DOOR	PRE	132	554	211	1919
			POST	142	652	145	1880
	PRKD CAR	2-DOOR	PRE	8	25	31	109
			POST	8	23	27	148
		4-DOOR	PRE	7	30	21	155
			POST	5	16	13	82
	OBJECT	2-DOOR	PRE	37	64	70	132
			POST	63	172	97	289
		4-DOOR	PRE	38	67	70	162
			POST	23	77	28	93
35 +	OTHER MV	2-DOOR	PRE	164	659	254	2263
			POST	275	1247	360	3862
		4-DOOR	PRE	437	1638	585	5538
			POST	516	2323	535	6630
	PRKD CAR	2-DOOR	PRE	8	22	37	165
			POST	9	24	40	162
		4-DOOR	PRE	20	83	74	519
			POST	14	47	37	259
	OBJECT	2-DOOR	PRE	46	89	66	130
			POST	54	134	90	200
		4-DOOR	PRE	102	159	174	285
			POST	93	208	104	270

TABLE A-3 (Continued)

City Size: Over 250,000

DRVAGE D	ACCTYPE A	STYLE S	PREPOST P	INJURY (I) K+A+B+C	O
15-24	OTHER MV	2-DOOR	PRE	603	5369
			POST	844	9942
		4-DOOR	PRE	403	4706
			POST	156	2659
	PRKD CAR	2-DOOR	PRE	81	381
			POST	85	433
		4-DOOR	PRE	71	395
			POST	16	125
	OBJECT	2-DOOR	PRE	264	509
			POST	300	741
		4-DOOR	PRE	209	433
			POST	74	159
25-34	OTHER MV	2-DOOR	PRE	336	2910
			POST	570	7177
		4-DOOR	PRE	297	2576
			POST	194	2658
	PRKD CAR	2-DOOR	PRE	42	184
			POST	44	220
		4-DOOR	PRE	54	199
			POST	15	70
	OBJECT	2-DOOR	PRE	122	204
			POST	180	401
		4-DOOR	PRE	121	183
			POST	65	106
35 +	OTHER MV	2-DOOR	PRE	445	3428
			POST	559	6459
		4-DOOR	PRE	603	6059
			POST	511	8090
	PRKD CAR	2-DOOR	PRE	55	243
			POST	52	255
		4-DOOR	PRE	101	417
			POST	53	236
	OBJECT	2-DOOR	PRE	115	172
			POST	150	278
		4-DOOR	PRE	191	349
			POST	117	263

THE TOTAL FREQUENCY IS 159693

TABLE A-4

FULLY CROSS CLASSIFIED TABLE OF TEXAS 1973
RAW DATA FOR KA/BCO INJURY DICHOTOMY

Driver Age: 15-24

RDCLASS R	CITYSIZE C	STYLE S	PREPOST P	INJURY (I) K+A	B+C+O
HIGHWAY	LT 50K	2-DOOR	PRE	59	706
			POST	165	2122
		4-DOOR	PRE	65	687
			POST	47	727
	50K-250K	2-DOOR	PRE	36	1859
			POST	73	4809
		4-DOOR	PRE	30	1770
			POST	14	1534
	250K +	2-DOOR	PRE	48	1808
			POST	91	5348
		4-DOOR	PRE	38	1572
			POST	17	1380
CNTY RD	LT 50K	2-DOOR	PRE	28	467
			POST	61	1137
		4-DOOR	PRE	29	477
			POST	17	380
	50K-250K	2-DOOR	PRE	9	266
			POST	13	662
		4-DOOR	PRE	2	237
			POST	1	210
	250K +	2-DOOR	PRE	3	83
			POST	1	278
		4-DOOR	PRE	1	69
			POST	1	63
CITY STR	LT 50K	2-DOOR	PRE	8	269
			POST	8	514
		4-DOOR	PRE	2	301
			POST	3	260
	50K-250K	2-DOOR	PRE	59	3349
			POST	78	7158
		4-DOOR	PRE	47	3388
			POST	11	2481
	250K +	2-DOOR	PRE	100	3863
			POST	154	8857
		4-DOOR	PRE	94	3364
			POST	36	2727

Driver Age: 25-34

RDCLASS R	CITYSIZE C	STYLE S	PREPOST P	INJURY (I) K+A	B+C+O
HIGHWAY	LT 50K	2-DOOR	PRE	55	294
			POST	75	1060
		4-DOOR	PRE	30	208
			POST	34	530
	50K-250K	2-DOOR	PRE	18	719
			POST	37	2291
		4-DOOR	PRE	24	803
			POST	13	1058
	250K +	2-DOOR	PRE	30	1004
			POST	71	3897
		4-DOOR	PRE	21	963
			POST	19	1346
CNTY RD	LT 50K	2-DOOR	PRE	16	168
			POST	28	533
		4-DOOR	PRE	17	190
			POST	14	284
	50K-250K	2-DOOR	PRE	2	81
			POST	7	274
		4-DOOR	PRE	5	87
			POST	4	101
	250K +	2-DOOR	PRE	2	44
			POST	6	200
		4-DOOR	PRE	0	55
			POST	0	57
CITY STR	LT 50K	2-DOOR	PRE	0	62
			POST	6	210
		4-DOOR	PRE	1	73
			POST	2	117
	50K-250K	2-DOOR	PRE	22	1043
			POST	32	3171
		4-DOOR	PRE	31	1173
			POST	12	1482
	250K +	2-DOOR	PRE	46	1892
			POST	96	6036
		4-DOOR	PRE	48	1774
			POST	24	2154

TABLE A-4 (Continued)

Driver Age: 35 and Older

RDCLASS R	CITYSIZE C	STYLE S	PREPOST P	INJURY (I) K+A	B+C+O
HIGHWAY	LT 50K	2-DOOR	PRE	48	424
			POST	82	1119
		4-DOOR	PRE	111	1094
			POST	176	2077
	50K-250K	2-DOOR	PRE	22	836
			POST	36	2185
		4-DOOR	PRE	53	2095
			POST	49	3653
	250K +	2-DOOR	PRE	48	1101
			POST	68	3285
		4-DOOR	PRE	52	1832
			POST	46	3599
CNTY RD	LT 50K	2-DOOR	PRE	14	204
			POST	31	531
		4-DOOR	PRE	40	452
			POST	54	814
	50K-250K	2-DOOR	PRE	7	92
			POST	2	220
		4-DOOR	PRE	3	192
			POST	9	389
	250K +	2-DOOR	PRE	1	47
			POST	1	175
		4-DOOR	PRE	0	79
			POST	4	168
CITY STR	LT 50K	2-DOOR	PRE	1	122
			POST	1	222
		4-DOOR	PRE	3	301
			POST	5	405
	50K-250K	2-DOOR	PRE	22	1329
			POST	27	2987
		4-DOOR	PRE	55	3127
			POST	43	4648
	250K +	2-DOOR	PRE	60	2180
			POST	61	5464
		4-DOOR	PRE	97	3938
			POST	66	6159

THE TOTAL FREQUENCY IS 161908

TABLE A-5

FULLY CROSS CLASSIFIED TABLE OF TEXAS 1973
RAW DATA FOR KAB/CO INJURY DICHOTOMY

Driver Age: 15-24

RDCLASS R	CITYSIZE C	STYLE S	PREPOST P	INJURY (I) K+A+B	C+O
HIGHWAY	LT 50K	2-DOOR	PRE	134	631
			POST	391	1896
		4-DOOR	PRE	133	619
			POST	116	658
	50K-250K	2-DOOR	PRE	167	1728
			POST	332	4550
		4-DOOR	PRE	158	1642
			POST	77	1471
	250K +	2-DOOR	PRE	180	1676
			POST	375	5064
		4-DOOR	PRE	127	1483
			POST	70	1327
CNTY RD	LT 50K	2-DOOR	PRE	70	425
			POST	161	1037
		4-DOOR	PRE	76	430
			POST	47	350
	50K-250K	2-DOOR	PRE	32	243
			POST	56	619
		4-DOOR	PRE	21	218
			POST	11	200
	250K +	2-DOOR	PRE	9	77
			POST	14	265
		4-DOOR	PRE	2	68
			POST	3	61
CITY STR	LT 50K	2-DOOR	PRE	23	254
			POST	36	486
		4-DOOR	PRE	18	285
			POST	12	251
	50K-250K	2-DOOR	PRE	289	3119
			POST	469	6767
		4-DOOR	PRE	247	3188
			POST	114	2378
	250K +	2-DOOR	PRE	371	3592
			POST	583	8428
		4-DOOR	PRE	297	3161
			POST	151	2612

Driver Age: 25-34

RDCLASS R	CITYSIZE C	STYLE S	PREPOST P	INJURY (I) K+A+B	C+O
HIGHWAY	LT 50K	2-DOOR	PRE	75	254
			POST	176	959
		4-DOOR	PRE	67	251
			POST	86	478
	50K-250K	2-DOOR	PRE	78	659
			POST	164	2164
		4-DOOR	PRE	86	741
			POST	77	994
	250K +	2-DOOR	PRE	98	936
			POST	248	3720
		4-DOOR	PRE	80	904
			POST	85	1280
CNTY RD	LT 50K	2-DOOR	PRE	39	145
			POST	71	490
		4-DOOR	PRE	43	164
			POST	38	260
	50K-250K	2-DOOR	PRE	4	79
			POST	22	259
		4-DOOR	PRE	10	82
			POST	12	93
	250K +	2-DOOR	PRE	9	37
			POST	13	193
		4-DOOR	PRE	7	48
			POST	3	54
CITY STR	LT 50K	2-DOOR	PRE	6	56
			POST	15	201
		4-DOOR	PRE	11	63
			POST	8	111
	50K-250K	2-DOOR	PRE	79	986
			POST	163	3040
		4-DOOR	PRE	117	1087
			POST	50	1444
	250K +	2-DOOR	PRE	172	1766
			POST	337	5795
		4-DOOR	PRE	162	1660
			POST	101	2077

TABLE A-5 (Continued)

Driver Age: 35 and Older

RDCLASS R	CITYSIZE C	STYLE S	PREPOST P	INJURY (I) K+A+B	C+O
HIGHWAY	LT 50K	2-DOOR	PRE	101	361
			POST	201	1000
		4-DOOR	PRE	222	983
			POST	369	1884
	50K-250K	2-DOOR	PRE	92	766
			POST	150	2071
		4-DOOR	PRE	182	1966
			POST	227	3475
	250K +	2-DOOR	PRE	134	1015
			POST	234	3119
		4-DOOR	PRE	181	1703
			POST	182	3463
CNTY RD	LT 50K	2-DOOR	PRE	36	182
			POST	77	485
		4-DOOR	PRE	83	409
			POST	124	744
	50K-250K	2-DOOR	PRE	20	79
			POST	22	200
		4-DOOR	PRE	16	179
			POST	30	368
	250K +	2-DOOR	PRE	5	43
			POST	7	169
		4-DOOR	PRE	7	72
			POST	11	161
CITY STR	LT 50K	2-DOOR	PRE	13	110
			POST	14	209
		4-DOOR	PRE	14	290
			POST	25	385
	50K-250K	2-DOOR	PRE	133	1218
			POST	158	2856
		4-DOOR	PRE	207	2975
			POST	225	4466
	250K +	2-DOOR	PRE	213	2027
			POST	301	5224
		4-DOOR	PRE	328	3707
			POST	301	5926

THE TOTAL FREQUENCY IS 161908

TABLE A-6

FULLY CROSS CLASSIFIED TABLE OF TEXAS 1973
RAW DATA FOR KABC/O INJURY DICHOTOMY

Driver Age: 15-24

RDCLASS R	CITYSIZE C	STYLE S	PREPOST P	INJURY (I) K+A+B+C	O
HIGHWAY	LT 50K	2-DOOR	PRE	164	601
			POST	484	1803
		4-DOOR	PRE	161	591
			POST	148	626
	50K-250K	2-DOOR	PRE	245	1650
			POST	506	4376
		4-DOOR	PRE	205	1595
			POST	122	1426
	250K +	2-DOOR	PRE	250	1606
			POST	561	4878
		4-DOOR	PRE	183	1427
			POST	118	1279
CNTY RD	LT 50K	2-DOOR	PRE	84	411
			POST	211	987
		4-DOOR	PRE	91	415
			POST	64	333
	50K-250K	2-DOOR	PRE	37	238
			POST	78	597
		4-DOOR	PRE	28	211
			POST	14	197
	250K +	2-DOOR	PRE	18	68
			POST	24	255
		4-DOOR	PRE	5	65
			POST	3	61
CITY STR	LT 50K	2-DOOR	PRE	30	247
			POST	57	465
		4-DOOR	PRE	24	279
			POST	18	245
	50K-250K	2-DOOR	PRE	413	2995
			POST	658	6578
		4-DOOR	PRE	358	3077
			POST	177	2315
	250K +	2-DOOR	PRE	547	3416
			POST	900	8111
		4-DOOR	PRE	425	3033
			POST	252	2511

Driver Age: 25-34

RDCLASS R	CITYSIZE C	STYLE S	PREPOST P	INJURY (I) K+A+B+C	O
HIGHWAY	LT 50K	2-DOOR	PRE	92	237
			POST	225	910
		4-DOOR	PRE	81	237
			POST	113	451
	50K-250K	2-DOOR	PRE	98	639
			POST	245	2083
		4-DOOR	PRE	114	713
			POST	112	959
	250K +	2-DOOR	PRE	145	889
			POST	385	3583
		4-DOOR	PRE	121	863
			POST	137	1228
CNTY RD	LT 50K	2-DOOR	PRE	46	138
			POST	98	463
		4-DOOR	PRE	49	158
			POST	46	252
	50K-250K	2-DOOR	PRE	7	76
			POST	29	252
		4-DOOR	PRE	11	81
			POST	16	89
	250K +	2-DOOR	PRE	11	35
			POST	24	182
		4-DOOR	PRE	9	46
			POST	9	48
CITY STR	LT 50K	2-DOOR	PRE	7	55
			POST	21	195
		4-DOOR	PRE	13	61
			POST	14	105
	50K-250K	2-DOOR	PRE	123	942
			POST	277	2926
		4-DOOR	PRE	158	1046
			POST	100	1394
	250K +	2-DOOR	PRE	245	1693
			POST	551	5581
		4-DOOR	PRE	234	1588
			POST	177	2001

TABLE A-6 (Continued)

Driver Age: 35 and Older

RDCLASS R	CITYSIZE C	STYLE S	PREPOST P	INJURY (I) K+A+B+C	O
HIGHWAY	LT 50K	2-DOOR	PRE	124	338
			POST	260	941
		4-DOOR	PRE	269	936
			POST	469	1784
	50K-250K	2-DOOR	PRE	113	745
			POST	226	1995
		4-DOOR	PRE	247	1901
			POST	352	3350
	250K +	2-DOOR	PRE	175	974
			POST	370	2983
		4-DOOR	PRE	253	1631
			POST	290	3355
CNTY RD	LT 50K	2-DOOR	PRE	45	173
			POST	104	458
		4-DOOR	PRE	103	389
			POST	161	707
	50K-250K	2-DOOR	PRE	22	77
			POST	37	185
		4-DOOR	PRE	19	176
			POST	40	358
	250K +	2-DOOR	PRE	6	42
			POST	13	163
		4-DOOR	PRE	9	70
			POST	16	156
CITY STR	LT 50K	2-DOOR	PRE	18	105
			POST	20	203
		4-DOOR	PRE	23	281
			POST	40	370
	50K-250K	2-DOOR	PRE	173	1178
			POST	280	2734
		4-DOOR	PRE	314	2868
			POST	385	4306
	250K +	2-DOOR	PRE	295	1945
			POST	522	5003
		4-DOOR	PRE	466	3569
			POST	518	5709

THE TOTAL FREQUENCY IS 161908

TABLE A-7

FULLY CROSS CLASSIFIED TABLE OF TEXAS 1974 RAW DATA FOR KA/BCO INJURY DICHOTOMY

TAD: 1-2

ACCTYPE A	CITYSIZE C	STYLE S	PREPOST P	INJURY (I) K+A	B+C+O
OTHER MV	LT 50K	2-DOOR	PRE	1	757
			POST	4	2902
		4-DOOR	PRE	4	1177
			POST	2	2306
	50K-250K	2-DOOR	PRE	1	3997
			POST	12	14470
		4-DOOR	PRE	2	5708
			POST	2	9641
	250K +	2-DOOR	PRE	18	5302
			POST	32	22178
		4-DOOR	PRE	11	6171
			POST	16	11952
PRKD CAR	LT 50K	2-DOOR	PRE	0	50
			POST	1	96
		4-DOOR	PRE	0	59
			POST	0	91
	50K-250K	2-DOOR	PRE	0	295
			POST	1	637
		4-DOOR	PRE	1	504
			POST	0	409
	250K +	2-DOOR	PRE	0	289
			POST	5	681
		4-DOOR	PRE	3	421
			POST	6	368
OBJECT	LT 50K	2-DOOR	PRE	4	105
			POST	5	375
		4-DOOR	PRE	2	127
			POST	3	227
	50K-250K	2-DOOR	PRE	2	301
			POST	3	829
		4-DOOR	PRE	0	375
			POST	2	385
	250K +	2-DOOR	PRE	6	339
			POST	10	915
		4-DOOR	PRE	9	351
			POST	5	387

TAD: 3-4

ACCTYPE A	CITYSIZE C	STYLE S	PREPOST P	INJURY (I) K+A	B+C+O
OTHER MV	LT 50K	2-DOOR	PRE	15	560
			POST	44	2199
		4-DOOR	PRE	32	833
			POST	25	1539
	50K-250K	2-DOOR	PRE	39	1594
			POST	63	5710
		4-DOOR	PRE	47	2005
			POST	26	3338
	250K +	2-DOOR	PRE	80	1998
			POST	173	8030
		4-DOOR	PRE	74	2156
			POST	71	3603
PRKD CAR	LT 50K	2-DOOR	PRE	3	45
			POST	5	127
		4-DOOR	PRE	2	53
			POST	4	66
	50K-250K	2-DOOR	PRE	10	234
			POST	11	573
		4-DOOR	PRE	9	339
			POST	6	400
	250K +	2-DOOR	PRE	16	280
			POST	17	663
		4-DOOR	PRE	17	302
			POST	16	333
OBJECT	LT 50K	2-DOOR	PRE	7	102
			POST	23	468
		4-DOOR	PRE	15	151
			POST	9	229
	50K-250K	2-DOOR	PRE	15	300
			POST	39	904
		4-DOOR	PRE	29	353
			POST	27	391
	250K +	2-DOOR	PRE	47	453
			POST	101	1203
		4-DOOR	PRE	56	432
			POST	42	487

TABLE A-7 (Continued)

TAD: 5-7

ACCTYPE A	CITYSIZE C	STYLE S	PREPOST P	INJURY (I) K+A	B+C+D
OTHER HV	LT 50K	2-DOOR	PRE	69	129
			POST	215	532
		4-DOOR	PRE	90	142
			POST	144	369
	50K-250K	2-DOOR	PRE	33	183
			POST	91	748
		4-DOOR	PRE	36	228
			POST	38	373
	250K +	2-DOOR	PRE	43	173
			POST	85	682
		4-DOOR	PRE	38	163
			POST	34	248
PRKD CAR	LT 50K	2-DOOR	PRE	3	11
			POST	12	36
		4-DOOR	PRE	6	10
			POST	3	16
	50K-250K	2-DOOR	PRE	6	19
			POST	15	119
		4-DOOR	PRE	8	46
			POST	8	65
	250K +	2-DOOR	PRE	2	30
			POST	15	92
		4-DOOR	PRE	5	38
			POST	5	35
OBJECT	LT 50K	2-DOOR	PRE	16	35
			POST	65	156
		4-DOOR	PRE	25	45
			POST	43	70
	50K-250K	2-DOOR	PRE	30	81
			POST	56	279
		4-DOOR	PRE	36	91
			POST	29	116
	250K +	2-DOOR	PRE	49	93
			POST	82	300
		4-DOOR	PRE	27	77
			POST	27	92

THE TOTAL FREQUENCY IS 146449

TABLE A-8

FULLY CROSS CLASSIFIED TABLE OF TEXAS 1974
RAW DATA FOR KAB/CO INJURY DICHOTOMY

TAD: 1-2

ACCTYPE A	CITYSIZE C	STYLE S	PREPOST P	INJURY (I) K+A+B	C+O
OTHER MV	LT 50K	2-DOOR	PRE	13	745
			POST	36	2870
		4-DOOR	PRE	19	1162
			POST	23	2285
	50K-250K	2-DOOR	PRE	46	3952
			POST	135	14347
		4-DOOR	PRE	82	5628
			POST	68	9575
	250K +	2-DOOR	PRE	104	5216
			POST	234	21976
		4-DOOR	PRE	113	6069
			POST	88	11880
PRKD CAR	LT 50K	2-DOOR	PRE	3	47
			POST	3	94
		4-DOOR	PRE	0	59
			POST	4	87
	50K-250K	2-DOOR	PRE	10	285
			POST	15	623
		4-DOOR	PRE	24	481
			POST	10	399
	250K +	2-DOOR	PRE	18	271
			POST	29	657
		4-DOOR	PRE	19	405
			POST	16	358
OBJECT	LT 50K	2-DOOR	PRE	9	100
			POST	19	361
		4-DOOR	PRE	9	120
			POST	11	219
	50K-250K	2-DOOR	PRE	17	286
			POST	48	784
		4-DOOR	PRE	26	349
			POST	20	367
	250K +	2-DOOR	PRE	28	317
			POST	78	847
		4-DOOR	PRE	33	327
			POST	26	366

