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FINAL REPORT FOR GHSP PROJECT (1990-91):

Occupant Restraint Monitoring Program

by

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I. INTRODUCTION

North Carolina has been involved in the occupant restraint area including child safety seats for the past 15 years or so. The initial effort was in the area of child restraints where a statewide law was passed in 1982 and then strengthened in 1985. This was followed by the passage of the North Carolina seat belt law which became effective October 1, 1985 with a 15-month warning ticket phase followed by the $25 citation period starting in January 1987.

Both of these laws have been evaluated by the UNC Highway Safety Research Center (HSRC). The three-year evaluation of the seat belt law by Reinfurt, Campbell, Stewart and Stutts (1988) was reported to the North Carolina Legislature as called for in the Act itself. This report certainly reflected very favorably on the legislation. The long-term effects of the belt law have been reported on to GHSP most recently in a study by Reinfurt, Weaver, Hall, Hunter, and Marchetti (1990) entitled, "Increased Seat Belt Use Through Police Actions."

The objectives of the current project have been to:

(1) Monitor the long-term effect of the law on seat belt use in the population-at-large in North Carolina through a statewide seat belt use survey in the Spring of 1991 and a special survey of automatic seat belts and belt usage in air bag cars;

(2) Examine injury/fatality trends across North Carolina to provide estimates of seat belt law and program benefits;

(3) Monitor activities related to enforcement of the seat belt law by both the Highway Patrol and also local police;

(4) Provide TAD manuals to Highway Patrol and local police departments; and

(5) Carry out a statistical follow-up analysis examining the overrepresentation of non-belt users in crashes.

The remainder of this report documents the activities and results associated with each of these objectives.

II. STATEWIDE BELT USAGE DATA

Background

A statewide seat belt usage law should increase belt usage in the population-at-risk and therefore, should prevent injuries in those persons involved in crashes. In order to assess the success of the belt law with respect to increasing usage in North Carolina, a series of surveys has been conducted over the past six years. The results represent usage rates in the baseline period (prior to October 1, 1985), the warning ticket phase (October 1, 1985 - December 31, 1986), and the citation phase (January 1, 1987 - today). The most complete description of the issues of survey design, observational procedures and previous data analysis results is given in the HSRC report entitled, "North Carolina Occupant Restraint Law: A Three-Year Evaluation", Reinfurt, Campbell, Stewart and Stutts, (1988).

In brief, 72 permanent sampling sites have been used in the series of surveys that have been conducted during this period (see Figure 1 for the locations of these sites). In each observational wave, belt use of front seat occupants is observed for a period of 90 minutes at each location. During this year, data were collected in April through June for all of these sites, as well as two mini-waves conducted in July and in September.

As previously, for those vehicles covered by the law, data were gathered on the gender, race and belt status of all occupants in the front seats as well as information on vehicle type (e.g., car, van, pickup, utility vehicle). In addition, certain site-specific data were collected including the starting and finishing times of the observational period, road type, weather condition, whether the area was urban or rural, date of observation, and a diagram of the particular intersection.

Results

The statewide driver belt usage rates by belt law phase (i.e., pre-law, warning, citation) are shown in Figure 2. As is clear from the figure, driver belt usage has risen from a baseline of approximately 25 percent to a level of between 42 and 45 percent during the warning ticket phase, to a high of 78 percent at the outset of the citation phase, and then to a fairly consistent 60 percent.

