To the Graduate Council:

I am submitting herewith a dissertation written by Randy L. Perry entitled "An Investigation of the Impact of Child Passenger Restraint Legislation and a Public Information and Education Program on Child Passenger Safety in Tennessee." I recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Civil Engineering.

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Major Professor

We have read this dissertation
and recommend its acceptance:

Accepted for the Council:

Vice Chancellor
Graduate Studies and Research

Thesis
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AN INVESTIGATION OF THE IMPACT OF CHILD PASSENGER RESTRAINT LEGISLATION AND A PUBLIC INFORMATION AND EDUCATION PROGRAM ON CHILD PASSENGER SAFETY IN TENNESSEE

A Dissertation

Presented for the

Doctor of Philosophy

Degree

The University of Tennessee, Knoxville

Randy L. Perry

June 1979

[illegible]

TO MY FAMILY

May you see your children's children.....

Psalms 128:6

...if I be bereaved of my children, I am bereaved.

Genesis 43:14

ACKNOWLEDGMENTS

The author expresses his gratitude to the many persons involved in the completion of this study. Appreciation goes to Dr. Kenneth W. Heathington, the major professor for the study, for his efforts in providing planning and guidance throughout the research. A special note of thanks is expressed to Dr. John W. Philpot for his time spent assisting in the statistical analysis and general counseling.

The author is also grateful to the other members of the graduate committee, Dr. Thomas L. Bell of the Geography Department, and Dr. Frederick J. Wegmann and Dr. William L. Grecco, of the Civil Engineering Department for the generous contribution of their time in reviewing and general guidance given to the author.

The staff of the Transportation Center of The University of Tennessee were most helpful during this research. A special thanks goes to Miss Deborah Presnell for her tireless efforts in typing the report.

The author's wife spent numerous hours proof reading and unaccountable hours of encouragement. The author expected it, but loves her for her tolerance, patience and love. Love is also expressed to his children, Paul and Sam for their understanding.

ABSTRACT

An investigation was made of the effect of child passenger protection legislation and a public information and education (PI&E) program on child passenger safety in Tennessee. Legislation to provide protection for child passengers under the age of four was enacted in 1977 with an implementation date of January 1, 1978. Tennessee was the first state in the United States to pass a restraint law, providing a unique situation for field investigation of a PI&E program coupled with legislation.

The measures of effectiveness were child restraint usage rates and changes in fatalities and serious injuries. Data were collected at shopping centers in the five major Standard Metropolitan Statistical Areas (SMSA's) of Tennessee (Memphis, Nashville, Knoxville, Chattanooga, and Tri-Cities) and at three non-metropolitan areas (Morristown, Columbia, and Dyersburg). Data collections were performed prior to and approximately six months after the effective date of the law to determine the usage rates for each period. Accident data on children were obtained from the Tennessee Department of Safety for comparing fatalities and serious injuries for the two periods.

Two levels of PI&E programs were implemented on the effective date of the law. One level, the basic state plan, called for a low intensity PI&E program which was implemented statewide. It included the distribution of informational brochures and promotional posters to hospitals, children's clinics, physicians offices, and other strategic locations where parents with small children may go. The objective of the basic statewide plan was to increase child restraint usage and

provide a comparison base for the comprehensive plan. The other level of PI&E, the comprehensive plan, included utilizing TV, radio, newspapers, and billboards in combination with the lower intensity plan. Nashville was the only area to receive the comprehensive PI&E plan during the first six months after the effective date of the law.

Comparisons of usage rates were made between Nashville and the other urban areas for the period of operation after January 1, 1978. Usage rates were also determined and compared between the time before the law and the time after the law for each area where data collection was made. Fatalities and injuries for 1975 through the first six months of 1978 were studied for comparative purposes.

All the areas had significant increases in child restraint usage rates between the period before and the period after the law. Nashville had the greatest percentage point increase (from 14.0 to 22.1 percent). The non-metropolitan areas had an initial rate of 6.5 percent and increased to 12.5 percent after six months. Estimates of the statewide usage rates based on the sample and a weighted average using the proportion of the population in the urban and non-urban areas were 9.8 percent before and 16.1 percent after the law and PI&E program. A comparison of areas with two different levels of PI&E treatments revealed that the difference in the usage rates in Nashville for before and after the law was 8.1 percentage points and 6.0 percentage points for the other metropolitan areas.

This study also involved the examination of characteristics of parents of small children to help identify those non-users toward whom

future programs may be directed. A profile of a non-user was made using a set of variables which best distinguish non-users from users.

One major conclusion of the study was that usage rates of child restraint increased after implementation of a law and PI&E program in Tennessee. This conclusion is based on a six-month evaluation assuming no effect for seasonal variation.

It was concluded from the study that seat belt usage of drivers with small children was increased after six months of the law and PI&E program. It was also found that there was a significant relationship between seat belt usage and child restraint usage.

Another major conclusion from the research was that the comprehensive PI&E plan applied in the Nashville area was not significantly more effective than the basic state plan of PI&E which was applied in all other urban areas. There were factors which may have affected the results from which this conclusion was drawn. One factor was the inability to rigidly restrict the comprehensive plan to only the Nashville area. Another factor was the amount of information (not included in the study design) which some of the areas received during the six-months period.

The impact of the child passenger protection legislation and a PI&E program for the first six-month period on the reduction of fatalities and serious injuries to children under age four in Tennessee was only moderate. A longer period of time is needed to evaluate the complete effect.

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CHAPTER 1

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 1-1). 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. The National Highway Traffic Safety Administration 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 be a significant factor for the decline (Traffic Safety '75, 1976).

TABLE 1-1

MILEAGE DEATH RATE

(TRAFFIC DEATHS PER 100 MILLION VEHICLE MILES)

Year	Fatality Rate
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, U.S. Department of Transportation, Traffic Safety '77 (Washington, D.C., 1978)

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 providing the vehicle occupant more protection 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 colliding with the interior 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 (The National Highway Safety Needs Report, 1976). It is estimated that approximately 3,000 lives are saved each year because of safety restraint usage. If the present national usage level could be increased from the present approximately 20 percent to 80 percent, an additional 7,000 to 9,000 lives could be

saved annually (Traffic Safety '75, 1976). The usage rates of passenger restraints for all vehicle occupants in the United States are low (Robertson, 1976). Accident record studies indicate that less than 10 percent of the vehicle occupants involved in fatal accidents were using passenger restraints (The National Highway Safety Needs Report, 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 safety belts (Fatal Accident Reporting System, 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 (Fatal Accident Reporting System, 1977).

While safety belts provide adequate protection for most vehicle occupants, they are not suitable for small children. Special restraints are needed to protect children smaller than approximately 40 lbs. (18.1 kg.).

Tennessee is the first state to pass legislation in reaction to the need for child passenger protection. A 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 for 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 restraints, active restraints or combination of the two. This study is concerned primarily with the utilization rates of active restraining devices, i.e. child restraining devices and driver safety belts; however, defining both terms will provide a better background for understanding the remainder of the report.

Passive occupant restraints include those devices inside the vehicle which require no initiation on the part of occupants for the restraints to perform their function 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 restraints, and padded instrument panel and knee panel. The passive seat restraint, sometimes referred to as the automatic seat restraint, 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 is the "air bag." The "air bag" technically is called the Air Cushion Restraint System (ACRS). Like the passive seat belt, the ACRS 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 restraints 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 restraining devices which have evolved from a primitive leather strap to hold race drivers in their seats. The lap-belt is an active restraint which requires buckling of two high-strength straps of flexible webbing across the lap of the occupant. The cross-chest lap-belt combination has an additional belt which crosses the chest diagonally to provide upper torso restraint.

Child restraint devices (CRD's) are of four types, two of which have webbing for securing the child in a snug position in the device for maximum protection. The most common type child restraint is the car seat type used for toddler size (approximately 20 to 40 pounds) children. This type restraint in a protective seat which must be secured to the seat of the vehicle by a lap-belt. Some of the child 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 restraint is used in the front seat or 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 child restraint is designed to protect children smaller than about 20 lbs. (approximately 9 kg.); it is designed to face toward the rear of the vehicle. This type also requires that the safety belt be used to secure it to the seat of the vehicle.

The third type is the safety shield; it is designed to cushion the blow over a large portion of the child's body during a crash. This restraint requires no harness in contrast to those previously described, but it does require the use of the lap belt to hold it securely on the vehicle seat.

The last type child restraint described 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. (6.8 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 public information and education (PI&E) program promoting child restraint usage in conjunction with the initiation of a law requiring child protection in motor vehicles. There has been considerable research conducted to determine safety 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 child passenger restraint 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 child restraints prior to and approximately six months after the effective date of the law and implementation of the PI&E program and to analyze the two usage levels;
2. to examine the usage rates of safety belts by drivers prior to and approximately six months after the effective date of the law and implementation of the PI&E program and to analyze the two usage levels;
3. to determine the number of fatalities and injuries of children under four before, and approximately six months 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;
4. to evaluate the drivers' safety belt usage in relation to child restraint usage;
5. to determine the relationship between child restraint usage and socio-economic variables such as family income and education,

for both before the law and PI&E program were implemented and approximately six months after;

6. to develop recommendations relative to the future emphasis of PI&E programs based upon the analysis of approximately six months of operation;
7. 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 operating a short period of time.

Basis For The Research

The implementation of an increased restraint usage program nationwide has the potential of a cumulative reduction of 230,000 fatalities and serious injuries by the year 2000 (The Report by The Federal Task Force on Motor Vehicle Goals Beyond 1980, 1976). Predicted deaths and injuries for two rates of restraint usage may be illustrated (Figure 1-1). High usage (70 percent), which is possible with a program, will likely result in a continuous 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 and/or programs are implemented by the year 2000, the increased number of vehicles, number of

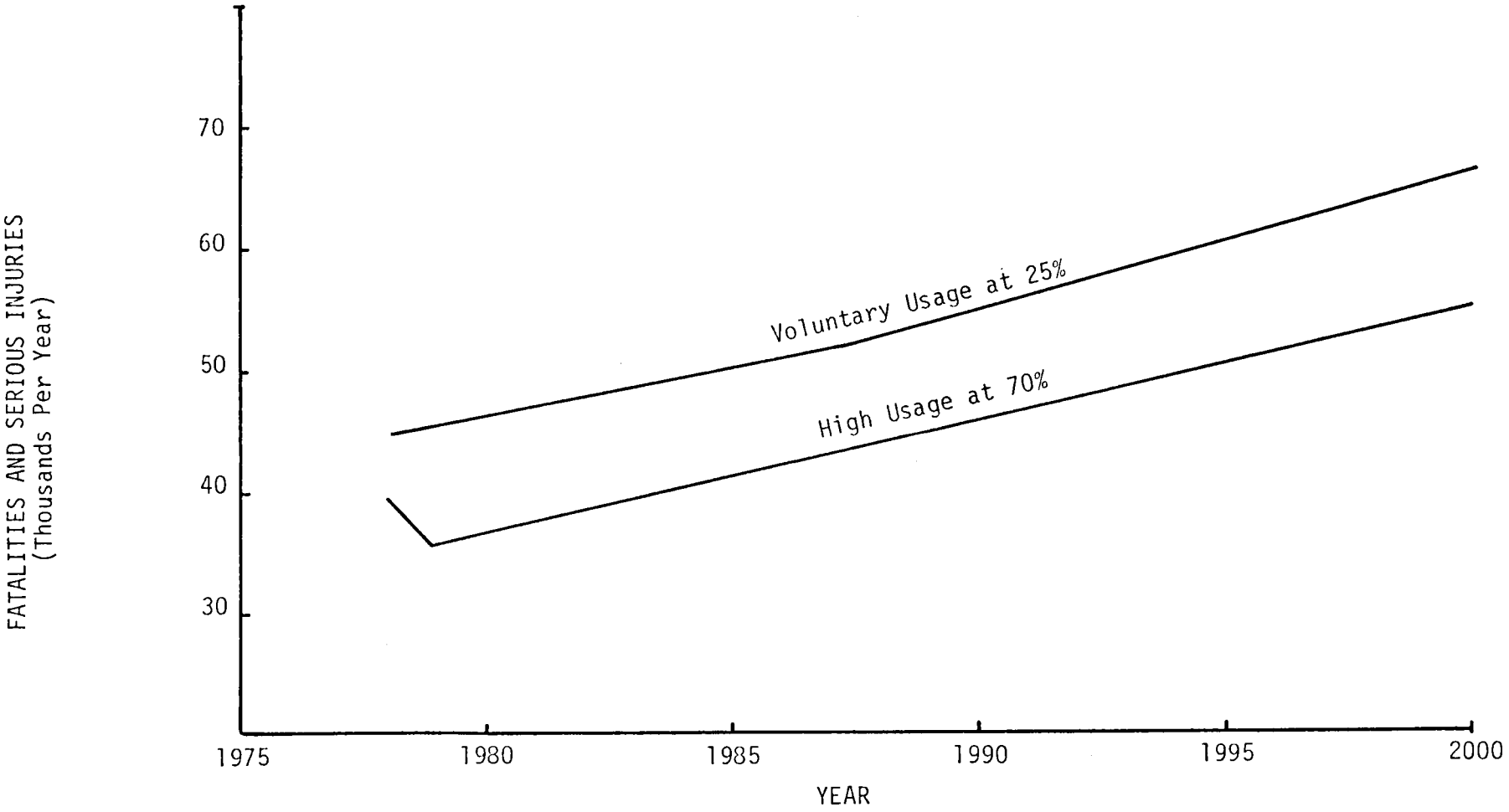


FIGURE 1-1

PREDICTED OCCUPANT DEATH AND SERIOUS INJURIES

Source: Herman et al., The Report by The Federal Task Force on Motor Vehicle Goals Beyond 1980. Washington: Energy Resource Council, September, 1976.

miles driven, and number of licensed drivers, over present levels will lead to a large increase in fatalities and serious injuries. (The Report by the Federal Task Force on Motor Vehicle Goals Beyond 1980, 1976).

The greatest threat to a child's life beyond the first month after birth is the motor vehicle accident (Shelness and Charles, 1975). Approximately 1600 children in the birth to four year old age group lost their lives in motor vehicle accidents in 1976 (Accident Facts, 1977). Of the number, approximately 700 were occupants of motor vehicles (Fatal Accident Reporting System 1977). The National Safety Council reported a total of 70,000 injuries to this same age group as a result of motor vehicle accidents (Accident Facts, 1977).

The Tennessee Department of Safety reported a total of 18 children fatalities and 1229 injuries in the 0-4 age group in Tennessee in 1976 resulting from motor vehicle accidents (Tennessee Motor Vehicle Accident Facts 1976, 1976). There were probably several hundred more injuries to children which were not reported to the Safety Department because they did not involve damage to other vehicles or property. These unreported injuries usually occur from unexpected stops, sudden turning movements, falling from vehicle, etc.

The value of using both safety belts and child restraint devices is generally known and yet there continues to be low utilization rates of each. Currently there is considerable interest in laws to require the use of safety belts by the majority of the states. Since 1972 a total of 44 states have introduced bills to make the use of safety

belts mandatory (Traffic Safety '75, 1976). Federal aid safety funds have been used in seven states to promote safety belt programs (Traffic Safety '76, 1977). No state in the United States has passed a safety belt usage law for all vehicle occupants or adult occupants, although the territories of Puerto Rico and several other countries have. The pre-law and post-law usage rates of passenger restraints for some selected countries where such laws have been in effect can be shown (Table 1-2). 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 at 80 percent when checked in 1976. The countries shown in Table 1-2 represent less than half 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 occupants to wear safety belts. Most of the countries which have laws have experienced increases from an approproximate 20 to 30 percent level to 70 to 90 percent.

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

Tennessee has passed the first active passenger restraint law in the nation requiring children under 4 years of age to be restrained

TABLE 1-2

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(1975)	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.

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. Public information and education on a national basis in the U.S. concerning safety belt use seem to have little effect on increasing safety belt usage rates to any significant degree. The combination of a law and a public information and education program has not been an option for research in the United States. This study reports the analysis of the impact of legislation and a public information and education program on child passenger safety in Tennessee.

Scope of the Study

This study is a part of a larger project which involves the evaluation of the impact of the Tennessee Child Passenger Restraint Act over a longer period of time (two and one-half years for some treatments) than was possible to use for this study. This portion of the project is limited to the first two time phases of the larger project. An investigation was made of the status of occupant restraint usage of small children and drivers before and approximately six months after the effective date of the law and the implementation of the PI&E program.

The restraint usage data collection for this research was statewide for both metropolitan and non-metropolitan areas. The target areas included the five major Standard Metropolitan Statistical Areas (SMSAs) of Memphis, Nashville, Knoxville, Chattanooga and Tri-Cities.

The three non-SMSA areas, referred to as "non-urban areas" for the purposes of this study, were Morristown, Columbia, and Dyersburg. The terms metropolitan and non-metropolitan are used interchangeably with urban and non-urban respectively in this report.

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 Transportaiton. Fatalities were few in number for the limited period of time of this study after the initiation of the law and the implementation of the PI&E programs. Comparisons of fatalities and non-fatal injuries before and after January 1, 1978 are made.

The characteristics of users and non-users 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 CRD's. The results, conclusions, and recommendations are organized to provide directions for short-term evaluations of similar safety programs.

Organization of the Report

The first three chapters of this report serve to introduce and provide background information for the remainder of the report.

Chapter 2 is a review of the existing literature on the subject of occupant restraints and child restraints in particular. Chapter 3 describes the design of the research project, strategy for the design and the details of the procedure for the data collection. A description of methods for analyzing the data is also given. A description of the target areas is also provided in Chapter 3.

Chapters 4 and 5 describe the analyses of the collected data dealing primarily with usage. Chapter 6 is a report of the examination made of the characteristics of restraint users and non-users. An evaluation of the effectiveness of the methods used in Tennessee to reduce deaths and serious injuries to motor vehicle occupants under the age of four is reported in Chapter 7. Accident data are analyzed for both before and after the application of the law and PI&E treatment. The major conclusions of the study along with recommendations are presented in Chapter 8.

CHAPTER 2

REVIEW OF LITERATURE

This literature review on vehicle occupant restraint usage includes four relevant areas: 1) history and development, 2) restraint regulations and laws, 3) public information and education and 4) costs and benefits of occupant 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 2-1). From this initial farsighted concept of Leveau until the early 1940's little was accomplished to advance the idea of restraining vehicle occupants to reduce injuries and fatalities.

Most of the use of passenger restraints 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, 1970). During the 1920's 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 occupant restraints, but little thought was given to restraining occupants other than the driver until the 1930's.

DeHaven, a pilot during World War I, contributed to the development of safety restraints in the early forties by collecting and

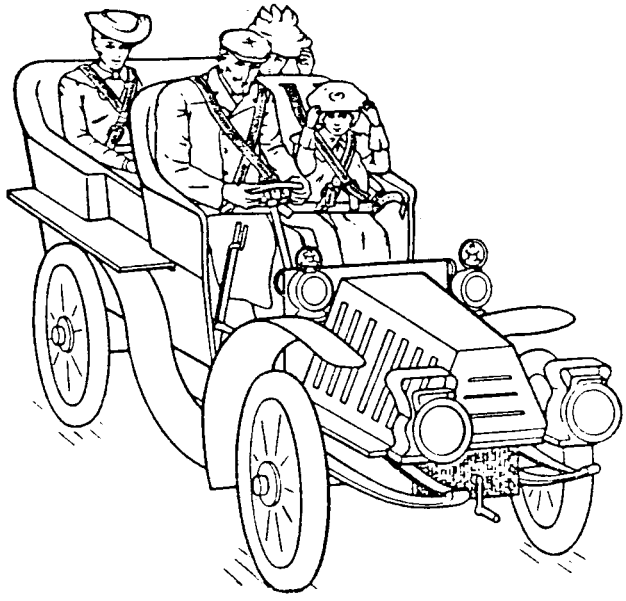


FIGURE 2-1

FULL BODY RESTRAINT CONCEPT, PATENTED IN 1903

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

analyzing data on survivals from falls of 50 to 150 feet with restraints (States, 1972). According to States, 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 occupant protection systems used years later in America's manned space programs (States, 1972).

Some of the work oriented toward development of safety systems for aircraft had a bearing on automobile restraint systems. Roberts 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" (Roberts, 1970). 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 of the potential protection offered automobile occupants by these advances.

After World War II the number of traffic accidents increased dramatically, thus increasing the demand for vehicle occupant safety. Investigations to find ways to protect vehicle passengers increased in the late 1940's. 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 the sleeping passenger with the seat in a reclining position (States, 1972). Both Ford and Chrysler Motor Companies offered safety belts as optional equipment in 1956

(Roberts, 1970). Several years later the automobile manufacturers began installing anchors and belts in all new automobiles. In 1964, two lap belts in the front seat were standard equipment for occupant use. In 1966 the number installed by the manufacturers had increased to four lap belts per unit and was followed in 1968 by the current type of restraint systems available; six lap belts and two upper torso restraints and anchorages for additional shoulder restraints in the rear position (Roberts, 1970).

Child Restraint Development

The majority of the history described thus far has been concerned with the evolution of the safety belt. At the same time the beginnings of the evolution of child restraint systems were being initiated. 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 et al., 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 sixties that the 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 child restraint device 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 et al., 1973). These developments point out the attempts by the automotive industry to develop children safety devices. There are presently approximately 18 manufacturers of CRD's, most of which began producing child safety devices on a competitive basis during the 1960's.

Safety harnesses for children were pioneered by Rose in the early sixties (Rose, 1962). In 1962, 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 Safety Belts

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

A myth that occupant restraints 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 safety belt users sustained approximately 35 percent fewer serious injuries than non-safety belt users (Garrett, 1960). Huelbe and Gikes estimated, from the results of their 1961 research, that 40 percent of the occupant deaths each year in the United States from motor vehicle accidents could be saved if safety belts were utilized. 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 concluded that lap 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 (Kihlberg, 1969). Levine and Campbell confirmed Kilhberg's finding, showing a reduction in severe injury and death of 43 percent when lap belts were used (Levine and Campbell, 1971).