TAD: 3-4

ACCTYPE A	CITYSIZE C	STYLE S	PREPOST P	INJURY (I) K+A+B	C+O
OTHER MV	LT 50K	2-DOOR	PRE	87	488
			POST	278	1965
		4-DOOR	PRE	150	715
			POST	179	1385
	50K-250K	2-DOOR	PRE	217	1416
			POST	550	5223
		4-DOOR	PRE	297	1755
			POST	266	3098
	250K +	2-DOOR	PRE	316	1762
			POST	842	7361
		4-DOOR	PRE	322	1908
			POST	346	3328
PRKD CAR	LT 50K	2-DOOR	PRE	11	37
			POST	13	119
		4-DOOR	PRE	8	47
			POST	12	58
	50K-250K	2-DOOR	PRE	53	191
			POST	99	485
		4-DOOR	PRE	74	274
			POST	56	350
	250K +	2-DOOR	PRE	68	228
			POST	103	577
		4-DOOR	PRE	77	242
			POST	68	281
OBJECT	LT 50K	2-DOOR	PRE	25	84
			POST	115	376
		4-DOOR	PRE	54	112
			POST	51	187
	50K-250K	2-DOOR	PRE	83	232
			POST	244	699
		4-DOOR	PRE	123	259
			POST	115	303
	250K +	2-DOOR	PRE	176	324
			POST	397	907
		4-DOOR	PRE	187	301
			POST	171	358

TABLE A-8 (Continued)

TAD: 5-7

ACCTYPE A	CITYSIZE C	STYLE S	PREPOST P	INJURY (I) K+A+B	C+O
OTHER MV	LT 50K	2-DOOR	PRE	125	73
			POST	408	339
		4-DOOR	PRE	163	69
			POST	286	227
	50K-250K	2-DOOR	PRE	95	121
			POST	330	509
		4-DOOR	PRE	122	142
			POST	147	264
	250K +	2-DOOR	PRE	105	111
			POST	315	452
		4-DOOR	PRE	96	125
			POST	108	174
PRKD CAR	LT 50K	2-DOOR	PRE	6	8
			POST	25	23
		4-DOOR	PRE	13	3
			POST	11	8
	50K-250K	2-DOOR	PRE	15	10
			POST	54	80
		4-DOOR	PRE	32	22
			POST	30	43
	250K +	2-DOOR	PRE	12	20
			POST	53	54
		4-DOOR	PRE	18	25
			POST	19	21
OBJECT	LT 50K	2-DOOR	PRE	36	15
			POST	146	75
		4-DOOR	PRE	52	18
			POST	85	28
	50K-250K	2-DOOR	PRE	68	43
			POST	198	137
		4-DOOR	PRE	84	43
			POST	89	56
	250K +	2-DOOR	PRE	101	41
			POST	217	165
		4-DOOR	PRE	66	38
			POST	72	47

THE TOTAL FREQUENCY IS 146449

TABLE A-9

FULLY CROSS CLASSIFIED TABLE OF TEXAS 1974 RAW DATA FOR KABC/O INJURY DICHOTOMY

TAD: 1-2

ACCTYPE A	CITYSIZE C	STYLE S	PREPOST P	INJURY (I) K+A+B+C	INJURY (I) O
OTHER MV	LT 50K	2-DOOR	PRE	19	739
			POST	58	2848
		4-DOOR	PRE	35	1146
			POST	50	2258
	50K-250K	2-DOOR	PRE	93	3905
			POST	290	14192
		4-DOOR	PRE	162	5548
			POST	186	9457
	250K +	2-DOOR	PRE	181	5139
			POST	561	21649
		4-DOOR	PRE	216	5966
			POST	254	11714
PRKD CAR	LT 50K	2-DOOR	PRE	3	47
			POST	6	91
		4-DOOR	PRE	0	59
			POST	8	83
	50K-250K	2-DOOR	PRE	15	280
			POST	31	607
		4-DOOR	PRE	29	476
			POST	14	395
	250K +	2-DOOR	PRE	22	267
			POST	40	646
		4-DOOR	PRE	25	399
			POST	20	354
OBJECT	LT 50K	2-DOOR	PRE	13	96
			POST	34	346
		4-DOOR	PRE	22	107
			POST	15	215
	50K-250K	2-DOOR	PRE	28	275
			POST	74	758
		4-DOOR	PRE	35	340
			POST	33	354
	250K +	2-DOOR	PRE	39	306
			POST	117	808
		4-DOOR	PRE	47	313
			POST	40	352

TAD: 3-4

ACCTYPE A	CITYSIZE C	STYLE S	PREPOST P	INJURY (I) K+A+B+C	INJURY (I) O
OTHER MV	LT 50K	2-DOOR	PRE	119	456
			POST	446	1797
		4-DOOR	PRE	205	660
			POST	303	1261
	50K-250K	2-DOOR	PRE	342	1291
			POST	932	4841
		4-DOOR	PRE	459	1593
			POST	519	2845
	250K +	2-DOOR	PRE	454	1624
			POST	1507	6696
		4-DOOR	PRE	509	1721
			POST	666	3008
PRKD CAR	LT 50K	2-DOOR	PRE	18	30
			POST	18	114
		4-DOOR	PRE	11	44
			POST	17	53
	50K-250K	2-DOOR	PRE	63	161
			POST	133	451
		4-DOOR	PRE	95	253
			POST	85	321
	250K +	2-DOOR	PRE	81	215
			POST	148	532
		4-DOOR	PRE	87	232
			POST	88	261
OBJECT	LT 50K	2-DOOR	PRE	30	79
			POST	147	344
		4-DOOR	PRE	66	100
			POST	67	171
	50K-250K	2-DOOR	PRE	109	206
			POST	316	627
		4-DOOR	PRE	146	236
			POST	144	274
	250K +	2-DOOR	PRE	216	284
			POST	499	805
		4-DOOR	PRE	214	274
			POST	229	300

TABLE A-9 (Continued)

TAD: 5-7

ACCTYPE A	CITYSIZE C	STYLE S	PREPOST P	INJURY (I) K+A+B+C	O
OTHER MV	LT 50K	2-DOOR	PRE	141	57
			POST	489	258
		4-DOOR	PRE	177	55
			POST	338	175
	50K-250K	2-DOOR	PRE	122	94
			POST	449	390
		4-DOOR	PRE	156	108
			POST	207	204
	250K +	2-DOOR	PRE	131	85
			POST	439	328
		4-DOOR	PRE	130	91
			POST	159	123
PRKD CAR	LT 50K	2-DOOR	PRE	6	8
			POST	31	17
		4-DOOR	PRE	13	3
			POST	12	7
	50K-250K	2-DOOR	PRE	16	9
			POST	62	72
		4-DOOR	PRE	34	20
			POST	36	37
	250K +	2-DOOR	PRE	14	18
			POST	66	41
		4-DOOR	PRE	24	19
			POST	22	18
OBJECT	LT 50K	2-DOOR	PRE	40	11
			POST	161	60
		4-DOOR	PRE	58	12
			POST	94	19
	50K-250K	2-DOOR	PRE	75	36
			POST	226	109
		4-DOOR	PRE	94	33
			POST	101	44
	250K +	2-DOOR	PRE	113	29
			POST	274	108
		4-DOOR	PRE	74	30
			POST	85	34

THE TOTAL FREQUENCY IS 146449

TABLE A-10

FULLY CROSS CLASSIFIED TABLE
OF NEW YORK 1974 RAW DATA FOR
KA/BCO INJURY DICHOTOMY

MANUFAC M	DRVAGE A	RDCLASS R	STYLE S	PREPOST P	KAXBCO (I) KA	BCO
GM	15 - 24	HIGHWAY	2 DOOR	PRE	41	505
				POST	172	2544
			4 DOOR	PRE	33	314
				POST	32	633
		ROAD	2 DOOR	PRE	44	433
				POST	140	1762
			4 DOOR	PRE	29	260
				POST	21	411
		STREET	2 DOOR	PRE	28	424
				POST	97	1960
			4 DOOR	PRE	17	294
				POST	21	598
	25 - 49	HIGHWAY	2 DOOR	PRE	43	427
				POST	204	2869
			4 DOOR	PRE	37	327
				POST	61	1207
		ROAD	2 DOOR	PRE	33	261
				POST	95	1741
			4 DOOR	PRE	30	213
				POST	32	601
		STREET	2 DOOR	PRE	40	531
				POST	129	3049
			4 DOOR	PRE	30	533
				POST	50	1428
	50 +	HIGHWAY	2 DOOR	PRE	25	193
				POST	63	1310
			4 DOOR	PRE	11	182
				POST	50	1014
		ROAD	2 DOOR	PRE	11	135
				POST	46	793
			4 DOOR	PRE	3	101
				POST	17	457
		STREET	2 DOOR	PRE	7	225
				POST	36	1252
			4 DOOR	PRE	21	233
				POST	27	995

TABLE A-10 (Continued)

MANUFAC M	DRVAGE A	RDCLASS R	STYLE S	PREPOST P	KAXBCO (I) KA	BCO
FORD	15 - 24	HIGHWAY	2 DOOR	PRE	37	393
				POST	92	1423
			4 DOOR	PRE	13	170
				POST	24	350
		ROAD	2 DOOR	PRE	31	318
				POST	72	908
			4 DOOR	PRE	9	121
				POST	13	207
		STREET	2 DOOR	PRE	18	276
				POST	45	888
			4 DOOR	PRE	11	100
				POST	6	253
	25 - 49	HIGHWAY	2 DOOR	PRE	23	257
				POST	110	1461
			4 DOOR	PRE	19	167
				POST	38	602
		ROAD	2 DOOR	PRE	20	184
				POST	60	760
			4 DOOR	PRE	6	94
				POST	22	325
		STREET	2 DOOR	PRE	25	297
				POST	81	1233
			4 DOOR	PRE	10	196
				POST	15	500
	50 +	HIGHWAY	2 DOOR	PRE	7	111
				POST	36	615
			4 DOOR	PRE	8	92
				POST	19	455
		ROAD	2 DOOR	PRE	2	70
				POST	20	330
			4 DOOR	PRE	5	46
				POST	14	184
		STREET	2 DOOR	PRE	3	101
				POST	15	434
			4 DOOR	PRE	2	89
				POST	8	356

TABLE A-10 (Concluded)

MANUFAC M	DRVAGE A	RDCLASS R	STYLE S	PREPOST P	KA	BCD
OTHER	15 - 24	HIGHWAY	2 DOOR	PRE	28	220
				POST	112	1363
			4 DOOR	PRE	17	241
				POST	24	368
		ROAD	2 DOOR	PRE	21	149
				POST	93	854
			4 DOOR	PRE	15	162
				POST	17	235
		STREET	2 DOOR	PRE	16	164
				POST	54	867
			4 DOOR	PRE	14	199
				POST	8	306
	25 - 49	HIGHWAY	2 DOOR	PRE	17	174
				POST	96	1324
			4 DOOR	PRE	25	242
				POST	38	665
		ROAD	2 DOOR	PRE	8	84
				POST	45	684
			4 DOOR	PRE	12	126
				POST	23	307
		STREET	2 DOOR	PRE	14	192
				POST	65	1105
			4 DOOR	PRE	14	289
				POST	32	812
	50 +	HIGHWAY	2 DOOR	PRE	8	78
				POST	30	581
			4 DOOR	PRE	13	172
				POST	39	602
		ROAD	2 DOOR	PRE	1	63
				POST	20	349
			4 DOOR	PRE	6	62
				POST	16	270
		STREET	2 DOOR	PRE	9	98
				POST	27	458
			4 DOOR	PRE	10	151
				POST	18	526

KAXBCD (I)

THE TOTAL FREQUENCY IS 62843

TABLE A-11

FULLY CROSS CLASSIFIED TABLE
OF NEW YORK 1974 RAW DATA FOR
KAB/CO INJURY DICHOTOMY

MANUFAC M	DRVAGE A	RDCLASS R	STYLE S	PREPOST P	KABXCO (I) KAB	CO
GM	15 - 24	HIGHWAY	2 DOOR	PRE	140	406
				POST	541	2175
			4 DOOR	PRE	102	245
				POST	107	558
		ROAD	2 DOOR	PRE	139	338
				POST	438	1464
			4 DOOR	PRE	77	212
				POST	87	345
		STREET	2 DOOR	PRE	88	364
				POST	333	1724
			4 DOOR	PRE	61	250
				POST	85	534
	25 - 49	HIGHWAY	2 DOOR	PRE	111	359
				POST	580	2493
			4 DOOR	PRE	93	271
				POST	200	1068
		ROAD	2 DOOR	PRE	89	205
				POST	306	1530
			4 DOOR	PRE	67	176
				POST	96	537
		STREET	2 DOOR	PRE	115	456
				POST	454	2724
			4 DOOR	PRE	91	472
				POST	186	1292
	50 +	HIGHWAY	2 DOOR	PRE	53	165
				POST	211	1162
			4 DOOR	PRE	40	153
				POST	161	903
		ROAD	2 DOOR	PRE	37	109
				POST	131	708
			4 DOOR	PRE	24	80
				POST	65	409
		STREET	2 DOOR	PRE	36	196
				POST	164	1124
			4 DOOR	PRE	51	203
				POST	98	924

TABLE A-11 (Continued)

MANUFAC M	DRVAGE A	RDCLASS R	STYLE S	PREPOST P	KABXCO (I) KAB	CO
FORD	15 - 24	HIGHWAY	2 DOOR	PRE	122	308
				POST	322	1193
			4 DOOR	PRE	46	137
				POST	71	303
		ROAD	2 DOOR	PRE	98	251
				POST	236	744
			4 DOOR	PRE	44	86
				POST	49	171
		STREET	2 DOOR	PRE	67	227
				POST	164	769
			4 DOOR	PRE	27	84
				POST	33	226
	25 - 49	HIGHWAY	2 DOOR	PRE	63	217
				POST	321	1250
			4 DOOR	PRE	46	140
				POST	101	539
		ROAD	2 DOOR	PRE	64	140
				POST	180	640
			4 DOOR	PRE	24	76
				POST	74	273
		STREET	2 DOOR	PRE	62	260
				POST	243	1071
			4 DOOR	PRE	30	176
				POST	63	452
	50 +	HIGHWAY	2 DOOR	PRE	32	86
				POST	111	540
			4 DOOR	PRE	25	75
				POST	82	392
		ROAD	2 DOOR	PRE	17	55
				POST	69	281
			4 DOOR	PRE	11	40
				POST	33	165
		STREET	2 DOOR	PRE	20	84
				POST	64	385
			4 DOOR	PRE	17	74
				POST	49	315

TABLE A-11 (Concluded)

MANUFAC M	DRVAGE A	RDCLASS R	STYLE S	PREPOST P	KABXCO (I) KAB	CO
OTHER	15 - 24	HIGHWAY	2 DOOR	PRE	70	178
				POST	309	1166
			4 DOOR	PRE	68	190
				POST	101	291
		ROAD	2 DOOR	PRE	54	116
				POST	251	696
			4 DOOR	PRE	58	119
				POST	60	192
		STREET	2 DOOR	PRE	34	146
				POST	181	740
			4 DOOR	PRE	53	160
				POST	48	266
	25 - 49	HIGHWAY	2 DOOR	PRE	53	138
				POST	308	1112
			4 DOOR	PRE	62	205
				POST	124	579
		ROAD	2 DOOR	PRE	26	66
				POST	151	578
			4 DOOR	PRE	31	107
				POST	61	269
		STREET	2 DOOR	PRE	41	165
				POST	222	948
			4 DOOR	PRE	50	253
				POST	95	749
	50 +	HIGHWAY	2 DOOR	PRE	20	66
				POST	126	485
			4 DOOR	PRE	39	146
				POST	128	513
		ROAD	2 DOOR	PRE	9	55
				POST	92	277
			4 DOOR	PRE	17	51
				POST	53	233
		STREET	2 DOOR	PRE	18	89
				POST	79	406
			4 DOOR	PRE	23	138
				POST	67	477

THE TOTAL FREQUENCY IS 62843

TABLE A-12

FULLY CROSS CLASSIFIED TABLE
OF NEW YORK 1974 RAW DATA FOR
KABC/O INJURY DICHOTOMY

MANUFAC M	DRVAGE A	RDCLASS R	STYLE S	PREPOST P	KABCXO (I) KABC	O
GM	15 - 24	HIGHWAY	2 DOOR	PRE	201	349
				POST	845	1887
			4 DOOR	PRE	142	210
				POST	164	505
		ROAD	2 DOOR	PRE	195	284
				POST	642	1264
			4 DOOR	PRE	106	183
				POST	142	292
		STREET	2 DOOR	PRE	138	316
				POST	600	1462
			4 DOOR	PRE	110	202
				POST	156	464
	25 - 49	HIGHWAY	2 DOOR	PRE	179	296
				POST	987	2108
			4 DOOR	PRE	125	240
				POST	369	906
		ROAD	2 DOOR	PRE	121	176
				POST	556	1290
			4 DOOR	PRE	97	148
				POST	189	445
		STREET	2 DOOR	PRE	194	379
				POST	907	2287
			4 DOOR	PRE	163	402
				POST	376	1113
	50 +	HIGHWAY	2 DOOR	PRE	75	143
				POST	379	1006
			4 DOOR	PRE	56	137
				POST	282	787
		ROAD	2 DOOR	PRE	56	91
				POST	234	612
			4 DOOR	PRE	33	71
				POST	117	362
		STREET	2 DOOR	PRE	66	166
				POST	317	979
			4 DOOR	PRE	77	179
				POST	216	809

TABLE A-12 (Continued)

MANUFAC M	DRVAGE A	RDCLASS R	STYLE S	PREPOST P	KABCXO KABC	(I) O
FORD	15 - 24	HIGHWAY	2 DOOR	PRE	184	250
				POST	517	1005
			4 DOOR	PRE	65	118
				POST	103	274
		ROAD	2 DOOR	PRE	141	211
				POST	363	622
			4 DOOR	PRE	64	67
				POST	76	146
		STREET	2 DOOR	PRE	94	202
				POST	272	662
			4 DOOR	PRE	41	70
				POST	68	191
	25 - 49	HIGHWAY	2 DOOR	PRE	92	188
				POST	531	1049
			4 DOOR	PRE	75	113
				POST	184	459
		ROAD	2 DOOR	PRE	92	113
				POST	276	547
			4 DOOR	PRE	41	60
				POST	111	236
		STREET	2 DOOR	PRE	103	219
				POST	408	910
			4 DOOR	PRE	64	144
				POST	131	386
	50 +	HIGHWAY	2 DOOR	PRE	48	71
				POST	178	474
			4 DOOR	PRE	36	64
				POST	138	339
		ROAD	2 DOOR	PRE	26	46
				POST	115	236
			4 DOOR	PRE	20	31
				POST	54	146
		STREET	2 DOOR	PRE	36	68
				POST	121	329
			4 DOOR	PRE	27	65
				POST	97	269

TABLE A-12 (Concluded)

MANUFAC M	DRVAGE A	RDCLASS R	STYLE S	PREPOST P	KABCXO (I) KABC	O
OTHER	15 - 24	HIGHWAY	2 DOOR	PRE	99	149
				POST	479	997
			4 DOOR	PRE	99	160
				POST	143	249
		ROAD	2 DOOR	PRE	76	94
				POST	371	582
			4 DOOR	PRE	72	105
				POST	89	164
		STREET	2 DOOR	PRE	57	125
				POST	292	631
			4 DOOR	PRE	73	141
				POST	79	236
	25 - 49	HIGHWAY	2 DOOR	PRE	84	107
				POST	482	945
			4 DOOR	PRE	101	167
				POST	225	481
		ROAD	2 DOOR	PRE	39	53
				POST	254	480
			4 DOOR	PRE	53	89
				POST	95	235
		STREET	2 DOOR	PRE	58	149
				POST	394	777
			4 DOOR	PRE	83	222
				POST	209	639
	50 +	HIGHWAY	2 DOOR	PRE	38	48
				POST	210	404
			4 DOOR	PRE	51	134
				POST	194	448
		ROAD	2 DOOR	PRE	21	45
				POST	140	231
			4 DOOR	PRE	22	46
				POST	93	194
		STREET	2 DOOR	PRE	27	80
				POST	151	336
			4 DOOR	PRE	47	115
				POST	127	418

