DOT HS-805 640

THE IMPACT OF A CHILD PASSENGER RESTRAINT LAW AND A PUBLIC INFORMATION AND EDUCATION PROGRAM ON CHILD PASSENGER SAFETY IN TENNESSEE

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Contract No. DOT HS-7-01730
Contract Amt. $309,026

OCTOBER 1980
FINAL REPORT

Prepared For
U.S. DEPARTMENT OF TRANSPORTATION
National Highway Traffic Safety Administration
Washington, D.C. 20590

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT-HS-805 640		

4. Title and Subtitle	5. Report Date
THE IMPACT OF A CHILD PASSENGER RESTRAINT LAW AND A PUBLIC INFORMATION AND EDUCATION PROGRAM ON CHILD PASSENGER SAFETY IN TENNESSEE	October 1980
	6. Performing Organization Code
	8. Performing Organization Report No.
7. Author(s) Randy L. Perry, K. W. Heathington, John W. Philpot, C. A. Pentz, Mark Lo	
9. Performing Organization Name and Address Transportation Center The University of Tennessee Knoxville, Tennessee 37916	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. DOT-HS-7-01730
	13. Type of Report and Period Covered Final Report 10/1/77-9/30/80
12. Sponsoring Agency Name and Address National Highway Traffic Safety Administration U.S. Dept. of Transportation Washington, D.C. 20590 Tennessee Governor's Highway Safety Program State of Tennessee Nashville, TN 37219	14. Sponsoring Agency Code
15. Supplementary Notes	

16. Abstract

This report provides an analysis of the impact of child passenger protection legislation and a public information and education (PI&E) program on child passenger safety in Tennessee. This study is unique in that Tennessee was the first state to pass legislation requiring the protection of small child passengers, thus providing an opportunity for field evaluation. The analyses in this report are based on evaluation of data collected prior to and in six-month increments after implementation of the law and the PI&E program.

The evaluation of the PI&E program involved the measurement of the effectiveness of two levels of PI&E activity by comparing target areas having a comprehensive PI&E treatment with areas having lower level of activity. The effectiveness was measured by collecting usage data in five urban areas and three rural areas of Tennessee. Data was gathered by observing automobiles entering major activity areas (shopping centers) and by interviewing drivers of automobiles in which children under four years of age were riding.

Changes in child restraint device usage rates are measured across time and between the two levels of PI&E activity. Discriminant analysis and partial correlation analysis are used to develop profiles of parents/guardians who use or do not use child restraint devices.

17. Key Words	18. Distribution Statement
child passenger protection law, child restraint device, public information and education	Document is available to the U.S. public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	270	

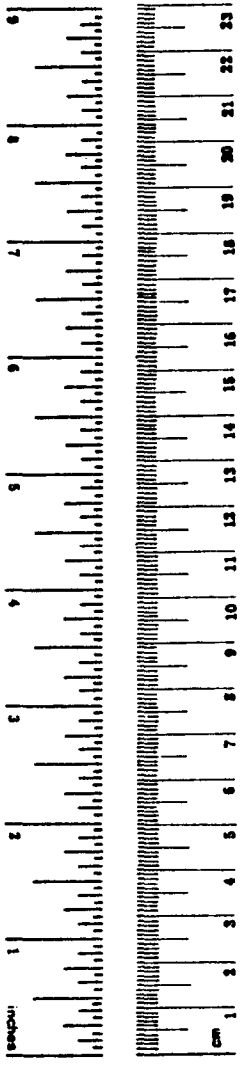
Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

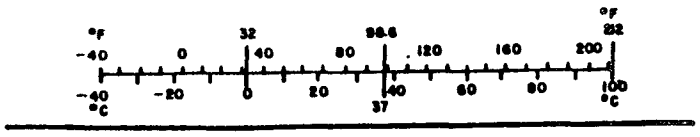
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	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



ACKNOWLEDGMENT

The authors wish to express their appreciation to the other project staff members for their contribution to the overall project. Many aspects of the data collection, analysis and interpretation were addressed by each staff member of the Child Passenger Safety Program. Specifically, the authors are indebted to Dr. E. Christy Hughes, Dianne B. Sontag, Dr. Carol J. Culler, Dr. Jo Lynn Cunningham, Dewey A. Wyrick, Kevin C. Trent, Pamela B. Moss and Linda S. Geiss for their contributions to this presentation.

PREFACE

This report is one in a series of 11 reports on the Child Passenger Safety Program in Tennessee. These reports are:

1. The Tennessee Child Passenger Safety Program;
2. The Impact of a Child Passenger Restraint Law and a Public Information and Education Program on Child Passenger Safety in Tennessee;
3. Development of Materials and Public Relations Efforts to Promote Child Passenger Safety;
4. Use of Telephone Surveys to Determine Awareness of Tennessee's Child Passenger Protection Law;
5. Organizational Networks for Promoting Child Passenger Safety;
6. Judicial Perspectives on Child Passenger Protection Legislation;
7. Enforcement of the Child Passenger Protection Law;
8. Development of Child Passenger Safety Component for Driver Education Programs;
9. Parents' Knowledge, Attitudes and Behavior About Child Passenger Safety;
10. Child Restraint Device Loaner Programs; and
11. Compliance with the Child Passenger Protection Law: Effects of a Loaner Program for Low-Income Mothers.

This report provides an analysis of the impact of child passenger protection legislation and a public information and education (PI&E) program on child passenger safety in Tennessee. This study is unique in that Tennessee was the first state to pass legislation requiring the protection of small child passengers, thus providing an opportunity for field evaluation. The analyses in this report are based on evaluation of data collected prior to and in six-month increments after implementation of the law and PI&E program.

The evaluation of the PI&E program involved the measurement of the effectiveness of two intensity levels of application. The higher intensity level, which was called the comprehensive plan, was applied in progression to specific target areas during the study. The lower intensity level, the basic state plan, was used statewide for the entire period after implementation of the law. An evaluation was made of the two intensity levels by comparing the target areas having the comprehensive plan with target areas having only the basic plan.

The urban areas selected for the target areas were Memphis, Nashville, Chattanooga, Knoxville and the Tri-Cities area. The nonurban areas selected for PI&E treatments were Dyersburg, Columbia and Morristown. There were

factors (which were practically uncontrollable) which may have influenced the CRD usage rates. These factors included the "leakage" of information which only comprehensive plan target areas were to receive. However, it is felt that these factors had only a minor impact upon the overall results. If these factors could have been controlled, there would have been an even higher measured impact of the comprehensive PI&E treatment.

It was found from this part of the Child Passenger Safety Program that the rate of usage of child restraint devices (CRDs) was significantly increased after implementation of the law and the PI&E program promoting child passenger safety. The final CRD usage rate was some 103 percent higher than the baseline rate, based on statewide estimates. The comprehensive plan, when applied to target areas during the operational period of this research, was significantly more effective in increasing CRD usage than the basic state plan. While the increase in CRD usage was not enough to show significant reductions in overall fatalities or serious injuries based on the accident data analysis for the operational period, children in CRDs had significantly more protection than those who were not in CRDs. Of the 20 deaths investigated in this two-year period, all were children riding without CRDs. By this measure, CRDs prevented at least 40 injuries and 7 fatalities over the two-year period.

While the "babes in arms" clause has been touted as a very serious weakness in the law, it is interesting to note that the percentage of children being held by an older individual did not change during the study period. The percentage remained approximately 22 to 25.

There was a strong correlation between individuals using seat belts and individuals protecting their children by placing them in CRDs. While there was not an increase in seat belt usage by all drivers observed between the baseline and operational measurement periods, the subset of drivers who had small children traveling with them showed a significant increase in seat belt usage.

Characteristics of nonusers of CRDs were identified through various statistical analyses. A nonuser is (1) less likely to be wearing a seat belt, (2) more likely to have a lower educational attainment level, (3) more likely to have more passengers in the vehicle, (4) more likely to be transporting older children (under four years of age), (5) less likely to be the parent of the child, (6) more likely to be in a lower income bracket and (7) less likely to own the vehicle.

The child passenger safety legislation in Tennessee has been effective. It becomes more effective when rigidly enforced and when comprehensive plan treatments are implemented to inform and educate the public. The legislation is an effective measure which can be improved through future modifications of the law.

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I. INTRODUCTION

Highway safety is of grave concern in the United States; thousands of fatalities and serious injuries occur annually. A continued effort is being made by federal, state and local agencies to reduce the number of deaths and injuries caused by motor vehicle accidents. These efforts involve improving the three primary elements which contribute to the cause of most motor vehicle accidents--the roadway, the driver and the vehicle.

Improvements to varying degrees have occurred in each of these areas in recent years, and the results are evident. The number of deaths per 100 million miles of travel has been declining since 1966 (Table I-1), except that the rate increased slightly to 3.24 in 1977 from 3.22 in 1976. The National Highway Traffic Safety Administration (NHTSA) estimates a rate of 3.27 for 1978. The number of miles traveled increased steadily each year from 1966 until the 1973-1974 fuel crisis. The "energy crisis" prompted national legislation to limit vehicle speed on highways to 55 miles per hour. This measure, taken in January 1974, produced lower speeds which, coupled with the scarcity and the increased price of fuel, reduced the total amount of travel across the nation. The total effect was fewer accidents and thus a lower number of fatalities and injuries. In 1975 and 1976, as fuel became more widely available, the amount of travel exceeded that of 1973. Because the speed limit was retained at 55 miles per hour, the number of fatalities and injuries still remained lower than before the legislation. NHTSA statistics indicate a reduction in traffic fatalities of approximately 17 percent for 1974 and 1975 compared to 1973; the 55 miles per hour speed limit is believed to have been a significant factor in the decline (NHTSA, 1976a).

Improvements in vehicle design also have contributed to the reduced rate of deaths and injuries. Examples of these improvements include better safety glass, improved door latching mechanisms, energy absorbing steering columns, padded instrument panels, recessed knobs and controls and improved passenger restraint systems. Many of these improvements involve protecting the vehicle occupant when the occupant is thrown against the interior surfaces of the vehicle in the event of a collision. One of the best protections for vehicle passengers is the passenger restraint system commonly called the seat belt.

Many safety engineers are committed to reducing the number of injuries and fatalities by reducing the number of second collisions (i.e., the occupant striking an interior surface of the vehicle after the vehicle has collided first with an object). Restraining vehicle occupants in a stationary position in the vehicle helps minimize the number of secondary collisions.

The value of the use of passenger restraint systems is well documented. The National Highway Safety Needs Report of April 1976 states that passenger restraint usage is the single most effective safety alternative which can be presently deployed to potentially save thousands of lives over the next few years (U.S. Department of Transportation, 1976). Approximately 3,000 lives are saved each year because of passenger restraint system usage. If the national usage level could be increased from the present approximately 20 percent to 80 percent, an additional 7,000 to 9,000

TABLE I-1

MILEAGE DEATH RATE

	Fatality Rate (per 100 million vehicle miles)
1966	5.48
1967	5.25
1968	5.17
1969	5.02
1970	4.72
1971	4.44
1972	4.32
1973	4.11
1974	3.52[a]
1975	3.35
1976	3.22[b]
1977	3.24[b]

[a]First year for mandatory 55 mph speed limit.

[b]Corrected rates by NHTSA by telephone.

Source: National Highway Traffic Safety Administration. Traffic Safety '77. Washington, D.C.: U.S. Department of Transportation, 1978.

lives could be saved annually (NHTSA, 1976a). The usage rates of passenger restraint systems for all vehicle occupants in the United States are low (Robertson, 1976). Accident records studies indicate that less than 10 percent of the vehicle occupants involved in fatal accidents use passenger restraint systems (U.S. Department of Transportation, 1976).

More than 33,000 vehicle occupants were killed in motor vehicle accidents in 1976. Approximately 27,000 of this number were in passenger cars, of which almost all were equipped with seat belts (U.S. Department of Transportation, 1977). A further examination of fatalities reveals that over 750 children under five years of age were included in the total number of vehicle occupant fatalities in 1976 (U.S. Department of Transportation, 1977).

While seat belts provide adequate protection for most vehicle occupants, they are not suitable for small children. Special restraint systems are needed to protect children smaller than approximately 40 lbs. (15 kg.).

Tennessee was the first state to pass legislation in reaction to the need for child passenger protection. The law, coupled with a public information and education (PI&E) program, was implemented in January 1978. This study presents the results of an investigation of the impact of the legislation and PI&E program on child passenger safety in Tennessee. The conclusions and recommendations of the study provide the information which could be helpful to Tennessee and possibly other states in making decisions concerning child passenger safety.

Definitions of Occupant Restraints

Occupant protection inside the motor vehicle may be provided by a variety of devices. These devices may be divided into the broad categories of passive restraint devices, active restraint devices or a combination of the two. This study is concerned primarily with the utilization rates of active restraint devices, i.e., child restraint devices (CRDs) and driver seat belts; however, defining both terms will provide a better background for understanding the remainder of the report.

Passive passenger restraint devices include those devices inside the vehicle which require no initiation on the part of occupants for the restraint devices to perform their functions during a crash. There are several passive type devices in most passenger vehicles, e.g., energy-absorbing steering column and steering wheel, sturdy seats and backrests, head restraint devices, and padded instrument and knee panels. The passive seat belt, sometimes referred to as the automatic seat belt, is one which requires no activation by the occupant for the system to be in place and ready to perform in case of a collision. Development of the passive seat belt is continuing; few vehicles have them at this time. Another type passive restraint device is the air bag that technically is called the Air Cushion Restraint System. Like the passive seat belt, the air bag is an automatic system which is activated upon frontal impact. The air bag must be used in concert with a seat belt in order to provide maximum protection during a crash. It is anticipated that more passenger vehicles will have passive restraint systems within the next five years since the Secretary of

Transportation has scheduled a mandate for the beginning of installation of automatic systems in new passenger cars by the 1982 model year.

Active restraint devices are defined as those devices which require some action by the occupant to be effective in the event of a crash. There are several types of active restraint devices which have evolved from a primitive leather strap to hold race drivers in their seats. The seat belt is an active restraint which requires buckling of two high-strength straps of flexible webbing across the lap of the occupant. The seat belt-shoulder harness combination has an additional belt which crosses the chest diagonally to provide upper torso restraint.

CRDs are of four types, two of which have webbing for securing the child in a snug position for maximum protection. The most common CRD type is the car seat used for toddler size children (approximately 20 to 40 lbs. or 7.5 to 15 kg.). This type of CRD must be secured to the seat of the vehicle by a seat belt. Some of the child car seats have an additional securing strap called a tether which is attached to the upper portion of the back of the seat to prevent the seat from pitching forward during a frontal collision. The tether is anchored securely to the floor or the back seat belt when the car seat is used in the front seat or to the back shelf or cargo area (station wagons) when used in the back seat.

The second type, and second most used, is the infant carrier. This type of CRD is designed to protect children smaller than about 20 lbs. (approximately 7.5 kg.). Infant carriers are designed to face toward the rear of the vehicle. Infant carriers also require that the seat belt be used to secure it to the seat of the vehicle.

The third type of CRD is the safety shield. Shields are designed to cushion the blow over a large portion of the child's body during a crash. A shield requires no internal harness in contrast to those previously described, but like the other CRD types requires the use of the seat belt to hold it securely on the vehicle seat.

The last CRD type is the harness. This device is made of straps similar to the webbing used to hold infants and toddlers in car seats or infant carriers described above. It consists of two shoulder straps, lap and crotch strap, and an anchorage belt which must be bolted securely to the body structure of the vehicle. Children should be at least 15 lbs. (5.6 kg.) and able to sit upright alone in order to use the harness.

Purpose of the Research

The purpose of this research is to evaluate the effectiveness of a PI&E program promoting CRD usage in conjunction with the initiation of a law requiring child protection in motor vehicles. Considerable research has been conducted to determine seat belt usage before, during and after national campaigns to increase the usage rate. The usage rates of drivers and passengers also have been studied after passage of laws in other countries. Additionally, studies of CRD usage have been conducted in the United States to determine voluntary usage rates. The uniqueness of the research reported herein is that for the first time a state law requiring the

restraint of small child passengers has been passed in the United States. The specific objectives of this research were:

1. To determine the usage rates of CRDs prior to the effective date of the law;

2. To determine CRD usage rates for a two-year period (in six-month increments) after the effective date of the law and implementation of the PI&E program;

3. To analyze the CRD usage rates across time to determine if there is an increase in CRD usage and to make contrasts within time periods (e.g., compare basic state plan and comprehensive plan usage of CRDs);

4. To examine the usage rates of seat belts by drivers prior to and after the effective date of the law and implementation of the PI&E program and to analyze the two usage levels;

5. To determine the number of fatalities and injuries of children under four before and after the effective date of the law and the implementation of the PI&E program and to analyze the differences between the two time periods;

6. To evaluate the drivers' seat belt usage in relation to CRD usage;

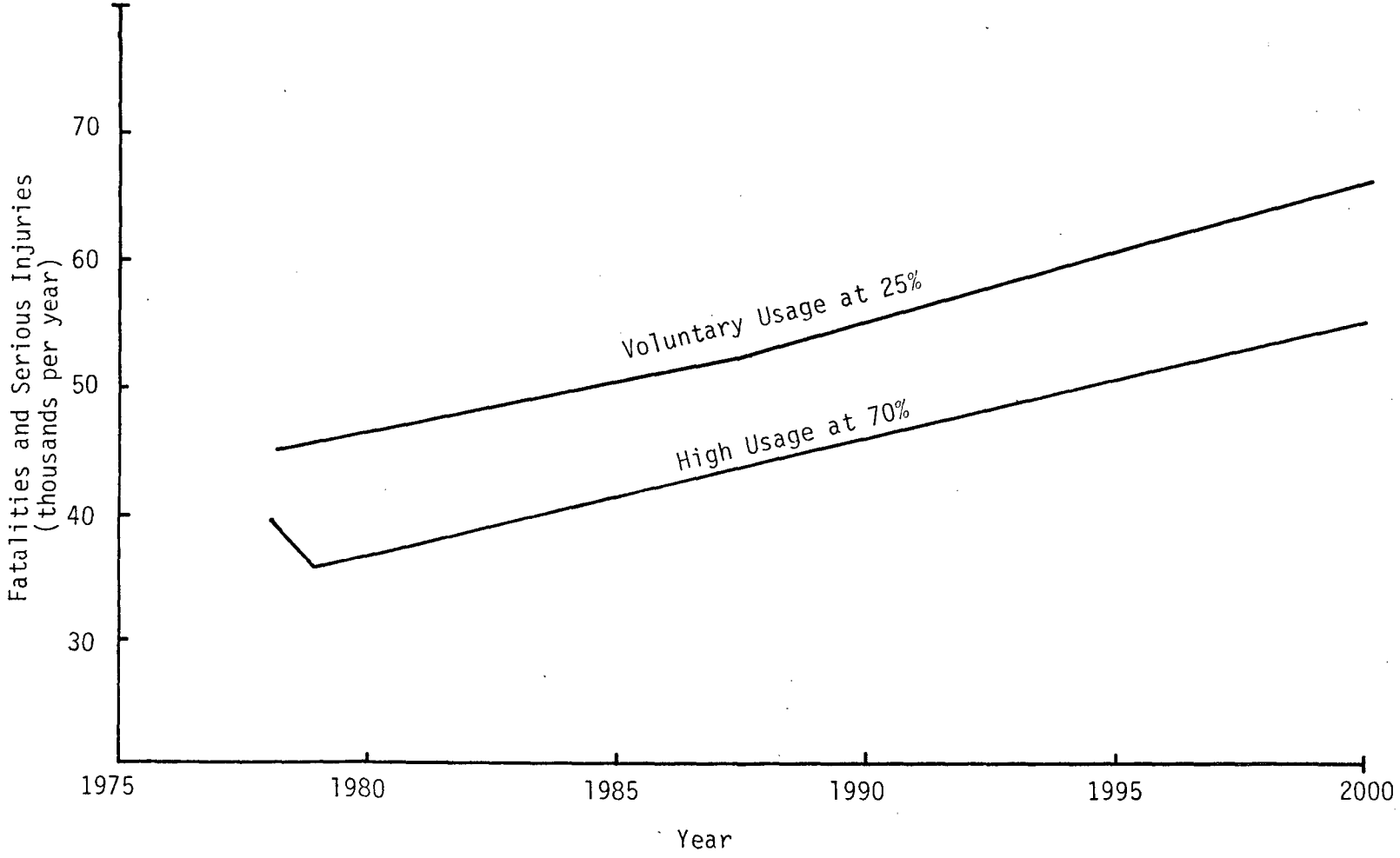
7. To determine the relationship between CRD usage and socio-economic variables such as family income and education, for both before the law and PI&E program were implemented and for a two-year period afterwards;

8. To develop recommendations relative to the future emphasis of PI&E programs based upon the analysis operation; and

9. To organize the results, conclusions and recommendations of the study to aid in an evaluation of the impact of similar passenger safety laws and PI&E programs which have been implemented and operated.

Basis for the Research

The implementation of an increased passenger restraint system usage program nationwide has the potential of a cumulative reduction of 230,000 fatalities and serious injuries by the year 2000 (Energy Resources Council, 1976). Predicted deaths and injuries for two rates of passenger restraint system usage may be illustrated (Figure I-1). High usage (70 percent), which is possible with an organized nationwide program, will likely result in a continuously lower rate of fatalities and serious injuries than the voluntary usage rate (25 percent). The 25 percent curve represents the expected restraint usage rate with no program implemented to promote usage. The implementation of a program which might produce a 70 percent usage rate over a long period of time may have a greater initial effect, as is shown for the first year of the curve. If no new occupant protection laws



Source: Energy Resources Council. The Report by the Federal Task Force on Motor Vehicle Goals Beyond 1980. Washington, D.C.: Author, September 1976.

FIGURE I-1

PREDICTED OCCUPANT DEATHS AND SERIOUS INJURIES

and/or programs are implemented by the year 2000, the increased number of vehicles, number of miles driven and number of licensed drivers over present levels will lead to a large increase in fatalities and serious injuries.

The greatest single threat to a child's life beyond the first month after birth is the motor vehicle accident (Shelness and Charles, 1975). Approximately 1,600 children in the birth to four year old age group lost their lives in motor vehicle accidents in 1976 (National Safety Council, 1977). Of the number, approximately 700 were occupants of motor vehicles (U.S. Department of Transportation, 1977). The National Safety Council (1977) reported a total of 70,000 injuries to this same age group as a result of motor vehicle accidents.

The Tennessee Department of Safety (1976) reported a total of 18 children fatalities and 1,229 injuries in the birth to four year old age group in Tennessee in 1976 resulting from motor vehicle accidents. There were probably several hundred more injuries to children which were not reported to the Department of Safety because they did not involve damage to other vehicles or property. These unreported injuries usually occur from unexpected stops, sudden turning movements and falling from vehicles.

The value of using both seat belts and CRDs is generally known, yet there continues to be low utilization rates of each. Currently there is considerable interest in laws to require the use of seat belts in the majority of the states. Since 1972, 44 states have introduced bills to make the use of seat belts mandatory (NHTSA, 1976a). Federal aid safety funds have been used in seven states to promote seat belt programs (NHTSA, 1977). No state in the United States has passed a seat belt usage law for all vehicle occupants or adult occupants, although the Commonwealth of Puerto Rico and several other countries have. The pre-law and post-law usage rates of passenger restraint systems for some selected countries where such laws have been in effect are shown in Table I-2. The country with the largest difference between the pre-law and post-law seat belt usage rates was Israel. In 1975, before Israel passed a seat belt law, the usage rate was 8 percent; the rate was 80 percent when checked in 1976. The countries shown in Table I-2 represent less than half of the number of foreign countries which have passed legislation. In 1970, the State of Victoria in Australia became the first large jurisdiction to pass legislation requiring vehicle passengers to wear seat belts. Most of the countries which have laws have experienced increases from an approximate 20 to 30 percent level to 70 to 90 percent.

Ziegler (1977) and Pulley (1975) reported that countries with compulsory regulations show substantial increase in usage rates immediately after the effective dates of the laws. In Ontario, Canada, and Victoria, Australia, the immediate increases in usage rates were followed by declines (Insurance Institute for Highway Safety, 1976; Andressend, 1972).

Tennessee passed the first active passenger restraint law in the United States requiring that children under four years of age be restrained while being transported in most motor vehicles (recreational vehicles and trucks rated at one ton or more are exempted). Appendix A contains a statement of the law. PI&E concerning seat belt use on a national basis seem to have

TABLE I-2

EFFECT OF SAFETY BELT USAGE LAWS AROUND THE WORLD

Country/ Territory	Effective Date of Law	Usage Rate Before Law Percent (Year)	Usage Rate After Law Percent (Year)
Australia	January 1, 1972	25(1971)	85(1975)
Canada (Ontario)	January 1, 1976	17(1975)	77(1976)
France	July 1, 1973	26(1973)	64(1974)
Israel	July 1, 1975	8(1975)	80(1976)
Japan	December 1, 1971	-	8(1975)
Netherlands	July 1, 1975	28(1974)*	72(1975)*
New Zealand	June 1, 1972	30(1972)	83(1975)
Norway	September 1, 1975	37(1973)*	61(1975)*
Puerto Rico	January 1, 1974	3(1973)	25(1976)
Sweden	January 1, 1975	36 (-)	79(1976)
Switzerland	January 1, 1976	50(1975)	95(1976)

*Represents rural data only.

Source: Office of Driver and Pedestrian Research, National Highway Traffic Safety Administration.

little effect on increasing seat belt usage rates to any significant degree. The combination of a law and a PI&E program has not been an option for research in the United States. This study reports the analysis of the impact of legislation and a PI&E program on child passenger safety in Tennessee.

Scope of the Study

This study involves the evaluation of the impact of Tennessee's child passenger protection law over a period of two and one-half years. An investigation was made of the status of passenger restraint system usage of small children and drivers before and after the effective date of the law and the implementation of the PI&E program.

The passenger restraint system usage data collection for this research was statewide for both urban and nonurban areas. The target areas included the five major Standard Metropolitan Statistical Areas of Memphis, Nashville, Knoxville, Chattanooga and Tri-Cities. The three nonurban areas were Morristown, Columbia and Dyersburg.

The Tennessee Department of Safety provided statistics on fatalities and injuries which were reported from investigated motor vehicle accidents. The Tennessee Office of Urban and Federal Affairs, Governor's Highway Safety Program, also provided fatal injury data. These data are those taken from the Tennessee Department of Safety and furnished to the Information Systems Division of the National Center for Statistics and Analysis, U.S. Department of Transportation. Comparisons of fatalities and nonfatal injuries before and after January 1, 1978, are made.

The characteristics of users and nonusers are examined using discriminant analysis and partial correlation analysis. A chi-square technique is used to compare seat belt usage of drivers and their decision to use or not to use CRDs. The results, conclusions and recommendations are organized to provide directions for short-term evaluations of similar safety programs.

II. REVIEW OF LITERATURE

This literature review on vehicle passenger restraint system usage includes four relevant areas: (1) history and development, (2) restraint regulations and laws, (3) PI&E and (4) costs and benefits of passenger restraint programs.

History and Development

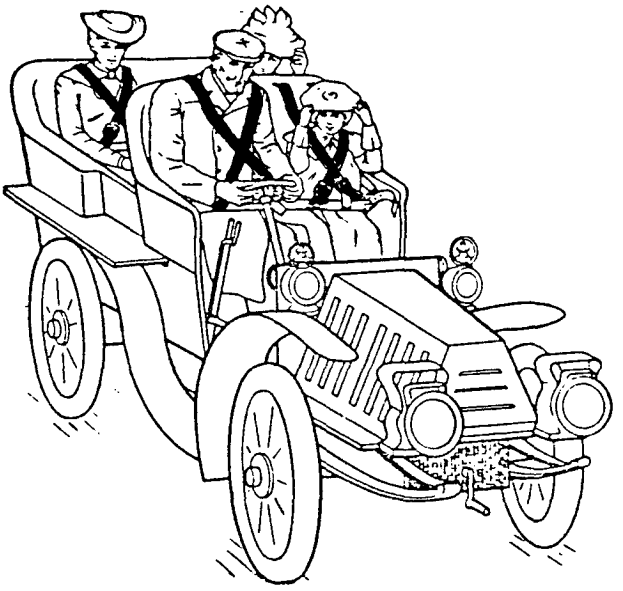
In 1903 a French inventor named Leveau designed and patented a full restraint system to protect seated occupants in automobiles (Roberts, 1970). The conceptual idea of the early full body restraint system has been graphically depicted (Figure II-1). From this initial farsighted concept of Leveau until the early 1940s, little was accomplished to advance the idea of restraining vehicle occupants to reduce injuries and fatalities.

Most of the use of passenger restraint systems was in automobile racing, beginning as early as 1908 when a mechanic was strapped in a racing vehicle during a long race to prevent his falling out while he napped (Snyder, 1969). During the 1920s Barney Oldfield successfully promoted a racing car equipped with a seat belt (States, 1972). Automobile racing continued to play an important role in advancing the potential use of passenger restraint systems, but little thought was given to restraining passengers other than the driver until the 1930s.

DeHaven, a pilot during World War I, contributed to the development of passenger restraint systems in the early 1940s by collecting and analyzing data on survivals from falls of 50 to 150 feet with restraints (States, 1972). According to States (1972), just after World War II John P. Stapp saw the potential safety benefits introduced by DeHaven and initiated a program of laboratory research utilizing acceleration sleds to test human tolerance to simulated vehicle crashes. Stapp, a personal friend of DeHaven, used DeHaven's work to develop the basis for the passenger protection systems used years later in America's manned space programs.

Some of the work oriented toward development of safety systems for aircraft had a bearing on automobile restraint systems. Roberts (1970) asserts that "many of the basic concepts which have been evolved from aircraft application are reasonable and proper for inclusion in current and projected automotive restraint systems." In World War II (1942-1945), military impact investigations were focused on the development of restraint protection (Snyder, 1970). Although this work was performed primarily to benefit pilots, the automotive manufacturing industry took an increased interest in the potential protection offered automobile passengers by these advances.

After World War II the number of traffic accidents increased dramatically, thus increasing the demand for vehicle passenger safety. In 1949, the Nash Motor Company introduced the first restraint system as a production item in American-made automobiles. The system was offered to restrain a sleeping passenger with the seat in a reclining position (States, 1972). Both Ford and Chrysler offered seat belts as optional equipment in 1956 (Roberts, 1970). In 1964, two lap belts in the front seat were standard equipment for occupant use. In 1966, four lap belts per unit were installed. In 1968, the



Source: Roberts, V. L. "Motor Vehicle Restraints," in 1970 International Automobile Safety Conference Compendium. New York: Society of Automotive Engineers, 1970.

FIGURE II-1

FULL BODY RESTRAINT CONCEPT, PATENTED IN 1903

current type of passenger restraint systems became available--six lap belts and two shoulder harnesses, with anchorages for additional shoulder harnesses in the rear position (Roberts, 1970).

Child Restraint Device Development. The majority of the history described thus far has been concerned with the evolution of the seat belt. At the same time, CRDs were being developed. The Bunny Bear Company in 1933 began producing a child's car seat which did very little restraining; they were designed for convenience more than safety. "Safety" was indeed a factor, but not crash safety (Robbins, Henke and Roberts, 1970). The car seat was used in an elevated position in the vehicle providing a better vantage point for the child and resulting in less distractions for the driver.

It was not until the mid 1960s that automobile manufacturers began to offer a safety seat for children. In 1965 the Ford Motor Company introduced the "Astro-Guard," but it was taken off the market for lack of sufficient demand (Shelness and Charles, 1975). Ford tried again in 1967 to introduce an innovative CRD called the "Tot-Guard" (Heap and Grenier, 1968). General Motors also introduced a seat in 1967, but this device proved inadequate and gave way to the "GM Love Seat" in 1970 (Makinen, Feles and Garvey, 1973). These developments point out the attempts by the automotive industry to develop CRDs. There are presently approximately 18 manufacturers of CRDs, most of which began producing CRDs on a competitive basis during the 1960s.

Safety harnesses for children were pioneered by Rose in the early 1960s (Rose, 1965). He reported that the design took into consideration not only physics and engineering, but also child physiology, parent and child psychology and the basic philosophy of safety. The strategy of Rose's design was to allow freedom of movement while simultaneously protecting the child from the harsh interior surfaces of the passenger vehicle.

Effectiveness of Seat Belts. As the seat belts and CRDs were being further developed, there was a considerable amount of research to determine the value of passenger restraint systems in passenger vehicles and the rates of usage of such devices. Babione (1956) made an analysis of all U.S. Navy and Marine personnel killed in car accidents between 1952 and 1954. He concluded that a large majority of the deaths would have been prevented by the use of seat belts.

A myth that passenger restraint systems were dangerous was a drawback to the progress of promoting vehicle passenger safety. Proponents of the myth claimed that there was great danger of being trapped inside the vehicle in case the vehicle burned or was submerged in water. Pioneer work of Tourin and Garrett along with other researchers in 1958 and 1959 provided conclusive statistical data to disprove this claim (Tourin, 1958; Tourin and Garrett, 1960).

Garrett's research in 1960 indicated that seat belt users sustained approximately 35 percent fewer serious injuries than non-seat belt users. Of 28,000 accidents studied in 1967, none involved fatalities when the occupants were restrained and the vehicle speed was below 60 mph (Bohlin, 1967).

Kihlberg (1969) concluded that seat belts reduced the risk of injury in a crash by 29 percent, serious injury by 41 percent and severe injury or death by 50 percent. Levine and Campbell (1971) confirmed Kihlberg's findings, showing a 43 percent reduction in severe injuries and deaths when seat belts were used.

A 1974 study in Pennsylvania was the basis for the estimate of a 73 percent lower fatality rate, a 53 percent lower serious injury rate and a 38 percent overall injury rate for all lap belt users (National Highway Traffic Safety Administration, 1976b). Research by Reinfurst, Silva and Seila (1975) reveals that the chances of injury to the front seat "outboard" position occupant is reduced by 31 percent for seat belt users.

Ineffectiveness of Seat Belts for Small Children. The use of seat belts by themselves for small children have been proven to be ineffective for adequately protecting children in the event of a crash. In 1971, Australia passed legislation requiring seat belts for all vehicle occupants. A study of fatalities and injuries showed a 20 percent reduction in most injury categories, but there was no significant reduction in fatalities and injuries to small children (Boughton, Lancashire and Johnston, 1977). Burdi, Huelke, Snyder and Lowry (1970) document the need for small children to have special devices to be used in conjunction with the seat belt. Because the body of the small child has not developed to the point of allowing a lap belt to be positioned correctly, the belt itself could possibly cause serious internal damage by riding up on the abdomen. Snyder (1969) concluded that the forces of a vehicle crash should be distributed over as much of the body area as possible. The rear-facing reclining infant carrier is designed to cause the forces of the crash to be taken by the infant's shoulders and back of head against the back of the strapped-in CRD in the event of a frontal collision. This design satisfies Snyder's recommendations.

Aldman (1966) recommended the rear-facing infant device which had proven to be effective in Sweden. Siegel, Nahum and Appleby in 1968 studied various types of designs of CRDs. They correlated the types and frequency of injuries to children under four in vehicle crashes to the design and provided convincing arguments for the effectiveness of CRDs in reducing the severity of injuries.

Rose (1965), Aldman (1966) and Appoldt (1966) studied special needs of children for CRDs focusing on anatomical and psychological differences between adults and children. They concluded that all CRDs designed for small children should be tested dynamically to determine if they served the purpose intended.

The anatomical differences between small children and adults and older children have been studied by physicians and engineers with regard to the development of an effective CRD for infants and young children. Snyder and O'Neill (1975) point out that because of these anatomical differences, the upper diagonal torso seat belt is not safe for small children. Williams and Zador (1976) report that the use of passenger restraint systems designed for adults and older children is safer than no restraint for smaller children.

Effectiveness of Child Restraint Devices. Additional research and writing in the 1960s and 1970s were directed toward effectiveness and public acceptance of CRDs. In March 1960, Moore and Lillienfield pointed out the need for protecting children in automobiles, suggesting that children be restrained in the rear seat of automobiles while being transported. Dye, before the Conference on Passenger Car Design and Highway Safety in 1962, advocated that children be secured to prevent ejection or contact with the interior surfaces of the automobile in the event of a collision.

Several studies have indicated the effectiveness of CRDs for young children when the devices are used properly. A study in the State of Washington indicated that, if all 30,602 children in the birth to five age group who were observed had been restrained by CRDs at the time of a motor vehicle accident, a reduction of 90 percent in fatalities and 67 percent in disabling injuries could be expected (Scherz, 1976).

Williams and Zador, in a 1976 study involving almost 27,000 passengers under age 15, found that using the back seat instead of the front seat location reduces the injury rate by 18 percent among restrained children. Further use of passenger restraint systems reduced the injury rate by 39 percent in the front seat and 31 percent in the back. Despite these very favorable injury reduction results, they also reported that over 90 percent of the children studied were unprotected by any type of restraint system.

Restraint Regulations and Laws

Consideration for regulations and laws regarding the availability of passenger restraint systems in vehicles and the specifications for restraint devices go back to 1957 when the pros and cons of seat belts were discussed and testimonies were heard before a congressional subcommittee on the crashworthiness of automobiles. The Roberts Act (Public Law 88-515) was passed to establish passenger vehicle safety standards for federal vehicles. Seventeen standards were issued and met by the federal government; the demonstrated effectiveness of the law stimulated the automotive industry to accept with a greater degree the responsibility of automobile safety (Commerce Clearing House, Inc., 1966).

The federal government took no immediate action to establish any mandatory requirements for installation of seat belts in new automobiles for the general public. The State of New York took the lead in 1961 in vehicle occupant safety legislation in this country by enacting a law requiring the installation of seat belt anchorages in all new automobiles sold in that state (States, 1972). It was from this meager beginning that seat belt measures spread to include the majority of the states. Public acceptance of the legislation requiring provisions for seat belt usage is thought to have convinced the automotive industry to begin making seat belts standard equipment (States, 1972).

Standards. In 1963, Public Law 88-201 was signed by the President of the United States requiring that standards for seat belts for use in motor vehicles be prescribed and published (Neff, 1965). The establishment of minimum standards for seat belts was assigned to the National Bureau of Standards (Neff, 1965). The Bureau depended upon the Society of Automotive Engineers which had begun research on seat belts in 1954 when the

Bureau of Motor Vehicles' Seat Belt Committee was created. In 1964, the government required that all new cars have two seat belts for the two outboard seating positions in the front seat installed as standard equipment. The National Traffic and Motor Vehicle Safety Act of 1966 mandated that seat and shoulder belts be made available for the two outboard positions in the front seat in almost all automobiles manufactured for sale in the United States, effective January 1, 1968. In addition, the mandate called for seat belts for all other seating positions (Robertson, 1975). Unfortunately, CRD standards were not included as part of the 1966 Safety Act; standards for "Child Seating Systems" were developed later and became effective April 1, 1971.

Standard No. 213, issued in 1971, covered only the car seat type CRD while omitting the infant carrier type. It was revised in 1973 but was not expanded to include all forms of child restraints. This standard, as originally written, required a "static" test which consisted of a static load being applied to the CRD with a wooden torso block inside. This test procedure, which checked the stability of the seat, essentially eliminated the "hook-over" baby seats which were on the market prior to the issuance of the standard. The new standard was studied by Dr. Verne Roberts, and in October 1971, six months following the effective date of the standard, he exposed the inadequacies of the test (Shelness and Charles, 1975). The Consumers Union crash tested 17 CRDs in August of 1972 and found only five acceptable for protection as defined by the Consumers Union ("Crash Tests," 1972). All 17 had previously passed the static test as set out in Standard 213.

In response to the need for improvements in the federal child safety standard, the NHTSA published a proposal (Motor Vehicle Standard No. 213, Docket No. 74-9, Notice 4) in March 1974 to expand the scope to cover all forms of CRDs, to require dynamic tests in lieu of static tests and to require that anthropomorphic test dummies be used in the simulated crash testing. Progress of this proposal was delayed until the details of the test dummy specifications and calibrations could be made. In 1978 the NHTSA issued a modified proposal for a revised CRD standard and sought public comment until December 1978. These deliberations have already taken over four years, and it is projected that the standard will not be effective until May 1980.

Motor Vehicle Standard No. 208, passed in 1971, effective from January 1, 1972 to August 14, 1973, required manufacturers to equip new cars with either passive passenger restraint systems to protect occupants from serious injury in frontal crashes of vehicles with speeds up to and including 30 miles per hour or a buzzer-light system to warn occupants that the front outboard seat belts were unfastened. The overwhelming majority of vehicles manufactured between January 1972 and August 1973 had the buzzer-light system instead of passive passenger restraint systems (Robertson, 1975). Effective August 15, 1973, Federal Standard No. 208 was amended to require an interlocking system which connected the passenger restraint and seat weight sensors to the ignition system. This mechanism prevented the engine from being started after the particular seating positions had a certain amount of weight unless the belts were pulled from their reels (Robertson, 1975).

Legislation. The first state bills proposing mandatory seat belt use were introduced in 1972 when 12 states tried and failed to pass such measures

(Pulley, 1975). The Highway Safety Act of 1973 provided for incentive payments to those states which enacted mandatory seat belt legislation. Interest and enthusiasm increased in 1973 because of the authorized incentive; 26 legislatures proposed bills for mandatory seat belt use. In no state did a bill actually become law, thus no state received an incentive payment. The Commonwealth of Puerto Rico, however, received almost $300,000 for enacting a law which became effective January 1, 1974 (Pulley, 1975).

The only municipality in the United States which has a seat belt use law is Brooklyn, Ohio, a suburb of Cleveland. The ordinance was made effective in March 1966, and the mayor, serving over 25 years in that capacity, states that the law is doing what it was designed to do (Pulley, 1975).

Charles Pulley, president of the American Seat Belt Council, was part of a team which surveyed seven European countries to determine the effectiveness of mandatory seat belt use legislation. Pulley (1975) concluded that seat belt usage laws are effective in the following instances: (1) when a public education program also is implemented, (2) when a civil fine or penalty is imposed and (3) when there is strict enforcement. He found that in Europe, where the importance of seat belts had been carefully put before the public and the laws were enforced, the usage is between 78 to 95 percent.

The leadership for legislation concerning use of restraints in automobiles has come from the states and not from the federal government. As was mentioned earlier, New York led the way with the original seat belt law. Tennessee's law (effective January 1, 1978) for the protection of small children in motor vehicles was a positive move toward increased usage of safety restraints. The law, coupled with appropriate education and information exposure, has been effective in increasing usage rates.