A 1974 study in Pennsylvania was the basis for the estimate of a 73 percent lower fatalities rate, a 53 percent lower serious injury rate and a 38 percent overall injury rate for all lap belt users ("Usage and Effectiveness of Seat and Shoulder Belts in Rural Pennsylvania," 1976). Research in 1976 by Reinfurst et al. reveals that the chances of injury to the front seat "outboard" position occupant is reduced by 31 percent for safety belt users (Reinfurst et al., 1976).

Ineffectiveness of Safety Belts for Small Children

The use of safety belts by themselves for small children have been proven to be ineffective for adequately protecting the child in the event of a crash. In 1971, Australia passed legislation requiring

safety belts for all vehicle occupants. A study of fatalities and injuries show a 20 percent reduction in most injury categories, but there was no significant reduction in fatalities and injuries to small children (Boughton, et al., 1977). Burdi, et al., document the need for small children to have special devices to be used in conjunction with the seat belt (Burdi, et al. 1970). Because the body of the small child has not developed to the point of allowing a lap belt to be correctly positioned, the belt itself could possibly cause serious internal damage by riding up on the abdomen. Snyder concluded that the forces of a vehicle crash should be distributed over as much of the body area as possible (Snyder, 1970). 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 satisfied Snyder's recommendations.

Aldman recommended the rear-facing infant device which has proven to be effective in Sweden (Aldman, 1966). Siegel, Nahum and Appleby in 1968 studied various types of designs of CRD's. 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 CRD's in reducing the severity of injuries (Siegel et al., 1968).

Rose, Aldham, and Appoldt studied special needs of children for restraint devices focusing on anatomical and psychological differences between adults and children (Rose, 1965; Aldham, 1966; Appoldt, 1966).

They concluded that all devices designed for small children should be dynamically tested 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 restraint device for infants and young children. Snyder and O'Neill (1975) point out that because of these anatomical differences the upper diagonal torso safety belt is not safe for small children. Williams and Zador (1976) report that the use of restraints 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 1960's and 1970's were directed toward effectiveness and public acceptance of restraints designed especially for children. In March, 1960, Moore and Lillienfeld pointed out the need for protecting children in automobiles, suggesting that children be restrained in the rear seat of automobiles while being transported (Moore and Lillienfeld, 1960). Dye, before a conference on Passenger Car Design and Highway Safety in 1962, advocated that children must be secured to prevent ejection or contact with the interior surfaces of the automobile in the event of a collision (Dye, 1962).

Several studies have indicated the effectiveness of CRD's for young children when the devices are used properly. A Washington State study indicated that if all 30,602 children in the 0-5 age group who were observed had been restrained by CRD's at the time of a motor

vehicle accident, a reduction of 90 percent in fatalities and 67 percent in disabling injuries may have been expected (Scherz, 1977).

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 (Williams and Zador, 1976). Further use of restraints 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 restraining device.

Restraint Regulations and Laws

Consideration for regulations and laws regarding the availability of restraints in vehicles and the specifications for devices go back to 1957 when the pros and cons of seat belts were discussed and testimonies 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 ("Motor Vehicle and Highway Safety Acts of 1966," 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. It was the state of New York who took the lead in 1961 in vehicle occupant safety legislation in this country by enacting a law requiring the installation of lap belt anchorages in

all new automobiles sold in that state (States, 1972). It was from this meager beginning that safety belt measures spread to include the majority of the states. Public acceptance of the legislation requiring provisions for safety belt usage is thought to have convinced the automotive industry to begin making safety belts standard equipment (States, 1972).

Standards

In 1963, Public Law 88-201 was signed by the President of the United States requiring standards for seat belts for use in motor vehicles to be prescribed and published (Neff, 1966). The establishment of minimum standards for seat belts was assigned to the National Bureau of Standards (Neff, 1966). The Bureau depended upon the Society of Automotive Engineers (SAE) who had begun research on seat belts in 1954 when the Bureau of Motor Vehicle Seat Belt Committee was created. In 1964 the government required that all new cars have two lap-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 lap 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 lap-belts for all other seating positions (Robertson, 1975). Unfortunately, child restraint 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 (1971) covered only the car seat type child restraint 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 CRD's in August of 1972 and found only five acceptable for protection as defined by the Consumers Union. All 17 had previously passed the static test as set out in Standard 213 (Consumer Report, 1972).

In response to the need for improvements in the federal child safety standard, the NHTSA published a proposal in March 1974 to expand the scope to cover all forms of infant and child restraints, require dynamic tests in lieu of static tests, and requiring anthropomorphic test dummies to be used in the simulated crash testing. (Motor Vehicle Standard No. 213, Docket No. 74-9, Notice 4, 1974). 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 child restraint system 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.

Another federal standard passed in 1971, effective from January 1, 1972 to August 14, 1973 (Motor Vehicle Standard No. 208, 1971) required manufacturers to equip new cars with passive devices 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 belts of the front seat were unfastened. The overwhelming majority of vehicles manufactured between January 1972 and August 1973 had the buzzer-light system instead of the passive protection devices (Robertson, 1975). Effective August 15, 1973, Federal Standard 208 was amended to require an interlocking system which connected the restraint system 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 a measure (Pulley, 1975). The United States Congress, in 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 and thus none received an incentive payment. The Territory of Puerto Rico, however, received almost $300,000 for enacting a law which was 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 (Pulley, 1975). 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 concluded that safety belt usage laws are effective in the following instances: 1) when a public education program is also 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 (Pulley, 1975).

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

Public Information and Education

Attempts to inform and educate the public concerning occupant protection in motor vehicles have been made by several organizations.

By and large, these attempts have been insignificant in increasing the rates of restraint 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 vehicle. The federal government along with several other organizations have distributed printed information in an effort to inform the public of the need for vehicle occupant protection.

Medical Profession PI&E

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 passenger restraints 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). Reisenger and Williams (1978) report that similar programs have been undertaken and are continuing at pediatrician offices and well-child clinics. They contend that although infant restraint 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 infant restraints. Their study included three in-hospital educational programs for post-partem women.

They concluded that different levels of education and the cost of infant carriers influence the mother concerning the decision to provide a device for protecting her child. The information and education techniques increased the number of decisions to use a restraint.

The states of Washington and Wisconsin have programs where the 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, in a study involving mothers, found that 69 percent of the counseled and 42 percent of the uncounseled women were using child restraints at the six-weeks visit back to the physician (Kanthor, 1976).

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 child restraints (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 CRD's for their children, but less than 3 percent use followup instruction and education on every visit (Lieberman, et al., 1976). There was a 20 percent increase, from 38 percent in 1963 to 58 percent in 1970, in the Academy Pediatricians who advised parents of the value of using passenger restraints (Pless, et al., 1972).

The medical profession has generated a sizeable amount of literature promoting and supporting the use of child restraints. Burg and others advocated strong support of child restraints from the pediatric physicians and the medical profession in general (Burg, et al., 1970). Their work led to a better understanding by the pediatricians of the need for child passenger safety. "Don't Risk Your Child's Life" (1976) is a brochure produced by the Physicians for Automotive Safety.

Printed Information

The NHTSA has developed and distributed numerous pamphlets and booklets. The NHTSA 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 (Traffic Safety, '75, 1976). Accident facts and safety 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 entitled "Selecting Automobile Safety Restraints for Small Children" was made available for national distribution by the United States Department of Health, Education and Welfare (HEW). This publication was intended to aid in educating parents on the types and availability of child restraints. Recently HEW's Office of Human Development Services has published a booklet concerning children and auto safety "Auto Safety and Your Child" (1977). This publication addresses the problem, cause, and solution of protection for child occupants under age four in motor vehicles.

A booklet entitled, "What to Buy in Child Restraint Systems," (1971) was distributed by the National Highway Traffic Safety Administration. This same agency published "Automobile Safety Belt Fact Book" (1972) 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 any persons who may request them to encourage students, employees, license applicants and others to use safety belts (Traffic Safety '76, 1977).

An organization called Action for Child Transportation Safety (ACTS) has distributed a brochure entitled "This is the Way the Baby Rides," which deals only with the protection of babies. ACTS 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.

Numbers of national magazines have carried articles about child safety in motor vehicles which have reached millions of readers. Consumer Reports in March 1975 and again in June 1977 reported on infant carriers and child restraints (Consumer Reports, 1975; Consumer Reports, 1977). Articles have also appeared recently in Motor Trend (October, 1976), Woman's Day (Candler, 1976), and Parade (Mitchell, 1978), to mention only a few.

There are several other publications which give some attention to child passenger protection such as Parents' Encyclopedia (1973), Parents' Almanac (1976), Parents' Guide to Child Safety (1973), and Let's Stop Destroying Our Children (1974). These publications are instructional, 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 is often times given too little attention or left out completely. Lonero believes that parents whose children are given formal instruction on safety belt use will use safety belts more often than those whose children receive no instruction (Lonero, et al., 1973). Others have reported that children are more likely to be observed using CRD's if their parents are using safety belts. This relation is a function of the parents' educational level and their sense of efficacy (Neumann, et al., 1974).

Effects of PI&E 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 CRD's after receiving only the literature. A surprising 71 percent purchased or obtained CRD's after a combination of only the literature and the film. A Swedish study showed that parents' acceptance of rear facing CRD's 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, et al. (1972) expressed the belief that public education of child automotive safety via the mass media has had limited success. Farr reports that a temporary increase in restraint usage in 1973 in England was not caused by a large national mass media PI&E program but coincidental to this. Robertson (1974) found that television messages urging safety belt use had no effect on use. He believes 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 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 (Scherz, 1978).

PI&E treatments used in combination with a usage law have been tried in most countries which have compulsory use laws (Zeigler, 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 in 1969 a campaign using radio, television, newspapers, posters, and speeches was launched to increase seat belt usage. The result was no significant change in use from before the campaign (Ontario Department of Transportation, 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 safety belt use. Observed safety 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.

There are several characteristics of users and non-users of safety restraints which can be identified and which should be considered when designing PI&E programs. Robertson (1972) points 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. He also found that the higher the person's education, the greater the likelihood that the person wears safety 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 dollars would be required to implement the countermeasures seen as needed. This cost coupled with countermeasure implementation costs greatly exceeds budgeted funds for highway safety (The National Highway Safety Needs Report, 1976). The cost of implementing

passenger restraint 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 1) potential to forestall fatalities and injuries (Table 2-1), 2) increasing cost of implementation (Table 2-2), and 3) diminishing cost of effectiveness (Table 2-3). It can be clearly seen from these three tables that Mandatory Safety Belt Use and Nationwide 55 mph Speed Limit are the two most cost-effective countermeasures.

Mandatory Seat Belt Use has the potential to save an estimated 89,000 lives over a 10-year period of time from 1976-1986 at a cost of approximately 45 million dollars based on 1974 dollars. The costs presented in Tables 2-2 and 2-3 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 (The National Safety Needs Report, 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 (1975 Societal Costs of Motor Vehicle Accidents, 1976). Medical care, vehicle repair, insurance administration, accident investigation, and court

TABLE 2-1

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: April, 1976).

TABLE 2-2

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: April, 1976).

TABLE 2-3

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: April 1976)

and legal fees are a few examples of costs which may be incurred as a result of a motor vehicle accident. 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 reported that in 1976 accidents in which deaths or disabling injuries, together with non-injury motor vehicle accidents, cost society about 52.8 billion dollars (Accident Facts, 1977). Of that total, motor vehicle accidents accounted for 24.7 billion dollars, which included: 1) 8.9 billion in property damage, 2) 7.6 billion in wage loss, 3) 6.1 billion in insurance administration, and 4) 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 U.S., Tennessee and the states which border on Tennessee may be shown (Table 2-4).

Summary

The literature on the early history and development of occupant restraints is sparse. The basic concepts of occupant protection for

TABLE 2-4

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, Material Compiled by NHTSA, June, 1975 (Washington: 1975).

pilots of aircrafts were applied to motor vehicle occupant protection, and by the late 40's interest had increased and more information became available.

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

The effectiveness of safety belts for adults and the ineffectiveness of safety belts for small children are documented. Safety belts are very effective for adults and larger children, but are not designed for infants and toddlers under age four. Special devices are needed for children too small to be adequately protected by seat belts. These "special devices" called child restraint devices should be dynamically tested to determine if they will serve the purpose for which they were designed.

It may be concluded from the literature that the impetus for occupant restraint 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 for the establishment of standards for safety belts. A standard to cover all forms of infant and child restraints has been in the proposed 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 restraint 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 safety belt usage countermeasure is apparent. The cost of implementing the most effective countermeasure has been estimated at 6.8 billion dollars per year, but on the other hand, in 1976 motor vehicle accidents accounted for approximately 24.7 billion dollars in damages and losses.

CHAPTER 3

RESEARCH DESIGN

The State of Tennessee, by passing an active restraint law, provided a unique research situation in the United States. Until Tennessee passed the restraint law in 1977 requiring children under four to be protected in most moving vehicles, there was no state which had any type of restraint law for any age group. Following the passage of the law, the Tennessee Child Passenger Safety Program was established in September, 1977 to promote the use of child restraints in Tennessee. A project entitled "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 to assist in the reduction of deaths and injuries to children under the age of four involved as occupants in motor vehicle accidents. The evaluation project was designed to investigate the effect of the Child Passenger Safety Program on the reduction of fatalities and injuries to children under age four in Tennessee over a two and one-half year period after the law and PI&E programs were implemented. The research for this study, which is a part of Child Passenger Safety Program, was designed to examine a shorter-range impact; an evaluation of the program after six months of operations. Study areas were selected and procedures developed to collect data on child restraint 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 age four and their parents.

Study Areas

The study areas chosen for this research are representative of both the urban and the non-urban areas in the state of Tennessee. A randomized sample from the entire state is 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 to represent the state. Convenience samples are judgment samples which are commonly used 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 non-urban 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 these non-urban 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 with in 30 miles which has over 5,000 residents; the Middle Tennessee area has two and the West Tennessee site has only one.

The areas from which specific target areas, both urban and non-urban, attract shopping trips may overlap. For example, residents in the Columbia area, a non-urban target area, may occasionally travel to Nashville for shopping purposes. The same is true for Morristown, but it is less likely that residents in the Dyersburg target area would travel to Memphis for shopping purposes.

The goal of this study is to evaluate the impact of the child restraint law and the PI&E program in Tennessee. Since implications will be made about child restraint usage for the state based on urban and non-urban data, it is important to include some of the characteristics and statistics about Tennessee.

Tennessee's geography may be described as varied; from peaks of over 6,000 feet 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; 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 (Tennessee Statistical Abstract 1977, July 1977). Approximately 59 percent of the people resided in non-rural settings. Non-rural 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 can be shown (Table 3-1). The populations of selected non-SMSA areas may also be shown (Table 3-2).

In 1975 the State of Tennessee had a total of 81,272 miles of urban and rural highways and streets, 12,308 miles of which were classified as urban (Tennessee Statistical Abstract, 1977). There were 2,725,569 motor vehicle registrations in 1975 including over 2 million automobiles. A total of 2,434,206 persons had valid drivers

TABLE 3-1

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	174,587	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)	372,876	339,000
Tri-Cities SMSA (TN)[a]	292,808	313,100

[a]Includes only population inside Tennessee.

[b]Includes all of Davidson County.

Sources: Tennessee Statistical Abstract 1977, Center for Business and Economic Research, The University of Tennessee, Knoxville, July, 1977; Center for Business and Economics Research, The University of Tennessee, Knoxville, September, 1977.

TABLE 3-2

POPULATION, SELECTED TENNESSEE NON-SMSA 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	119,584

Sources: Tennessee Statistical Abstract 1977, Center for Business and Economic Research, The University of Tennessee, Knoxville, July, 1977; Center for Business and Economic Research, The University of Tennessee, Knoxville, September, 1977.

licenses in Tennessee in 1975 (Highway Statistics, 1975). There was a total of 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 U.S. Bureau of Census figure for the number of children under the age of four was 256,650. Approximately 149,000 of this total lived in urban areas (General Population Characteristics of Tennessee, 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 is estimated to be 251,132 (Table 3-3). 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 a total of 10 cities. The major urban areas of Memphis, Nashville, Knoxville, and Chattanooga were chosen as study areas along with the Tri-City Area of Johnson City, Kingsport and Bristol. The non-urban study area group was made up of Dyersburg, Columbia, and Morristown. An average of five sites was chosen within each urban area to collect data. The non-urban areas had one or two sites for each city. 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 locations selected for sites of data collection in each study area represent a variety of types of shopping areas which attract a broad range of shoppers from low to high socio-economic and educational levels. The locations of

TABLE 3-3

ESTIMATED NUMBER OF CHILDREN UNDER AGE FOUR IN TENNESSEE
(AS OF JANUARY 1, 1978)

	Year				
	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	54	
Died			1,007		
					61,453 (1976)
Born				66,632	
Died				1,007	
					65,625 (1977)
				TOTAL	251,132*
			(approximately 5.8 percent of estimated Tennessee population of 4,299,000)		

*Migration is assumed to be compensating

Source: Tennessee Bureau of Vital Statistics, (February '78).

the SMSA areas and the non-SMSA areas chosen as the study areas for this study may be illustrated (Figures 3-1 and 3-2).

Relationship of Study to Larger Evaluation Project

This study is related to a larger project to evaluate the impact of the Tennessee Child Passenger Protection Act. The larger project was designed to study the impact over a period of two and one-years after implementation of the law. A combination of PI&E treatments will have been applied to different target areas by the end of project. This study in relation to the longer period evaluation is an investigation of the impact of the law and PI&E program after the first six-month period following the effective date of the law and PI&E implementation.

The sampling and PI&E implementation plan for the larger study which includes this study is shown (Figure 3-3). The initial sampling occurred prior to the effective date of the law and PI&E program. This sampling was taken to obtain baseline data (BLD). The samplings taken after the implementation of the law and PI&E program were called semi-annual surveys (SAS). The Nashville target area was the only area uniquely different from the other target areas during the first operational period (six months). The Comprehensive PI&E Program was implemented in Nashville. The comprehensive plan included using the mass media approach to inform the general public about the law and inform them of the need for occupant protection. Public service announcements (PSA's), news spots and talk shows on television and radio were used. The newspapers were encouraged to run feature stories and cover of events such as press conferences. Newspaper editorials

TENNESSEE

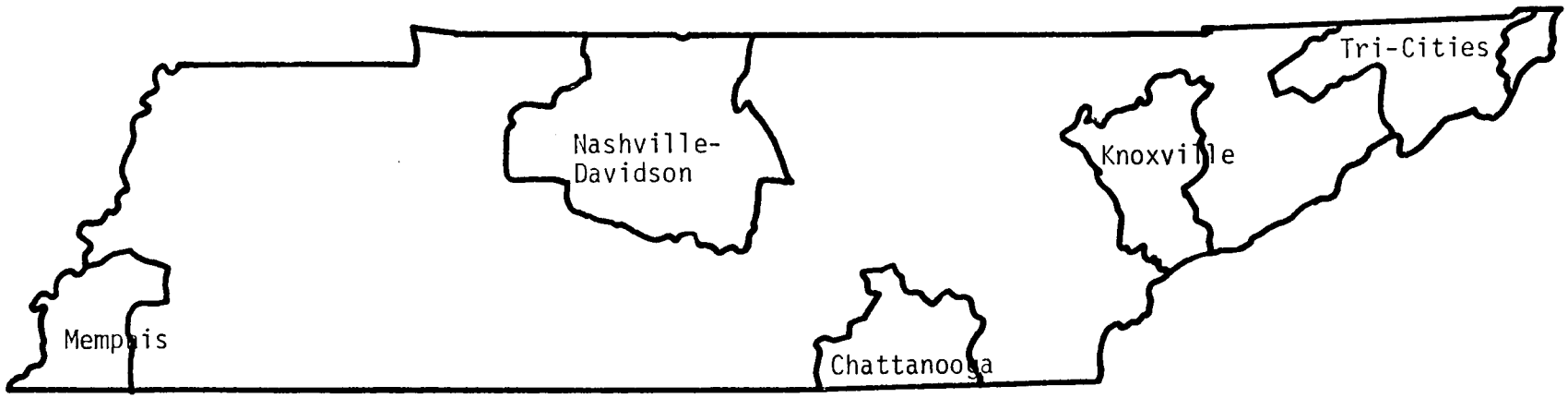


FIGURE 3-1

LOCATIONS OF SELECTED SMSA AREAS

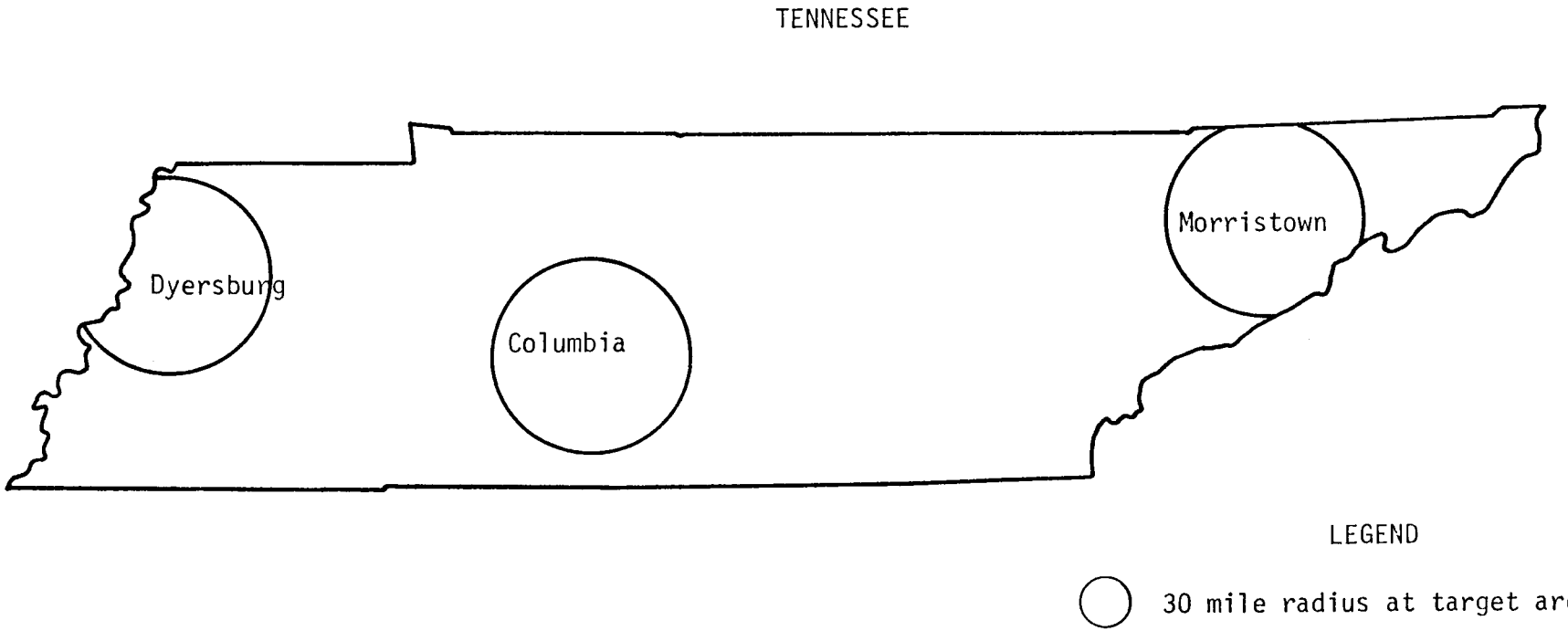


FIGURE 3-2

LOCATIONS OF SELECTED NON-SMSA AREAS

TARGET AREA	OCT 77	JAN 78	JUL 78	JAN 79	JUL 79	JAN 80	JUL 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	BSP	CP	CP		
	BLD	SAS	SAS	SAS	SAS			
Non-Urban 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 3-3

SAMPLING AND PUBLIC INFORMATION AND EDUCATION IMPLEMENTATION PLAN

were also effective public information sources. Billboards were also used as part of the comprehensive plan.