THE TOTAL FREQUENCY IS 63137

TABLE A-13

FULLY CROSS CLASSIFIED TABLE OF NORTH CAROLINA 1973
RAW DATA FOR KA/BCO INJURY DICHOTOMY

VEHSPEED X	MANUFAC M	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KA	BCO
1-29MPH	GM	LT 3000	2 DOOR	PRE	2	142
				POST	1	168
			4 DOOR	PRE	4	93
				POST	1	89
		3K-3599	2 DOOR	PRE	9	625
				POST	12	1567
			4 DOOR	PRE	9	620
				POST	6	604
		3600 +	2 DOOR	PRE	1	163
				POST	6	1050
			4 DOOR	PRE	8	423
				POST	7	1747
	FORD	LT 3000	2 DOOR	PRE	7	559
				POST	8	763
			4 DOOR	PRE	4	231
				POST	3	102
		3K-3599	2 DOOR	PRE	2	396
				POST	7	433
			4 DOOR	PRE	4	287
				POST	0	264
		3600 +	2 DOOR	PRE	2	151
				POST	1	299
			4 DOOR	PRE	2	233
				POST	3	515
	OTHER	LT 3000	2 DOOR	PRE	0	54
				POST	3	384
			4 DOOR	PRE	0	67
				POST	1	128
		3K-3599	2 DOOR	PRE	1	112
				POST	2	386
			4 DOOR	PRE	3	169
				POST	2	179
		3600 +	2 DOOR	PRE	0	42
				POST	2	122
			4 DOOR	PRE	0	88
				POST	1	384

TABLE A-13 (Continued)

VEHSPEED X	MANUFAC M	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KA	BCO
30-49MPH	GM	LT 3000	2 DOOR	PRE	3	103
				POST	5	120
			4 DOOR	PRE	5	66
				POST	5	46
		3K-3599	2 DOOR	PRE	12	467
				POST	21	1099
			4 DOOR	PRE	11	372
				POST	10	368
		3600 +	2 DOOR	PRE	1	111
				POST	18	698
			4 DOOR	PRE	12	241
				POST	33	960
	FORD	LT 3000	2 DOOR	PRE	18	389
				POST	16	590
			4 DOOR	PRE	5	146
				POST	3	72
		3K-3599	2 DOOR	PRE	13	339
				POST	8	337
			4 DOOR	PRE	6	195
				POST	4	147
		3600 +	2 DOOR	PRE	4	90
				POST	7	199
			4 DOOR	PRE	6	153
				POST	3	324
	OTHER	LT 3000	2 DOOR	PRE	1	35
				POST	10	258
			4 DOOR	PRE	1	27
				POST	3	59
		3K-3599	2 DOOR	PRE	2	103
				POST	5	290
			4 DOOR	PRE	3	89
				POST	5	115
		3600 +	2 DOOR	PRE	2	32
				POST	3	102
			4 DOOR	PRE	1	44
				POST	6	212

TABLE A-13 (Concluded)

VEHSPEED X	MANUFAC M	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KA	BCO
50 MPH +	GM	LT 3000	2 DOOR	PRE	1	22
				POST	4	25
			4 DOOR	PRE	4	16
				POST	0	9
		3K-3599	2 DOOR	PRE	14	136
				POST	44	349
			4 DOOR	PRE	5	81
				POST	9	103
		3600 +	2 DOOR	PRE	1	30
				POST	13	211
			4 DOOR	PRE	9	45
				POST	12	316
	FORD	LT 3000	2 DOOR	PRE	15	111
				POST	15	135
			4 DOOR	PRE	5	23
				POST	2	22
		3K-3599	2 DOOR	PRE	8	90
				POST	6	105
			4 DOOR	PRE	6	47
				POST	1	39
		3600 +	2 DOOR	PRE	2	29
				POST	7	78
			4 DOOR	PRE	6	37
				POST	6	113
	OTHER	LT 3000	2 DOOR	PRE	0	8
				POST	13	84
			4 DOOR	PRE	0	6
				POST	2	14
		3K-3599	2 DOOR	PRE	3	31
				POST	18	115
			4 DOOR	PRE	3	19
				POST	3	30
		3600 +	2 DOOR	PRE	1	8
				POST	0	40
			4 DOOR	PRE	4	6
				POST	8	86

THE TOTAL FREQUENCY IS 25901

TABLE A-14

FULLY CROSS CLASSIFIED TABLE OF NORTH CAROLINA 1973
RAW DATA FOR KAB/CO INJURY DICHOTOMY

VEHSPEED X	MANUFAC M	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KAB	CO
1-29MPH	GM	LT 3000	2 DOOR	PRE	5	139
				POST	8	161
			4 DOOR	PRE	8	89
				POST	4	86
		3K-3599	2 DOOR	PRE	39	595
				POST	56	1523
			4 DOOR	PRE	30	599
				POST	28	582
		3600 +	2 DOOR	PRE	7	157
				POST	29	1027
			4 DOOR	PRE	21	410
				POST	47	1707
	FORD	LT 3000	2 DOOR	PRE	36	530
				POST	34	737
			4 DOOR	PRE	15	220
				POST	6	99
		3K-3599	2 DOOR	PRE	16	382
				POST	28	412
			4 DOOR	PRE	19	272
				POST	5	259
		3600 +	2 DOOR	PRE	4	149
				POST	9	291
			4 DOOR	PRE	8	227
				POST	20	498
	OTHER.	LT 3000	2 DOOR	PRE	2	52
				POST	22	365
			4 DOOR	PRE	5	62
				POST	7	122
		3K-3599	2 DOOR	PRE	3	110
				POST	12	376
			4 DOOR	PRE	8	164
				POST	5	176
		3600 +	2 DOOR	PRE	3	39
				POST	8	116
			4 DOOR	PRE	3	85
				POST	20	365

TABLE A-14 (Continued)

VEHSPEED X	MANUFAC M	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KAB	CO
30-49MPH	GM	LT 3000	2 DOOR	PRE	14	92
				POST	25	100
			4 DOOR	PRE	12	59
				POST	8	43
		3K-3599	2 DOOR	PRE	63	416
				POST	110	1010
			4 DOOR	PRE	56	327
				POST	30	348
		3600 +	2 DOOR	PRE	14	98
				POST	62	654
			4 DOOR	PRE	26	227
				POST	93	900
	FORD	LT 3000	2 DOOR	PRE	70	337
				POST	70	536
			4 DOOR	PRE	22	129
				POST	16	59
		3K-3599	2 DOOR	PRE	47	305
				POST	34	311
			4 DOOR	PRE	23	178
				POST	12	139
		3600 +	2 DOOR	PRE	9	85
				POST	16	190
			4 DOOR	PRE	19	140
				POST	30	297
	OTHER	LT 3000	2 DOOR	PRE	8	28
				POST	32	236
			4 DOOR	PRE	4	24
				POST	9	53
		3K-3599	2 DOOR	PRE	14	91
				POST	26	269
			4 DOOR	PRE	13	79
				POST	14	106
		3600 +	2 DOOR	PRE	4	30
				POST	13	92
			4 DOOR	PRE	5	40
				POST	27	191

TABLE A-14 (Concluded)

VEHSPEED X	MANUFAC M	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KAB	CO
50 MPH +	GM	LT 3000	2 DOOR	PRE	5	18
				POST	9	20
			4 DOOR	PRE	7	13
				POST	1	8
		3K-3599	2 DOOR	PRE	38	112
				POST	93	300
			4 DOOR	PRE	10	76
				POST	26	86
		3600 +	2 DOOR	PRE	3	28
				POST	38	186
			4 DOOR	PRE	15	39
				POST	50	278
	FORD	LT 3000	2 DOOR	PRE	34	92
				POST	40	110
			4 DOOR	PRE	9	19
				POST	9	15
		3K-3599	2 DOOR	PRE	19	79
				POST	15	96
			4 DOOR	PRE	9	44
				POST	5	35
		3600 +	2 DOOR	PRE	10	21
				POST	16	69
			4 DOOR	PRE	12	31
				POST	15	104
	OTHER	LT 3000	2 DOOR	PRE	1	7
				POST	30	67
			4 DOOR	PRE	1	5
				POST	5	11
		3K-3599	2 DOOR	PRE	6	28
				POST	35	98
			4 DOOR	PRE	7	15
				POST	4	29
		3600 +	2 DOOR	PRE	1	8
				POST	1	39
			4 DOOR	PRE	5	5
				POST	16	78

THE TOTAL FREQUENCY IS 25901

TABLE A-15

FULLY CROSS CLASSIFIED TABLE OF NORTH CAROLINA 1973
RAW DATA FOR KABC/O INJURY DICHOTOMY

VEHSPEED X	MANUFAC M	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KABC	O
1-29MPH	GM	LT 3000	2 DOOR	PRE	13	131
				POST	15	154
			4 DOOR	PRE	12	85
				POST	9	81
		3K-3599	2 DOOR	PRE	70	564
				POST	123	1456
			4 DOOR	PRE	61	568
				POST	66	544
		3600 +	2 DOOR	PRE	10	154
				POST	69	987
			4 DOOR	PRE	42	389
				POST	107	1647
	FORD	LT 3000	2 DOOR	PRE	61	505
				POST	77	694
			4 DOOR	PRE	32	203
				POST	12	93
		3K-3599	2 DOOR	PRE	33	365
				POST	46	394
			4 DOOR	PRE	39	252
				POST	15	249
		3600 +	2 DOOR	PRE	9	144
				POST	27	273
			4 DOOR	PRE	21	214
				POST	42	476
	OTHER	LT 3000	2 DOOR	PRE	6	48
				POST	42	345
			4 DOOR	PRE	8	59
				POST	13	116
		3K-3599	2 DOOR	PRE	11	102
				POST	31	357
			4 DOOR	PRE	23	149
				POST	20	161
		3600 +	2 DOOR	PRE	4	38
				POST	12	112
			4 DOOR	PRE	9	79
				POST	42	343

TABLE A-15 (Continued)

VEHSPEED X	MANUFAC M	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KABC	O
30-49MPH	GM	LT 3000	2 DOOR	PRE	20	86
				POST	33	92
			4 DOOR	PRE	17	54
				POST	15	36
		3K-3599	2 DOOR	PRE	106	373
				POST	198	922
			4 DOOR	PRE	80	303
				POST	68	310
		3600 +	2 DOOR	PRE	26	86
				POST	124	592
			4 DOOR	PRE	53	200
				POST	159	834
	FORD	LT 3000	2 DOOR	PRE	102	305
				POST	127	479
			4 DOOR	PRE	39	112
				POST	22	53
		3K-3599	2 DOOR	PRE	76	276
				POST	56	289
			4 DOOR	PRE	34	167
				POST	26	125
		3600 +	2 DOOR	PRE	14	80
				POST	35	171
			4 DOOR	PRE	30	129
				POST.	57	270
	OTHER	LT 3000	2 DOOR	PRE	9	27
				POST	51	217
			4 DOOR	PRE	7	21
				POST	15	47
		3K-3599	2 DOOR	PRE	25	80
				POST	47	248
			4 DOOR	PRE	19	73
				POST	25	95
		3600 +	2 DOOR	PRE	5	29
				POST	18	87
			4 DOOR	PRE	10	35
				POST	40	178

TABLE A-15 (Concluded)

VEHSPEED X	MANUFAC M	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KABC	O
50 MPH +	GM	LT 3000	2 DOOR	PRE	6	17
				POST	10	19
			4 DOOR	PRE	8	12
				POST	1	8
		3K-3599	2 DOOR	PRE	42	108
				POST	126	267
			4 DOOR	PRE	21	65
				POST	41	71
		3600 +	2 DOOR	PRE	5	26
				POST	51	173
			4 DOOR	PRE	19	35
				POST	71	257
	FORD	LT 3000	2 DOOR	PRE	46	80
				POST	54	96
			4 DOOR	PRE	11	17
				POST	10	14
		3K-3599	2 DOOR	PRE	25	73
				POST	26	85
			4 DOOR	PRE	15	38
				POST	9	31
		3600 +	2 DOOR	PRE	11	20
				POST	25	60
			4 DOOR	PRE	14	29
				POST	24	95
	OTHER	LT 3000	2 DOOR	PRE	2	6
				POST	37	60
			4 DOOR	PRE	2	4
				POST	6	10
		3K-3599	2 DOOR	PRE	7	27
				POST	45	88
			4 DOOR	PRE	9	13
				POST	4	29
		3600 +	2 DOOR	PRE	1	8
				POST	3	37
			4 DOOR	PRE	6	4
				POST	27	67

THE TOTAL FREQUENCY IS 25901

TABLE A-16

FULLY CROSS CLASSIFIED TABLE OF
NORTH CAROLINA 1974 RAW DATA FOR
KA/BCO INJURY DICHOTOMY

MANUFAC M	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KA	BCO
GM	LT 3000	2 DOOR	PRE	5	205
			POST	13	285
		4 DOOR	PRE	9	190
			POST	5	161
	3K-3599	2 DOOR	PRE	25	985
			POST	58	3087
		4 DOOR	PRE	31	996
			POST	25	1069
	3600 +	2 DOOR	PRE	7	253
			POST	47	2615
		4 DOOR	PRE	9	706
			POST	41	3445
FORD	LT 3000	2 DOOR	PRE	34	898
			POST	49	1630
		4 DOOR	PRE	19	328
			POST	11	209
	3K-3599	2 DOOR	PRE	18	654
			POST	19	740
		4 DOOR	PRE	13	465
			POST	15	446
	3600 +	2 DOOR	PRE	4	253
			POST	18	756
		4 DOOR	PRE	10	302
			POST	25	1209
OTHER	LT 3000	2 DOOR	PRE	1	81
			POST	27	740
		4 DOOR	PRE	3	92
			POST	3	184
	3K-3599	2 DOOR	PRE	3	201
			POST	17	847
		4 DOOR	PRE	4	245
			POST	11	377
	3600 +	2 DOOR	PRE	3	72
			POST	6	282
		4 DOOR	PRE	4	145
			POST	15	779

THE TOTAL FREQUENCY IS 26539

TABLE A-17

FULLY CROSS CLASSIFIED TABLE OF NORTH CAROLINA 1974 RAW DATA FOR KAB/CO INJURY DICHOTOMY

MANUFAC M	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KAB	CO
GM	LT 3000	2 DOOR	PRE	20	190
			POST	40	258
		4 DOOR	PRE	29	170
			POST	20	146
	3K-3599	2 DOOR	PRE	105	905
			POST	267	2878
		4 DOOR	PRE	110	917
			POST	93	1001
	3600 +	2 DOOR	PRE	20	240
			POST	171	2491
		4 DOOR	PRE	57	658
			POST	181	3305
FORD	LT 3000	2 DOOR	PRE	113	819
			POST	181	1498
		4 DOOR	PRE	47	300
			POST	25	195
	3K-3599	2 DOOR	PRE	70	602
			POST	59	700
		4 DOOR	PRE	33	445
			POST	35	426
	3600 +	2 DOOR	PRE	20	237
			POST	63	711
		4 DOOR	PRE	35	277
			POST	75	1159
OTHER	LT 3000	2 DOOR	PRE	5	77
			POST	97	670
		4 DOOR	PRE	9	86
			POST	16	171
	3K-3599	2 DOOR	PRE	21	183
			POST	83	781
		4 DOOR	PRE	22	227
			POST	29	359
	3600 +	2 DOOR	PRE	10	65
			POST	27	261
		4 DOOR	PRE	8	141
			POST	54	740

THE TOTAL FREQUENCY IS 26539

TABLE A-18

FULLY CROSS CLASSIFIED TABLE OF NORTH CAROLINA 1974 RAW DATA FOR KABC/O INJURY DICHOTOMY

MANUFAC M	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KABC	O
GM	LT 3000	2 DOOR	PRE	33	177
			POST	62	236
		4 DOOR	PRE	42	157
			POST	28	138
	3K-3599	2 DOOR	PRE	169	841
			POST	474	2671
		4 DOOR	PRE	193	834
			POST	153	941
	3600 +	2 DOOR	PRE	38	222
			POST	341	2321
		4 DOOR	PRE	99	616
			POST	407	3079
FORD	LT 3000	2 DOOR	PRE	166	766
			POST	320	1359
		4 DOOR	PRE	80	267
			POST	43	177
	3K-3599	2 DOOR	PRE	111	561
			POST	104	655
		4 DOOR	PRE	68	410
			POST	65	396
	3600 +	2 DOOR	PRE	47	210
			POST	106	668
		4 DOOR	PRE	46	266
			POST	152	1082
OTHER	LT 3000	2 DOOR	PRE	16	66
			POST	158	609
		4 DOOR	PRE	15	80
			POST	34	153
	3K-3599	2 DOOR	PRE	36	168
			POST	140	724
		4 DOOR	PRE	42	207
			POST	60	328
	3600 +	2 DOOR	PRE	15	60
			POST	46	242
		4 DOOR	PRE	19	130
			POST	105	689

THE TOTAL FREQUENCY IS 26539

TABLE A-19

FULLY CROSS CLASSIFIED TABLE OF NORTH CAROLINA 1975 RAW DATA FOR KA/BCO INJURY DICHOTOMY

MANUFAC M	DRVSEX X	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KA	BCO
GM	MALE	LT 3000	2 DOOR	PRE	2	163
				POST	5	182
			4 DOOR	PRE	5	100
				POST	2	80
		3K-3599	2 DOOR	PRE	23	608
				POST	35	1977
			4 DOOR	PRE	12	533
				POST	14	706
		3600 +	2 DOOR	PRE	7	141
				POST	31	2020
			4 DOOR	PRE	5	392
				POST	35	2353
	FEMALE	LT 3000	2 DOOR	PRE	1	44
				POST	7	88
			4 DOOR	PRE	1	79
				POST	4	91
		3K-3599	2 DOOR	PRE	4	209
				POST	25	1159
			4 DOOR	PRE	5	319
				POST	13	584
		3600 +	2 DOOR	PRE	0	62
				POST	18	1194
			4 DOOR	PRE	5	189
				POST	25	1553

TABLE A-19 (Continued)

MANUFAC M	DRVSEX X	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KA	BCO
FORD	MALE	LT 3000	2 DOOR	PRE	13	586
				POST	24	1000
			4 DOOR	PRE	7	202
				POST	1	144
		3K-3599	2 DOOR	PRE	14	432
				POST	10	510
			4 DOOR	PRE	8	312
				POST	5	298
		3600 +	2 DOOR	PRE	5	127
				POST	5	595
			4 DOOR	PRE	4	190
				POST	22	877
	FEMALE	LT 3000	2 DOOR	PRE	6	290
				POST	26	795
			4 DOOR	PRE	6	136
				POST	8	145
		3K-3599	2 DOOR	PRE	9	185
				POST	11	326
			4 DOOR	PRE	5	171
				POST	5	192
		3600 +	2 DOOR	PRE	3	56
				POST	10	357
			4 DOOR	PRE	2	95
				POST	16	503

TABLE A-19 (Concluded)

MANUFAC M	DRVSEX X	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KA	BCO
OTHER	MALE	LT 3000	2 DOOR	PRE	0	61
				POST	12	434
			4 DOOR	PRE	1	54
				POST	0	118
		3K-3599	2 DOOR	PRE	2	133
				POST	14	569
			4 DOOR	PRE	2	134
				POST	6	249
		3600 +	2 DOOR	PRE	2	43
				POST	5	186
			4 DOOR	PRE	0	94
				POST	12	571
	FEMALE	LT 3000	2 DOOR	PRE	1	33
				POST	9	326
			4 DOOR	PRE	2	41
				POST	3	82
		3K-3599	2 DOOR	PRE	3	72
				POST	6	265
			4 DOOR	PRE	1	117
				POST	7	174
		3600 +	2 DOOR	PRE	2	27
				POST	1	117
			4 DOOR	PRE	0	68
				POST	2	316

THE TOTAL FREQUENCY IS 28236

TABLE A-20

FULLY CROSS CLASSIFIED TABLE OF NORTH CAROLINA 1975 RAW DATA FOR KAB/CO INJURY DICHOTOMY

MANUFAC M	DRVSEX X	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KAB	CO
GM	MALE	LT 3000	2 DOOR	PRE	21	144
				POST	26	161
			4 DOOR	PRE	13	92
				POST	9	73
		3K-3599	2 DOOR	PRE	71	560
				POST	130	1882
			4 DOOR	PRE	46	499
				POST	51	669
		3600 +	2 DOOR	PRE	18	130
				POST	119	1932
			4 DOOR	PRE	32	365
				POST	144	2244
	FEMALE	LT 3000	2 DOOR	PRE	8	37
				POST	17	78
			4 DOOR	PRE	7	73
				POST	11	84
		3K-3599	2 DOOR	PRE	26	187
				POST	110	1074
			4 DOOR	PRE	28	296
				POST	55	542
		3600 +	2 DOOR	PRE	3	59
				POST	75	1137
			4 DOOR	PRE	19	175
				POST	121	1457

TABLE A-20 (Continued)

MANUFAC M	DRVSEX X	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KAB	CO
FORD	MALE	LT 3000	2 DOOR	PRE	59	540
				POST	92	932
			4 DOOR	PRE	17	192
				POST	7	138
		3K-3599	2 DOOR	PRE	40	406
				POST	38	482
			4 DOOR	PRE	27	293
				POST	25	278
		3600 +	2 DOOR	PRE	10	122
				POST	33	567
			4 DOOR	PRE	21	173
				POST	65	834
	FEMALE	LT 3000	2 DOOR	PRE	35	261
				POST	107	714
			4 DOOR	PRE	19	123
				POST	30	123
		3K-3599	2 DOOR	PRE	29	165
				POST	28	309
			4 DOOR	PRE	15	161
				POST	18	179
		3600 +	2 DOOR	PRE	8	51
				POST	48	319
			4 DOOR	PRE	10	87
				POST	54	465