Public Information and Education

Attempts to inform and educate the public concerning passenger protection in motor vehicles have been made by several organizations. By and large, these attempts have been insignificant in increasing the rates of passenger restraint system usage. The medical profession has made efforts to contribute to child passenger safety by informing parents of the need to protect their children in motor vehicles. The federal government and several other organizations have distributed printed information in an effort to inform the public of the need for vehicle passenger protection.

Medical Profession Public Information and Education. The medical profession has been trying for a number of years to convince the American public that traveling unrestrained in a motor vehicle is dangerous. The philosophy used by physicians primarily is that early learned habits and practices are the most difficult to modify. Therefore, several programs have been launched to orient parents and children to the use of CRDs for children. Through the efforts of the Physicians for Automotive Safety, a number of hospitals throughout the United States have programs which give instruction and encouragement to parents of new babies concerning restraining their children while traveling (Shelness and Charles, 1975). Reisinger and Williams (1978) report that similar programs have been undertaken and are continuing at pediatrician offices and well-child clinics. They contend that although CRD use is increased because of these types of programs, there is room for

doubt on some of the percentages reported. They believe the results may be biased because the program participants are volunteers who would be favorably predisposed and thus likely users of CRDs. Their study included three in-hospital educational programs for postpartum women. They concluded that different levels of education and the cost of CRDs influence the mother concerning the decision to provide a CRD for protecting her child. The information and education techniques increased the number of decisions to use a CRD.

The states of Washington and Wisconsin have programs where emphasis is placed on educating the mother on the importance of safely transporting the child home from the hospital and to use that initial first step for continued protection (Shelness and Charles, 1975). Kanthor (1976), in a study involving mothers, found that 69 percent of the counseled and 42 percent of the uncounseled women were using CRDs at the six-weeks visit back to the physician.

Pediatricians have played an important role in instructing parents of the value of the prevention of dangerous diseases. The result has been a phenomenal drop in deaths from communicable diseases to children; some diseases such as poliomyelitis are almost nonexistent in the United States because of the pediatricians' disease treatment program. There are studies which show that physicians in general, and pediatricians in particular, and their staffs can influence parents to obtain and use CRDs (Bass and Wilson, 1964; Scherz, 1974). A survey of 192 pediatricians of the Southern California Academy shows that over 70 percent teach parents initially about CRDs for their children, but less than 3 percent use followup instruction and education on every visit (Lieberman, Emmett and Coutson, 1976). There was a 20 percent increase, from 38 percent in 1963 to 58 percent in 1970, in the number of Academy Pediatricians who advised parents of the value of using passenger restraints (Pless, Roghmann and Algranati, 1972).

The medical profession has generated a sizable amount of literature promoting and supporting the use of CRDs. Burg, Douglas, Diamond and Siegel (1970) advocated strong support of CRDs from the pediatric physicians and the medical profession in general. Their work led to a better understanding by the pediatricians of the need for child passenger safety.

Printed Information. The NHTSA has developed and distributed numerous pamphlets and booklets. The NHTSA (1976a) has also designed educational and informational programs to give the public a better understanding of the vehicle occupant safety problem and how solving the problem will benefit the community. Accident facts and seat belt usage rates are used in these programs to estimate the savings of lives and serious injuries for a particular community.

In 1967, a public service publication titled "Selecting Automobile Safety Restraints for Small Children" was made available for national distribution by the U.S. Department of Health, Education and Welfare. This publication was intended to aid in educating parents on the types and availability of CRDs. In 1977, the department's Office of Human Development Services published a booklet concerning children and auto safety titled "Auto Safety and Your Child." This publication addresses the problem, cause and solution of protection for child occupants under four years of age in motor vehicles.

A booklet titled, "What to Buy in Child Restraint Systems," was distributed by the NHTSA. In 1972, this same agency published "Automobile Safety Belt Fact Book" which deals with both adult and children restraint systems. Other informational materials provided by the NHTSA include: "How Many of These Fairy Tales Have You Heard?," Safety Belt: Activity Book, Encouraging Employees to Use Safety Belts, "Teaching the Safety Belt Message," "The Safety Belt Message," "Getting the Safety Belt Message Across" and a safety belt game. These materials are sent to driver education teachers, safety directors and persons who may request them to encourage students, employees, license applicants and others to use seat belts (NHTSA, 1977).

An organization called Action for Child Transportation Safety has distributed a brochure titled "This is the Way the Baby Rides," which deals only with the protection of babies. Action for Child Transportation Safety also offers films, slide programs, posters, brochures, booklets, bumper stickers and other materials which aid in spreading the message of transportation safety for small children.

Numerous national magazines have carried articles about child safety in motor vehicles which have reached millions of readers. The Consumers Union in March 1975 and again in June 1977 reported on infant carriers and CRDs ("Infant Carriers," 1975; "Car Safety," 1977).

There are several other publications which give some attention to child passenger protection, such as Parents' Encyclopedia (Levine and Seligmann, 1973), but few emphasize the urgency of the problem of child protection in motor vehicles. Many parents depend on books such as Dr. Benjamin Spock's classic Baby and Child Care (1974) to guide them in parenting their children. Spock's book is an example of parenting books in which protection for children in passenger vehicles often is given too little attention or left out completely. Lonero, Wilson and Ish (1973) believe that parents whose children are given formal instruction on seat belt use will use seat belts more often than those whose children receive no instruction. Others have reported that children are more likely to be observed using CRDs if their parents are using seat belts. This relation is a function of the parents' educational levels and their sense of efficacy (Neumann, Neumann, Cockrell and Banani, 1974).

Effects of Public Information and Education Programs. Allen and Bergman (1976) found that 60 percent of those parents who received literature, viewed a film and witnessed a demonstration of CRD use decided to obtain a CRD for their use, while 54 percent decided to obtain CRDs after receiving only the literature. A surprising 71 percent purchased or obtained CRDs after a combination of only the literature and the film. A Swedish study showed that parents' acceptance of rear-facing CRDs goes up with actual experience in using them (Arnberg, 1974). Christopherson's research (1977) on children's behavior relative to CRD use indicates that behavior improves with continued use if the child was properly taught about the CRD initially.

Pless, Roghmann and Algranati (1972) expressed the belief that public education of child automotive safety via the mass media has had limited success. Robertson, Kelley, O'Neill, Wixom, Eiswirth and Haddon (1974) found

that television messages urging seat belt use had no effect on use. They believe that a behavior modification approach is often ineffective in attempting to convince the public to use automotive safety devices.

In a telephone survey to determine sources of information received about accident prevention, 50 percent of those called said the news media was their primary source (Pless et al., 1972). Scherz (1978) states that there is insufficient data to determine the differences that may be attributed to types of PI&E programs in the countries where they are being used, but he reports that there is a 10 to 20 percent increase in usage overall.

PI&E treatments used in combination with a usage law have been tried in most countries which have compulsory use laws (Ziegler, 1977). It is likely that PI&E programs have been implemented in some cases after the law has been effective for a period of time. One reason for this likelihood is the initial peak/later decline pattern which seems to be present in the usage rate after a law is implemented. PI&E programs may help counteract the potential decline by keeping the message before the public.

In Toronto, a campaign using radio, television, newspapers, posters and speeches was launched in 1969 to increase seat belt usage. The result was no significant change in use from before the campaign (Ontario Department of Transport, 1970). Fleischer (1972) reported on a study done in 1971 with three demographically similar communities which received three different levels of television and radio exposure concerning seat belt use. Observed seat belt usage was slightly higher where exposure intensity was highest and where there was no exposure, but there was no increase in the moderate exposure level area.

There are several characteristics of users and nonusers of passenger restraint systems which can be identified and which should be considered when designing PI&E programs. Robertson, O'Neill and Wixom (1972) point out that slogans such as "buckle up for safety," "lock it to me" and "what's your excuse" are ineffective and result from inadequate knowledge of the factors which cause the lack of use. They also found that the higher the person's education, the greater the likelihood that the person wears seat belts.

Costs and Benefits of Occupant Restraint Programs

The cost estimates for improving highway safety are great. The U.S. Department of Transportation estimated in April 1976 that, based on constant 1974 dollars for a 10-year period, an annual expenditure of $6.8 billion would be required to implement the countermeasures seen as needed. This cost coupled with countermeasure implementation costs greatly exceeds budgeted funds for highway safety (U.S. Department of Transportation, 1976). The cost of implementing passenger restraint system countermeasures is only a small portion of the overall budget.

Among some 37 traffic accident countermeasures identified, the rankings of the top seven are given with regard to potential to forestall fatalities and injuries (Table II-1), increasing cost of implementation (Table II-2) and diminishing cost-effectiveness (Table II-3). It can be clearly seen from these three tables that mandatory seat belt use and nationwide 55 mph speed limit are the most cost-effective countermeasures.

TABLE II-1

RANKING OF COUNTERMEASURES BY DECREASING POTENTIAL TO FORESTALL FATALITIES AND INJURY ACCIDENTS--10-YEAR TOTAL (1976-1986)

	Countermeasure	Fatalities Forestalled	Injury Accidents Forestalled
1.	Mandatory Safety Belt Usage	89,000	3,220,000
2.	Nationwide 55 mph Speed Limit	31,900	415,000
3.	Combined Alcohol Safety Action Countermeasures	13,000	153,000
4.	Combined Emergency Medical Countermeasures	8,000	146,000
5.	Selective Traffic Enforcement	7,560	296,000
6.	Impact Absorbing Roadside Safety Devices	6,780	158,000
7.	Tire and Braking System Safety Critical Inspection--Selective	4,590	180,000

Source: U.S. Department of Transportation. The National Highway Safety Needs Report. Washington, D.C.: Government Printing Office, 1976.

TABLE II-2

RANKING OF COUNTERMEASURES BY INCREASING COST OF IMPLEMENTATION-- 10-YEAR TOTAL (1976-1986)

	Countermeasure	Cost ($ Millions)*
1.	Motorcycle Lights-On Practice	5.2
2.	Highway Construction and Maintenance Practices	9.2
3.	Upgrade Bicycle and Pedestrian Safety Curriculum Offerings	13.2
4.	Pedestrian Safety Information and Education	18.0
5.	Driver Improvement Schools for Young Offenders	36.0
6.	Wrong-Way Entry Avoidance Techniques	38.5
7.	Mandatory Safety Belt Usage	45.0

*Based on constant 1974 dollars and converted to 1976 value; equivalent by using a 10 percent discount rate.

Source: U.S. Department of Transportation. The National Highway Safety Needs Report. Washington, D.C.: Government Printing Office, 1976.

TABLE II-3

RANKING OF COUNTERMEASURES BY DECREASING COST EFFECTIVENESS IN PRESENT VALUE DOLLARS PER TOTAL FATALITIES FORESTALLED--10-YEAR TOTAL (1976-1986)

	Countermeasure	Fatalities Forestalled	Cost ($ Millions)*	Dollars Per Fatality Forestalled
1.	Mandatory Safety Belt Usage	89,000	45.0	506
2.	Highway Construction and Maintenance Practices	459	9.2	20,000
3.	Upgrade Bicycle and Pedestrian Safety Curriculum Offerings	649	13.2	20,400
4.	Nationwide 55 mph Speed Limit	31,900	676.0	21,200
5.	Driver Improvement Schools	2,470	53.0	21,400
6.	Regulatory and Warning Signs	3,670	125.0	34,000
7.	Guardrail	3,160	108.0	34,100

*Based on constant 1974 dollars and converted to present (1976) value. Equivalent by using a 10 percent discount rate.

Source: U.S. Department of Transportation. The National Highway Safety Needs Report. Washington, D.C.: Government Printing Office, 1976.

Mandatory seat belt use has the potential to save an estimated 89,000 lives over a 10-year period of time from 1976 to 1986 at a cost of approximately $45 million based on 1974 dollars. The costs presented in Tables II-2 and II-3 were extrapolated to the national level from cost information from 20 states and 593 local jurisdictions. It must be pointed out that the analysis performed in the needs study took into consideration only those costs and benefits associated with highway safety. The costs include public funds for capital costs, start-up costs, supporting costs and recurring costs. The benefits are only those received from forestalled fatalities and injuries (U.S. Department of Transportation, 1976).

Societal costs and benefits may be considered as those which are external to those directly related to highway safety. Societal costs may be identified as resources used in the repair of damage to people or property and costs to society due to losses in production (NHTSA, 1975). Medical care, vehicle repair, insurance administration, accident investigation and court and legal fees are a few examples of costs which may be incurred as a result of motor vehicle accidents. Production losses are related to the inability of a victim to produce in society. The victim may be directly involved in an accident and delayed indefinitely or indirectly involved and delayed temporarily because of an accident.

The National Safety Council (1977) reported that in 1976 accidents cost society about $52.8 billion. Of that total, motor vehicle accidents accounted for $24.7 billion dollars, which include $8.9 billion in property damage, $7.6 billion in wage loss, $6.1 billion in insurance administration and $2.1 billion in medical expenses. The Highway Users Federation reported in 1975 that each fatality costs society about $240,000 and each injury about $7,000 (Sanders, 1976).

The American Safety Belt Council published some estimates of societal cost savings in 1975 based on information compiled by NHTSA in June 1975. The estimates are conservative because the 55 mph speed limit was not considered. It is estimated that savings were probably 25 percent higher because of the lowered speed limit. These anticipated estimates of savings for the United States, Tennessee and the states which border on Tennessee are shown (Table II-4).

Summary

The literature on the early history and development of passenger restraint systems is sparse. The basic concepts of passenger protection for pilots of aircrafts were applied to motor vehicle occupant protection, and by the late 1940s interest had increased and more information became available.

CRD development for infants and small children began much later than seat belt development for adults and larger children. Although the concept of providing a seat for small children was developed earlier, it was not until the mid 1960s that anything of significance was accomplished in providing CRDs. The interest in and demand for CRDs has grown to the point that 18 major manufacturers are now producing CRDs.

The effectiveness of seat belts for adults and the ineffectiveness of seat belts for small children are documented. Seat belts are very effective for

TABLE II-4

ANTICIPATED EFFECTS OF MANDATORY SAFETY BELT LAWS
FOR 1974

State	Use Rate Percent	Fatality Reduction	Injury Reduction	Equivalent Dollars
United States	80	13,530	1,260,000	12.6 Billion
	70	11,197	1,040,000	10.0 Billion
	60	8,864	825,000	7.9 Billion
Tennessee	80	395	36,800	352 Million
	70	327	30,400	291 Million
	60	259	24,100	231 Million
Alabama	80	316	29,400	281 Million
	70	261	24,300	233 Million
	60	207	19,200	184 Million
Arkansas	80	168	15,600	140 Million
	70	139	12,900	124 Million
	60	110	10,200	98 Million
Georgia	80	495	46,100	442 Million
	70	410	38,100	365 Million
	60	324	30,200	289 Million
Kentucky	80	248	23,100	221 Million
	70	205	19,100	183 Million
	60	102	15,100	145 Million
Mississippi	80	209	19,400	186 Million
	70	173	16,100	154 Million
	60	137	12,700	122 Million
Missouri	80	328	30,600	293 Million
	70	272	25,300	242 Million
	60	215	20,000	192 Million
North Carolina	80	487	45,300	434 Million
	70	403	37,500	359 Million
	60	319	29,700	284 Million
Virginia	80	312	29,000	278 Million
	70	258	24,000	230 Million
	60	204	19,000	182 Million

Source: American Seat Belt Council.

adults and larger children, but are not designed for infants and toddlers under four years of age. Special devices are needed for children too small to be protected adequately by seat belts. These special devices, called CRDs, should be tested dynamically to determine if they will serve the purpose for which they were designed.

It may be concluded from the literature that the impetus for passenger restraint system installation and usage has come from the states; likewise, the lead in restraint regulations and laws has come from the states. The federal government began work in 1963 to establish standards for seat belts. A standard to cover all forms of CRDs has been in the proposal stage for more than four years and now has a projected effective date of May 1980.

PI&E attempts alone have been relatively insignificant in increasing passenger restraint system usage rates. Other countries have experienced substantial increases when the combination of an enforced law and PI&E programs were implemented. The current study is unique in that for the first time in this country a PI&E program could be implemented with a state child restraint law.

Information on costs and benefits of restraint programs are gathered primarily from federal government publications. The advantage of implementing the mandatory seat belt usage countermeasure is apparent. The cost of implementing the most effective countermeasure has been estimated at $6.8 billion per year, but on the other hand, in 1976 motor vehicle accidents accounted for approximately $24.7 billion in damages and losses.

III. RESEARCH DESIGN

The State of Tennessee, by passing an active child restraint law, provided a unique research situation in the United States. Until Tennessee passed the restraint law in 1977 requiring that children under four be protected in most moving vehicles, no state had any type of passenger restraint law for any age group.

The Tennessee Child Passenger Safety Program was established in September 1977 to promote the use of CRDs in Tennessee. A project titled "Evaluation of the Impact of the Tennessee Child Passenger Protection Act" was begun about the same time to investigate the impact of the law coupled with a public information and education (PI&E) program. This study was designed to investigate the effect of the Child Passenger Safety Program on the reduction of fatalities and injuries to children under four years of age in Tennessee over a two and one-half year period after the law and PI&E programs were implemented. Study areas were selected, and procedures were developed to collect data on CRD usage. The data collection instruments were designed to record information from both observations of CRD usage and interviews with parents. The information collected included characteristics of children under four years of age and their parents.

Study Areas

The study areas chosen for this research are representative of both the urban and the nonurban areas in Tennessee. A randomized sample from the entire state would have been the most desirable for the evaluation, but time and budget constraints did not permit such a design. A convenience sampling was taken in lieu of a random sample. Convenience samples are judgment samples which are used commonly when random sampling is too costly and/or time consuming. The five major metropolitan areas of the state were selected for the urban sampling. Three nonurban areas, one in each of the geographical divisions of the state, were chosen to represent the "more rural" population. The term "more rural" is used because the three areas where the sampling occurred may not be considered rural by most standards; however, the population which surrounds each town for an approximate 30-mile radius is largely rural. Each of the nonurban areas chosen, however, has towns within the 30 mile radius which are over 5,000 persons in population. The East Tennessee area has three towns within 30 miles which have over 5,000 residents; the Middle Tennessee area has two; and the West Tennessee site has one.

Specific target areas, both urban and nonurban, may attract shopping trips from other areas. For example, residents in the Columbia area, a nonurban target area, may occasionally travel to Nashville for shopping purposes; the same is true for Morristown. It is less likely that residents in the Dyersburg target area would travel to Memphis for shopping purposes.

The goal of this study was to evaluate the impact of the child passenger protection law and the PI&E program in Tennessee. Since implications

are made about CRD usage for the state based on urban and nonurban data, it was important to research some of the characteristics and statistics about Tennessee.

Tennessee's geography may be described as varied, from peaks of over 6,000 feet (1,830 meters) in the rugged area of the Great Smoky Mountains National Park in the east to flat Mississippi alluvial plains in the west. The breadth of the state is 432 miles (695 kilometers), while its span from north to south is only 112 miles (180 kilometers). The state divides naturally into three geographical divisions--the mountains and valleys of East Tennessee, the basins and rolling hills of Middle Tennessee and the flat lowlands of West Tennessee.

In 1970 the population was 3,923,687, which represented about 1.9 percent of the population of the nation (Center for Business and Economic Research, 1977). Approximately 59 percent of the people resided in non-rural settings. Nonrural is defined as places of 2,500 or more inhabitants. The most recent estimate (1977) of the population of Tennessee is 4,299,000. Urban populations in Tennessee are shown in Table III-1. The populations of selected nonurban areas are shown in Table III-2.

There are several facts which are basic to this study of child passenger safety. An understanding of how many vehicles, miles of highways and number of children under four years of age is important in studying the reduction of fatalities and injuries to small children involved in motor vehicle accidents. In 1975 Tennessee had 81,272 miles of highways and streets, 12,308 miles of which were classified as urban (Center for Business and Economic Research, 1977). There were 2,725,569 registered motor vehicles in 1975, including over two million automobiles. A total of 2,434,206 perons had valid driver's licenses in Tennessee in 1975 (Federal Highway Administration, 1977). There were 32,926 million vehicle miles driven in Tennessee in 1975. This total increased to over 36,000 million vehicle miles in 1977. The estimation for 1978 by the Tennessee Department of Transportation was 37,500 million vehicle miles.

The 1970 figure for the number of children under four years of age was 256,650. Approximately 149,000 of this total lived in urban areas (Bureau of the Census, 1971). The total number of births per year in Tennessee decreased from 1970 to 1975 from 72,273 to 62,265. The estimate of the total number of children under four years of age as of January 1, 1978, was 251,132 (Table III-3). This number represents approximately 5.8 percent of the estimated population in Tennessee for 1977 of 4,299,000.

Data were collected for six study areas involving 10 cities. The major urban areas of Memphis, Nashville, Knoxville and Chattanooga were chosen as study areas along with the Tri-Cities area of Johnson City, Kingsport and Bristol. The nonurban study area group was made up of Dyersburg, Columbia and Morristown. An average of five sites were chosen within each urban area to collect data. The nonurban areas had one or two sites each. Shopping areas, regional and local, were selected as the sites to collect a large percentage of the data because of the large volume of traffic made up of parents who shop with small children. The selected sites represent a variety of types of shopping areas which attract a broad range of shoppers

TABLE III-1

POPULATION, SELECTED TENNESSEE URBAN AREAS

Area	Population 1970	Estimated Population 1975
Memphis	623,530	661,319
Memphis (SMSA)	834,006	873,300
Memphis SMSA (TN)[a]	750,015	767,000
Nashville (Metro)[b]	448,003	451,200
Nashville (SMSA)	669,144	753,100
Knoxville	174,586	183,383
Knoxville (SMSA)	409,409	436,100
Chattanooga	119,082	165,282
Chattanooga (SMSA)	370,016	393,000
Chattanooga SMSA (TN)[a]	260,567	294,000
Tri-Cities	85,772	99,365
Tri-Cities (SMSA)	312,876	339,000
Tri-Cities SMSA (TN)[a]	292,808	313,000

[a]Includes only population inside Tennessee.

[b]Includes all of Davidson County.

Source: Center for Business and Economic Research. Tennessee Statistical Abstract 1977. Knoxville: The University of Tennessee, 1977.

TABLE III-2

POPULATION, SELECTED TENNESSEE NONURBAN AREAS

Area	Population 1970		Estimated Population 1975	
Dyersburg	14,523		14,694	
Dyer County		30,427		31,727
Columbia	21,471		22,124	
Maury County		43,376		45,879
Morristown	20,318		20,655	
Hamblen County		38,696		43,405
Totals	56,312	112,499	57,473	121,011

Source: Center for Business and Economic Research. Tennessee Statistical Abstract 1977. Knoxville: The University of Tennessee, 1977.

TABLE III-3

ESTIMATED NUMBER OF CHILDREN UNDER FOUR YEARS OF AGE IN TENNESSEE (as of January 1, 1978)

	1974	1975	1976	1977	Total
Born	64,154				
Died	1,110	81	40	30	
					62,893 (1974)
Born		62,265			
Died		1,004	52	48	
					61,161 (1975)
Born			62,514		
Died			1,007	54	
					61,453 (1976)
Born				66,632	
Died				1,007	
					65,625 (1977)
				Total	251,132
				(approximately 5.8 percent of the estimated Tennessee population of 4,299,000)	

Note: Migration is assumed to be compensating.

Source: Tennessee Bureau of Vital Statistics, February 1978.

from low to high socioeconomic and educational levels. The locations of the urban areas and the nonurban areas chosen as the study areas for this study are illustrated in Figure III-1.

Sampling and Public Information and Education Implementation Plan

The sampling and PI&E implementation plan for this study is shown in Figure III-2. Sample data were taken before the effective date of the law and every six months after the effective date of the law. The initial sampling occurred before the effective date of the law and PI&E program to obtain baseline data. Samples taken after the implementation were called semiannual surveys.

The comprehensive plan included using a mass media approach to inform the general public about the law and the need for passenger protection. Public service announcements, news spots and talk shows on television and radio were used. Newspapers were encouraged to run feature stories and to cover events such as press conferences. Newspaper editorials were also effective public information sources. Billboards were also used as part of the comprehensive plan. The comprehensive plan was initially implemented in Nashville.

The basic state plan was designed to distribute brochures informing parents of children under the age of four of the law and how they could protect their children. Stand-up posters for offices were designed and distributed with the brochures. Distribution was made to hospitals, doctors' offices, clinics and other strategic places which parents with small children visit frequently.

The master plan for the study called for the number of target areas receiving the comprehensive plan treatment to be increased during each six-month interval until all target areas were included. A loaner program designed to provide CRDs to selected citizens who could not afford them was implemented in one target area beginning six months after the effective date of the law and PI&E program. One other target area received a loaner program six months after the first one.

Evaluation Limitations

This study was designed to evaluate the impact of legislation and a PI&E program promoting child passenger safety in Tennessee for approximately two years after implementation. Measures used for evaluation were CRD usage and the change in number of fatalities and serious injuries among children under four years of age.

One limitation recognized early in the operational period was the inability to restrict the PI&E treatment to the one target area for which the study design called. Nashville was designated as the target area to receive the comprehensive plan initially. An evaluation of the effectiveness of the comprehensive plan was based upon the premise that Nashville could be compared to all other urban target areas which had received only the basic state plan. Leakage of the comprehensive plan information intended only

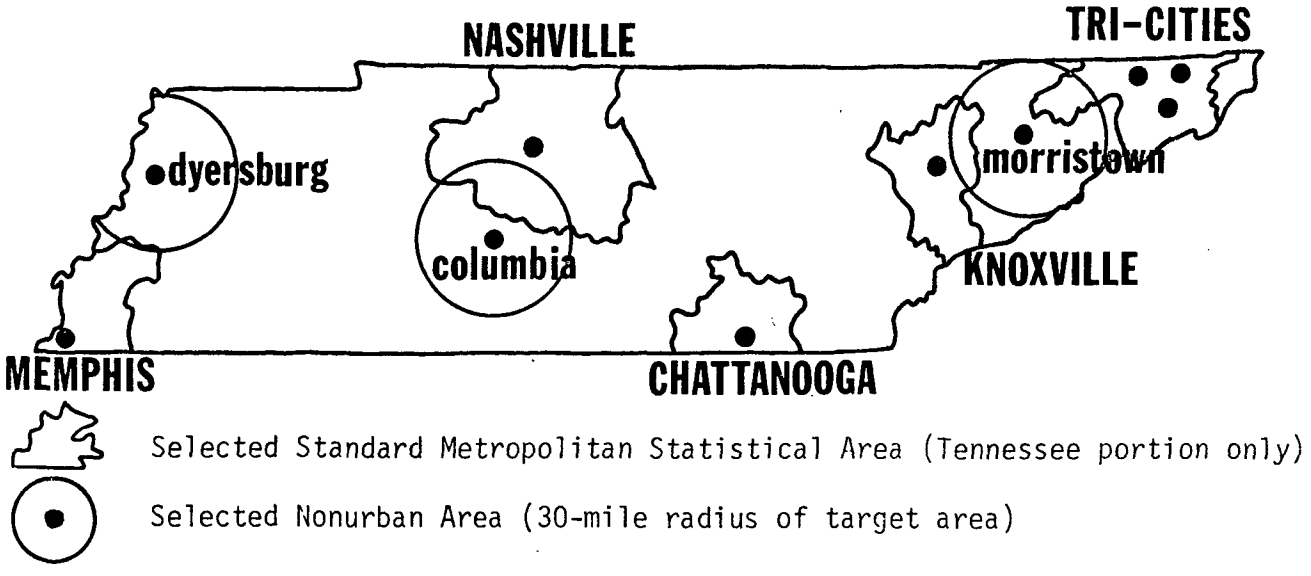


FIGURE III-1

LOCATION OF TARGET AREAS FOR DATA COLLECTION

Target Area	Oct. 77	Jan. 78	July 78	Jan. 79	July 79	Jan. 80	July 80	Oct. 80
Memphis		BSP	CP + LP	CP + LP	CP + LP	CP + LP		Analysis and Report Preparation
	BLD	SAS	SAS	SAS	SAS			
Nashville		CP	CP	CP	CP	CP		
	BLD	SAS	SAS	SAS	SAS			
Knoxville		BSP	CP	CP	CP	CP		
	BLD	SAS	SAS	SAS	SAS			
Chattanooga		BSP	BSP	CP + LP	CP + LP	CP + LP		
	BLD	SAS	SAS	SAS	SAS			
Tri-Cities		BSP	BSP	CP	CP	CP		
	BLD	SAS	SAS	SAS	SAS			
Nonurban Dyersburg Columbia Morristown		BSP	BSP	CP	CP	CP		
	BLD	SAS	SAS	SAS	SAS			

Legend: BLD = Baseline Data
SAS = Semiannual Survey
BSP = Basic State Plan
CP = Comprehensive Plan (includes BSP)
LP = Loaner Program

FIGURE III-2

DATA COLLECTION AND PUBLIC INFORMATION AND EDUCATION IMPLEMENTATION PLAN

for the Nashville target area was reported. Urban areas other than Nashville also had some programs promoting CRD usage which were not a part of the project design. These programs likely had an influence on CRD usage rates beyond what the basic state plan might have had. For example, in Knoxville, one physician personally initiated a promotional program for CRD usage which seemed to be effective. Based on personal experiences in the emergency room at the East Tennessee Children's Hospital, this local physician used television, radio, bumper stickers, posters, brochures, lapel buttons, mall displays and possibly other methods to promote CRD usage in the Knoxville area. These kinds of activities may have occurred in other urban areas and may have influenced CRD usage. If and when these activities occurred, more than just the basic plan was influencing CRD usage during the evaluation period.

Another limitation is that each of the urban areas surveyed is different in several respects; this may have had a bearing on CRD usage. Even though all of these variables causing the differences are not controlled for in the analysis, it is important to know them for a clearer understanding of the results. Nashville, for instance, is the state capital; therefore there is a larger number of governmental employees than in other urban areas in Tennessee. Nashville area residents are more likely than residents of other urban areas to be aware of new legislation because of local publicity. Other differences involve income, educational attainment levels, economic bases and unemployment situations.

Procedure

The procedures described herein are those used for the data collection design. The design included sample sizes, data source selection, data collection and evaluation.

Data Collection Design. To examine the usage of passenger restraint systems during the period of time before the effective date of the law and PI&E implementation (baseline), it was necessary to collect sufficient data to make a confident assessment. The criteria for sample size selection are shown in Table III-4. A sample size of 400 observations per basic state plan target area was determined by the project director and approved by the NHTSA Contract Technical Manager. The rationale for selecting 400 observations is given in Appendix B. This particular size was based upon the need to detect significant changes in the usage rates at critical times during the implementation plan. A further decision to increase the size of the sample to 500 in target areas receiving the comprehensive plan was made in order to increase the precision of the calculations. Baseline sample sizes were set at 800 to ensure the accuracy of the starting point.

Data Requirements for Seat Belt Usage. A family of curves was developed for sample size selection (Figure III-3) using the same procedures as shown in Appendix B for CRD usage sample size selection. Sample sizes were selected for both urban and nonurban areas (Figure III-3). The sample size for each category is based on a power of test of .99 and an alpha level of .01. The sample size required for each urban target area is 3,800 observations. This sample size was chosen by assuming a 15 percent usage rate during the baseline data collection period and a 19 percent usage

TABLE III-4

CRITERIA USED FOR SAMPLE SIZE SELECTION

		Estimated Usage for Baseline Period (percent)	Minimum Estimated Usage for Operational Period[a] (percent)	Minimum Difference Between Periods (percent)	Confidence Level (percent)
CRD Use (children under four years of age)		5	8	3	90
Seat Belt Use (drivers)	Urban	15	19	4	99[b]
	Non-urban	5	8	3	

[a]After approximately six months of operation.

[b]The confidence level for seat belt usage by drivers is greater than for CRD usage because of the fact that drivers represent a larger sample size.

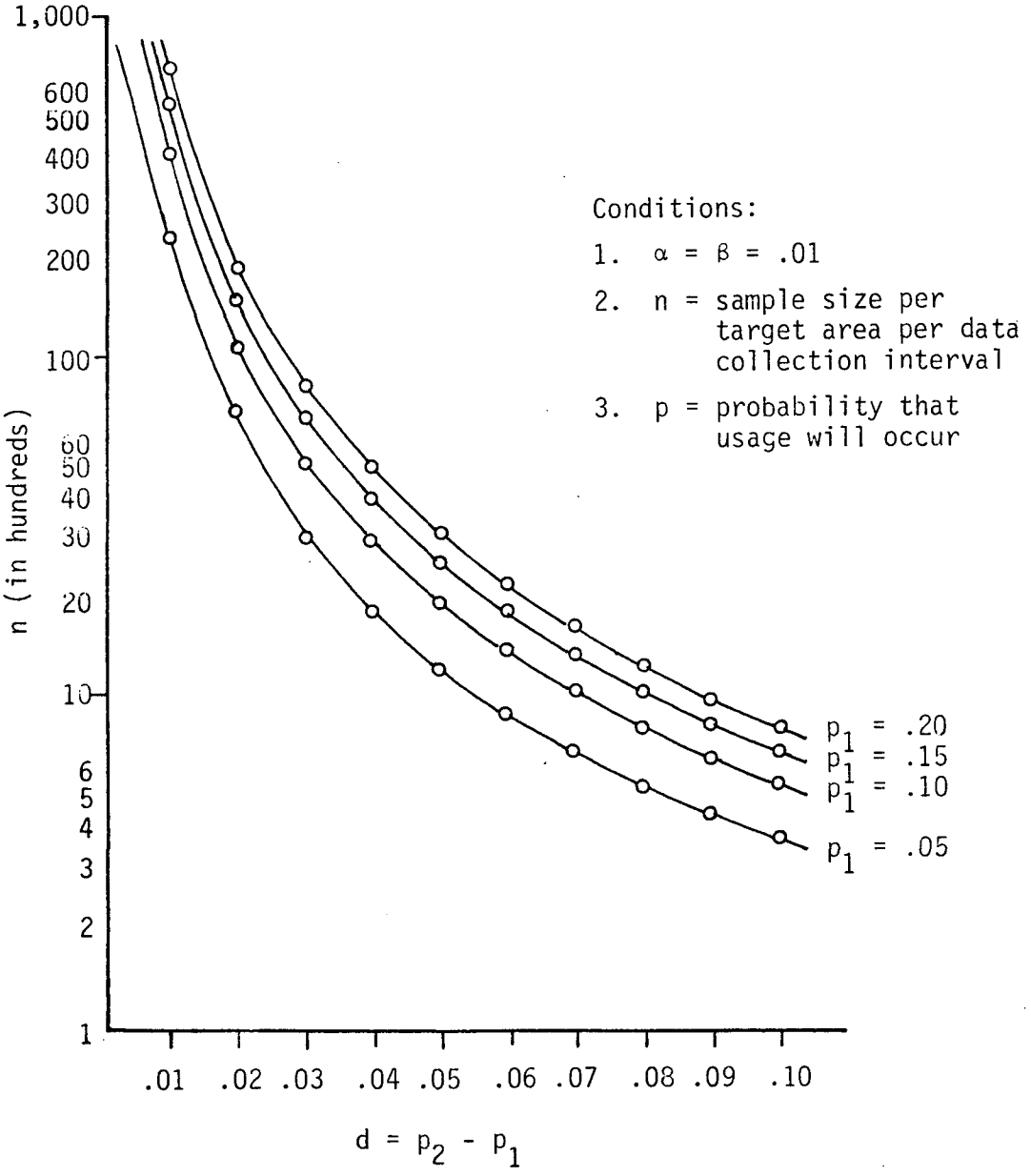


FIGURE III-3

SAMPLE SIZE SELECTION
(For Seat Belt Usage)

rate during the first operational data collection period. The sample size required for nonurban areas is 2,912 observations--971 at each nonurban location. The assumption of 5 percent seat belt use by drivers at the nonurban locations was made after preliminary review of one day's data collection at one nonurban location. It was assumed that there would be about the same increase (3 percent) in seat belt usage by drivers as the assumed increase in CRD usage because of the fact that the PI&E program had an underlying message for all occupants and not just child passengers. It was anticipated that this sample size would be greatly exceeded if all drivers were observed while collecting the sample size for CRD usage.

To determine the death and injury rates resulting from motor vehicle accidents for the baseline and operational periods, it was necessary to depend on accident records with 100 percent reporting from accident investigation files. Based on the records of previous years, approximately 450 accident injuries to children under four years of age were expected for each operational period.

To accomplish the usage rate objectives before and after the implementation of the law and the PI&E program, the most appropriate sources of data were the eligible users of passenger restraint systems--more specifically, child passengers under four years of age and drivers. The Tennessee Department of Safety was the source of accident records of child occupants under four years of age involved in vehicle accidents.

The data collection instruments were designed to collect data at three levels. This study used the data from the first two levels of collection.

Tennessee's child passenger protection law specifically exempts certain vehicles (see Appendix A). A method was devised to make counts of all eligible vehicles, all CRDs observed and driver seat belt usage information. A copy of the data sheet on which this information was recorded is shown in Appendix C.

The tier one instrument (Appendix D) was designed to record observed information in a matter of seconds as vehicles passed an observational post. Tier one data were not recorded on vehicles specifically exempted by the law. Data were gathered only if those eligible vehicles had at least one child estimated by the observer to be under four years of age. This level of data collection was performed primarily at entrances to parking areas of shopping areas, although a few observations were made at public health centers, pediatrics offices/clinics and children's hospitals. The information recorded on the tier one instrument included the disposition of the child or children in the vehicle (e.g., restrained or unrestrained), the use of seat belts by the driver of the vehicle and the license number of the vehicle for identification purposes. It was important to determine the child's or children's disposition in the vehicle since the law permits children under four years of age to be held by an older passenger in lieu of being restrained in an approved CRD. The different dispositions chosen were in a CRD, held by a passenger, held by the driver and other. Because of the difficulty in determining whether the driver is using seat belts (especially older vehicles with only lap belts), a third decision category of "undetermined" was added to "yes" and "no" for this question. This feature of the instrument was included to ensure that the determination of driver seat belt usage rates was as accurate as possible.

The tier two level of data collection (Appendix E) was designed as a combination observational, personal interview and self-administered questionnaire. This instrument was used to gather specific information about the child, parent/guardian, vehicle and the CRD if one was present in the vehicle or if one was owned but not present. The self-administered portion of the questionnaire was used to collect demographic data on the parent/guardian. This level of data collection was designed to collect the essential information in a minimum of time in order to not delay the respondent more than a matter of minutes. The personal interview took approximately 30-60 seconds, and the self-administered part took about 60-90 seconds. Tier two level respondents were a portion of those observed at the tier one level where only an estimate of the child's age was made; therefore, the first question at the tier two level was the age of the child. Provisions were made to record ages for as many as three children under four years of age. Other than age and sex of the child and driver's relation to the child, only two questions were asked of the respondent--year of car and brand and type CRD (whether present in vehicle or not). All other questions were answered by the trained data collector after the subject had completed the reverse side of the questionnaire and had departed from the vehicle. The self-administered part of the questionnaire consisted of 10 questions of which two were repeated for the respondent's mate. Questions 6 through 10 have seven categories. Some of these categories have been combined for certain analyses of this study.

Most of the accident data received from the Tennessee Department of Safety was collected by investigating officers at the scene of the accident. The report form used to record this data is shown as Appendix F. Information recorded in the "Total Injured" section of the report is of particular interest in regard to this study.

Data Collection Procedures. It was imperative that the baseline data be collected prior to the effective date of implementing the law and the PI&E program in order to be able to assess the situation before the parents/guardians under the law were exposed to a PI&E program. Timing was important because of the funding, shopping patterns and the possibility of saving lives and serious injuries if the baseline collection could be completed and the PI&E begun before Christmas shopping and traveling. The tier one and two levels of usage data collection were pretested at the Broadway Shopping Center in Knoxville, Tennessee. The procedures used for data collection included the utilization of two-way radios by the observers and interviewers to track vehicles which had small children as occupants. The pretest served to point out the necessity of good communications and highly trained teams of observers and interviewers to collect adequately the usage data needed to make the analyses required by the objectives of the study.

Recruitment and selection of qualified personnel were conducted, and a training session was scheduled just prior to the pretest. Training included interviewing techniques, two-way radio operations procedures and the specifics of obtaining the required data, both by observation and by personal contact. On-the-job training was also conducted prior to the initial recording of data.

A minimum of 800 observations, including at least 400 matched observations, was set for all target areas in the baseline period. A matched observation is when the tier one and tier two data sheets' license tag numbers are the same indicating that the same occupants of the vehicle that were observed for CRD usage at the observation post were interviewed to collect additional information. Fridays, Saturdays and Sundays were chosen to collect data at the shopping area sites. These days are considered heavy shopping days and provide the assurance of an ample number of observations. Six weekends were needed to complete the baseline collection (Table III-5). A summary of the CRD usage data collection procedure is given in Appendix G.

Because the baseline data collection for CRD usage determination was completed by November 19, 1977, and some PI&E efforts began in December 1977, it was decided to begin the first operational period data collection in June 1978, after approximately six months of PI&E treatment. The collection was finished by July 1, 1978, the date for the second target area to begin receiving the comprehensive plan (Table III-6).

The operational period data collection was designed to be as much like the baseline data collection as possible. The same target areas, sites and supervisors were used to ensure this effect. The training was the same, although new training techniques were employed for time efficiency purposes. The personnel used as observers and interviewers were not the same as for the baseline period for the most part.

The overall survey plan for the project called for semiannual surveys. The primary purpose of this plan was to check on the effectiveness of a particular PI&E treatment at different target areas. Nashville was the only target area which had a different treatment applied during the first six months of operation after the law.

Fatalities and injuries to children under four years of age for all periods, baseline and operational, were collected from the Tennessee Department of Safety. Unlike the usage data collection where a survey over a period of a few weeks gave a good assessment of the baseline usage rates of CRDs, data on fatalities and injuries to children under four years of age were needed for a period of three years (1975-1977).

Evaluation. The raw data were checked manually for errors, and tier one level data were matched with tier two level data by license tag number on each data sheet. Particular questions were coded manually prior to entering the field data into the computer system. A summary of the procedures for processing the data both manually and by computer appear in Appendix H.