The basic state plan (BSP, Figure 3-3) was designed to make distribution of brochures informing parents of children under the age of four of the law and how they could protect their child. Stand-up posters for offices were also designed and distributed at the same time as the brochures. Distribution was made to hospitals, doctors offices, clinics, and other strategic places which may have had parents with small children making frequent visits.

For the larger study the master plan called for the number of target areas receiving the comprehensive PI&E plan (CP, Figure 3-3) to be increased each six-month increment until all target areas were included. A loaner program (LP, Figure 3-3) designed to provide CRD's to selected citizens who could not afford them was planned for implementation in one target area beginning six-months after the effective date of the law and PI&E program. One other target is scheduled to receive the loaner program at a period of six-month 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 six months after implementation. Measures used for evaluation were child restraint usage and the change in fatalities and serious injuries to children under four years of age. One limitation in using the later of the two measures is the low number of fatalities during a six-month

period of time. The frequentcy of fatalities for this age group is too low to provide meaningful statistical significance testing.

Another limitation recognized early in the operational period was the slight problem of restricting the comprehensive PI&E treatment to the one target area for which the study design called. Nashville was designated as the one target area to receive the comprehensive PI&E treatment during the operational period of this study. An evaluation of the effectiveness of the comprehensive treatment was based upon the premise that Nashville could be compared to all other urban target areas which had received only the basic PI&E plan. There was some leakage of the comprehensive plan information intended only for the Nashville target area reported during the operational period. A review of the newspaper clipping service reports from the other metropolitan areas, and information received from other sources revealed that this leakage should have had only a relatively small effect on the overall PI&E comparisons.

The other urban areas (other than Nashville) also had some programs promoting child restraint usage which were not a part of the project design. These programs likely had a slight 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 child restraint usage. These kinds of activities may have occurred in other urban areas and may have influenced usage of CRD's. If and when these activities occurred, more than just the basic PI&E plan was influencing CRD usage during this six month evaluation period.

Another limitation is that each of the urban areas surveyed is different in several respects which 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 capitol and therefore there is a larger number of governmental employees than in other urban areas in Tennessee. Nashville area residents are likely to be more aware than residents of other urban areas of new legislation because of local publicity. Other differences for each target area are the different economic bases and unemployment situations.

Procedures

The procedures described herein are those used for data collection design to include sample sizes, data collection, and evaluation. Since this study is a portion of a larger study, the procedures discussed apply for that study also.

Data Collection Design

Data Requirements for CRD Usage. To make a confident estimate of restraint usage during the period of time before the effective date of the law and PI&E implementation it was necessary to collect data by sampling. The criteria for sample size selection is shown (Table 3-4). A sample size of 400 observations per target area, necessary for the larger study, was approved by the NHTSA Contract Technical Manager. The rationale for selecting 400 observations is shown in Appendix B. This particular size was based upon the need to detect

TABLE 3-4

CRITERIA USED FOR SAMPLE SIZE SELECTION

		Estimated Usage for Baseline Period (percent)	Estimated Usage for Operational Period[a] (percent)	Difference between Periods (percent)	Confidence Level (percent)
CRD Use (childen less than four years old)		5	8	3	90
Safety Belt Use (Drivers)	Urban	15	19	4	99[b]
	Non-Urban	5	8	3	

[a]After approximately 6 months of operation.

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

significant changes in the usage rates at critical times during the implementation plan of PI&E treatments of the larger research project. For this study 400 observations were adequate to test for the significance between the usage rates for Nashville and the other urban areas for the first operational period when comparing the two types of PI&E treatments. A further decision to increase the size of the sample to 500 in target areas receiving the comprehensive PI&E treatment was made for the larger project in order to increase the precision of the calculations.

Data Requirements for Safety Belt Usage. Since safety belt usage by drivers was not a part of the sampling plan of the larger project, a family of curves was developed for sample size selection (Figure 3-4). These curves were developed using the same procedures as shown in Appendix B for CRD usage sample size selection. Sample sizes were selected for both urban and non-urban areas (Figure 3-4). 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 3800 observations. This sample size was chosen by assuming a 15 percent usage rate during the baseline data collection period and a 19 percent usage rate during the operational data collection period. The sample size required for the non-urban areas is a total of 2912 observations which is a total of 971 needed at each non-urban location. The assumption of 5 percent safety belt use by drivers at the non-urban locations was made after preliminary review of one day's data collection at one non-urban location. It was assumed that there would be about the same increase (3 percent) in safety belt usage by drivers as

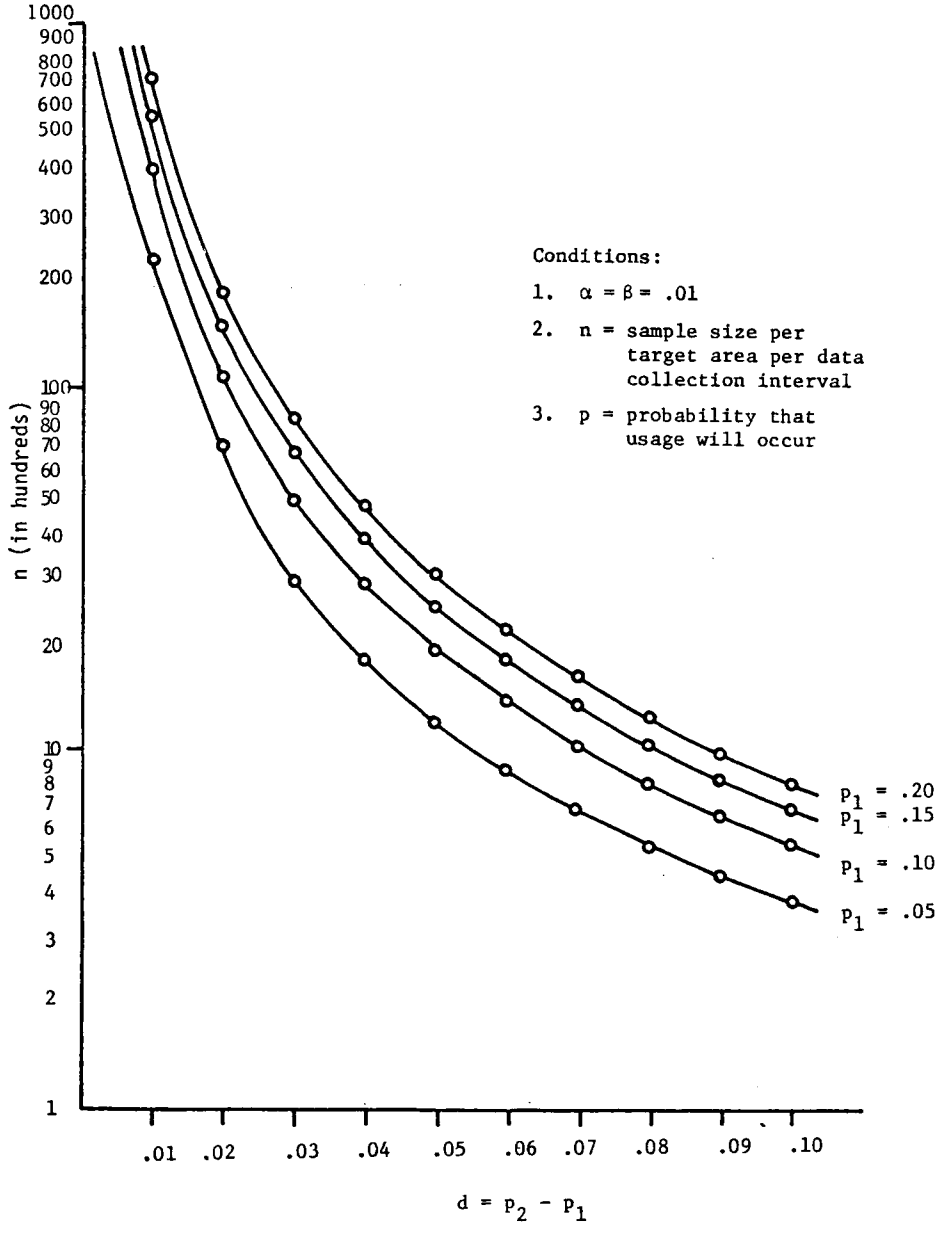


FIGURE 3-4

SAMPLE SIZE SELECTION
(For Seat Belt Usage)

the assumed increase in CRD usage because of the fact that the PI&E program had an underlying message of safety for all occupants and not just child passenger safety. 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 age four were expected for the operational period.

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

The Tennessee Child Passenger Protection Act specifically exempted certain vehicles (see Appendix A). A method was devised to make counts of all eligible vehicles, all CRD's observed, and safety belt usage of drivers. A copy of the data sheet on which this information was recorded is shown in Appendix C.

Three tier levels were used to collect the necessary data for restraint usage analyses for the larger project. 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 (see Appendix A); data were gathered only if those eligible vehicles had a 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 childrens hospitals. The information recorded at this point included: 1) the disposition of the child or children in the vehicle, (e.g. restrained or unrestrained) 2) the use of seat belts by the driver of the vehicle, and 3) 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 allows an option to be exercised by the parent or guardian. The law (see Appendix A) permits children under four to be held by an older passenger in lieu of being restrained in an approved child restraint device. The different dispositions chosen were; 1) in a Child Restraint Device (CRD), 2) held by a passenger, 3) held by the driver, and 4) other. Because of the difficulty in determining whether the driver is using safety belts (especially 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 insure that the determination of driver safety belt usage rates were as accurate as possible.

The tier two level of data collection (Appendix E) was designed as an observational, personal interview, and self-administered combination 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 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 as many as three children's ages under the age of four. Besides the age, sex, and driver's relation to child, only two other questions were asked of the respondent; 1) year of car and 2) 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 departed the vehicle. The self-administered part of the questionnaire consisted of 10 questions of which two were repeated for the respondent's mate (see Appendix E). 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

Baseline Restraint Usage Data. It was imperative that the baseline data be collected prior to the effective date of implementing the law and the PI&E program, January 1, 1978, in order to be able to

assess the situation before the parents/guardians under the law were exposed to a great deal of information and education concerning the subject. 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 early and public information begun early, 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 adequately collect 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 first trial run. Training included interviewing techniques and two-way radio operations procedures, as well as 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 quota of 400 matched observations was set for all target areas except the one receiving the comprehensive PI&E treatment where 500 observations were needed. A matched observation is when the tier one and tier two data sheet's license tag number are the same indicating that the same occupants of the vehicle that were observed for restraint usage at the observation post were observed again upon parking

by the interviewer as well as having been 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 provided the assurance of an ample number of observations. Six week ends were needed to complete the baseline collection (Table 3-5). A summary of the restraint usage data collection procedure is given in Appendix G.

Operational Restraint Usage Data. Because the baseline data collection for restraint usage determination was completed by November 19, 1977 and some PI&E began in December, 1977, it was decided to begin operational data collection in June, 1978, after approximately 6 months of PI&E treatment. The collection was finished by July 1, 1978, the date for the target area to begin comprehensive PI&E treatments (Table 3-6).

The operational data collection was designed to be as much like the baseline collection as possible. The same target areas, sites and supervisors were used to insure 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 larger project called for semi-annual surveys. The primary purpose of this plan is to check on the effectiveness of a particular PI&E treatment at different target areas. For this study Nashville was the only target area which had a different treatment applied during the first six months of operation after the law.

TABLE 3-5

BASELINE RESTRAINT USAGE DATA COLLECTION DATES

	Dates of Collection (1977)					
	October			November		
Target Area	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
Non-Urban Areas						X

TABLE 3-6

OPERATIONAL RESTRAINT USAGE DATA COLLECTION DATES

	Dates of Collection (1978)				
	June				
Target Area	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	
Non-Urban Areas			X	X	X

Based upon the baseline data collection experience factors, such as the number of times the age of children were incorrectly estimated by observers, it was decided a sample size of 400 was needed for the operational period for each target area except Nashville where a sample of 500 was needed to increase accuracy. This sample size was no different from the baseline except the 400 observations were to be composed of unmatched observations along with matched data (see Appendix B).

Accident Data. Fatalities and injuries to children under four years of age for both 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 restraints, data on fatalities and injuries to children under four were needed for a longer period of time. These data were available from the files of accident reports at the Tennessee Department of Safety in Nashville. A period of approximately three months is needed by the department to process the accident data and place it on computer tape for accessible use.

Evaluation

The procedures will be discussed in light of the several specific objectives of this study. It order to determine the usage rates of restraint usage by children under four and drivers from the data collected, organization of the data was necessary. The raw data were checked manually for errors, sorted, and tier one level data 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 of children in CRD's, 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, were therefore restrained in CRD's. From the second tier level of data collection the frequency of CRD use may have shown, for instance, 60 of 400 children observed using CRD's for a 15 percent rate. In order to obtain the most accurate percentage of usage the two levels were combined and adjustments made for over-age estimates (children four and older). The equations and procedure for calculating usage rates using both levels of data are continued in the next chapter concerning the baseline data analysis.

The determination of the usage rate of safety belts by drivers is simply done by using the proportions of use observed of the total number of drivers observed. Drivers were divided into two categories, one of which includes the other; all drivers of eligible vehicles under the child restraint law 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 of 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 non-users of CRD's. The analysis identified those distinguishing characteristics which influenced the subject to either use or not use CRD's.

The procedure followed to compare usage rates of the operational period with the baseline period was to first compare rates within each target area for the two periods and then make comparisons between target areas and/or groups of target areas. The z statistic was used to test the hypotheses that a difference existed between the two data collection intervals. The results of the analysis are discussed fully in Chapter 5.

The objectives dealing with comparisons of the number of deaths and injuries to children under four 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-June 1978. Chapter 7 contains a discussion and shows the results of the comparisons.

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 safety belt usage in relation to CRD usage as stated in objective five. The z test statistic was used to test the significance of the comparison. The results are discussed in Chapter 4 and 5 with an explanation of the technique in Appendix L.

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 user and nonusers of CRD. 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. This analysis is discussed in Chapter 6.

The evaluation of the effectiveness of each PI&E plan with the law was made by comparing CRD usage rates before and after implementation. These comparisons are discussed in Chapter 5 and in the results section of Chapter 7.

The procedure for dealing with the last objective 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. The discussion in Chapter 7 includes accident analysis results, investment costs and expected benefits. The concluding chapter, Chapter 8, deals with summarizing the major conclusions of the study and recommendations for the future.

CHAPTER 4

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 restraint usage. The data collected before January, 1978 included information on restraint usage for two groups; children under four years of age and drivers. The analysis also included the interrelatedness of seat belt usage of drivers and CRD usage.

The variables which were measured included the information needed to determine a description of 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 accompanying driver of the vehicle were determined for each target area. Several variables were used to measure the distinguishing features of drivers/parents/ guardians. Two socio-economic variables, family income and educational attainment, were extremely important measures, since they were expected to have considerable

impact on CRD usage. Vehicle characteristics were part of the collection as well. Data on CRD ownership by type and brand were gathered to establish which were most owned and used.

The discussion is divided into two sections; child restraint usage and safety belt usage by drivers. Most of the discussion in this chapter is focused on child restraint usage. The section on driver restraint usage includes all drivers observed as well as drivers observed with small children.

Child Restraint Usage

Data collected at both the tier one level (observational) and the tier two level (observational and personal interview) were used to serve as supporting documentation for the discussion of CRD usage. The observational data (tier one level) is discussed prior to the discussion of the various variables or groups of variables selected from the data collected by personal interview (tier two level) of adults with small children. These discussions provide supporting information for the analysis of CRD usage later in the section.

By examination of the tier one level data (observational) one may discern the magnitude of the number of vehicles, number of small children in vehicles, and the number of the different dispositions of small children in vehicles which were collected for this analysis. The analysis of tier two level data (personal interviews) includes the characteristics of children under age four and of the accompanying adults who were parents or guardians of the children. It also includes an analysis of CRD ownership, type, brand, and location with 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 further study the usage of CRD's. Each of the variables or groups of variables examined in an earlier section of the chapter was crosstabulated with CRD usage.

Tier One (Observational) Level Data

The data collected at the observational level provided information for the investigation of child restraint usage. Although the period of time for observing a vehicle was short, (usually 2 to 4 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 were tabulated (Table 4-1). More observations were 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 for all urban target areas of 8.8 percent.

A total of 68,884 vehicles were observed at all target areas with 9.1 percent of those having small children present. Out-of-state

TABLE 4-1

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
Non-Urban Areas	8,843	976	11.0
Total Urban and Non-Urban	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 Restraint 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.

vehicles were included in raw data counts for total vehicles and vehicles with small children. A total of 5.7 percent of the vehicles with small children 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, and Kingsport and Bristol of the Tri-Cities Area) had the greatest number. There were no observations at the non-urban areas of out-of-state vehicles with small children.

At the observational level of collection the disposition of the child or children estimated to be under age four in the vehicle was determined and recorded on the tier one data sheet. When there were two children in the vehicle estimated to be less than 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 estimated at under four in the vehicle, the second most safe child became child #2. These were no provisions for collecting data on more than two children at the tier one level. If there were two children under age four 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 age four 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 (Table 4-2).

TABLE 4-2

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	1076	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	1115	9.0	30.7	1.9	58.5
	2	121	1.7	4.1	0.0	94.2
Total Urban	1	4344	11.1	29.0	1.9	58.1
	2	636	2.2	4.5	0.5	92.8
Non-Urban Areas	1	824	6.6	28.5	3.0	61.9
	2	120	0.0	12.5	0.8	86.7
Total Urban and Non-Urban	1	5168	10.4	28.9	2.0	58.7
	2	756	1.9	5.8	0.5	91.8

It was discovered from the observational data that only a small percentage of second children under age four were restrained. A total of 756 children were observed as the second child under age four in the vehicle. This figure represents 12.8 percent of the total number of child #1 and child #2 combined. Only 14 of these second children (1.9 percent) were restrained in CRD's while 44 (5.8 percent) were held by older passengers and 694 (91.8 percent) where totally unrestrained. A comparison of the first child's dispositions in the vehicle showed 10.4 percent in CRD's, 28.9 percent in older passenger arms, and 58.7 percent 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 a total of 2,787 children under age four were observed and a total of 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.

Child restraint usage data by type and manufacturer of CRD was collected at the tier two level. The data also furnished essential knowledge on the various properties of the vehicles observed.

Children's Characteristics. A summary of the percentages of the children observed by age and sex, was tabulated (Table 4-3). There were slightly more two year old children observed than any other age group. The percentages for all areas combined ranged from 21.6 percent for the less than one year old group to 27.7 percent for two year

TABLE 4-3

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*					
		By Age (Percent)				By 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
Non-Urban Areas	456	15.8	28.5	31.1	24.6	46.4	53.6
Total Urban and Non-Urban	2,787	21.6	26.3	27.7	24.5	50.6	49.4

*Children #1 and #2 only.

olds. The largest difference in percentages of children observed by age occurred in the non-urban areas; from 15.8 percent for the less than one year old group to 31.1 percent for the two year olds.

The split for male and female children occurred with slightly more female children being observed (50.6 percent). The non-urban areas showed the greatest difference in the sex of child passengers; 46.4 percent were female.

Drivers' Characteristics. It was anticipated that a high percentage of drivers of the vehicles in which children under four were observed would be parents of the children. The percentage of this occurrence was 87.2 percent while another 10.4 percent of the drivers were relatives of the children observed. A tabulation was prepared to show the distribution (Table 4-4). There was a smaller percentage of parents as drivers in the non-urban areas (82.5) compared with the urban areas (88.1). The percentage of relatives as drivers, on the other hand, was larger for the non-urban areas, 14.1 compared to 9.6 percent for urban areas.

It also was anticipated that the majority of the drivers observed with small children would be female. The observed percentage was not as large as anticipated, however; the overall percentage for all target areas was 53.6 female drivers (Table 4-4). A comparison between urban and non-urban areas showed that just over 67 percent of the drivers were female in the non-urban 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 toward a family activity.

TABLE 4-4

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
Non-Urban Areas	419	82.5	14.1	2.6	0.7	399	67.2	32.8
Total Urban and Non-Urban Areas	2,552	87.2	10.4	2.0	0.5	2,424	53.6	46.4

*Includes child #1 and child #2.

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 another adult, other than the driver, furnished the information, 92 percent were female.

A comparison was made between the percentage of users and non-users of CRD's by driver's sex (Table 4-5). Drivers observed with children in CRD's were most often female. One possible reason why more females than males were observed with children in CRD's 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 child. It is often the desire of a mother to have the 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 CRD's more often than males is the traditionalism 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 what the consequences of having an unrestrained child in the vehicle might be.