TABLE A-20 (Concluded)

MANUFAC M	DRVSEX X	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KAB	CO
OTHER	MALE	LT 3000	2 DOOR	PRE	4	57
				POST	40	406
			4 DOOR	PRE	9	46
				POST	12	106
		3K-3599	2 DOOR	PRE	10	125
				POST	42	541
			4 DOOR	PRE	7	129
				POST	17	238
		3600 +	2 DOOR	PRE	4	41
				POST	20	171
			4 DOOR	PRE	9	85
				POST	36	547
	FEMALE	LT 3000	2 DOOR	PRE	3	31
				POST	49	286
			4 DOOR	PRE	7	36
				POST	9	76
		3K-3599	2 DOOR	PRE	12	63
				POST	29	242
			4 DOOR	PRE	10	108
				POST	26	155
		3600 +	2 DOOR	PRE	6	23
				POST	4	114
			4 DOOR	PRE	2	66
				POST	21	297

THE TOTAL FREQUENCY IS 28236

TABLE A-21

FULLY CROSS CLASSIFIED TABLE FOR
NORTH CAROLINA 1975 RAW DATA FOR
KABC/O INJURY DICHOTOMY

MANUFAC M	DRVSEX X	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KABC	O
GM	MALE	LT 3000	2 DOOR	PRE	27	138
				POST	36	151
			4 DOOR	PRE	15	90
				POST	12	70
		3K-3599	2 DOOR	PRE	103	528
				POST	223	1789
			4 DOOR	PRE	77	468
				POST	86	634
		3600 +	2 DOOR	PRE	22	126
				POST	236	1815
			4 DOOR	PRE	58	339
				POST	249	2139
	FEMALE	LT 3000	2 DOOR	PRE	15	30
				POST	27	68
			4 DOOR	PRE	16	64
				POST	22	73
		3K-3599	2 DOOR	PRE	51	162
				POST	220	964
			4 DOOR	PRE	66	258
				POST	121	476
		3600 +	2 DOOR	PRE	8	54
				POST	206	1006
			4 DOOR	PRE	28	166
				POST	257	1321

TABLE A-21 (Continued)

MANUFAC M	DRVSEX X	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KABC	O
FORD	MALE	LT 3000	2 DOOR	PRE	96	503
				POST	154	870
			4 DOOR	PRE	30	179
				POST	16	129
		3K-3599	2 DOOR	PRE	58	388
				POST	70	450
			4 DOOR	PRE	44	276
				POST	38	265
		3600 +	2 DOOR	PRE	20	112
				POST	77	523
			4 DOOR	PRE	31	163
				POST	124	775
	FEMALE	LT 3000	2 DOOR	PRE	63	233
				POST	211	610
			4 DOOR	PRE	34	108
				POST	48	105
		3K-3599	2 DOOR	PRE	54	140
				POST	61	276
			4 DOOR	PRE	38	138
				POST	43	154
		3600 +	2 DOOR	PRE	14	45
				POST	86	281
			4 DOOR	PRE	16	81
				POST	102	417

TABLE A-21 (Concluded)

MANUFAC M	DRVSEX X	WEIGHT W	STYLE S	PREPOST P	INJURY (I) KABC	O
OTHER	MALE	LT 3000	2 DOOR	PRE	10	51
				POST	62	384
			4 DOOR	PRE	13	42
				POST	19	99
		3K-3599	2 DOOR	PRE	14	121
				POST	77	506
			4 DOOR	PRE	16	120
				POST	33	222
		3600 +	2 DOOR	PRE	6	39
				POST	29	162
			4 DOOR	PRE	14	80
				POST	66	517
	FEMALE	LT 3000	2 DOOR	PRE	8	26
				POST	83	252
			4 DOOR	PRE	11	32
				POST	17	68
		3K-3599	2 DOOR	PRE	21	54
				POST	50	221
			4 DOOR	PRE	20	98
				POST	33	148
		3600 +	2 DOOR	PRE	10	19
				POST	15	103
			4 DOOR	PRE	12	56
				POST	49	269

THE TOTAL FREQUENCY IS 28236

APPENDIX B

COMPLETE MARGINAL ASSOCIATIONS OF MODEL EFFECTS FOR STATE MASS ACCIDENT DATA

TABLE B-1

SUMMARY OF TESTS OF MARGINAL ASSOCIATION OF MODEL EFFECTS FOR INJURY DICHOTOMY KA vs BCO TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost	184.75	1	0.000	151.73	1	0.000	138.18	2	0.000
Injury x Style	1.15	1	0.283	0.73	1	0.394	0.92	2	0.337
Injury x Accident Type	1,871.17	2	0.000	-	-	-	1,474.52	2	0.000
Injury x Driver Age	15.19	2	0.000	4.85	2	0.089	-	-	-
Injury x City Size	1,189.18	2	0.000	1,296.82	2	0.000	844.14	2	0.000
Injury x Road Type	-	-	-	491.11	2	0.000	-	-	-
Injury x TAD	-	-	-	-	-	-	7,235.74	2	0.000
Prepost x Style	4,860.68	1	0.000	4,878.59	1	0.000	4,569.23	1	0.000
Prepost x Accident Type	992.45	2	0.000	-	-	-	663.02	2	0.000
Prepost x Driver Age	730.43	2	0.000	588.60	2	0.000	-	-	-
Prepost x City Size	139.09	2	0.000	136.50	2	0.000	135.27	2	0.000
Prepost x Road Type	-	-	-	307.74	2	0.000	-	-	-
Prepost x TAD	-	-	-	-	-	-	30.86	2	0.000
Style x Accident Type	126.33	2	0.000	-	-	-	118.53	2	0.000
Style x Driver Age	11,095.57	2	0.000	11,179.07	2	0.000	-	-	-
Style x City Size	570.90	2	0.000	604.32	2	0.000	558.01	2	0.000
Style x Road Type	-	-	-	0.79	2	0.673	-	-	-
Style x TAD	-	-	-	-	-	-	121.12	2	0.000
Accident Type x Driver Age	643.54	4	0.000	-	-	-	-	-	-
Accident Type x City Size	832.77	4	0.000	984.43	4	0.000	-	-	-
Accident Type x TAD	-	-	-	-	-	-	6,231.50	4	0.000
Driver Age x City Size	823.72	4	0.000	-	-	-	-	-	-
City Size x Road Type	-	-	-	24,816.45	4	0.000	-	-	-
City Size x Accident Type	-	-	-	-	-	-	734.40	4	0.000
City Size x TAD	-	-	-	-	-	-	3,326.20	4	0.000
Road Type x Driver Age	-	-	-	177.23	4	0.000	-	-	-
Injury x Prepost x Style	0.78	1	0.377	0.81*	1	0.369	0.21*	1	0.647
Injury x Prepost x Accident Type	2.32	2	0.313	-	-	-	-	-	-
Injury x Prepost x City Size	25.76	2	0.000	26.62*	2	0.000	-	-	-
Injury x Style x Accident Type	4.96	2	0.084	-	-	-	-	-	-
Injury x Style x City Size	1.79	2	0.408	3.31	2	0.191	-	-	-
Injury x Style x Driver Age	-	-	-	3.71	2	0.156	-	-	-
Injury x Accident Type x City Size	270.45	4	0.000	-	-	-	-	-	-
Injury x Accident Type x TAD	-	-	-	-	-	-	167.86*	4	0.000
Injury x Driver Age x City Size	16.67*	4	0.002	12.68	4	0.013	-	-	-
Injury x City Size x Road Type	-	-	-	148.76*	4	0.000	-	-	-

*Effect is specified directly in the model.

TABLE B-1 (Continued)

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x City Size x Accident Type	-	-	-	-	-	-	205.77*	4	0.000
Injury x City Size x TAD	-	-	-	-	-	-	104.71*	4	0.000
Injury x Road Type x Driver Age	-	-	-	21.35*	4	0.000	-	-	-
Prepost x Style x Accident Type	65.34	2	0.000	-	-	-	14.33	2	0.001
Prepost x Style x Driver Age	1043.16	2	0.000	743.34*	2	0.000	-	-	-
Prepost x Style x City Size	12.39	2	0.002	16.05*	2	0.000	5.32*	2	0.070
Prepost x Style x TAD	-	-	-	-	-	-	4.69	2	0.096
Prepost x Accident Type x Driver Age	29.49	4	0.000	-	-	-	-	-	-
Prepost x Accident Type x City Size	36.17	4	0.000	-	-	-	-	-	-
Prepost x Accident Type x TAD	-	-	-	-	-	-	41.90	4	0.000
Prepost x City Size x Road Type	-	-	-	27.54*	4	0.000	-	-	-
Prepost x City Size x Driver Age	-	-	-	3.44*	4	0.487	-	-	-
Prepost x City Size x Accident Type	-	-	-	-	-	-	57.92*	4	0.000
Prepost x City Size x TAD	-	-	-	-	-	-	38.10*	4	0.000
Prepost x Road Type x Driver Age	-	-	-	15.17*	4	0.004	-	-	-
Style x Accident Type x Driver Age	27.14	4	0.000	-	-	-	-	-	-
Style x Accident Type x City Size	13.31	4.	0.010	-	-	-	-	-	-
Style x Accident Type x TAD	-	-	-	-	-	-	4.05	4	0.400
Style x Driver Age x City Size	61.38*	4	0.000	89.16	4	0.000	-	-	-
Style x City Size x Road Type	-	-	-	18.95	4	0.001	-	-	-
Style x City Size x Accident Type	-	-	-	-	-	-	16.86*	4	0.002
Style x Road Type x Driver Age	-	-	-	59.57	4	0.000	-	-	-
Accident Type x Driver Age x City Size	17.23*	8	0.028	-	-	-	-	-	-
City Size x Road Type x Driver Age	-	-	-	84.74	8	0.000	-	-	-
City Size x Accident Type x TAD	-	-	-	-	-	-	510.98*	8	0.000
Injury x Prepost x Style x Accident Type	0.56	2	0.754	-	-	-	-	-	-
Injury x Prepost x Style x City Size	4.60	2	0.100	-	-	-	-	-	-
Injury x Prepost x Acc Type x City Size	9.48	4	0.050	-	-	-	-	-	-
Injury x Style x Acc Type x City Size	17.05	4	0.002	-	-	-	-	-	-
Injury x Style x City Size x Driver Age	-	-	-	12.33*	4	0.015	-	-	-
Prepost x Style x Acc Type x Driver Age	11.07*	4	0.026	-	-	-	-	-	-
Prepost x Style x Acc Type x City Size	6.88	4	0.142	-	-	-	-	-	-
Prepost x Style x Acc Type x TAD	-	-	-	-	-	-	10.60*	4	0.032
Style x City Size x Road Type x Driver Age	-	-	-	18.15*	8	0.020	-	-	-
Inj x Prepost x Style x Acc Type x City Size	11.50	4	0.021	-	-	-	-	-	-
SUMMARY OF MODEL	112.35	98	0.152	115.24	106	0.2537	141.42	122	0.1103

*Effect is specified directly in the model.

TABLE B-2

SUMMARY OF TESTS OF MARGINAL ASSOCIATION OF MODEL EFFECTS FOR INJURY DICHOTOMY KAB vs CO TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost	370.72	1	0.000	378.46	1	0.000	347.04	1	0.000
Injury x Style	2.19	1	0.139	8.16	1	0.004	8.30	1	0.004
Injury x Accident Type	4,630.34	2	0.000	-	-	-	4,992.58	2	0.000
Injury x Driver Age	2.16	2	0.339	3.58	2	0.167	-	-	-
Injury x City Size	1,459.82	2	0.000	1,370.29	2	0.000	1,017.14	2	0.000
Injury x Road Type	-	-	-	564.33	2	0.000	-	-	-
Injury x TAD	-	-	-	-	-	-	19,452.24	2	0.000
Prepost x Style	4,860.68	1	0.000	4,878.59	1	0.000	4,569.23	1	0.000
Prepost x Accident Type	992.45	2	0.000	-	-	-	663.02	2	0.000
Prepost x Driver Age	730.43	2	0.000	588.60	2	0.000	-	-	-
Prepost x City Size	139.09	2	0.000	136.50	2	0.000	135.27	2	0.000
Prepost x Road Type	-	-	-	307.74	2	0.000	-	-	-
Prepost x TAD	-	-	-	-	-	-	30.86	2	0.000
Style x Accident Type	126.33	2	0.000	-	-	-	118.53	2	0.000
Style x Driver Age	11,095.57	2	0.000	11,179.07	2	0.000	-	-	-
Style x City Size	570.90	2	0.000	604.32	2	0.000	558.01	2	0.000
Style x Road Type	-	-	-	0.78	2	0.676	-	-	-
Style x TAD	-	-	-	-	-	-	121.12	2	0.000
Accident Type x Driver Age	643.54	4	0.000	-	-	-	-	-	-
Accident Type x City Size	832.77	4	0.000	-	-	-	-	-	-
Accident Type x TAD	-	-	-	-	-	-	6,231.50	4	0.000
Driver Age x City Size	823.66	4	0.000	984.43	4	0.000	-	-	-
City Size x Road Type	-	-	-	24,316.45	4	0.000	-	-	-
City Size x Accident Type	-	-	-	-	-	-	734.40	4	0.000
City Size x TAD	-	-	-	-	-	-	3,326.20	4	0.000
Road Type x Driver Age	-	-	-	177.20	4	0.000	-	-	-
Accident Type x TAD	-	-	-	-	-	-	6,231.50	2	0.000

TABLE B-2 (Continued)

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost x Style	0.68*	1	0.408	0.04	1	0.839	14.58*	1	0.000
Injury x Prepost x Accident Type	6.99	2	0.030	-	-	-	26.12*	2	0.000
Injury x Prepost x Driver Age	13.50*	2	0.001	21.55	2	0.000	-	-	-
Injury x Prepost x City Size	39.86	2	0.000	37.95	2	0.000	-	-	-
Injury x Prepost x Road Type	-	-	-	10.95	2	0.004	-	-	-
Injury x Style x Accident Type	12.90	2	0.002	-	-	-	-	-	-
Injury x Style x City Size	8.17	2	0.017	-	-	-	1.10*	2	0.578
Injury x Style x Driver Age	-	-	-	14.41	2	0.001	-	-	-
Injury x Accident Type x Driver Age	12.04	4	0.017	-	-	-	-	-	-
Injury x Accident Type x City Size	504.00	4	0.000	-	-	-	-	-	-
Injury x Accident Type x TAD	-	-	-	-	-	-	242.48*	4	0.000
Injury x Driver Age x City Size	31.68	4	0.000	16.07	4	0.003	-	-	-
Injury x City Size x Road Type	-	-	-	178.00*	4	0.000	-	-	-
Injury x City Size x Accident Type	-	-	-	-	-	-	353.[illegible]3*	4	0.000
Injury x City Size x TAD	-	-	-	-	-	-	54.50*	4	0.000
Injury x Road Type x Driver Age	-	-	-	26.35*	4	0.000	-	-	-
Prepost x Style x Accident Type	65.34	2	0.000	-	-	-	14.33	2	0.001
Prepost x Style x Driver Age	1,043.15	2	0.000	743.34	2	0.000	-	-	-
Prepost x Style x City Size	12.39*	2	0.002	16.07*	2	0.000	5.32*	2	0.070
Prepost x Style x TAD	-	-	-	-	-	-	4.69	2	0.096
Prepost x Accident Type x Driver Age	29.49	4	0.000	-	-	-	-	-	-
Prepost x Accident Type x City Size	36.17	4	0.000	-	-	-	-	-	-
Prepost x Accident Type x TAD	-	-	-	-	-	-	41.90	4	0.000
Prepost x City Size x Road Type	-	-	-	27.52*	4	0.000	-	-	-
Prepost x City Size x Driver Age	-	-	-	3.48	4	0.482	-	-	-
Prepost x Road Type x Driver Age	-	-	-	15.17*	4	0.004	-	-	-
Prepost x City Size x Accident Type	-	-	-	-	-	-	57.92	4	0.000
Prepost x City Size x TAD	-	-	-	-	-	-	38.10	4	0.000

*Effect is specified directly in the model.

TABLE B-2 (Concluded)

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Style x Accident Type x Driver Age	27.14	4	0.000	-	-	-	-	-	-
Style x Accident Type x City Size	13.31	4	0.001	-	-	-	-	-	-
Style x Accident Type x TAD	-	-	-	-	-	-	4.05	4	0.400
Style x City Size x Road Type	-	-	-	18.95	4	0.001	-	-	-
Style x City Size x Driver Age	-	-	-	89.16	4	0.000	-	-	-
Style x City Size x Accident Type	-	-	-	-	-	-	16.86*	4	0.002
Style x Road Type x Driver Age	-	-	-	59.55	4	0.000	-	-	-
Accident Type x Driver Age x City Size	17.20	8	0.028	-	-	-	-	-	-
City Size x Road Type x Driver Age	-	-	-	84.74	8	0.000	-	-	-
City Size x Accident Type x TAD	-	-	-	-	-	-	510.98*	8	0.000
Injury x Prepost x Accident Type x City Size	9.94*	4	0.041	-	-	-	-	-	-
Injury x Prepost x Style x Driver Age	-	-	-	14.32*	2	0.001	-	-	-
Injury x Prepost x City Size x Driver Age	-	-	-	10.34*	4	0.035	-	-	-
Injury x Style x Accident Type x City Size	17.38*	4	0.002	-	-	-	-	-	-
Inj. x Acc.Type x Driver Age x City Size	23.20*	8	0.003	-	-	-	-	-	-
Prepost x Style x Accident Type x Dr. Age	11.07*	4	0.026	-	-	-	-	-	-
Prepost x Style x Accident Type x TAD	-	-	-	-	-	-	10.60*	4	0.032
Style x City Size x Road Type x Driver Age	-	-	-	18.15*	8	0.020	-	-	-
SUMMARY OF MODEL	91.50	96	0.6108	118.89	104	0.1508	129.82	116	0.1794

*Effect is specified directly in the model.

TABLE B-3

SUMMARY OF TESTS OF MARGINAL ASSOCIATION OF MODEL EFFECTS FOR INJURY DICHOTOMY KABC vs O TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost	320.73	1	0.000	284.91	1	0.000	230.17	1	0.000
Injury x Style	8.73	1	0.003	14.71	1	0.000	7.52	1	0.006
Injury x Accident Type	4,522.61	2	0.000	-	-	-	4,831.43	2	0.000
Injury x Driver Age	6.62	2	0.037	0.27	2	0.872	-	-	-
Injury x City Size	1,286.50	2	0.000	1,184.21	2	0.000	944.74	2	0.000
Injury x Road Type	-	-	-	445.13	2	0.000	-	-	-
Injury x TAD	-	-	-	-	-	-	24,149.57	2	0.000
Prepost x Style	4,860.68	1	0.000	4,878.59	1	0.000	4,569.23	1	0.000
Prepost x Accident Type	992.45	2	0.000	-	-	-	663.02	2	0.000
Prepost x Driver Age	730.43	2	0.000	588.60	2	0.000	-	-	-
Prepost x City Size	139.09	2	0.000	136.50	2	0.000	135.27	2	0.000
Prepost x Road Type	-	-	-	307.74	2	0.000	-	-	-
Prepost x TAD	-	-	-	-	-	-	30.86	2	0.000
Style x Accident Type	126.33	2	0.000	-	-	-	118.53	2	0.000
Style x Driver Age	11,095.57	2	0.000	11,179.07	2	0.000	-	-	-
Style x City Size	570.90	2	0.000	604.32	2	0.000	558.01	2	0.000
Style x Road Type	-	-	-	0.78	2	0.676	-	-	-
Style x TAD	-	-	-	-	-	-	121.12	2	0.000
Accident Type x Driver Age	643.54	4	0.000	-	-	-	-	-	-
Accident Type x City Size	832.77	4	0.000	984.43	4	0.000	-	-	-
Accident Type x TAD	-	-	-	-	-	-	6,231.50	4	0.000
Driver Age x City Size	823.69	4	0.000	-	-	-	-	-	-
City Size x Road Type	-	-	-	24,816.45	4	0.000	-	-	-
City Size x Accident Type	-	-	-	-	-	-	734.40	4	0.000
City Size x TAD	-	-	-	-	-	-	3,326.20	4	0.000

TABLE B-3 (Continued)

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost x Style	0.46*	1	0.496	0.26*	1	0.608	13.40*	1	0.000
Injury x Prepost x Accident Type	11.45	2	0.003	-	-	-	18.10	2	0.000
Injury x Prepost x Driver Age	19.15*	2	0.000	11.57	2	0.003	-	-	-
Injury x Prepost x City Size	25.97	2	0.000	32.54	2	0.000	13.05	2	0.002
Injury x Prepost x Road Type	-	-	-	8.53	2	0.014	-	-	-
Injury x Prepost x TAD	-	-	-	-	-	-	4.07	2	0.131
Injury x Style x Accident Type	10.82	2	0.004	-	-	-	-	-	-
Injury x Style x Driver Age	15.30	2	0.000	17.17	2	0.000	-	-	-
Injury x Style x City Size	17.01	2	0.000	1.95	2	0.378	-	-	-
Injury x Style x Road Type	-	-	-	2.23	2	0.327	-	-	-
Injury x Accident Type x City Size	378.95	4	0.000	-	-	-	205.82	4	0.000
Injury x Driver Age x City Size	28.15	4	0.000	18.23	4	0.001	-	-	-
Injury x City Size x Road Type	-	-	-	184.11	4	0.000	-	-	-
Injury x City Size x TAD	-	-	-	-	-	-	39.63	4	0.000
Injury x Road Type x Driver Age	-	-	-	16.54	4	0.002	-	-	-
Prepost x Style x Accident Type	65.34	2	0.000	-	-	-	14.33	2	0.001
Prepost x Style x Driver Age	1,043.17	2	0.000	743.34*	2	0.000	-	-	-
Prepost x Style x City Size	12.39*	2	0.002	16.07*	2	0.000	5.32*	2	0.070
Prepost x Style x Road Type	-	-	-	0.42	2	0.812	-	-	-
Prepost x Style x TAD	-	-	-	-	-	-	4.69	2	0.096
Prepost x Accident Type x Driver Age	29.49	4	0.000	-	-	-	-	-	-
Prepost x Accident Type x City Size	36.17	4	0.000	-	-	-	-	-	-
Prepost x Accident Type x TAD	-	-	-	-	-	-	41.90	4	0.000
Prepost x City Size x Road Type	-	-	-	27.52*	4	0.000	-	-	-
Prepost x City Size x Driver Age	-	-	-	3.48	4	0.480	-	-	-
Prepost x City Size x Accident Type	-	-	-	-	-	-	57.92	4	0.000
Prepost x City Size x TAD	-	-	-	-	-	-	38.10	4	0.000
Prepost x Road Type x Driver Age	-	-	-	15.17*	4	0.004	-	-	-
Style x Accident Type x Driver Age	27.14	4	0.000	-	-	-	-	-	-
Style x Accident Type x City Size	13.31	4	0.010	-	-	-	-	-	-
Style x Accident Type x TAD	-	-	-	-	-	-	4.05	4	0.400

*Effect is specified directly in the model.