From a computer listing of the frequency of occurrences, CRD usage rates were determined. For example, from the tier one level data (observational only), it might be determined that CRD usage occurred 40 times out of 400 vehicles observed with small children; 10 percent of the small children estimated by the observer to be under four therefore were restrained in CRDs. From the second tier level of data collection, 15 of 100 children may have been observed using CRDs for a 15 percent rate. In

TABLE III-5

BASELINE CRD USAGE DATA COLLECTION DATES

Target Area	Dates of Collection (1977)					
	October			November		
	15-16	21-23	28-30	4-5	11-13	18-20
Memphis				X	X	
Nashville		X	X	X		
Knoxville	X	X	X			
Chattanooga			X		X	
Tri-Cities				X	X	X
Nonurban Areas						X

TABLE III-6

OPERATIONAL CRD USAGE DATA COLLECTION DATES

Target Area	Dates of Collection (1978)				
	June				
	2-3-4	9-10-11	11-17-18	23-24	28-29-30
Memphis		X			
Nashville			X		X
Knoxville	X	X			
Chattanooga	X	X			
Tri-Cities			X	X	
Nonurban Areas			X	X	X

order to obtain the most accurate percentage of usage, the two levels were combined, and adjustments were made for overage estimates (children four and older).

The determination of the usage rate of seat belts by drivers is done simply by using the proportion of use observed of the total number of drivers observed. Drivers were divided into two categories--all drivers of eligible vehicles and drivers of vehicles with children estimated to be under four.

The statistical technique of discriminant analysis was used to determine the relationship of selected demographic characteristics to CRD usage. Discriminant analysis is an appropriate technique for classifying subjects into two or more groups. In this study, two distinct a priori groups were identified among adults with small children--CRD users and nonusers of CRDs. The analysis identified those distinguishing characteristics which influenced the subject either to use or not use CRDs.

The procedure followed to compare usage rates of the operational period with the baseline period was first to compare rates within each target area for the periods and then to make comparisons between target areas and/or groups of target areas. The z statistic was used to test the hypothesis that a difference existed between the data collection intervals.

The objectives dealing with comparisons of the number of deaths and injuries to children under four years of age resulting from motor vehicle accidents were accomplished by examining the data to detect any differences for each six-month period for the years 1975-1977 and January 1978 through December 1979.

The chi-square technique of using a two-by-two table for testing independence between two variables was used to make an evaluation of driver's seat belt usage in relation to CRD usage as stated in Objective 5. The z test statistic was used to test the significance of the comparison. An explanation of the technique is provided in Appendix I.

Discriminant analysis and partial correlation analysis were the techniques chosen to analyze the relationships between selected variables and CRD usage (Objective 5). Discriminant analysis aided in distinguishing between users and nonusers of CRDs. Partial correlation analysis was used to investigate the differences between groups to determine if the differences were significant because of a particular variable or could be attributed to other variables which were correlated with the first.

The evaluation of the effectiveness of each PI&E plan with the law was made by comparing CRD usage rates before and after implementation.

The procedure for dealing with Objective 8 was to organize the results, conclusions and recommendations from the various analyses into a form which would aid in an evaluation of similar passenger safety programs elsewhere.

IV. ANALYSIS OF BASELINE RESTRAINT USAGE DATA

The purpose of this chapter is to analyze the restraint usage data which were collected prior to the effective date of the law and the implementation of the PI&E program (January 1, 1978). The baseline data, collected during October and November of 1977, were analyzed to establish the basic information needed to make comparisons with results of data collected after the law and PI&E program became operational.

The analysis of the baseline data provided an assessment of the pre-law situation concerning CRD usage. The data collected before January 1978 included information on CRD usage for two groups--children under four years of age and drivers. The analysis also included the interrelationship of seat belt usage by drivers and CRD usage.

The variables which were measured included the information needed to describe the children and their parents/guardians. It was essential to have a good knowledge of the characteristics of the children who were eligible under the law. The child's age, sex and relation to the driver of the vehicle were determined for each target area. Several variables were used to measure the distinguishing features of drivers/parents/guardians. Two socioeconomic variables--family income and educational attainment--were extremely important measures which were expected to have considerable impact on CRD usage. Vehicle characteristics were recorded as well. Data on CRD ownership by CRD type and brand were gathered to establish which were most widely owned and used.

Child Restraint Device Usage

By examination of the tier one level data (observational), one may discern the magnitude of the data collected for this analysis on the number of vehicles, the number of small children in vehicles and the number of the different dispositions of small children in vehicles. The analysis of tier two level data (personal interviews) includes the characteristics of children under four years of age and of accompanying adults who were parents or guardians of the children. It also includes an analysis of CRD ownership, type, brand and location in the vehicle.

CRD usage during the baseline period was studied by examining both levels of data (tier one and two). Equations were formulated to include both levels in the calculations of composite usage rates. Contingency table analyses were utilized to study the usage of CRDs further.

Tier One Level Data. The data collected at the observational level provided information for the investigation of CRD usage. Although the period of time for observing a vehicle was short (usually two to four seconds), the information gathered, such as the disposition of the child(ren) in the vehicle, could not have been collected as accurately at the tier two level.

The number of eligible vehicles observed at each target area and the number and percentage of these vehicles with children appearing to be under four years of age are tabulated in Table IV-1. More observations were

TABLE IV-1

SUMMARY OF BASELINE RAW FIELD OBSERVATIONAL DATA
(Total Vehicles and Vehicles with Small Children)

Target Area	Number of Vehicles Observed[a]	Number of Vehicles with Small Children[b]	Percentage of Vehicles with Small Children
Memphis	7,599	841	11.1
Nashville	8,883	842	9.5
Knoxville	16,502	1,207	7.3
Chattanooga	9,115	869	9.5
Tri-Cities	17,942	1,549	8.6
Total Urban	60,041	5,308	8.8
Nonurban Areas	8,843	976	11.0
Total Urban and Nonurban	68,884	6,284	9.1

[a]This number represents the total number of vehicles observed which were described as "motor vehicles" in the child passenger protection law (see Appendix A). This number includes out-of-state vehicles.

[b]This number, taken from the raw data files, includes out-of-state vehicles (5.7 percent of the total) observed with small children at the tier one observational level.

needed in Knoxville and Tri-Cities because of the size of the shopping areas surveyed and the large volume of vehicles. The larger the shopping center, the more difficult it was to track vehicles for the tier two level collection.

The percentage of vehicles with children estimated by observers to be under four years of age was greatest at the Memphis target area (11.1 percent). This percentage was substantially greater than the average of 8.8 percent for all urban target areas.

Of the 68,884 vehicles observed at all target areas, 9.1 percent had small children present. Out-of-state vehicles were included in raw data counts for total vehicles and vehicles with small children. Of the vehicles with small children, 5.7 percent had out-of-state license tags. All of the urban target areas had out-of-state vehicles, but those with metropolitan areas nearest the state border (Memphis, Chattanooga, Kingsport and Bristol) had the greatest number. There were no observations at the non-urban areas of out-of-state vehicles with small children.

At the tier one level of collection, the disposition in the vehicle of the child or children estimated to be under four years of age was recorded. When there were two children in the vehicle estimated to be under four years of age, the child appearing to have the safest disposition was recorded as child #1 on the data sheet. When there were two or more children in the vehicle estimated to be under four years of age, the second most safe child became child #2. There were no provisions for collecting data on more than two children at the tier one level. If there were two children under four years of age equally safe or unsafe in the vehicle, no distinction was made between children.

The purpose of distinguishing between child #1 and child #2 was to have data to compare between baseline and operational periods on the disposition of children in the vehicle. More second children under four years of age may have been totally unrestrained during the baseline period, for example, but during the operational period more second children may have been held by older passengers. A summary of the percentages of the different dispositions is shown in Table IV-2.

Of all children observed, 12.8 percent were second children. It was discovered from the observational data that only a small percentage of second children under age four were restrained. Of 756 children observed, only 14 (1.9 percent) were restrained in CRDs, while 44 (5.8 percent) were held by older passengers and 694 (91.8 percent) were totally unrestrained. Of the first children, 10.4 percent were in CRDs, 28.9 percent were in older passenger arms and 58.7 percent were unrestrained. There was a small percentage (2.0 for child #1 and 0.5 for child #2) of children held by the driver.

Tier Two Level Data. At the tier two level of data collection, 2,787 children under four years of age were observed and 2,504 accompanying adults were interviewed. The data collected at this level provided the information needed to analyze some of the characteristics of children and drivers/parents/guardians. CRD data by type and manufacturer also was collected at the tier two level. The data also furnished essential knowledge on the various properties of the vehicles observed.

TABLE IV-2

SUMMARY OF PERCENTAGES OF DISPOSITIONS OF CHILDREN OBSERVED AT THE TIER ONE LEVEL FOR THE BASELINE PERIOD
(Row Percentages)

Target Area	Child No.	Number of Observations	Child Disposition: In Child Restraint Device (CRD) Percent	Held by Passenger Percent	Held by Driver Percent	Other Percent
Memphis	1	703	10.1	16.8	1.8	71.3
	2	154	1.9	1.3	0.0	96.8
Nashville	1	770	12.9	29.7	2.3	55.1
	2	100	5.0	9.0	0.0	86.0
Knoxville	1	1,076	12.0	33.6	1.2	53.2
	2	111	2.7	9.9	0.9	86.5
Chattanooga	1	680	11.8	30.7	2.4	55.1
	2	150	0.7	1.3	1.3	96.7
Tri-Cities	1	1,115	9.0	30.7	1.9	58.5
	2	121	1.7	4.1	0.0	94.2
Total Urban	1	4,344	11.1	29.0	1.9	58.1
	2	636	2.2	4.5	0.5	92.8
Nonurban Areas	1	824	6.6	28.5	3.0	61.9
	2	120	0.0	12.5	0.8	86.7
Total Urban and Nonurban	1	5,168	10.4	28.9	2.0	58.7
	2	756	1.9	5.8	0.5	91.8

A summary of the percentages of the children observed by age and sex is tabulated in Table IV-3. Slightly more two year old children were observed than children of any other age group. The percentages for all areas combined ranged from 21.6 percent for children under one year of age to 27.7 percent for two year olds. The largest difference in percentages of children observed by age occurred in the nonurban areas with a range from 15.8 percent for the children under one year of age to 31.1 percent for the two year olds.

Slightly more female children were observed (50.6 percent) than male children. The nonurban areas showed the greatest difference in the sex of child passengers; only 46.4 percent were female.

It was anticipated that a high percentage of drivers of the vehicles in which children under four years of age were observed would be parents of the children. Of drivers, 87.2 percent were the parents of the children observed and 10.4 percent were relatives of the children observed (Table IV-4). Fewer drivers were parents in the nonurban areas (82.5 percent) than in urban areas (88.1 percent). Conversely, relatives were more frequently driving in nonurban areas (14.1 percent) than in urban areas (9.6 percent).

It also was anticipated that the majority of the drivers observed with small children would be female. However, the observed percentage (53.6) was not as large as anticipated (Table IV-4). A comparison between urban and nonurban areas showed that just over 67 percent of the drivers were female in the nonurban areas and about 51 percent were female in the urban areas. One possible reason for fewer female drivers than expected is that weekend shopping trips may be more oriented as a family activity.

The driver was the first person in the vehicle asked by the interviewer to furnish the information needed. A review of the tier two data revealed that when an interview was agreed upon, the driver was the one interviewed in 70 percent of the cases. When an adult other than the driver furnished the information, 92 percent were female.

A comparison was made between the percentage of users and nonusers of CRDs by driver's sex (see Table IV-5). Drivers observed with children in CRDs were most often female. One possible reason why more females than males were observed with children in CRDs is the fact that, in many cases when females are driving to shop, no other adults are present in the vehicle to tend to the children. It is often the desire of a mother to have a child confined to one place in the vehicle when she is driving and there is no other adult to assist her should the child require attention. Another possible reason why females restrain their children in CRDs more often than males is the traditional view of the mother being the parent most protective of a child from particular types of harm. A third possible reason is that women travel with small children more often than men and therefore are more likely to know the consequences of having an unrestrained child in the vehicle. Of all drivers who had their children restrained in CRDs, 58.9 percent were female. In nonurban areas, 77.8 percent of drivers using CRDs were female. Of all drivers who did not restrain their children in CRDs, 52.7 percent were female.

TABLE IV-3

SUMMARY OF AGE AND SEX OF CHILDREN AT TIER TWO LEVEL FOR THE BASELINE PERIOD
(Row Percentages)

Target Area	Number of Observations	Information on Child					
		Age (Percent)				Sex (Percent)	
		<1	1	2	3	F	M
Memphis	472	19.3	27.3	28.0	25.4	52.7	47.3
Nashville	446	24.4	25.6	29.4	20.6	52.3	47.7
Knoxville	445	22.2	27.6	24.9	25.3	52.9	47.1
Chattanooga	475	23.0	25.3	25.9	25.1	48.0	52.0
Tri-Cities	493	23.7	23.5	26.8	26.0	51.2	48.8
Total Urban	2,331	22.7	25.8	27.0	24.5	51.4	48.6
Nonurban Areas	456	15.8	28.5	31.1	24.6	46.4	53.6
Total Urban and Nonurban	2,787	21.6	26.3	27.7	24.5	50.6	49.4

TABLE IV-4

SUMMARY OF DRIVERS' RELATION TO CHILD(REN) AND SEX OF DRIVERS AT THE TIER TWO LEVEL FOR THE BASELINE PERIOD
(Row Percentages)

Target Area	Number of Observations	Drivers' Relation to Child(ren)				Number of Observations	Drivers' Sex	
		Parent Percent	Relative Percent	Friend Percent	Other Percent		Female Percent	Male Percent
Memphis	439	87.7	10.3	1.8	0.2	413	57.4	42.6
Nashville	423	90.5	7.6	1.7	0.2	381	45.2	54.8
Knoxville	392	86.6	11.6	1.3	0.5	387	50.9	49.1
Chattanooga	442	86.9	10.4	2.3	0.5	410	50.5	49.5
Tri-Cities	437	88.6	8.5	2.1	0.9	434	50.0	50.0
Total Urban	2,133	88.1	9.6	1.8	0.5	2,025	50.9	49.1
Nonurban Areas	419	82.5	14.1	2.6	0.7	399	67.2	32.8
Total Urban and Nonurban Areas	2,552	87.2	10.4	2.0	0.5	2,424	53.6	46.4

TABLE IV-5

COMPARISON OF MALE AND FEMALE DRIVERS AMONG USERS AND NONUSERS OF CRDs AT THE TIER TWO LEVEL FOR THE BASELINE PERIOD
(Row Percentages)

Target Area	Number of Observations	Drivers With Child(ren) Using CRDs*			Drivers With Child(ren) Not Using CRDs		
		N	Female Percent	Male Percent	N	Female Percent	Male Percent
Memphis	392	63	71.4	28.6	329	54.7	45.3
Nashville	367	65	50.8	49.2	302	44.0	56.0
Knoxville	373	60	56.7	43.3	313	49.8	50.2
Chattanooga	402	53	52.8	47.2	349	50.1	49.9
Tri-Cities	424	65	53.8	46.2	359	49.3	50.7
Total Urban	1,958	306	57.2	42.8	1,652	49.7	50.3
Nonurban Areas	390	27	77.8	22.2	363	66.4	33.6
Total Urban and Nonurban Areas	2,348	333	58.9	41.1	2,015	52.7	47.3

*Drivers with at least one child in a CRD.

Data collected on vehicles included year of vehicle, manufacturer, body style and size. These features were selected in order to examine the possible difference a particular feature might make in CRD usage rates. Knowledge of these features also served as a check on the consistency of observations of vehicles for the two data collection periods. Information pertaining to vehicle observations appears in Appendix J.

A determination of type of CRD and CRD manufacturer was made for situations when an interview was made and there was no CRD present in the vehicle and when an interview was made and at least one CRD was present. A number of the adults interviewed without CRDs in their vehicles indicated they owned CRDs, but only a small percentage (9.2 percent) were able to name the manufacturer. The identification of types was made easier for the interviewee by an illustration card used by the interviewer. Those interviewed with CRDs present in the vehicle were asked the brand name. A verification of the brand was made by observation by the interviewer when possible. If the respondent did not know the brand, the interviewer attempted to make a determination.

A tabulation of CRD ownership by type is shown in Table IV-6. Car seat type CRDs were most common. Car seats were also the most likely type to be left behind when children were transported. When drivers claimed CRD ownership when no CRDs were present in the vehicles, most (83.7 percent) claimed ownership of car seats.

The determination of which of the types are most likely to be used was the primary purpose of making the comparison with CRD ownership. The car seat type accounted for 75.6 percent of all CRD usage. The infant carrier, used by 21 percent of drivers using CRDs, was far ahead of the remaining types.

A discussion of the manufacturers of CRDs and accompanying tables is provided in Appendix K. A cross tabulation of CRD usage by brand and by type is also provided.

A comparison of the percentages of use and nonuse of CRDs by type for urban and nonurban areas is shown in Table IV-7. Nonurban areas had low frequencies, but a comparison between the urban and nonurban areas was needed for future analysis. The nonurban areas had a higher rate of usage of infant carriers (29.6 percent) than urban areas (20.7 percent).

A comparison of the car seat type usage revealed lower usage in nonurban areas (66.7 percent) than in urban areas (75.9 percent). The frequencies of use of the protective shield and harness types were too low to make any meaningful comparisons, but the percentages for these two types are displayed in the table to point out the contrast between the types used and not used.

CRD Usage Comparisons for Baseline Period. CRD usage rates vary with the data from each level of collection. The usage rates are consistently greater from the data from the tier two level of collection than for tier one. Observations of small children and CRD usage were tabulated for both levels of data (see Table IV-8). The overall usage rate calculated from tier one

TABLE IV-6

CRD OWNERSHIP BY TYPE FOR THE BASELINE PERIOD
(Row Percentages)

CRD Disposition	Number of Types Identified	Type: Infant Carrier Percent	Type: Protective Shield Percent	Type: Car Seat Percent	Type: Harness Percent
Not Present in Vehicle	605	6.6	6.6	83.7	3.1
Present in Vehicle	561	21.6	2.9	74.3	1.2
Present and in Use in Vehicle	349	20.9	2.6	75.6	0.9

TABLE IV-7

COMPARISON OF CRD TYPES OBSERVED AT THE TIER TWO LEVEL FOR THE BASELINE PERIOD
(Row Percentages)

Area(s)		Number of Observations of CRDs	CRD Type: Infant Carrier Percent	Protective Shield Percent	Car Seat Percent	Harness Percent
Nashville	Used	73	23.3	5.5	69.9	1.3
	Not used	34	23.5	5.9	70.6	0.0
Other Urban Areas	Used	249	19.3	1.6	78.3	0.8
	Not used	117	17.9	2.6	77.8	1.7
All Urban Areas	Used	322	20.7	2.5	75.9	0.9
	Not used	151	19.2	3.3	76.2	1.3
Nonurban Areas	Used	27	29.6	3.7	66.7	0.0
	Not used	16	31.3	0.0	68.8	0.0
All Urban and Nonurban Areas	Used	349	20.9	2.6	75.6	0.9
	Not used	167	20.4	3.0	75.4	1.2

TABLE IV-8

PERCENTAGES OF BASELINE OBSERVATIONS OF SMALL CHILDREN AND CRD USAGE AT THE TIER ONE AND TIER TWO LEVELS

Target Area	Tier One			Tier Two		
	Number of Observations of Small Children	Number and Percent of Children in CRDs		Number of Observations of Small Children	Number and Percent of Children in CRDs	
Memphis	857	73	8.5	483	72	14.9
Nashville	870	104	12.0	452	80	17.7
Knoxville	1,187	132	11.1	456	64	14.0
Chattanooga	830	81	9.8	480	55	11.5
Tri-Cities	1,236	102	8.3	495	68	13.7
Total Urban	4,980	492	9.9	2,366	339	14.3
Nonurban Areas	944	54	5.7	465	27	5.8
Total Urban and Nonurban	5,924	546	9.2	2,831	366	12.9

data was 9.2 percent; the overall usage rate from tier two level data was 12.9 percent. The differences are more distinct between the tier levels in the urban areas (9.9 percent usage rate from tier one data and 14.3 percent from tier two data). The largest difference for any one target area occurs in Memphis data.

The overage factor at the tier one level accounts for a portion of the difference between the rates. Observers were instructed in training for data collection to describe all vehicles with small children, even when some of the children would be over four years of age. This instruction was given to ensure that all vehicles with children under four years of age were described. Since few children over four use CRDs, the overage estimates by the observers caused lower usage rates at the tier one level. Another possible reason for differences in the two sets of data is that the tier two interviewers sometimes faced a choice of interviews between vehicles; intuitively the choice was toward vehicles with CRDs in use.

There is no concrete explanation why there was more difference in the rates between the levels in the urban areas than the nonurban areas. The variances in training and personnel may be considered as a factor in the difference. Other possible explanations are that the nonurban areas were surveyed last, both supervisory personnel and most other personnel had received the benefit of several days of data collecting and the experience of recognizing the correct age range of children had improved. Supervisors definitely placed more emphasis upon the value of unbiased sampling of described vehicles by the end of the collection period. Also, the necessity for interviewers to choose between described vehicles happened less frequently in the nonurban areas.

Since usage rate differences generally exist between the two levels of collection, a method was devised to calculate the usage rate using both levels of data and to compensate for the number of overage estimates. The field data were divided into three data sets. The first data set consisted of matched tier one and two data. The second data set included all the tier one data which had no followup interview, i.e., no matching tier two data. The third data set included tier two data for which there were no matching data at the tier one level. This third data set was smallest because interviewers were instructed to interview only adults of vehicles which were described by observers. Some of the reasons for obtaining tier two data without accompanying tier one observations were (1) the interviewer misunderstood the observer's description of vehicle, (2) the interviewer assumed the observer described the vehicle while he/she was busy with another interview and had the radio turned off and (3) the interviewers were frequently eager and interviewed adults with small children instead of waiting for the next vehicle description from the observer. The data collected in this manner accounted for about 11 percent of the total tier two level data collected. The percentage of tier two data without matching tier one data was almost 20 percent in Memphis, which helps explain why that target area had the greatest difference in usage rates between tier one data and tier two data as discussed above.

Percentage of usage was calculated using one of two equations designed to take into account both levels of data collection, the number of overage

estimates and the number of persons refusing to furnish information. The appropriate equation was selected depending upon the amount of tier one level data in proportion to tier two level data. The tier one level data had a downward bias and tier two data had an upward bias in estimating CRD usage percentages; therefore a pooled estimate was made on the basis of approximately equal variation for each bias. An explanation of the equations used to make the pooled estimate appears in Appendix I.

The rationale for using the equation together with an explanation of the adjustments made for the age bias and for using tier one data which had refusals at the tier two level are also presented in Appendix I. The results of the composite usage rates calculations are presented in Table IV-9. The overall usage rate for all target areas for the baseline period was 10.9 percent. This percentage represents a weighted averaging of all six target areas. A weighted average of the five urban target areas yielded an 11.8 percent rate.

The highest usage rate among the five metropolitan target areas was at Nashville where the composite usage rate was 14.0 percent. The other urban areas had rates ranging from 10.7 percent for the Tri-Cities to 12.8 percent for Knoxville.

Contingency Table Analysis of Child Restraint Device Usage. Contingency table analysis was used to examine sets of relationships between child restraint usage and other selected variables. This cross tabulation gave a frequency display for two or more variables. CRD usage variables were cross tabulated with other pertinent variables to establish a representation of the factors which were thought to impact CRD usage. The number of observations in all the contingency tables is limited to those of child #1 to avoid having multiple responses to CRD usage from the same vehicle. Each observation must be independent for chi-square significance testing to be accurate.

Age and sex were two characteristics of children recorded during data collection. A cross tabulation of the age of children and CRD usage was made (see Table IV-10). The CRD usage rate for child #1 is highest for the youngest children and lowest for three year olds. The rates ranged from 24.6 percent to 6.1 percent. Age may be considered a major contributor in usage determination, particularly when determining the usage rate of only one child (child #1) in the vehicle.

There was no significance difference between CRD usage and the sex of the child. A slightly higher percentage of female children were restrained than were male children.

Of the 2,415 observed children at the tier two level, 2,113 (87.5 percent) were the only child under four in the vehicle, while only 22 vehicles (0.9 percent) of the 2,415 observed had as many as three children under four. A cross tabulation of usage by number of children under four in the vehicle was made (see Table IV-11). CRD usage rates for each category of number of children is shown in the table. The usage rate was considerably greater when two or more children under the age of four were present in the vehicle. There was a 12.8 percent usage rate when only one child

TABLE IV-9

COMPOSITE BASELINE CRD USAGE RATES USING BOTH TIER ONE AND TIER TWO LEVEL DATA

Target Area	Number Of Observations of Children: Tier One Data[a] Unmatched With Tier Two	Tier Two Only Data	Tier One/Tier Two Matched Data	Effective[b] Number of Observations	Composite CRD Usage Rate Percent
Memphis	509	95	388	871	10.9
Nashville	548	56	396	821	14.0
Knoxville	836	32	424	912	12.8
Chattanooga	470	30	450	749	10.9
Tri-Cities	928	46	449	990	10.7
Total Urban	658[c]	52[c]	421[c]	869[c]	11.8[d]
Nonurban Areas	670	60	405	872	6.5
Total Urban and Nonurban Areas	660[c]	53[c]	419[c]	869[c]	10.9[d]

[a]Includes tier one data of overage children and refusals at the tier two level.

[b]See Appendix I.

[c]Averages.

[d]Weighted averages.

TABLE IV-10

CHILDREN CHARACTERISTICS VERSUS CRD USAGE RATES
FOR THE BASELINE PERIOD

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Age:			110.45	<0.001
<1	496	24.6		
1	639	18.8		
2	682	8.1		
3	593	6.1		
Sex:			0.11*	0.743
Female	1,137	14.2		
Male	1,140	13.7		

*Corrected chi-square.

TABLE IV-11

CRD USAGE VERSUS NUMBER OF CHILDREN IN THE VEHICLE FOR THE BASELINE PERIOD

Number of Children Under Age 4 in Vehicle	Number of Observations	CRD Usage Rate	Chi-Square	Significance Level
			16.43	<.001
1	2,113	12.8		
2	280	20.7		
3	22	27.3		

under four years of age was in the vehicle, but when there were two children under four, the percentage of use of at least one CRD increased to 20.7 percent. The percentage was even greater (27.3 percent) when there were as many as three children under four years of age in the vehicle.

One logical explanation why the percentage of usage is much greater when two or more children under four are in the vehicle is the convenience factor for the driver. Frequently a driver may be the only adult in the vehicle, and a CRD is helpful in keeping a child confined, requiring less attention by the driver.

Data were collected dealing with variables which included socioeconomic status of the family and variables on an individual basis, i.e., education and employment of respondent and respondent's mate. A cross tabulation was made for each of these selected variables by CRD usage for child #1 (see Table IV-12). Usage rates were lowest for low income families and increased as family incomes increased.

Marital status is significant in relation to CRD usage. The respondents who were married or living with a mate used CRDs at a rate almost twice that of those unmarried or living without a mate. Less than 10 percent of those responding to the interview were in the latter category.

The number of children under four in the vehicle was discussed earlier in this chapter. It was found that as the number of children under four in vehicles increased, the usage of restraints also increased. The number of children over four in the vehicle, however, does not have the same effect. When there was only one child four and older, the use of CRDs for children under four years of age in the vehicle was 12.5 percent, but when there were two children four years or older in the vehicle, the rate dropped considerably to 7.7 percent.

The same effect on usage rates was experienced with the increase in the number of adult passengers in the vehicle as with the increase in the number of older children. When there was only one adult passenger, the usage was high at 14.9 percent, but usage dropped to 9.3 percent with two adult passengers.

The status of employment of the respondent and the respondent's mate were considered separately as well as in combination. The differences are significant for the respondent, but they are not for the respondent's mate. The homemaker is the category with the highest use for both the respondent and the respondent's mate. The combinations of employment situations used to compare usage rates were limited to four, ranging from "full-time" (both mates working full-time) to "unemployed" (neither mates working full-time). The combined category of "both mates working less than full-time" showed the lowest usage rate (4.3 percent). The best combination for the highest usage (18.9 percent) was when one adult was employed full-time and the other adult was a homemaker. The traditional situation of father as breadwinner and mother as caretaker of the house and children is apparent.

Educational status versus CRD usage was highly significant in all three comparisons. There was little difference between the respondent and the respondent's mate when usage rates were compared to the four educational

TABLE IV-12

FAMILY CHARACTERISTICS VERSUS CRD USAGE RATES FOR THE BASELINE PERIOD

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Family Income:			31.45	<0.001
0,000-9,999	586	9.2		
10,000-14,999	524	14.7		
15,000-19,999	415	18.6		
20,000+	335	21.8		
Marital Status:			5.50*	0.018
Married/living with mate	1,940	15.0		
Single/living without a mate	190	8.4		
Number of Children in Vehicle (4-17 years old):			4.57	0.206
1	689	12.5		
2	233	7.7		
3	64	9.4		
4 or more	37	8.1		
Number of Adults in Vehicle:			16.66	0.008
1	1,110	14.9		
2	668	9.3		
3	117	7.7		
4 or more	28	3.6		

*Corrected chi-square.

TABLE IV-12 (continued)

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Driver Relationship to the Child:			26.7	<0.001
Parent	1,980	15.1		
Nonparent	269	3.3		
Employment Status of Respondent:			13.17	0.011
Full-time	1,297	12.7		
Part-time	119	16.8		
Homemaker	541	18.7		
Student, retired or other	81	12.3		
Unemployed	89	10.1		
Employment Status of Respondent's Mate:			5.52	0.238
Full-time	1,314	14.9		
Part-time	97	14.4		
Homemaker	388	17.5		
Student, retired or other	78	7.7		
Unemployed	78	12.8		
Employment Status of Couple:			22.82	<0.001
Both full-time	659	10.9		
1 full-time, 1 not full-time, and not homemaker	294	15.6		
1 full-time, 1 homemaker	852	18.9		
Both less than full-time	47	4.3		

TABLE IV-12 (continued)

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Educational Status of Respondent:			73.49	<0.011
Less than high school	241	5.4		
High school, G.E.D. and/or vocational technical school	1,079	10.8		
Some college (no degree)	390	17.4		
College degree(s)	430	25.6		
Educational Status of Respondent's Mate:			66.36	<0.001
Less than high school	288	6.6		
High school, G.E.D., and/or vocational/technical school	961	11.3		
Some college (no degree)	328	18.9		
College degree(s)	411	25.5		
Educational Status of Couple:			69.31	<0.001
Both less than high school	125	3.2		
1 with high school/vocational technical, 1 less than high school	241	9.5		
Both with high school/vo-tech/ some college	906	11.6		
1 with college degree(s), 1 with less than college degree	80	16.3		
Both with college degree(s)	540	24.8		

categories. CRD usage rates varied widely with the educational level of respondents, from 5.4 percent usage among respondents with the least education to 25.6 percent usage among respondents with the most education. The range was similar for the respondent's mate, from 6.6 percent to 25.5 percent. When the educational status of the couple was considered, the range of rates was higher. When both mates had the lowest level of education (both less than high school) usage was only 3.2 percent. When both mates had the highest level (each mate with at least one college degree), usage was 24.8 percent.

Vehicle ownership characteristics were significant factors in contributing to CRD usage rates (see Table IV-13). Vehicle ownership, however, may have been related to income level; those persons not owning the vehicle they were driving may have been nonusers of CRDs because of lack of sufficient income. The same logic may be used concerning the number of vehicles owned. The lower CRD usage rate (10.7 percent) for one vehicle families versus a higher rate (16.6 percent) for those families with two or more may have been related to low income.

An assessment of the relationships between year of vehicle and CRD usage rate may again indicate that income was a factor. It was found that the newer the vehicle, the higher the percentage of use of CRDs. Another factor in considering the increased CRD usage in newer vehicles is that later year models have either the interlock (1974) or the warning signal (1975-1978) systems for seat belt usage.

The relationship between CRD usage and size, body style and manufacturer was shown to be insignificant. It is interesting to note, nonetheless, that there is a higher CRD usage rate in station wagons than in vehicles of other body styles. There was no significant difference between station wagon models and other styles when categorized into 2-door and 4-door models; however, when grouped together and compared with all other types, Philpot, Heathington, Perry and Hughes (1979) found there was a significant difference at less than the .05 level.

The results of the cross tabulation of CRD usage by types were tabulated (see Table IV-14). There was no significant difference in CRD usage detected between the different types of CRDs. There was little difference between the usage of infant carriers (69.2 percent) and of car seat types (67.4 percent). The frequency counts for harnesses and protective shields were low, representing only 3.3 percent of the 488 CRDs observed.

Seat Belt Usage by Drivers

Although this study was primarily concerned with child passenger safety, the determination of the use of seat belts by drivers was included. The study of seat belt usage by drivers was not limited to those drivers with small children in the vehicle.

Data collectors observed 68,884 vehicles during the baseline period. Each driver was observed for seat belt usage. A traffic counter was used to record the number of observations, number of times seat belts were observed in use and the number of times the observers could not distinguish between use and nonuse of seat belts by drivers. A tabulation of seat belt usage by drivers is presented in Table IV-15.

TABLE IV-13

VEHICLE INFORMATION VERSUS CRD USAGE RATES FOR THE BASELINE PERIOD

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Vehicle Ownership:			15.15*	<.001
Owned	1,864	15.5		
Not owned	286	6.6		
Number of Vehicles Owned:			13.25*	<.001
One	759	10.7		
Two or more	1,351	16.6		
Year of Vehicle:			4.65	.200
<69	247	12.1		
69-73	855	12.7		
74	268	15.7		
75-78	840	15.8		
Vehicle Manufacturer:			5.08	.280
AMC	31	9.7		
Chrysler	236	16.5		
Ford	528	12.3		
General Motors	1,070	14.7		
Foreign	210	17.6		
Vehicle Size:			1.72	.422
Subcompact	215	15.8		
Compact	526	12.7		
Full size	1,479	14.8		

*Corrected chi-square.

TABLE IV-13 (continued)

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Body Style:			7.08	.215
2-door sedan	1,359	13.4		
4-door sedan	533	13.7		
2-door station wagon	49	24.5		
4-door station wagon	181	17.7		
Pickup/van	204	13.2		
Other	30	13.3		

TABLE IV-14

CRD TYPE VERSUS CRD USAGE RATES FOR THE BASELINE PERIOD

CRD Type	Number of Observations*	CRD Usage Rate Percent	Chi-Square	Significance Level
Infant Carrier	104	69.2	0.70	0.872
Protective Shield	12	66.7		
Car Seat	368	67.4		
Safety Harness	4	50.0		

*Observations of Child #1.

TABLE IV-15

SUMMARY OF SEAT BELT USAGE BY DRIVERS FOR THE BASELINE PERIOD

Target Area	Number of Observations[a]	Number of Times Use was Undetermined	Number of Drivers Observed Using Seat Belts	Percent Use
Urban:				
Memphis	7,599	1,379	348	5.6
Nashville	8,883	1,648	528	7.3
Knoxville	16,502	2,806	1,279	9.3
Chattanooga	9,115	1,965	665	9.3
Tri-Cities	17,942	806	1,152	6.7
Total Urban Areas	60,041	8,604	3,972	7.7[b]
Nonurban:				
Dyersburg	3,273	204	33	1.1
Columbia	1,714	189	40	2.6
Morristown	3,856	302	100	2.8
Total Nonurban Areas	8,843	695	173	2.1[b]
Total Urban and Nonurban Areas	68,884	9,299	4,145	7.0[b]

[a]This number includes some out-of-state vehicles.

[b]Weighted averages.

Based on research by others, seat belt usage in the nonurban areas was expected to be lower than the urban areas. The nonurban target area was tabulated by town where data were collected to investigate the difference between locations. The number of observations for all locations were for more than the minimum needed for making statistical analyses. This abundance of data came as a result of collecting CRD data which required large numbers of vehicles in order to have a sufficient number of vehicles with small children.

The proportion used for making the percentage calculations was the number of drivers observed who were definitely using seat belts divided by the total number of observations of drivers less the number of times the use of seat belts was undetermined. An examination of the percentages shows use of seat belts was substantially lower in rural areas (2.1 percent) than in urban areas (7.7 percent). The nonurban area of Dyersburg had the lowest seat belt usage rate by drivers (1.1 percent). A search of any irregularity in the data to explain this low rate was made and nothing was found, and the percentage of undetermined data was even less than for Morristown and Columbia, the other nonurban locations.

Among the urban areas, Chattanooga and Knoxville had the highest driver belt seat usage rates (9.3 percent each). The Tri-Cities urban area was expected to be closest to the nonurban usage rate because of its overall lower population density, but Memphis was closest at 5.6 percent (Tri-Cities had a 6.7 percent rate).

Seat belt usage by drivers with small children in the vehicle was tabulated for comparison between target areas (see Table IV-16). The rates of usage of seat belts by drivers with small children were somewhat different from the usage of all drivers observed. Recall that the total of urban areas had a 7.7 percent usage when a weighted average for the various sample sizes was made, but Table IV-16 shows that only 4.5 percent of drivers with small children were using seat belts.

A chi-square technique, with Yate's correction applied, was used to determine if drivers' decisions to use seat belts for themselves was independent of their decision to use CRDs for their children. A simple two-by-two matrix was used to arrange the two variables for significance testing. The number of users and nonusers for each cell are shown in Table IV-17.

The null hypothesis that there was no relationship between drivers' decisions with respect to seat belts and CRD usage must be rejected. There was a significant relationship between drivers' decisions to use seat belts and their decisions to place their children in CRDs.

Table IV-17 shows fewer total observations and different percentages than Table IV-16 due to missing and undetermined data. Data used in Table IV-17 includes those observations with positive determinations of usage/nonusage for both the driver and child or children. A firm determination of usage of both driver and child or children was most difficult in many cases. Observers were encouraged to not guess but to record on the data sheets as undetermined those cases where drivers' use of seat belts was in doubt.

TABLE IV-16

PERCENTAGE OF USE OF SEAT BELTS BY DRIVERS WITH SMALL CHILDREN IN VEHICLE AT THE TIER ONE LEVEL FOR THE BASELINE PERIOD

Target Area	Number of Drivers with Small Children[a]	Number of Drivers Where There Was Undetermined Usage	Number of Drivers with Positive Determination of Seat Belt Usage	Percentage of Seat Belt Use by Drivers with Small Children
Memphis	777	248	36	6.8
Nashville	832	247	38	6.5
Knoxville	1,130	279	28	3.3
Chattanooga	791	422	23	6.2
Tri-Cities	1,238	233	24	2.4
Total Urban	4,768	1,429	149	4.5[b]
Nonurban Areas	953	106	23	2.7
Total Urban and Nonurban Areas	5,721	1,535	172	4.1[b]

[a]This number from the valid tier one data file includes vehicles with overage children.

[b]Weighted averages.

TABLE IV-17

RELATIONSHIP BETWEEN DRIVERS' SEAT BELT USAGE AND CRD USAGE FOR THE BASELINE PERIOD

	Decision	CRD Usage		
		No	Yes	Total
Seat Belt Use By Drivers	Yes	84	66	150
	No	3,335	264	3,599
	Total	3,419	330	3,749

It was interesting to note the different percentages for the situations as shown in Table IV-18. The percentages were based on the number of observations of drivers where seat belt use was determined. Of the number of drivers using seat belts, 44.0 percent also place their children in CRDs. Those drivers not using seat belts and who had children under four with them place their children in CRDs at only a 7.3 percent rate.

Summary

A sizable number of vehicles (68,884) were observed during the baseline data collection in order to have a sufficient number of vehicles with small children. Only 9.1 percent of the vehicles observed had small children as passengers. The drivers of vehicles with children under four years of age as passengers were the parents of the children in 87.2 percent of the cases observed. The majority of the drivers with children under four were females (53.6 percent). There were more female (58.9 percent) than male drivers observed with children using CRDs. Of the types of CRDs owned, almost 93 percent are car seats and infant carriers. The car seat and infant carrier types account for 75.6 percent and 20.9 percent respectively.

The composite usage for all target areas combined for the baseline period was 10.9 percent. This percentage is a weighted average of the percentages of usage for all target areas. A weighted average for just the urban areas showed 11.8 percent usage compared to 6.5 for the nonurban areas.

The contingency table analysis of usage for the baseline period revealed that there is a significant relationship between CRD usage and the age of the child. The usage rate was highest for the youngest children and lowest for three year olds. The number of children under four years of age in the vehicle has a significant bearing on usage rates. The usage rate was greatest when two or more children under four were present in the vehicle.

Other significant relationships between selected variables and usage included family income, marital status, number of adult passengers in vehicles, employment status of respondent, employment status of the couple, educational status of respondent, educational status of the respondent's mate and educational status of the couple.

Seat belt usage of all drivers observed during the baseline data collection period was only 7.0 percent. The percentage of seat belt usage by drivers with small children was even smaller at 4.1 percent.

There was a significant relationship between the driver's decision to use seat belts and the driver's decision to place a child in a CRD. It was discovered that of those drivers who used seat belts themselves, 44 percent placed their children in CRDs. Of those drivers not using seat belts themselves, only 7.3 percent had their children restrained in CRDs.

TABLE IV-18

PERCENTAGES OF RELATIONSHIPS BETWEEN DRIVERS' SEAT BELT USE AND CRD USAGE FOR THE BASELINE PERIOD
(Row Percentages)

	Decision	CRD Usage		
		Number of Observations	No	Yes
Seat Belt Usage By Drivers	Yes	150	56.0	44.0
	No	3,599	92.7	7.3

V. ANALYSIS OF OPERATIONAL PERIOD CHILD RESTRAINT DEVICE USAGE DATA AND A COMPARISON TO BASELINE USAGE DATA

The CRD usage data collected after the law and the PI&E program were operational were analyzed. The same procedures as described in Chapter IV were employed. Discussions in Chapter IV which applied to analyses for both the baseline and operational period data are not repeated in this chapter.

The analysis of the operational period CRD usage data included making comparisons with data collected during the baseline period to point out similarities and differences between the periods. It was important to know if the samples for the collection periods represented the general population or at least the subset of the population which were eligible subjects of the study. It was also important to be confident that two samples were enough alike in their distribution across critical variables, such as family income and educational levels attained, to be comparable samples.