The overall (both urban and non-urban) percentage of female drivers who had their children restrained in CRD's was 58.9 percent; the non-urban areas were substantially higher at almost 78 percent. It was also found that of drivers who do not restrain their children in CRD's that females prevailed with 52.7 percent.

TABLE 4-5

COMPARISON OF MALE AND FEMALE DRIVERS AMONG USERS AND NON-USERS OF CRDs
AT THE TIER TWO LEVEL FOR THE BASELINE PERIOD
(ROW PERCENTAGES)

Target Areas	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
Non-Urban Areas	390	27	77.8	22.2	363	66.4	33.6
Total Urban and Non-Urban Areas	2,348	333	58.9	41.1	2,015	52.7	47.3

*Drivers with at least one child in CRD.

Vehicle Information. 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 I.

CRD Ownership, Types and Manufacturers. A determination of type and manufacturer of CRD's was made for two situations; 1) when an interview was made and there was no CRD present in the vehicle, and 2) when an interview was made and at least one CRD was present. A number of adults interviewed without CRD's in their vehicles indicated they owned CRD's, 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 CRD's present in the vehicle were asked the brand name. A verification of the brand was made by the interviewer when possible by observation. If the respondent did not know the brand, the interviewer attempted to make a determination.

A tabulation of ownership by type was made to illustrate the differences in percentages between, 1) the CRD not being present but ownership claimed, 2) the CRD being in the vehicle but not being used, and 3) the CRD being in the vehicle and being used (Table 4-6). The overall ownership by both type and manufacturer was calculated by totaling all those observed and those reported by interviewed adults as being owned but not present in the vehicle.

TABLE 4-6

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
Overall Ownership	1211	13.5	4.9	79.4	2.2
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

The car seat type was by far the highest in percentage of CRD's owned. It was also the type which was most likely to be left behind when children were transported. Car seats account for 79.4 percent of all CRD's owned and 83.7 percent of all those which were not present in the vehicles observed and in which adults were interviewed. The infant carrier type was left behind less frequently than other types; 13.5 percent of all CRD's owned were this type, but infant carriers represented only 6.6 percent of all CRD's owned but not present in the vehicle.

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 usage of CRD types. The infant carrier was far ahead of the remaining types with almost 21 percent of all types.

A discussion of the manufacturers of CRD's and accompanying tables are given in Appendix J. A crosstabulation of CRD usage by brand by type is also shown.

Child Restraint Types. The types of CRD's were discussed briefly in Chapter 1. Usage of child restraints by type was shown in Table 4-6 and discussed with regards to CRD ownership. A further explanation of child restraint devices is provided in Appendix K.

A comparison of the percentages of use and non-use of CRD's by type for Nashville and other combinations of areas is shown (Table 4-7). Although the frequencies were low for some of the categories, it was important that Nashville, being a target area selected for

TABLE 4-7

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	324	20.7	2.5	75.9	0.9
	Not Used	151	19.2	3.3	76.2	1.3
Non-Urban 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 Non-Urban Areas	Used	349	20.9	2.6	75.6	0.9
	Not Used	167	20.4	3.0	75.4	1.2

comprehensive PI&E treatment during the operational period, be separate in the comparison. The non-urban areas had low frequencies but a comparison between the urban and non-urban areas was also needed.

Nashville, when compared to the other urban areas as a group, had a higher rate of infant carriers observed being used (23.3 versus 19.3 percent). The non-urban areas had a higher rate of usage of infant carriers than the urban areas; 29.6 percent to 20.7 percent.

A comparison of car seat type usage between Nashville and other metropolitan areas showed 69.9 and 78.3 percent usage respectively. The non-urban areas were considerably below the urban areas at 66.7 percent compared to 75.9 percent. The frequencies 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.

Child Restraint Usage Comparisons for Baseline Period

Usage rates vary with the data from each level of collection. The usage rates are consistently greater for the data from the tier two level of collection than for tier one. Observation of small children and CRD usage was tabulated for both levels of data (Table 4-8). The overall usage rate calculated from tier one data was 9.2 percent, the overall usage rate from tier two level data was greater (12.9 percent). The differences are more distinct between the tier levels in the urban areas; 9.9 percent usage rate for tier one data and 14.3 percent for tier two. The largest difference for any one target area was Memphis.

TABLE 4-8

PERCENTAGES OF BASELINE 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	857	73	8.5	483	72	14.9
Nashville	870	104	11.9	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
Non-Urban Areas	944	54	5.7	465	27	5.8
Total Urban and Non-Urban	5,924	546	9.2	2,831	366	12.9

The over-age 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 were described. Since few children over four use CRD's, the over-age estimates by the observers caused lowered usage rates at the tier one level. Another possible reason for differences in the two sets of data is that of the number of tier two observations which were made, the interviewer sometimes faced a choice of interviews between vehicles; intuitively the choice was toward vehicles with CRD's in use.

There is no concrete explanation why there was more difference in the rates between the levels in the urban areas than the non-urban areas. The variances in training and personnel may be considered as a factor in the difference. Another possible explanation is that the non-urban areas were surveyed last and 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 emphasize 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 non-urban 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 over-age

estimates. The field data were divided into three data sets. The first data set consisted of matched tier one and two data; data set number two included all the tier one data which had no followup interview, i.e. no matching tier two data. The third data set included data which had interviews conducted but no observation made at the tier one level. The latter 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 an accompanying tier one observation 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 of the total 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 over-age 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 L.

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 L. The results of the composite usage rates calculations were tabulated (Table 4-9). 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 a 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 for Knoxville.

Contingency Table Analysis of CRD Usage

Contingency table analysis was used to examine sets of relationships between child restraint usage and other selected variables. This crosstabulation gave a frequency display for two or more variables. Child restraint usage variables were crosstabulated 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.

TABLE 4-9

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	Number of Observations of Children: Tier Two Only Data	Number of Observations of Children: 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]
Non-Urban Areas	670	60	405	872	6.5
Total Urban and Non-Urban Areas	660[c]	53[c]	419[c]	869[c]	10.9[d]

[a]Includes Tier One Data of over-age children and refusals at the Tier Two Level.

[b]See Appendix J.

[c]Averages.

[d]Weighted averages.

CRD Usage and Characteristics of Children. Age and sex were two characteristics of children recorded during data collection. A crosstabulation of the age of children under four and CRD usage was made (Table 4-10). 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. Female children had a slightly higher percentage of use of CRD's than males.

A total of 2,113 of the 2,415 observed children (87.5 percent) at the tier two level were the only child under four in the vehicle, while only 22 of the 2,415 observed (0.9 percent) of the vehicles observed had as many as three children under four (Table 4-11). A crosstabulation of usage by number of children under four in the vehicle was made (Table 4-11). Restraint usage for child #1 and for each category of number of children is shown in the table. The usage rate was considerably greater when two or more children under age four were present in the vehicle. There was a 12.8 percent usage rate when only one child under four years of age was in the vehicle, but when there were two 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 in the vehicle.

TABLE 4-10

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	1137	14.2		
Male	1140	13.7		

*Corrected Chi-Square.

TABLE 4-11

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	2113	12.8		
2	280	20.7		
3	22	27.3		

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.

CRD Usage and Family Characteristics. Data were collected dealing with variables which included socio-economic status of the family as well as variables on an individual basis, i.e. education and employment of respondent and respondent's mate. A crosstabulation was made for each of these selected variables by CRD usage for child #1 (Table 4-12). Usage rates were lowest for low income families and increased as family incomes increased.

Marital status is significant in relation to child restraint usage. The respondents who were married or living with a mate used

TABLE 4-12

FAMILY CHARACTERISTICS VERSUS CRD USAGE RATES FOR THE BASELINE PERIOD

Characteristics	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->20,000	335	21.8		
Marital Status:			5.50*	0.018
Married/living with mate	1940	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	1110	14.9		
2	668	9.3		
3	117	7.7		
4 or more	28	3.6		

TABLE 4-12 (continued)

Characteristics	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Employment Status of Respondent:			13.17	0.011
o Full time	1297	12.7		
o Part time	119	16.8		
o Homemaker	541	18.7		
o Student, Retired or Other	81	12.3		
o Unemployed	89	10.1		
Employment Status of Respondent's Mate:			5.52	0.238
o Full time	1314	14.9		
o Part time	97	14.4		
o Homemaker	388	17.5		
o Student, Retired, or Other	78	7.7		
o Unemployed	78	12.8		
Employment Status of Couple:			22.82	<0.001
o Both, Full time	659	10.9		
o 1 Full time, 1 not Full time, and not Homemaker	294	15.6		
o 1 Full time, 1 Homemaker	852	18.9		
o Both, Less than Full time	47	4.3		
Educational Status of Respondent:			73.49	<0.001
o Less than High School	241	5.4		
o High School, G.E.D., and/or Vocational/Technical School	1079	10.8		
o Some College (no degree)	390	17.4		
o College Degree(s)	430	25.6		

TABLE 4-12 (continued)

Characteristics	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Educational Status of Respondent's Mate:			66.36	<0.001
o Less than High School	288	6.6		
o High School, G.E.D., and/or Vocational/Technical School	961	11.3		
o Some College (no degree)	328	18.9		
o College Degree(s)	411	25.5		
Educational Status of Couple:			69.31	<0.001
o Both, Less than High School	125	3.2		
o 1 with High School/Vocational Technical, 1 Less than High School	241	9.5		
o Both with High School/Vo-Tech/ Some College	906	11.6		
o 1 with College Degree(s), 1 with less than College Degree	80	16.3		
o Both with College Degree(s)	540	24.8		

*Corrected Chi-Square.

CRD's 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 does not, however, have the same effect. When there was only one child four and older, the use of CRD's by children less than four years old 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 larger children. When there was only one adult passenger the usage was high at 14.9 percent, but it dropped to 9.3 percent with two adult passengers.

The status of employment of the respondent and the respondents 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 as was discussed earlier in this chapter.

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 categories of 1) less than high school, 2) high school or equivalent, vocational or technical school, 3) some college but no degree, and 4) college degree or degrees. The range from lowest to highest educational level of respondents was 5.4 and 25.6 percent CRD usage respectively, while the range was similar for the respondent's mate from 6.6 to 25.5 percent. When the educational status of the couple was considered, both mates with the lowest level of education (both less than high school) to the highest level (each mate with at least one college degree), the range of CRD usage was wider; from 3.2 to 24.8.

CRD Usage and Vehicle Information. Essential vehicle information was discussed in the first of this chapter with an additional discussion in Appendix L. These variables were crosstabulated with CRD usage and the results were placed in tabular form (Table 4-13).

Vehicle ownership characteristics were significant factors in contributing to CRD usage rates. Vehicle ownership, however, may have been related to income level; those persons driving but not owning a vehicle may have been non-users of CRD's because of lack of sufficient income to afford one. The same logic may be used concerning the number of vehicles owned. The lower CRD usage rate (10.7 percent) for

TABLE 4-13

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
Sub-compact	215	15.8		
Compact	526	12.7		
Full Size	1,479	14.8		

TABLE 4-13 (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		

*Corrected Chi-Square.

one vehicle families versus a 16.6 percent rate 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 CRD's. 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 safety 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 station wagons have a higher CRD usage rate than 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 et al. (1978) found there was a significant difference at less than the .05 level.

CRD Usage Versus Child Restraint Types. The results of the crosstabulation of CRD usage by types were tabulated (Table 4-14). There was no significance difference in CRD usage detected between the different types of CRD's. There was little difference between the infant carrier and the car seat types, 69.2 to 67.4 percent usage respectively. The frequency counts for harnesses and protective shields were low, representing only 3.3 percent of the total of 488 CRD's observed.

TABLE 4-14

CRD TYPE VERSUS CRD USAGE RATES FOR THE BASELINE PERIOD

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

*Observations of Child No. 1.

Safety Belt Usage by Drivers

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

A total of 68,884 vehicles were observed by data collectors during the baseline period. Each driver was observed for safety belt usage. A traffic counter was used to record the number of observations, number of times safety belts were observed in use, and also the number of times the observers could not distinguish between use and non-use of safety belts by drivers. A tabulation of safety belt usage by drivers was prepared (Table 4-15).

Based on research by others safety belt usage in the non-urban areas was expected to be lower than the urban areas. The non-urban 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 safety belts divided by the total number of observations of drivers less the number of times the use of safety belts was undetermined. An examination of the percentages shows that the non-urban areas were substantially lower in use of safety belts by drivers than urban areas; 2.1 percent

TABLE 4-15

SUMMARY OF SAFETY 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 Safety 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	8.7
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	7.4[b]
Non-Urban:				
Dyersburg	3,273	204	33	1.1
Columbia	1,714	189	40	2.6
Morristown	3,856	302	100	2.8
Total Non-Urban Areas	8,843	695	173	2.1[b]
Combined Urban and Urban Areas	68,884	9,299	4,145	6.7[b]

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

[b]Weighted averages.

compared to 7.6 percent. The non-urban area of Dyersburg was lowest in safety belt usage by drivers with only 1.1 percent observed usage. 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 Morristown and Columbia, the other two non-urban locations.

Among the urban areas, Chattanooga had the highest driver safety belt usage rate (9.3 percent). The Tri-Cities urban area was expected to be closest to the non-urban 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).

Safety belt usage by drivers with small children in the vehicle with them was arranged in tabular form for comparison between target areas (Table 4-16). The rates of usage of safety belts by drivers with small children were somewhat different from the usage of all drivers observed. All urban areas, for example, had a 7.4 percent usage when a weighted average for the various sample sizes was made, but only 4.5 percentage when drivers with small children were taken as a subset of the larger data set.

A Chi-Square technique, with Yate's correction applied, was used to determine if drivers' decisions to use safety belts for themselves was independent of their decision to use CRD's for their children. A simple two by two matrix was used to arrange the two variables for significance testing. The number of users and non-users for each cell are shown in Table 4-17.

The null hypothesis that there was no relationship between drivers' decisions with respect to safety belts and CRD's usage must be

TABLE 4-16

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

	Number of Drivers with Small Children[a]	Number of Drivers Where There Was Undetermined Usage	Number of Drivers with Positive Determination of Safety Belt Usage	Percentage of Safety 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]
Non-Urban Areas	953	106	23	1.4
Total Urban and Non-Urban Areas	5,721	1,535	172	4.1[b]

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

[b]Weighted averages.

TABLE 4-17

RELATIONSHIP BETWEEN DRIVERS' SAFETY BELT USAGE AND CHILD RESTRAINT USAGE FOR THE BASELINE PERIOD

		CRD Usage		
	Decision	No	Yes	Total
Safety Belt Use By Drivers	Yes	84	66	150
	No	3335	264	3599
	Total	3419	330	3749

rejected. There was a significant relationship between drivers' decisions to use seat belts and their decisions to place their children in CRD's.

Table 4-17 shows fewer total observations and different percentages than Tables 4-16 due to missing and undetermined data. Data used in Table 4-17 includes those observations with positive determinations of usage/non-usage 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 safety belts was in doubt.

It was interesting to note the different percentages for the situations as shown in Table 4-18. The percentages were based on the number of observations of drivers where safety belt use was determined; of the number of drivers using safety belts 44.0 percent also place their children in CRD's. Those drivers not using safety belts and who had children under four with them, place their children in CRD's at only a 7.3 percent rate.

Summary

The purpose of this chapter was to obtain an assessment of the conditions surrounding restraint usage during a period of time prior to the implementation of a law and PI&E program promoting child restraint use. Several tables of baseline data were discussed to provide supporting information to the composite usage rate calculations found in Table 4-9, page 93.

TABLE 4-T8

PERCENTAGES OF RELATIONSHIPS BETWEEN DRIVERS' SAFETY BELT USE AND CHILD RESTRAINT USAGE FOR THE BASELINE PERIOD (ROW PERCENTAGES)

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

A sizeable number of vehicles (68,884) were observed during the baseline data in order to have a sufficient number of vehicles with small children. It was found that only 9.1 percent of those vehicles observed had small children 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 (53.6 percent) of the drivers with children under four were females. There were more females (58.9 percent) than male drivers observed with children using CRD's. Of the types of child restraints owned almost 93 percent are car seats and infant carriers. The car seat and infant carrier types account for 75.6 and 20.9 percent respectively of the four types used.

Since Nashville was selected as the only target area to receive a comprehensive PI&E treatment during the operational period of this study, a comparison of Nashville with other combinations of areas was made. Nashville was higher than other urban areas in the percentage of use of infant carriers (23.3 to 19.3 percent) compared to all types of CRD's. Nashville, however, was lower in percentage of use of car seats (69.9 to 78.3 percent for other urban areas).

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 a 11.8 percent usage compared to 6.5 for the non-urban 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 age four 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 and of the respondent and respondent's mate combined, and educational status of respondent, respondent's mate, and of the couple.

Safety belt usage of all drivers observed during the baseline data collection period was only 6.8 percent. The percentage of usage of drivers with small children was even smaller at 3.8 percent.

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

CHAPTER 5

ANALYSIS OF OPERATIONAL RESTRAINT USAGE DATA AND A COMPARISON TO BASELINE RESTRAINT USAGE DATA

The restraint usage data collected after the law and the PI&E program were operational for a period of approximately six months were analyzed. The same procedures as used in Chapter 4 were employed. Discussions made in Chapter 4 which applied to analyses for both the baseline and operational data are not repeated in this chapter.

The analysis of the operational restraint usage data included making comparisons to data collected during the baseline period. These comparisons were made to point out similarities and differences between the two periods.

It was important to know if the sample for each collection period 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 the 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. There were only two variables which seemed to be 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 two 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 comparitive purposes. The two samples generally represented parents between the 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 read; "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 a questionnaire with this question and nine other questions. More respondents failed to answer this question than any other; the response rate was 73.5 percent (1913 of 2504 baseline and 1350 of 1937 operational). Figure 5-1 depicts the comparison between the distribution of income levels in the baseline and operational samples and the general population.

The largest differences between the sample data and the established averages for family income for all Tennessee families was in

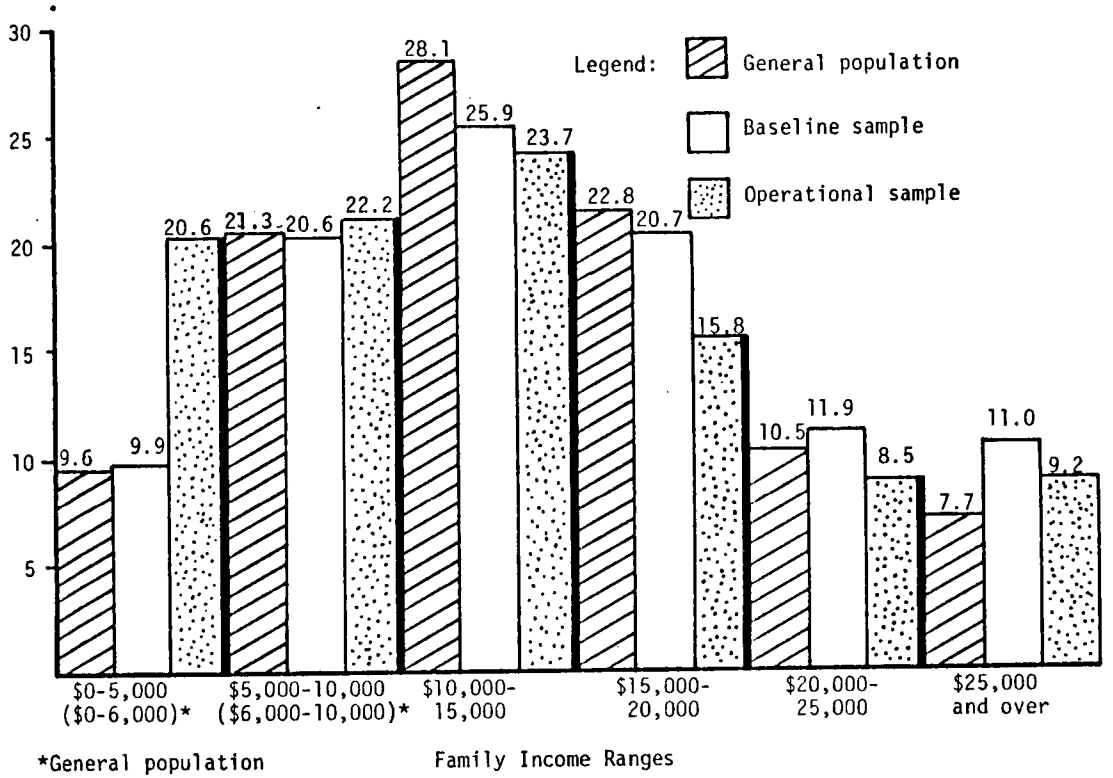


FIGURE 5-1

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

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

the "below $5,000" category. Because of the age difference in the sampled group and those of 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 data on family income were for 1976, since the question asked for income of "last year." The operational 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 operational periods compared favorably with each other, which was more important than a favorable comparion 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 asking an income level question, the response rate was only 84.9 percent. Comparisons of percentages of educational attainment for the two 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 may be illustrated (Figure 5-2). As with income levels, the lower portion of the scale was where the largest differences occurred. The age

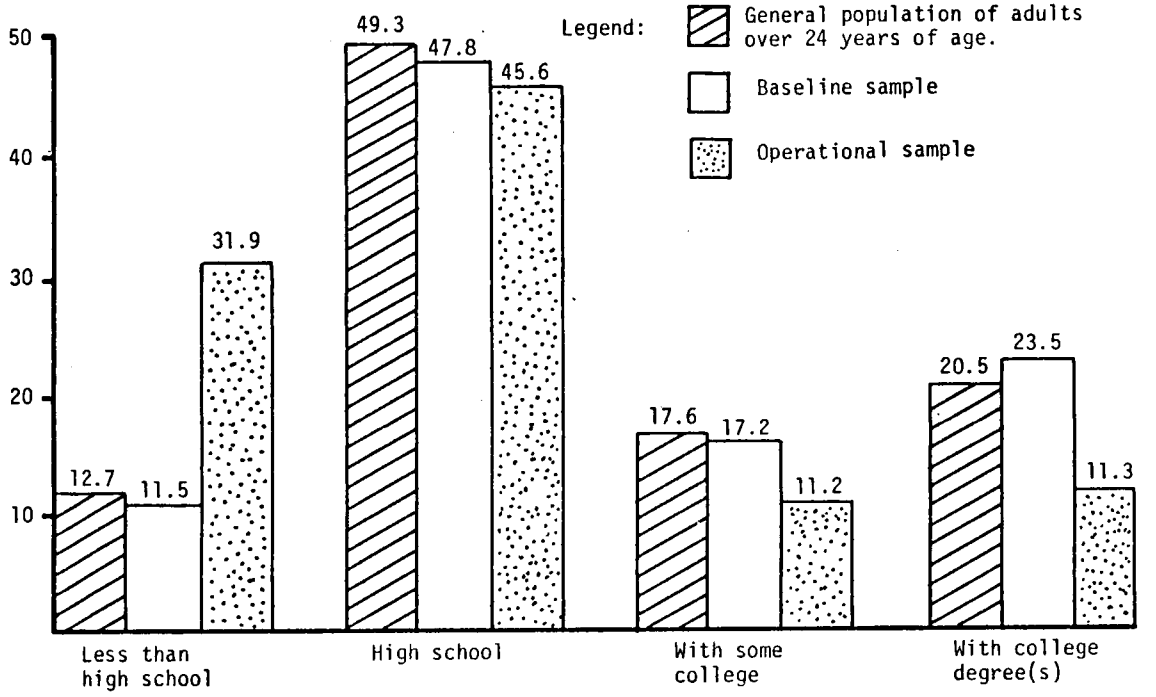


FIGURE 5-2

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

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

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 4 to facilitate observational comparisons of the two sets of data. The same format for discussion is used in this chapter as in Chapter 4 for comparitive purposes.