North Carolina

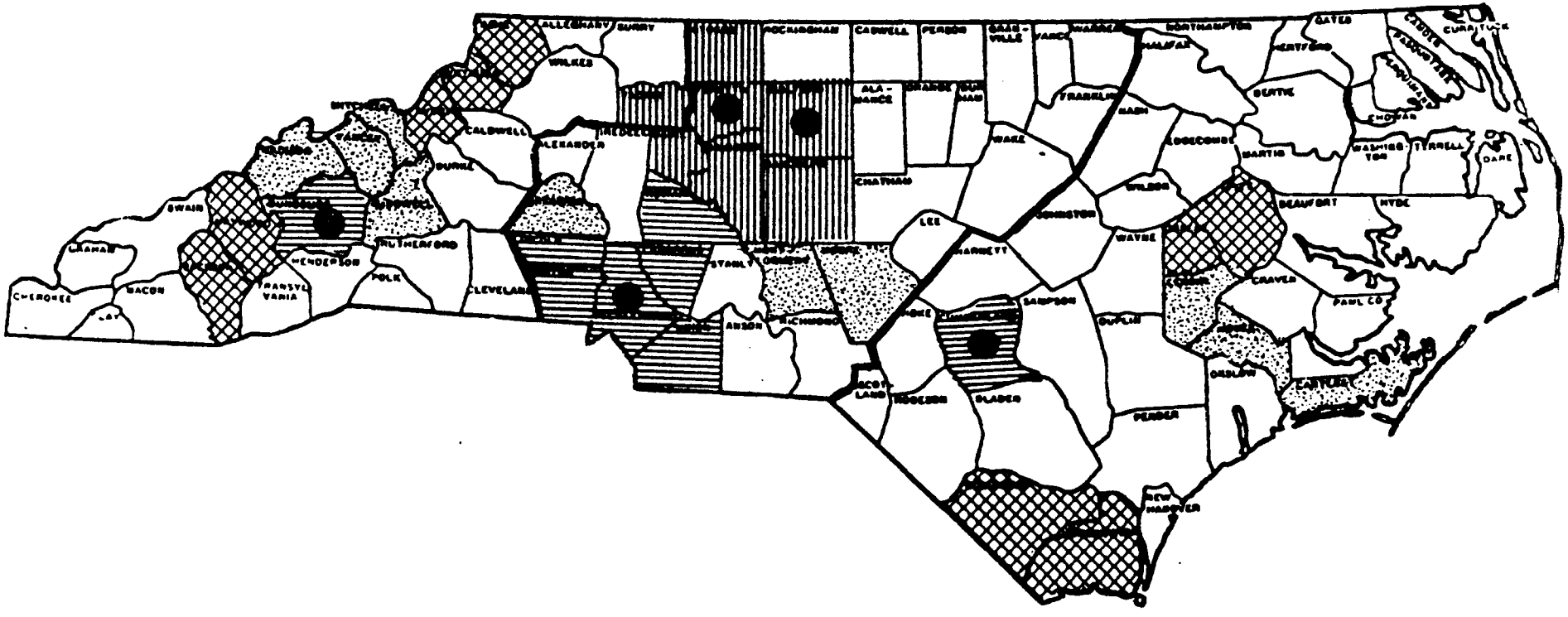


Figure 1. County units and urban areas identified for collection of statewide belt use data.