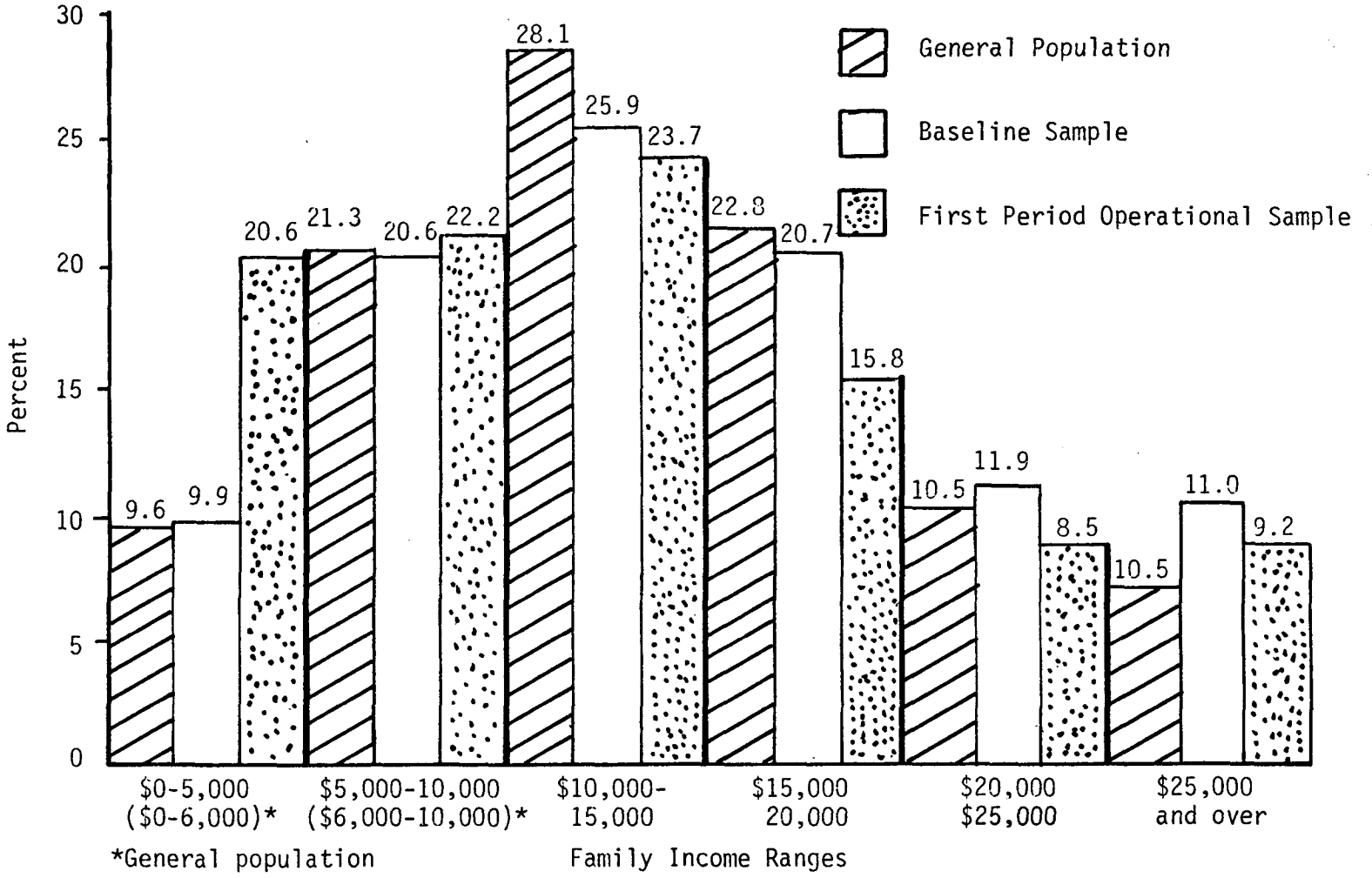
Comparison of Operational and Baseline Samples and Selected Population Characteristics

The purpose of comparing the collected sample data with established data for the population is to determine how well the sample represents the population. Only two variables were critical with regard to population sampling. Because family income and educational attainment are variables which often affect so many other variables, it was desirable to obtain a cross-sectional sample which represented the averages for each category designated for these variables.

Family income and educational attainment were compared between the samples (baseline and operational) and with the general population of Tennessee. A more ideal comparison would have been between the samples and a subset population which represented only families with small children. These data were not readily available for comparative purposes. The samples generally represent parents between 20 and 40 years of age who have children under four years of age.

Family Income. The question seeking information about family income contained seven categories, with each having a $5,000 incremental range, except the last one which was theoretically an open-ended category of $30,000 and over. The question reads: "What was your family income last year before taxes? (If you are single/not living with a mate, what was your personal income?)." During the data collection periods, subjects were asked to complete questionnaires with this and nine other questions. More respondents refused to answer this question than any other. The response rate was 73.5 percent (1,913 of 2,504 for the baseline period and 1,350 of 1,937 for the first operational period). Figure V-1 depicts the comparison between the distribution of income levels in the baseline and the first operational period samples and the general population.

The largest differences between sample data and the established averages for family income for all Tennessee families was in the "below $5,000"



Source: U.S. Department of Commerce, Bureau of the Census, Current Population Reports, Consumer Income, Series P-60, No. 112, June 1978.

FIGURE V-1

COMPARISON OF INCOME DISTRIBUTIONS BETWEEN SAMPLE DATA AND GENERAL POPULATION OF TENNESSEE

category. Because of the age difference between the sampled group and the general population which make up the lower income group, this difference was expected. Another possible contributing factor to this difference is low vehicle ownership for this income level.

The baseline period data on family income were for 1976, since the question asked for income of "last year." The first operational period data represented 1977 income. The general population income data is for 1975. These three dates were considered when comparing the sampled groups with each other and with the general population. It appeared that the samples taken for both the baseline and first operational periods compared favorably with each other, which was more important than a favorable comparison between the sample and the general population. It was important, however, that the sample be representative of all income levels, which it appeared to be.

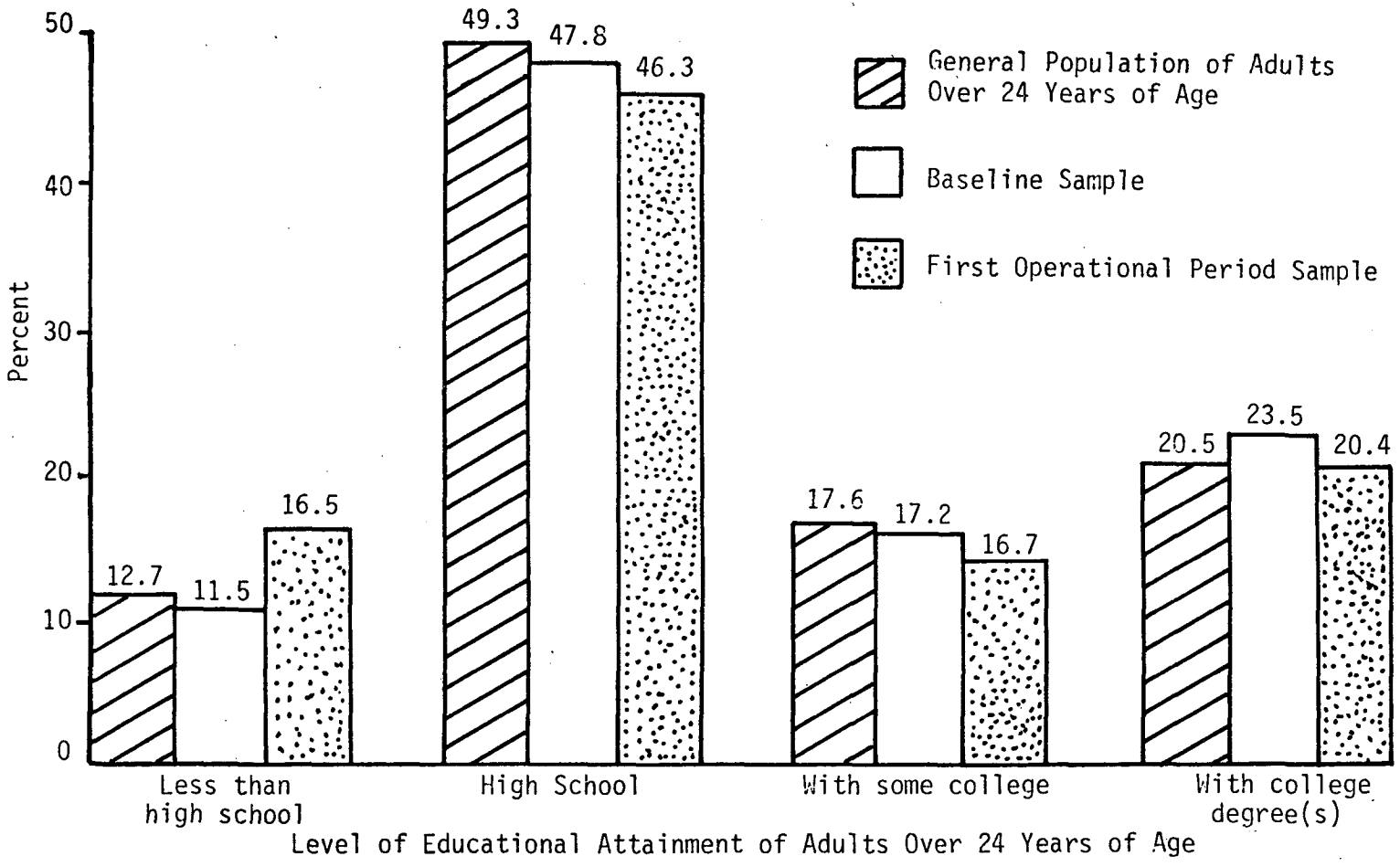
Education. The questions asked to gather information on educational attainment were "What is the highest level of education you have completed?" and "What is the highest level of education your mate has completed?" Although this question was not as sensitive as an income level question, the response rate was only approximately 85 percent. Comparisons of percentages of educational attainment for the baseline and first operational periods showed small differences. When the two periods were compared to the averages for the population of adults over 24 years of age in Tennessee, some differences appeared. The distribution of the educational levels are illustrated (Figure V-2). As with income levels, the lower portion of the scale was where the largest differences occurred. The age difference between the respondents and their mates in the sample and the population over 24 years of age likely accounts for a large portion of the difference. The other categories compared favorably as expected.

Child Restraint Usage

Tables used in this chapter parallel those used in Chapter IV to facilitate comparisons of the data sets. The same format for discussion is used in this chapter as in Chapter IV.

Tier One (Observational) Level Data. The total number of observations of small children for each of the four operational period data collections was a function of the sampling plan which was implemented. The rationale for deciding the number of observations at each tier level is given in Appendix B; it led to effective sample size goals of 400 for each basic state plan area and 500 for each comprehensive plan area. A tabulation was made of the total number of vehicles observed, the number with small children and the percentages of vehicles with small children (see Tables V-1 through V-4). The contrast in the numbers of observations is a function of the size of the shopping centers for the target area as well as the number of interviewers on the team trying to track the vehicles observed.

The percentage of vehicles with small children was highest for the Memphis target area (an average of 10 percent for all operational periods). This percentage was comparable to 11.1 percent for Memphis during the



Source: U.S. Department of Commerce, Bureau of the Census, Current Population Reports, Consumer Income, Series P-60, No. 112, June 1978.

FIGURE V-2

COMPARISON OF THE DISTRIBUTIONS OF EDUCATIONAL ATTAINMENT LEVELS BETWEEN SAMPLE DATA AND GENERAL POPULATION

TABLE V-1

SUMMARY OF FIRST OPERATIONAL PERIOD RAW FIELD OBSERVATIONAL DATA
(Total Vehicles and Vehicles with Small Children)

Target Area	Number of Vehicles Observed[a]	Number of Vehicles with Small Children[b]	Percentage of Vehicles with Small Children
Memphis	4,607	531	11.5
Nashville	8,106	686	8.5
Knoxville	9,831	776	7.9
Chattanooga	6,635	674	10.2
Tri-Cities	6,619	527	8.0
Total Urban	35,798	3,868	10.8
Nonurban Areas	4,761	511	10.7
Total Urban and Nonurban	40,559	4,379	10.8

[a]This number represents the total number of vehicles observed which were described as "motor vehicles" in the child passenger protection law (see Appendix A). This number includes out-of-state vehicles.

[b]This number, taken from the raw data files, includes out-of-state vehicles observed with small children at the tier one observational level.

TABLE V-2

SUMMARY OF SECOND OPERATIONAL PERIOD RAW FIELD OBSERVATIONAL DATA
(Total Vehicles and Vehicles with Small Children)

Target Area	Number of Vehicles Observed[a]	Number of Vehicles with Small Children[b]	Percentage of Vehicles with Small Children
Memphis	6,574	631	9.6
Nashville	6,472	821	12.7
Knoxville	7,648	734	9.6
Chattanooga	5,094	569	11.2
Tri-Cities	10,706	699	6.5
Total Urban	36,494	3,454	9.5
Nonurban Areas	5,710	565	9.9
Total Urban and Nonurban	42,204	4,019	9.5

[a]This number represents the total number of vehicles observed which were described as "motor vehicles" in the child passenger protection law (see Appendix A). This number includes out-of-state vehicles.

[b]This number, taken from the raw data files, includes out-of-state vehicles (5.7 percent of total) observed with small children at the tier one observational level.

TABLE V-3

SUMMARY OF THIRD OPERATIONAL PERIOD RAW FIELD OBSERVATIONAL DATA
(Total Vehicles and Vehicles with Small Children)

Target Area	Number of Vehicles Observed[a]	Number of Vehicles with Small Children[b]	Percentage of Vehicles with Small Children
Memphis	6,079	573	9.4
Nashville	6,935	637	9.2
Knoxville	7,909	693	8.8
Chattanooga	5,347	388	7.3
Tri-Cities	7,275	519	7.1
Total Urban	33,545	2,810	8.4
Nonurban Areas	3,821	427	11.2
Total Urban and Nonurban	37,366	3,237	8.7

[a]This number represents the total number of vehicles observed which were described as "motor vehicles" in the child passenger protection law (see Appendix A). This number includes out-of-state vehicles.

[b]This number, taken from the raw data files, includes out-of-state vehicles (5.7 percent of total) observed with small children at the tier one observational level.

TABLE V-4

SUMMARY OF FOURTH OPERATIONAL PERIOD RAW FIELD OBSERVATIONAL DATA
(Total Vehicles and Vehicles with Small Children)

Target Area	Number of Vehicles Observed[a]	Number of Vehicles with Small Children[b]	Percentage of Vehicles with Small Children
Memphis	5,359	534	10.0
Nashville	7,786	662	8.5
Knoxville	9,747	710	7.3
Chattanooga	7,346	532	7.2
Tri-Cities	10,155	813	8.0
Total Urban	40,393	3,251	8.0
Nonurban Areas	4,502	528	11.7
Total Urban and Nonurban	44,895	3,779	8.4

[a]This number represents the total number of vehicles observed which were described as "motor vehicles" in the child passenger protection law (see Appendix A). This number includes out-of-state vehicles.

[b]This number, taken from the raw data files, includes out-of-state vehicles (5.7 percent of total) observed with small children at the tier one observational level.

baseline period. Percentages for other target areas were also comparable. The nonurban areas were slightly higher than the urban areas in the percentage of vehicles with small children.

A summary of the number of children observed and percentages of their dispositions is provided in Tables V-5 through V-8. The summary includes only child #1 and child #2, although occasionally as many as three or four small children estimated to be under four years of age were observed in one vehicle. Approximately the same percentage (13.5 percent) of second children (child #2) was observed during the operational periods as for the baseline period (12.8 percent). The percentage of use of CRDs for second children increased considerably between the baseline and operational periods; usage was only 1.9 percent for the baseline period but 4.3 percent for the operational periods. The percentage of second children being held by older passengers also increased from 5.8 percent to 6.7 percent.

Comparisons of the disposition of child #1 in the vehicle between the two periods showed 10.4 percent in CRDs for the baseline period and 15.8 percent for the operational periods. It was expected that the percentage of children being held by an older passenger might increase after the effective date of the law, but this did not occur as evidenced by comparing the two periods' percentages. Although the percentage of second children being held by older passengers was up for the operational periods, there was a decrease for first children (child #1) from 28.9 to 25.0 percent. The overall percentages of children (both child #1 and child #2) being held by older passengers were 26.0 for the baseline period and 22.6 for the operational periods.

Tier Two Level Data. A total of 7,180 observations of children under four years of age were made in the tier two level for the four operational periods. This is an average of 1,795 per period. This number included child #1 and child #2 in the vehicle; it was rare that more than two children under four years of age were observed in the same vehicle.

A tabulation of the percentages of children by age and sex is presented in Tables V-9 through V-12. An examination of the percentages of children by age and sex for the baseline and operational periods showed little difference overall. The major difference in the two data sets is between the percentages of children under age one in nonurban areas. The baseline data on children under one year of age in nonurban areas showed a relative low percentage (15.8); the data for the same age group for all operational periods showed 19.9 percent which is closer to the two overall percentages of 21.6 for the baseline period and 21.1 for the operational periods. Another variable in the data for the two periods was with the percentages of male and female children in nonurban areas. The baseline percentage for females was 46.4 compared to 50.2 for the operational periods.

A summary of drivers' relationships to children and drivers' sex is shown in Tables V-13 through V-16. The percentage for each relationship of drivers to children remained relatively constant for the operational periods and the baseline period. The percentage of male and female drivers with children under four years of age remained almost exactly the same for the nonurban areas for the baseline and operational periods, but there was an

TABLE V-5

SUMMARY OF PERCENTAGES OF DISPOSITIONS OF CHILDREN
OBSERVED AT THE TIER ONE LEVEL
FOR THE FIRST OPERATIONAL PERIOD
(Row Percentages)

Target Area	Child No.	Number of Observations	In CRD Percent	Held by Passenger Percent	Held by Driver Percent	Other Percent
Memphis	1	465	14.2	18.9	3.4	63.4
	2	61	4.9	19.7	1.6	73.8
Nashville	1	615	20.5	25.7	2.3	51.5
	2	73	5.5	5.5	0.0	89.0
Knoxville	1	637	19.0	34.7	1.6	44.7
	2	80	3.8	13.8	2.5	80.0
Chattanooga	1	603	16.7	27.7	3.8	51.7
	2	101	6.9	6.9	1.0	85.1
Tri-Cities	1	454	15.4	28.4	3.3	52.9
	2	52	7.7	9.6	0.0	82.7
Total Urban	1	2,774	17.4	27.5	2.8	52.2
	2	367	5.7	10.6	1.1	82.6
Nonurban	1	433	12.2	25.4	1.8	60.5
	2	85	2.4	2.4	1.2	94.1
Total Urban and Nonurban	1	3,207	16.7	27.2	2.7	53.4
	2	452	5.1	9.1	1.1	84.7

TABLE V-6

SUMMARY OF PERCENTAGES OF DISPOSITIONS OF CHILDREN OBSERVED AT THE TIER ONE LEVEL FOR THE SECOND OPERATIONAL PERIOD
(Row Percentages)

Target Area	Child No.	Number of Observations	In CRD Percent	Held by Passenger Percent	Held by Driver Percent	Other Percent
Memphis	1	651	13.1	21.2	2.3	63.4
	2	59	5.1	8.5	0.0	86.4
Nashville	1	692	12.9	17.9	2.3	66.9
	2	144	2.1	2.1	0.0	95.8
Knoxville	1	774	19.5	29.7	2.5	48.3
	2	115	5.2	5.2	1.7	87.8
Chattanooga	1	555	6.5	22.2	0.7	70.6
	2	94	1.1	1.1	0.0	97.9
Tri-Cities	1	654	11.5	33.6	3.8	51.1
	2	113	8.8	23.0	4.4	63.7
Total Urban	1	3,326	13.1	25.1	2.4	59.4
	2	525	4.4	7.8	1.3	86.5
Nonurban Areas	1	530	7.0	29.6	2.6	60.8
	2	79	0.0	8.9	1.3	89.8
Total Urban and Nonurban	1	3,856	12.3	25.7	2.4	59.6
	2	604	3.8	7.9	1.3	86.9

TABLE V-7

SUMMARY OF PERCENTAGES OF DISPOSITIONS OF CHILDREN OBSERVED AT THE TIER ONE LEVEL FOR THE THIRD OPERATIONAL PERIOD
(Row Percentages)

Target Area	Child No.	Number of Observations	In CRD Percent	Held by Passenger Percent	Held by Driver Percent	Other Percent
Memphis	1	583	20.1	17.8	4.1	58.0
	2	112	2.7	2.7	0.9	93.8
Nashville	1	620	16.1	25.2	2.1	56.6
	2	147	6.1	5.4	2.7	85.7
Knoxville	1	667	18.6	19.2	2.8	59.4
	2	128	2.3	3.1	0.8	93.8
Chattanooga	1	379	11.9	29.0	2.1	57.0
	2	59	1.7	3.4	1.7	93.2
Tri-Cities	1	509	14.9	25.7	1.6	57.8
	2	50	8.0	8.0	0.0	84.0
Total Urban	1	2,758	16.8	22.8	2.6	57.8
	2	496	4.0	4.2	1.4	90.3
Nonurban Areas	1	413	10.4	22.5	4.8	62.2
	2	54	0.0	1.9	0.0	98.1
Total Urban and Nonurban	1	3,171	15.9	22.8	2.9	58.4
	2	550	3.6	4.0	1.3	91.1

TABLE V-8

SUMMARY OF PERCENTAGES OF DISPOSITIONS OF CHILDREN OBSERVED AT THE TIER ONE LEVEL FOR THE FOURTH OPERATIONAL PERIOD
(Row Percentages)

Target Area	Child No.	Number of Observations	In CRD Percent	Held by Passenger Percent	Held by Driver Percent	Other Percent
Memphis	1	465	17.8	28.0	4.5	49.7
	2	80	3.8	3.8	1.3	91.3
Nashville	1	578	20.6	22.0	1.6	55.9
	2	111	5.4	0.9	0.0	93.7
Knoxville	1	701	22.3	26.1	5.4	46.2
	2	61	9.8	6.6	0.0	83.6
Chattanooga	1	601	19.3	25.1	3.3	52.2
	2	66	7.6	10.6	1.5	80.3
Tri-Cities	1	765	14.4	26.4	1.2	58.0
	2	161	1.9	8.7	0.0	89.4
Total Urban	1	3,110	18.8	25.5	3.1	52.6
	2	479	4.8	6.1	0.4	88.7
Nonurban Areas	1	487	15.8	18.1	3.9	62.2
	2	79	2.5	2.5	2.5	92.4
Total Urban and Nonurban	1	3,597	18.4	24.5	3.2	53.9
	2	558	4.5	5.6	0.7	89.2

TABLE V-9

SUMMARY OF AGE AND SEX OF CHILDREN AT THE TIER TWO LEVEL FOR THE FIRST OPERATIONAL PERIOD
(Row Percentages)

Target Area	Number of Observations	Information on Child*					
		By Age (Percent)				By Sex (Percent)	
		<1	1	2	3	F	M
Memphis	342	20.5	26.9	29.8	22.8	52.9	47.1
Nashville	415	27.2	28.0	22.4	22.4	49.9	50.1
Knoxville	399	18.6	29.3	26.3	25.8	47.6	52.4
Chattanooga	360	23.3	27.2	28.1	21.4	50.6	49.4
Tri-Cities	282	22.4	25.9	27.3	24.4	50.6	49.4
Total Urban	1,798	22.7	28.0	26.2	33.1	50.2	49.8
Nonurban Areas	344	22.4	25.9	27.3	24.4	50.6	49.4
Total Urban and Nonurban	2,142	22.6	27.6	26.4	23.3	50.3	49.7

*Children #1 and #2 only.

TABLE V-10

SUMMARY OF AGE AND SEX OF CHILDREN AT THE TIER TWO LEVEL FOR THE SECOND OPERATIONAL PERIOD
(Row Percentages)

Target Area	Number of Observations	Information on Child*					
		By Age (Percent)				By Sex (Percent)	
		<1	1	2	3	F	M
Memphis	298	25.1	24.1	29.5	21.4	56.4	43.6
Nashville	310	21.9	23.3	32.3	22.6	52.6	47.4
Knoxville	327	18.2	25.9	27.8	28.1	51.1	48.9
Chattanooga	235	12.9	25.8	32.6	28.8	53.2	46.8
Tri-Cities	247	17.2	25.8	26.2	30.7	52.6	49.4
Total Urban	1,417	19.4	24.9	29.6	26.1	53.1	46.9
Nonurban Areas	248	19.5	27.0	25.3	28.2	47.2	52.8
Total Urban and Nonurban	1,665	19.4	25.2	29.0	26.4	52.3	47.7

*Children #1 and #2 only.

TABLE V-11

SUMMARY OF AGE AND SEX OF CHILDREN AT THE TIER TWO LEVEL FOR THE THIRD OPERATIONAL PERIOD
(Row Percentages)

Target Area	Number of Observations	Information on Child*					
		By Age (Percent)				By Sex (Percent)	
		<1	1	2	3	F	M
Memphis	211	20.1	26.5	24.5	28.9	54.0	46.0
Nashville	293	28.8	28.8	20.7	21.7	50.5	49.5
Knoxville	317	21.4	26.0	28.0	24.7	52.7	47.3
Chattanooga	232	21.1	26.6	24.1	28.1	50.0	50.0
Tri-Cities	215	17.4	26.6	33.5	22.5	47.9	52.1
Total Urban	1,268	22.2	27.0	26.0	24.8	51.1	48.9
Nonurban Areas	200	20.3	26.6	30.7	22.4	49.0	51.0
Total Urban and Nonurban	1,468	22.0	26.9	26.6	24.5	50.8	49.2

*Children #1 and #2 only.

TABLE V-12

SUMMARY OF AGE AND SEX OF CHILDREN AT THE TIER TWO LEVEL FOR THE FOURTH OPERATIONAL PERIOD
(Row Percentages)

Target Area	Number of Observations	Information on Child*					
		By Age (Percent)				By Sex (Percent)	
		<1	1	2	3	F	M
Memphis	293	19.5	26.3	30.0	24.2	52.1	47.9
Nashville	322	18.9	33.9	27.0	20.2	49.2	50.8
Knoxville	312	18.3	30.1	26.6	25.0	51.7	48.3
Chattanooga	337	23.1	21.7	32.6	22.6	49.7	50.3
Tri-Cities	345	23.5	28.4	24.3	23.8	53.1	46.9
Total Urban	1,609	20.8	28.0	28.1	23.1	51.2	48.8
Nonurban Areas	296	17.2	27.0	31.4	24.3	54.2	45.8
Total Urban and Nonurban	1,905	20.2	27.9	28.6	23.3	51.7	48.3

*Children #1 and #2 only.

TABLE V-13

SUMMARY OF DRIVERS' RELATION TO CHILD(REN) AND SEX OF DRIVERS AT THE TIER TWO LEVEL FOR THE FIRST OPERATIONAL PERIOD
(Row Percentages)

Target Area	Number of Observations*	Drivers' Relation to Child(ren)				Number of Observations*	Drivers' Sex	
		Parent Percent	Relative Percent	Friend Percent	Other Percent		Female Percent	Male Percent
Memphis	313	87.2	10.6	2.2	0.0	285	70.2	29.8
Nashville	376	86.7	9.6	3.5	0.2	338	56.2	43.8
Knoxville	359	84.7	12.5	2.5	0.3	353	49.9	50.1
Chattanooga	333	88.3	9.3	1.8	0.6	304	53.6	46.4
Tri-Cities	247	91.1	7.3	1.6	0.0	255	53.3	46.7
Total Urban	1,628	87.3	10.0	2.4	0.3	1,535	56.4	43.6
Nonurban Areas	297	80.1	15.5	3.7	0.7	277	67.1	32.9
Total Urban and Nonurban	1,925	86.2	10.9	2.6	0.3	1,812	58.0	42.0

*Includes child #1 and child #2.

TABLE V-14

SUMMARY OF DRIVERS' RELATION TO CHILD(REN) AND SEX OF DRIVERS
AT THE TIER TWO LEVEL FOR THE SECOND OPERATIONAL PERIOD
(Row Percentages)

Target Area	Number of Observations*	Drivers' Relation to Child(ren)				Number of Observations*	Drivers' Sex	
		Parent Percent	Relative Percent	Friend Percent	Other Percent		Female Percent	Male Percent
Memphis	276	81.2	16.3	2.5	0.0	281	59.1	40.9
Nashville	300	89.7	8.7	1.7	0.0	272	46.7	53.3
Knoxville	297	83.2	12.5	3.4	1.0	302	64.6	35.4
Chattanooga	227	87.7	8.4	1.4	2.2	224	55.4	44.6
Tri-Cities	235	83.0	14.0	3.0	0.0	237	38.8	61.2
Total Urban	1,335	84.9	12.0	2.5	0.6	1,316	53.5	46.5
Nonurban Areas	237	80.6	15.2	3.0	1.3	233	64.8	35.2
Total Urban and Nonurban	1,572	84.3	12.5	2.5	0.7	1,549	55.2	44.8

*Includes child #1 and child #2.

TABLE V-15

SUMMARY OF DRIVERS' RELATION TO CHILD(REN) AND SEX OF DRIVERS
AT THE TIER TWO LEVEL FOR THE THIRD OPERATIONAL PERIOD
(Row Percentages)

Target Area	Number of Observations*	Drivers' Relation to Child(ren)				Number of Observations*	Drivers' Sex	
		Parent Percent	Relative Percent	Friend Percent	Other Percent		Female Percent	Male Percent
Memphis	181	89.0	7.7	2.2	1.1	190	65.8	34.2
Nashville	246	92.7	6.1	1.2	0.0	280	47.5	52.5
Knoxville	288	82.3	13.9	3.8	0.0	285	55.1	44.9
Chattanooga	211	87.2	11.8	0.9	0.0	212	60.4	39.6
Tri-Cities	202	87.6	10.9	1.5	0.0	195	47.2	52.8
Total Urban	1,128	87.5	10.3	2.0	0.2	1,162	54.6	45.4
Nonurban Areas	166	87.3	10.2	2.4	0.0	185	55.7	44.3
Total Urban and Nonurban	1,294	87.5	10.3	2.1	0.2	1,347	54.8	45.2

*Includes child #1 and child #2.

TABLE V-16

SUMMARY OF DRIVERS' RELATION TO CHILD(REN) AND SEX OF DRIVERS AT THE TIER TWO LEVEL FOR THE FOURTH OPERATIONAL PERIOD
(Row Percentages)

Target Area	Number of Observations*	Drivers' Relation to Child(ren)				Number of Observations*	Drivers' Sex	
		Parent Percent	Relative Percent	Friend Percent	Other Percent		Female Percent	Male Percent
Memphis	260	85.8	11.5	1.9	0.8	258	58.9	41.1
Nashville	264	94.3	3.4	1.9	0.4	286	52.1	47.8
Knoxville	282	87.2	9.9	2.5	0.4	279	57.7	42.3
Chattanooga	280	86.5	11.7	1.8	0.0	298	65.1	34.9
Tri-Cities	301	85.2	11.7	3.0	0.0	301	61.2	38.8
Total Urban	1,387	87.7	9.7	2.2	0.3	1,422	59.1	40.9
Nonurban Areas	288	82.8	13.4	3.4	0.3	278	75.2	24.8
Total Urban and Nonurban Areas	1,675	86.9	10.4	2.4	0.3	1,700	61.7	38.3

*Includes child #1 and child #2.

increase in the percentage of female drivers in the urban areas over the baseline percentages; 50.9 percent for the baseline and 55.9 percent for the operational periods.

A comparison of users and nonusers of CRDs by driver's sex was made for the operational periods (see Tables V-17 through V-20). Only minor differences were found in the percentages of males and females who used CRDs in the baseline period and in the operational periods. Among all drivers not utilizing CRDs, 56.2 percent during the operational periods were females compared to 52.7 percent that were females during the baseline period. The baseline data showed more male than female nonusers of CRDs in urban areas. The data collected after the law became effective showed more females were nonusers in urban areas.

Information collected during the operational periods on the properties of vehicles parallel those collected in the baseline period. These two sets of data are presented in Appendix J.

There was no noticeable difference in the percentages of types of CRDs owned when the data sets for the two periods were compared (Table IV-6 and Tables V-21 through V-24). Information about manufacturers for the operational period is found in Appendix K.

A comparison of CRD types by use/nonuse is presented in Tables V-25 through V-28. These tables can be compared to the parallel table in Chapter IV (Table IV-7). The percentages of usage of CRDs for both periods were close. Use of protective shield types showed some large percentage increases; however, frequencies were low for use of this type.

Of those CRDs observed in vehicles but not being used, nonuse car seat type CRDs increased while nonuse infant carriers decreased. During the baseline period, 75.4 percent of all CRDs not in use were the car seat type, but during the operational period this percentage climbed to 77.8 percent for all areas surveyed. Infant carrier percentages of nonuse went from 20.4 percent to 14.9 percent for all target areas combined. The greatest difference occurred in the nonurban areas where nonusage dropped from 31.3 percent to 10.2 percent for the two time periods.

It is suspected that one reason the percentages of nonuse were up for car seats and down for infant carriers is that many CRDs (all types) were purchased to obey the law, but parents found toddlers to be much harder to keep in CRDs than infants.

Child Restraint Device Usage Comparisons. A compilation of percentages of use at each tier level for each target area was made for each operational periods (Tables V-29 through V-32). A comparison of these tables with Table IV-8 shows an approximate proportionate increase in percentage of use for each target area for each level of data, with the overall rate increasing from 9.2 percent to 14.3 percent for tier one data and from 12.9 percent to 22.8 percent for tier two data.

A composite usage percentage was calculated for the operational period data using the equations discussed in Chapter IV and Appendix I. The

TABLE V-17

COMPARISON OF MALE AND FEMALE DRIVERS AMONG USERS AND NONUSERS OF CRDs AT THE TIER TWO LEVEL FOR THE FIRST OPERATIONAL PERIOD
(Row Percentages)

Target Area	Number of Observations	Drivers with Child(ren) Using CRDs*			Drivers with Child(ren) Not Using CRDs		
		N	Female Percent	Male Percent	N	Female Percent	Male Percent
Memphis	272	54	68.5	31.5	218	71.1	28.9
Nashville	329	106	55.7	44.3	223	56.1	43.9
Knoxville	344	91	51.6	48.4	253	49.8	50.2
Chattanooga	292	55	61.8	38.2	237	50.6	49.4
Tri-Cities	246	56	48.2	51.8	190	55.3	44.7
Total Urban	1,483	362	56.4	43.6	1,121	56.3	43.7
Nonurban Areas	272	43	79.1	20.9	229	65.5	34.5
Total Urban and Nonurban	1,755	405	58.8	41.2	1,350	57.9	42.1

*Includes child #1 only.

TABLE V-18

COMPARISON OF MALE AND FEMALE DRIVERS AMONG USERS AND NONUSERS OF CRDs AT THE TIER TWO LEVEL FOR THE SECOND OPERATIONAL PERIOD
(Row Percentages)

Target Area	Number of Observations	Drivers with Child(ren) Using CRDs*			Drivers with Child(ren) Not Using CRDs		
		N	Female Percent	Male Percent	N	Female Percent	Male Percent
Memphis	271	70	62.9	37.1	201	57.2	42.8
Nashville	263	68	55.9	44.1	195	44.6	55.4
Knoxville	298	71	63.4	36.6	227	65.6	34.4
Chattanooga	220	32	65.6	34.4	188	54.3	45.7
Tri-Cities	233	43	32.6	67.4	190	39.5	60.5
Total Urban	1,285	284	57.0	43.0	1,001	52.7	47.3
Nonurban Areas	228	30	70.0	30.0	198	64.1	35.9
Total Urban and Nonurban	1,513	314	58.3	41.7	1,199	54.6	45.4

*Drivers with at least one child in a CRD.

TABLE V-19

COMPARISON OF MALE AND FEMALE DRIVERS AMONG USERS AND NONUSERS OF CRDs AT THE TIER TWO LEVEL FOR THE THIRD OPERATIONAL PERIOD
(Row Percentages)

Target Area	Number of Observations	Drivers with Child(ren) Using CRDs*			Drivers with Child(ren) Not Using CRDs		
		N	Female Percent	Male Percent	N	Female Percent	Male Percent
Memphis	185	62	71.0	29.0	123	62.6	37.4
Nashville	267	76	47.4	52.6	191	47.6	52.4
Knoxville	278	77	57.1	42.9	201	54.2	45.8
Chattanooga	205	43	74.4	25.6	162	54.9	45.1
Tri-Cities	192	53	60.4	39.6	139	43.2	56.8
Total Urban	1,127	311	60.5	39.5	816	52.2	47.8
Nonurban Areas	175	30	60.0	40.0	145	53.8	46.2
Total Urban and Nonurban	1,302	341	60.4	39.6	961	52.4	47.6

*Drivers with at least one child in a CRD.

TABLE V-20

COMPARISON OF MALE AND FEMALE DRIVERS AMONG USERS AND NONUSERS OF CRDs AT THE TIER TWO LEVEL FOR THE FOURTH OPERATIONAL PERIOD
(Row Percentages)

Target Area	Number of Observations	Drivers with Child(ren) Using CRDs*			Drivers with Child(ren) Not Using CRDs		
		N	Female Percent	Male Percent	N	Female Percent	Male Percent
Memphis	253	77	61.0	39.0	176	57.4	42.6
Nashville	276	93	55.9	44.1	183	49.7	50.3
Knoxville	270	99	61.6	38.4	171	54.4	45.6
Chattanooga	292	105	73.3	26.7	187	61.5	38.5
Tri-Cities	291	92	63.0	37.0	199	59.8	40.2
Total Urban	1,382	466	63.3	36.7	916	56.7	43.3
Nonurban Areas	252	53	77.4	22.6	199	75.4	24.6
Total Urban and Nonurban	1,634	519	64.7	35.3	1,115	60.0	40.0

*Divers with at least one child in a CRD.

TABLE V-21

CRD OWNERSHIP BY TYPE FOR THE FIRST OPERATIONAL PERIOD
(Row Percentages)

CRD Disposition	Number of Types Identified	Infant Carrier Percent	Protective Shield Percent	Car Seat Percent	Harness Percent
Not Present in Vehicle	449	6.7	8.7	82.4	2.2
Present in Vehicle	646	19.7	4.3	75.2	0.8
Present and in Use in Vehicle	411	20.9	5.1	73.3	0.7

TABLE V-22

CRD OWNERSHIP BY TYPE FOR THE SECOND OPERATIONAL PERIOD
(Row Percentages)

CRD Disposition	Number of Types Identified	Infant Carrier Percent	Protective Shield Percent	Car Seat Percent	Harness Percent
Not Present in Vehicle	355	11.8	6.8	78.3	3.1
Present in Vehicle	528	20.5	4.4	74.2	0.9
Present and in Use in Vehicle	331	21.7	2.9	74.5	0.9

TABLE V-23

CRD OWNERSHIP BY TYPE FOR THE THIRD OPERATIONAL PERIOD
(Row Percentages)

CRD Disposition	Number of Types Identified	Infant Carrier Percent	Protective Shield Percent	Car Seat Percent	Harness Percent
Not Present in Vehicle	280	5.4	13.2	80.4	1.1
Present in Vehicle	559	16.1	4.1	76.6	3.2
Present and in Use in Vehicle	378	18.0	2.9	75.9	3.2

TABLE V-24

CRD OWNERSHIP BY TYPE FOR THE FOURTH OPERATIONAL PERIOD
(Row Percentages)

CRD Disposition	Number of Types Identified	Infant Carrier Percent	Protective Shield Percent	Car Seat Percent	Harness Percent
Not Present in Vehicle	207	8.2	8.7	76.3	6.8
Present in Vehicle	835	18.4	3.1	74.6	3.8
Present and in Use in Vehicle	520	19.4	2.5	74.0	4.0

TABLE V-25

COMPARISON OF CRD TYPES OBSERVED AT THE TIER TWO LEVEL
FOR THE FIRST OPERATIONAL PERIOD
(Row Percentages)

Area(s)	Number of Observations of CRD's		Infant Carrier Percent	Protective Shield Percent	Car Seat Percent	Harness Percent
Total Urban	Used	367	19.9	5.2	74.1	0.8
	Not Used	131	13.0	3.1	84.0	0.0
Nonurban Areas	Used	44	29.5	4.6	65.9	0.0
	Not Used	28	14.3	3.6	75.0	7.1
Total Urban and Nonurban	Used	411	20.9	5.2	73.2	0.7
	Not Used	159	13.2	3.1	82.4	1.3

TABLE V-26

COMPARISON OF CRD TYPES OBSERVED AT THE TIER TWO LEVEL
FOR THE SECOND OPERATIONAL PERIOD
(Row Percentages)

Area(s)	Number of Observations of CRDs		Infant Carrier Percent	Protective Shield Percent	Car Seat Percent	Harness Percent
Total Urban	Used	285	22.5	2.8	73.7	1.1
	Not Used	140	22.1	5.7	71.4	0.7
Nonurban Areas	Used	30	20.0	0.0	80.0	0.0
	Not Used	25	4.0	8.0	88.0	0.0
Total Urban and Nonurban	Used	315	22.2	2.5	74.3	1.0
	Not Used	165	19.4	6.1	73.9	0.6

TABLE V-27

COMPARISON OF CRD TYPES OBSERVED AT THE TIER TWO LEVEL
FOR THE THIRD OPERATIONAL PERIOD
(Row Percentages)

Area(s)	Number of Observations of CRDs		Infant Carrier Percent	Protective Shield Percent	Car Seat Percent	Harness Percent
Total Urban	Used	317	17.4	3.5	76.7	2.5
	Not Used	132	12.1	6.8	76.5	4.5
Nonurban Areas	Used	31	25.8	0.0	71.0	3.2
	Not Used	14	7.1	0.0	92.9	0.0
Total Urban and Nonurban	Used	348	18.1	3.2	76.1	2.6
	Not Used	146	11.6	6.2	78.1	4.1

TABLE V-28

COMPARISON OF CRD TYPES OBSERVED AT THE TIER TWO LEVEL
FOR THE FOURTH OPERATIONAL PERIOD
(Row Percentages)

Area(s)	Number of Observations of CRDs		Infant Carrier Percent	Protective Shield Percent	Car Seat Percent	Harness Percent
Total Urban	Used	466	20.2	2.6	73.0	4.3
	Not Used	178	15.7	5.1	77.0	2.2
Nonurban Areas	Used	54	13.0	1.9	83.3	1.9
	Not Used	33	15.2	6.1	75.8	3.0
Total Urban and Nonurban	Used	520	19.4	2.5	74.0	4.0
	Not Used	211	15.6	5.2	76.8	2.4

TABLE V-29

PERCENTAGES OF FIRST OPERATIONAL OBSERVATIONS OF SMALL CHILDREN AND CRD USAGE AT THE TIER ONE AND TIER TWO LEVELS

Target Area	Tier 1			Tier 2		
	Number of Observations of Small Children	Number and Percent of Children in CRDs		Number of Observations of Small Children	Number and Percent of Children in CRDs	
Memphis	526	69	13.1	341	62	18.2
Nashville	688	130	18.9	425	117	27.5
Knoxville	717	124	17.3	395	98	24.8
Chattanooga	704	108	15.3	371	72	19.4
Tri-Cities	506	74	14.6	289	60	20.8
Total Urban	3,141	505	16.1	1,821	409	22.5
Nonurban Areas	513	53	10.3	348	47	13.5
Total Urban and Nonurban	3,654	558	15.3	2,169	456	21.0

TABLE V-30

PERCENTAGES OF SECOND OPERATIONAL OBSERVATIONS OF SMALL CHILDREN AND CRD USAGE AT THE TIER ONE AND TIER TWO LEVELS

Target Area	Tier 1			Tier 2		
	Number of Observations of Small Children	Number and Percent of Children in CRDs		Number of Observations of Small Children	Number and Percent of Children in CRDs	
Memphis	710	88	12.4	326	76	23.3
Nashville	836	92	11.0	325	77	23.7
Knoxville	889	157	17.7	362	78	21.5
Chattanooga	649	37	5.7	258	32	12.4
Tri-Cities	767	85	11.1	264	45	17.0
Total Urban	3,851	459	11.9	1,535	308	20.1
Nonurban Areas	609	37	6.1	269	31	11.5
Total Urban and Nonurban	4,460	496	11.1	1,804	339	18.8

TABLE V-31

PERCENTAGES OF THIRD OPERATIONAL OBSERVATIONS OF SMALL CHILDREN AND CRD USAGE AT THE TIER ONE AND TIER TWO LEVELS

Target Area	Tier 1			Tier 2		
	Number of Observations of Small Children	Number and Percent of Children in CRDs		Number of Observations of Small Children	Number and Percent of Children in CRDs	
Memphis	695	120	17.3	233	66	28.3
Nashville	767	109	14.2	329	86	26.1
Knoxville	795	127	16.0	347	83	23.9
Chattanooga	438	46	10.5	249	45	18.1
Tri-Cities	559	80	14.3	228	55	24.1
Total Urban	3,254	482	14.8	1,386	335	24.2
Nonurban Areas	467	43	9.2	218	31	14.2
Total Urban and Nonurban	3,721	525	14.1	1,604	366	22.8

TABLE V-32

PERCENTAGES OF FOURTH OPERATIONAL OBSERVATIONS OF SMALL CHILDREN AND CRD USAGE AT THE TIER ONE AND TIER TWO LEVELS

Target Area	Tier 1			Tier 2		
	Number of Observations of Small Children	Number and Percent of Children in CRDs		Number of Observations of Small Children	Number and Percent of Children in CRDs	
Memphis	545	86	15.8	300	85	28.3
Nashville	689	125	18.1	333	102	30.6
Knoxville	762	162	21.3	330	111	33.6
Chattanooga	667	121	18.1	340	110	32.4
Tri-Cities	926	113	12.2	358	105	29.3
Total Urban	3,589	607	16.9	1,661	513	30.9
Nonurban Areas	566	79	14.0	322	56	17.4
Total Urban and Nonurban	4,155	686	16.5	1,983	569	28.7

summary of the numbers of observations on which the calculations were based and the usage rates are shown in Tables V-33 through V-36. The overall usage rate for the operational periods was 18.1 percent based on a weighted average of all target areas. This is an increase from 10.9 percent during the baseline period. The largest increase occurred in Nashville (14.0 percent to 21.3 percent). Chattanooga had the least change between periods (10.9 percent to 16.0 percent). All urban areas combined went from 11.8 percent to 19.1 percent usage. Nonurban areas had a 91 percent change from 6.5 percent to 12.4 percent in usage.