Tier One (Observational) Level Data

The total number of observations of small children was less for the operational data collection period because of the modified sampling plan which was implemented. The rationale for modifying the method of deciding the number of observations at each tier level is given in Appendix B. A tabulation was made of the total number of vehicles observed, the number with small children, and the percentages of vehicles with small children (Table 5-1). 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 percentages of vehicles with small children were highest for the Memphis target area (11.5 percent). This percentage was comparable to 11.1 percent for Memphis during the baseline period. Percentages for other target areas were also comparable for the two periods.

TABLE 5-1

SUMMARY OF OPERATIONAL 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
Non-Urban Areas	4,761	511	10.7
Total Urban and Non-Urban	40,559	4,379	10.8

[a]This number represents the total number of vehicles observed, including 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.

A summary of the number of children observed and percentages of their dispositions was made (Table 5-2). The summary includes only child #1 and child #2 although occasionally as many as three or four small children estimated to be under four were present in one vehicle. Approximately the same percentage of second children (child #2) was observed during the operational period as for the baseline; 12.4 percent (452 of 3659) compared to 12.8 percent. The percentage of use of CRD's by second children increased considerably between the baseline and operational periods; usage was only 1.9 percent for the baseline period but 5.1 for the operational. The percentage of second children being held by older passengers also increased from 5.8 to 9.1 percent.

Comparisons of the disposition of child #1 in the vehicle between the two periods showed 10.4 percent in CRD's for the baseline and 16.7 percent for the operational. 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 child being held by older passengers was up for the operational period, there was a decrease for first children (child #1) from 28.9 to 27.2 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 25.0 for the operational.

Tier Two Level Data

A total of 2,142 observations of children under four years of age were made in the tier two level for the operational period. This

TABLE 5-2

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

Target Area	Child No.	Number of Observations	In Child Restraing Device (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	2774	17.4	27.5	2.8	52.2
	2	367	5.7	10.6	1.1	82.6
Non-Urban Areas	1	433	12.2	25.4	1.8	60.5
	2	85	2.4	2.4	1.2	94.1
Total Urban and Non-Urban Areas	1	3207	16.7	27.2	2.7	53.4
	2	452	5.1	9.1	1.1	84.7

number included child #1 and #2 in the vehicle; it was rare that more than two children under age four were observed in the same vehicle. A total of 1,937 interviews of adults with children under age four were conducted at this level.

Children's Characteristics. A tabulation of the percentages of children by age and sex was made (Table 5-3). An examination of the percentages of children by age and sex for the two periods showed little difference overall. The major difference in the two data sets is between the percentages of children under age one in the non-urban areas. The baseline data on children under one year of age in the non-urban area showed a relative low percentage (15.8); the operational data for the same age group showed 22.4 percent which was closer to the two overall percentages of 21.6 for the baseline period and 22.6 for the operational period. Another variability in the data for the two periods was with the percentages of male and female children in the non-urban areas. The baseline percentage for females was 46.4 compared to 50.6 for the operational period.

Drivers' Characteristics. A summary of drivers' relation to children and drivers' sex is shown in Table 5-4. The percentage for each relationship of drivers to children remained relatively constant for the operational period as for the baseline period. The percentage of male and female drivers with children under age four remained almost exactly the same for the non-urban areas, but there was an increase in the percentage of female drivers in the urban areas over the baseline percentages; 50.9 percent for the baseline and 56.4 percent for the operational.

TABLE 5-3

SUMMARY OF AGE AND SEX OF CHILDREN AT TIER TWO LEVEL FOR THE 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
Non-Urban Areas	344	22.4	25.9	27.3	24.4	50.6	49.4
Total Urban and Non-Urban	2,142	22.6	27.6	26.4	23.3	50.3	49.7

*Children #1 and #2 only.

TABLE 5-4

SUMMARY OF DRIVERS' RELATION TO CHILD(REN) AND SEX OF DRIVERS
AT THE TIER TWO LEVEL FOR THE 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
Non-Urban Areas	297	80.1	15.5	3.7	0.7	277	67.1	32.9
Total Urban and Non-Urban Areas	1,925	86.2	10.9	2.6	0.3	1,812	58.0	42.0

*Includes child #1 and child #2.

A comparison of users and non-users of CRD's by drivers sex was made for the operational period (Table 5-5). Only minor differences were found in the percentages of males and females who used CRD's in the baseline period and in the operational period. Among all drivers not utilizing CRD's 57.9 percent during the operational period were females compared to 52.7 percent during the baseline. This increase may be attributed primarily to the increase in female non-users in the urban areas from the baseline to operational periods. The baseline data showed more male than female non-users of CRD's in the urban areas. The data collected after the law showed more females were non-users in urban areas.

Vehicle Information. Information collected during the operational period on the properties of vehicles parallel those collected prior to the law. These two sets of data are presented in Appendix I.

CRD Ownership, Types and Manufacturers. There was no noticeable difference in the percentages of types of CRD's owned when the two data sets for the two periods were compared (Tables 4-6, page 85 and 5-6). Information about manufacturers for the operational period is found in Appendix J.

Child Restraint Types. A comparison of CRD types by use/non-use for Nashville and a combination of areas was prepared (Table 5-7). This table was compared to the parallel table in chapter four (Table 4-7, page 87). The percentages of usage of CRD's for both periods were close. The protective shield types had some large increases; however, frequencies were still low for this type.

TABLE 5-5

COMPARISON OF MALE AND FEMALE DRIVERS AMONG USERS AND NON-USERS OF CRDs
AT THE TIER TWO LEVEL FOR THE OPERATIONAL PERIOD
(ROW PERCENTAGES)

Target Areas	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
Non-Urban Areas	272	43	79.1	20.9	229	65.5	34.5
Total Urban and Non-Urban Areas	1,755	405	58.8	41.2	1,350	57.9	42.1

*Includes Child #1 only.

TABLE 5-6

CRD OWNERSHIP BY TYPE, PERCENTAGES FOR THE OPERATIONAL PERIOD (ROW PERCENTAGES)

CRD Disposition	Number of Types Identified	Type: Infant Carrier Percent	Type: Protective Shield Percent	Type: Car Seat Percent	Type: Harness Percent
Overall Ownership	1095	14.3	6.1	78.2	1.4
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 5-7

COMPARISON OF CRD TYPES OBSERVED AT THE TIER TWO LEVEL FOR THE OPERATIONAL PERIOD (ROW PERCENTAGES)

Area(s)	Number of Observations of CRD's		CRD Type: Infant Carrier Percent	CRD Type: Protective Shield Percent	CRD Type: Car Seat Percent	CRD Type: Harness Percent
Nashville	Used	103	24.3	6.7	68.0	1.0
	Not Used	39	15.4	2.6	82.1	0.0
Other Urban Areas	Used	264	18.2	4.5	76.5	0.8
	Not Used	92	12.0	3.3	84.8	0.0
All Urban Areas	Used	367	19.9	5.2	74.1	0.8
	Not Used	131	13.0	3.1	84.0	0.0
Non-Urban Areas	Used	44	29.5	4.6	65.9	0.0
	Not Used	28	14.3	3.6	75.0	7.1
All Urban and Non-Urban	Used	411	20.9	5.2	73.2	0.7
	Not Used	159	13.2	3.1	82.4	1.3

Two noticeable changes occurred between the periods; of those CRD's observed in vehicles but not being used, the car seat type increased while infant carriers decreased. During the baseline period 75.4 percent of all CRD's not in use were the car seat type, but during the operational period this percentage climbed to 82.4 percent for all areas surveyed. This difference was more pronounced in Nashville where the baseline data showed 70.6 percent and the operational data showed 82.1 percent. Infant carrier percentages went in the opposite direction, from 23.5 to 15.4 percent non-usage for Nashville and from 20.4 to 13.2 percent for all target areas combined. The greatest difference occurred in the non-urban areas where non-usage dropped from 31.3 to 14.3 percent between the two time periods.

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

Child Restraint Usage Comparisons

A compilation of percentages of use at each tier level for each target area was made for the operational period (Table 5-8). A comparison of Table 5-8 with Table 4-8, page 89 showed 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 to 15.3 percent for tier one data and from 12.9 to 21.0 percent for tier two.

A composite usage percentage was calculated for the operational data using the equations discussed in Chapter 4 and Appendix L. The summary of the numbers of observations on which the calculations were

TABLE 5-3

PERCENTAGES OF 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
Non-Urban Areas	513	53	10.3	348	47	13.5
Total Urban and Non-Urban	3,654	558	15.3	2,169	456	21.0

based and the usage rates are shown (Table 5-9). The overall usage rate for the operational period was 17.5 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 to 22.1). Memphis had the least change between periods; 10.9 to 13.5 percent. All urban areas combined went from 11.8 to 18.4 percent usage. The non-urban areas had a 92 percent change from 6.5 to 12.5 percent in usage. Nashville was the only target area where the comprehensive PI&E program was implemented during this study. The comprehensive PI&E plan provided for a type of exposure of information about the law and the need for parents of small children to provide protection for them in motor vehicles which was different from the basic state plan. Each plan was designed to inform parents; the basic state plan involved getting informative brochures into the hands of parents of small children by making distribution to those places they would most likely be going with their child. The comprehensive plan, on the other hand, involved informing the general public by television, radio, billboards, and newspaper.

Changes in CRD 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 of 61.4 percent lived in the five major standard metropolitan statistical areas (SMSA's) of the state. The urban sample was

TABLE 5-9

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

Target Area	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	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]
Non-Urban Areas	287	62	286	521	12.5
Total Urban and Non-Urban Areas	370[c]	71[c]	291[c]	627[c]	17.5[d]

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

[b]See Appendix J.

[c]Averages

[d]Weighted averages.

taken at shopping centers which had market areas approximately coinciding with the SMSA's boundaries. Therefore, a weighted average based on population distribution was used to estimate that about 9.8 percent of those subject to the child passenger law were using CRD's during the period (baseline) before January 1, 1978.

The overall state usage rate utilizing the same rationale of weighting by percentage of population was 16.1 percent when measured in June of 1978. This represents an increase of 6.3 percentage points and a 64.3 percent change from the baseline condition.

Data collected approximately six months after the first collection revealed an increase in usage in each target area. Nashville had increased by 8.1 percentage points to 22.1 percent usage. Non-urban areas had increased to 12.5 percent (6.0 percentage points increase), and urban areas other than Nashville went to 17.3 from 11.3 percent. A comparison of the CRD usage rates are shown in tabular form (Table 5-10). The differences between periods were all significant at the 0.10 level or better. The comparison of usage rates increases between Nashville and the other urban areas was found to be insignificant. The actual difference was only 2.1 percentage points; there was 6.0 percentage point change for other urban areas and 8.1 percentage point change for Nashville.

There may have been several factors affecting the difference between the usage rate in the Nashville-Davidson SMSA area and the other urban areas. Because Nashville is the capitol of Tennessee, the site of all state legislative activities, residents of that area are exposed to current law making via the news media more so that the

TABLE 5-10

COMPARISON OF CRD USAGE RATES BEFORE AND AFTER THE LAW AND PI&E PROGRAM

Area	Percent Before	Percent After	Percentage Points Gained
Nashville	14.0	22.1	8.1
Other Urban	11.3[a]	17.3[a]	6.0
Total Urban	11.8[a]	18.4[a]	6.6
Non-Urban	6.5	12.5	6.0
State-wide	9.8[b]	16.1[b]	6.3

[a]Based on weighted averages of effective sample sizes of urban non-urban areas.

[b]Based on the weighted average of the residential population.

remainder of the state. The child restraint law was passed in the spring of 1977 and received news media coverage in Nashville. This along with other factors raised the awareness of the law in the Nashville area likely contributing to a higher initial rate than other areas. Supporting evidence to this conjecture is the fact that Columbia, which is not in the Nashville-Davidson SMSA area but close enough to receive news media coverage, had a substantial higher usage rate initially than did the other two comparable non-urban areas. Columbia had a CRD usage rate of 13.9 percent which parallels Nashville's 14.0, while the other non-urban areas of Dyersburg and Morristown had 2.5 and 5.9 percent usage respectively. Another factor may have been that other urban areas gained access and used PSA's intended only for Nashville for the first six months. This happened at least once during the operational period.

Contingency Table Analysis of CRD Usage

The same variables were chosen to be crosstabulated with child restraint usage for the operational period as were selected for analysis using baseline data. Comparisons of these two sets of analyses will be made in this section by characteristics of the children observed, family characteristics, vehicle information, and CRD type.

CRD Usage and Characteristics of Children. CRD usage was up considerably by age of child for the operational period over the baseline period as may be seen by comparing Table 5-11 with Table 4-10, page 95 in Chapter 4. There was an increase of approximately 10 percentage points in usage for each age group up to 3 years old where the difference was much smaller (6.1 to 7.5 percent). Age was, as with baseline

TABLE 5-11

CHILDREN CHARACTERISTICS VERSUS CRD USAGE RATES
FOR THE OPERATIONAL PERIOD

Characteristic	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
			107.3	<0.001
Age:				
<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.

data, again found to be a highly significant contributor to usage of CRD's.

The usage rates by sex of children were about the same as during the baseline period, and again 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 the age of four was a significant factor in determining CRD usage during the baseline period, but, as shown in Table 5-12, during the operational period 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. The percentage for one child being present and using CRDs changed from 12.8 percent for the baseline period to 21.6 percent for the operational period.

TABLE 5-12

CRD USAGE VERSUS NUMBER OF CHILDREN IN THE VEHICLE FOR THE 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	1636	21.6		
2	206	27.7		
3	15	26.7		

CRD Usage and Family Characteristics. Those family characteristics which were significant in determining usage were, 1) family income, 2) marital status, 3) number of children of age four and over in the vehicle, 4) number of adults in the vehicle, 5) employment status of respondent, 6) employment status of couple (respondent and respondent's mate combined), and 7) educational status of respondent, respondent's mate, and both respondent and mate (Table 5-13). The level of significance differed to some extent for all variables considered, but only one variable changed enough to go from being insignificant during the baseline period to significance for the operational period. The number of children of age four and older in the vehicle was shown to be insignificant during the baseline period but the

TABLE 5-13

FAMILY CHARACTERISTICS VERSUS CRD USAGE RATES FOR THE OPERATIONAL PERIOD

Characteristics	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->20,000	297	31.3		
Marital Status:			15.45*	0.001
Married/living with mate	1368	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		

TABLE 5-13 (continued)

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

TABLE 5-13 (continued)

Characteristics	Number of Observations	CRD Usage Rate Percent	Chi-Square	Significance Level
Educational Status of Respondent's Mate:			79.15	<0.001
o Less than High School	188	18.1		
o High School, G.E.D., and/or Vocational/Technical School	635	17.2		
o Some College (no degree)	242	25.6		
o College Degree(s)	322	42.5		
Educational Status of Couple:			73.41	<0.001
o Both, Less than High School	71	15.5		
o 1 with High School/Vocational Technical, 1 less than High School	170	18.8		
o Both with High School/ Vo-Tech/Some College	607	17.3		
o 1 with College Degree(s), 1 with less than College Degree	50	24.0		
o Both with College Degree(s)	427	39.3		

*Corrected Chi-Square.

percentages of usage were such during the operational period that this variable became significant at the .01 level relative to usage.

All the percentages of usage for the operational period for all variables measured and crosstabulated were expected to be greater. There were four sub-categories where this did not occur; when there were three children in the vehicle older than three, the usage rate (4.0 percent) was lower for the operational period than for the baseline (9.4 percent). The same was true with three adults present in the vehicle; the baseline usage rate was 7.7 percent and dropped to 2.7 for the operational period. A logical explanation may seem to be that usage declined because of more laps and arms available to hold small children not restrained in CRD's, but this logic is weakened somewhat by the fact that usage increased when there were four or more passengers over four years of age in the vehicle. The other two sub-categories where usage was lower during the operational period were for those respondents who classified themselves in either the student, retired or other group, or in the unemployed group.

CRD Usage and Vehicle Information. The "year of manufacture of the vehicle" was the only variable which changed from being an insignificant factor relative to CRD usage during the baseline period to one of significance for the operational period (Table 5-14). One contributor to the difference was possibly the fact that the operational data were collected approximately six months after the baseline data collection in which time more 1978 year models and fewer older vehicles were observed. During this period of time the percentage of owners of

TABLE 5-14

VEHICLE INFORMATION VERSUS CRD USAGE RATES FOR THE 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 Behicle:			8.77	.033
<69	160	16.3		
69-73	626	20.9		
74	185	24.3		
75-78	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
Sub-compact	157	31.8		
Compact	429	23.8		
Full Size	1,067	21.9		

TABLE 5-14 (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.

newer vehicles increased from 37.9 percent to 42.9 percent as is shown in Appendix I.

The only sub-category in which there was a decrease in the CRD usage rate was two-door station wagons in the body style category. CRD usage was 24.5 percent for two-door station wagons for the baseline period compared to 14.6 percent usage for the operational period. There is no apparent reason for this decline.

There were two substantial increases in usage between the two periods; CRD usage in observed AMC cars increased from 9.7 to 29.7 percent, however, there were only 31 and 37 observations for the baseline and operational periods respectively. Usage in sub-compacts increased from 15.8 to 31.8 percent.

CRD Usage Versus Child Restraint Types. CRD usage was crosstabulated with the four types of CRD's used (Table 5-15). This crosstabulation was compared to the one performed for the data collected during the baseline period. The chi-square significance testing for the operational data on types and usage showed that there was a significant difference in usage between the types used. Prior to January 1, 1978, the effective date of the law and PI&E implementation, there was no significant difference shown in usage with relation to types used. The frequency count for harnesses again was low as during the baseline period.

This comparison points out again that more parents/guardians purchased and used infant carriers during the operational period. The increased use of infant carriers may be attributed to the convenience of and relative ease of keeping infants in CRDs compared to relative difficulty with some toddlers.

TABLE 5-15

CRD TYPE VERSUS CRD USAGE RATES FOR THE 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		

Safety Belt Usage by Drivers

A total of 40,559 drivers were observed during the operational period (January through June 1978). A determination of whether the driver was using a safety belt was made in over 90 percent of the cases. This represents a small improvement (approximately 2.0 percent) over the baseline period.

The same pattern of lower safety belt usage in the non-urban areas held for the operational period of the study. The non-urban areas, however, did increase at a greater rate than did the urban areas; 2.1 to 3.6 (71.4 percent increase) for the non-urban areas and 7.4 to 8.1 (9.5 percent increase) for the urban areas (Table 5-16). There were two urban areas where the usage rate declined; Nashville (7.3 to 6.1) and Tri-Cities (6.7 to 5.3). The target area with the largest gain in usage between the baseline and operational periods was Knoxville (from a 8.7 percent rate to an 11.1 percent usage rate).

One objective of this study was to examine the relationship between the drivers' use of safety belts and children's use of CRD's 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 period in Table 5-17. These percentages were compared with those calculated for the baseline period (Table 4-16), and it was found that the percentage of usage of safety belts by drivers with small children increased substantially. Each target area experienced an increase in usage, with Knoxville having the

TABLE 5-16

SUMMARY OF SAFETY BELT USAGE BY DRIVERS
FOR THE OPERATIONAL PERIOD

Target Area	Number of Observations[a]	Number of Times Use was Undetermined	Number of Drivers Observed Using Safety 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	11.1
Tri-Cities	6,619	105	347	5.3
Total Urban Areas	35,798	3,200	2,658	8.1[c]
Non-Urban:				
Dyersburg	1,654	431	31	2.5
Columbia	1,145	53	38	3.5
Morristown	1,962	70	83	4.4
Total Non-Urban Areas	4,761	554	152	3.6[c]
Combined Urban and Non-Urban 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 5-17

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

	Number of Drivers with Small Children[a]	Number of Drivers Where There Was Undetermined Usage	Number of Drivers with Positive Determination of Safety Belt Usage	Percentage of Safety Belt Use by Drivers with Small Children
Memphis	531	131	47	11.8
Nashville	671	245	25	7.0
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]
Non-Urban Areas	498	142	10	2.8
Total Urban and Non-Urban Areas	3,531	1,132	220	9.2[b]

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

[b]Weighted averages.

greatest increase from 3.3 to 16.7 percent. The overall increase was from 3.8 to 9.2 percent.

A further investigation of the relationship between drivers' use of safety belts and children's use of CRD's was made by preparing a matrix to test for significance between the two variables (Table 5-18). The Chi-Square technique was used for the test as was done for the baseline data and discussed in Chapter 4. A significant relationship was found between the CRD and seat belt usage as was the case using baseline frequencies in the two-by-two matrix.