TABLE B-3 (Concluded)

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Style x City Size x Road Type	-	-	-	18.94	4	0.001	-	-	-
Style x City Size x Driver Age	61.38	4	0.000	89.25	4	0.000	-	-	-
Style x Road Type x Driver Age	-	-	-	59.55	4	0.000	-	-	-
Accident Type x Driver Age x City Size	17.25*	8	0.028	84.74	8	0.000	-	-	-
City Size x Road Type x Driver Age	-	-	-	-	-	-	-	-	-
City Size x Accident Type x TAD	-	-	-	-	-	-	510.98	8	0.000
Injury x Prepost x Accident Type x City Size	10.13*	4	0.038	-	-	-	6.91	4	0.141
Injury x Prepost x City Size x Driver Age	-	-	-	11.68*	4	0.020	-	-	-
Injury x Prepost x City Size x TAD	-	-	-	-	-	-	6.31	4	0.177
Injury x Prepost x Accident Type x TAD	-	-	-	-	-	-	2.00	4	0.736
Injury x Style x Accident Type x City Size	12.66*	4	0.013	-	-	-	-	-	-
Injury x Style x Driver Age x City Size	10.97*	4	0.027	2.45	4	0.654	-	-	-
Injury x Style x City Size x Road Type	-	-	-	5.87	4	0.209	-	-	-
Injury x Style x Road Type x Driver Age	-	-	-	0.62	4	0.960	-	-	-
Injury x City Size x Road Type x Driver Age	-	-	-	11.77	8	0.162	-	-	-
Injury x City Size x Accident Type x TAD	-	-	-	-	-	-	10.05	8	0.262
Prepost x Style x Accident Type x Driver Age	11.05*	4	0.026	-	-	-	-	-	-
Prepost x Style x Accident Type x TAD	-	-	-	-	-	-	10.60*	4	0.032
Prepost x City Size x Accident Type x TAD	-	-	-	-	-	-	7.20	8	0.515
Style x City Size x Road Type x Driver Age	-	-	-	18.15	8	0.020	-	-	-
Inj x Style x City Size x Rd Type x Dr Age	-	-	-	17.13*	8	0.029	-	-	
Inj x Prepost x City Size x Acc Type x TAD	-	-	-	-	-	-	17.95*	8	0.022
SUMMARY OF MODEL	93.47	102	0.7149	82.05	74	0.2440	95.46	80	0.1144

*Effect is specified directly in the model.

TABLE B-4

SUMMARY OF TESTS OF MARGINAL ASSOCIATION OF MODEL EFFECTS FOR THE THREE INJURY DICHOTOMIES NEW YORK 1974 DRIVERS-ONLY SAMPLE

Effect	KA vs BCO			KAB vs CO			KABC vs O		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost	95.59	1	0.000	209.79	1	0.000	137.46	1	0.000
Injury x Style	23.85	1	0.000	47.95	1	0.000	55.32	1	0.000
Injury x Rd Cl	123.51*	2	0.000	274.18	2	0.000	159.54	2	0.000
Injury x Age	57.11*	2	0.000	162.51	2	0.000	95.39*	2	0.000
Injury x Mfg	17.26	2	0.000	70.39	2	0.000	57.36	2	0.000
Prepost x Style	879.34	1	0.000	879.34	1	0.000	885.18	1	0.000
Prepost x Rd Cl	56.98	2	0.000	56.98	2	0.000	58.18	2	0.000
Prepost x Age	260.75	2	0.000	260.75	2	0.000	265.65	2	0.000
Prepost x Weight	49.69	2	0.000	49.69	2	0.000	50.80	2	0.000
Style x Rd Cl	195.16	2	0.000	195.16	2	0.000	198.05	2	0.000
Style x Age	1579.48	2	0.000	1579.84	2	0.000	1582.21	2	0.000
Style x Mfg	333.28	2	0.000	333.28	2	0.000	333.61	2	0.000
Rd Cl x Age	635.39	4	0.000	635.39	4	0.000	638.11	4	0.000
Rd Cl x Mfg	144.86	4	0.000	144.86	4	0.000	144.14	4	0.000
Age x Mfg	113.69	4	0.000	113.69	4	0.000	115.88	4	0.000
Injury x Prepost x Style	6.64*	1	0.010	9.99*	1	0.002	5.92*	1.	0.015
Injury x Prepost x Rd Cl	-	-	-	-	-	-	9.68*	2	0.008
Injury x Prepost x Mfg	7.67*	2	0.022	15.12*	2	0.001	10.31*	2	0.006
Injury x Style x Rd Cl	-	-	-	8.67*	2	0.013	-	-	-
Injury x Style x Age	-	-	-	10.40*	2	0.006	-	-	-
Injury x Rd Cl x Age	-	-	-	-	-	-	9.61*	4	0.048
Prepost x Style x Rd Cl	2.45	2	0.029	2.45	2	0.294	2.42	2	0.298
Prepost x Style x Age	114.30	2	0.000	114.30	2	0.000	113.75	2	0.000
Prepost x Style x Mfg	111.25	2	0.000	111.25	2	0.000	112.87	2	0.000
Prepost x Rd Cl x Age	17.80*	4	0.001	17.80*	4	0.001	17.05*	4	0.002
Prepost x Rd Cl x Mfg	9.26	4	0.055	9.26	4	0.055	9.14	4	0.058
Prepost x Age x Mfg	12.29	4	0.015	12.29	4	0.015	12.87	4	0.012
Style x Rd Cl x Age	23.69*	4	0.000	23.69*	4	0.000	23.49*	4	0.000
Style x Rd Cl x Mfg	15.19	4	0.004	15.19	4	0.004	15.35	4	0.004
Style x Age x Mfg	9.65	4	0.047	9.65	4	0.047	10.22	4	0.037
Prepost x Style x Rd Cl x Mfg	13.00*	4	0.011	13.00*	4	0.011	13.33*	4	0.010
Prepost x Style x Age x Mfg	13.70*	4	0.008	13.70*	4	0.008	13.85*	4	0.008
SUMMARY OF MODEL	138.49	132	0.3321	133.98	128	0.3409	141.47	126	0.1637

*Effect is specified directly in the model.

TABLE B-5

SUMMARY OF TESTS OF MARGINAL ASSOCIATION OF MODEL EFFECTS FOR THE INJURY DICHOTOMY KA vs BCO NORTH CAROLINA DRIVERS-ONLY SAMPLE

Effect	North Carolina 1973			North Carolina 1974			North Carolina 1975		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost	11.54	1	0.001	10.34	1	0.001	6.07	1	0.018
Injury x Style	0.98	1	0.322	1.04	1	0.307	1.71	1	0.192
Injury x Weight	17.34	2	0.000	44.87*	2	0.000	17.46*	2	0.000
Injury x Est Speed	476.51	2	0.000	-	-	-	-	-	-
Injury x Sex	-	-	-	-	-	-	4.00*	1	0.046
Prepost x Style	71.20	1	0.000	117.65	1	0.000	93.19	1	0.000
Prepost x Weight	1020.65	2	0.000	1272.48	2	0.000	1646.50	2	0.000
Prepost x Mfg	711.23	2	0.000	535.10	2	0.000	566.95	2	0.000
Prepost x Est Speed	21.13	2	0.000	-	-	-	-	-	-
Prepost x Sex	-	-	-	-	-	-	66.08	1	0.000
Style x Weight	2757.12	2	0.000	2493.78	2	0.000	2304.72	2	0.000
Style x Mfg	217.36	2	0.000	186.11	2	0.000	185.00	2	0.000
Style x Est Speed	88.64	2	0.000	-	-	-	-	-	-
Style x Sex	-	-	-	-	-	-	28.93	1	0.000
Weight x Mfg	3684.54	4	0.000	4000.89	4	0.000	4405.18	4	0.000
Weight x Est Speed	28.88	4	0.000	-	-	-	-	-	-
Weight x Sex	-	-	-	-	-	-	27.74	2	0.000
Mfg x Est Speed	20.34*	4	0.000	-	-	-	-	-	-
Sex x Mfg	-	-	-	-	-	-	1.73	2	0.421
Injury x Prepost x Style	5.79*	1	0.016	1.93*	1	0.165	1.75*	1	0.187
Injury x Weight x Est Speed	9.99*	4	0.041	-	-	-	-	-	-
Prepost x Style x Weight	82.32	2	0.000	72.51	2	0.000	19.51	2	0.000
Prepost x Style x Mfg	25.94	2	0.000	81.27	2	0.000	46.57	2	0.000
Prepost x Style x Est Speed	6.00*	2	0.050	-	-	-	-	-	-
Prepost x Weight x Mfg	201.70	4	0.000	214.94	4	0.000	290.84	4	0.000
Style x Weight x Mfg	123.11	4	0.000	266.54	4	0.000	275.29	4	0.000
Prepost x Style x Sex	-	-	-	-	-	-	19.96*	1	0.000
Prepost x Weight x Sex	-	-	-	-	-	-	6.25*	2	0.044
Prepost x Sex x Mfg	-	-	-	-	-	-	31.07*	2	0.000
Style x Weight x Sex	-	-	-	-	-	-	20.16	2	0.000
Style x Sex x Mfg	-	-	-	-	-	-	17.03	2	0.000
Weight x Sex x Mfg	-	-	-	-	-	-	10.06	4	0.039
Prepost x Style x Weight x Mfg	75.99*	4	0.000	88.20*	4	0.000	78.61*	4	0.000
Style x Weight x Sex x Mfg	-	-	-	-	-	-	20.74*	4	0.000
SUMMARY OF MODEL	162.56	152	0.264	34.49	30	0.262	88.83	77	0.168

*Effect is specified directly in the model.

TABLE B-6

SUMMARY OF TESTS OF MARGINAL ASSOCIATION OF MODEL EFFECTS FOR THE INJURY DICHOTOMY KAB vs CO NORTH CAROLINA DRIVERS-ONLY SAMPLE

Effect	North Carolina 1973			North Carolina 1974			North Carolina 1975		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost	30.98	1	0.000	32.57	1	0.000	25.71	1	0.000
Injury x Style	11.27	1	0.001	22.17	1	0.000	4.11	1	0.043
Injury x Weight	69.27	2	0.000	119.35	2	0.000	79.53	1	0.000
Injury x Mfg	-	-	-	18.36	2	0.000	26.00	2	0.000
Injury x Est Speed	898.49	2	0.000	-	-	-	-	-	-
Injury x Sex	-	-	-	-	-	-	45.97	1	0.000
Prepost x Style	71.18	1	0.000	117.65	1	0.000	93.19	1	0.000
Prepost x Weight	1020.65	2	0.000	1272.48	2	0.000	1646.52	2	0.000
Prepost x Mfg	711.25	2	0.000	535.10	2	0.000	566.97	2	0.000
Prepost x Est Speed	21.13	2	0.000	-	-	-	-	-	-
Prepost x Sex	-	-	-	-	-	-	66.08	1	0.000
Style x Weight	2757.17	2	0.000	2493.78	2	0.000	2304.74	2	0.000
Style x Mfg	217.37	2	0.000	186.11	2	0.000	185.02	2	0.000
Style x Est Speed	88.65*	2	0.000	-	-	-	-	-	-
Style x Sex	-	-	-	-	-	-	28.92	1	0.000
Weight x Mfg	3684.57	4	0.000	4000.89	4	0.000	4405.21	4	0.000
Weight x Est Speed	28.88	4	0.000	-	-	-	-	-	-
Weight x Sex	-	-	-	-	-	-	27.73	2	0.000
Mfg x Est Speed	20.32*	4	0.000	-	-	-	-	-	-
Sex x Mfg	-	-	-	-	-	-	1.73	2	0.421
Injury x Prepost x Style	0.47*	1	0.494	6.87*	1	0.009	2.32*	1	0.127
Injury x Prepost x Weight	1.05	2	0.591	-	-	-	8.81*	2	0.012
Injury x Prepost x Est Speed	1.72	2	0.423	-	-	-	-	-	-
Injury x Weight x Est Speed	2.69	4	0.611	-	-	-	-	-	-
Injury x Weight x Mfg	-	-	-	10.65*	4	0.031	13.58	4	0.009
Injury x Weight x Sex	-	-	-	-	-	-	2.51	2	0.285
Injury x Sex x Mfg	-	-	-	-	-	-	7.93	2	0.019
Prepost x Style x Weight	82.30	2	0.000	72.51	2	0.000	19.50	2	0.000
Prepost x Style x Mfg	25.94	2	0.000	81.27	2	0.000	46.58	2	0.000
Prepost x Weight x Mfg	201.71	4	0.000	214.94	4	0.000	290.85	4	0.000
Prepost x Weight x Est Speed	4.73	4	0.316	-	-	-	-	-	-
Prepost x Style x Sex	-	-	-	-	-	-	19.96*	1	0.000
Prepost x Sex x Mfg	-	-	-	-	-	-	31.06*	2	0.000

*Effect is specified directly in the model.

TABLE B-6 (Continued)

Effect	North Carolina 1973			North Carolina 1974			North Carolina 1975		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Style x Weight x Mfg	123.11	4	0.000	266.64	4	0.000	275.27	4	0.000
Style x Weight x Sex	-	-	-	-	-	-	20.16	2	0.000
Style x Sex x Mfg	-	-	-	-	-	-	17.05	2	0.000
Weight x Sex x Mfg	-	-	-	-	-	-	10.06	4	0.039
Injury x Prepost X Wt x Est Speed	11.33*	4	0.023	-	-	-	-	-	-
Prepost x Style x Weight x Mfg	75.98*	4	0.000	88.20*	4	0.000	78.60*	4	0.000
Injury x Weight x Sex x Mfg	-	-	-	-	-	-	12.34*	4	0.015
Style x Weight x Sex x Mfg	-	-	-	-	-	-	20.74*	4	0.000
SUMMARY OF MODEL	161.69	142	0.124	29.60	24	0.198	67.07	63	0.400

*Effect is specified directly in the model.

TABLE B-7

SUMMARY OF TESTS OF MARGINAL ASSOCIATION OF MODEL EFFECTS FOR THE INJURY DICHOTOMY KABC vs O NORTH CAROLINA DRIVERS-ONLY SAMPLE

Effect	North Carolina 1973			North Carolina 1974			North Carolina 1975		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost	24.17	1	0.000	24.29	1	0.000	14.97	1	0.001
Injury x Style	5.11	1	0.024	14.94	1	0.000	6.08	1	0.014
Injury x Weight	70.55*	2	0.000	109.44*	2	0.000	75.72*	2	0.000
Injury x Est Speed	918.70*	2	0.000	-	-	-	-	-	-
Injury x Sex	-	-	-	-	-	-	244.97*	1	0.000
Injury x Mfg	-	-	-	-	-	-	38.36	2	0.000
Prepost x Style	71.18	1	0.000	117.65	1	0.000	93.19	1	0.000
Prepost x Weight	1020.65	2	0.000	1272.48	2	0.000	1646.52	2	0.000
Prepost x Mfg	711.25	2	0.000	535.10	2	0.000	566.97	2	0.000
Prepost x Est Speed	21.13	2	0.000	-	-	-	-	-	-
Prepost x Sex	-	-	-	-	-	-	66.08	1	0.000
Style x Weight	2757.17	2	0.000	2493.78	2	0.000	2304.74	2	0.000
Style x Mfg	217.34	2	0.000	186.11	2	0.000	185.02	2	0.000
Style x Est Speed	88.65	2	0.000	-	-	-	-	-	-
Style x Sex	-	-	-	-	-	-	28.92	1	0.000
Weight x Mfg	3684.57	4	0.000	-	-	-	4405.21	4	0.000
Weight x Est Speed	28.88*	4	0.000	4000.89	4	0.000	-	-	-
Weight x Sex	-	-	-	-	-	-	27.73	2	0.000
Mfg x Est Speed	20.32*	4	0.000	-	-	-	-	-	-
Sex x Mfg	-	-	-	-	-	-	1.74	-	0.421
Injury x Prepost x Style	2.01*	1	0.157	6.96 *	1	0.008	0.06*	1	0.811
Injury x Prepost x Mfg	-	-	-	-	-	-	7.65*	2	0.022
Prepost x Style X Weight	82.30	2	0.000	72.51	2	0.000	19.50	2	0.000
Prepost x Style x Mfg	25.94	2	0.000	81.27	2	0.000	46.58	2	0.000
Prepost x Style x Est Speed	6.00*	2	0.050	-	-	-	-	-	-
Prepost x Weight x Mfg	201.71	4	0.000	214.94	4	0.000	290.85	4	0.000
Prepost x Style x Sex	-	-	-	-	-	-	19.96*	1	0.000
Prepost x Sex x Mfg	-	-	-	-	-	-	31.06*	2	0.000
Style x Weight x Mfg	123.11	4	0.000	266.64	4	0.000	275.27	4	0.000
Style x Weight X Sex	-	-	-	-	-	-	20.16	2	0.000
Style x Sex x Mfg	-	-	-	-	-	-	17.05	2	0.000
Weight x Sex x Mfg	-	-	-	-	-	-	10.06	4	0.039
Prepost x Style x Weight x Mfg	75.98*	4	0.000	88.20*	4	0.000	78.60*	4	0.000
Style x Weight x Sex x Mfg	-	-	-	-	-	-	20.74*	4	0.000
SUMMARY OF MODEL	174.60	156	0.147	29.51	30	0.491	76.34	75	0.435

*Effect is specified directly in the model.

TABLE B-8

SUMMARY OF TESTS OF MARGINAL ASSOCIATION OF MODEL EFFECTS FOR THE INJURY DICHOTOMY KA vs BCO MODEL YEARS 1965-1971 TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost	71.47	1	0.000	39.63	1	0.000	49.29	1	0.000
Injury x Style	0.0	1	1.000	0.20	1	0.652	0.86	1	0.353
Injury x Accident Type	1,198.00	2	0.000	-	-	-	835.89	2	0.000
Injury x Driver Age	3.59*	2	0.166	-	-	-	-	-	-
Injury x City Size	862.73	2	0.000	901.15	2	0.000	464.02	2	0.000
Injury x Road Type	-	-	-	331.06	2	0.000	-	-	-
Injury x TAD	-	-	-	-	-	-	4,161.54	2	0.000
Prepost x Style	755.43	1	0.000	803.77	1	0.000	681.56	1	0.000
Prepost x Accident Type	276.04	2	0.000	-	-	-	93.64	2	0.000
Prepost x Driver Age	398.59	2	0.000	305.59	2	0.000	-	-	-
Prepost x City Size	34.56	2	0.000	14.86	2	0.001	23.50	2	0.000
Prepost x Road Type	-	-	-	78.68	2	0.000	-	-	-
Prepost x TAD	-	-	-	-	-	-	2.80	2	0.247
Style x Accident Type	107.44	2	0.000	-	-	-	118.40	2	0.000
Style x Driver Age	9,740.99	2	0.000	7,477.56	2	0.000	-	-	-
Style x City Size	395.12	2	0.000	322.24	2	0.000	235.44	2	0.000
Style x Road Type	-	-	-	6.10	2	0.047	-	-	-
Style x TAD	-	-	-	-	-	-	110.61*	2	0.000
Accident Type x Driver Age	463.41	4	0.000	-	-	-	-	-	-
Accident Type x City Size	628.48	4	0.000	-	-	-	-	-	-
Accident Type x TAD	-	-	-	-	-	-	4,003.20	4	0.000
City Size x Road Type	-	-	-	15,475.01	4	0.000	-	-	-
City Size x Driver Age	539.23	4	0.000	644.73	4	0.000	-	-	-
City Size x Accident Type	-	-	-	-	-	-	427.76	4	0.000
City Size x TAD	-	-	-	-	-	-	1,793.45	4	0.000
Road Type x Driver Age	-	-	-	95.31	4	0.000	-	-	-

*Effect is specified directly in the model.