In the discussions of changes of usage from baseline to operational periods, only target areas or groups of target areas have been mentioned. Those were important for comparisons because of the levels of treatment. But statewide CRD usage was also estimated for comparative purposes.

The 1975 estimate of population in Tennessee was 4,174,000; of this number 61.4 percent lived in the five major standard metropolitan statistical areas (SMSA) of the state. The urban sample was taken at shopping centers which had market areas approximately coinciding with the SMSA boundaries. Since a portion of the SMSA is relatively rural, the percentage of 61.4 was reduced to 50 percent to satisfy the definition of urban and rural. This premise was used to estimate that statewide about 9.2 percent of those subject to the child passenger law were using CRDs during the baseline period before January 1, 1978 (Table V-37). The overall state CRD usage rate utilizing the same rationale of weighting by a 50-50 population split was 15.4 percent when measured for the first operational period in June 1978. This represents an increase of 6.2 percentage points or a 67.4 percent change from the baseline condition.

Data collected in the first operational period, approximately six months after the baseline collection, revealed an increase in usage in each target area. Usage in Nashville had increased by 8.1 percentage points to 22.1 percent usage. Usage in nonurban areas had increased to 12.5 percent (6.0 percentage points increase), and usage in all urban areas went to 18.3 percent from 11.3 percent. A comparison of the CRD usage rates are shown in tabular form (Table V-37). The percentage estimates for the state were generally on an incline for the study period although a two percentage point decrease occurred between the first and second operational periods. The urban areas where the comprehensive plan was initially implemented showed the greatest increases between periods.

Results of Statistical Analysis of Child Restraint Device Usage Rates

In longitudinal comparisons, all six target areas shown in Table V-37, whether taken individually or grouped, have significantly higher CRD usage rates ($\alpha \leq .05$) at the end of the two-year period when compared to the corresponding baseline measures. The urban average is 94 percent larger than its baseline; the nonurban average is 123 percent higher than its baseline; and statewide estimates show a change from a 9.2 percent baseline measure to an 18.7 percent CRD usage rate in the fourth operational period, which is a 103 percent increase over baseline.

The general trend shown in Table V-37 is to begin with low baseline rates; then a significant increase in CRD usage at all target areas in the

TABLE V-33

COMPOSITE FIRST OPERATIONAL CRD USAGE RATES USING BOTH TIER ONE AND TIER TWO LEVEL DATA

Target Area	Tier One Data Unmatched With Tier Two[a]	Tier Two Only Data	Tier One/Tier Two Matched Data	Effective Number of Observations[b]	Composite CRD Usage Rate Percent
Memphis	305	62	279	532	13.5
Nashville	425	94	331	737	22.1
Knoxville	464	66	329	711	20.4
Chattanooga	448	96	275	742	16.5
Tri-Cities	291	45	244	519	17.9
Total Urban	387[c]	73[c]	292[c]	648[c]	18.4[d]
Nonurban Areas	287	62	286	521	12.5
Total Urban and Nonurban	370[c]	71[c]	291[c]	627[c]	17.5[d]

[a]Includes tier one data of overage children and refusals at the tier two level.

[b]See Appendix I.

[c]Averages.

[d]Weighted averages.

TABLE V-34

COMPOSITE SECOND OPERATIONAL CRD USAGE RATES USING BOTH TIER ONE AND TIER TWO LEVEL DATA

Target Area	Tier One Data Unmatched With Tier Two[a]	Tier Two Only Data	Tier One/Tier Two Matched Data	Effective Number of Observations[b]	Composite CRD Usage Rate Percent
Memphis	491	108	218	652	16.3
Nashville	580	89	236	635	19.4
Knoxville	586	71	291	724	23.3
Chattanooga	426	48	210	498	9.2
Tri-Cities	545	51	213	528	15.1
Total Urban	525[c]	73[c]	234[c]	607[c]	17.0[d]
Nonurban Areas	429	97	172	538	9.7
Total Urban and Nonurban	509[c]	77[c]	224[c]	596[c]	15.9[d]

[a]Includes tier one data of overage children and refusals at the tier two level.

[b]See Appendix I.

[c]Averages.

[d]Weighted averages.

TABLE V-35

COMPOSITE THIRD OPERATIONAL CRD USAGE RATES USING BOTH TIER ONE AND TIER TWO LEVEL DATA

Target Area	Tier One Data Unmatched With Tier Two[a]	Tier Two Only Data	Tier One/Tier Two Matched Data	Effective Number of Observations[b]	Composite CRD Usage Rate Percent
Memphis	582	119	111	460	22.4
Nashville	566	139	191	660	19.1
Knoxville	518	87	260	694	21.5
Chattanooga	254	69	180	413	14.7
Tri-Cities	386	50	178	444	19.6
Total Urban	461[c]	93.4[c]	183[c]	534[c]	18.1[d]
Nonurban Areas	307	53	165	436	13.0
Total Urban and Nonurban	436[c]	86[c]	180[c]	518[c]	17.4[d]

[a]Includes tier one data of overage children and refusals at the tier two level.

[b]See Appendix I.

[c]Averages.

[d]Weighted averages.

TABLE V-36

COMPOSITE FOURTH OPERATIONAL CRD USAGE RATES USING TIER ONE AND TIER TWO LEVEL DATA

Target Area	Tier One Data Unmatched With Tier Two	Tier Two Only Data	Tier One/Tier Two Matched Data	Effective Number of Observations[b]	Composite CRD Usage Rate Percent
Memphis	409	123	180	599	18.9
Nashville	548	128	221	698	24.6
Knoxville	553	52	278	660	26.9
Chattanooga	532	190	153	686	23.7
Tri-Cities	762	180	175	710	20.6
Total Urban	561[c]	135[c]	201[c]	671[c]	22.9[d]
Nonurban Areas	373	104	224	627	14.5
Total Urban and Nonurban	530[c]	130[c]	205[c]	663[c]	21.6[d]

[a]Includes tier one data of overage children and refusals at the tier two level.

[b]See Appendix I.

[c]Averages.

[d]Weighted averages.

TABLE V-37

STATEWIDE CRD USAGE RATE ESTIMATES

Target Area	Baseline	First Operational Period	Second Operational Period	Third Operational Period	Fourth Operational Period
Nashville	14.0	22.1 (CP)	19.0 (CP)	19.1 (CP)	24.6 (CP)
Memphis	10.9	13.5 (BSP)	16.5 (CP)	22.6 (CP)	18.9 (CP)
Knoxville	12.8	20.4 (BSP)	22.3 (CP)	21.5 (CP)	26.9 (CP)
Chattanooga	10.9	16.5 (BSP)	9.2 (BSP)	15.0 (CP)	23.7 (CP)
Tri-Cities	10.7	17.9 (BSP)	15.1 (BSP)	19.9 (BSP)	20.6 (CP)
Urban Average[a]	11.8	18.3	17.0	20.0	22.9
Nonurban Average	6.5	12.5 (BSP)	9.7 (BSP)	13.0 (CP)	14.5 (CP)
Statewide Estimates[b]	9.2	15.4	13.4	16.5	18.7

[a]Weight according to sample size.

[b]Estimate = ½ (rural + urban average)

BSP = Basic State Plan

CP = Comprehensive Plan

first operational period is shown; next a general decline in the second operational period occurs, somewhat offset by significant increases in CRD usage in Knoxville and Memphis (corresponding to the introduction of their comprehensive PI&E plans); and finally general increases in CRD usage are found in the third and fourth operational periods.

The comparison of PI&E programs is not straightforward unless other time trends are ignored. Under this limitation, Figure V-3 is helpful in illustrating CRD usage rates by target area and PI&E plan. Figure V-3 is based on Table V-37. The figure reveals that, in every contrast indicated by arrow pairs, each basic state plan CRD usage rate is significantly higher than its corresponding baseline value. In turn, each comprehensive plan CRD usage rate is significantly higher than its corresponding basic state plan value. It also shows that Nashville's four periods of the comprehensive plan led to significantly higher rates compared to its baseline measure.

An alternative method of comparing PI&E plans is available if the basic differences between urban target areas are considered negligible. Under this assumption, the PI&E plans can be contrasted within the first, second and third operational periods using the urban data:

Period	1	2	3
CP	22.1	19.3	19.6
BSP	17.3	12.2	19.9

The comparison shows that the comprehensive plan rates of CRD usage are significantly higher than the corresponding basic state plan rates in the first and second operational periods. While the two CRD usage rates are equivalent in the third operational period, it should be recalled that Chattanooga was the only target area receiving the basic state plan in the third operational period. Thus bleeding of information from the comprehensive plan could have been severe, not only accumulating with time but also from all other target areas, including the nonurban sites. It is not surprising that this was the only time the comprehensive plan did not outperform the basic state plan.

Finally, it should be noted that, within each period, the nonurban CRD usage rate was significantly lower than the average of those urban areas receiving the comparable PI&E plan.

Contingency Table Analysis of Child Restraint Device Usage. The same variables were chosen to be cross tabulated with CRD usage for the operational periods as were selected for analysis using baseline data. Comparisons of these analyses will be made in this section by characteristics of the children observed, family characteristics, vehicle information and CRD type.

CRD usage was up considerably by age of child for the operational periods over the baseline period as may be seen by comparing Tables V-38 through V-41 with Table IV-10. There was an overall increase of approximately 15 percentage points in usage for the less than one year old age

	Baseline	BSP (average)	CP (average)
Nashville	14.0		21.2
Memphis	10.9	13.5	19.3
Knoxville	12.8	20.4	23.6
Chattanooga	10.9	12.9	19.4
Tri-Cities	10.7	17.6	20.6
Urban Average	11.8	16.1	21.0
Nonurban Avg.	6.5	11.1	13.8
Statewide Estimates	9.2	13.6	17.4

BSP = Basic State Plan
CP = Comprehensive Plan

FIGURE V-3

COMPARISON OF USAGE RATE CHANGES

TABLE V-38

CHILDREN CHARACTERISTICS VERSUS CRD USAGE RATES
FOR THE FIRST OPERATIONAL PERIOD

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Age:			107.3	<0.001
<1	404	34.9		
1	520	28.8		
2	505	18.4		
3	425	7.5		
Sex:			0.03*	0.854
Female	905	22.1		
Male	886	22.6		

*Corrected Chi-Square.

TABLE V-39

CHILDREN CHARACTERISTICS VERSUS CRD USAGE RATES
FOR THE SECOND OPERATIONAL PERIOD

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Age:			90.87	0.0000
<1	323	34.1		
1	414	26.6		
2	448	14.5		
3	374	8.3		
Sex:			0.00027	0.9870
Female	754	20.8		
Male	707	20.7		

TABLE V-40

CHILDREN CHARACTERISTICS VERSUS CRD USAGE RATES
FOR THE THIRD OPERATIONAL PERIOD

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Age:			96.27	0.000
<1	281	43.4		
1	381	32.5		
2	344	19.5		
3	306	10.8		
Sex:			2.42	0.1194
Female	637	27.6		
Male	630	23.7		

TABLE V-41

CHILDREN CHARACTERISTICS VERSUS CRD USAGE RATES
FOR THE FOURTH OPERATIONAL PERIOD

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Age:			82.32	0.0000
<1	337	45.7		
2	467	36.6		
3	507	27.4		
4	393	16.5		
Sex:			0.17	0.6841
Female	826	31.7		
Male	770	30.6		

group. Usage with the one year old age group increased 12.3 percentage points while usage with the two year old group increased at 11.9 percent. The difference was much smaller (6.1 percent to 10.8 percent) for three year old children. As with baseline data, age again was found to be a highly significant contributor to CRD usage.

There was no significant relationship between CRD usage and the sex of the child during the operational period. The number of children in the vehicle under four years of age was a significant factor in determining CRD usage during the baseline period. But, as shown in Tables V-42 through V-45, the percentage of usage when only one child was present increased to the point that there was no significant relationship between usage and the number of children in the vehicle for three of the four operational periods. The percentage for one child being present and using CRDs changed overall from 12.8 percent for the baseline period to 24.0 percent for the operational periods.

Those family characteristics which were significant in determining usage were family income, marital status, number of children four years of age and older in the vehicle, number of adults in the vehicle, driver relationship to the child, employment status of respondent, employment status of couple (respondent and respondent's mate combined) and educational status of respondent, respondent's mate and couple (Tables V-46 through V-49). The levels of significance differed to some extent for all variables considered, but the variables which were consistently significant at a high level of confidence were family income, marital status, number of adults in the vehicle, employment status of couple, educational status of respondent's mate and educational status of couple.

Vehicle ownership was the only variable which did not vary in significance over the study (see Tables V-50 through V-53). The number of vehicles owned was generally a significant factor relative to CRD usage. The year of the vehicle variable changed for an insignificant influence in the baseline period to a significant influence during the operational periods. Manufacturer of vehicle remained a constant insignificant factor on CRD usage. Vehicle size showed as significant for subcompacts over compacts and full-size vehicles for the first operational period only. In other periods all variation by vehicle size is insignificant. No explanation is offered for this erratic result.

CRD usage was cross tabulated with the four types of CRDs used for each operational period (see Tables V-54 through V-57). These cross tabulations were compared to the one performed for the data collected during the baseline period. The chi-square significance testing for the first operational period data on types and usage showed that there was a significant difference in usage between the types used, but no significant difference occurred in following periods. Prior to January 1, 1978, there was no significant difference shown in usage with relation to types used. The frequency counts for harnesses and protective shields were relatively low as during the baseline period.

This comparison points out again that more parents/guardians purchased and used infant carriers during the operational periods. The increased use of infant carriers may be attributed to the convenience of and relative ease

TABLE V-42

CRD USAGE VERSUS NUMBER OF CHILDREN IN THE VEHICLE
FOR THE FIRST OPERATIONAL PERIOD

Number of Children Under Age 4 in Vehicle	Number of Observations	CRD Usage Rate	Chi-Square	Significance Level
			4.1	0.1295
1	1,636	21.6		
2	206	27.7		
3	15	26.7		

TABLE V-43

CRD USAGE VERSUS NUMBER OF CHILDREN IN THE VEHICLE
FOR THE SECOND OPERATIONAL PERIOD

Number of Children Under Age 4 in Vehicle	Number of Observations	CRD Usage Rate	Chi-Square	Significance Level
			4.529	0.1039
1	1,386	19.8		
2	167	21.0		
3	11	45.5		

TABLE V-44

CRD USAGE VERSUS NUMBER OF CHILDREN IN THE VEHICLE FOR THE THIRD OPERATIONAL PERIOD

Number of Children Under Age 4 in Vehicle	Number of Observations	CRD Usage Rate	Chi-Square	Significance Level
			4.06	0.254
1	1,191	25.2		
2	163	28.8		
3	10	20.0		

TABLE V-45

CRD USAGE VERSUS NUMBER OF CHILDREN IN THE VEHICLE FOR THE FOURTH OPERATIONAL PERIOD

Number of Children Under Age 4 in Vehicle	Number of Observations	CRD Usage Rate	Chi-Square	Significance Level
			15.09	0.0005
1	1,510	29.5		
2	193	43.0		
3	6	16.7		

TABLE V-46

FAMILY CHARACTERISTICS VERSUS CRD USAGE RATES FOR THE FIRST OPERATIONAL PERIOD

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Family Income:			25.35	<0.001
0,000- 9,999	397	16.4		
10,000-14,999	336	25.9		
15,000-19,999	266	29.7		
20,000+	297	31.3		
Marital Status:			15.45*	0.001
Married/living with mate	1,368	25.1		
Single/living without a mate	147	10.2		
Number of Children in Vehicle (4-17 years old):			13.63	0.008
1	491	24.2		
2	184	17.4		
3	50	4.0		
4 or more	22	18.2		
Number of Adults in Vehicle:			20.51	0.001
1	838	23.0		
2	430	19.3		
3	74	2.7		
4 or more	18	5.6		
Driver Relationship to the Child:			30.28	<0.001
Parent	1,471	24.6		
Nonparent	226	8.0		

TABLE V-46 (Continued)

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Employment Status of Respondent:			18.28	0.001
Full-time	836	23.1		
Part-time	101	28.7		
Homemaker	439	28.0		
Student, retired or other	43	11.6		
Unemployed	70	8.6		
Employment Status of Respondent's Mate:			4.47	0.346
Full-time	995	24.4		
Part-time	43	32.6		
Homemaker	244	28.7		
Student, retired or other	41	19.5		
Unemployed	36	19.4		
Employment Status of Couple:			12.16	0.007
Both full-time	446	20.2		
1 full-time, 1 not full-time and not Homemaker	193	26.9		
1 full-time, 1 homemaker	635	29.3		
Both less than full-time	17	17.6		
Educational Status of Respondent:			67.04	<0.001
Less than high school	150	14.0		
High school, G.E.D. and/or vocational/technical school	755	18.4		
Some college (no degree)	260	24.2		
College degree(s)	344	39.5		

TABLE V-46 (Continued)

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Educational Status of Respondent's Mate:			79.15	<0.001
Less than high school	188	18.1		
High school, G.E.D. and/or vocational/technical school	635	17.2		
Some college (no degree)	242	25.6		
College degree(s)	322	42.5		
Educational Status of Couple:			73.41	<0.001
Both less than high school	71	15.5		
1 with high school vocational technical, 1 less than high school	170	18.8		
Both with high school vo-tech some college	607	17.3		
1 with college degree(s) 1 with less than college degree	50	24.0		
Both with college degree(s)	427	39.3		

*Corrected Chi-Square.

TABLE V-47

FAMILY CHARACTERISTICS VERSUS CRD USAGE RATES FOR THE SECOND OPERATIONAL PERIOD

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Family Income:			44.34	<0.001
0,000- 9,999	331	10.0		
10,000-14,999	334	22.5		
15,000-19,999	254	28.0		
20,000+	274	30.2		
Marital Status:			5.83	0.0158
Married/living with mate	1,268	22.2		
Single/living without a mate	127	12.6		
Number of Children in Vehicle (4-17 years old):			4.06	0.2549
1	446	16.4		
2	140	12.1		
3	49	16.3		
4 or more	14	0.0		
Number of Adults in Vehicle:			20.534	<0.001
1	631	22.2		
2	470	14.9		
3	85	7.1		
4 or more	14	0.0		
Driver Relationship to the Child:			26.53	<0.001
Parent	1,190	23.0		
Nonparent	217	7.4		

TABLE V-47 (Continued)

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Employment Status of Respondent:			8.926	0.0630
Full-time	840	20.0		
Part-time	93	21.5		
Homemaker	340	26.8		
Student, retired or other	53	15.1		
Unemployed	66	16.7		
Employment Status of Respondent's Mate:			5.37	0.2509
Full-time	874	22.9		
Part-time	49	20.4		
Homemaker	251	23.5		
Student, retired or other	49	20.4		
Unemployed	58	10.3		
Employment Status of Couple:			15.635	<0.001
Both full-time	0	0.0		
1 full-time, 1 not full-time and not homemaker	889	21.3		
1 full-time, 1 homemaker	312	28.5		
Both less than full-time	72	8.3		
Educational Status of Respondent:			79.0265	<0.001
Less than high school	161	7.5		
High school, G.E.D. and/or vocational/technical school	674	15.6		
Some college (no degree)	250	28.0		
College degree(s)	309	36.2		

TABLE V-47 (Continued)

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Educational Status of Respondent's Mate:			51.69	<0.001
Less than high school	176	10.8		
High school, G.E.D. and/or vocational technical school	624	18.6		
Some college (no degree)	214	24.3		
College degree(s)	282	36.5		
Educational Status of Couple:			56.76	<0.001
Both less than high school	2	0.0		
1 with high school vocational technical, 1 less than high school	216	10.6		
Both with high school/vocational technical/some college	694	19.7		
1 with college degree(s), 1 with less than college degree	103	30.1		
Both with college degree(s)	215	38.6		

TABLE V-48

FAMILY CHARACTERISTICS VERSUS CRD USAGE RATES FOR THE THIRD OPERATIONAL PERIOD

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Family Income:			20.78	<0.001
0,000-9,999	296	17.9		
10,000-14,999	270	21.9		
15,000-19,999	257	31.1		
20,000 +	358	31.0		
Marital Status			9.18	0.0024
Married/living with mate	1,207	27.1		
Single/living with mate	141	14.9		
Number of Children in Vehicle (4-17 years old):			5.88	0.1175
1	357	21.0		
2	125	21.6		
3	34	11.8		
4 or more	16	0.0		
Number of Adults in Vehicle:			12.725	0.0053
1	507	28.2		
2	548	22.3		
3	47	10.6		
4 or more	21	9.5		
Driver Relationship to the Child:			29.69	<0.001
Parent	1,007	27.9		
Nonparent	130	5.4		

TABLE V-48 (Continued)

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Employment Status of Respondent:			15.46	0.0038
Full-time	819	23.0		
Part-time	85	22.4		
Homemaker	340	33.5		
Student	27	29.6		
Unemployed	65	21.5		
Employment Status of Respondent's Mate:			9.767	0.0445
Full-time	834	27.9		
Part-time	56	32.1		
Homemaker	228	27.6		
Student	43	20.9		
Unemployed	46	8.7		
Employment Status of Couple:			12.6778	0.0018
Both full-time	0	0.0		
1 full-time, 1 not full-time and not homemaker	831	24.3		
1 full-time, 1 homemaker	307	34.9		
Both less than full-time	62	25.8		
Educational Status of Respondent:			67.20	<0.001
Less than high school	142	5.6		
High school, G.E.D. and/or vocational technical school	634	22.1		
Some college (no degree)	252	28.6		
College degree(s)	307	39.7		

TABLE V-48 (Continued)

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Educational Status of Respondent's Mate:			58.29	<0.001
Less than high school	155	11.6		
High school, G.E.D. and/or Vocational technical school	546	20.7		
Some college (no degree)	233	32.2		
College degree(s)	299	39.8		
Educational Status of Couple:			68.70	<0.001
Both less than high school	2	50.0		
1 with high school vocational technical, 1 less than high school	197	9.6		
Both with high school/vocational technical, some college	632	22.9		
1 with college degree(s), 1 with less than college degree	136	37.5		
Both with college degree(s)	215	41.9		

TABLE V-49

FAMILY CHARACTERISTICS VERSUS CRD USAGE RATES FOR THE FOURTH OPERATIONAL PERIOD

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Family Income:			45.21	<0.001
0,000- 9,999	255	18.4		
10,000-14,999	271	30.6		
15,000-19,999	233	32.2		
20,000+	403	43.4		
Marital Status:			9.88	0.0017
Married/living with mate	1,238	34.6		
Single/living without a mate	135	20.7		
Number of Children in Vehicle (4-17 years old):			1.98	0.5762
1	512	28.1		
2	144	24.3		
3	45	20.0		
4 or more	18	27.8		
Number of Adults in Vehicle:			27.02	<0.001
1	600	35.7		
2	647	26.3		
3	108	14.8		
4 or more	14	14.3		
Driver Relationship to the Child:			24.11	<0.001
Parent	1,281	32.6		
Nonparent	194	14.9		

TABLE V-49 (Continued)

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Employment Status of Respondent:			20.96	<0.001
Full-time	746	29.6		
Part-time	98	37.8		
Homemaker	402	41.8		
Student, retired or other	40	25.0		
Unemployed	61	26.2		
Employment Status of Respondent's Mate:			10.93	0.0273
Full-time	912	36.0		
Part-time	59	39.0		
Homemaker	173	30.6		
Student, retired or other	39	41.0		
Unemployed	34	11.8		
Employment Status of Couple:			11.75	0.0028
Both full-time	0	0.0		
1 full-time, 1 not full-time and not homemaker	766	31.9		
1 full-time, 1 homemaker	367	42.2		
Both less than full-time	67	34.3		
Educational Status of Respondent:			65.74	<0.001
Less than high school	128	13.3		
High school, G.E.D. and/or vocational/technical school	648	27.2		
Some college (no degree)	268	42.5		
College degree(s)	324	45.4		

TABLE V-49 (Continued)

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Educational Status of Respondent's Mate:			91.03	<0.001
Less than high school	144	11.1		
High school, G.E.D. and/or vocational/technical school	545	27.2		
Some college (no degree)	238	42.4		
College degree(s)	328	50.3		
Educational Status of Couple:			77.94	<0.001
Both less than high school	1	0.0		
1 with high school vocational technical, 1 less than high school	179	12.8		
Both with high school/vo-tech/ some college	637	31.4		
1 with college degree(s), 1 with less than college degree	131	42.7		
Both with college degree(s)	228	52.6		

TABLE V-50

VEHICLE INFORMATION VERSUS CRD USAGE RATES FOR THE FIRST OPERATIONAL PERIOD

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Vehicle Ownership:			15.65*	<0.001
Owned	1,339	25.2		
Not owned	187	11.8		
Number of Vehicles Owned:			4.18*	.041
One	560	20.9		
Two or more	930	25.7		
Year of vehicle:			8.77	.033
<69	160	16.3		
69-73	626	20.9		
74	185	24.3		
>75	712	25.7		
Vehicle Manufacturer:			2.96	.565
AMC	37	29.7		
Chrysler	203	25.6		
Ford	412	21.1		
General Motors	785	22.8		
Foreign	184	25.0		
Vehicle Size:			7.58	.023
Subcompact	157	31.8		
Compact	429	23.8		
Full size	1,067	21.9		

TABLE V-50 (Continued)

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Body Style:			9.14	.104
2 door sedan	1,016	22.4		
4 door sedan	403	25.3		
2 door station wagon	41	14.6		
4 door station wagon	161	29.8		
Pickup/van	128	18.0		
Other	21	19.0		

*Corrected chi-square.

TABLE V-51

VEHICLE INFORMATION VERSUS CRD USAGE RATES FOR THE SECOND OPERATIONAL PERIOD

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Vehicle Ownership:			20.548	<0.001
Owned	1,231	23.0		
Not owned	185	8.1		
Number of Vehicles Owned:			2.03	0.154
One	498	19.3		
Two or more	885	22.7		
Year of Vehicle:			8.87	0.031
<69	130	11.5		
69-73	447	18.8		
74	173	22.0		
>75	699	22.3		
Vehicle Manufacturer:			4.854	0.3026
AMC	30	20.0		
Chrysler	130	20.0		
Ford	433	17.1		
General Motors	747	21.7		
Foreign	173	23.7		
Vehicle Size:			1.89	0.387
Subcompact	157	24.2		
Compact	330	22.4		
Full size	846	20.0		

TABLE V-51 (Continued)

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Body Style			6.54	0.257
2 door sedan	855	21.3		
4 door sedan	331	19.9		
2 door station wagon	45	26.7		
4 door station wagon	134	23.9		
Pickup/van	140	13.6		
Other	17	17.6		

TABLE V-52

VEHICLE INFORMATION VERSUS CRD USAGE RATES FOR THE THIRD OPERATIONAL PERIOD

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Vehicle Ownership:			9.529	<0.0020
Owned	1,177	27.3		
Not owned	175	16.0		
Number of Vehicles Owned:			4.19	0.0405
One	448	22.3		
Two or more	881	27.7		
Year of Vehicle:			7.46	0.0584
<69	97	17.5		
69-73	356	23.3		
74	94	24.5		
>75	671	28.6		
Vehicle Manufacturer:			1.819	0.7689
AMC	33	30.3		
Chrysler	126	23.8		
Ford	340	27.4		
General Motors	625	24.2		
Foreign	161	26.1		
Vehicle Size:			0.646	0.724
Subcompact	125	23.2		
Compact	298	26.8		
Full size	727	25.3		

TABLE V-52 (Continued)

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Body Style			19.59	0.0015
2 door sedan	704	23.2		
4 door sedan	301	32.9		
2 door station wagon	39	23.1		
4 door station wagon	97	34.0		
Pickup/van	138	17.4		
Other	22	31.8		

TABLE V-53

VEHICLE INFORMATION VERSUS CRD USAGE RATES FOR THE FOURTH OPERATIONAL PERIOD

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Vehicle Ownership:			18.56*	<0.001
Owned	1,208	35.1		
Not owned	182	18.7		
Number of Vehicles Owned:			5.79	0.0161
One	472	28.8		
Two or more	895	35.4		
Year of Vehicle:			11.03	0.0116
<69	93	32.3		
69-73	371	25.1		
74	124	26.6		
>75	925	33.9		
Vehicle Manufacturer:			3.29	.189
AMC	56	25.0		
Chrysler	141	20.6		
Ford	370	26.2		
General Motors	814	23.5		
Foreign	204	30.7		
Vehicle Size:			0.97	0.6156
Subcompact	205	35.1		
Compact	396	31.8		
Full size	842	31.6		

TABLE V-53 (Continued)

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Body Style:			15.02	0.0103
2 door sedan	901	30.6		
4 door sedan	353	33.4		
2 door station wagon	37	35.1		
4 door station wagon	145	40.0		
Pickup/van	126	23.8		
Other	23	8.7		

*Corrected chi-square.

TABLE V-54

CRD TYPE VERSUS CRD USAGE RATES FOR
THE FIRST OPERATIONAL PERIOD

CRD Type	Number of Observations*	CRD Usage Rate Percent	Chi-Square	Significance Level
			7.97	.047
Infant Carrier	109	84.4		
Protective Shield	26	67.9		
Car Seat	413	71.2		
Safety Harness	4	75.0		

*Observations of child #1.

TABLE V-55

CRD TYPE VERSUS CRD USAGE RATES FOR
THE SECOND OPERATIONAL PERIOD

CRD Type	Number of Observations*	CRD Usage Rate Percent	Chi-Square	Significance Level
			0.29	0.5141
Infant Carrier	95	67.4		
Protective Shield	16	50.0		
Car Seat	310	67.7		
Safety Harness	4	75.0		

*Observations of child #1.

TABLE V-56

CRD TYPE VERSUS CRD USAGE RATES FOR
THE THIRD OPERATIONAL PERIOD

CRD Type	Number of Observatons*	CRD Usage Rate Percent	Chi-Square	Significance Level
			5.77	0.123
Infant Carrier	80	78.8		
Protective Shield	20	55.0		
Car Seat	379	69.9		
Safety Harness	15	60.0		

*Observations of child #1.

TABLE V-57

CRD TYPE VERSUS CRD USAGE RATES FOR
THE FOURTH OPERATIONAL PERIOD

CRD Type	Number of Observations*	CRD Usage Rate Percent	Chi-Square	Significance Level
			5.86	0.1185
Infant Carrier	134	75.4		
Protective Shield	24	54.2		
Car Seat	547	70.4		
Safety Harness	26	80.8		

*Observations of child #1.

of keeping infants in CRDs compared to relative difficulty with some toddlers.

Seat Belt Usage by Drivers

A total of 165,024 drivers were observed during the operational periods. A determination of whether or not the driver was using a seat belt was made in over 90 percent of the cases.

The same pattern of a lower rate of seat belt usage in nonurban areas held for the operational period of the study as during the baseline period. The rates ranged from 1.7 percent to 3.6 percent for nonurban areas and from 6.3 percent to 8.2 percent for urban areas (see Tables V-58 through V-61). The average observed usage for all operational periods was 6.7 percent. This was exactly the composite average for the baseline period. The usage was up by almost one percent for the first operational period, but declined steadily to below the baseline level by the end of the operational periods.

One objective of this study was to examine the relationship between the drivers' use of seat belts and restraint of children in CRDs in the same vehicle. Parallel data were collected for both periods to determine the percentages of usage of safety belts by drivers who had small children accompanying them in the vehicle. Those percentages are shown for the operational periods in Tables V-62 through V-65. These percentages were compared with those calculated for the baseline period (Table IV-16), and it was found that the percentage of usage of seat belts by drivers with small children more than doubled in the first operational period but declined to about 6 percent for each period thereafter.

A further investigation of the relationship between drivers' use of seat belts and restraint of children in CRDs was made by preparing a matrix to test for significance between the two variables (see Tables V-66 through V-69). The chi-square technique was used for the test as was done for the baseline data and discussed in Chapter IV. A significant relationship was found between CRD and seat belt usage for each operational period as was the case using baseline frequencies in the two-by-two matrix.

Using the frequencies in each cell of the matrix shown in the tables, tabulations of percentages for the four situations were made (see Tables V-70 through V-73). Drivers who were observed as seat belt users had their children in CRDs also in 55.3 percent of the cases studied for all the periods. This percentage compares to 44 percent for the period of time before the law. Only 19.7 percent of those drivers who had children under four with them and who were not using seat belts themselves were observed with children in CRDs in the vehicle. This percentage (19.7) is a vast improvement over the 7.3 percent for the baseline period, and the percentage increased steadily from 16.1 percent to 25.1 percent during the operational periods.

It was hypothesized from the beginning of this study that seat belt usage would increase with an increase in CRD usage. It was recognized that this increase should occur to a greater degree among drivers with children under four since public information was focused on that population.

TABLE V-58

SUMMARY OF SEAT BELT USAGE BY DRIVERS
FOR THE FIRST OPERATIONAL PERIOD

Target Area	Number of Observations[a]	Number of Times Use was Undetermined	Number of Drivers Observed Using Seat Belts	Percent Use
Urban:				
Memphis	4,607	360	236	5.6
Nashville	8,106	978	436	6.1
Knoxville	9,831	327	1,059	11.1
Chattanooga	6,635	1,430[b]	580	5.3
Tri-Cities	6,619	105	347	5.3
Total Urban Areas	35,798	3,200	2,658	8.2[c]
Nonurban:				
Dyersburg	1,654	431	31	2.5
Columbia	1,145	53	38	3.5
Morristown	1,962	70	83	4.4
Total Nonurban Areas	4,761	554	152	3.6[c]
Total Urban and Nonurban Areas	40,559	3,754	2,810	7.6[c]

[a]This number includes some out-of-state vehicles.

[b]Estimation based on baseline data.

[c]Weighted averages.

TABLE V-59

SUMMARY OF SEAT BELT USAGE BY DRIVERS
FOR THE SECOND OPERATIONAL PERIOD

Target Area	Number of Observations[a]	Number of Times Use was Undetermined	Number of Drivers Observed Using Seat Belts	Percent Use
Urban:				
Memphis	6,574	1,668	419	8.5
Nashville	6,472	1,357	246	4.8
Knoxville	7,648	1,385	691	11.0
Chattanooga	5,094	1,934	390	12.3
Tri-Cities	10,706	814	510	5.2
Total Urban Areas	36,494	7,158	2,256	7.7[b]
Nonurban:				
Dyersburg	1,921	132	21	1.2
Columbia	1,220	183	40	3.9
Morristown	2,569	118	66	2.7
Total Nonurban Areas	5,710	433	127	2.4[b]
Total Urban and Nonurban Areas	42,204	7,591	2,383	6.9[b]

[a]This number includes some out-of-state vehicles.

[b]Weighted averages.

TABLE V-60

SUMMARY OF SEAT BELT USAGE BY DRIVERS
FOR THE THIRD OPERATIONAL PERIOD

Target Area	Number of Observations[a]	Number of Times Use was Undetermined	Number of Drivers Observed Using Seat Belts	Percent Use
Urban:				
Memphis	6,079	1,385	263	5.6
Nashville	6,935	576	359	5.6
Knoxville	7,909	343	579	7.7
Chattanooga	5,347	107	284	5.4
Tri-Cities	7,275	1,778	572	10.4
Total Urban Areas	33,545	4,189	2,057	7.0[b]
Nonurban:				
Dyersburg	1,324	58	19	1.5
Columbia	599	59	27	5.0
Morristown	1,898	50	40	2.2
Total Nonurban Areas	3,821	167	86	2.4[b]
Total Urban and Nonurban Areas	37,366	4,356	2,143	6.5[b]

[a]This number includes some out-of-state vehicles.

[b]Weighted averages.

TABLE V-61

SUMMARY OF SEAT BELT USAGE BY DRIVERS
FOR THE FOURTH OPERATIONAL PERIOD

Target Area	Number of Observations[a]	Number of Times Use was Undetermined	Number of Drivers Observed Using Seat Belts	Percent Use
Urban:				
Memphis	5,359	1,199	281	6.8
Nashville	7,786	741	492	7.0
Knoxville	9,747	1,616	701	8.6
Chattanooga	7,346	396	342	4.9
Tri-Cities	10,153	1,462	401	4.6
Total Urban Areas	40,393	5,414	2,217	6.3[b]
Nonurban:				
Dyersburg	1,126	30	30	2.7
Columbia	1,135	23	32	2.9
Morristown	2,241	84	14	0.6
Total Nonurban Areas	4,502	137	76	1.7[b]
Total Urban and Nonurban Areas	44,895	5,551	2,293	5.8[b]

[a]This number includes some out-of-state vehicles.

[b]Weighted averages.

TABLE V-62

PERCENTAGES OF USE OF SEAT BELTS BY DRIVERS WITH SMALL CHILDREN IN VEHICLE AT THE TIER ONE LEVEL FOR THE FIRST OPERATIONAL PERIOD

	Number of Drivers with Small Children[a]	Number of Drivers Where There was Undetermined Usage	Number of Drivers with Positive Determination of Seat Belt Usage	Percentage of Seat Belt Use by Drivers with Small Children
Memphis	531	131	47	11.8
Nashville	671	245	25	5.9
Knoxville	712	233	80	16.7
Chattanooga	634	246	27	7.0
Tri-Cities	485	135	31	8.9
Total Urban	3,033	990	210	10.3[b]
Nonurban Areas	498	142	10	2.8
Total Urban and Nonurban Areas	3,531	1,132	220	9.2[b]

[a]This number from the valid tier one data file includes vehicles with overage children.

[b]Weighted averages.

TABLE V-63

PERCENTAGES OF USE OF SEAT BELTS BY DRIVERS WITH SMALL CHILDREN IN VEHICLE AT THE TIER ONE LEVEL FOR THE SECOND OPERATIONAL PERIOD

	Number of Drivers with Small Children[a]	Number of Drivers Where There Was Undetermined Usage	Number of Drivers with Positive Determination of Seat Belt Usage	Percentage of Seat Belt Use by Drivers with Small Children
Memphis	636	218	33	7.9
Nashville	694	183	33	6.5
Knoxville	760	278	63	13.1
Chattanooga	546	279	10	3.7
Tri-Cities	693	223	11	2.3
Total Urban	3,329	1,181	150	7.0[b]
Nonurban Areas	530	193	4	1.2
Total Urban and Nonurban Areas	3,859	1,374	154	6.2[b]

[a]This number from the valid tier one data file includes vehicles with overage children.

[b]Weighted averages.