Using the frequencies in each cell of the matrix shown in Table 5-18, a table of percentages for the four situations was made (Table 5-19). Drivers who were observed as safety belt users had their children in CRD's also in 60 percent of the cases studied. This percentage compares to 44 percent for the period of time before the law. Only 16.1 percent of those drivers who had children under four with them and who were not using safety belts themselves were observed with children in CRD's in the vehicle. This percentage (16.1), however, is a vast improvement over the 7.3 percent for the baseline period.

Changes in Seat Belt Usage. It was hypothesized from the beginning of this study that seat belt usage would increase with an increase in child restraint 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 5-18

RELATIONSHIP BETWEEN DRIVERS' SAFETY BELT USAGE AND CHILD RESTRAINT USAGE FOR THE OPERATIONAL PERIOD

		CRD Usage		
	Decision	No	Yes	Total
Safety Belt Use by Drivers	Yes	48	72	120
	No	779	150	929
	Total	827	222	1049

TABLE 5-19

PERCENTAGES OF RELATIONSHIPS BETWEEN DRIVERS' SAFETY BELT USE AND CHILD RESTRAINT USAGE FOR THE OPERATIONAL PERIOD (ROW PERCENTAGES)

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

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 5-20. The table shows the percentages of usage for all drivers observed and for a subset of drivers to include only those with children under age four in the vehicle with them. The overall usage rate increased for the state based on the assumption that the urban samples represent the population which lives in Tennessee's major SMSA's (61.4 percent of total). The overall rate increased one percentage point from 5.4 to 6.4 percent. The comparison between periods for the driver subset was more dramatic, going from 3.3 to 7.4 percent. The urban areas other than Nashville showed the largest difference in seat belt usage for drivers with small children; the rate went from 4.0 to 11.4 percent. All the urban areas had increases, but Nashville showed the smallest increase, gaining only 0.5 percentage points from 6.5 to 7.0 percent usage. It should be recalled that Nashville decreased in overall usage of seat belts by all drivers observed. This phenomenon is difficult to explain in light of the fact that Nashville was the target area which experienced the largest increase in CRD usage in the six months period.

Summary

The analysis of restraint usage for the operational period (January through June 1978) has been presented in this chapter. The analysis included comparisons to the analysis of the baseline usage data as presented in Chapter 4.

The distributions of the baseline and operational income and education data were compared with each other and with the general

TABLE 5-20

SUMMARY OF SEAT BELT USAGE BY DRIVERS BEFORE AND AFTER THE LAW AND PI&E PROGRAM

Area	All Drivers		Driver with Children Under Age Four	
	Percent Before	Percent After	Percent Before	Percent After
Nashville	7.3	6.1	6.5	7.0
Other Urban	7.8[a]	8.7[a]	4.0[a]	11.4[a]
Total Urban	7.4[a]	8.1[a]	4.5[a]	10.3[a]
Non-Urban	2.1	3.6	1.4	2.8
Statewide	5.4[b]	6.4[b]	3.3[b]	7.4[b]

[a]Weighted averages based on sample sizes.

[b]Weighted average based on urban/non-urban population split.

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 1 and 2 year olds and slightly more females than males of the total number of observations of children.

A comparison of calculated composite usage rates for each period showed 17.5 percent for the latter period (operational) and 10.9 for the initial period (baseline). Nashville, the only target area with a comprehensive PI&E treatment during the operational period, had the biggest increase; 14.0 percent for the baseline period to 22.1 percent usage for the period after the law and implementation of the PI&E program. The non-urban areas experienced a 92 percent change in usage rates from 6.5 to 12.5 percent. Based on a weighted average of the residential population in Tennessee the statewide CRD usage rate increased from 9.8 to 16.1 percent (64 percent increase).

The pattern of seat belt usage by drivers remained the same for the operational period; lower usage rates for all drivers than for drivers with small children. There was also less usage in the non-urban areas than in the urban areas. The non-urban areas had a 3.6 percent usage of safety belts by drivers while the urban areas had 8.1

percent for the operational period. These figures represented a large percentage change (71.4 percent) for a small percentage point increase from 2.1 to 3.6 for the non-urban areas, but a small change (9.5 percent) for approximately the same percentage point change from 7.4 to 8.1 for the urban area. The change in usage rates for drivers with small children between the two periods was greater than for all drivers. The change in seat belt usage rates for drivers with small children went from 4.5 to 10.3 percent in the urban areas, while the non-urban areas had a doubling of usage percentage from 1.4 to 2.8 percent. Generally, the subset of drivers, those with small children, had a lower initial usage than the set of all drivers. The rates measured after approximately six months, however, showed the subset with a greater overall seat belt usage rate than the entire set.

The relationship between drivers' use of safety belts and children's use of CRD's, 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 safety belt users and who also had children in the vehicle in CRD's increased between the two time periods; there were 44 percent during the baseline and 60 percent for the operational. On the other hand, those drivers not using safety belts used CRD's for the children with them at only a 16.1 percent rate, but this percentage is more than a 100 percent improvement over the 7.3 percent for the baseline period.

CHAPTER 6

ANALYSIS OF THE CHARACTERISTICS OF USERS AND NON USERS OF CHILD RESTRAINTS

The previous two chapters involved an examination of restraint usage. Chapter 4 was primarily devoted to a discussion of the analysis of restraint usage characteristics for the baseline period to give an assessment of the pre-law situation. A similar analysis and discussion was made of restraint usage using the operational period data. That discussion, which included a comparison of the difference in CRD usage rates between the two periods, appeared in Chapter 5. This chapter is a report of a more detailed study of the characteristics of users of child restraint devices. Those variables which were found to be significant contributors to CRD usage in the analyses of Chapter 4 and 5 were examined more fully by utilizing two statistical methods, discriminant analysis and partial correlation analysis.

The objectives of this analysis are 1) to determine if there is a set of characteristics which significantly distinguishes between users and non-users of CRD's, 2) to determine the relationship between selected significant variables and CRD usage (the dependent variable) when the effect of two socio-economic variables (educational level and family income) are adjusted for, and 3) to provide a profile of the characteristics of users and non-users.

Analysis of CRD Usage

Two statistical analyses were employed to examine CRD usage; discriminant analysis was the method used to accomplish the first

objective previously mentioned, 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 non-users 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 non-user group such 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 1) target groups toward which specific attention may be given, and 2) behaviorial characteristics of users which should be promoted among non-users.

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 4 and 5 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 varibles which were found to be individually significant at the .05 level or better from the contingency table analyses in Chapters 4 and 5 formed the basis for the list. Added to the list were two variables which were not discussed in Chapters 4 and 5; seat belt usage by passengers and driver relation to child (child #1) were found to have potential contributing influences on CRD usage when tested for significance. The full list of candidate variables which were identified for further analysis are summarized with their respective significance levels from previous tests for each period in Table 6-1.

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 (DISCRIM) of the Statistical Package for the Social Sciences (SPSS) 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 6-2.

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 will 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 respondent's

TABLE 6-1

LIST OF CANDIDATE VARIABLES

Variable	Significance Level	
	Baseline	Operational
Family Income	<0.001	<0.001
Educational Attainment of Respondent	<0.001	<0.001
Educational Attainment of Respondent's Mate	<0.001	<0.001
Age of Child (Child #1)	<0.001	<0.001
Vehicle Ownership	<0.001	<0.001
Number of Vehicles Owned	<0.001	0.041
Number of Adults in Vehicle	0.008	0.001
Employment Status of Respondent	0.001	0.001
Marital Status	0.018	0.001
Driver Relationship to Child (Child #1)	0.001[a]	0.001[a]
Seat Belt Usage of Passenger Other Than Small Children	0.001[a]	0.001[a]

[a]Determined by Correlation Analysis (zero order).

TABLE 6-2

SELECTED VARIABLES FOR DISCRIMINANT ANALYSIS
(Univariate F Ratios)

Variable	F Ratio, Rank Order			
	Baseline		Operational	
Seat Belt Usage of Passengers in Vehicle with Child	148.02	1	124.42	1
Educational Attainment of Respondent	67.54	2	51.67	3
Educational Attainment of Respondent's Mate	66.24	3	71.97	2
Number of Adults in Vehicle	31.32	4	25.13	4
Family Income	31.25	5	15.76	6
Vehicle Ownership	14.16	6	8.82	8
Driver Relationship to Child (Child #1)	14.02	7	10.95	7
Age of Child (Child #1)	13.50	8	8.54	9
Number of Vehicles Owned	10.90	9	0.95	10
Marital Status	6.08	10	16.41	5
Employment Status of Respondent	4.07	11	0.01	11

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. This category includes both married and single parents, friends, relatives and others.

Another variable deleted from consideration as one of the set to enter discriminant analysis was employment status of respondent. Not only was this variable partially a function of family income and educational attainment, but it was also among the most sensitive (along with income and education) on the questionnaire. Since there was a large number of missing data for this variable, it was deleted. 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 on partial correlation results. Partial correlations were run on selected variables. 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 both periods and which rank high among all the variables

considered measured by the univariate F value. The seven chosen to be used as a set for the discriminant analysis are shown with partial F values and rank order of importance in Table 6-3. These seven represent about 68 percent of all observations using baseline data and about 60 percent of all operational observations. 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 insure an α level of at least .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 usage for both periods. The correlation matrix for the seven selected independent variables along the dependent variable, are shown (Tables 6-3 and 6-4). 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 also shown with univariate F values (Table 6-3).

Among the predictor variables the ones with the strongest relationship between them were family income and educational level. The variables "passengers 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. The lowest correlations were found among age of child and family income, educational attainment of respondent and passengers use of seat belts.

TABLE 6-3

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	1.000	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 6-4

CORRELATION MATRIX FOR SEVEN INDEPENDENT VARIABLES AND CHILD RESTRAINT USE FOR THE OPERATIONAL 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	0.3077	0.2017	0.1179	0.0868	0.0808	0.1451	0.0984
Seat Belt Usage of Passengers	0.3077	1.000	0.2339	0.0595	0.0529	0.0619	0.1477	0.0676
Educational Attainment of Respondent	0.2017	0.2339	1.000	0.0329	0.0247	0.0484	0.4456	0.0506
Number of Adults in Vehicle	0.1179	0.0595	0.0329	1.000	0.0201	0.1245	0.1134	0.1928
Age of Child	0.0868	0.0529	0.0247	0.0201	1.000	0.1502	0.0108	0.0099
Driver Relation to Child	0.0808	0.0619	0.0484	0.1245	0.1502	1.000	0.0736	0.1707
Family Income	0.1451	0.1477	0.4456	0.1134	0.0108	0.0736	1.000	0.1436
Vehicle Ownership	0.0984	0.0676	0.0506	0.1928	0.0099	0.1707	0.1436	1.000

Results. The seven variables chosen for the analysis were all significance contributors to CRD usage when taken individually. Five of the seven variables were found to be significant indicators of CRD usage in Chapters 4 and 5 when the chi-square method was used. These five variables showed significance again when discriminate analysis was applied using only one variable at a time. The remaining two variables, driver relation to child and seat belt usage of passengers, were not discussed in the previous chapters but showed significance at the .001 level for both periods when tested one at a time against CRD usage by the discriminant analysis procedure. Table 6-2 showed the significance level for each variable tested individually in the discriminant analysis.

When taken as a set, the seven variables had an overall F ratio of 31.26 for the baseline period and 24.67 for the operational period. Because of the reduced number of variables in the analysis, the overall F values were recalulated using the degrees of freedom associated with the original number of variables. The significance levels were not changed from being <0.001 level with the new F values. This was true using both baseline and operational data.

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 6-5. 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.

Except for driver relation to the child (child #1) in the operational period all variables contributed in detecting significant

TABLE 6-5

RESULTS OF DISCRIMINANT ANALYSIS

Variable	Rank Order of Importance		Semi-Partial F Ratios	
	Baseline	Operational	Baseline	Operational
Seat Belt Usage of Passengers in Vehicle with Child	1	1	141.76	120.75
Educational Attainment of Respondent	2	2	30.31	23.15
Number of Adults in Vehicle	3	3	17.31	12.39
Age of Child (Child #1)	4	4	14.12	5.99
Driver Relationship to Child (Child #1)	5	7	5.06	0.19
Family Income	6	6	2.89	1.37
Vehicle Ownership	7	5	1.41	4.07

differences between users and non-users. Family income was the fifth variable to enter the analysis for both the baseline and operational data. The driver's relationship to the child was more important in detecting a difference between the group using baseline data than for operational data. The reverse was true for the variable that measured vehicle ownership.

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 about the influence of socio-economic 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 varibles 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 socio-economic variables which were expected to affect usage rates, directly or indirectly. It is evident from Chapters 4 and 5 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 are shown for the baseline data in Table 6-6. The computed correlation coefficient at zero order between passenger seat belt usage and CRD usage was .2807, but when adjusted by partialling out the effect of income and education, the correlation coefficient was reduced to .2437. 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 CRD's. 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 .0755 with the significance level at 0.001. The partial correlation coefficient adjusting for income reduced to 0.0564; adjusting for both income and education the coefficient did not reduce much further (.0515). The significant level changed from .001 to a .013 level 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

TABLE 6-6

SUMMARY OF RESULTS OF PARTIAL CORRELATION ANALYSIS--BASELINE PERIOD
(CRD USAGE WITH X_1 BY X_2, X_3)

X_1	Variable X_2	X_3	Correlation Coefficients (Level of Significance)			
			Zero Order	1st Order, Controlling for: Family Income	1st Order, Controlling for: Educational Attainment	2nd Order Controlling for: Family Income and Educational Attainment
Passenger Use of Seat Belts	Family Income	Educational Attainment	.2807 (.001)	.2648 (.001)	.2467 (.001)	.2437 (.001)
Vehicle Ownership	Family Income	Educational Attainment	.0755 (.001)	.0564 (.008)	.0583 (.006)	.0515 (.013)
Number of Vehicles Owned	Family Income	Educational Attainment	.0802 (.001)	.0391 (.047)	.0550 (.009)	.0391 (.047)
Make of Vehicle	Family Income	Educational Attainment	.0625 (.004)	.0565 (.009)	.0379 (.056)	.0387 (.053)
Year of Vehicle	Family Income	Educational Attainment	.0500 (.019)	.0061 (.400)	.0116 (.315)	.0051 (.416)

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 .0802; 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 "year of vehicle" was spurious for the baseline period, which means the variable explained no variation without income and education and became insignifant when their effects were eliminated. The relationship of either income or education with the variable was enough to create the spurious correlation between year of vehicle and CRD usage. The significance level went to .40 without impact of income and to .315 without education. The combination of the two being eliminated changed the level to .416.

The partial correlations for the operational data were much like the ones for the baseline (Table 6-7). There were three spurious relationships; year of vehicle, (as in the baseline period), number of vehicles, and make of vehicle. The "make of vehicle" variable was recorded for both 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 foreign vehicle owners than American made vehicle owners. Educational level was the variable which caused the greatest reduction in the correlation coefficient.

An aspect of the partial correlation analysis of particular importance was the examination of the level of significance changes

TABLE 6-7

SUMMARY OF RESULTS OF PARTIAL CORRELATION ANALYSIS--OPERATIONAL PERIOD
(CRD USAGE WITH X_1 BY X_2, X_3)

X_1	Variable X_2	X_3	Correlation Coefficients (Level of Significance)			
			Zero Order	1st Order, Controlling for: Family Income	1st Order, Controlling for: Educational Attainment	2nd Order Controlling for: Family Income and Educational Attainment
Passenger Use of Seat Belts	Family Income	Educational Attainment	.2964 (.001)	.2814 (.001)	.2631 (.001)	.2607 (.001)
Vehicle Ownership	Family Income	Educational Attainment	.0996 (.001)	.0829 (.001)	.0916 (.001)	.0859 (.001)
Year of Vehicle	Family Income	Educational Attainment	.0707 (.008)	.0300 (.152)	.0184 (.263)	.0075 (.398)
Number of Vehicles Owned	Family Income	Educational Attainment	.0470 (.047)	.0013 (.481)	.0195 (.243)	.0040 (.444)
Make of Vehicle	Family Income	Educational Attainment	.0240 (.199)	.0175 (.269)	.0009 (.488)	.0008 (.489)

the effects of various combinations of variables for the two periods. The make of vehicle, for example, was a significant variable in influencing CRD usage when it was taken in combination with other independent variables considered during the baseline period, but it was insignificant when using the variables during the operational period. It was also insignificant when adjusted for both income and education (significance level was .053). The contrast in the analysis using the operational period data showed the variable "make of the vehicle" insignificant with a .489 significance level.

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 significant when adjustments were not made for income and education to being insignificant when adjustments were made.

This indicates that the effects of income and education on the number of vehicles owned was enough to make the significance occur. This variable had a spurious relationship with the dependent variable using operational data. The other variable (year of vehicle) with spurious relationships during the baseline and operational period was the same; insignificant without the effects of income and education.

Profile of Users and Non-Users

Profiles of CRD users and non-user of child restraints were made to better 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 non-users of CRD's were selected and the importance of their effect on CRD usage was examined. All the characteristics are linear with respect to CRD usage and therefore a determination was made as to which end of the line a subject should be placed. Table 6-8 shows the profiles of CRD users and non-users for the variables considered. Variables which were analyzed by discriminant analysis, partial correlation, or by 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 obtainment 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 not used in the partial correlation analysis but remained significant for both periods after discriminant analyses were categorized as primary characteristics.

Prediction of CRD 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 his/her decision to use CRD's was significant. There are variables which affect the relationship between CRD usage and seat belt usage as was evidenced from partial

TABLE 6-8

PROFILES OF USERS AND NON-USERS OF CHILD RESTRAINTS

Characteristics	Users	Non-Users
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 1	Most Likely 1
4. Year of Vehicle (Spurious)	Owner of Newer Vehicle	Owner of Older Vehicle

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 crosstabulations of the two variables with a third variable. An illustrative example of the results of crosstabulation of CRD usage by seat belt usage of drivers with small children by educational attainment level of the respondent may be shown in Figure 6-1.

The "seat belt usage by driver" variable was dichotomous as was CRD usage. The third variable, "educational attainment of respondent," was categorized into three groupings of 1) less than high school, 2) high school diploma but no college degree, and 3) college degree or degrees. As expected, the non-seat belt user with the lowest level of educational attainment had the lowest CRD usage rate. The other extreme revealed the opposite; a safety belt user with the highest level of education had the highest CRD usage rate. The range of CRD usage was from 4.1 percent to 69.2 percent. The category of seat belt user with less than high educated had limited responses, but with those few the percentage of usage fell in line with the others.

Summary

Several variables were determined to be discriminating in distinguishing between users and non-users of CRD's. Seat belt usage by passengers other than small children was the single most important variable which helped to identify the users and non-users. Using 11 variables for "discriminating" between the groups it was found that a

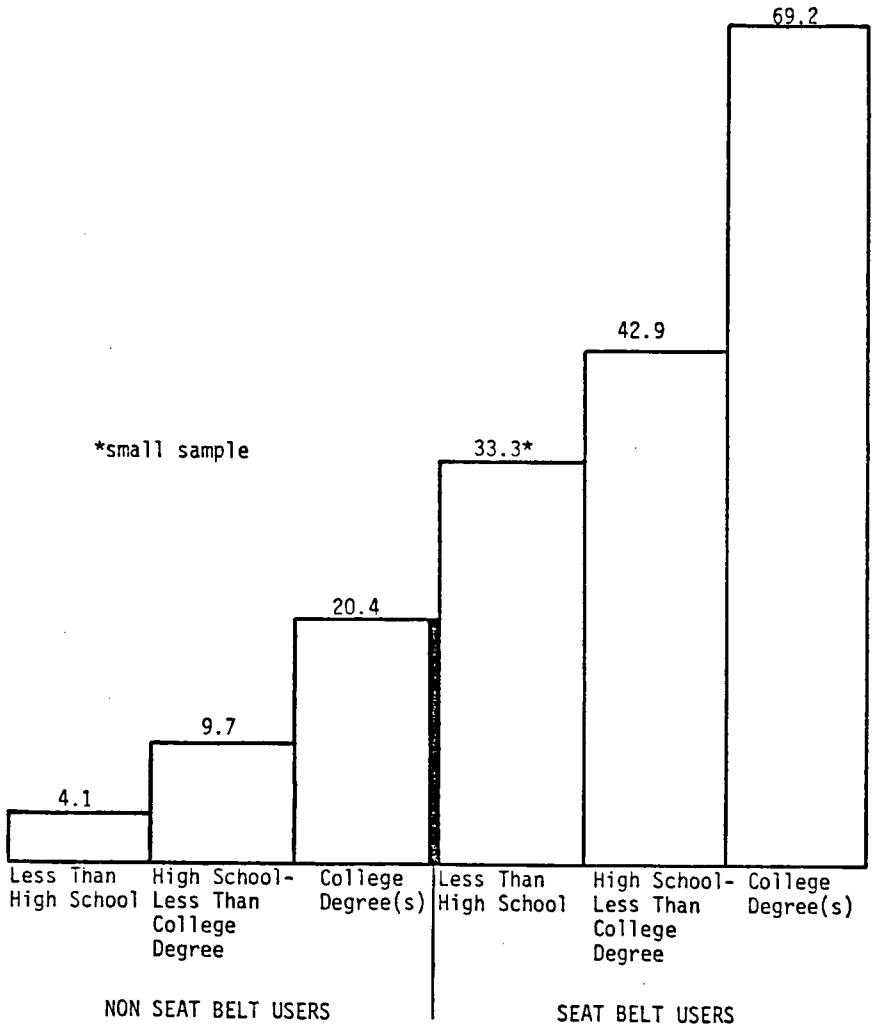


FIGURE 6-1

CRD USAGE BY SEAT BELT
USAGE AND EDUCATIONAL ATTAINMENT

CRD user is more likely to 1) be wearing a seat belt, 2) have a higher educational level, 3) had fewer passengers in the vehicle, 4) be transporting younger child(ren), 5) be the parent of the child, 6) have a higher income, 7) be the owner of the vehicle, 8) be employed or a homemaker, 9) be married or living with a mate, 10) be the owner of more than one vehicle, and 11) own a newer vehicle than did non-users.