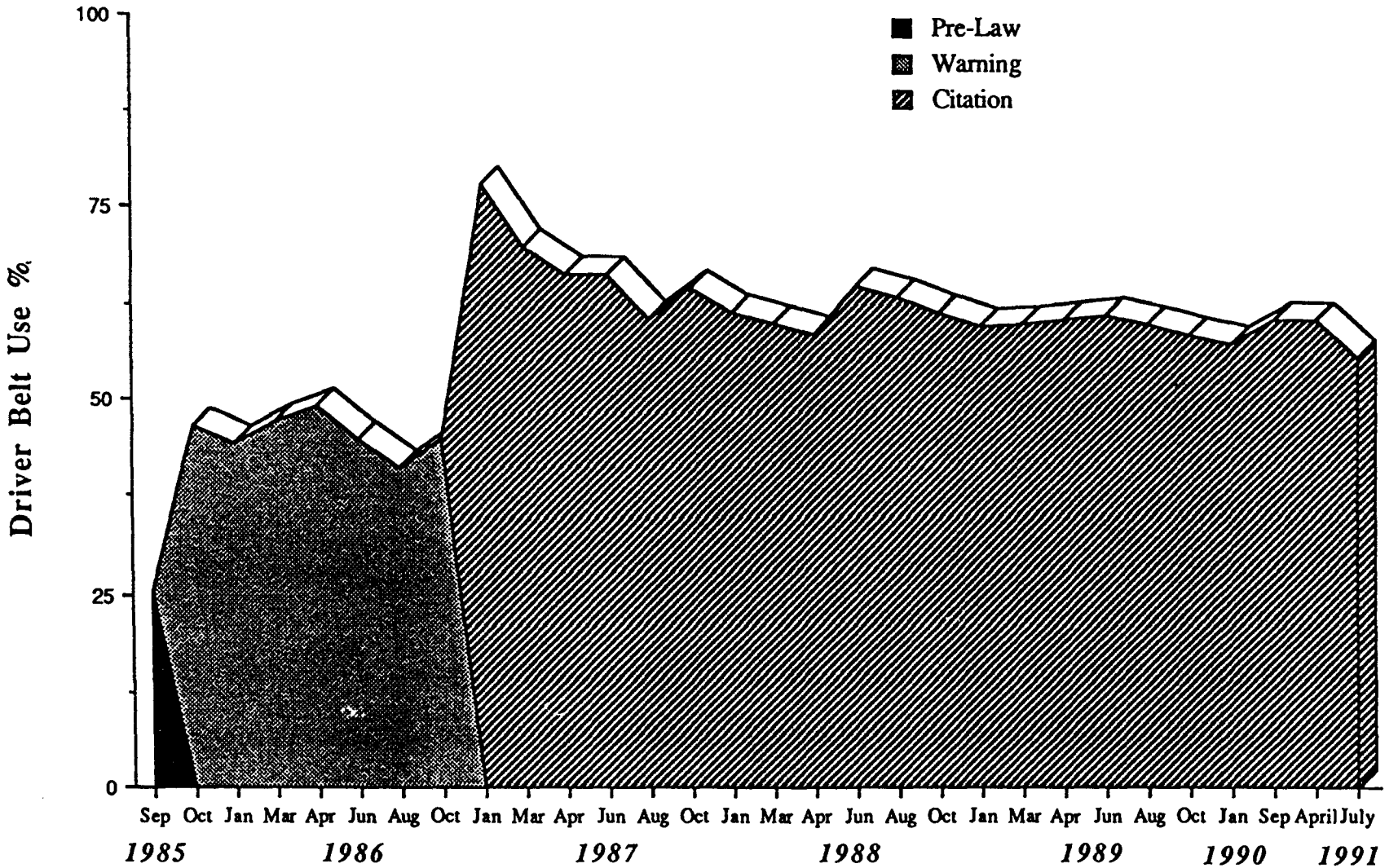


Figure 2. Statewide driver belt usage rates by belt law phase.

Detailed usage rates for each of the surveys carried out in North Carolina are presented in Table 1 (belt usage for drivers) and Table 2 (usage rates for all front seat occupants). The results of the surveys carried out during this project are given on the last page of each table in the shaded area. The overall weighted rates of belt usage for the driver vary between 57.2 percent and 60.6 percent in the three surveys. As has been seen in previous surveys, usage rates for all front seat occupants continue to be approximately 2 percentage points lower than those for the driver. In this case, front seat occupant use rates vary between 55.4 percent and 58.8 percent in the most recent observations.

Focusing on driver belt usage rates shown on the last page of Table 1, it can be seen that usage rates are approximately 10 percentage points higher for drivers in urban areas than in rural areas; 4 percentage points higher in the piedmont area than in the coast which, in turn, is 10 to 14 percentage points higher than in the mountains; approximately the same in the commuting vs the non-commuting periods; some 20 percentage points higher or so for cars than for pickups or vans; 12 to 16 percentage points higher for females than for males; and consistently 5 to 8 percentage points higher for non-white drivers than for their white counterparts. Similar findings hold for all front seat occupants as can be seen in Table 2.

Seat Belt Misuse Data

For the past several years, in addition to collecting information on belt usage of drivers and front seat passengers of vehicles covered by the seat belt law, the data collectors have also recorded various types of seat belt misuse. The primary types of misuse include the following:

- Loose belt: Although shoulder belt is properly routed and fastened, it is excessively slack;
- Underarm: Shoulder belt does not properly fit across the shoulder, but instead is worn under the arm;
- Hanging Belt: Shoulder belt is draped over the shoulder and not fastened; and
- Behind the back: Shoulder belt is not properly fit across the shoulder, but instead is put behind the back.

Table 1. **Driver** belt usage rates in North Carolina.