TABLE V-64

PERCENTAGES OF USE OF SEAT BELTS BY DRIVERS WITH SMALL CHILDREN IN VEHICLE AT THE TIER ONE LEVEL FOR THE THIRD OPERATIONAL PERIOD

	Number of Drivers with Small Children[a]	Number of Drivers Where There Was Undetermined Usage	Number of Drivers with Positive Determination of Seat Belt Usage	Percentage of Seat Belt Use by Drivers with Small Children
Memphis	509	189	19	5.9
Nashville	642	236	25	6.2
Knoxville	739	197	17	3.1
Chattanooga	607	55	29	5.3
Tri-Cities	696	160	19	3.5
Total Urban	3,193	837	109	4.6[b]
Nonurban Areas	516	143	3	0.8
Total Urban and Nonurban Areas	3,709	980	112	4.1[b]

[a]This number from the valid tier one data file includes vehicles with overage children.

[b]Weighted averages.

TABLE V-65

PERCENTAGES OF USE OF SEAT BELTS BY DRIVERS WITH SMALL CHILDREN IN VEHICLE AT THE TIER ONE LEVEL FOR THE FOURTH OPERATIONAL PERIOD

	Number of Drivers with Small Children[a]	Number of Drivers Where There Was Undetermined Usage	Number of Drivers with Positive Determination of Seat Belt Usage	Percentage of Seat Belt Use by Drivers with Small Children
Memphis	649	146	33	6.6
Nashville	595	128	17	3.6
Knoxville	657	294	51	14.0
Chattanooga	376	19	9	2.5
Tri-Cities	502	272	13	5.7
Total Urban	2,779	859	123	6.4[b]
Nonurban Areas	410	75	12	3.6
Total Urban and Nonurban Areas	3,189	834	135	6.0[b]

[a]This number from the valid tier one data file includes vehicles with overage children.

[b]Weighted averages.

TABLE V-66

RELATIONSHIP BETWEEN DRIVERS' SEAT BELT USAGE AND CRD USAGE FOR THE FIRST OPERATIONAL PERIOD

	Decision	CRD Usage		
		No	Yes	Total
Seat Belt Usage by Drivers	Yes	48	72	120
	No	779	150	929
	Total	827	222	1,049

TABLE V-67

RELATIONSHIP BETWEEN DRIVERS' SEAT BELT USAGE AND CRD USAGE FOR THE SECOND OPERATIONAL PERIOD

	Decision	CRD Usage		
		No	Yes	Total
Seat Belt Usage by Drivers	Yes	72	74	146
	No	881	175	1,056
	Total	953	249	1,202

TABLE V-68

RELATIONSHIP BETWEEN DRIVERS' SEAT BELT USAGE AND CRD USAGE FOR THE THIRD OPERATIONAL PERIOD

	Decision	CRD Usage No	CRD Usage Yes	Total
Seat Belt Usage by Drivers	Yes	67	70	137
	No	752	199	951
	Total	819	269	1,088

TABLE V-69

RELATIONSHIP BETWEEN DRIVERS' SEAT BELT USAGE AND CRD USAGE FOR THE FOURTH OPERATIONAL PERIOD

	Decision	CRD Usage No	CRD Usage Yes	Total
Seat Belt Usage by Drivers	Yes	87	128	215
	No	813	273	1,086
	Total	900	401	1,301

TABLE V-70

PERCENTAGES OF RELATIONSHIPS BETWEEN DRIVERS' SEAT BELT USAGE AND CRD USAGE FOR THE FIRST OPERATIONAL PERIOD
(Row Percentages)

		CRD Usage		
	Decision	Number of Observations	Percent No	Yes
Seat Belt Usage by Drivers	Yes	120	40.0	60.0
	No	929	83.9	16.1

TABLE V-71

PERCENTAGES OF RELATIONSHIPS BETWEEN DRIVERS' SEAT BELT USAGE AND CRD USAGE FOR THE SECOND OPERATIONAL PERIOD
(Row Percentages)

		CRD Usage		
	Decision	Number of Observations	Percent No	Yes
Seat Belt Usage by Drivers	Yes	146	49.3	50.7
	No	1,056	83.4	16.6

TABLE V-72

PERCENTAGES OF RELATIONSHIPS BETWEEN DRIVERS' SEAT BELT USAGE AND CRD USAGE FOR THE THIRD OPERATIONAL PERIOD
(Row Percentages)

		CRD Usage		
		Number of	Percent	
	Decision	Observations	No	Yes
Seat Belt Usage by Drivers	Yes	137	48.9	51.1
	No	951	79.1	20.9

TABLE V-73

PERCENTAGES OF RELATIONSHIPS BETWEEN DRIVERS' SEAT BELT USAGE AND CRD USAGE FOR THE FOURTH OPERATIONAL PERIOD
(Row Percentages)

		CRD Usage		
		Number of	Percent	
	Decision	Observations	No	Yes
Seat Belt Usage by Drivers	Yes	215	40.5	59.5
	No	1,086	74.9	25.1

A summary of seat belt usage by drivers before and after the implementation of the law and the PI&E program is shown in Table V-74. The table shows the percentages of usage for all drivers observed and for a subset of drivers to include only those with children under four years of age in the vehicle. The overall usage rate for the state decreased based on the assumption that the urban samples represent one-half of the population which lives in Tennessee. The overall rate for all drivers decreased from 4.9 percent to 4.6 percent. The comparison between periods for the subset of drivers with children under four years old showed an increase from 3.6 percent to 5.0 percent, which is a statistically significant increase.

Summary

The analysis of CRD usage for the operational periods has been presented in this chapter. The analysis included comparisons to the analysis of the baseline usage data as presented in Chapter IV.

The distributions of the baseline period and operational period income and education data were compared with each other and with the general population of Tennessee. The distributions compared favorably for each period. A comparison of the data distribution with the general population appeared acceptable as a representation of Tennesseans. Age difference between the samples and the population was possibly the reason for the differential in the distribution of both income and education.

The comparison of age and sex of the children observed for each period showed little difference. All categories were virtually the same percentage. There were slightly more one and two year olds and slightly more females than males of the total number of observations of children.

Significant increases in CRD usage were observed at each target area by the end of the two-year program. Statewide CRD usage was improved by more than 100 percent over the baseline rate of 9.2 percent. Comparisons across time indicated that the basic state PI&E plan resulted in a significant increase over baseline, and the comprehensive PI&E plan generated a significant increase over the basic state plan rates. Comparisons within time periods tended to confirm these PI&E results. Nonetheless the increases were relatively small in absolute terms, and the cost effectiveness of the programs therefore becomes more important.

While the usage of seat belts for all drivers declined overall after the initial measurement (baseline period), the usage rate increased substantially for those drivers with small children. There was less usage in nonurban areas than in urban areas. Nonurban areas had a 2.2 percent usage of seat belts by all drivers while the urban areas had 7.0 percent usage for the operational periods.

The change in seat belt usage rates for drivers with small children went from 4.5 percent to 7.1 percent in the urban areas, while in nonurban areas usage shifted from 2.7 percent to 2.8 percent. Generally, the subset of drivers with small children had a lower initial usage than the set of all drivers.

TABLE V-74

SUMMARY OF SEAT BELT USAGE BY DRIVERS

Area	All Drivers		Driver with Children Under Age Four	
	Percent Before Law	Percent After Law	Percent Before Law	Percent After Law
Memphis	5.6	7.0	6.8	8.1
Nashville	7.3	5.8	6.5	5.6
Knoxville	9.3	9.1	3.3	11.7
Chattanooga	9.3	7.5	6.2	4.6
Tri-Cities	6.7	6.7	2.4	5.1
Total Urban	7.7[a]	7.0[a]	4.5[a]	7.1[a]
Nonurban	2.1	2.2	2.7	2.8
Statewide Average	4.9[b]	4.6[b]	3.6[b]	5.0[b]

[a]Weighted averages based on sample sizes.

[b]Weighted average based on assumed urban/nonurban population split.

The relationship between drivers' use of seat belts and restraint of children in CRDs, which proved to be significant for baseline data, was also significant when tested using operational frequencies for the variables. The percentage of drivers observed as seat belt users and who also had children in CRDs increased between the two time periods from 44 percent during the baseline period to 55.3 percent in the operational periods. On the other hand, those drivers not using seat belts used CRDs for the children with them at only a 19.7 percent rate; but this percentage is a tremendous improvement over the 7.3 percent observed for the baseline period.

VI. ANALYSIS OF THE CHARACTERISTICS OF USERS AND NONUSERS OF CHILD RESTRAINT DEVICES

The objectives of this analysis are (1) to determine if there is a set of characteristics which significantly distinguishes between users and nonusers of CRDs, (2) to determine the relationship between selected significant variables and CRD usage (the dependent variable) when adjustments are made for the effect of two socioeconomic variables (educational level and family income) and (3) to provide a profile of the characteristics of users and nonusers.

Two statistical analyses were employed to examine CRD usage; discriminant analysis was the method used to accomplish the first objective, and partial correlation analysis was applied to adjust for the effects of educational attainment and family income. A profile of the characteristics of users and nonusers was developed from the results of the two analyses.

Discriminant Analysis

Discriminant analysis is a statistical technique used to distinguish between two or more groups. This technique linearly combines the discriminating variables such that the differences between the group means of the variables are maximized. The primary purpose for using discriminant analysis for this portion of the study was to discriminate between the CRD user group and the nonuser group so that the specific characteristics of the groups that significantly distinguish one from the other may be ascertained. The results of discriminant analysis may prove to be an important tool in identifying target groups toward which specific attention may be given, and particular behaviorial characteristics of users which should be promoted among nonusers.

Procedure. The first step in the procedure was one of variable selection. Because there were many variables measured and because some of the items on the questionnaire to measure the variables were sensitive, there were missing data. The amount of missing data was too great to use all variables concurrently in the discriminant analysis. For example, when the variables which were analyzed in Chapters IV and V were entered into the discriminant analysis at the same time using the baseline data, the number of observations with no missing data was less than 20 percent of the total number of observations.

It was therefore necessary to be more selective in choosing the variables for a candidate list. Those variables which were found to be individually significant at the .05 level or better from the contingency table analyses in Chapters IV and V formed the basis for the list. Added to the list was a variable which was not discussed in Chapters IV and V. Seat belt usage by passengers was found to have potential contributing influences on CRD usage beyond that of seat belt use by the driver. The full list of candidate variables are summarized in Table VI-1, and their respective significance levels from previous tests for each period are given.

TABLE VI-1

LIST OF SIGNIFICANT VARIABLES

Variable	Significant Level				
	Baseline Period	First Operational Period	Second Operational Period	Third Operational Period	Fourth Operational Period
Family Income	<0.001	<0.001	<0.001	<0.000	<0.001
Educational Attainment of Respondent	<0.001	<0.001	<0.001	<0.000	<0.001
Educational Attainment of Respondent's Mate	<0.001	<0.001	<0.001	<0.000	<0.001
Age of Child (Child #1)	<0.001	<0.001	<0.001	<0.000	<0.001
Vehicle Ownership	<0.001	<0.001	<0.001	0.0020	<0.001
Number of Vehicles Owned	<0.001	0.041	0.0665	0.0214	0.0474
Number of Adults in Vehicle	0.008	0.001	0.001	0.0118	0.001
Employment Status of Couples (categorical)	0.001	0.001	0.1005	0.0002	0.001
Marital Status	0.018	0.001	0.0158	0.0024	0.0017
Year of Vehicle (categorical)	0.05	0.033	0.0218	0.0219	0.0129
Driver Relationship to Child (Child #1)	<0.001	<0.001	<0.001	<0.001	<0.001
Seat Belt Usage of Passengers Other than Small Children	0.001	0.001	<0.001	<0.001	<0.001

The next step in the process of selecting the influential variables as possible candidates was to analyze each variable individually against CRD usage to establish a priority list of potential discriminating variables. The discriminant analysis computer program of the Statistical Package for the Social Sciences was utilized to accomplish this task by analyzing one variable at a time. The analysis yielded an univariate F value for each variable. The variables were arranged in rank order according to the value of the F ratios for each period as shown in Table VI-2.

A decision was made to eliminate the least important variables from the candidate list to establish a set of variables for the discriminant analysis which would have a high percentage of the total number of observations. Deleted first from the list were those variables which furnished supplemental but somewhat redundant information. These variables were educational attainment of the repondent's mate and marital status. Educational attainment of the respondent's mate was actually redundant information since educational attainment of the respondent was one of the other variables considered for the analysis. Educational attainment for both respondent and respondent's mate was approximately the same. Marital status is redundant information considering the information gained from the variable "driver's relation to child." Both of these variables primarily reveal whether or not the respondent is the parent of the child. Driver relationship to the child was a broader category than marital status because the first category includes both married and single parents, with the other division being friends, relatives and others.

Another variable deleted from consideration as one of the set to enter discriminant analysis was employment status of respondent. This variable was among the most sensitive (along with income and education) on the questionnaire and was somewhat a function of family income and educational attainment. For this reason there was a large number of missing data, and because of the missing data it was best to delete employment status of respondent. The last variable to be eliminated from the candidate list was "number of vehicles owned." This variable was eliminated on the basis of having the lowest univariate F value after the other three variables were deleted and from partial correlation results. When partial correlations were run on this variable, the correlation coefficient dropped considerably when the number of vehicles was correlated with CRD usage, controlling for family income. The variable became insignificant when adjusted for family income during the operational period.

This elimination process left seven variables which are significant for all periods and which rank high among all the variables considered measured by the univariate F value. These seven represent about 68 percent of all observations using baseline data and about 60 percent of all observations using operational period data. It was recognized that the selection process used to obtain this reduced set of variables (less than one-half the original number) could have affected the significance level of the final results of discriminant analysis. The F values were checked against Bonferroni bounds to ensure an alpha level of at least 0.05.

The correlations between each of the variables were useful in the examination of the effect of each variable or combination of variables on CRD

TABLE VI-2

SELECTED VARIABLES FOR DISCRIMINANT ANALYSIS
(Univariate F Ratios)

Variable	F Ratio (Rank Order)									
	N	Baseline Period	First Operational N	First Operational Period	Second Operational N	Second Operational Period	Third Operational N	Third Operational Period	Fourth Operational N	Fourth Operational Period
Seat Belt Usage of Passengers in Vehicle with Child	1926	148.02(1)	1316	124.42(1)	1238	132.99(1)	1182	81.14(1)	1187	138.70(1)
Educational Attainment of Respondent	1940	67.54(2)	1346	51.67(3)	1260	66.65(2)	1189	62.43(2)	1205	53.36(3)
Educational Attainment of Respondent's Mate	1941	63.47(3)	1346	65.55(2)	1265	52.78(3)	1193	52.29(3)	1208	90.54(2)
Number of Adults in Vehicle	1531	15.04(6)	996	9.04(7)	975	14.75(6)	980	11.40(6)	971	13.79(7)
Family Income	1713	31.25(4)	1175	15.76(4)	1096	24.75(4)	1066	10.16(7)	1039	31.36(4)
Vehicle Ownership	1937	14.16(7)	1344	8.81(8)	1262	14.15(7)	1189	6.51(9)	1207	14.49(6)
Driver Relationship to Child (Child #1)	1806	16.23(5)	1227	13.07(5)	1141	16.43(5)	992	20.43(4)	1049	19.77(5)
Age of Child (Child #1)	1941	13.50(8)	1346	12.90(6)	1265	10.19(8)	1193	9.54(8)	1208	4.86(9)

TABLE VI-2 (Continued)

Variable	F Ratio (Rank Order)									
	N	Baseline Period	First Operational N	First Operational Period	Second Operational N	Second Operational Period	Third Operational N	Third Operational Period	Fourth Operational N	Fourth Operational Period
Owned	1924	10.92(9)	1333	0.96(10)	1252	0.46(10)	1180	2.04(10)	1198	1.80(11)
Marital Status	1932	0.65(11)	1340	4.80(9)	1258	0.19(11)	1190	1.23(11)	1203	2.39(10)
Employment Status of Respondent	1932	4.31(10)	1327	0.013(11)	1259	1.53(9)	1186	12.13(5)	1193	5.53(8)

usage for both periods. The correlation matrix for the seven selected independent variables and the dependent variable for the baseline period are shown in Table VI-3. The highest correlation of the seven independent variables with CRD usage was "passengers seat belt usage" and "educational attainment of the respondent," which confirms that these variables have the most important influence on CRD usage as was shown with univariate F values (Table VI-2). A correlation matrix for each operational period was formed to check the consistency of the relationships between variables. The same strong relationship held throughout the study.

Among the predictor variables the ones with the strongest relationship between them were family income and educational level. The variables "passenger use of seat belts" was somewhat correlated with educational attainment of the respondent and family income. Vehicle ownership was correlated to family income and the number of adult passengers in vehicle.

Results. The seven variables chosen for the analysis were all significant contributors to CRD usage when taken individually. Six of the seven variables were found to be significant indicators of CRD usage in Chapters IV and V when the chi-square method was used. These six variables showed significance again when discriminate analysis was applied using only one variable at a time. The remaining variable, seat belt usage of passengers, was not discussed in the previous chapters but showed significance at the .001 level for all periods when tested one at a time against CRD usage by the discriminant analysis procedure. Table VI-2 showed the significance level for each variable tested individually in the discriminant analysis.

The seven variables used in the discriminant analysis were rank ordered in accordance with their semi-partial F values. These results are shown in Table VI-4. Operational data were averaged for each of the four periods for comparison purposes. The average number of observations for discriminant analysis for the operational periods was 735. This compares to 1,710 observations for the baseline data. This was due to the elimination of partially completed data sheets during the operational periods which accounts for lower semi-partial F ratios in relation to the baseline period ratios in some categories. It was found that seat belt usage by passengers other than children under four was the single most important predictor of CRD usage. Educational attainment of the respondent proved to be the next best variable.

Partial Correlation Analysis

The measurement of the strength of the relationship between the dependent variable and any independent variable with the effects of other considered independent variables being statistically controlled is called partial correlation analysis (Harnett, 1970). The measure of this relationship is known as a partial correlation coefficient. Simple correlation (zero order) does not take into account the effects of any other variables, regardless of their relationship with the dependent variable or with one another.

Partial correlation analysis was considered to be an appropriate method to measure the relationship between CRD usage (dependent variable) and the selected independent variables since there was a great deal of uncertainty

TABLE VI-3

CORRELATION MATRIX FOR SEVEN INDEPENDENT VARIABLES AND CHILD RESTRAINT USE FOR THE BASELINE PERIOD DATA

	Child Restraint Usage	Seat Belt Usage of Passengers	Educational Attainment of Respondent	Number of Adults in Vehicle	Age of Child	Driver Relation to Child	Family Income	Vehicle Ownership
Child Restraint Usage	1.000	0.2768	0.1918	0.1216	0.0966	0.0957	0.1414	0.0824
Seat Belt Usage of Passengers	0.2768	1.000	0.2487	0.0643	0.0409	0.0511	0.1647	0.0997
Educational Attainment of Respondent	0.1918	0.2487	1.000	0.0829	0.0262	0.1121	0.4337	0.1013
Number of Adults in Vehicle	0.1216	0.0643	0.0829	1.000	0.0231	0.1172	0.1170	0.1615
Age of Child	0.0966	0.0409	0.0262	0.0231	1.000	0.0108	0.0138	0.0180
Driver Relation to Child	0.0957	0.0511	0.1121	0.1172	0.0108	0.1000	0.0973	0.1361
Family Income	0.1414	0.1647	0.4337	0.1170	0.0138	0.0973	1.000	0.1508
Vehicle Ownership	0.0824	0.0997	0.1013	0.1615	0.0180	0.1361	0.1508	1.000

TABLE VI-4

RESULTS OF DISCRIMINANT ANALYSIS

Variable	Rank Order of Importance		Semi-Partial F Ratios	
	Baseline	Operational (average)	Baseline	Operational
Seat Belt Usage of Passengers in Vehicle with Child	1	1.25	141.76	66.62
Educational Attainment of Respondent	2	1.75	30.31	25.98
Number of Adults in Vehicle	3	4.25	17.31	6.89
Age of Child (Child #1)	4	4.50	14.12	4.19
Driver Relationship to Child (Child #1)	5	5.00	5.06	4.32
Family Income	6	5.00	2.89	2.28
Vehicle Ownership	7	6.50	1.41	1.48

about the influence of socioeconomic variables in combination with other variables. There are numerous possibilities for analyses using partial correlation when a number of variables are available as was the case in this study. The selected variables which showed promise of contributing to the description of the variation of usage were considered for the analyses for the purposes of this study. Two other variables, "make of vehicle" and "year of vehicle," were included to demonstrate the impact of partial correlation.

Income and educational levels of adults were two socioeconomic variables which were expected to affect usage rates, directly or indirectly. It is evident from Chapters IV and V and the discriminant analysis section of this chapter that these variables were influences on CRD usage when considered separately and along with other variables.

Results. A summary of the computed partial correlations is shown for the baseline data in Table VI-5. The computed correlation coefficient at zero order between passenger seat belt usage and CRD usage was .2816, but when adjusted by partialling out the effect of income and education, the correlation coefficient was reduced to .2442. This reduction did not change the significance level; passenger seat belt usage was significant with and without the influences of education and family income.

It was anticipated that vehicle ownership would make a difference in use of CRDs. It was thought that family income would greatly influence whether or not the vehicle was owned and thereby influence usage. Partial correlations showed that for the baseline period with income eliminated, the correlation coefficient between ownership of vehicle and CRD usage was .0756 with the significance level at 0.001. Adjusting for income reduced the partial correlation coefficient to .0566; adjusting for both income and education did not reduce the coefficient much further (.0516). The significant level changed from .001 to .013 which was still highly significant.

The number of vehicles owned was another variable which was expected to be affected by family income to a great extent. The usage rates were higher for two-vehicle families but declined slightly for three-vehicle owners. Therefore, the number of vehicles were categorized into one and two or more for the analysis to make the variable linear. This variable without adjustments for income had a partial correlation coefficient of .0801; after adjusting for income, the number of vehicles owned was not as important. The level of significance went from a level of .001 to .047 (still significant).

The variable "make of vehicle" for the baseline period became insignificant when the effects of income and education were eliminated. The significance level went to 0.134 after adjusting for the impact of income and education. The year of vehicle changed only slightly, regardless of the effect of income or education or the combination of the two, but remained insignificant in the analyses.

The partial correlations for the operational period data were much like the ones for the baseline data (Table VI-6 through VI-9). The "make of vehicle" variable was recorded for all periods to include only two categories: all U.S. made vehicles were in one category and all foreign manufacturers made up the second. This was done because there was higher usage among

TABLE VI-5

SUMMARY OF RESULTS OF PARTIAL CORRELATION ANALYSIS--BASELINE PERIOD
(CRD Usage with X_1 by X_2, X_3)

Variable			Correlation Coefficients (Level of Significance)			
				1st Order Controlling for:		2nd Order Controlling for: Family Income and Educational Attainment
X_1	X_2	X_3	Zero Order	Family Income	Educational Attainment	
Passenger Use of Seat Belts	Family Income	Educational Attainment	.2816 .001	.2655 .001	.2472 .001	.2442 .001
Vehicle Ownership	Family Income	Educational Attainment	.0756 .001	.0566 .007	.0583 .006	.0516 .013
Number of Vehicles Owned	Family Income	Educational Attainment	.0801 .001	.0389 .048	.0551 .009	.0392 .047
Make of Vehicle	Family Income	Educational Attainment	.0504 .017	.0435 .034	.0262 .137	.0265 .134
Year of Vehicle	Family Income	Educational Attainment	.0265 .136	.0265 .136	.0277 .125	.0148 .270

TABLE VI-6

SUMMARY OF RESULTS OF PARTIAL CORRELATION ANALYSIS--FIRST OPERATIONAL PERIOD
(CRD Usage with X_1 by X_2, X_3)

Variable			Correlation Coefficients (Level of Significance)			
				1st Order Controlling for:		2nd Order Controlling for: Family Income and Educational Attainment
X_1	X_2	X_3	Zero Order	Family Income	Educational Attainment	
Passenger Use of Seat Belts	Family Income	Educational Attainment	.2978 .001	.2826 .001	.2540 .001	.2615 .001
Vehicle Ownership	Family Income	Educational Attainment	.1013 .001	.0836 .001	.0917 .001	.0880 .001
Number of Vehicles Owned	Family Income	Educational Attainment	.0456 .052	.0020 .471	.0195 .244	.0039 .445
Make of Vehicle	Family Income	Educational Attainment	.0317 .132	.0241 .199	.0071 .402	.0067 .407
Year of Vehicle	Family Income	Educational Attainment	.0516 .027	.0185 .264	.0098 .368	.0004 .484

TABLE VI-7

SUMMARY OF RESULTS OF PARTIAL CORRELATION ANALYSIS--SECOND OPERATIONAL PERIOD
(CRD Usage with X_1 by X_2, X_3)

Variable			Correlation Coefficients (Level of Significance)			
				1st Order Controlling for:		2nd Order Controlling for: Family Income and Educational Attainment
X_1	X_2	X_3	Zero Order	Family Income	Educational Attainment	
Passenger Use of Seat Belts	Family Income	Educational Attainment	.281 .001	.2918 .001	.2537 .001	.2586 .001
Vehicle Ownership	Family Income	Educational Attainment	.1128 .001	.0985 .001	.0952 .001	.0905 .001
Number of Vehicles Owned	Family Income	Educational Attainment	.0382 .096	.0242 .205	.0011 .484	.0254 .194
Make of Vehicle	Family Income	Educational Attainment	.0178 .274	.0187 .288	.0020 .473	.0004 .484
Year of Vehicle	Family Income	Educational Attainment	.0586 .025	.0079 .397	.0014 .482	.0068 .287

TABLE VI-8

SUMMARY OF RESULTS OF PARTIAL CORRELATION ANALYSIS--THIRD OPERATIONAL PERIOD
(CRD Usage with X_1 by X_2, X_3)

Variable			Correlation Coefficients (Level of Significance)			
				1st Order Controlling for:		2nd Order Controlling for: Family Income and Educational Attainment
X_1	X_2	X_3	Zero Order	Family Income	Educational Attainment	
Passenger Use of Seat Belts	Family Income	Educational Attainment	.2486 .001	.2397 .001	.2149 .001	.2147 .001
Vehicle Ownership	Family Income	Educational Attainment	.0629 .016	.0502 .043	.0536 .033	.0525 .036
Number of Vehicles Owned	Family Income	Educational Attainment	.0463 .058	.0094 .375	.0224 .224	.0217 .231
Make of Vehicle	Family Income	Educational Attainment	.0067 .412	.0017 .478	.0348 .123	.0349 .124
Year of Vehicle	Family Income	Educational Attainment	.0540 .040	.0206 .252	.0054 .431	.0004 .495

TABLE VI-9

SUMMARY OF RESULTS OF PARTIAL CORRELATION ANALYSIS--FOURTH OPERATIONAL PERIOD
(CRD Usage with X_1 by X_2, X_3)

Variable			Correlation Coefficients (Level of Significance)			
				1st Order Controlling for:		2nd Order Controlling for: Family Income and Educational Attainment
X_1	X_2	X_3	Zero Order	Family Income	Educational Attainment	
Passenger Use of Seat Belts	Family Income	Educational Attainment	.3385 .001	.3234 .001	.3005 .001	.2985 .001
Vehicle Ownership	Family Income	Educational Attainment	.1303 .001	.1068 .001	.1040 .001	.0946 .001
Number of Vehicles Owned	Family Income	Educational Attainment	.0436 .070	.0302 .154	.0203 .246	.0209 .240
Make of Vehicle	Family Income	Educational Attainment	.0781 .005	.0677 .013	.0531 .041	.0512 .047
Year of Vehicle	Family Income	Educational Attainment	.0556 .036	.0049 .438	.0233 .226	.0016 .480

owners of foreign vehicles than among owners of American-made vehicles. Educational level was the variable which caused the greatest reduction in its correlation coefficient.

The "number of vehicles owned" was a significant predictor of CRD usage for both periods when tested individually by the chi-square method as reported in earlier chapters of this report. It was also significant when tested with and without the impact of income or education or a combination of the two for the baseline period, but using operational data it went from being barely insignificant when no adjustments were made for income and education to being highly insignificant when adjustments were made.

Profile of Users and Nonusers

Profiles of users and nonusers of CRDs were made to distinguish between the groups. A profile is intented to show the most outstanding characteristics of a group with regard to a particular criterion. The characteristics of users and nonusers of CRDs were selected, and the importance of their effect on CRD usage was examined. All the characteristics are linear with respect to CRD usage. Therefore a determination was made as to which end of the line a subject should be placed. Table VI-10 shows the profiles of CRD users and nonusers for the variables considered. Variables which were analyzed by discriminant analysis, partial correlation or both and found to be contributors to CRD usage were used.

The variables were categorized into primary and secondary characteristics according to their impact on CRD usage. A variable which affected usage when first measured individually and also after the effects of family income and education attainment were removed was placed in the primary characteristics category. If the variable was important by itself but lost importance after the second order partial correlation, it became a secondary characteristic. Those variables which were not used in the partial correlation analysis but which remained significant for both periods after discriminant analyses were categorized as primary characteristics.

Prediction of Child Restraint Device Usage by Characteristics of Respondent

The use of seat belts by passengers has been the one variable which has stood out among the others as being the best predictor of CRD usage. It has been proven also that the relationship between a driver's decision to use seat belts and the driver's decision to use CRDs was significant. There are variables which affect the relationship between CRD usage and seat belt usage as was evidenced from partial correlation of CRD usage and passenger seat belt use with family income and educational attainment as control variables.

Another way to investigate the relationship between CRD usage and seat belt usage is by performing cross tabulations of the two variables with a third variable. An illustrative example of the results of cross tabulation of CRD usage by seat belt usage of drivers with small children by educational attainment level of the respondent for both periods is shown in Figure VI-1.

TABLE VI-10

PROFILES OF USERS AND NONUSERS OF CRDs

Characteristics		Users	Nonusers
Primary:			
1.	Seat Belt Use of Passengers Over 4 Years Old	Wearing Seat Belts	Does Not Wear Seat Belts
2.	Educational Attainment	Higher Level	Lower Level
3.	Family Income	Higher	Lower
4.	Vehicle Ownership	Most Likely Yes	Less Likely Yes
5.	Age of Child (Child #1)	Younger Children	Older Children
6.	Driver Relation to Child (Child #1)	Most Likely Parent	Less Likely Parent
7.	Number of Adults in Vehicle	Fewer	More
Secondary:			
1.	Employment Status of Respondent	Employed or Homemaker	Student, Retired Unemployed, Other
2.	Marital Status	Most Likely Married/ Living with a Mate	Less Likely Married/ Living with a Mate
3.	Number of Vehicles Owned	Most Likely More Than One	Most Likely One
4.	Year of Vehicle	Owner of Newer Vehicle	Owner of Older Vehicle

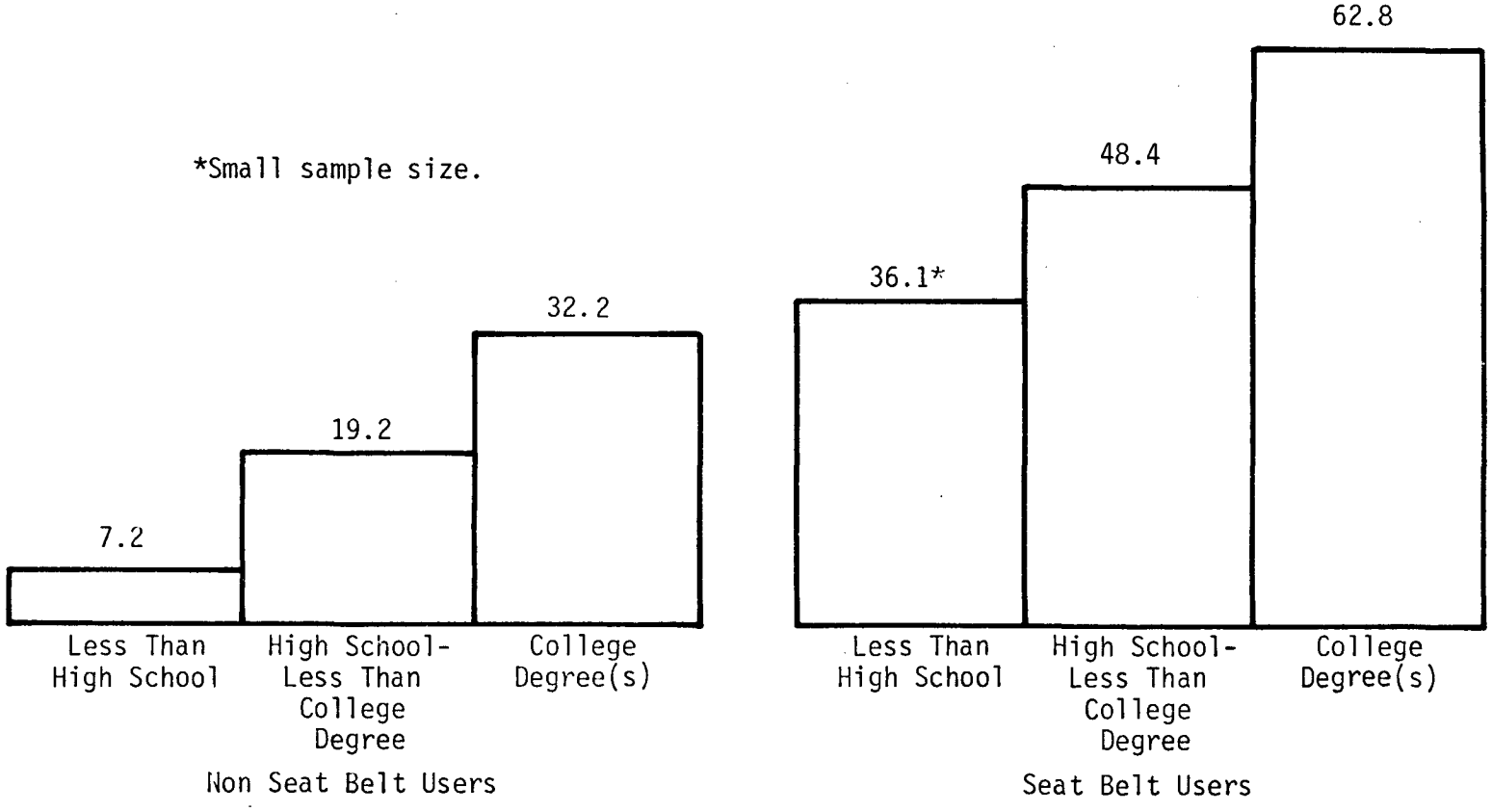


FIGURE VI-1

PREDICTION OF CRD USAGE BY DRIVER'S SEAT BELT USAGE AND EDUCATIONAL ATTAINMENT

Summary

Several variables were determined to be discriminating in distinguishing between users and nonusers of CRDs. Seat belt usage by passengers other than small children was the single most important variable which helped to identify users and nonusers. Using 11 variables for "discriminating" between the groups, it was found that a CRD user is more likely (1) to be wearing a seat belt, (2) to have a higher educational level, (3) to have fewer passengers in the vehicle, (4) to be transporting a younger child, (5) to be the parent of the child, (6) to have a higher income, (7) to be the owner of the vehicle, (8) to be employed or a homemaker, (9) to be married or living with a mate, (10) to be the owner of more than one vehicle and (11) to own a newer vehicle than would a nonuser.

The relationship between CRD usage (the dependent variable) and several independent variables were examined. Partial correlation analysis revealed some interesting results. When the effects of family income and educational attainment are adjusted in the analysis, it was found that only a spurious relationship existed between "make of vehicle" and CRD usage for the baseline period, and no relationship existed for all the operational periods. There were spurious correlations between the independent variable "year of vehicle" and the dependent variable (CRD usage) during the operational period, although this did not occur using baseline data.

The effects of family income and educational attainment were not as powerful as anticipated in reducing the amount of explained variation in CRD usage. The partial correlation coefficients between the independent variables tested and CRD usage before adjustments were reduced only slightly after adjusting for income and education. This was true of all variables tested with the exception of seat belt usage of passengers other than children under four years of age.

The observed adults who had their children in CRDs were wearing safety belts themselves more often than those observed with children not using CRDs. However, when there were two or more adults in the vehicle, the data collected did not distinguish between which adult made the decision on whether to use CRDs or not. Therefore, the identification of "user" in a singular sense was lost for this question when two or more adults were in the vehicle with a child under four years of age in a CRD. Regardless which adult made the decision to use the CRD, there was more CRD usage in vehicles which had other passengers wearing seat belts.

It was important to learn the types of characteristics which influence CRD usage. The socioeconomic characteristics of families were good predictors of usage, but the characteristic of safety awareness was greater. Adults who were safety minded enough to protect themselves also protected their children. Other variables which were useful in distinguishing between users and nonusers but to a lesser degree were employment status of respondent, marital status, number of vehicles owned and year of vehicle.

VII. ANALYSIS OF MOTOR VEHICLE ACCIDENTS INVOLVING CHILD PASSENGERS

The concern of this study was to evaluate the effectiveness of a PI&E program in conjunction with a child passenger restraint law. One important measure of the effectiveness of highway safety programs is to determine if the total number of deaths and serious injuries has been reduced over a period of time and to contrast rates for CRD users with rates for unrestrained children. For an evaluation of the Child Passenger Safety Program, an analysis of accidents involving children under four years of age was made. This chapter includes a discussion of the results of that analysis.

The first analysis of accidents involving injuries of one kind or another was performed by examining the data in six-month increments for the years 1976 through 1979. The reason for using this time increment was to be able to compare like periods of time, i.e., January-June for each year for which data were collected. It should be kept in mind that historically these data have exhibited wide variations, and the variations could mask any underlying trend.

The data on nonfatal injury accidents were furnished by the Tennessee Department of Safety. Fatal accident injury data were also furnished by the Tennessee Department of Safety via the Tennessee Governor's Highway Safety Program, which has the responsibility of reporting highway accident fatalities to the National Highway Traffic Safety Administration.

Summaries of fatalities and injuries to children under four years of age for both pre-law (1976-1977) and post-law (1978-1979) conditions are shown in Tables VII-1 through VII-4. An examination of the number of injury/fatality accidents in each category for each half year revealed no significant changes, except for an unusual increase in fatalities in the latter half of 1979. More accidents occur during the summer months when the amount of travel is increased. When comparing the first half of each calendar year only small differences occur. This, of course, was expected for fatalities since the number of deaths were low.

A possibility existed that the number of minor injuries could have increased substantially because of the so-called "babes in arms" amendment to the law which allows older passengers to hold children under four years of age. Children who often rode in a safer position in the back seat could have been relocated to the lap of an older passenger in the less safe position of the front seat. The data indicate that the percentage of children being held by older passengers did not increase, and there was no evidence of more minor injuries as was reflected by the accident data. No inference is made that any increase was due to the change in riding positions of children in vehicles.

It was hoped that a reduction in the number of serious injuries to small children might occur due to an overall increase in CRD usage. The number of serious injuries to children under four years of age has remained steady over the last four years when comparing the first half-year data. Tables VII-1 and VII-3 reflect the total number of serious injuries and the

TABLE VII-1

ACCIDENT INJURIES TO CHILD PASSENGERS UNDER FOUR YEARS OF AGE BY SIX-MONTH PERIODS (1976-1979)

Year	Injury Severity		
	Minor[a]	Major[b]	Fatal
1976-1	390	78	8
1976-2	448	128	5
1977-1	360	60	7
1977-2	462	81	9
1978-1	372	77	6
1978-2	452	84	10
1979-1	325	74	7
1979-2	389	61	18

[a]Minor injuries are defined as pain and/or bruises.

[b]Major injuries are defined as major bleeding.

Note: Data on injuries and fatalities to children under one year of age were unknown. It was estimated that data for this category were approximately the same as the year old category. All unknown data were distributed proportionately to all categories.

Source: Tennessee Department of Safety data files.

TABLE VII-2

FATAL INJURIES TO CHILD PASSENGERS UNDER FOUR YEARS OF AGE BY CALENDAR SIX-MONTH PERIODS AND AGE (1976-1979)

Year	Fatalities by Age				Total
	Under 1[a]	1	2	3	
1976-1	1	1	1	2	5
1976-2	1	1	0	2	4
1977-1	1	1	3	1	6
1977-2	2	2	2	1	7
1978-1	2	2	0	1	5
1978-2	2	2	3	3	10
1979-1	3	3	1	0	7
1979-2	7	7	2	2	18

[a]Data on fatalities to children under one year of age were unknown. It was estimated that data for this category were approximately the same as the one year old category. All unknown data were proportionately distributed to all categories.

Source: Tennessee Governor's Highway Safety Program report to the National Center for Statistics and Analysis, National Highway Traffic Safety Administration, U.S. Department of Transportation.

TABLE VII-3

SERIOUS NONFATAL INJURIES TO CHILD PASSENGERS UNDER FOUR YEARS OF AGE BY SIX-MONTH PERIODS BY AGE[a] (1976-1979)

Year	Age of Child				Total
	Under 1[b]	1	2	3	
1976-1	12	12	28	26	78
1976-2	21	21	42	44	128
1977-1	11	11	25	23	70
1977-2	15	15	28	23	81
1978-1	17	17	18	25	77
1978-2	19	19	19	27	84
1979-1	19	19	9	27	74
1979-2	15	15	16	15	61

[a]Serious injuries are defined as those reported as bleeding.

[b]Data on injuries to children under one year of age were unknown. It was estimated that injuries for this category were approximately the same as the one year old category. All unknown data were distributed proportionately to all categories.

Source: Tennessee Department of Safety data files.

TABLE VII-4

MINOR INJURIES TO CHILD PASSENGERS UNDER FOUR YEARS OF AGE BY SIX-MONTH PERIODS BY AGE[a] (1976-1979)

Year	Age of Child				Total
	Under 1[b]	1	2	3	
1976-1	68	68	130	124	390
1976-2	106	106	114	122	448
1977-1	69	69	106	116	360
1977-2	84	84	157	137	462
1978-1	101	101	63	107	372
1978-2	139	139	75	98	451
1979-1	95	95	53	82	325
1979-2	98	98	81	112	389

[a]Minor injuries are defined as those reported as pain and/or bruises.

[b]Data on injuries to children under one year of age were unknown. It was estimated that injuries for this category were approximately the same as the one year old category. All unknown data were distributed proportionately to all categories.

Source: Tennessee Department of Safety data files.

number by age for the years 1976-1979. There is little difference between the number of serious injuries for those years.