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 for in the analysis, it was found that a spurious relationship existed between "year of vehicle" and CRD usage for both periods. There was also spurious correlations between independent variables the "make of vehicle" and "number of vehicles owned" and the dependent variable (CRD usage) during the operational period.

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 CRD's were wearing safety belts themselves more often than those observed with children not using CRD's. 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 CRD's 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 child restraint usage in vehicles which had other passengers wearing seat belts.

The socio-economic 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. The variables which were useful in distinguishing between users and non-users but to a lesser degree were 1) employment status of respondent, 2) marital status, 3) number of vehicles owned, and 4) year of vehicle.

CHAPTER 7

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 how much the rate of deaths and serious injuries has been reduced over a period of time. For the short-term 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.

Accident Analysis

The analysis of accidents involving injuries of one kind or another was performed by examining the data in six-month increments. 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 researched.

The data on non-fatal injury accidents were furnished by the Tennessee Department of Safety. Fatal accident injury data were also furnished by the Tennessee Safety Department 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 age four are shown in Tables 7-1 through 7-4. An examination of the number of

TABLE 7-1

ACCIDENT INJURIES TO CHILD PASSENGERS UNDER AGE FOUR
BY SIX-MONTH PERIODS (1975-1978)

Year	Injury Severity[a]		
	Minor	Major	Fatal
1975-1	331	94	7
1975-2	369	88	10
1976-1	390	78	8
1976-2	448	128	5
1977-1	360	60	7
1977-2	462	81	9
1978-1	396	77	6

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

Note: 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 proportionately distributed to all categories.

Source: Tennessee Department of Safety Data Files

TABLE 7-2

FATAL INJURIES TO CHILD PASSENGERS UNDER AGE FOUR BY CALENDAR SIX-MONTH PERIODS AND AGE (1975-1978)

Year	Fatalities By Age				Total
	Under 1*	1	2	3	
1975-1	2	2	2	1	7
1975-2	3	3	1	5	10
1976-1	1	1	1	2	8
1976-2	1	1	0	2	5
1977-1	1	1	3	1	7
1977-2	2	2	2	1	9
1978-1	2	2	0	1	6

*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 proportionately distributed to all categories.

Source: Tennessee Governor's Highway Safety Office Report to the National Center for Statistics and Analysis (NCSA), NHTSA, U.S. Department of Transportation.

TABLE 7-3

SERIOUS NON-FATAL INJURIES TO CHILD PASSENGERS UNDER AGE FOUR BY SIX-MONTH PERIODS BY AGE (1975-1978)[a]

Year	Age of Child				Total
	Under 1[b]	1	2	3	
1975-1	17	17	27	33	94
1975-2	15	15	32	26	88
1976-1	12	12	28	26	78
1976-2	21	21	42	44	128
1977-1	11	11	25	23	60
1977-2	15	15	28	23	81
1978-1	17	17	18	25	77

[a]Serious injuries are defined as those reported as major 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 the categories.

Source: Tennessee Department of Safety Data Files

TABLE 7-4

MINOR INJURIES TO CHILD PASSENGERS UNDER AGE FOUR
BY SIX-MONTH PERIODS BY AGE (1975-1978)[a]

Year	Age of Child				Total
	Under 1[b]	1	2	3	
1975-1	67	67	106	91	331
1975-2	69	69	126	105	369
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

[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

injury accidents in each category for each half-year revealed no significant changes. More accidents occur during the summer months when the amount of travel is increased. The large difference between 1976-2 and 1977-1 is partially accounted for by this factor. When comparing the first half of each calendar year only small differences occur.

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 age four. 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. The number of minor and major injuries were up from the same period in 1977 but in line with the 1976 results. 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 age four has remained steady over the last four years when comparing the first half-year data. Tables 7-1 and 7-3 reflect the total number of serious injuries and the number by age for the years 1975-1978. There is little difference between the number of serious injuries for those years.

Minor injuries appear to have decreased for two year olds during the first six months of 1978 (Table 7-4). Minor injuries were up

substantially for smaller children (less than two year old) during the same period (January-June 1978). The number of minor injuries to three year olds remained stable when comparing the first six-month periods of each year investigated.

A further investigation was made of the number of accidents in an attempt to better understand why increased CRD usage has no obvious effect on the number of injuries. The percentages of injury accidents to children under age four of all injury accidents (including fatal injuries) were calculated for each of the six-month periods investigated. These percentages were tabulated for comparative purposes (Table 7-5). The proportion of minor and major injuries to all injuries to children under age four was also calculated (Table 7-5). Only a small percentage (approximately 6 percent) of all injury accidents involve children under four years of age, and of this small percent only about 15 percent are injured seriously (Table 7-5). 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. While there was one less fatality for the first six months of 1978 than for the same period in 1977, and there were newspaper reports of children being safe in CRD's in accidents in 1978, there was insufficient evidence to prove any significant change.

It was not in the scope of this study to research the investigative details of accidents such as whether or not the child was in a CRD. It was found that over 80 percent of all injuries are minor, and

TABLE 7-5

PROPORTIONS OF ACCIDENT INJURIES TO CHILDREN UNDER AGE FOUR

Year	Percentage of Injuries to Children Under Age Four of All Accident Injuries	Percentage of Major Non-Fatal Injuries of Total Injuries to Children Under Age Four	Percentage of Minor Injuries of Total Injuries to Children Under Age Four
1975-1		21.8	76.6
1975-2	5.4[a]	18.8	79.0
1976-1		16.4	81.9
1976-2	5.2[a]	22.0	77.1
1977-1		14.1	84.3
1977-2	5.7[a]	14.7	83.7
1978-1	5.7	16.1	82.7

[a]Percentage for entire year

although it is important to reduce minor injuries, the primary emphasis is to reduce fatalities and serious injuries which may cause or lead to death or life-long disablement.

Summary

An investigation of accident injuries to small children for the years 1975 through 1977 and for the first half-year of 1978 was made. It was found that there was no significant changes in the number of fatalities or major injuries when comparing first half-year numbers for four years (1975-1978). Although there was one less fatality reported for the first six months of 1978 than for the same period of time in 1977, no inference can be made that the law and/or the PI&E program was the reason for the small reduction.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

The overall objective of this research 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.

This study is a part of a larger study to research the effectiveness of the law in conjunction with PI&E programs over a longer period of time (two and one-half years). The report of the conclusions and recommendations drawn here are for a relatively short period of time (six months) after implementation of the law and PI&E program. The term "significant" as used in these conclusions means at the .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 only one target area (Nashville) for the study. The lower intensity level, the basic state plan, was used statewide. An evaluation was made of the two levels by comparing the Nashville target area with like urban target areas. There were factors which may have slightly influenced the usage rates in both Nashville and the other urban areas, and which were practically uncontrollable. These factors included some leakage of information to other metropolitan areas which

only Nashville was to receive, and individual programs in the urban areas, both of which were outside the design of this study.

The results of this study should have application for future programs in Tennessee and elsewhere. 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 child restraint devices was increased in Tennessee after implementation of a law and a public information and education program promoting child passenger safety. This conclusion is based on evaluation after six months of operation assuming no seasonal variation.

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

2. Conclusion: The increase in CRD usage was not enough to show significant reductions in fatalities or serious injuries based on the accident data analysis for the six-month increment of time.

Recommendation: The reduction in fatalities should not be considered as a measure of effectiveness for such a short period (six months) of time because of the low frequencies in this category. A longer period of time should be used for evaluation purposes.

3. Conclusion: The proportion of children under four being held by older passengers in the vehicle was relatively high and did not change significantly after the implementation of legislation and the

PI&E program; 25 percent for the base line period and 26 percent for the operations period.

Recommendation: The law should be changed by deleting the so called "babes in arms" amendment which allows older passengers to hold a child under age four. This measure could decrease the number of children being held and increase the number using child restraints.

4. Conclusion: There was an increase in seat belt usage by all drivers observed between the baseline and operational measurement periods. The change was only slight for all drivers, but when a subset of drivers who had small children with them was measured, the change was greater. Drivers who were users of seat belts tended to protect their children by placing them in CRD's. There was a significant relationship between drivers' decision to use seat belts and their decision to place their children in CRD's. Drivers with children under age four were more concerned with occupant safety than drivers with no children under age four.

Recommendation: To increase the usage rates of both seat belts and CRD's a passenger restraint usage law for all vehicle occupants should be passed and strictly enforced.

5. Conclusion: The variables which best distinguish between users and non-users of CRD's were identified. Using these variables as descriptors a non-user, when compared to a user of CRD's, is 1) less likely to be wearing a seat belt, 2) likely to have a lower educational attainment level, 3) likely to have more passengers in the

vehicle, 4) likely to be transporting older children (of the under age four group), 5) less likely to be the parent of the child, 6) likely to be in a lower income bracket, and 7) less likely to own the vehicle.

Recommendation: Since there is a much larger percentage of non-users than users of CRD's, the focus of PI&E campaigns should be directed toward the target group which fits the model of the non-user.

6. Conclusion: The comprehensive PI&E treatment as used in Nashville for the operational period (six months) of this research was not significantly more effective in increasing CRD usage than the basic state plan used in the other metropolitan areas.

Recommendation: The comprehensive plan should be continued in Nashville and evaluated for an additional period of time.

7. Conclusion: The results of this study indicate that a short period (six-month) evaluation of the impact of a child passenger safety law and PI&E program on highway safety is limited in its effectiveness because of low frequencies in the fatality category and inability to account for seasonal variation in travel.

Recommendation: An evaluation of the effectiveness of a passenger safety law and an accompanying PI&E program should be made for a longer period of time than six months.

8. Conclusion: The impact of the law and PI&E program has been moderate for a six-month period. Based on the results of this research the overall estimated CRD usage for the state went from 9.8 percent

for the baseline period to 16.1 percent usage for the operational period. The use in the urban areas was higher (11.8) percent) than the non-urban (6.5 percent) for the baseline period, but each increased about the same in percentage points (6.6 and 6.0 respectively). Although the percent increase is high, the level of usage reached was too low to have a significant impact on child passenger safety in a six-month period.

Recommendation: To aid in substantially increasing the CRD usage to a level to have a greater impact on child passenger safety in the State of 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" (see Appendix A).

b. The law needs to be more rigidly enforced. A special plea should be made to all law enforcement agencies in Tennessee to cite those observed in violation of the law as it now reads. Along with the enforcement the news media should be encouraged to make an increased effort to inform the public that citations are being issued.

c. An endeavor should be made to notify judges of the need to convict offenders.

d. The fine of two to ten dollars mandated by the law should be substantially increased. Although the court costs are added to the fine, which increases the penalty, a fine equivalent to the approximate average cost of a CRD or proof of purchase of an approved CRD is recommended to further deter potential offenders.

e. A safety belt usage law should be passed by the legislature and rigidly enforced.

f. The basic state PI&E plan needs to be continued and monitored closely for maximum effectiveness.

g. The involvement of selected civic organizations and individuals should be sought to aid in informing the public about passenger protection.

h. The medical profession should be urged to view the prevention of motor vehicle accident injuries as it does the prevention of a child disease and highly encourage parents provide for the protection of their children.

i. One organization should be designated as a clearinghouse of information and coordination of activities for the promotion of child passenger safety.

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APPENDIXES

APPENDIX A

STATE OF TENNESSEE CHILD PASSENGER PROTECTION LAW

1977

CUMULATIVE SUPPLEMENT

TENNESSEE CODE ANNOTATED

The Compilation of the Public Acts of the Sessions of the Eighty-sixth General Assembly through the First Session of the Ninetieth General Assembly

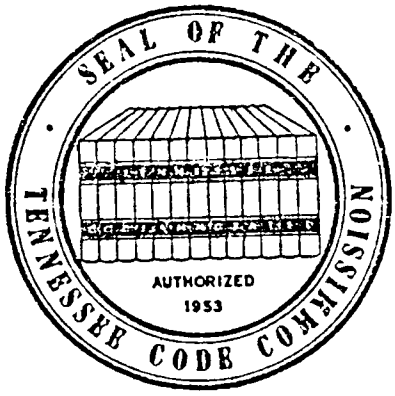
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Completely Annotated

VOLUME 10A

1968 REPLACEMENT

Prepared under the Supervision of the Tennessee Code Commission



ROBERT E. COOPER, Chairman
JAMES A. CLODFELTER, Executive Secretary
WILLIAM J. HARBISON
BROOKS MCLEMORE
PAUL R. SUMMERS

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

RATIONALE FOR SELECTION OF SAMPLE SIZES

Based on the presupposition that the baseline usage rate would be low (5 percent) and would change only 3 percent to 8 percent for the operational period, 400 observations were chosen as the sample for the baseline period. This number was needed to be able to show significance at the 0.10 level of confidence.

This number was to be 400 "matched" data, that is tier one and tier two data were identified by license tag number as being information obtained from the same vehicle. The same size sample was called for during the operational period for the basic plan target areas, except the required number of matched data was less. For the operational sample the age adjusted tier one observations were given equal weight with the tier two level observations. 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

TOTAL 400

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 rationalism for using fewer matched data during the operational period was the experience gained during baseline sampling. Tier one data could be predicted as to how many would be age adjusted and approximately how many refusals there would be. It was also found from baseline experience that tier one data was more reliable than anticipated before the baseline period.

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. This type error may be adjusted for and more tier one observationed used than was the case for the baseline period. This can be done without being detrimental to the sample size.

The attachment to the following letter is an explanation of the basis for selecting the sample sizes for the larger research project.

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:

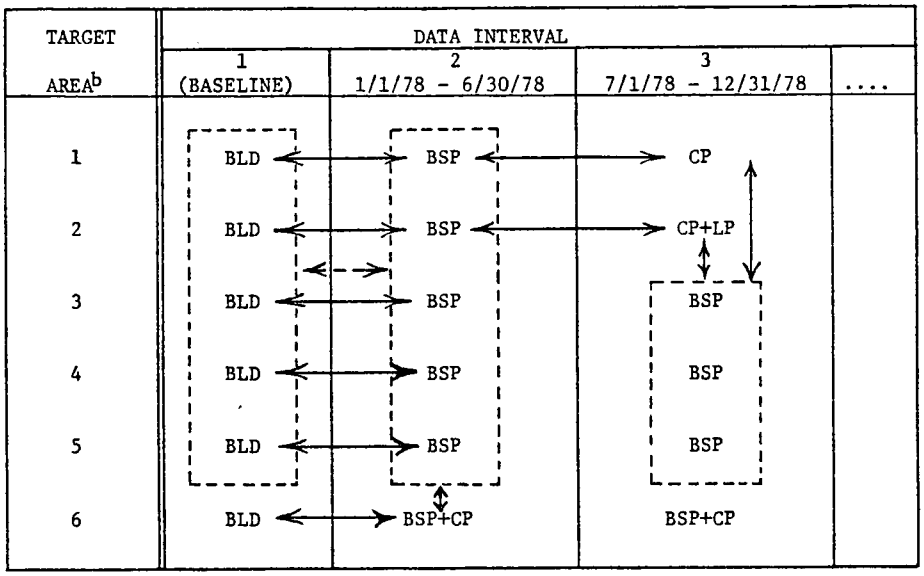
1. Does the Basic Statewide Program (BSP) generate an increase in the CRS usage rate when compared to the baseline data (BLD) a) within each pertinent target area, and b) across all pertinent target areas?
2. Does the BSP + the comprehensive Plan (CP) treatment cause an increase in the CRS usage rate when compared to the BLD for that target area.
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 $\alpha=.05$, $\beta=.20$.

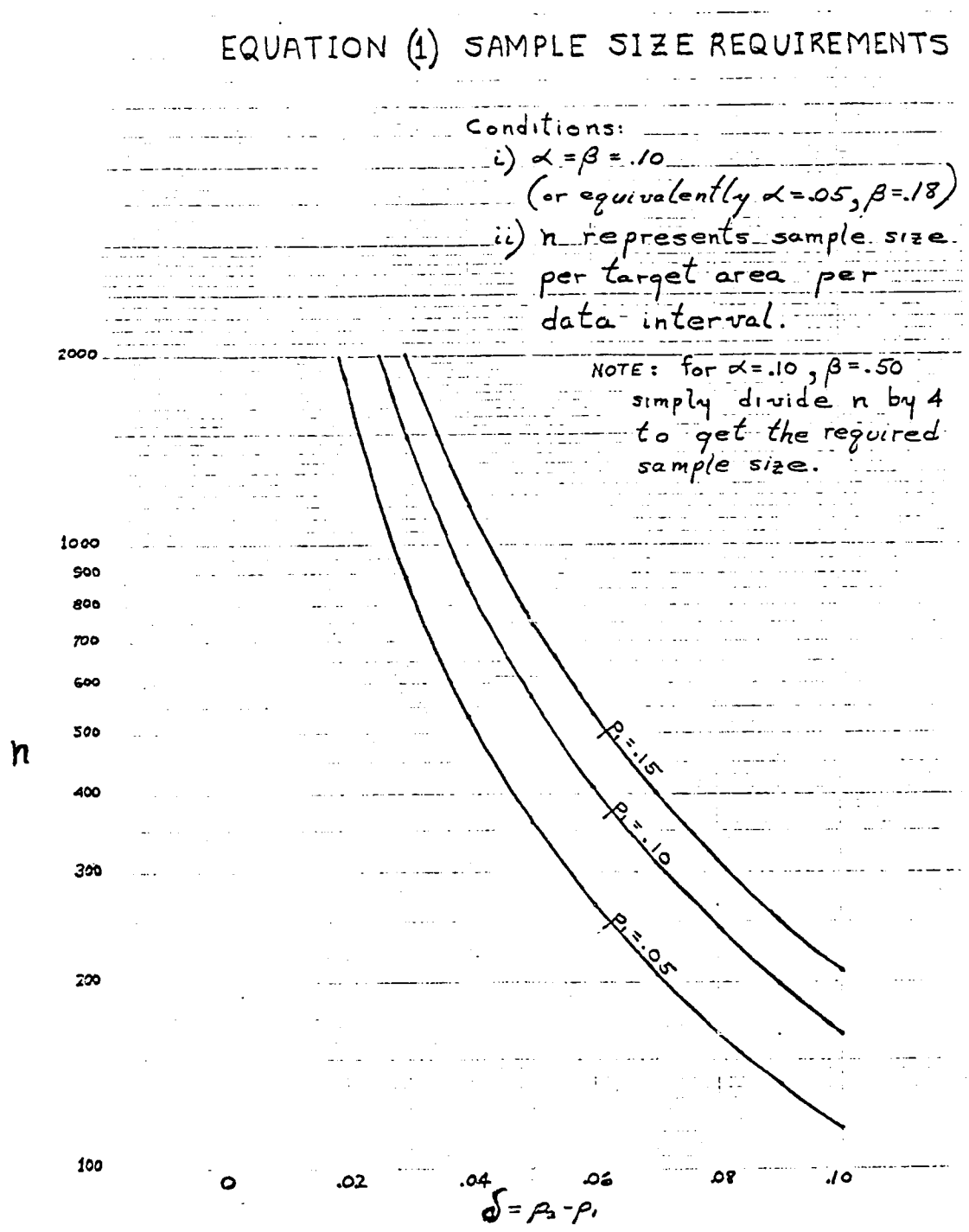

EQUATION (1) SAMPLE SIZE REQUIREMENTS
Conditions:
i) α = β = .10
(or equivalently α = .05, β = .18)
ii) n represents sample size per target area per data interval.
NOTE: for α = .10, β = .50 simply divide n by 4 to get the required sample size.
n
2000
1000
900
800
700
600
500
400
300
200
100
0
.02
.04
.06
.08
.10
δ = p2 - p1
p1 = .15
p1 = .10
p1 = .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 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-SR-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 TOTAL

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 # ____

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

Address ____ Tele. No. ____

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

Vehicle Moved To ____ Name of Garage Address By ____

CIRCLE POINT OF INITIAL IMPACT-MAKE DAMAGED AREAS

0 UNDERCARRIAGE
U UNDOM (USE FOR ROLL)

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 # ____

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

Address ____ Tele. No. ____

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

Vehicle Moved To ____ Name of Garage Address By ____

CIRCLE POINT OF INITIAL IMPACT-MAKE DAMAGED AREAS

0 UNDERCARRIAGE
U UNDOM (USE FOR ROLL)

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

WAS 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)

Name ____

Charge(s) ____ Court Dw. ____

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

Where Else Was Investigation Made?