	PRE-LAW	POST-LAW Citation Phase						
	Sept. 1985 (72 sites)	Nov. 1985 (12 sites)	Jan. 1986 (72 sites)	March 1986 (12 sites)	April 1986 (12 sites)	June 1986 (72 sites)	Aug. 1986 (12 sites)	Oct. 1986 (72 sites)
Overall Usage %:								
Observed	25.4	45.0	41.9	45.4	47.7	43.7	40.8	43.8
[Weighted]	[25.5]	[46.5]	[44.3]	[47.0]	[49.0]	[44.8]	[41.0]	[44.8]
(No. occupants)	(18,212)	(6734)	(19,927)	(3380)	(3339)	(19,159)	(4260)	(21,859)
Rural/Urban								
Rural	22.1	40.5	38.2	41.3	42.8	41.0	36.5	40.5
Urban	28.4	49.0	45.4	48.8	51.6	47.0	43.9	47.6
Region								
Mountains	23.5	40.8	43.7	40.5	42.2	41.9	34.5	41.9
Piedmont	27.6	48.5	44.2	47.6	50.4	46.5	45.2	46.6
Coast	25.1	49.2	37.9	50.8	51.3	42.5	44.0	43.4
Time of Day								
Commuting	27.2	47.3	43.2	42.6	47.3	46.3	42.1	47.0
Non-Commuting	24.0	44.0	41.1	46.7	47.9	41.8	40.1	41.6
Vehicle Type								
Car	26.6	45.8	45.1	48.1	50.4	46.5	43.3	47.4
Van	25.9	49.3	34.2	48.8	48.2	45.2	44.1	44.5
Pickup	18.5	39.0	30.1	33.3	36.8	31.3	28.8	30.5
Other	31.1	50.4	43.2	51.3	42.2	51.3	45.5	42.7
Sex of Occupant								
Male	23.7	43.0	37.2	41.8	45.9	39.9	38.8	38.8
Female	28.0	47.7	49.2	50.4	50.5	49.9	43.7	51.3
Race of Occupant								
White	26.5	45.1	43.0	45.3	47.9	44.5	41.3	44.7
Non-white	15.5	43.8	34.9	46.0	46.8	35.7	38.1	36.0

Table 1. **Driver** belt usage rates in North Carolina. (Con't)

	POST-LAW Citation Phase							
	Jan. 1987 (72 sites)	March 1987 (12 sites)	April 1987 (12 sites)	June 1987 (72 sites)	Aug. 1987 (12 sites)	Oct. 1987 (72 sites)	Jan. 1988 (72 sites)	March 1988 (12 sites)
Overall Usage %: Observed [Weighted] (No. occupants)	77.7 [77.9] (15,847)*	71.3 [69.9] (3042)	67.4 [66.6] (3150)	64.0 [66.6] (17,971)	63.1 [60.6] (3537)	62.7 [64.7] (21,423)	60.0 [61.6] (21,341)	60.2 [60.0] (3802)
Rural/Urban								
Rural	75.7	69.7	61.8	59.3	61.6	58.7	54.6	57.8
Urban	80.1	72.4	71.5	69.2	64.7	67.4	65.0	62.3
Region								
Mountains	71.9	63.8	59.9	56.9	57.4	53.7	46.8	51.0
Piedmont	78.9	75.3	74.7	69.5	68.2	67.8	65.3	66.3
Coast	81.1	76.3	68.3	64.3	63.4	65.8	66.6	66.6
Time of Day								
Commuting	80.2	70.5	66.3	65.8	61.4	66.1	62.2	60.1
Non-Commuting	75.5	72.2	68.4	62.5	64.3	60.0	57.4	60.2
Vehicle Type								
Car	80.3	75.4	70.6	68.1	67.4	66.4	64.7	65.2
Van	72.9	63.7	69.4	55.7	51.9	51.7	52.3	41.4
Pickup	69.5	58.3	53.5	50.1	48.6	50.3	43.7	45.6
Other	76.7	70.3	64.8	66.6	53.8	64.9	59.8	56.6
Sex of Occupant								
Male	73.8	67.4	54.3	59.6	58.7	57.5	53.5	55.2
Female	84.4	77.3	72.0	71.0	69.9	70.3	69.9	68.2
Race of Occupant								
White	77.2	70.6	65.9	63.8	62.3	62.7	58.8	59.6
Non-white	80.4	74.0	73.6	65.7	66.4	62.8	65.4	62.9

*Survey methodology modified to collect only for vehicles completely stopped.