A further investigation was made of the number of accidents in an attempt to understand better why increased CRD usage had no obvious effect on the number of injuries. The percentages of injury accidents to children under four years of age of all injury accidents (including fatal injuries) were calculated for each of the years used in the study (see Table VII-5). The proportion of minor and major injuries of all injuries to children under four years of age was also calculated (see Table VII-5). Only a small percentage (approximately six percent) of all injury accidents involve children under four years of age, and of this small percentage only about 16 percent involve serious injury (Table VII-5). Therefore the number of major injuries is relatively small--60 and 77 respectively for the first half years of 1977 and 1978. With CRD usage low and the number of deaths and serious injuries relatively low, the chances of preventing a serious injury is small, and the chances of preventing a fatality is even smaller. There was a large increase in the number of fatalities for the last reporting period over comparable periods, but there is no logical explanation since the January-June periods over the four years are practically unchanged.

Since the injury/fatality totals have exhibited a great deal of variation through the years, a more realistic basis of evaluating the impact of CRD usage is to contrast the injury/fatality rates of CRD users and those that do not use restraints within each year. This is done in Tables VII-6 and VII-7, using data provided by the Tennessee Highway Patrol. The first table shows the numbers in each specific injury category, along with new percentages. It is immediately apparent that CRD users have a number of advantages over the unrestrained:

1. CRD users are more likely to escape without injury.

2. CRD users have less risk in each injury category.

3. CRD users have almost no risk of fatality.

This last point arises because of the 20 fatalities to children under the age of four that were reported in the two-year period all occurred among the unrestrained group.

The second table, VII-7 shows the data consolidated for statistical analysis. Using chi-square tests, significant differences ($\alpha \leq .025$) were found between the CRD users and the unrestrained. Not only is the likelihood of escaping without injury higher for the CRD group, but its serious injury and fatality rates were nearly 50 percent smaller in 1978 and 71 percent smaller in 1979 as compared to the unrestrained group. In fact, if the rates of fatalities and injuries for the unrestrained group had been applied to the CRD group, 7 more fatalities and 40 more injuries would have been observed over the two-year period. The data indicate conclusively that CRDs are protecting those who use them, and only the relatively low rate of usage is preventing an impact on the overall injury and fatality rates.

TABLE VII-5

PROPORTIONS OF ACCIDENT INJURIES TO CHILDREN UNDER FOUR YEARS OF AGE

Year	Percentage of Injuries to Children Under Four Years of Age of All Accident Injuries[a]	Percentage of Major Nonfatal Injuries of Total Injuries to Children Under Four Years of Age	Percentage of Minor Injuries of Total Injuries to Children Under Four Years of Age
1975-1		21.8	76.6
1975-2	5.4	18.8	79.0
1976-1		16.4	81.9
1976-2	5.2	22.0	77.1
1977-1		14.1	84.3
1977-2	5.7	14.7	83.7
1978-1		16.9	81.8
1978-2	6.0	15.4	82.8
1979-1		18.2	80.0
1979-2	5.9	13.0	83.1

[a]Percentage for entire year.

TABLE VII-6

STATE OF PREPAREDNESS VS SPECIFIC INJURY CATEGORY

1978		None	Complain of Pain	Bruises, Limping	Blood & Gore	Fatal	Total
CRD	N	78	7	22	5	0	112
	Row %	69.6	6.3	19.6	4.5	-	100
Unrestrained	N	175	45	79	24	3	326
	Row %	53.7	13.8	24.2	7.4	0.9	100
1979							
CRD	N	72	16	16	6	0	110
	Row %	65.5	14.5	14.5	5.5	-	100
Unrestrained	N	110	41	84	38	17	290
	Row %	37.9	14.1	29.0	13.1	5.9	100

TABLE VII-7

STATE OF PREPAREDNESS VS CONSOLIDATED INJURY CATEGORY

1978		None	Minor	Major	Total
CRD	N	78	29	5	112
	Row %	69.6	25.9	4.5	100
Unrestrained	N	175	124	27	326
	Row %	53.7	38.0	8.3	100
$X^2(2) = 8.9$, significant at $\alpha = .025$					
1979					
CRD	N	72	32	6	110
	Row %	65.6	29.0	5.5	100
Unrestrained	N	110	125	55	290
	Row %	37.9	43.1	19.0	100
$X^2(2) = 21.5$, significant at $\alpha = .025$					

VIII. CONCLUSIONS AND RECOMMENDATIONS

The objective of this portion of the overall research project was to determine the impact of child passenger restraint legislation and a public information and education program on child passenger safety in Tennessee. The study was unique in that Tennessee was the first state to pass legislation requiring the protection of small child passengers, thus providing an opportunity for field evaluation. The major conclusions and recommendations drawn here are based on analyses of data collected prior to and in six-month increments after implementation of the law and PI&E program. The term "significant" as used in these conclusions means at the 0.10 level or better.

The evaluation of the PI&E program involved the measurement of the effectiveness of two intensity levels of application. The highest intensity level, which was called the comprehensive plan, was applied in progression to specific target areas during the study. The lower intensity level, the basic state plan, was used statewide for the entire period after the implementation of the law. An evaluation was made of the two intensity levels by comparing the target areas having the comprehensive plan with target areas having only the basic plan.

There were factors which may have influenced the CRD usage rates which were practically uncontrollable. These factors included the leakage of information (which only comprehensive plan target areas were to receive) to other urban areas and independent programs in the urban areas, both of which were outside the control of this study.

The results of this study should have application for similar situations in Tennessee and other states. The implications of the results of this study are included in the following summary of the major conclusions and recommendations:

1. Conclusion: The rate of usage of CRDs was significantly increased in Tennessee after implementation of a law and a PI&E program promoting child passenger safety. This conclusion is based on evaluation after two years of operation assuming no seasonal variation. The final CRD usage rate was 103 percent higher than the baseline rate, based on statewide estimates.

Recommendation: Every state should develop methods to increase child passenger protection. Legislation requiring the use of CRDs by small children should be one of the more important methods developed.

2. Conclusion: The comprehensive PI&E treatment, when applied to target areas during the operational period of this research, was significantly more effective in increasing CRD usage than the basic state plan. The actual size of the difference was partially masked by the bleeding of information into basic state plan areas. The comprehensive PI&E treatment is also substantially more costly than the basic plan.

Recommendation: The decision of whether or not to use a comprehensive PI&E plan as defined in this project should also be based on economic considerations. A lower intensity plan such as the basic plan in this study

has a relatively low cost. Since the comprehensive campaign had a definite impact, low cost mass media programs should be considered.

3. Conclusion: While the increase in CRD usage was not enough to show significant reductions in overall fatalities or serious injuries based on the accident data analysis for the operational period, the children in CRDs had significantly more protection than those that were not in CRDs. Of the 20 deaths investigated in this two year period, all were without CRDs. By this measure, use of CRDs prevented at least 40 injuries and 7 fatalities during the two years.

Recommendation: Since the frequencies of fatalities are low, this should not be used as a measure of effectiveness of this type of safety program. The best measure of effectiveness of the program is to apply the injury/ fatality rates of the unrestrained children to the group in CRDs.

4. Conclusion: The proportion of children under four being held by older passengers in the vehicle did not change significantly after the implementation of legislation and the PI&E program; 26.0 percent of children in the baseline period and 22.6 percent of the children in the operational periods were held by older passengers. However, holding children while traveling in an automobile is very dangerous.

Recommendation: The law should be changed by deleting the so-called "babes in arms" amendment which allows older passengers to hold a child under four years of age.

5. Conclusion: There was no increase in seat belt usage by all drivers observed between the baseline and operational measurement periods. But when a subset of drivers who had small children with them was measured, there was a significant increase in seat belt use. Drivers who are users of seat belts tend to protect their children by placing them in CRDs, i.e., there was a significant relationship between drivers' decision to use seat belts and their decision to place their children in CRDs.

Recommendation: To increase the usage rates of both seat belts and CRDs and thus to decrease deaths and injuries, a passenger restraint usage law for all vehicle occupants should be passed and strictly enforced.

6. Conclusion: The variables which best distinguish between users and nonusers of CRDs were identified. Using these variables as descriptors, a nonuser is (1) less likely to be wearing a seat belt, (2) more likely to have a lower educational attainment level, (3) more likely to have more passengers in the vehicle, (4) more likely to be transporting older children (under four years of age), (5) less likely to be the parent of the child, (6) more likely to be in a lower income bracket and (7) less likely to own the vehicle.

Recommendation: The major focus of future PI&E campaigns should be directed toward the specific target groups which fit characteristics of the nonuser.

7. Conclusion: The CRD usage rates in Tennessee are still too low. Although the urban usage rate is well over 20 percent and the nonurban rate is nearly 15 percent, almost 80 percent of the targeted children remain unprotected.

Recommendation: To aid in substantially increasing the CRD usage to a level that will have a greater impact on child passenger safety in Tennessee, several specific measures should be taken as summarized below:

a. The law needs to be strengthened by deleting the clause "or assuring that such child is held in the arms of an older person riding as a passenger in the motor vehicle."

b. There should not be an exemption for any vehicle because of size, type or ownership.

c. All drivers of vehicles should be required to use CRDs for children in their vehicle regardless of the relationship to the child.

d. All drivers of vehicles should be required to use CRDs for children in their vehicle regardless of their state of residence.

e. The present law needs to be enforced more rigidly at all levels of government.

f. Convictions should be uniform across the state.

g. A fine equivalent to the approximate average cost of a CRD or proof of purchase of an approved CRD is recommended to deter potential offenders.

h. An occupancy restraint usage law for all vehicle passengers should be passed by the legislature and enforced rigidly.

i. One organization in the state should be established as a clearing-house of information and for coordination of activities for the promotion of child passenger safety.

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APPENDIX A

TENNESSEE CODE

59-930. Safety belts and child passenger restraint systems required —Violations—Penalties.—(a) It shall be unlawful for any person to buy, sell, lease, trade or transfer from or to Tennessee residents, at retail, an automobile which is manufactured or assembled commencing with the 1964 models, unless such automobile is equipped with safety belts installed for use in the left front and right front seats thereof. All such safety belts shall be of such type and be installed in a manner approved by the department of safety of the state of Tennessee. The department shall establish specifications and requirements of approved types of safety belts and attachments. The department will accept, as approved, all seat belt installations and the belt and anchor meeting the specifications of the Society of Automotive Engineers. Provided that in no event shall failure to wear seat belts be considered as contributory negligence, nor shall such failure to wear said seat belt be considered in mitigation of damages on the trial of any civil action.

(b) Effective January 1, 1978, every parent or legal guardian of a child under the age of four (4) years residing in this state shall be responsible, when transporting his child in a motor vehicle owned by that parent or guardian operated on the roadways, streets or highways of this state, for providing for the protection of his child and properly using a child passenger restraint system meeting federal motor vehicle safety standards, or assuring that such child is held in the arms of an older person riding as a passenger in the motor vehicle. Provided that the term "motor vehicle" as used in this paragraph shall not apply to recreational vehicles of the truck or van type. Provided further that the term "motor vehicle" as used in this paragraph shall not apply to trucks having a tonnage rating of one (1) ton or more. Provided that in no event shall failure to wear a child passenger restraint system be considered as contributory negligence, nor shall such failure to wear said child passenger restraint system be admissible as evidence in the trial of any civil action.

(c) Violation of any provision of this section is hereby declared a misdemeanor and anyone convicted of any such violation shall be fined not less than twenty-five dollars ($25.00) nor more than fifty dollars ($50.00) for each violation of subsection (a) of this section and not less than two dollars ($2.00) nor more than ten dollars ($10.00) for each violation of subsection (b) of this section. [Acts 1963, ch. 102, §§ 1, 2; 1977, ch. 114, §§ 1, 2.]

Amendments. The 1977 amendment designated the former first paragraph as subsection (a), the former second paragraph as subsection (c), added subsection (b) and added the material at the end of subsection (c) following "fifty dollars for each violation."

Effective Dates. Acts 1977, ch. 114, § 3. January 1, 1978.

Law Reviews. Ellithorpe—Adoption of Crashworthiness Via Strict Products Liability (Gail O. Mathes), 4 Memphis State U. L. Rev. 497.

Cited: Ellithorpe v. Ford Motor Company (1973), — Tenn. —, 503 S. W. (2d) 516.

NOTES TO DECISIONS

1. Contributory Negligence.

Failure to wear seat belts does not constitute contributory negligence in Tennessee. Mann v. United States (1968), 294 Fed. Supp. 691.

In wrongful death action where defendant's automobile, after failing to yield right-of-way, struck the decedent's vehicle, an instruction as to possible remote contributory negligence of decedent because of his failure to wear a seat belt was precluded by the proviso in this section that states that a failure to wear seat belt shall not be considered contributory negligence. Stallcup v. Taylor (1970), 62 Tenn. App. 407, 463 S. W. (2d) 416.

APPENDIX B

RATIONALE FOR SELECTION OF SAMPLE SIZES

The minimum design objectives were to detect the condition of no change in the CRD usage rate of the population with 90 percent confidence and to detect a 6 percent change in the population with 90 percent confidence. These objectives imply that a sample difference in CRD usage rates of 3 percent will be a significant difference. For a low initial usage rate (10 percent) this leads to a minimum sample size requirement of 400. This total could be obtained from two sources. For example, if a target area had a requirement of 400, it could be met by:

Tier Two Matched Observations + Tier Two Unmatched Observations	= 200
Tier One Observations (age adjusted)	= 200
	400

For counterbalancing bias, the age adjusted tier one observations were given equal weight with the tier two level observations. The limiting factor for this rationale is that the number of age adjusted tier one data should not exceed the number of tier two data.

The purpose for matching observations was to confirm the "observational only" data. For example, the age of child may be in error at the tier one level of observation.

The attachment to the following letter is an explanation of the basis for selecting the sample sizes for the larger research project. The minimum sample size of 400 was approved for basic state plan target areas. However a decision was made to increase the sample size requirement to 500 in target areas receiving the comprehensive plan and to obtain 800 observations at each target area in the baseline period to increase the precision of the calculations.

Transportation Center
-Research/Service

The University of Tennessee
Knoxville, Tennessee 37916
Phone (615) 974-5255

September 15, 1977

Mr. Lee Seaver
U.S. Department of Transportation
National Highway Traffic Safety Administration
NTS-14
400, 7th Street S.W.
Washington, DC 20590

Dear Mr. Seavers:

Enclosed is a summarized explanation of Dr. John Philpot's sample size recommendations and a copy of a revision of page 45 of the proposal. Please contact Dr. Philpot and/or me if you have questions concerning the explanation (615-974-2556 or 5255 for me).

Your early attention of this matter will be appreciated since time is short for collecting baseline data.

Sincerely,

Randy L. Perry
Assistant Director

RLP:dkp

cc: Dr. John Philpot

Sample Size Requirements for Project: Evaluation of the Impact of the Tennessee Child Passenger Protection Act

John Philpot

The sample size calculations made here are predicated on the need to detect significant changes in the usage rates of Child Restraint Systems (CRS) at critical points in the implementation plan. These critical points correspond to particular questions that must be answered six months after each new treatment or treatment combination (other than the Basic Statewide Program, BSP) is introduced. The questions are:

1. Does the Basic Statewide Program (BSP) generate an increase in the CRS usage rate when compared to the baseline data (BLD) a) within each pertinent target area, and b) across all pertinent target areas?

2. Does the BSP + the comprehensive Plan (CP) treatment cause an increase in the CRS usage rate when compared to the BLD for that target area.[2]

3. Does the BSP + CP treatment generate an increase in the CRS usage rate when compared to the pooled BSP results in the same time period?

4. Does the CP treatment cause an increase in the CRS usage rate when compared to the earlier BSP treatment for that target area.

5. Does the CP + Loaner Program (LP) treatment generate an increase in the CRS usage rate when compared to the earlier BSP treatment for that target area.

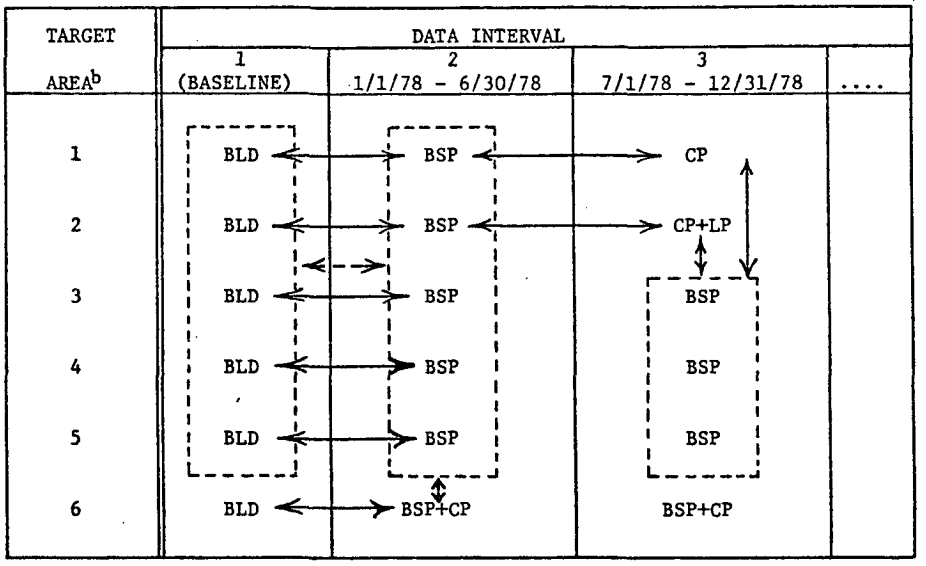
6. Does the CP treatment cause an increase in the CRS usage rate when compared to the pooled BSP results in that same time period?

7. Does the CP + LP treatment cause an increase in the CRS usage rate when compared to the BSP results in that same time period?

The comparisons are shown in Table 1, with arrow-pairs (↔) indicating the critical comparisons to be made.

TABLE 1[a]

IMPLEMENTATION PLAN (PARTIAL)



a. Similar to p. 45 of the proposal, except target areas 5 & 6 are switched for graphical clarity.

b. Assumes the 3 rural sites comprise one target area.

ASSUMPTIONS

All subsequent calculations will assume: (i) $\alpha=\beta=.10$*; (ii) that the Δp change in the CRS usage rate induced by the BSP is about .03 per the first 6 month period and about .01 per the next 6 month period; (iii) that the Δp change resulting from the CP is at least .05 per each 6 month period; (iv) that the Δp caused by the LP is about .01 per each 6 month period; and (v) that all effects are additive.

In addition, when comparing across data intervals, sample sizes per intervals will be assumed equal, and the following formula will be used:

$$n = \frac{4z^2}{d^2}(p_1q_1 + p_2q_2) \quad , \quad \text{where } d=p_2-p_1. \tag{1}$$

Figure 1 shows sample sizes using the above formula for the stated conditions.

In some cases sample sizes are necessarily unequal, as in comparisons within a data interval where one treatment group is composed of t target areas. Here sample sizes will be assumed equal for each target area, and the following formula will be used:

$$n = \frac{4z^2}{d^2}\left(\frac{p_1q_1}{t} + p_2q_2\right) \tag{2}$$

*This is slightly more conservative than $\alpha=.05$, $\beta=.20$.

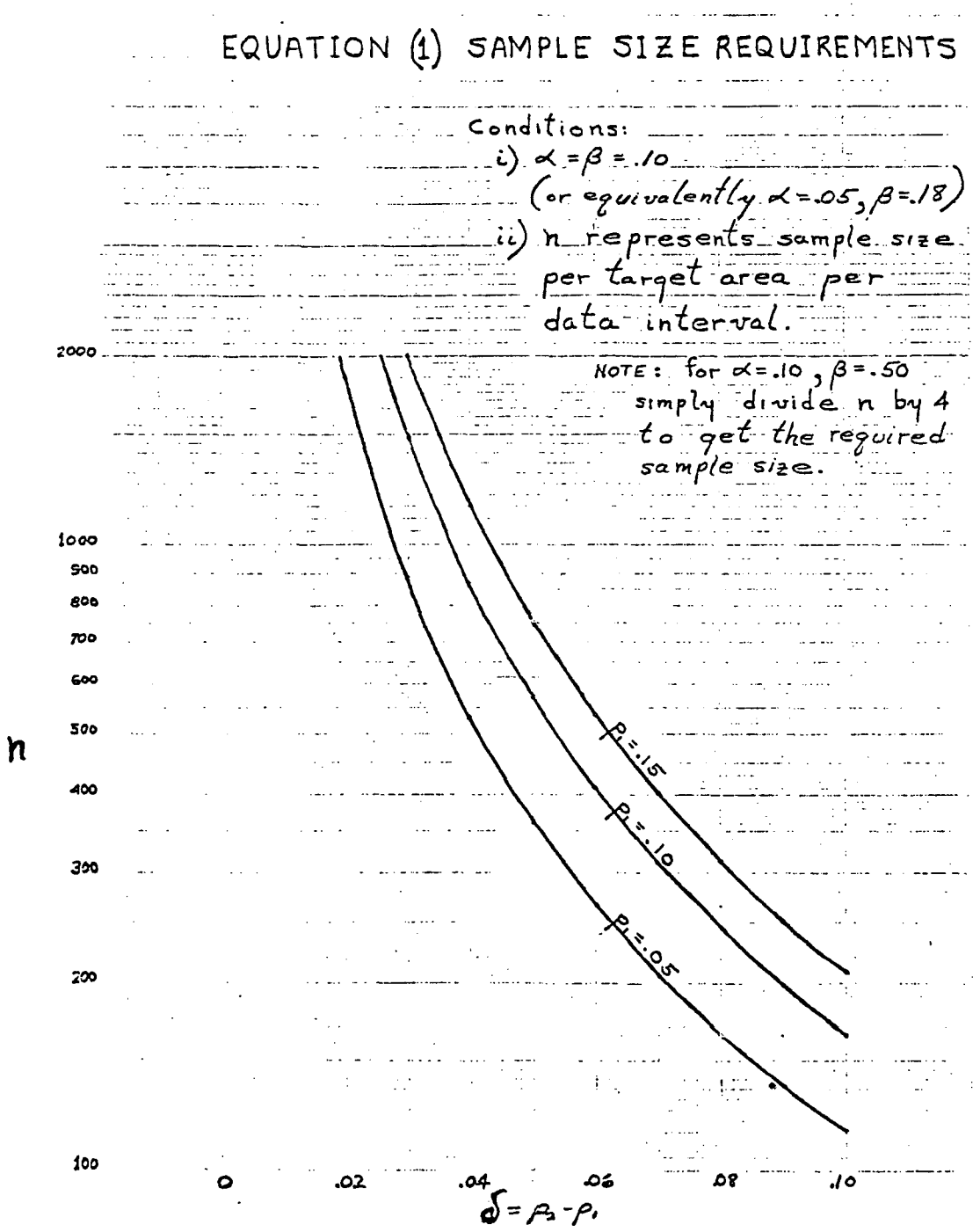

EQUATION (1) SAMPLE SIZE REQUIREMENTS
Conditions:
i) $\alpha = \beta = .10$
(or equivalently $\alpha = .05, \beta = .18$)
ii) n represents sample size per target area per data interval.
NOTE: for $\alpha = .10, \beta = .50$ simply divide n by 4 to get the required sample size.
n
2000
1000
900
800
700
600
500
400
300
200
100
0
.02
.04
.06
.08
.10
$\delta = p_2 - p_1$
$p_1 = .15$
$p_1 = .10$
$p_1 = .05$

FIGURE 1

CALCULATIONS

Note: Subscripts on treatment acronyns refer to data intervals.

Question 1 (a): BSP_2 vs BLD_1; comparison within each pertinent target area

Assume: $p(BSP_2) = .08$
$p(BLD_1) = .05$
$d = .03$

n = 885 per target area per interval
(Not feasible, test must run at a lower power.)

Question 1 (b): BSP_2 vs BLD_1; comparison based on pooled data across five target areas.

$n = \frac{885}{5} = 177$ (approximately per target area per data interval.

Question 2: $BSP+CP_2$ vs BLD_1 in target area 6.

Assume: $p(BSP+CP_2) = .13$
$p(BLD_1) = .05$
$d = .08$

n = 165 per data interval, target area 6.

Question 3: $BSP+CP_2$ vs pooled* BSP_2.

Assume: t = 5

$p(BSP+CP_2) = .13$
$p(BSP_2) = .08$
$d = .05$

n = 337 per target area, data interval 2.

Question 4: CP_2 vs BSP_2; within target area 1.

Assume: $p(CP_3) = .13$
$p(BSP_2) = .08$
$d = .05$

n = 491

Question 5: $CP+LP_3$ vs BSP_2; within target area 2.

*It is assumed that the data can be pooled after adjusting for BLD results.

Assume: $p(CP+LP_3) = .14$
$p(BSP_2) = .08$
$d = .06$

n = 354

Question 6: CP_3 vs pooled BSP_3; during data interval 3.

Assume: t = 3

$p(CP_3) = .13$
$p(BSP_3) = .09$
$d = .04$

n = 477 per target area, data interval 3.
(Not feasible, test must be run at a lower power.)

Question 7: $(CP+LP_3)$ vs pooled BSP_3; during data interval 3.

Assume: t = 3

$p(CP+LP) = .14$
$p(BSP) = .09$
$d = .05$

n = 389 per target area, data interval 3.

Recommendations: No one sampling plan can satisfy both the budget constraints and the requirements for precision. However, in general, a compromise recommendation is: let n=400 per target area per data interval, except where new treatments or treatment combinations are introduced. In those 3 cases it is recommended that n=500 be the standard in order to increase the precision for those critical comparisons. Within a given target area, it is recommended that the sample be allocated among the sites according to the population represented by that site (e.g. proportional to number of parking spaces per site).

Finally, in recognition of the fact that a PI&E program must be demonstrably successful before being moved, it is recommended that the sampling within a target area be done monthly (e.g. 2 sites per month). This would allow for a projection at the end of 3 or 4 months regarding the 6 month effect of the PI&E treatment. This would then permit a recommendation at the end of 3 or 4

months. The decision will be whether to move the treatment to new target areas as is, or modify it radically and test anew in the next data interval. Agreement on this or some similar strategy is essential, since PI&E programs take a substantial amount of time to develop and implement.

APPENDIX C

DAILY TALLY DATA SHEET

DAILY TALLY SHEET

_____
City

_____ _____
Site Date

_____
Data Collection Times

Station # 1_____
Location of Entrance

Number of Tier 1's_____

Counter Totals

1. Total Private Vehicles	2. Child Restraint Devices	3. Seat Belts Used	4. Seat Belts Undetermined
_____	_____	_____	_____

Station #2_____
Location of Entrance

Number of Tier 1's_____

Counter Totals

1. Total Private Vehicles	2. Child Restraint Devices	3. Seat Belts Used	4. Seat Belts Undetermined
_____	_____	_____	_____

I. Counter Totals (Combine figures from Station 1 and Station 2):

1. Total Private Vehicles	2. Child Restraint Devices	3. Seat Belts Used	4. Seat Belts Undetermined
_____	_____	_____	_____

II. Tier 1 totals
- A. Total number of Tier 1's (In State)_____
- B. Total number of Tier 1's (Out of State)_____
- C. Number of Tier 1's using CRD's (In State)_____
- D. Number of Tier 1's using CRD's (Out of State)_____

III. Tier 2 totals (In-state cars only):
- A. Total Number of Tier 2's _____
  1. Number of refusals (no data)_____
  2. Number of vehicles with no children under 4 ____
  3. Total number of valid Tier 2's _____
- B. Number of Tier 2's using CRD's _____

APPENDIX D

TIER ONE DATA SHEET

Child Passenger Safety Program
TIER 1
Data Sheet

1. Child(ren) under four years of age

_____ 1. In CRD

_____ 2. Held by Passenger

_____ 3. Held by Driver

_____ 4. Other

2. Seat Belts in use (Driver Only)

_____ 1. Yes

_____ 2. No

_____ 3. Undetermined

APPENDIX E

TIER TWO DATA SHEET

CHILD PASSENGER SAFETY PROGRAM

TIER 2

Data Sheet

QUESTIONS ASKED OF SUBJECT

1. Child(ren) younger than 4

(# of)

Child (under 4)	Birthdate	Sex		Driver's Relation to Child			
	mth/yr	F	M	Par.	Rel.	Friend	Other
#1							
#2							
#3							

2. Year of car 19 _ _

3. If CRD is not present

Do you own a CRD?

☐ 1. Yes _____ brand _____ type

☐ 2. No

4. If CRD is present

a) What Brand? #1_____

(if more than 1) #2_____

OBSERVED ITEMS

4. b) Type

#1 #2

☐ ☐ 1. Infant Carrier

☐ ☐ 2. Protective Shield

☐ ☐ 3. Car Seat

☐ ☐ 4. Safety Harness

c) Is CRD federally approved?

#1 #2

☐ ☐ 1. Yes

☐ ☐ 2. No

☐ ☐ 3. Undetermined

d) Location

#1 #2

☐ ☐ 1. Back seat

☐ ☐ 2. Front seat

☐ ☐ 3. Cargo area

e) Was CRD used?

#1 #2

☐ ☐ 1. Yes

☐ ☐ 2. No

☐ ☐ 3. Undetermined

f) When use was observed

#1 #2

☐ ☐ 1. Before Removal

☐ ☐ 2. Demonstrated

☐ ☐ 3. Not viewed

g) Usage

#1 #2

☐ ☐ 1. Proper

☐ ☐ 2. Improper

☐ ☐ 3. Undetermined

5. Passengers 4 and older

a) _____children (4-17 yrs.)
(# of)

b) _____adults
(# of)

6. Driver

Sex: ☐ F ☐ M

7. If the respondent is not the driver, what sex?

☐ F ☐ M

8. Seat Belts Used (driver only)

☐ yes ☐ no ☐ unknown

9. Vehicle Information

a) Body Style

☐ 1. 2 door sedan

☐ 2. 4 door sedan

☐ 3. 2 door station wagon

☐ 4. 4 door station wagon

☐ 5. Pickup/van

☐ 6. Other _____

b) Size

☐ 1. Subcompact

☐ 2. Compact

☐ 3. Full size

c) Make _____

d) License Number _____

Participation in this survey is completely voluntary. Only summary data will be reported. All individual responses will be confidential. You may withdraw your participation at any time. If you have any questions about the program you may call the Transportation Center 974-5255.

1. Do you (or your mate) own this car?

- ☐ 1. Yes
- ☐ 2. No

2. How many cars do you and your mate own?

- ☐ 1. One
- ☐ 2. Two
- ☐ 3. Three or more

3. Were the driver and the passengers over 4 years of age wearing seat belts?

- ☐ 1. Yes, all were
- ☐ 2. Some passengers were
- ☐ 3. No, none were

4. What is your marital status?

- ☐ 1. Married/living with a mate
- ☐ 2. Single/living without a mate

5. How many children do you have?

	Number living at home	Number not living at home	Children
a.	_____	_____	Under 4 years
b.	_____	_____	4-17 years
c.	_____	_____	18 years or older

6. What was your family income last year before taxes? (If you are single/not living with a mate, what was your personal income?)

- ☐ 1. Less than $5,000
- ☐ 2. $5,000 to $9,999
- ☐ 3. $10,000 to $14,999
- ☐ 4. $15,000 to $19,999
- ☐ 5. $20,000 to $24,999
- ☐ 6. $25,000 to $29,999
- ☐ 7. $30,000 or more

7. What is your employment status? (Check only one)

- ☐ 1. Employed full time, outside home
- ☐ 2. Employed part time, outside home
- ☐ 3. Retired
- ☐ 4. Homemaker
- ☐ 5. Student
- ☐ 6. Unemployed
- ☐ 7. Other _____ (please specify)

8. What is your mate's employment status? (Check only one)

- ☐ 0. No mate
- ☐ 1. Employed full time, outside home
- ☐ 2. Employed part time, outside home
- ☐ 3. Retired
- ☐ 4. Homemaker
- ☐ 5. Student
- ☐ 6. Unemployed
- ☐ 7. Other _____ (please specify)

9. What is the highest level of education you have completed?

- ☐ 1. No formal schooling
- ☐ 2. Less than High School
- ☐ 3. High School or G.E.D.
- ☐ 4. Vocational or Technical School
- ☐ 5. Some college
- ☐ 6. College degree
- ☐ 7. Graduate degree

10. What is the highest level of education your mate has completed?

- ☐ 0. No mate
- ☐ 1. No formal schooling
- ☐ 2. Less than High School
- ☐ 3. High School or G.E.D.
- ☐ 4. Vocational or Technical School
- ☐ 5. Some college
- ☐ 6. College degree
- ☐ 7. Graduate degree

APPENDIX F

TENNESSEE DEPARTMENT OF SAFETY OFFICER'S ACCIDENT REPORT

TENNESSEE OFFICER'S ACCIDENT REPORT

TDS-50.1 (Rev 8/73)

REPORTING AGENCY (Please Print)

LOCATION

Street, Highway No., or Name

At Intersection With

or.

1 ____ Ft. North 3 ____ Ft. East

2 ____ Ft. South 4 ____ Ft. West

Of Intersection, House Number, Bridge, RR Crossing, or Other Identifying Landmark

____ Ft. (N S E W) of ____ Log Mile ☆ ____ County ☐ In near ____ City

1 ☐ Urban
2 ☐ Rural
3 ☐ Industrial
4 ☐ Shopping
5 ☐ School or Playground
6 ☐ Posted Speed
Veh. 1 ____
Veh. 2 ____

TIME

Date ____ Month Day Year Time ____ 1 ☐ AM 2 ☐ PM Day of Week ____

ACCIDENT INVOLVED

1 ☐ Pedestrian 3 ☐ Other Motor Vehicle 5 ☐ Pedal Cycle 7 ☐ Parked Vehicle 8 ☐ Other ____
2 ☐ Animal 4 ☐ Train 6 ☐ Fixed Object ____ ____ Ft. from Roadway

VEHICLES INVOLV

VEHICLE	YEAR	MAKE	TYPE	COLOR	PLATE NO	YR. OF PLATE	STATE
1							

Driver ____ Last First Middle Address ____ ☆ Street, Route City State

Telephone No. ____ D.O.B. ____ Month Day Year Age ____ DL ☆ ____ State ____

TYPE LICENSE 1 ☐ Regular 3 ☐ Other 2 ☐ Chauffeur 4 ☐ None ____ SEX 1 ☐ Male 2 ☐ Female RACE 1 ☐ White 2 ☐ Negro 3 ☐ Other

Owner ____ D.O.B. ____ Month Day Year DL ☆ ____

Address ____ Tele. No. ____

Vehicle Going ☐ East ☐ West ☐ North ☐ South On ____ Street Highway

Vehicle Moved To ____ Name of Garage Address By ____

1 ☐ Less than $200
2 ☐ $200 to $500
3 ☐ If Over $500 enter Amount $ ____

CIRCLE POINT OF INITIAL IMPACT-SHADE DAMAGED AREAS

0 ☐ UNDERCARRIAGE
9 ☐ UNKNOWN (USE FOR HIT & RUN)

VEHICLE	YEAR	MAKE	TYPE	COLOR	PLATE NO.	YR. OF PLATE	STATE
2							

Driver ____ Last First Middle Address ____ ☆ Street, Route City State

Telephone No. ____ D.O.B. ____ Month Day Year Age ____ DL ☆ ____ State ____

TYPE LICENSE 1 ☐ Regular 3 ☐ Other 2 ☐ Chauffeur 4 ☐ None ____ SEX 1 ☐ Male 2 ☐ Female RACE 1 ☐ White 2 ☐ Negro 3 ☐ Other

Owner ____ D.O.B. ____ Month Day Year DL ☆ ____

Address ____ Tele. No. ____

Vehicle Going ☐ East ☐ West ☐ North ☐ South On ____ Street Highway

Vehicle Moved To ____ Name of Garage Address By ____

1 ☐ Less than $200
2 ☐ $200 to $500
3 ☐ If Over $500 enter Amount $ ____

CIRCLE POINT OF INITIAL IMPACT-SHADE DAMAGED AREAS

0 ☐ UNDERCARRIAGE
9 ☐ UNKNOWN (USE FOR HIT & RUN)

TOTAL

Damage to Property Other than Vehicles — Name object, show ownership, and state nature of damage.

TOTAL INJURED

Veh. ( ) 1 ☐ Dr. 2 ☐ Pass. 3 ☐ Ped. Sex ____ Race ____

Name ____ Age ____

Address ____

Telephone No. ____ Injury Code ____

Taken To ____ By ____

Veh. ( ) 1 ☐ Dr. 2 ☐ Pass. 3 ☐ Ped. Sex ____ Race ____

Name ____ Age ____

Address ____

Telephone No. ____ Injury Code ____

Taken To ____ By ____

(INJURY CODE)

1. Complaint of pain, no visible injury
2. Bruises, abrasions, swelling, limping, etc.
3. Bleeding wound, distorted member
4. Dead at time of report

THIS ACCIDENT HIT AND RUN: 1 ☐ Yes 2 ☐ No IF YES, IS ADDITIONAL REPORT BEING FILED? 1 ☐ Yes 2 ☐ No SOLVED: 1 ☐ Yes 2 ☐ No

WITNESSES

(1) First Middle Last Sex Race Age Address Phone Bus. ____ Res. ____

(2) Phone Bus. ____ Res. ____

Name ____

Charge(s) ____ Court Dw. ____

Court Date ____ Time ____ 1 ☐ AM 2 ☐ PM

Ticket Number ____

Disposition ____ Continued to ____

Name ____

Charge(s) ____ Court Dw. ____

Court Date ____ Time ____ 1 ☐ AM 2 ☐ PM

Ticket Number ____

Disposition ____ Continued to ____

Time Notified of Accident ____ Date ____ Hour 1 ☐ AM 2 ☐ PM

Investigation Made at Scene of Accident ____ Date ____ Hour 1 ☐ AM 2 ☐ PM

Where Else Was Investigation Made?

Were Photographs Taken? 1 ☐ Yes 2 ☐ No

Is Investigation Completed? 1 ☐ Yes 2 ☐ No

WERE SEAT BELTS IN USE?

Vehicle	1			2		
	Yes	No	Don't Know	Yes	No	Don't Know
Driver	☐	☐	☐	☐	☐	☐
Passenger	☐	☐	☐	☐	☐	☐

APPENDIX G

SUMMARY OF DATA COLLECTION PROCEDURES

SUMMARY OF PROCEDURES USED FOR RESTRAINT USAGE DATA COLLECTION

Introduction

The data collection process begins with a planning session of the project staff. The session is used to make specific assignments to individuals in order to ensure that all tasks associated with data collection are covered. Because it is a statewide effort equipment and personnel are critical issues.

Personnel

Personnel used for supervision purposes are usually project staff. Survey workers are usually recruited from universities, colleges, high schools, and temporary employment pools.

Equipment

Equipment includes projectors and other visual aids to include child restraints. Two-way radios are necessary for communications during collection. Traffic counters, clipboards, pens, name tags, and observation platforms are other items of equipment which must be remembered. The following is an equipment check list.

EQUIPMENT LIST

Each Observer Team needs:

1. One two-way radio
2. Two tunics
3. One four-input traffic counter

4. One two-ring clipboard
5. Tier 1 forms
6. One writing pen
7. Two name tags
8. Six or seven crates for observer platform

Each Interviewer needs:

1. One two-way radio
2. One tunic
3. One Child Restraint Device Reference Card
4. One writing pen
5. Tier 2 forms
6. Tier 3 forms
7. Balloons (optional)
8. Name tags

Training

Adequate sized rooms depending on number of survey workers, are arranged for the training session. A typical program for training includes a short safety film, slide presentation on the program, and the details of the data collection procedure.

Exhibit G-1 is an outline of the training session program. Exhibit G-2 is a set of instructions for the observer team. Exhibit G-3 is an instructional sheet for Interviewers.

Operation

Exhibit G-4 is a flow chart which depicts the data collection operation in the field. This operation is for collecting more data than was used in this study, but was used in the larger project of which this study is a part.

EXHIBIT G-1

TRAINING PROGRAM OUTLINE

. Welcome.

. Introduction to CPS and purpose of session.

. Begin slide program:

    . General overview.
    . Explain what CRD's are and point out different types.
    . Explain the collection arrangement.
        1. Where we will collect data.
        2. How we will split up into observer teams and interviewers.
    . Further explain Tier 1 (hand out a copy of tier #1 and example sheets).
    . Discuss the importance of accuracy of recognizing children under four years old.
    . Explain how observers should give directions to interviewers (use blackboard).
    . Explain interviewer's job (hand out tier #2 and example sheets).
    . Carefully go over references card.
    . Stress the crucial nature of accurately recording the Tier 3 number on Tier 2 (handout tier #3).
    . Show mock up situations.
    . Quiz workers on Tier 2 by having them observe situations using 35mm slides.

END OF SLIDE PROGRAM

. Point out the real life problems with which they will be dealing.
. Explain that friendliness and courtesy are <u>essential</u>.

EXHIBIT G-1 (continued)

- Ask each worker to use their introduction guidelines and introduce themselves to their neighbor on both sides of them.
- Make sure you have answered all questions and proceed with some practical exercises using role playing if possible.

EXHIBIT G-2

INSTRUCTIONS FOR OBSERVER TEAM

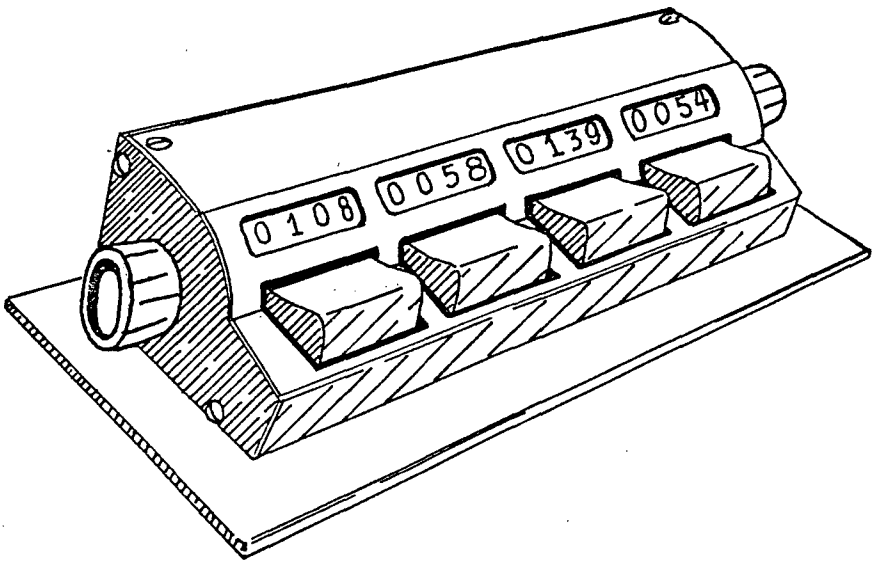
The general purpose of this segment of the study is to identify families with children under four so that they may be asked to participate in the study. The team requires two people. One observer observes each vehicle and uses the two-ring clipboard to complete the Tier 1 forms. The other observer makes four types of traffic counts and communicates by two-way radio with the interviewers.