TABLE B-8 (Continued)

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost x Style	0.42*	1	0.518	0.06*	1	0.804	0.14*	1	0.705
Injury x Prepost x City Size	-	-	-	17.93*	2	0.000	-	-	-
Injury x Prepost x Accident Type	-	-	-	-	-	-	2.78	2	0.250
Injury x Prepost x TAD	-	-	-	-	-	-	7.59	2	0.022
Injury x Style x Accident Type	1.36	2	0.507	-	-	-	6.35*	2	0.042
Injury x Style x City Size	7.09	2	0.029	-	-	-	-	-	-
Injury x Accident Type x City Size	179.82	4	0.000	-	-	-	-	-	-
Injury x Accident Type x TAD	-	-	-	-	-	-	108.32	4	0.000
Injury x City Size x Road Type	-	-	-	84.48*	4	0.000	-	-	-
Injury x City Size x Accident Type	-	-	-	-	-	-	123.71*	4	0.000
Injury x City Size x TAD	-	-	-	-	-	-	69.86*	4	0.000
Prepost x Style x Accident Type	29.14	2	0.000	-	-	-	8.55*	2	0.014
Prepost x Style x Driver Age	280.18*	2	0.000	132.49	2	0.000	-	-	-
Prepost x Style x City Size	7.23*	2	0.267	12.57*	2	0.002	6.90*	2	0.032
Prepost x Accident Type x Driver Age	12.56*	4	0.014	-	-	-	-	-	-
Prepost x Accident Type x TAD	-	-	-	-	-	-	23.03	4	0.000
Prepost x City Size x Road Type	-	-	-	13.10*	4	0.011	-	-	-
Prepost x City Size x Accident Type	17.13*	4	0.002	-	-	-	13.13*	4	0.011
Prepost x City Size x TAD	-	-	-	-	-	-	12.08*	4	0.017
Style x Accident Type x Driver Age	20.51*	4	0.000	-	-	-	-	-	-
Style x Accident Type x City Size	9.54	4	0.049	-	-	-	-	-	-
Style x Driver Age x City Size	41.69*	4	0.000	65.71*	4	0.000	-	-	-
Style x City Size x Road Type	-	-	-	17.98*	4	0.001	-	-	-
City Size x Road Type x Driver Age	-	-	-	41.74*	8	0.000	-	-	-
City Size x Accident Type x TAD	-	-	-	-	-	-	286.51*	8	0.000
Injury x Style x Accident Type x City Size	17.81*	4	0.001	-	-	-	-	-	-
Injury x Prepost x Accident Type x TAD	-	-	-	-	-	-	10.94*	4	0.027
SUMMARY OF MODEL	147.04	134	0.2083	148.72	144	0.3766	132.00	126	0.3393

*Effect is specified directly in the model.

TABLE B-9

SUMMARY OF TESTS OF MARGINAL ASSOCIATION OF MODEL EFFECTS FOR THE INJURY DOCHOTOMY KAB vs CO MODEL YEARS 1965-1971 TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost	118.91	1	0.000	128.23	1	0.000	113.21	1	0.000
Injury x Style	5.65	1	0.017	20.46	1	0.000	12.90	1	0.000
Injury x Accident Type	2,993.90	2	0.000	-	-	-	3,159.08	2	0.000
Injury x Driver Age	1.55	2	0.461	1.05	2	0.591	-	1	1
Injury x City Size	1,054.67	2	0.000	878.27	2	0.000	505.63	2	0.000
Injury x Road Type	-	-	-	375.81	2	0.000	-	-	-
Injury x TAD	-	-	-	-	-	-	681.56	1	0.000
Prepost x Style	755.43	1	0.000	-	-	-	93.64	2	0.000
Prepost x Accident Type	276.04	2	0.000	305.59	2	0.000	-	-	-
Prepost x Driver Age	398.59	2	0.000	14.86	2	0.001	22.50	2	0.000
Prepost x City Size	34.56	2	0.000	14.86	2	0.001	-	-	-
Prepost x Road Type	-	-	-	76.68	2	0.000	-	-	-
Prepost x TAD	-	-	-	-	-	-	2.80	2	0.247
Style x Accident Type	107.44	2	0.000	-	-	-	-	-	-
Style x Driver Age	9,740.99	2	0.000	7,477.56	2	0.000	-	-	-
Style x City Size	395.11	2	0.000	322.24	2	0.000	235.44	2	0.000
Style x Road Type	-	-	-	6.10	2	0.048	-	-	-
Style x TAD	-	-	-	-	-	-	110.61*	2	0.000
Accident Type x Driver Age	463.41	4	0.000	-	-	-	-	-	-
Accident Type x City Size	628.48	4	0.000	-	-	-	-	-	-
Accident Type x TAD	-	-	-	-	-	-	4,003.20	4	0.000
Driver Age x City Size	539.23	4	0.000	644.73	4	0.000	-	-	-
City Size x Road Type	-	-	-	15,475.01	4	0.000	-	-	-
City Size x Accident Type	-	-	-	-	-	-	427.75	4	0.000
City Size x TAD	-	-	-	-	-	-	1,793.39	4	0.000
Road Type x Driver Age	-	-	-	95.30	4	0.000	-	-	-
Injury x Prepost x Style	0.14*	1	0.707	0.68*	1	0.409	7.93*	1	0.005
Injury x Prepost x City Size	15.99*	2	0.000	19.80*	2	0.000	12.41*	2	0.002
Injury x Prepost x Driver Age	-	-	-	11.98*	2	0.002	-	-	-

*Effect is specified directly in the model.

TABLE B-9 (Continued)

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Style x Accident Type	9.27	2	0.010	-	-	-	9.15*	2	0.010
Injury x Style x Driver Age	5.86*	2	0.053	9.77*	2	0.008	-	-	-
Injury x Style x City Size	10.02	2	0.007	-	-	-	-	-	-
Injury x Accident Type x City Size	368.70	4	0.000	-	-	-	-	-	-
Injury x Accident Type x TAD	-	-	-	-	-	-	154.15*	4	0.000
Injury x Driver Age x City Size	28.43*	4	0.000	-	-	-	-	-	-
Injury x City Size x Road Type	-	-	-	116.13*	2	0.000	-	-	-
Injury x City Size x Accident Type	-	-	-	-	-	-	195.01*	4	0.000
Injury x City Size x TAD	-	-	-	-	-	-	41.52*	4	0.000
Injury x Road Type x Driver Age	-	-	-	19.58*	4	0.001	-	-	-
Prepost x Style x Accident Type	29.14*	2	0.000	-	-	-	8.55*	2	0.014
Prepost x Style x Driver Age	280.18*	2	0.000	132.49*	2	0.000	-	-	-
Prepost x Style x City Size	7.23*	2	0.027	12.57*	2	0.002	6.92*	2	0.031
Prepost x Accident Type x Driver Age	12.56*	4	0.014	-	-	-	-	-	-
Prepost x Accident Type x City Size	17.13*	4	0.002	-	-	-	-	-	-
Prepost x Accident Type x TAD	-	-	-	-	-	-	23.03*	4	0.000
Prepost x City Size x Road Type	-	-	-	13.10*	4	0.011	-	-	-
Prepost x City Size x Accident Type	-	-	-	-	-	-	13.12*	4	0.011
Style x Accident Type x Driver Age	20.51*	4	0.000	-	-	-	-	-	-
Style x Accident Type x City Size	9.54	4	0.049	-	-	-	-	-	-
Style x Driver Age x City Size	41.69*	4	0.000	65.71*	4	0.000	-	-	-
Style x City Size x Road Type	-	-	-	17.98*	4	0.001	-	-	-
City Size x Road Type x Driver Age	-	-	-	41.74*	8	0.000	-	-	-
City Size x Accident Type x TAD	-	-	-	-	-	-	286.51*	8	0.000
Injury x Style x Accident Type x City Size	12.78*	4	0.012	-	-	-	-	-	-
SUMMARY OF MODEL	130.56	126	0.3722	146.17	134	0.2228	155.25	136	0.1237

*Effect is specified directly in the model.

TABLE B-10

SUMMARY OF TESTS OF MARGINAL ASSOCIATION OF MODEL EFFECTS FOR THE INJURY DICHOTOMY KABC vs CO MODEL YEARS 1965-1971 TEXAS DRIVERS-ONLY SAMPLE

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Prepost	115.34	1	0.000	96.50	1	0.000	67.96	1	0.000
Injury x Style	11.29	1	0.001	19.54	1	0.000	11.18	1	0.001
Injury x Accident Type	2,932.70	2	0.000	-	-	-	2,981.45	2	0.000
Injury x Driver Age	4.70	2	0.095	1.15	2	0.563	-	-	-
Injury x City Size	944.24	2	0.000	726.86	2	0.000	476.94	2	0.000
Injury x Road Type	-	-	-	284.22	2	0.000	-	-	-
Injury x TAD	-	-	-	-	-	-	13,987.60	2	0.000
Prepost x Style	755.43	1	0.000	803.77	1	0.000	681.56	1	0.000
Prepost x Accident Type	276.04	2	0.000	-	-	-	93.64	2	0.000
Prepost x Driver Age	398.59	2	0.000	305.59	2	0.000	-	-	-
Prepost x City Size	34.56	2	0.000	14.86	2	0.001	23.50	2	0.000
Prepost x Road Type	-	-	-	78.68	2	0.000	-	-	-
Prepost x TAD	-	-	-	-	-	-	2.80	2	0.247
Style x Accident Type	107.44	2	0.000	-	-	-	118.40	2	0.000
Style x Driver Age	9,740.99	2	0.000	7,477.56	2	0.000	-	-	-
Style x City Size	395.11	2	0.000	322.24	2	0.000	235.44	2	0.000
Style x Road Type	-	-	-	6.10	2	0.047	-	-	-
Style x TAD	-	-	-	-	-	-	110.61*	2	0.000
Accident Type x Driver Age	463.46	4	0.000	-	-	-	-	-	-
Accident Type x City Size	628.48	4	0.000	-	-	-	-	-	-
Accident Type x TAD	-	-	-	-	-	-	4,003.20	4	0.000
Driver Age x City Size	539.23	4	0.000	644.73	4	0.000	-	-	-
City Size x Road Type	-	-	-	15,475.01	4	0.000	-	-	-
City Size x Accident Type	-	-	-	-	-	-	427.76	4	0.000
City Size x TAD	-	-	-	-	-	-	1,793.39	4	0.000
Road Type x Driver Age	-	-	-	95.31	4	0.000	-	-	-
Injury x Prepost x Style	0.02	1	0.890	3.09*	1	0.079	6.02*	1	0.014
Injury x Prepost x Accident Type	1.93	2	0.380	-	-	-	-	-	-
Injury x Prepost x City Size	10.81	2	0.004	13.06*	2	0.002	-	-	-
Injury x Style x Accident Type	5.96	2	0.051	-	-	-	7.35*	2	0.025
Injury x Style x Driver Age	9.51*	2	0.009	10.71	2	0.005	-	-	-
Injury x Style x City Size	19.18	2	0.000	1.30	2	0.521	-	-	-
Injury x Style x Road Type	-	-	-	3.45	2	0.178	-	-	-
Injury x Accident Type x City Size	277.63	4	0.000	-	-	-	-	-	-
Injury x Accident Type x TAD	-	-	-	-	-	-	149.11*	4	0.000

*Effect is specified directly in the model.

TABLE B-10 (Continued)

Effect	Texas 1972			Texas 1973			Texas 1974		
	LR χ^2	df	Prob.	LR χ^2	df	Prob.	LR χ^2	df	Prob.
Injury x Driver Age x City Size	23.88*	4	0.000	-	-	-	-	-	-
Injury x City Size x Road Type	-	-	-	122.15	4	0.000	-	-	-
Injury x City Size x Driver Age	-	-	-	12.61	4	0.013	-	-	-
Injury x City Size x Accident Type	-	-	-	-	-	-	150.86*	4	0.000
Injury x City Size x TAD	-	-	-	-	-	-	32.97*	4	0.000
Injury x Road Type x Driver Age	-	-	-	11.51	4	0.021	-	-	-
Prepost x Style x Accident Type	29.14	2	0.000	-	-	-	8.55*	2	0.014
Prepost x Style x Driver Age	280.18*	2	0.000	132.49*	2	0.000	-	-	-
Prepost x Style x City Size	7.23	2	0.027	12.57*	2	0.002	6.90*	2	0.032
Prepost x Accident Type x Driver Age	12.56*	4	0.014	-	-	-	-	-	-
Prepost x Accident Type x City Size	17.13	4	0.002	-	-	-	-	-	-
Prepost x Accident Type x TAD	-	-	-	-	-	-	23.03*	4	0.000
Prepost x City Size x Road Type	-	-	-	13.09*	4	0.011	-	-	-
Prepost x City Size x Accident Type	-	-	-	-	-	-	13.12*	4	0.011
Style x Accident Type x Driver Age	20.51*	4	0.000	-	-	-	-	-	-
Style x Accident Type x City Size	9.54	4	0.049	-	-	-	-	-	-
Style x Driver Age x City Size	41.69*	4	0.000	65.71	4	0.000	-	-	-
Style x City Size x Road Type	-	-	-	17.98	4	0.001	-	-	-
Style x Road Type x Driver Age	-	-	-	17.67	4	0.001	-	-	-
City Size x Road Type x Driver Age	-	-	-	41.74	8	0.000	-	-	-
City Size x Accident Type x TAD	-	-	-	-	-	-	286.51*	8	0.000
Injury x Prepost x Style x Accident Type	0.41	2	0.814	-	-	-	-	-	-
Injury x Prepost x Style x City Size	1.85	2	0.397	-	-	-	-	-	-
Injury x Prepost x Acc. Type x City Size	4.36	4	0.359	-	-	-	-	-	-
Injury x Style x Accident Type x City Size	8.09	4	0.088	-	-	-	-	-	-
Injury x Style x City Size x Road Type	-	-	-	3.01	4	0.556	-	-	-
Injury x Style x City Size x Driver Age	-	-	-	2.80	4	0.591	-	-	-
Injury x Style x Road Type x Driver Age	-	-	-	3.15	4	0.533	-	-	-
Injury x City Size x Road Type x Driver Age	-	-	-	10.15	8	0.255	-	-	-
Prepost x Style x Accident Type x City Size	2.77	4	0.597	-	-	-	-	-	-
Style x City Size x Road Type x Driver Age	-	-	-	12.57	8	0.128	-	-	-
Inj. x Prepost x Style x Acc.Type x City Size	10.81*	4	0.029	-	-	-	-	-	-
Inj. x Style x City Size x Rd. Type x Dr.Age	-	-	-	20.33*	8	0.009	-	-	-
SUMMARY OF MODEL	119.69	108	0.2079	92.81	88	0.3422	148.45	138	0.2566

*Effect is specified directly in the model.

APPENDIX C

SUMMARY OF EFFECTIVENESS RESULTS FOR OBSERVED UNADJUSTED STATE MASS ACCIDENT DATA

TABLE C-1

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1972 TEXAS
OBSERVED, NOT ADJUSTED
TOTAL CASES = 159693

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	996	0.6	1131	0.7	1165	0.7	687	0.4	3979	2.5
B+C+O	30005	18.8	54517	34.1	37638	23.6	33554	21.0	155714	97.5
K+A+B	3076	1.9	3985	2.5	3596	2.3	2220	1.4	12877	8.1
C+O	27925	17.5	51663	32.4	35207	22.0	32021	20.1	146816	91.9
K+A+B+C	4256	2.7	5928	3.7	4935	3.1	3305	2.1	18424	11.5
O	26745	16.7	49720	31.1	33868	21.2	30936	19.4	141269	88.5
K+A+B+C+O	31001	19.4	55648	34.8	38803	24.3	34241	21.4	159693	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	5.11	6.08	-4.87	15.09
K+A+B	-3.23	3.58	-9.11	2.64
K+A+B+C	-2.29	2.90	-7.05	2.47

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	3.21	2.03	3.00	2.01	2.49
K+A+B	9.92	7.16	9.27	6.48	8.06
K+A+B+C	13.73	10.65	12.72	9.65	11.54

TABLE C-2

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1973 TEXAS
OBSERVED, NOT ADJUSTED
TOTAL CASES = 161908

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	734	0.5	1311	0.8	899	0.6	723	0.4	3667	2.3
B+C+O	24312	15.0	64745	40.0	30381	18.8	38803	24.0	158241	97.7
K+A+B	2582	1.6	4790	3.0	2902	1.8	2555	1.6	12829	7.9
C+O	22464	13.9	61266	37.8	28378	17.5	36971	22.8	149079	92.1
K+A+B+C	3533	2.2	7166	4.4	3973	2.5	3911	2.4	18583	11.5
O	21513	13.3	58890	36.4	27307	16.9	35615	22.0	143325	88.5
K+A+B+C+O	25046	15.5	66056	40.8	31280	19.3	39526	24.4	161908	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	-6.69	7.17	-18.45	5.07
K+A+B	-1.03	3.53	-6.82	4.77
K+A+B+C	1.23	2.82	-3.39	5.86

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.93	1.98	2.87	1.83	2.26
K+A+B	10.31	7.25	9.28	6.46	7.92
K+A+B+C	14.11	10.85	12.70	9.89	11.48

TABLE C-3

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1974 TEXAS
OBSERVED, NOT ADJUSTED
TOTAL CASES = 146449

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	515	0.4	1185	0.8	584	0.4	593	0.4	2877	2.0
B+C+0	17755	12.1	65904	45.0	22377	15.3	37536	25.6	143572	98.0
K+A+B	1847	1.3	4984	3.4	2263	1.5	2377	1.6	11471	7.8
C+0	16423	11.2	62105	42.4	20698	14.1	35752	24.4	134978	92.2
K+A+B+C	2503	1.7	7554	5.2	3123	2.1	3792	2.6	16972	11.6
0	15767	10.8	59535	40.7	19838	13.5	34337	23.4	129477	88.4
K+A+B+C+0	18270	12.5	67089	45.8	22961	15.7	38129	26.0	146449	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	-2.84	8.00	-15.96	10.28
K+A+B	-16.28	4.45	-23.58	-8.97
K+A+B+C	-12.47	3.51	-18.23	-6.70

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.82	1.77	2.54	1.56	1.96
K+A+B	10.11	7.43	9.86	6.23	7.83
K+A+B+C	13.70	11.26	13.60	9.95	11.59

TABLE C-4

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1974 NEW YORK
OBSERVED, NOT ADJUSTED
TOTAL CASES = 62816

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	POST	%	4 - DOOR PRE	%	POST	%	ROW TOTAL	ROW PCT
K+A	560	0.9	2055	3.3	420	0.7	658	1.0	3693	5.9
B+C+O	6363	10.1	32917	52.4	5176	8.2	14667	23.3	59123	94.1
K+A+B	1678	2.7	6587	10.5	1277	2.0	2377	3.8	11919	19.0
C+O	5245	8.3	28385	45.2	4319	6.9	12975	20.6	50924	81.0
K+A+B+C	2540	4.0	11021	17.5	1943	3.1	4227	6.7	19731	31.3
O	4418	7.0	24112	38.2	3683	5.8	11193	17.7	43406	68.7
K+A+B+C+O	6923	11.0	34972	55.7	5596	8.9	15325	24.4	62816	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	-27.38	9.67	-43.24	-11.51
K+A+B	-14.62	4.50	-22.00	-7.25
K+A+B+C	-8.31	3.10	-13.39	-3.23

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	POST	4 - DOOR PRE	POST	TOTAL
K+A	8.09	5.88	7.51	4.29	5.88
K+A+B	24.24	18.84	22.82	15.48	18.97
K+A+B+C	36.50	31.37	34.54	27.41	31.25

TABLE C-5

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1973 N. CAROLINA
OBSERVED, NOT ADJUSTED
TOTAL CASES = 25901

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	125	0.5	255	1.0	126	0.5	139	0.5	645	2.5
B+C+O	4378	16.9	10007	38.6	3824	14.8	7047	27.2	25256	97.5
K+A+B	475	1.8	871	3.4	372	1.4	512	2.0	2230	8.6
C+O	4028	15.6	9391	36.3	3578	13.8	6674	25.8	23671	91.4
K+A+B+C	745	2.9	1508	5.8	641	2.5	946	3.7	3840	14.8
O	3758	14.5	8754	33.8	3309	12.8	6240	24.1	22061	85.2
K+A+B+C+O	4503	17.4	10262	39.6	3950	15.3	7186	27.7	25901	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	-49.82	24.39	-89.82	-9.82
K+A+B	-6.75	9.06	-21.60	8.11
K+A+B+C	-9.71	6.86	-20.97	1.54