Table 1. **Driver** belt usage rates in North Carolina. (Con't)

	POST-LAW Citation Phase						
	April 1988 (12 sites)	June 1988 (72 sites)	Aug. 1988 (12 sites)	Jan. 1989 (72 sites)	June 1989 (72 sites)	Jan. 1990 (72 sites)	Sept. 1990 (72 sites)
Overall Usage %: Observed [Weighted] (No. occupants)	59.8 [58.6] (4089)	62.4 [65.0] (24,183)	62.7 [63.6] (3768)	55.6 [59.7] (24,317)	56.9 [61.3] (25,775)	53.5 [57.5] (24,363)	57.5 [60.6] (25,066)
Rural/Urban							
Rural	55.1	58.5	60.6	48.5	51.1	46.8	51.9
Urban	63.7	66.5	65.1	62.9	63.1	60.6	63.6
Region							
Mountains	50.2	55.5	58.1	48.7	49.8	47.1	50.6
Piedmont	68.2	67.7	66.7	61.8	62.7	59.7	63.7
Coast	63.1	64.0	64.7	55.2	57.7	52.7	57.9
Time of Day							
Commuting	59.1	63.3	62.0	57.9	57.7	55.6	59.1
Non-Commuting	60.5	61.6	63.3	53.8	56.2	51.7	56.3
Vehicle Type							
Car	63.7	67.1	68.4	60.3	61.9	58.8	63.3
Van	54.9	47.6	49.3	45.6	41.4	36.5	39.3
Pickup	45.4	47.5	44.4	38.7	39.8	35.8	40.0
Other	64.4	64.0	63.7	57.9	58.4	53.2	55.1
Sex of Occupant							
Male	54.7	56.5	57.0	49.5	51.3	47.0	51.8
Female	67.3	70.9	71.5	64.8	65.2	62.9	66.1
Race of Occupant							
White	58.5	62.0	61.9	55.4	56.4	53.2	57.3
Non-white	66.5	65.1	67.1	57.1	60.0	55.4	59.3

Table 1. **Driver** belt usage rates in North Carolina. (Con't)

	POST-LAW Citation Phase		
	April 1991 (72 sites)	July 1991 (12 sites)	September 1991 (12 sites)
Overall Usage %: Observed [Weighted] (No. occupants)	57.4 [60.6] (26,084)	58.7 [57.2] (5295)	58.3 [57.5] (5546)
Rural/Urban			
Rural	51.8	51.9	52.3
Urban	63.3	63.2	62.3
Region			
Mountains	48.5	47.9	48.7
Piedmont	63.3	66.6	65.1
Coast	59.3	61.1	62.8
Time of Day			
Commuting	58.7	57.4	57.5
Non-Commuting	56.3	59.8	59.0
Vehicle Type			
Car	62.7	65.5	64.1
Van	37.2	37.2	43.8
Pickup	40.0	39.0	39.3
Other	57.3	60.8	56.6
Sex of Occupant			
Male	51.7	52.4	53.6
Female	65.5	68.7	65.7
Race of Occupant			
White	56.8	57.1	57.4
Non-white	61.4	65.1	62.5

Table 2. **Front seat occupant** belt usage rates in North Carolina.

	PRE-LAW	POST-LAW Warning Ticket Phase						
	Sept. 1985 (72 sites)	Nov. 1985 (12 sites)	Jan. 1986 (72 sites)	March 1986 (12 sites)	April 1986 (12 sites)	June 1986 (72 sites)	Aug. 1986 (12 sites)	Oct. 1986 (72 sites)
Overall Usage %:								
Observed	24.1	42.3	39.7	42.8	45.8	42.2	38.9	42.0
[Weighted]	[24.1]	[44.1]	[42.6]	[45.0]	[47.1]	[43.3]	[39.7]	[43.3]
(No. occupants)	(25,084)	(8858)	(26,722)	(4647)	(4549)	(26,546)	(5675)	(29,982)
Rural/Urban								
Rural	21.2	38.0	35.8	38.7	41.9	40.0	34.9	39.0
Urban	27.0	46.5	43.6	46.4	49.1	45.3	41.9	45.5
Region								
Mountains	22.5	38.4	41.8	38.2	41.2	41.2	33.4	40.4
Piedmont	26.2	46.8	42.3	44.5	48.7	44.6	42.6	44.3
Coast	23.8	45.4	35.2	48.5	47.9	40.6	42.3	41.5
Time of Day								
Commuting	25.8	44.1	40.7	39.5	45.4	44.4	39.5	45.3
Non-Commuting	22.9	41.6	39.1	44.5	45.9	40.7	38.6	39.8
Vehicle Type								
Car	25.5	43.3	42.9	45.3	48.5	45.1	41.6	45.5
Van	24.8	45.4	33.3	49.1	48.8	44.2	40.9	44.0
Pickup	16.3	35.8	27.4	31.1	33.5	29.5	26.3	28.3
Other	30.2	50.3	40.4	47.3	44.6	49.4	43.1	41.6
Sex of Occupant								
Male	22.3	40.3	34.9	39.9	43.5	38.3	36.7	36.8
Female	25.9	44.2	45.7	46.1	48.6	47.0	41.4	47.9
Race of Occupant								
White	25.2	42.7	41.1	42.9	46.3	43.2	39.5	43.1
Non-white	14.4	39.4	31.2	42.7	43.2	32.5	35.5	32.8