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

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

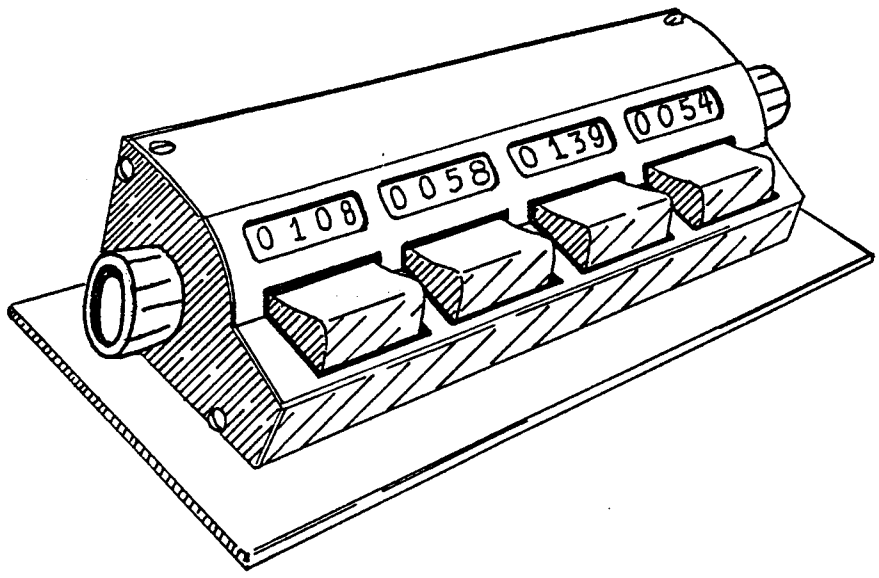
The general purpose of this segment of the study is to identify families with children under four so that they may be asked to participate in the study. The team requires two people. One observer observes each vehicle and uses the two-ring clipboard to complete the Tier 1 forms. The other observer makes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

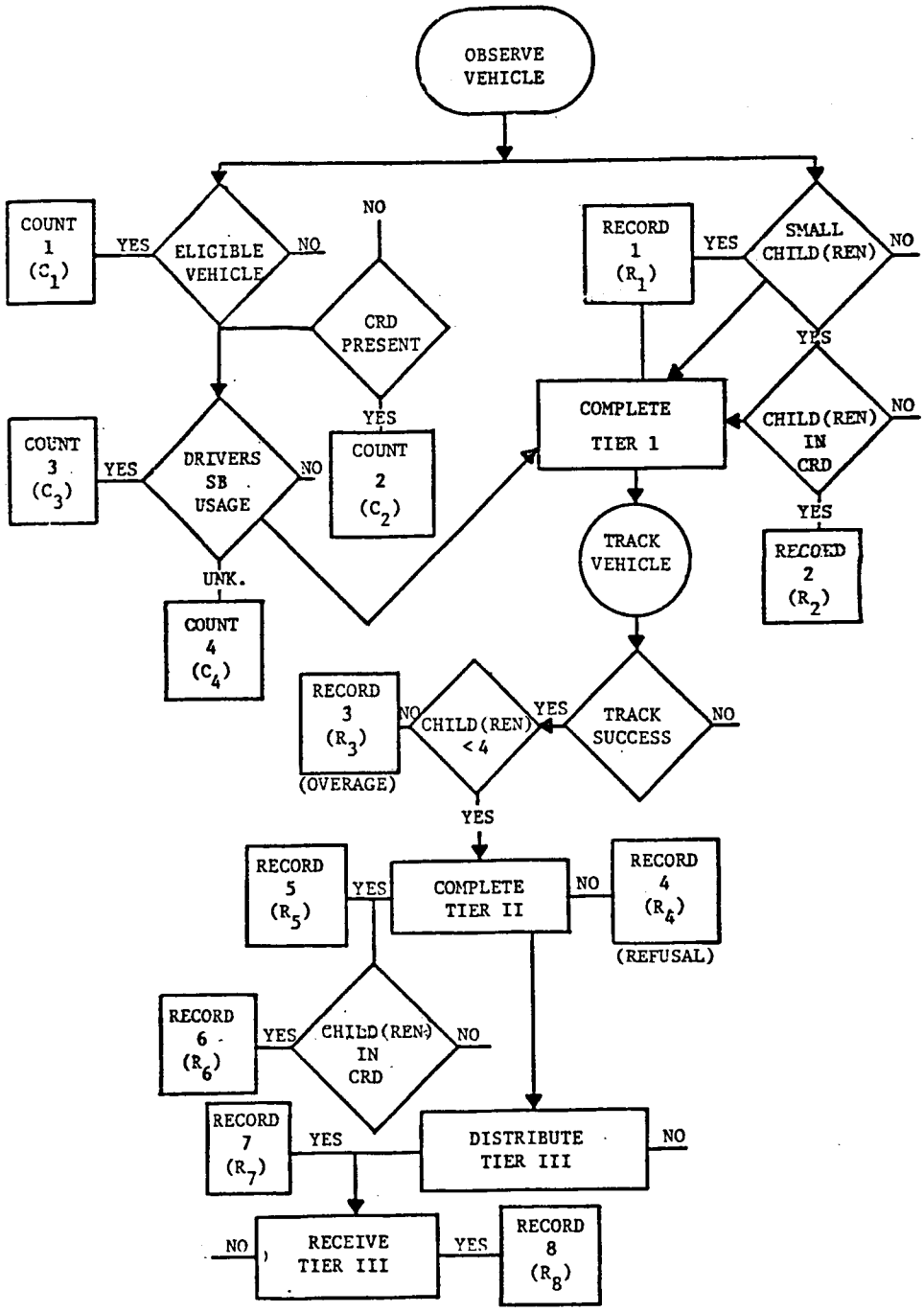
IMPORTANT!! IMPORTANT!! IMPORTANT!! IMPORTANT!!

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 DATA PROCESSING

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 B) 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, crosstabulation, 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 back-up.

APPENDIX I

VEHICLE INFORMATION

TABLE I-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
Non-Urban Area	387	12.9	38.5	13.4	35.1
Total Urban and Non-Urban	2277	11.1	38.7	12.3	37.9

TABLE I-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
Non-Urban Area	400	1.5	8.8	26.0	59.0	4.8
Total Urban and Non-Urban	2339	1.5	11.5	25.3	51.8	9.9

TABLE I-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		
		Sub-compact	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
Non-Urban	380	10.0	25.0	65.0
Total Urban and Non-Urban	2288	9.6	23.7	66.7

TABLE I-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
Non-Urban	400	52.0	26.8	1.8	6.0	12.8	0.8
Total Urban and Non-Urban	2430	57.5	22.7	2.1	7.7	8.7	1.3

TABLE I-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
Non-Urban Area	276	10.9	35.9	10.1	43.1
Total Urban and Non-Urban	1740	9.4	36.8	11.0	42.9

TABLE I-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
Non-Urban Area	292	1.7	9.6	29.8	52.1	6.8
Total Urban and Non-Urban	1586	2.2	12.4	25.8	48.4	11.2

TABLE I-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		
		Sub-compact	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
Non-Urban	261	9.2	19.9	70.9
Total Urban and Non-Urban	1704	9.3	26.0	64.7

TABLE I-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	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
Non-Urban	278	53.6	24.1	2.5	7.6	9.0	3.2
Total Urban and Non-Urban	1827	57.4	22.4	2.3	9.3	7.3	1.2

APPENDIX J

MANUFACTURER INFORMATION

MANUFACTURERS OF CHILD RESTRAINT DEVICES

There were 14 different manufacturers which Consumers Union listed as having child restraints worthy of testing (Consumer Reports, 1977). Of these brands there were three which were owned by parents in Tennessee more than any other. The data collected and analyzed on brands for both periods are given in tabular form and discussed briefly.

Ownership of child restraints were tabulated by the three most owned brands and "others" categories (Table J-1). Others represented 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 CRD's was determined by totaling those not present and those present.

The Bobby-Mac brand accounted for 23.5 percent of all CRD's owned by persons interviewed. The distribution for the three manufacturers selected was about the same for those CRD's present and those not present in the vehicle. About 39 percent (231 of 588) of the claimed ownership of CRD's were not present in the vehicle. When those present were examined by brand it was found that the distribution was close to the percentages of overall ownership for each brand. 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 CRD's in use in vehicles, 25.2 and 23.9 percent respectively. CRD's manufactured by General Motors had the lowest of the three compared at 20.8 percent of all CRD's observed in vehicles in which adults were interviewed.

TABLE J-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.

A crosstabulation (Table J-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 (Table J-3). The comparison made between usage, brand, and type showed Peterson was highest for car seat types but lowest for infant carriers. 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 similar usage rates of 66.7 and 68.2 percent respectively. Peterson's car seats, however, were the ones being used most often with 83.7 percent usage, while the other two brands along with the others identified rated about the same; 62.5, 64.9, and 65.0 percent.

When ownership by brands were compared for the two periods, it was found that brands named other than the three identified (Bobby-Mac, GM, and Peterson) had increased a great deal in percentage of overall ownership from 33.3 to 41.3 percent (Tables J-1 and J-4). An even greater increase was seen for the "others" category in the percentage of CRD's in use from 30.1 to 51.9 percent. This means that at least one of the remaining three had a lower percentage for the operational period. As it turned out all three had lower percentages of use for the operational period; Bobby-Mac from 25.2 to 20.8, GM from 20.8 to 12.6, and Peterson from 23.9 to 14.7 percent.

Table J-5 shows the percentages of use/non-use by manufacturer using the same three brands and "others" categories. A comparison to the baseline data showed that each category had increased in use;

TABLE J-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	percent =	67.1	63.5	78.3	68.0
Not in Use	percent =	32.9	36.5	21.7	32.0

*Others with identified manufacturers.

TABLE J-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 J-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 J-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	percent =	67.6	70.7	82.9	75.0
Not in Use	percent =	32.4	29.3	17.1	25.0

*Others with identified manufacturers.

Bobby-Mac increased only minutely while the others were more substantial.

A further study of use was done by performing a crosstabulation of use by manufacturer by the two most used types (Table J-6). A comparison with the baseline crosstabulation of the same variables showed increases for each category of brands for the infant carrier type; however, low frequencies for Peterson must be taken into account in making the comparison. All categories of brands of the car seat type were higher for the operational period except for Bobby-Mac which dropped from 64.9 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.

TABLE J-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.

APPENDIX K

TYPES OF CRDS

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.

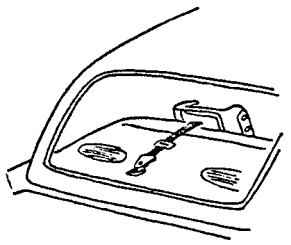


Fig. 1 Tether anchored to package shelf

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.

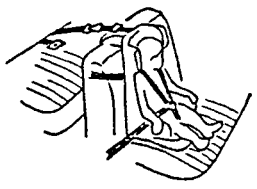
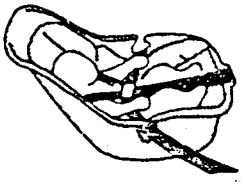


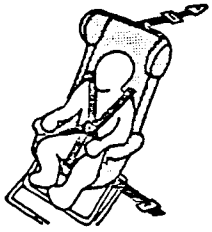
Fig. 2 Tether attached to rear safety belt

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*



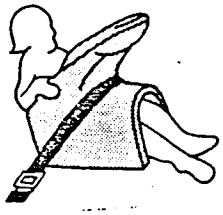
CAR SEAT. The traditional car seat, which is intended for use by children over 20 pounds who are able to sit without support, has a harness system consisting of two shoulder straps, lap belt and a crotch strap. The seat is then secured to the vehicle with the vehicle lap belt. This belt is either threaded 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*

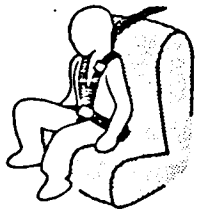
II. Converts from Infant to Toddler

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.*



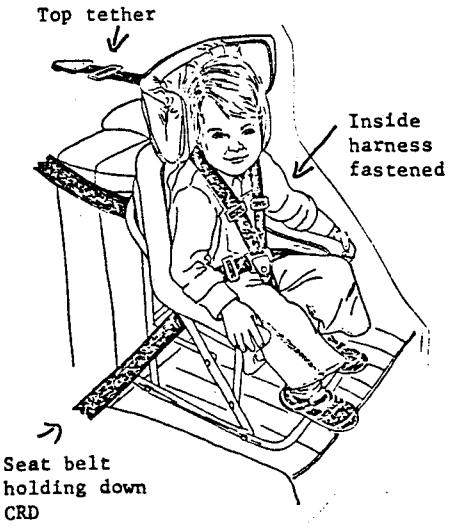
HARNESS. The harness consists of shoulder, lap and crotch straps and an anchorage strap. This anchorage strap, which requires installation, must be bolted to the car. The harness should be used only in center seat positions.

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.

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

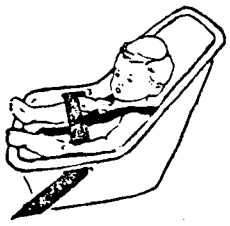
The child restraint devices listed on the following page have been dynamically tested by one or more independent research laboratories. They vary in their performance depending on the type of accident. Remember current Federal standards may not be a sufficient guide to safety. Neither the Child Passenger 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.

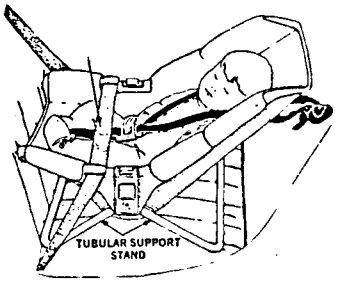
There are 4 classes of child restraint devices. These are explained below. Manufactured brands of child restraint devices are listed under each basic type.

CHILD RESTRAINT DEVICES

INFANT RESTRAINT DEVICES

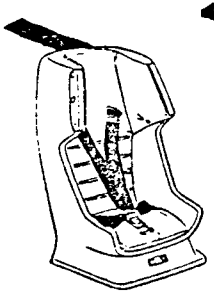


GM Infant
Love Seat

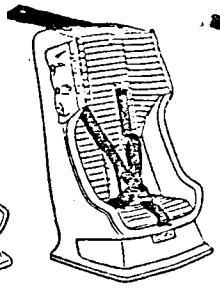


Dyn-O-Mite

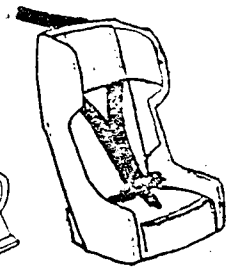
TODDLER - CAR SEAT



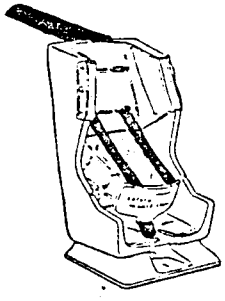
Child Love Seat



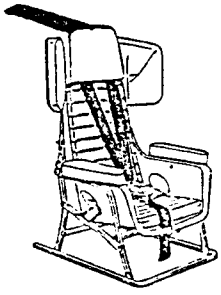
Motor Totor



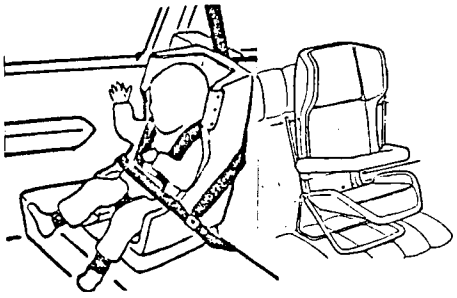
Positest Car Seat



Swyngomatic Safety Seat



Teddy Tot

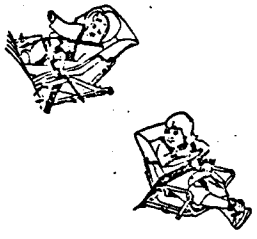


Astroseat V

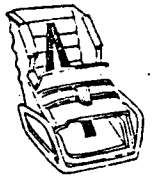
American Safety

Kantwet #597

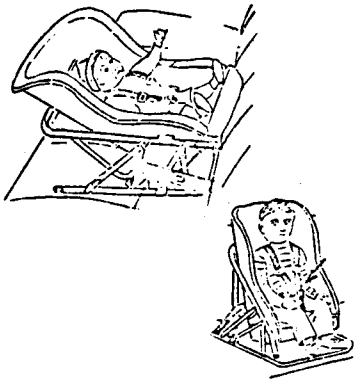
INFANT/TODDLER CONVERTABLE



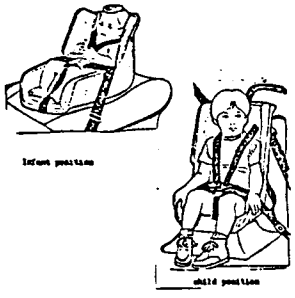
Mobby Mac 2 in 1



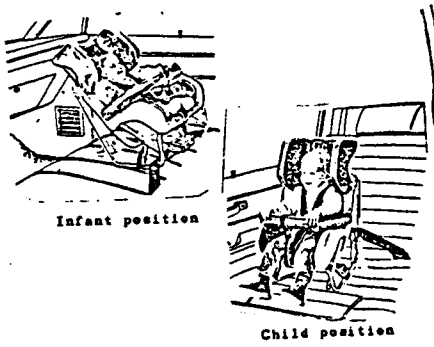
Bobby Mac Delux



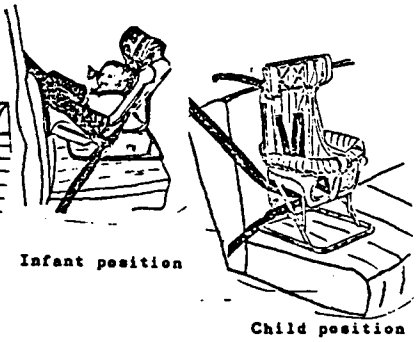
Bunny Bear



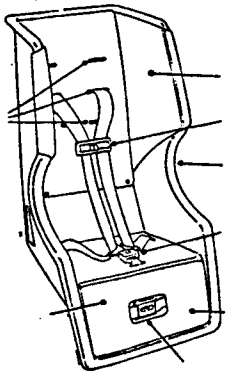
Safety Shell



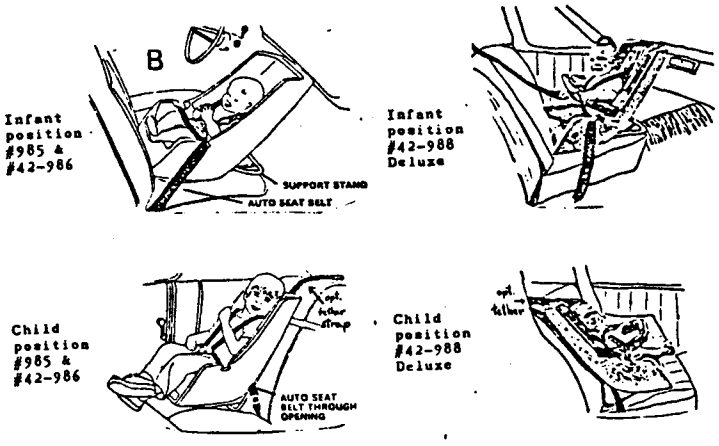
Trav-L-Guard



Wee Care



Safe & Easy

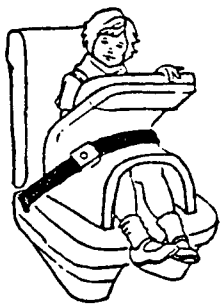


Kantwet Car Seat #985, #986, #988

TODDLER - PROTECTIVE SHIELD



Mopar Child Seat

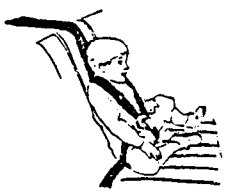


Tot Guard

TODDLER - SAFETY HARNESS



Little Rider



Infanseat

APPENDIX L

CRD USAGE EQUATIONS

CRD USAGE EQUATIONS

Equations were formulated to take into account both levels of data collected (tier one and two), the number of over-age estimates made at the tier one level, and the number of refusals to provide data. The equations take into account also the fact that tier one data tends to underestimate the CRD usage rate, while the 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 as good, but under more ideal conditions the differences in information collected at the two levels may not be as much. The number of follow-ups of tier-one observations is also a function of a set of conditions which includes the weather, the size of the shopping area where the data is collected, and size of interview team and others. 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 seem 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

$$(2)\quad p = \tfrac{1}{2}\ \frac{x_m + x_{II}}{n_m + n_{II}}\ \frac{x_I}{n_I}\ ,\ \text{if } n_I > n_m + n_{II}$$

where,

x_m = the number of observations of children under four years of age using CRD's 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 CRD's, having only a tier one completed. Tier ones were adjusted for over-age.

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 over-age 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 vehciles having only tier two completed (no matching tier one)

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 over-age 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. The tier one data sheets without license numbers were discarded and not used.

The adjustment of tier one data for over-age were made by calculating and applying two correction factors using tier two data. The first correction factor is:

$$C_1 = \frac{n_m + n_{II}}{n_m + h_{II} + a_n}$$

where, a_n = the number of children at the tier two level identified as being over-age

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 over-age, 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 over-age children who were observed using CRD's at the tier two level:

$$C_2 = \frac{x_m}{x_m + a_x}$$

where, a_x = the number of over-age children in CRD's (this number will be small or equal to zero)

x_m = the number of children under four years of age using CRD's 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 in 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) $p = \dfrac{x_m + x_I + x_{II}}{n_m + n_I + n_{II}}$

for Nashville baseline, where, number of age adjusted tier one data were less than $n_m + n_{II}$

$x_m = 72$ $\quad n_m = 396$
$x_{IU} = 36$ $\quad n_{IU} = 430$
$x_{II} = 8$ $\quad n_{II} = 56$
$a_x = 2$ $\quad a_n = 85$

$$C_1 = \frac{n_m + n_{II}}{n_m + n_{II} + a_n} = \frac{396 + 56}{396 + 56 + 85} = .8417$$

$$C_2 = \frac{x_m}{x_m + a_x} = \frac{72}{72 + 2} = .9730$$

$$n_I = C_1 n_{IU} = .8417(438) = 369$$

$$x_I = C_1 n_{IU} = .9730(36) = 35$$

$$p = \frac{72 + 35 + 8}{396 + 369 + 56} = .1401 = 14.0\%$$

Equation (2) $p = \frac{1}{2} \left(\dfrac{x_m + x_{II}}{n_m + n_{II}} + \dfrac{x_I}{n_I} \right)$

for Knoxville Baseline, where, the number of age adjusted tier one data exceeded $n_m + n_{II}$

$x_m = 55$ $\quad$ $n_m = 424$

$x_{IU} = 81$ $\quad$ $n_{IU} = 779$

$x_{II} = 9$ $\quad$ $n_{II} = 32$

$a_x = 1$ $\quad$ $a_n = 57$

$$c_1 = \frac{n_m + n_{II}}{n_m + n_{II} + a_n} = \frac{424 + 32}{424 + 32 + 57} = .8889$$

$$c_2 = \frac{x_m}{x_m + a_x} = \frac{55}{55 + 1} = .9821$$

$$n_I = C_1 n_{IU} = .8889\ (779) = 692$$

$$X_I = C_2 x_{IU} = .9821\ (81) = 80$$

$$p = \tfrac{1}{2}\left(\frac{55 + 9}{424 + 32} + \frac{80}{692}\right) = .1280 = 12.8\%$$

VITA

Randy L. Perry was born in Ashland City, Tennessee on April 15, 1940, the son of B. F. and Louise Perry. He attended public schools in Ashland City and began his college work at Middle Tennessee State University in Murfreesboro in 1958.

He later transferred to The University of Tennessee, Knoxville where he received the Bachelor of Science degree in Civil Engineering in 1964. He received his Master of Science degree at UT in Civil Engineering in 1971.

From 1964-1966 he was an officer in the U.S. Army Corps of Engineers, serving a two year tour of duty in Europe. From 1966 to 1974 he was employed by the State of Tennessee Department of Transportation as Regional Tests Engineer. In 1974 he was employed by The University of Tennessee as Assistant Director of the Transportation Center.

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