Tier 1 forms are completed on vehicles with a child(ren) that is/are believed to be under four years old. If only one child under four years of age was in a vehicle the observer checks the appropriate boxes in the lefthand column. If there appears to be two or more children under four years in the vehicle, use the lefthand column for the child who appears to be the safest and the right hand column for the child who appears to be the second most safest.

If the vehicle is out-of-state, simply write O.S. in the license number blank. It is very important that you record the license number on in-state vehicles.

The second observer holds a traffic counter and punches in a number for each private vehicle that passes, each child restraing device observed (whether obcupied or not), and seat belt usage observed or undetermined usage (see following example).

EXHIBIT G-2 (continued)



The second observer calls the interviewers when a vehicle with children appearing to be under four years of age enters their area. The observer should call out the color and model/make and the direction of the vehicle only.

EXHIBIT G-3

INSTRUCTIONS FOR INTERVIEWERS

General Overview of the Tier 2 Data Sheet

The general purpose of this data collection instrument is twofold. First of all, we are attempting to determine the current usage rate of child restraint devices (CRD). Secondly, we are attempting to determine whether or not the child restraint devices are being used properly. (See your guidelines for proper and improper use.)

Questions 1 through 4a (those questions above the dotted line) are to be asked of the subject. Items 4b through 9 which are observed by the interviewer during the interview are to be completed after the subject has answered the questions on the reverse side.

The interviewers will also carry and give to parents (only) a mail-in questionnaire designed to determine their attitudes about child restraint devices.

Instructions for the Tier 2 Data Sheet

If at all possible, get to the vehicle before the occupants begin to get out. Getting to the vehicle before the occupants get out will allow you to view child restraint usage before the child is removed. If you get to the vehicle after the child is removed, you should ask the subject to demonstrate use of the child restraint device (see instructions for question 4a). Furthermore, in cold weather people will be more willing to talk to you through a partially open window than out in the weather.

Upon reaching the vehicle you should identify yourself and your purpose by using the INTRODUCTION GUIDELINES or some paraphrase thereof. If the subject should refuse to be interviewed, gracefully thank them and write "refused" on the top of the data sheet.

EXHIBIT G-3 (continued)

Question 1. After identifying yourself and receiving permission for the interview, the first thing you should determine is whether or not the child(ren) observed is/are younger than four years of age. If there are no children younger than four in the car, enter zero in the blank provided and thank the subject for his or her cooperation. (Also be sure to enter the license number of the car in the blank provided on the bottom right hand corner of the Tier 2 Data Sheet.) If there are children younger than four in the car, get their birthdates (month and year), their sex, and the driver's relationship to them (i.e., whether the driver is the parent, other relative, friend, or other, such as babysitter). Enter this information in the boxes provided.

Question 2. After completing question 1, ask the subject the year of the vehicle and enter the last two digits in the blanks provided.

Question 3. Only ask this question if there is no child restraint device (CRD) in the vehicle. If there is a child restraint device in the vehicle, skip to question 4a. If there is no child restraint device in the vehicle, ask the subject if he or she owns one. If the subject owns one, ask the subject what brand it is and what type it is, and enter this information on the lines provided. (Show the subject the types on the card, if necessary.)

Question 4a. Only ask this question if there is a child restraint device in the vehicle. (This question should not be asked if Question 3 was asked.) If there is a child restraint device in the vehicle, ask the subject what brand it is and enter this information in the first blank. If the subject does not know the brand, place a question mark in the blank. If there are two child restraint devices in the vehicle, try to determine both brands and enter the information in the lines provided.

EXHIBIT G-3 (continued)

IF YOU HAVE BEEN UNABLE TO VIEW THE USE OF THE CHILD RESTRAINT, ASK THE SUBJECT TO DEMONSTRATE HOW IT IS USED.

The remaining items on the front of the data sheet can be answered without questioning the subject. In order not to detain the subject any longer than necessary, answer these items after the subject has completed the questions on the reverse side. In other words, once you have asked the subject the first four questions and entered his or her responses turn the data sheet over and ask the subject if he or she would mind completing the reverse side. After the subject has completed the reverse side and returned it to you, hand the subject (only parents) the envelop containing the Tier 3 questionnaire explaining that if he or she returns it we will send their child a gift. (BE SURE TO RECORD THE TIER 3 ON THE TIER 2 DATA SHEET IN THE LOWER LEFT HAND CORNER.) Finally, thank the subject for his or her cooperation and walk a small distance from the car allowing the subject and the passengers to freely get out of the vehicle and continue their business. Once you've removed yourself a short distance, finish completing the Tier 2 Data Sheet (items 4a through 9d). Questions 4b through 5g have two columns. The left hand column is for information corresponding to brand #1 in question 4a. The second column corresponds to brand #2 in 4a.

Question 4b. Indicate the type of CRD in the vehicle by checking the appropriate box. If you are unsure of the type, consult the card which has been provided.

Question 4c. Indicate whether or not the CRD is federally approved.

Question 4d. Indicate the location of the CRD(s).

Question 4e. Indicate whether or not you saw the CRD(s) in use when you reached the vehicle.

EXHIBIT G-3 (continued)

Question 4f. Indicate when you observed the use of the CRD. If you reached the vehicle after the child had been removed from the CRD or if the child was not in the CRD, you should have asked the subject to demonstrate use. If the subject demonstrated use, check demonstrated. If the subject refused to demonstrate, check not viewed.

Question 4g. Determine whether or not usage of the CRD was proper or improper. Follow your guidelines for improper and proper use on the card provided.

Question 5.

a. Write in the number of children in the vehicle who were between 4 and 17 years of age. If none, write in zero.
b. Write in the number of adult passengers in the blank provided. If there were no adults other than the driver, write in zero.

Question 6. Indicate the sex of the driver.

Question 7. Only answer this question if someone other than the driver completed the reverse side of the Tier 2 Data Sheet. Indicate the sex of the person who completed the reverse side of this data sheet, if this person was not the driver.

Question 8. Indicate whether or not the driver was using seat belts. If you reached the vehicle too late to observe whether seat belts were used or not by the driver, check unknown.

Question 9a and 9b. Indicate the body style of the vehicle.

Question 9c. Write in the make (i.e., Ford, Chev.) of the vehicle.

Question 9d. IMPORTANT! WRITE IN LICENSE NUMBER OF THE VEHICLE.

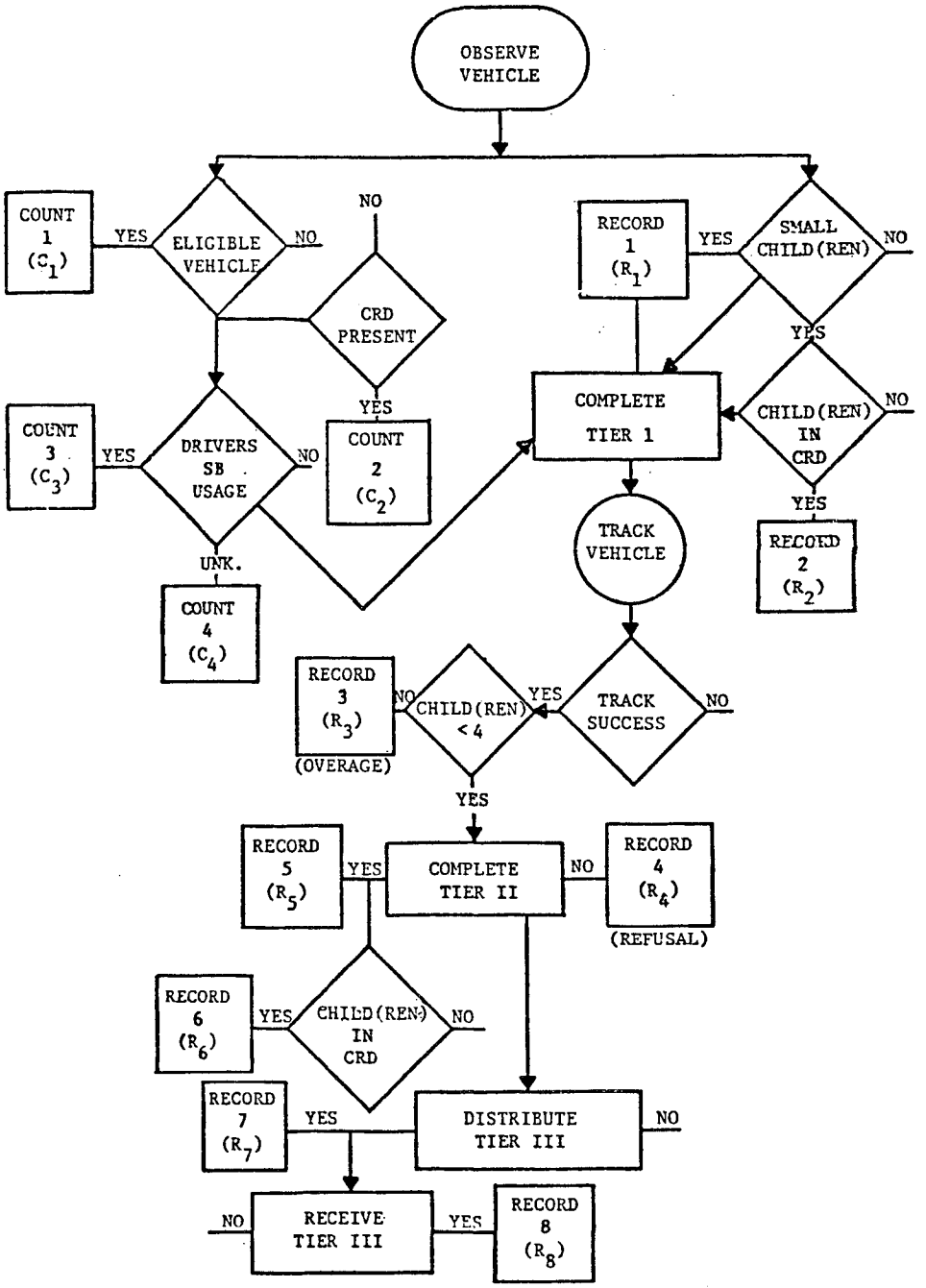
IMPORTANT!! IMPORTANT!! IMPORTANT!! IMPORTANT!!

THE ENVELOPE CONTAINING THE TIER 3 QUESTIONNAIRE HAS A NUMBER IN THE LOWER LEFT HAND CORNER. THIS NUMBER MUST BE RECORDED IN THE LOWER LEFT HAND CORNER OF THE TIER 2 DATA SHEET. THIS IS THE METHOD OF CONNECTING ALL THREE DATA SETS.

EXHIBIT G-4

USAGE DATA COLLECTION

FLOW CHART



APPENDIX H

SUMMARY OF THE PROCEDURES FOR PROCESSING THE DATA

The following steps for processing the data from the field to computer output are summarized:

1. Raw data daily tally sheets (Appendix C) are completed in the field recording the target area, site, time of day, location of observers and number of observations.

2. Raw data are manually sorted and tier one data are matched with tier two data by target areas.

3. Tier two data questions which require coding are manually coded and readied for computer entry.

4. Data are categorized into data sets according to the amount of information available. For example, if information matches on tier ones and tier twos the set is called a "matched" set; if there are tier one data which had no follow-up, they become a set of "tier one only" data, etc.

5. Data are entered into the computer system by data sets.

6. Data are cleaned by checking computer frequencies for critical items such as license tag numbers on the matched data set.

7. Computer programs for frequencies, cross tabulation and other statistical analyses are written to analyze the data.

8. Output is interpreted and reduced to report form.

9. All data are stored on disk with a tape backup.

APPENDIX I

CRD USAGE EQUATIONS

Equations were formulated to take into account both levels of data collected (tier one and tier two), the number of overage estimates made at the tier one level and the number of refusals to provide data. The equations also take into account the fact that tier one data tend to underestimate the CRD usage rate, while tier two data tends to overestimate. For example, on a less than ideal day the visibility into vehicles may be bad and the accuracy of the tier one data will not be good, but under more ideal conditions the differences from information collected at the two levels may not be as great. The number of follow-ups of tier one observations is a function of a set of conditions which include the weather, the size of the shopping area where the data is collected and size of the interview team. Nevertheless, the tier two data usually accounted for about 50 percent of the tier one observations.

The basis for pooling the two levels of data is that, although estimates using tier one data had a tendency to be lower than actual usage rates and estimates using tier two data seemed to be high, the amount of variation in each seemed to be about the same. Therefore, since the tier one data set and tier two data set had approximately equal variances, a pooled equation is appropriate.

The following equations were designed to calculate the most representative percentage (p) of CRD usage from the data collected:

$$(1)\quad p = \frac{x_m + x_I + x_{II}}{n_m + n_I + n_{II}} \quad , \text{ if } n_I \leq n_m + n_{II}$$

or

$$(2)\quad p = \tfrac{1}{2} \left(\frac{x_m + x_{II}}{n_m + n_{II}} \times \frac{x_I}{n_I} \right) \quad , \text{ if } n_I > n_m + n_{II}$$

where: x_m = the number of observations of children under four years of age using CRDs with matching tier one and tier two data (matched by license plate number and usage information)

n_m = the number of observations of children under four years of age in vehicles having matched tier one and tier two data (matched by license plate number and usage information)

x_I = the number of observations of children estimated by observers to be under age

four and using CRDs, having only a tier one completed. Tier ones were adjusted for overage.

n_I = the number of observations of children estimated by observers to be younger than four in vehicles having a completed tier one but no tier two. (the adjustment for overage children was made based on tier one versus tier two experiences of age estimates. Also included in n_I were those who refused to complete a tier two.)

x_{II} = the number of observations of children younger than four in vehicles having only tier two completed but no tier one.

n_{II} = the number of observations of children younger than four in vehicles having only tier two completed (no matching tier one)

$n_m + n_I + n_{II}$ = effective number of observations for $n_I < n_m + n_{II}$

$2(n_m + n_{II})$ = effective number of observations for $n_I > n_m + n_{II}$

The three groups used in the equations are distinct and separate. The "Matched" set (m) had two data sheets matched by license number and usage information which verified that the observer's estimate of age and decision whether CRD was in use was correct. The "Tier One Only" set (I) was a large set because of the difficulties experienced in vehicle trackage for a follow-up interview. This set was adjusted for overage estimates. This set also included the refusals at the tier two level. The "Tier Two Only" set (II) was a small group. A completed tier two which had no matching tier one occurred infrequently; usually it was when the observer misread the license number or the interviewer interviewed a subject not spotted by the observer. Tier one data sheets without license numbers were discarded and not used.

The adjustment of tier one data for overage were made by calculating and applying two correction factors using tier two data. The first correction factor is:

$$C_1 = \frac{n_m + n_{II}}{n_m + n_{II} + a_n}$$

where, a_n = the number of children at the tier two level identified as being overage

n_m, n_{II} = number of "Matched" and "Tier Two" data (same as in equations (1) and (2))

The number of observations at the tier one level, when adjusted for overage estimates, is:

$$n_I = C_1 n_{IU}$$

where, n_{IU} = the number of unadjusted observations at the tier one level

The second adjustment factor is for the small number of overage children who were observed using CRDs at the tier two level:

$$C_2 = \frac{x_m}{x_m + a_x}$$

where, a_x = the number of overage children in CRDs (this number will be small or equal to zero)

x_m = the number of children under four years of age using CRDs with matching tier one and tier two data

Equation 1 was used when the number of the "Tier One Only" set was less than the "Matched" set plus the "Tier Two Only" set. Equation 2 was used when the number of the "Tier One Only" set exceeded the number of the "Matched" set and the "Tier Two Only" set combined. The later equation was used to ensure that the number of tier one data did not outweigh the number of tier two data. In large shopping centers, the number of tier one data was much larger than the tier two data because of the difficulty in tracking vehicles.

Examples of the use of two equations:

Equation (1) $$p = \frac{x_m + x_I + x_{II}}{n_m + n_I + n_{II}}$$

for Nashville baseline, where, number of age adjusted tier one data were less than $n_m + n_{II}$

$x_m = 72$ $n_m = 396$
$x_{IU} = 36$ $n_{IU} = 438$
$x_{II} = 8$ $n_{II} = 56$
$a_x = 2$ $a_n = 85$

$$C_1 = \frac{n_m + n_{II}}{n_m + n_{II} + a_n} = \frac{396 + 56}{396 + 56 + 85} = .8417$$

$$C_2 = \frac{x_m}{x_m + a_x} = \frac{72}{72 + 2} = .9730$$

p

$$n_I = C_1 n_{IU} = .8417(438) = 369$$

$$x_I = C_1 x_{IU} = .9730(36) = 35$$

$$p = \frac{72 + 35 + 8}{396 + 369 + 56} = .1401 = 14.0\%$$

Equation (2) $$p = \tfrac{1}{2} \left(\frac{x_m + x_{II}}{n_m + n_{II}} + \frac{x_I}{n_I} \right)$$

for Knoxville baseline, where, the number of age adjusted tier one data exceeded $n_m + n_{II}$

$$x_m = 55 \qquad n_m = 424$$

$$x_{IU} = 81 \qquad n_{IU} = 779$$

$$x_{II} = 9 \qquad n_{II} = 32$$

$$a_x = 1 \qquad a_n = 57$$

$$c_1 = \frac{n_m + n_{II}}{n_m + n_{II} + a_n} = \frac{424 + 32}{424 + 32 + 57} = .8889$$

$$c_2 = \frac{x_m}{x_m + a_x} = \frac{55}{55 + 1} = .9821$$

$$n_I = C_1 n_{IU} = .8889\ (779) = 692$$

$$x_I = C_2 x_{IU} = .9821\ (81) = 80$$

$$p = \tfrac{1}{2} \left(\frac{55 + 9}{424 + 32} + \frac{80}{692} \right) = .1280 = 12.8\%$$

APPENDIX J

VEHICLE INFORMATION

TABLE J-1

SUMMARY OF PERCENTAGES OF INFORMATION ON VEHICLES WITH CHILDREN UNDER FOUR AT THE TIER TWO LEVEL FOR THE BASELINE PERIOD--YEAR OF VEHICLE

Target Area(s)	Number of Observations	Vehicle Information Year of Vehicle			
		<69	69-73	74	75-78
Memphis	372	6.5	36.3	17.2	40.1
Nashville	329	7.0	30.1	12.5	50.5
Knoxville	385	15.1	42.3	10.6	31.9
Chattanooga	370	11.6	45.9	10.8	31.6
Tri-Cities	434	12.7	38.2	9.7	39.4
Total Urban	1890	10.7	38.8	12.1	38.4
Nonurban Area	387	12.9	38.5	13.4	35.1
Total Urban and Nonurban	2277	11.1	38.7	12.3	37.9

TABLE J-2

SUMMARY OF PERCENTAGES OF INFORMATION ON VEHICLES WITH CHILDREN UNDER FOUR AT THE TIER TWO LEVEL FOR THE BASELINE PERIOD--MANUFACTURER

Target Area(s)	Number of Observations	Vehicle Information Manufacturer				
		AMC	Chrysler	Ford	GM	Foreign
Memphis	346	0.9	7.2	29.8	52.6	9.5
Nashville	369	0.5	15.4	20.6	51.2	12.2
Knoxville	377	2.9	12.2	27.9	48.5	8.5
Chattanooga	418	1.7	11.5	26.1	53.1	7.7
Tri-Cities	429	1.6	13.8	21.9	46.4	16.3
Total Urban	1939	1.6	12.1	25.1	50.3	10.9
Nonurban Area	400	1.5	8.8	26.0	59.0	4.8
Total Urban and Nonurban	2339	1.5	11.5	25.3	51.8	9.9

TABLE J-3

SUMMARY OF PERCENTAGES OF INFORMATION ON VEHICLES WITH CHILDREN UNDER FOUR AT THE TIER TWO LEVEL FOR THE BASELINE PERIOD--SIZE

Target Area(s)	Number of Observations	Vehicle Information: Size		
		Subcompact	Compact	Full Size
Memphis	380	7.9	24.7	64.4
Nashville	371	8.4	20.8	70.9
Knoxville	357	7.8	23.8	68.3
Chattanooga	381	10.5	24.1	65.4
Tri-Cities	419	12.4	23.9	63.7
Total Urban	1908	9.5	23.5	67.0
Nonurban	380	10.0	25.0	65.0
Total Urban and Nonurban	2288	9.6	23.7	66.7

TABLE J-4

SUMMARY OF PERCENTAGES OF INFORMATION ON VEHICLES WITH CHILDREN UNDER FOUR AT THE TIER TWO LEVEL FOR THE BASELINE PERIOD--BODY STYLE

Target Area(s)	Number of Observations	Vehicle Information: Body Style					
		2-door Sedan	4-door Sedan Wagon	2-door Station Wagon	4-door Station Wagon	Van/ Pickup	Other
Memphis	409	56.0	27.4	2.0	6.1	6.8	1.7
Nashville	388	57.7	22.2	1.8	9.5	8.5	0.3
Knoxville	386	58.5	20.7	3.1	7.8	9.3	0.5
Chattanooga	415	60.0	21.9	1.9	6.7	7.7	1.7
Tri-Cities	432	60.4	17.6	2.3	10.0	7.2	2.5
Total Urban	2030	58.6	21.9	2.2	8.0	7.9	1.4
Nonurban	400	52.0	26.8	1.8	6.0	12.8	0.8
Total Urban and Nonurban	2430	57.5	22.7	2.1	7.7	8.7	1.3

TABLE J-5

SUMMARY OF PERCENTAGES OF INFORMATION ON VEHICLES WITH CHILDREN UNDER FOUR AT THE TIER TWO LEVEL FOR THE OPERATIONAL PERIOD--YEAR OF VEHICLE

Target Area(s)	Number of Observations	Vehicle Information Year of Vehicle			
		<69	69-73	74	75-78
Memphis	269	5.6	36.8	13.8	43.9
Nashville	319	5.3	34.8	9.4	50.5
Knoxville	335	12.2	37.0	11.0	39.7
Chattanooga	290	10.7	36.2	14.8	38.3
Tri-Cities	251	11.6	40.6	6.4	41.4
Total Urban	1464	9.1	37.0	11.1	42.8
Nonurban Area	276	10.9	35.9	10.1	43.1
Total Urban and Nonurban	1740	9.4	36.8	11.0	42.9

TABLE J-6

SUMMARY OF PERCENTAGES OF INFORMATION ON VEHICLES WITH CHILDREN UNDER FOUR AT THE TIER TWO LEVEL FOR THE OPERATIONAL PERIOD--MANUFACTURER

Target Area(s)	Number of Observations	Vehicle Information Manufacturer				
		AMC	Chrysler	Ford	GM	Foreign
Memphis	272	3.7	8.5	29.4	42.6	15.8
Nashville	356	2.2	12.6	23.9	49.2	12.1
Knoxville	345	1.7	15.1	25.5	46.7	11.0
Chattanooga	332	1.5	13.6	23.5	51.2	10.2
Tri-Cities	259	2.7	14.7	23.2	47.9	11.6
Total Urban	1564	2.3	13.0	25.0	47.7	12.0
Nonurban Area	292	1.7	9.6	29.8	52.1	6.8
Total Urban and Nonurban	1856	2.2	12.4	25.8	48.4	11.2

TABLE J-7

SUMMARY OF PERCENTAGES OF INFORMATION ON VEHICLES WITH CHILDREN UNDER FOUR AT THE TIER TWO LEVEL FOR THE OPERATIONAL PERIOD--SIZE

Target Area(s)	Number of Observations	Vehicle Information: Size		
		Subcompact	Compact	Full Size
Memphis	269	13.0	35.7	51.3
Nashville	311	11.6	27.0	61.4
Knoxville	336	11.0	21.1	67.9
Chattanooga	278	6.8	25.9	67.3
Tri-Cities	249	3.2	26.9	69.9
Total Urban	1443	9.4	27.0	63.6
Nonurban	261	9.2	19.9	70.9
Total Urban and Nonurban	1704	9.3	26.0	64.7

TABLE J-8

SUMMARY OF PERCENTAGES OF INFORMATION ON VEHICLES WITH CHILDREN UNDER FOUR AT THE TIER TWO LEVEL FOR THE OPERATIONAL PERIOD--BODY STYLE

Target Area(s)	Number of Observations	Vehicle Information: Body Style					
		2-door Sedan	4-door Sedan Wagon	2-door Station Wagon	4-door Station Wagon	Van/ Pickup	Other
Memphis	291	60.1	23.0	1.0	11.0	4.5	0.3
Nashville	340	58.5	22.1	2.6	10.6	5.3	0.9
Knoxville	352	54.8	24.4	1.1	7.7	11.1	0.9
Chattanooga	307	58.0	20.8	3.3	10.7	6.2	1.0
Tri-Cities	259	59.8	19.7	3.5	8.1	7.7	1.2
Total Urban	1549	58.1	22.1	2.3	9.6	7.0	0.8
Nonurban	278	53.6	24.1	2.5	7.6	9.0	3.2
Total Urban and Nonurban	1827	57.4	22.4	2.3	9.3	7.3	1.2

APPENDIX K

MANUFACTURERS OF CHILD RESTRAINT DEVICES

There were 14 different manufacturers which the Consumers Union listed as having CRDs worthy of testing ("Car Safety Restraints," 1977). Of these 14 brands, there were three owned by parents in Tennessee in substantial numbers. The data collected and analyzed on brands for both periods are given in tabular form and discussed briefly.

Ownership of CRDs was tabulated by the three most owned brands and "others" categories (see Table K-1). Others represents those observations where names of brands were determined. The name of manufacturer was difficult to obtain from the respondent when the CRD was not in the vehicle. There were many cases were brand names were undetermined. Overall ownership of CRDs was determined by totaling those not present and those present.

Of all persons interviewed, 23.5 percent owned Bobby-Macs. The distribution for the three manufacturers selected was about the same for those CRDs not present but claimed as for the CRDs in the vehicles. About 39 percent (231 of 588) of the claimed CRDs were not present in the vehicle. Larger differences appeared between percentages present in the vehicle and percentages in use in the vehicle. Bobby-Mac and Peterson had about the same percentage of CRDs in use in vehicles, 25.2 percent and 23.9 percent, respectively. CRDs manufactured by General Motors had the lowest use of the three compared at 20.8 percent.

A cross tabulation (Table K-2) of manufacturer by use revealed that Peterson had the highest percentage of use (78.3 percent) compared to the mid 60s percentages for the other two brands. A summary of the number present in the vehicles and the number and percentage of use for each brand for the two most used types was made (see Table K-3). The Bobby-Mac Infant Carrier was the most used of those infant carriers compared and present in the vehicle (79.2 percent). Peterson and GM showed usage rates of 66.7 percent and 68.2 percent, respectively. Peterson's car seats, however, were the ones used most often with 83.7 percent usage.

When ownership by brands were compared for the two periods, it was found that brands named other than the three identified had increased in overall ownership from 33.3 percent to 41.3 percent (Tables K-1 and K-4). An even greater increase (from 30.1 percent to 51.9 percent) was seen for the "others" category in the percentage of CRDs in use.

Table K-5 shows the percentages of use/nonuse by manufacturer using the same three brands and "others" categories. A comparison to the baseline data showed that each category had increased in use; Bobby-Mac increased only minutely, while increases for the others were more substantial.

A further study of use was done by performing a cross tabulation of use by manufacturer by the two most used types (see Table K-6). A comparison with the baseline cross tabulation of the same variables showed increases in use for each brand of infant carriers; however, low frequencies

TABLE K-1

CRD OWNERSHIP BY MANUFACTURER FOR THE BASELINE PERIOD
(Row Percentages)*

CRD Disposition	Number of Manufacturers Identified	Manufacturer			
		Bobby-Mac (percent)	General Motors (percent)	Peterson (percent)	Others (percent)
Overall Ownership	559	23.8	22.2	20.7	33.3
Not Present in Vehicle	231	20.8	21.7	20.3	37.2
Present in Vehicle	328	25.9	22.6	21.0	30.5
Present and in Use in Vehicle	226	25.2	20.8	23.9	30.1

*Percentages based on number of observations where manufacturers were known.

TABLE K-2

COMPARISON OF OBSERVED CRD USAGE BY MANUFACTURER
FOR THE BASELINE PERIOD
(Column Percentages)

CRD Disposition	Manufacturer			
	Bobby-Mac	General Motors	Peterson	Others*
Number	85	74	69	100
In Use (%)	67.1	63.5	78.3	68.0
Not in Use (%)	32.9	36.5	21.7	32.0

*Others with identified manufacturers.

TABLE K-3

COMPARISON OF CRD OBSERVED USAGE BY TYPE BY MANUFACTURER FOR THE BASELINE PERIOD

CRD Manufacturer	CRD Type			
	Infant Carrier		Car Seat	
	Number Present	Percent Used	Number Present	Percent Used
Bobby-Mac	24	79.2	57	64.9
General Motors	22	68.2	48	62.5
Peterson	12	66.7	49	83.7
Others*	17	76.5	80	65.0

*Others with identified manufacturers.

TABLE K-4

CRD OWNERSHIP BY MANUFACTURER FOR THE OPERATIONAL PERIOD
(Row Percentages)*

CRD Disposition	Number of Manufacturers Identified	Manufacturer			
		Bobby-Mac (percent)	General Motors (percent)	Peterson (percent)	Others (percent)
Overall Ownership	508	27.4	16.7	14.6	41.3
Not Present in Vehicle	154	37.0	20.1	13.6	29.2
Present in Vehicle	354	23.2	15.2	15.0	46.6
Present and in Use in Vehicle	231	20.8	12.6	14.7	51.9

*Percentages based on number of observations where manufacturers were known.

TABLE K-5

COMPARISON OF OBSERVED CRD USAGE BY MANUFACTURER
FOR THE OPERATIONAL PERIOD
(Column Percentages)

CRD Disposition	Manufacturer			
	Bobby-Mac	General Motors	Peterson	Others*
Number	71	41	41	160
In Use (%)	67.6	70.7	82.9	75.0
Not in Use (%)	32.4	29.3	17.1	25.0

*Others with identified manufacturers.

TABLE K-6

COMPARISON OF CRD OBSERVED USAGE BY TYPE BY MANUFACTURER FOR THE OPERATIONAL PERIOD

CRD Manufacturer	CRD Type			
	Infant Carrier		Car Seat	
	Number Present	Percent Used	Number Present	Percent Used
Bobby-Mac	18	83.3	42	61.9
General Motors	17	76.5	22	68.2
Peterson	5	100.0	26	84.6
Others*	64	79.7	338	70.1

*Others with identified manufacturers.

for Peterson must be taken into account in making the comparison. All brands of car seats were higher in use for the operational period except for Bobby-Mac which dropped from 64.9 percent use to 61.9 percent use.

The purpose of making a comparison of percentages of CRD use by type and manufacturer was to determine if, during the operational phase, any shifts in ownership and usage of types or brands had occurred. It appears that the major shift in ownership and usage since the baseline period was in the percentages of "others." One explanation for this shift is that after the law and PI&E program were implemented, more brands became available in Tennessee for consumers. Other factors such as consumer publications may have had some impact on brand purchased.

Reference

"Car Safety Restraints for Children." Consumer Reports, Vol. 37, No. 8 (August), 1977, pp. 484-489.

APPENDIX L

TYPES OF CHILD RESTRAINT DEVICES

A SELECTION GUIDE FOR CHILD RESTRAINT DEVICES

What things should you consider?

When you buy a child restraint device, you are making a very important decision. Of course, you want to select the child restraint device that will provide the best protection for your child. In order to make a good choice for your child, you and your automobile, you should compare the different brands of child restraint devices that are available to see how they meet your family's needs. To help you get started in this comparison shopping, we have included information on the general installation, use requirements and age range of different brands of crash tested child restraint devices in this selection guide. How do you choose which one you want to buy and use with your child? You should think carefully about the following two things:

A. Your child's need for a strong device that will provide good crash protection for his/her size and weight.

B. Your responsibility for installing the device properly and using it correctly each time your child rides in the automobile.

A. Age and Weight Considerations

You should start using a child restraint device on the first trip you take with your child. (Some child restraint devices are designed just for infants.) All child restraint devices for use with infants face rearward. Other devices are convertible so that you can use them with infants and toddlers. If you select a convertible device, make sure that you always follow the manufacturers instructions regarding the correct position for the age and weight of your child.

An infant carrier is designed to be used with children under 20 pounds. Rolled-up receiving blankets around your newborn's head and shoulders add extra comfort and support. As your baby grows the blankets can be adjusted and/or removed. After the child reaches about 20 pounds, (usually around 9 months of age) you will be ready to use a child restraint device designed for Toddlers or the Toddler position of a convertible device.

Toddlers should ride in a child restraint device until they weigh 40-50 pounds. (about 4 years of age). At his time you can be using the car's lap belt system with your children. However you should put the shoulder belt behind them if it comes across their neck or face.

B. Installation and Proper Use

The safest place for your child is the rear seat position. Proper installation and proper use of your child restraint device are extremely important for the safety of your child. Therefore, you should carefully follow the instructions provided by the manufacturers of your device. Since research has shown that proper installation and use of a child restraint device is the

exception rather than the rule, one of the many important things you should consider before purchasing a child restraint device is how easily it can be installed and used. Many of the child restraint devices with the highest safety performance in crash tests are also those which are among the most complicated to install and use properly. If used incorrectly, these devices may not provide adequate protection for your child.

Many car seat types and harnesses require the use of a properly anchored top tether strap. Failing to use the tether strap is one of the most frequent ways in which these child restraint devices are misused. When a top tether anchorage strap is part of the device, *IT MUST BE USED*, or the protection of the device is greatly reduced. The proper use of this top tether strap prevents the restraint from tipping too far forward or too far to the side, protecting the child from collision with the interior of the vehicle.

Before you buy a car seat with a top tether strap, make sure that you are prepared to spend the time and effort to anchor it properly in your automobile. *The tether must be attached to sturdy metal.* When used in the back seat of the vehicle, the tether anchor must be bolted to the rear shelf or floor board of the rear storage area. (See fig. 1) Remember that the center of the rear seat is generally the safest place for a child to ride. A tether anchor should not be attached to either plastic or cardboard. Once the tether anchor is installed you simply clip the tether strap to it and tighten it. The child restraint device can easily be taken out of the car for such things as cleaning. However, if you plan to use a restraint with a tether in more than one car, you must install an anchor in each car. Most manufacturers only supply one anchor with each device but additional anchors may be ordered.

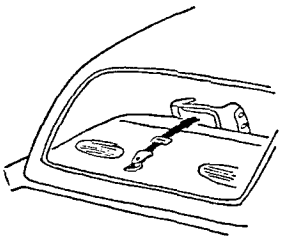


Fig. 1 Tether anchored to package shelf

When used in the front seat, most tethers are anchored by the rear safety belt. (See fig. 2) Restraints with a top tether cannot be used in a front bucket seat which has an integral head restraint (the head restraint and tall seat back are one continuous piece) since the tether will slip off the top of the seat.

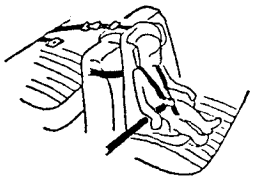


Fig. 2 Tether attached to rear safety belt

C. Federal Standards

One of the more important ways in which child restraint devices differ is how they perform in crash situations. There are two major ways of testing this performance. One way is called "static" testing. Static testing simply requires that the device withstand a gradual pulling force. Wooden blocks are used to represent the child riding in the device. The Federal Government's standards for child restraint devices are currently based on static tests.

A better way of testing the devices has been developed called "dynamic" testing or crash testing. The dynamic method is superior to the static method in its recreation of the extreme forces produced in crash situations. Currently, there is not a Federal dynamic crash standard for child restraint devices. It is anticipated that a new Federal dynamic crash standard will go into effect sometime in the next two years.

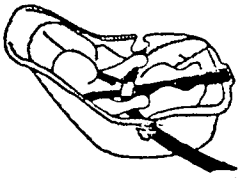
CHILD RESTRAINT DEVICES

The child restraint devices listed on the following page have been dynamically tested by one or more independent research laboratories. They vary in their performance depending on the type of accident. Remember current Federal standards may not be a sufficient guide to safety. Neither the Child Passenger Safety Program nor the independent research laboratories can endorse particular brands of child restraint devices. The choice of which child restraint device to use is your responsibility.

Most department stores, discount stores and children's specialty stores carry child restraint devices. Several automobile dealers also carry child restraint devices through their parts departments. The prices vary from store to store.

There are 4 classes of child restraint devices. These are explained below. Manufactured brands of child restraint devices are listed under each basic type.

NAME AND MANUFACTURER



INFANT CARRIER. Infant car carriers are designed to face rearward. The infant, semi-reclined, is secured in the carrier with a harness, and the carrier is secured to the vehicle with a lap belt. The infant carrier is designed to be used with children under 20 pounds. Do not confuse sturdy child restraint infant carriers with flimsy household feeder stands or shopping carriers.

Dyn-O-Mite *by Infanseat/Questor*
Infant Love Seat *by General Motors (Also sold as the Ford Infant Carrier and the Mopar Infant Safety Carrier)*
Trav-L-ette *by Century*

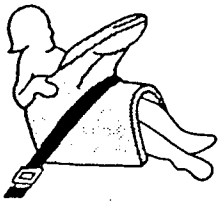
CAR SEAT. The traditional car seat, which is intended for use by children over 20 pounds who are able to sit without support, has a harness system consisting of two shoulder straps, lap belt and a crotch strap. The seat is then secured to the vehicle with the vehicle lap belt. This belt is either threaded through the back of the seat where it can remain permanently secured or around the fron where it must be disengaged each time the child is removed. Some traditional car seats also incorporate the use of the shield. Some car seats require a top tether anchorage strap. WHEN AN ANCHORAGE STRAP IS PRESENT, IT MUST BE USED, or the safety of the device is greatly reduced.

I. Toddler Seat Only

Child Love Seat *by General Motors*
Motor Totor *by Century Products*
Positest Car Seat *by Hedstrom*
Swyngomatic Safety Seat *by Swyngomatic/Graco*
Teddy Tot Astroseat V *by International Mfg. Co.*
American Safety *by Swyngomatic*
Kantwet Car Seat #579 *by Questor*

II. Converts from Infant to Toddler

Bobby-Mac 2 in 1 *by Collier-Kenworth*
Bobby-Mac Delux *by Collier-Kenworth*
Bunny Bear *by Bunny Bear*
Safety Shell #74, #75 *by Peterson*
Trav-L-Guard *by Century Products*
Wee Care #597 *by Strolee*
Safe and Easy *by Cosco*
Sweetheart II *by Bunny Bear*
Kantwet Car Seat #985, 986, 988 *by Questor*



SHIELD. The sheild is a 'C' shaped device that is designed to catch the child's body in a crash, cushioning and distributing the weight over a large area. The shield requires no harness and is secured to the vehicle with a lap belt. Children using a shield should weigh over 20 pounds and be able to sit without support.

Mopar Child Seat *bu Chrysler Corp.*
Tot Guard *by Ford Motor Co.*

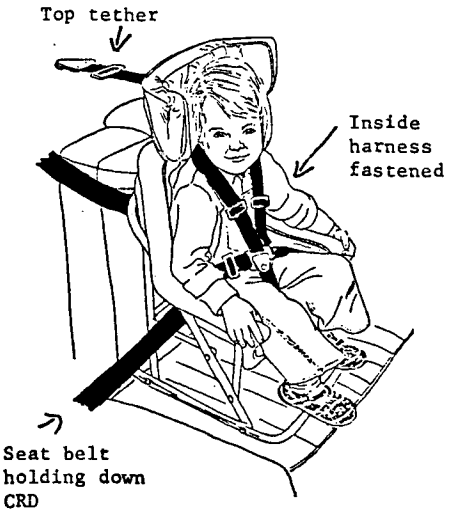
HARNESS. The harness consists of shoulder, lap and crotch straps and an anchorage strap. This anchorage strap, which requires installation, must be bolted to the car. The harness should be used only in center seat positions.

Little Rider Harness *by Rose Mfg. Co.*
Infanseat Harness *by Questor*

A second way in which a child restraint device is frequently misused is by failing to use the safety belt system or harness inside the device. (See fig. 3). The internal harness must be used at all times. Before purchasing a child restraint device check to see how convenient its harness system is to use and adjust. The harness system in some restraint devices can only be adjusted from behind or beneath the restraint.

Other devices for toddlers such as the shields, have no inside harness system. For example, shields work by using the automobile lap belt to fasten the shield around the child and do not require buckling of an inside harness system. While shields are hard for parents to misuse, some children may be able to wriggle out of shields more easily than they could from other types. Shields should only be used in the center of the rear seat because they do not provide the same protection for the child in side collisions that some other child restraint devices do.

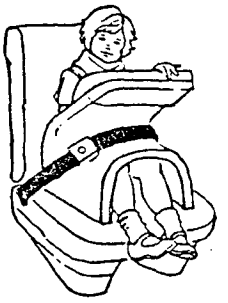
Failure to use the automobile lap belt to fasten down the child restraint device is a third type of misuse. Instructions that come with the device show you where the car's lap belt should be fastened. Follow these instructions carefully, as the restraint devices offers little protection without it. Some automobiles have inertia lap belts that should not be used with child restraint devices. (Inertia lap belts only hold securely during sudden stops or hard braking.) If your automobile has this type of lap belt, you can buy a special locking clip that will make the lap belt safe for use with a child restraint device. The clips are inexpensive and available from your automobile parts dealer.



Some brands have to be resecured with the lap belt each time you put your child in for a ride. Other brands can be left secured to the seat with the lap belt so that you only need to buckle the inside harness system for each ride.

TODDLER - PROTECTIVE SHIELD

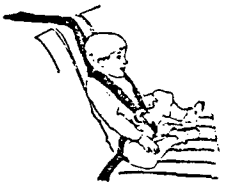
Mopar Child Seat



Tot Guard

TODDLER - SAFETY HARNESS

Little Rider



Infanseat