Table 2. **Front seat occupant** belt usage rates in North Carolina. (Con't)

	POST-LAW Warning Ticket Phase							
	Jan. 1987 (72 sites)	March 1987 (12 sites)	April 1987 (12 sites)	June 1987 (72 sites)	Aug. 1987 (12 sites)	Oct. 1987 (72 sites)	Jan. 1988 (72 sites)	March 1988 (12 sites)
Overall Usage %: Observed [Weighted] (No. occupants)	75.8 [76.4] (21,675)*	69.1 [68.0] (4142)	65.3 [64.3] (4273)	61.7 [64.9] (25,033)	60.4 [58.3] (4870)	60.5 [62.6] (28,946)	57.6 [59.8] (28,467)	59.1 [59.3] (4945)
Rural/Urban								
Rural	74.0	67.6	60.5	57.1	58.7	56.8	52.9	57.5
Urban	78.2	70.3	69.0	67.0	62.1	65.1	62.7	60.7
Region								
Mountains	70.7	62.2	58.3	54.4	55.5	51.7	45.1	50.5
Piedmont	76.9	72.9	72.8	67.6	64.8	65.8	63.0	64.4
Coast	79.0	73.6	65.3	62.0	60.8	63.7	65.3	66.4
Time of Day								
Commuting	78.0	68.1	64.8	63.1	58.0	63.4	60.0	58.6
Non-Commuting	74.1	70.4	65.7	60.6	62.0	58.4	55.5	59.6
Vehicle Type								
Car	78.8	73.3	68.4	65.8	64.8	64.4	62.6	64.3
Van	70.3	61.4	64.8	53.0	45.5	49.1	49.9	39.0
Pickup	66.5	56.1	51.7	47.8	46.1	47.1	41.5	44.0
Other	78.0	68.9	66.2	63.8	50.7	63.4	58.3	58.3
Sex of Occupant								
Male	71.7	65.3	62.0	57.3	56.3	54.9	51.8	53.1
Female	81.3	74.1	69.2	67.1	65.6	67.0	65.0	67.3
Race of Occupant								
White	75.6	68.6	63.9	61.4	59.9	60.6	57.0	58.5
Non-white	77.5	71.1	70.6	63.5	62.7	60.2	61.6	62.1

*Survey methodology modified to collect only for vehicles completely stopped.

Table 2. **Front seat occupant** belt usage rates in North Carolina. (Con't)

	POST-LAW Warning Ticket Phase						
	April 1988 (12 sites)	June 1988 (72 sites)	Aug. 1988 (12 sites)	Jan. 1989 (72 sites)	June 1989 (72 sites)	Jan. 1990 (72 sites)	Sept. 1990 (72 sites)
Overall Usage %: Observed [Weighted] (No. occupants)	57.6 [56.7] (5448)	60.7 [63.7] (32,590)	62.2 [63.5] (5002)	53.5 [57.8] (31,845)	54.8 [59.3] (34,424)	51.2 [55.7] (32,035)	55.4 [58.7] (33,505)
Rural/Urban							
Rural	53.1	56.9	60.1	46.5	49.6	44.4	50.1
Urban	61.6	65.1	64.7	60.9	60.9	58.7	61.6
Region							
Mountains	48.4	53.7	58.5	46.8	48.5	45.0	49.5
Piedmont	65.5	66.2	65.4	60.0	60.3	57.3	61.3
Coast	61.2	62.9	63.9	52.8	55.6	50.7	55.4
Time of Day							
Commuting	56.6	61.1	61.2	55.6	55.5	53.2	56.5
Non-Commuting	58.6	60.4	62.9	51.9	54.3	49.6	54.6
Vehicle Type							
Car	61.5	65.6	68.2	58.3	59.8	56.4	61.1
Van	54.6	45.8	51.3	42.7	38.7	35.3	36.8
Pickup	42.6	44.9	41.6	35.8	36.9	33.4	37.2
Other	63.3	63.1	66.4	56.4	57.3	51.0	53.9
Sex of Occupant							
Male	52.2	54.3	55.4	47.1	48.7	44.5	49.2
Female	64.4	68.1	70.5	61.4	62.3	59.4	62.9
Race of Occupant							
White	56.5	60.3	61.7	53.4	54.6	51.1	55.4
Non-white	63.2	63.5	64.9	54.6	56.2	51.7	55.5