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.78	2.48	3.19	1.93	2.49
K+A+B	10.55	8.49	9.42	7.12	8.61
K+A+B+C	16.54	14.69	16.23	13.16	14.83

TABLE C-6

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1974 N. CAROLINA
OBSERVED, NOT ADJUSTED
TOTAL CASES = 26539

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	100	0.4	254	1.0	102	0.4	151	0.6	607	2.3
B+C+O	3602	13.6	10982	41.4	3469	13.1	7879	29.7	25932	97.7
K+A+B	384	1.4	988	3.7	350	1.3	528	2.0	2250	8.5
C+O	3318	12.5	10248	38.6	3221	12.1	7502	28.3	24289	91.5
K+A+B+C	631	2.4	1751	6.6	604	2.3	1047	3.9	4033	15.2
O	3071	11.6	9485	35.7	2967	11.2	6983	26.3	22506	84.8
K+A+B+C+O	3702	13.9	11236	42.3	3571	13.5	8030	30.3	26539	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	-29.19	22.24	-65.65	7.28
K+A+B	-26.88	11.07	-45.03	-8.73
K+A+B+C	-18.86	7.52	-31.19	-6.52

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.70	2.26	2.86	1.88	2.29
K+A+B	10.37	8.79	9.80	6.58	8.48
K+A+B+C	17.04	15.58	16.91	13.04	15.20

TABLE C-7

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1979 N. CAROLINA
OBSERVED, NOT ADJUSTED
TOTAL CASES = 28236

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	97	0.3	254	0.9	71	0.3	180	0.6	602	2.1
B+C+0	3272	11.6	12100	42.9	3226	11.4	9036	32.0	27634	97.9
K+A+B	367	1.3	1007	3.6	298	1.1	711	2.5	2383	8.4
C+0	3002	10.6	11347	40.2	2999	10.6	8505	30.1	25853	91.6
K+A+B+C	600	2.1	1923	6.8	539	1.9	1335	4.7	4397	15.6
0	2769	9.8	10431	36.9	2758	9.8	7881	27.9	23839	84.4
K+A+B+C+0	3369	11.9	12354	43.8	3297	11.7	9216	32.6	28236	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	20.05	14.55	-3.81	43.91
K+A+B	12.01	7.72	-0.65	24.66
K+A+B+C	1.16	6.25	-9.09	11.42

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.88	2.06	2.15	1.95	2.13
K+A+B	10.89	8.15	9.04	7.71	8.44
K+A+B+C	17.81	15.57	16.35	14.49	15.57

TABLE C-8

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1972 TEXAS 65-71
OBSERVED, NOT ADJUSTED
TOTAL CASES = 109145

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	544	0.5	923	0.8	468	0.4	582	0.5	2517	2.3
B+C+O	17889	16.4	44234	40.5	16340	15.0	28165	25.8	106628	97.7
K+A+B	1681	1.5	3243	3.0	1442	1.3	1909	1.7	8275	7.6
C+O	16752	15.3	41914	38.4	15366	14.1	26838	24.6	100870	92.4
K+A+B+C	2387	2.2	4803	4.4	2027	1.9	2829	2.6	12046	11.0
O	16046	14.7	40354	37.0	14781	13.5	25918	23.7	97099	89.0
K+A+B+C+O	18433	16.9	45157	41.4	16808	15.4	28747	26.3	109145	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	4.42	7.78	-8.34	17.17
K+A+B	-1.84	4.50	-9.23	5.54
K+A+B+C	-0.72	3.64	-6.69	5.24

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.95	2.04	2.78	2.02	2.31
K+A+B	9.12	7.18	8.58	6.64	7.58
K+A+B+C	12.95	10.64	12.06	9.84	11.04

TABLE C-9

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1973 TEXAS 65-71
OBSERVED, NOT ADJUSTED
TOTAL CASES = 101844

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	421	0.4	860	0.8	394	0.4	535	0.5	2210	2.2
B+C+O	15459	15.2	41756	41.0	14975	14.7	27444	26.9	99634	97.8
K+A+B	1552	1.5	3132	3.1	1299	1.3	1842	1.8	7825	7.7
C+O	14328	14.1	39484	38.8	14070	13.8	26137	25.7	94019	92.3
K+A+B+C	2160	2.1	4656	4.6	1825	1.8	2842	2.8	11483	11.3
O	13720	13.5	37960	37.3	13544	13.3	25137	24.7	90361	88.7
K+A+B+C+O	15880	15.6	42616	41.8	15369	15.1	27979	27.5	101844	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	-2.48	9.03	-17.29	12.34
K+A+B	3.35	4.42	-3.90	10.61
K+A+B+C	6.03	3.51	0.28	11.78

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.65	2.02	2.56	1.91	2.17
K+A+B	9.77	7.35	8.45	6.58	7.68
K+A+B+C	13.60	10.93	11.87	10.16	11.28

TABLE C-10

SUMMARY OF FMVSS 207 EFFECTIVENESS STUDY USING
1974 TEXAS 65-71
OBSERVED, NOT ADJUSTED
TOTAL CASES = 85112

INJURY DISTRIBUTIONS

INJURY CATEGORY	2 - DOOR PRE	%	2 - DOOR POST	%	4 - DOOR PRE	%	4 - DOOR POST	%	ROW TOTAL	ROW PCT
K+A	323	0.4	653	0.8	290	0.3	409	0.5	1675	2.0
B+C+O	11934	14.0	35711	42.0	11903	14.0	23889	28.1	83437	98.0
K+A+B	1180	1.4	2831	3.3	1153	1.4	1612	1.9	6776	8.0
C+O	11077	13.0	33533	39.4	11040	13.0	22686	26.7	78336	92.0
K+A+B+C	1631	1.9	4253	5.0	1604	1.9	2540	3.0	10028	11.8
O	10626	12.5	32111	37.7	10589	12.4	21758	25.6	75084	88.2
K+A+B+C+O	12257	14.4	36364	42.7	12193	14.3	24298	28.5	85112	100.0

EFFECTIVENESS VALUES (PERCENT)

INJURY CATEGORIES	EFFECTIVENESS VALUE	STANDARD DEVIATION	95% CONFIDENCE INTERVAL FROM	TO
K+A	3.19	9.83	-12.93	19.31
K+A+B	-15.42	5.72	-24.80	-6.04
K+A+B+C	-10.70	4.48	-18.05	-3.36

INJURY PROBABILITIES (PERCENT)

INJURY CATEGORIES	2 - DOOR PRE	2 - DOOR POST	4 - DOOR PRE	4 - DOOR POST	TOTAL
K+A	2.64	1.80	2.38	1.68	1.97
K+A+B	9.63	7.79	9.46	6.63	7.96
K+A+B+C	13.31	11.70	13.16	10.45	11.78

APPENDIX D

CONFIDENCE LIMITS FOR A DOUBLE RATIO OF PROBABILITIES

CONFIDENCE LIMITS FOR A DOUBLE RATIO OF PROBABILITIES

1. Objective

To estimate a confidence interval for

$$R = \frac{p_1}{p_2} : \frac{p_3}{p_4} = \frac{p_1 p_4}{p_2 p_3}, \qquad (1)$$

where $p_i = x_i/n_i$, and the x_i are binomially distributed random variables.

2. Approach

We write

$$R = \frac{\pi_1 \pi_4}{\pi_2 \pi_3} \frac{(1+\varepsilon_1)(1+\varepsilon_4)}{(1+\varepsilon_2)(1+\varepsilon_3)}, \qquad (2)$$

where the π_i are the expected values of the p_i.

Then we study

$$r = \frac{(1+\varepsilon_1)(1+\varepsilon_4)}{(1+\varepsilon_2)(1+\varepsilon_3)} \qquad (3)$$

by expanding the fraction in power series in ε_2 and ε_3. These series expressions hold only if $|\varepsilon| < 1$; that requires p to be restricted to the range $0...2\pi$, or x to the range $0...2n\pi$. Since $\sigma(x) = \sqrt{n\pi(1-\pi)}$, this is a $\pm$ 2σ range for $n\pi = 4(1-\pi)$. Since $n\pi = m$ is usually much larger than 4, the restriction is violated only by a minimal fraction of all cases.

We calculate the first four moments of r to various degrees of approximation and compare them. Finally, we will explore by numerical examples how large the data base from which r is estimated has to be in order to use the simple approximation.

3. Some Basic Formulas

The ε are implicitly defined as:

$$\varepsilon = \frac{p-\pi}{\pi} . \tag{4}$$

Since $p = x/n$

$$\varepsilon = \frac{x-n\pi}{n\,\pi} . \tag{5}$$

Therefore, for the central moments the relation

$$\mu_i(\varepsilon) = \frac{\mu_i(x)}{(n\pi)^i} \tag{6}$$

holds. Since x was assumed to be binomially distributed,

$$\left.\begin{aligned} \mu_1(x) &= 0 \\ \mu_2(x) &= n\pi(1-\pi) \\ \mu_3(x) &= n\pi(1-\pi)(1-2\pi) \\ \mu_4(x) &= 3n^2\pi^2(1-\pi)^2 + n\pi(1-\pi)(1-6\pi(1-\pi)), \end{aligned}\right\} \tag{7}$$

therefore

$$\left.\begin{aligned} \mu_1(\varepsilon) &= 0 \\ \mu_2(\varepsilon) &= \frac{1-\pi}{n\,\pi} \\ \mu_3(\varepsilon) &= \frac{(1-\pi)(1-2\pi)}{(n\pi)^2} \\ \mu_4(\varepsilon) &= \frac{3(1-\pi)^2}{(n\pi)^2} + \frac{(1-\pi)(1-6\pi(1-\pi))}{(n\pi)^3} \end{aligned}\right\} \tag{8}$$

Introducing the number of "successes" (or injuries in our context) $m = n\pi$, and assuming π to be negligibly small relative to 1, one obtains the approximation

$$\left.\begin{aligned} \mu_2(\varepsilon) &\approx \frac{1}{m} \\ \mu_3(\varepsilon) &\approx \frac{1}{m^2} \\ \mu_4(\varepsilon) &\approx \frac{3}{m^2} + \frac{1}{m^3} \end{aligned}\right\} \qquad (9)$$

Later we will use t = 1/m to simplify the writing of the formulas.

To calculate powers of r, we need

$$\left.\begin{aligned} (1+\varepsilon)^2 &= 1 + 2\varepsilon + \varepsilon^2 \\ (1+\varepsilon)^3 &= 1 + 3\varepsilon + 3\varepsilon^2 + \varepsilon^3 \\ (1+\varepsilon)^4 &= 1 + 4\varepsilon + 6\varepsilon^2 + 4\varepsilon^3 + \varepsilon^4 \end{aligned}\right\} \qquad (10)$$

and

$$\left.\begin{aligned} \frac{1}{1+\varepsilon} &= 1-\varepsilon + \varepsilon^2 - \varepsilon^3 + \varepsilon^4 \ldots \\ \left(\frac{1}{1+\varepsilon}\right)^2 &= 1-2\varepsilon+3\varepsilon^2 - 4\varepsilon^3 + 5\varepsilon^4 \ldots \\ \left(\frac{1}{1+\varepsilon}\right)^3 &= 1 - 3\varepsilon + 6\varepsilon^2 - 10\varepsilon^3 + 15\varepsilon^4 \ldots \\ \left(\frac{1}{1+\varepsilon}\right)^4 &= 1 - 4\varepsilon + 10\varepsilon^2 - 20\varepsilon^3 + 35\varepsilon^4 \ldots \end{aligned}\right\} \qquad (11)$$

Taking expectations, one obtains

$$\left.\begin{aligned} E(1+\varepsilon) &= 1 \\ E(1+\varepsilon)^2 &= 1 + \mu_2 \\ E(1+\varepsilon)^3 &= 1 + 3\mu_2 + \mu_3 \\ E(1+\varepsilon)^4 &= 1 + 6\mu_2 + 4\mu_3 + \mu_4 \end{aligned}\right\} \qquad (12)$$

and

$$\left.\begin{aligned} E\left(\frac{1}{1+\varepsilon}\right) &= 1 + \mu_2 - \mu_3 + \mu_4 \ldots \\ E\left(\frac{1}{1+\varepsilon}\right)^2 &= 1 + 3\mu_2 - 4\mu_3 + 5\mu_4 \ldots \\ E\left(\frac{1}{1+\varepsilon}\right)^3 &= 1 + 6\mu_2 - 10\mu_3 + 15\mu_4 \ldots \\ E\left(\frac{1}{1+\varepsilon}\right)^4 &= 1 + 10\mu_2 - 20\mu_3 + 35\mu_4 \ldots \end{aligned}\right\} \qquad (13)$$

If we substitute the approximations (9) and use $t = 1/m$, we obtain

$$\left.\begin{aligned} E(1+\varepsilon)^2 &\approx a_2 = 1+t \\ E(1+\varepsilon)^3 &\approx a_3 = 1 + 3t + t^2 \\ E(1+\varepsilon)^4 &\approx a_4 = 1 + 6t + 7t^2 + t^3 \end{aligned}\right\} \quad (14)$$

and

$$\left.\begin{aligned} E\left(\frac{1}{1+\varepsilon}\right) &\approx b_1 = 1 + t + 2t^2 + t^3 \\ E\left(\frac{1}{1+\varepsilon}\right)^2 &\approx b_2 = 1 + 3t + 11t^2 + 5t^3 \\ E\left(\frac{1}{1+\varepsilon}\right)^3 &\approx b_3 = 1 + 6t + 35t^2 + 15t^3 \\ E\left(\frac{1}{1+\varepsilon}\right)^4 &\approx b_4 = 1 + 10t + 85t^2 + 35t^3 \end{aligned}\right\} \quad (15)$$

We will later also need b_1^2, b_1^3, and b_1^4 and a_2^2. The approximations up to t^3 are:

$$\left.\begin{aligned} a_2^{\,2} &= 1 + 2t + t^2 \\ b_1^{\,2} &= 1 + 2t + 5t^2 + 6t^3 \\ b_1^{\,3} &= 1 + 3t + 9t^2 + 16t^3 \\ b_1^{\,4} &= 1 + 4t + 14t^2 + 32t^3 \end{aligned}\right\} \quad (16)$$

We also will use that for independent random variables x and y

$$E(xy) = E(x)E(y) \quad (17)$$

holds.

Finally, we will use the following relations between the central moments μ_i and non-central moments μ_i' :

$$\left.\begin{aligned} \mu_2 &= \mu_2' - (\mu_1')^2 \\ \mu_3 &= \mu_3' - 3\mu_1'\mu_2' + 2(\mu_1')^3 \\ \mu_4 &= \mu_4' - 4\mu_1'\mu_3' + 6(\mu_1')^2\mu_2' - 3(\mu_1')^4 \end{aligned}\right\} \quad (18)$$

4. The First Moment

4.1 Approximation Using Linear Terms Only

If one expands r, considering only the linear terms, one obtains

$$r = 1 + \varepsilon_1 + \varepsilon_4 - \varepsilon_2 - \varepsilon_3 \tag{19}$$

and therefore

$$E(r) = 1. \tag{20}$$

4.2 Approximation Using Terms up to the Second Order

An expansion up to second order terms is

$$r = (1+\varepsilon_1)(1+\varepsilon_4)(1-\varepsilon_2+\varepsilon_2^2)(1-\varepsilon_3+\varepsilon_3^2) \tag{21}$$

$$= 1 + \varepsilon_1+\varepsilon_4-\varepsilon_2-\varepsilon_3+\varepsilon_1\varepsilon_4-\varepsilon_1\varepsilon_2-\varepsilon_1\varepsilon_3-\varepsilon_4\varepsilon_2-\varepsilon_4\varepsilon_3+\varepsilon_2\varepsilon_3+\varepsilon_2^2+\varepsilon_3^2.$$

Because independence between the ε_i was assumed, this gives

$$E(r) = 1 + \mu_2\ (\varepsilon_2) + \mu_2\ (\varepsilon_3). \tag{22}$$

This shows that the expected value of R is greater than $(p_1/p_2)/(p_3/p_4)$; therefore using this as an estimator for R overestimates the effectiveness 1-R. To assess the magnitude of this bias, we use the approximation (9) and obtain:

$$E(r) \approx 1 + \frac{1}{m_2} + \frac{1}{m_3}\ . \tag{23}$$

For the situation where each of the four p's is calculated from 20 injuries,

$$E(r) \approx 1.1,$$

for the situation where each is based on 100 injuries,

$$E(r) \approx 1.02.$$

These biases may appear small. However, if e.g., R = 0.95, was estimated, in the first case the true expected value would be R' = 1.04, and instead of an effectiveness 1-0.95 = 0.05, 1-1.04 = -0.04 should be used in the first case: this means that the expected effect is approximately the opposite of what one would expect from the biased estimate. In the second case R' = 0.97 is the unbiased expected value and the effectiveness should be 0.03 instead of 0.05, a reduction by 40%!

4.3 Approximation Using Terms up to the Third Order

Using equation (17), we obtain

$$E(r) = E(1+\varepsilon_1)E(1+\varepsilon_4)E(\frac{1}{1+\varepsilon_2})\ E(\frac{1}{1+\varepsilon_3}), \tag{24}$$

and from (12) and (15)

$$\begin{aligned} E(r) &= (1+t_2+2t_2^2+t_2^{\ 3})(1+t_3+2t_3^{\ 2} + t_3^{\ 3}) \\ &\approx 1+t_2+t_3+2t_2^{\ 2} +t_2t_3+2t_3^{\ 2}+t_2^{\ 3}+2t_2^{\ 2}t_3+2t_2t_3^{\ 2}+t_3^{\ 3}, \end{aligned} \tag{25}$$

retaining only terms up to the third order. To make estimates of the order of magnitude of the higher order terms, we assume $t_2 = t_3 = T$ and obtain

$$\begin{aligned} E(r) &= 1+2T +5T^2+6T^3 \\ &= 1 +2T(1+ \frac{5}{2}\ T +3T^2) \end{aligned} \tag{26}$$

For the first case discussed in 4.2, m = 20, T = 0.05, one obtains E(r) = 1.11, compared with 1.1 in Section 4.3. Whether this difference is important depends on how large R is. For the second case, m = 100, T = 0.01, the effect is to increase E(r) from 1.02 to 1.0205, which is negligible.

5. The Second Moment

5.1 Approximation Using Linear Terms Only

Using (12), (13) and (17), we obtain

$$\begin{aligned} E(r^2) &= (1+\mu_2(\varepsilon_1))(1+\mu_2(\varepsilon 4))(1+3\mu_2(\varepsilon 2))(1+3\mu_2(\varepsilon 3)) \\ &= 1 + \mu_2(\varepsilon_1) + \mu_2(\varepsilon_4) + 3\mu_2(\varepsilon_2) + 3\mu_2(\varepsilon_3), \end{aligned} \tag{27}$$

when only first order terms in the μ_2 are retained. In order to calculate $\mu_2(r)$, we use (18) which requires $(\mu_1'(r))^2$.

$$\mu_1'(r) = (1+\mu_2(\varepsilon_2))\ (1+\mu_2(\varepsilon_3)) \text{ and} \tag{28}$$

$$(\mu_1'(r))^2 = 1 + 2\mu_2(\varepsilon_2) + 2\mu_2(\varepsilon_3), \tag{29}$$

retaining only the first order terms in the μ_2. Combining (27) and (29) according to (18) gives

$$\mu_2(r) = \mu_2(\varepsilon_1) + \mu_2(\varepsilon_2) + \mu_2(\varepsilon_3) + \mu_2(\varepsilon_4); \tag{30}$$

the variance of the double ratio is the sum of the variances of the four factors.

5.2 Approximation Using Terms up to the Third Order

For this approximation we immediately use the approximations (15) and (16). First we have

$$\begin{aligned} \mu_2'(r) = E(r^2) &= E(1+\varepsilon_1)^2 E(1+\varepsilon_4)^2 E(\tfrac{1}{1+\varepsilon_2})^2 E(\tfrac{1}{1+\varepsilon_3})^2 \\ &= (1+t_1)(1+t_4)(1+3t_2+11t_2^2+5t_2^3)(1+3t_3+11t_3^2+5t_3^3) \\ &= (1+t_1+t_4+t_1t_4)(1+3t_2+3t_3+11t_2^2+9t_2t_3+11t_3^2+5t_2^3+33t_2^2t_3+33t_2t_3^2+5t_3^2) \\ &= 1 + 3t_2+3t_3+11t_2^2+9t_2t_3+11t_3^2+5t_2^3+33t_2^2t_3+33t_2t_3^2+5t_3^2 \\ &\quad +(t_1+t_4)(1+3t_2+3t_3+11t_2^2+9t_2t_3 +11t_3^2) + t_1t_4(1+3t_2+3t_3), \end{aligned} \tag{31}$$

if one retains only terms up to the third order. Since

$$\mu_1' = b_1(\varepsilon_2)b_1(\varepsilon_3) \tag{32}$$

(16) gives

$$(\mu_1')^2 = (1+2t_2+5t_2{}^2+6t_2{}^3)(1+2t_3+5t_3{}^2+6t_3{}^3) \tag{33}$$
$$= 1 + 2t_2+2t_3+5t_2{}^2+4t_2t_3+5t_3{}^2+6t_2{}^3+10t_2{}^2t_3 +10t_2t_3^2+6t_3{}^3$$

retaining only terms up to the third order. Combining (31) and (33) according to (18) gives

$$\begin{aligned}\mu_2 &= t_1+t_2+t_3+t_4 \\ &\quad +6t_2{}^2+5t_2t_3+6t_3{}^2-t_2{}^3+23t_3{}^2t_3+23t_2t_3{}^2-t_3{}^3 \\ &\quad +(t_1+t_4)(3t_2+3t_3+11t_2{}^2+9t_2t_3+11t_3{}^2) \\ &\quad +t_1t_4(1+3t_2+3t_3).\end{aligned} \tag{34}$$

The linear terms correspond to the sum of the four $\mu_2(\varepsilon_i)$. The higher order terms are impracticably complicated to be used. Therefore, we use again the special case where all $t_i = T$ and obtain:

$$\begin{aligned}\mu_2(r) &= 4T + 30T^2 + 112T^3 \\ &= 4T\ (1 + \tfrac{15}{2}T^m + 23T^2) \\ &= 4Tf\end{aligned} \tag{35}$$

Since 4T corresponds to the linear terms of $\mu_2(r)$, f is the factor by which it has to be increased. For m = 20, one has f = 1.43, and for m = 100, one has f = 1.08, for m = 500, f = 1.015. Thus, for m = 20, the higher terms are not negligible; for 100 they will usually be so, whereas for 500 they are practically always negligible.

6. The Third Moment

(18) gives for the third moment

$$\mu_3 = \mu_3' -3(\mu_1'\mu_2')+2(\mu_1')^3 \tag{36}$$

Using directly (14), (15) and (16) and substituting one T for the t_i, we obtain

$$\begin{aligned} \mu_3'(r) &= (1+3T+T^2)^2 (1+6T+35T^2+15T^3)^2 \\ &= (1+6T+11T^2+6T^3)(1+12T+106T^2+450T^3) \\ &= 1 + 18T+189T^2+1224T^3 \end{aligned} \tag{37}$$

omitting all terms of higher than third order.

Combining

$$\begin{aligned} \mu_2'(r) &= (1+T)^2(1+3T+11T^2+5T^3)^2 \\ &= 1 + 8T + 44T^2 + 144T^3 \end{aligned} \tag{38}$$

with (26) gives

$$\begin{aligned} \mu_1'(r)\mu_2'(r) &= (1+2T+5T^2+6T^3)(1+8T+44T^2+144T^3) \\ &= 1 + 10T + 65T^2 + 278T^3 \end{aligned} \tag{39}$$

up to terms of the third order.

Finally, we need

$$(\mu_1')^3 = [1+2T+5T^2+6T^3]^3 \tag{40}$$

according to (26). This gives

$$(\mu_1')^3 = 1 + 6T + 27T^2 + 86T^3 \tag{41}$$

again omitting terms of higher than third order. Combining (37), (39) and (41) according to (36) gives

$$\mu_3 \quad = 48T^2 + 562\ T^3. \tag{42}$$

Since μ_3 is not easily interpretable, we will use it only for the Gram-Charlier series expansion to be performed later.

7. <u>The Fourth Moment</u>

$$\mu_4 = \mu_4' - 4(\mu_1'\mu_3') + (6(\mu_1')^2\mu_2') - 3(\mu_1')^4. \tag{43}$$

$$\mu_4' = E(r^4) = E(1+\varepsilon_1)^4 E(1+\varepsilon_4)^4 E(\frac{1}{1+\varepsilon_2})^4 E(\frac{1}{1+\varepsilon_3})^4. \tag{44}$$

Using (14) and (15) this becomes:

$$\begin{aligned} \mu_4' &= (1+6T+7T^2+T^3)^2 (1+10T+85T^2+35T^3)^2 \\ &= (1+12T+50T^2+86T^3)(1+20T+270T^2+1770T^3) \\ &= 1 + 32T + 560T^2 + 6096T^3 \end{aligned} \tag{45}$$

if omitting terms of higher than third order.

Combining (26) and (37) gives

$$\begin{aligned} \mu_1'(r)\mu_3'(r) &= (1+2T+5T^2+6T^3)(1+18T+189T^2+1224T^3) \\ &= 1 + 20T + 230T^2 + 1698T^3 \end{aligned} \tag{46}$$

Combining the simplified versions of (31) and (33) gives

$$\begin{aligned} (\mu_1'(r))^2\mu_2'(r) &= (1+4T+14T^2+32T^3)(1+8T+44T^2+144T^3) \\ &= 1 + 12T + 90T^2 + 464T^3. \end{aligned} \tag{47}$$

Finally, by squaring (33) we obtain

$$\begin{aligned} (\mu_1')^4 &= (1 + 4T + 14T^2 + 32T^3)^2 \\ &= 1 + 8T + 44T^2 + 176T^3. \end{aligned} \tag{48}$$

Combining (45), (46), (47) and (48) according to (43), we obtain

$$\begin{aligned} \mu_4 &= 1 + 32T + 560T^2 + 6096T^3 \\ &\quad -4(1+20T+230T^2+1698T^3) \\ &\quad +6(1+12T+90T^2+464T^3) \\ &\quad -3(1+8T+44T^2+176T^3) \\ &= 48T^2 + 1560T^3. \end{aligned} \tag{49}$$

Since $\mu_2 = 4T+\ldots$, the excess or curtosis μ^4/μ_2^2 approaches 3 for small values of T; this is the value for the normal distribution.

8. Gram-Charlier Series Expansion

8.1 Basic Formulas

A probability density function f(x) can be expanded into a series

$$f(x) = \phi(x) \ (1 + \frac{\mu_3^*}{6} H_3(x) + \frac{\mu_4^* - 3}{24} H_4(x) + \ldots), \tag{50}$$

where it is assumed that x is transformed to have mean zero and variance 1; μ_3^* and μ_4^* are the correspondingly transformed third and fourth moments. $H_i(x)$ are the Hermite polynomials

$$\begin{aligned} H_2(x) &= x^2-1 \\ H_3(x) &= x^3-3x \\ H_4(x) &= x^4-6x^2+3 \end{aligned} \tag{51}$$

$\phi(x)$ is the normal probability density.

The cumulative probability function can be expressed as

$$F(x) = \Phi(x)-\phi(x) \ (\frac{\mu_3^*}{6} H_2(x) + \frac{\mu_4^* - 3}{24} H_3(F) + \ldots .) \tag{52}$$

where $\Phi(x)$ is the cumulative normal probability distribution.

In standard texts I found no remainder terms indicating how accurately a finite series using only a few terms of the infinite series approximates the true distribution.

8.2 Numerical Examples

8.2.1 m = 20

If we assume that all four p_i are estimated from 20 injury cases, and that the injury probability is small, we obtain:

First two moments (using linear terms only):

$$\begin{aligned} \mu_1' &= 1 \\ \mu_2 &= \frac{4}{20} = 0.2 \end{aligned} \tag{53}$$

First two moments (using terms up to the third order):

$$\begin{aligned} \mu_1' &= 1 + \frac{2}{20} + \frac{5}{20^2} + \frac{6}{20^3} = 1.113 \\ \mu_2 &= \frac{4}{20} + \frac{30}{20^2} + \frac{112}{20^3} = 0.289 \end{aligned} \tag{54}$$

First four moments (using terms up to the third order):

$$\begin{aligned}
\mu_1' &= 1.113 \\
\mu_2 &= 0.289 \\
\mu_3 &= 0.190 \qquad \mu_3^* = \mu_3/\sqrt{\mu_2^3} = 1.223 \\
\mu_4 &= 0.315 \qquad \mu_4^* = \mu_4/\mu_2^2 = 3.772
\end{aligned} \tag{55}$$

Figure 1 shows the two tails of the cumulative distribution of r. The approximation of the first four moments was calculated from the Gram-Charlier series. It is presumably the closest approximation to the "true" distribution of r. The lower and upper 5th percentiles are at r = 0.37 and r = 2.26
The approximation of the first two moments using terms up to the third order is based upon a normal distribution with the "true" mean and variance; the lower and upper 5th percentiles are 0.26 and 2.00
The approximation of the first two moments using linear terms only is based upon a normal distribution with mean 1 and variance = $\varepsilon_1^2+\varepsilon_2^2+\varepsilon_3^2+\varepsilon_4^2$. It has the lower and upper fifth percentiles 0.22 and 1.74.
Both of the latter two approximations are unsatisfactory since the effectiveness is 1-R; using one of them may result in accepting an effect as significant which is with a fairly high probability due to chance. r = 2.04 would be considered significant at the 99% level, whereas it is only 92.5% significant with the "true" distribution.

8.2.2 m = 100

The corresponding results are:

First two moments (using linear terms only):

$$\begin{aligned}
\mu_1' &= 1 \\
\mu_2^2 &= \frac{4}{100} = 0.04
\end{aligned} \tag{56}$$

First two moments (using terms up to the third order):

$$\begin{aligned}
\mu_1' &= 1 + \frac{2}{100} + \frac{5}{100^2} + \frac{6}{100^3} = 1.021 \\
\mu_2 &= \frac{4}{100} + \frac{30}{100^2} + \frac{112}{100^3} = 0.0431
\end{aligned} \tag{57}$$

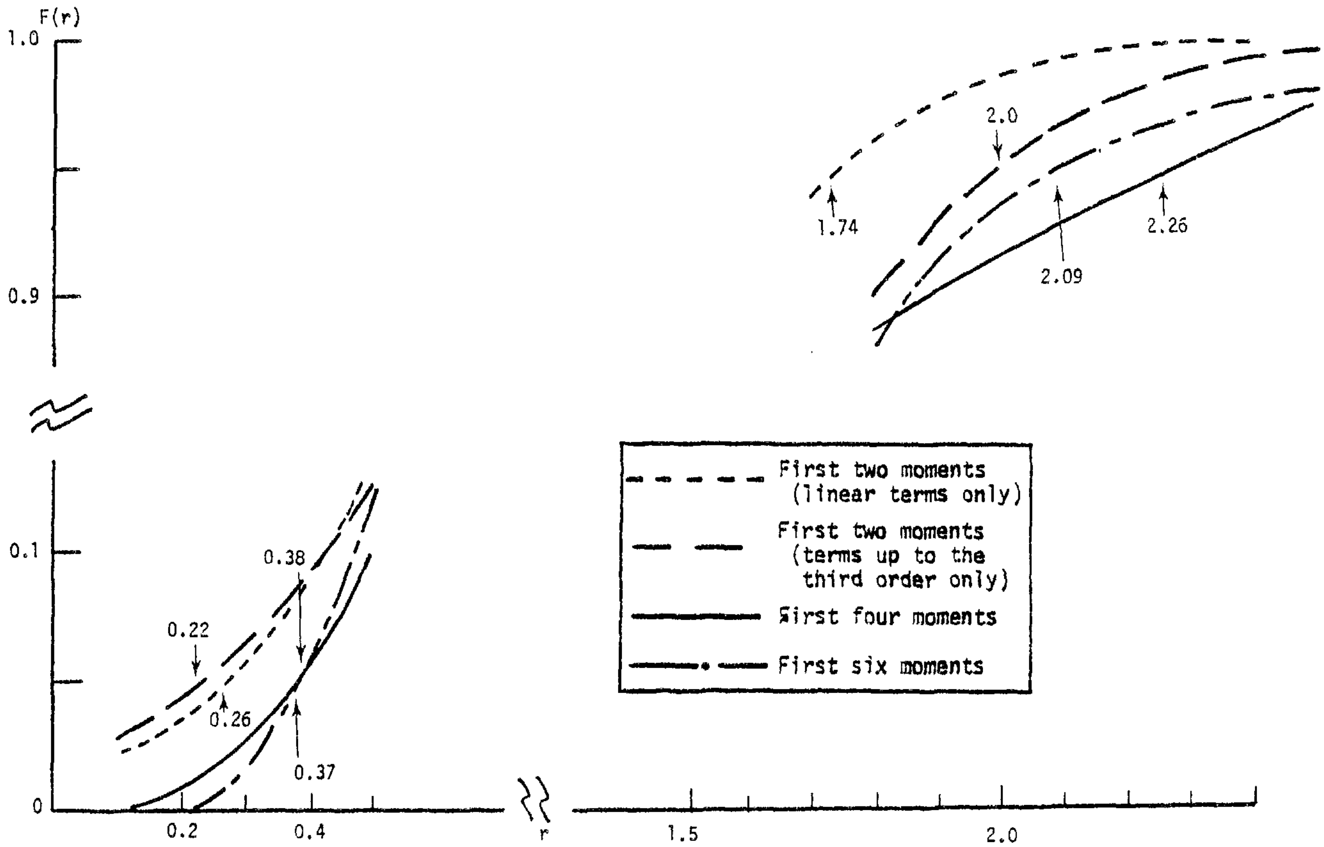

Figure 1. Two tails of the cumulative distribution of r (m=20).

First four moments (using terms up to the third order):

$$\mu_1' = 1.021$$

$$\mu_2 = 0.0431 \tag{58}$$

$$\mu_3 = 0.00536 \qquad \mu_3^* = \mu_3/\sqrt{\mu_2^3} = 0.599$$

$$\mu_4 = 0.00636 \qquad = \mu_4^* = \mu_4/\mu_2^2 = 3.424$$

Figure 2 shows the tails of the corresponding distribution. Here, at the left tail, the differences between the three distributions are negligible. At the right tail, the difference between the approximations of the first four and the first two moments (using terms up to the third order) is negligible; the difference between them and the approximation of the first two moments using linear terms only may just be important in some cases.

8.3 Approximate Estimation of Confidence Limits

To calculate the entire distribution or part of it to determine for which x', $F(x') = 1-\alpha$ holds is relatively time-consuming. An approximation may be sufficient. We write

$$F(x) = F(x_o) + F'(x_o)\ (x - x_o) \tag{59}$$

We now chose x_o so that $\phi(x_o) = 1-\alpha$, x_o is the derived confidence limit for the normal distribution. We define x' as the confidence limit for the studied distribution: $F(x') = 1-\alpha$. Then we have

$$x' - x_o = \frac{1-\alpha-F(x_o)}{F'(x_o)}. \tag{60}$$

(52) gives

$$\begin{aligned} F(x_o) &= \phi(x_o) - \Phi(x_o)\left(\frac{\mu_3^*}{6} H_2(x_o) + \frac{\mu_4^*-3}{24} H_2(x_o)\right) \\ &= 1-\alpha-\Phi(x_o)\left(\frac{\mu_3^*}{6} H_2(x_o) + \frac{\mu_4^*-3}{24} H_3(x_o)\right) \end{aligned} \tag{61}$$

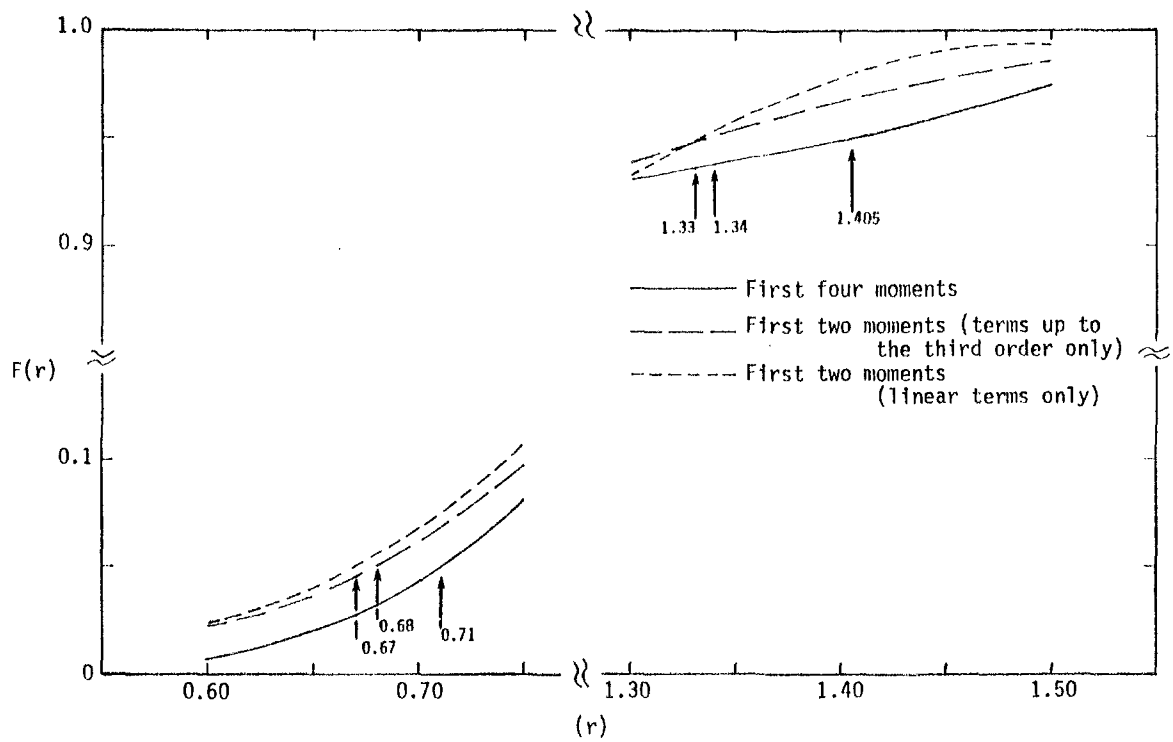

Figure 2. Two tails of the cumulative distribution of r(m=100).

Since $F'(x) = f(x)$, we can combine (60), (61) and (50) and obtain

$$x'-x_o = \frac{\frac{\mu_3^*}{6} H_2(x_o) + \frac{\mu_4^*-3}{24} H_3(x_o)}{1 + \frac{\mu_3^*}{6} H_3(x_o) + \frac{\mu_4^*-3}{24} H_4(x_o)} \quad (62)$$

If we use $\alpha = 0.05$ as an example, $x_o = 1.64$, and we have $H_2(x_o) = 1.690$,

$H_3(x_o) = -0.509$, $H_4(x_o) = -5.904$. Therefore,

$$x'-1.64 = \frac{0.282\mu_3^* - 0.021(\mu_4^*-3)}{1-0.085\mu_3^* - 0.246(\mu_4^*-3).} \quad (63)$$

Thus, one can calculate the approximate upper 95% confidence limit for any distribution, where the μ_3^* (skewness) and μ_4^* (excess, curtosis) are given.

9. Conclusions and Recommendations

The numerical examples suggest that for $m > 100$ one can use the normal approximation, preferably corrected for the bias in $\bar{r}$; but for $m > 400$ or 500, this is definitely not necessary.

For $m = 20$ the normal approximation, even if corrected for bias and with an inflated ϵ, is definitely inadequate. Somewhere between 20 and 100 is an m where it becomes sufficient to correct r and inflate ϵ. The approximations were derived for "small" values of the π_i. That means that the p_i have highly skewed distributions. For larger π_i the distributions are less skewed; for $\pi_i = 0.5$ they are symmetric. Therefore, one can expect that the normal approximations will be sufficient for smaller values of m than suggested above, if the π_i are not small.

For small values of m one should proceed as follows:

1) Calculate $\mu_i(\varepsilon_j)$

2) Calculate $E(\frac{1}{1+\varepsilon_j})^k$

3) Calculate $E(r^k)$

4) Calculate $\mu_k(r)$

5) Calculate $\mu_3^*(r)$ and $\mu_4^*(r)$

6) Apply equation (62) for the desired α

Elaboration

1) Calculate $\mu_i(\varepsilon_j)$
i = order of moment, j index of p_j in $\frac{p_1}{p_2}:\frac{p_3}{p_4}$

Formulae (8) do this

2) Calculate $E(\frac{1}{1+\varepsilon_j})^k$; $E(1+\varepsilon_j)^k$. Assume that only the second order approximation will be used: $k = 1, 2$.

$$E(\frac{1}{1+\varepsilon_j}) = 1 + \mu_2(\varepsilon_j) - \mu_3(\varepsilon_j) + \mu_4(\varepsilon_j)$$

$$E(\frac{1}{1+\varepsilon_j})^2 = 1 + 3\mu_2(\varepsilon_j) - 4\mu_3(\varepsilon_j) + 5\mu_4(\varepsilon_j)$$

$$E(1+\varepsilon_j) = 1$$
$$E(1+\varepsilon_j)^2 = 1 + \mu_2(\varepsilon_j)$$

3) Calculate $E(r^k) = E(1+\varepsilon_1)^k\, E(1+\varepsilon_4)^k E(\frac{1}{1+\varepsilon_2})^k\, E(\frac{1}{1+\varepsilon_3})^k$
$\mu_k'(r) = E(r^k)$

4) Calculate $\mu_2(r)$. Use formula (18).

Calculate $\mu_k(R) = (\frac{\pi_1}{\pi_2} : \frac{\pi_3}{\pi_4})^k\, \mu_k(r)$

Calculate $\mu_k'(R) = (\frac{\pi_1}{\pi_2} : \frac{\pi_3}{\pi_4}) \quad \mu_k'(r)$

5) Omit for this level approximation.

6) For $m_j > 100$, use a normal distribution with $\mu_1'(R)$ and $\mu_2(R)$