Table 2. **Front seat occupant** belt usage rates in North Carolina. (Con't)

	POST-LAW Warning Ticket Phase		
	April 1991 (72 sites)	July 1991 (12 sites)	September 1991 (12 sites)
Overall Usage %: Observed [Weighted] (No. occupants)	55.3 [58.8] (34,223)	56.9 [55.4] (6924)	56.1 [55.4] (7256)
Rural/Urban			
Rural	49.9	49.6	50.6
Urban	61.3	61.8	59.9
Region			
Mountains	46.8	46.4	46.7
Piedmont	61.0	65.3	62.8
Coast	57.3	57.6	60.6
Time of Day			
Commuting	56.1	55.9	55.2
Non-Commuting	54.7	57.7	56.8
Vehicle Type			
Car	60.4	63.5	61.7
Van	35.6	35.4	40.9
Pickup	37.8	37.0	36.6
Other	55.6	60.8	55.4
Sex of Occupant			
Male	49.3	50.6	50.8
Female	62.4	65.7	63.0
Race of Occupant			
White	55.0	55.5	55.2
Non-white	57.3	62.4	60.0

Table 3 contains these misuse rates for the Spring 1991 survey by driver gender and race. The most common misuse categories were either not

Table 3. Seat belt misuse rates by driver gender and race.

Misuse Category	White Male	White Female	Non-White Male	Non-White Female	Total
Loose	1.2%	2.4%	1.0%	2.3%	1.7%
Under Arm	.81%	2.6%	.43%	2.1%	1.6%
Hanging	.12%	.07%	.21%	.05%	.10%
Behind Back	.06%	.10%	.09%	.05%	.08%
Total	16,234	13,436	2,340	1,985	33,995

releasing excessive slack ("Loose") or wearing the shoulder belt "under arm"--both at nearly 2 percent of the total. Females were much more likely to fall into these misuse categories while males were more likely to leave the belt hanging -- perhaps to try to avoid receiving a $25 citation.

Conclusion

Belt usage rates for drivers and front seat passengers in vehicles in North Carolina have remained amazingly constant over the years since shortly after the citation phase came into effect in 1987. It had been hoped that with the introduction of automatic seat belts, there would be a gradual increase in the overall usage rate. Such has not been the case to date. It would appear that the main avenue for increasing seat belt use in North Carolina is primarily through increased enforcement at the local level as will be discussed in Chapter V.

III. USAGE PATTERNS AND MISUSE RATES OF AUTOMATIC SEAT BELTS BY SYSTEM TYPE: AN UPDATE

Introduction

As far back as 1966, lap belts have been a requirement in vehicle engineering, and in 1968, shoulder belts joined lap belts as mandatory equipment. Although they were supplied to motorists, the usage rate was a slim 10 to 15 percent. The restraint type most commonly employed initially was a four-point system and then the interlocking three-point system was initiated in 1974. Now, however, there are many types of restraint systems used by manufacturers, each with distinct features that lead to varying usage rates. Most notably, automatic seat belts have found their way into cars of all price ranges, and the air bag is becoming an increasingly popular option. This chapter explores the belt usage rates of drivers of cars equipped with these different restraint types, and serves to update the contributions of Reinfurt, St. Cyr and Hunter (In Press).

Two new groups of data join the original data in the analysis. The first addition in the data collection efforts took place in the Fall of 1990, and the second in the Spring of 1991. The descriptive analyses that follow are arranged to show trends in these usage patterns.

Method

The data collection method for the most current data was identical to the methods used previously. One different element in this process was the selection of the data collection sites. As North Carolina is divided into six media markets, 36 collection sites were allocated among these pre-established market zones. Thus, six collection sites were selected in each media market. Positioned at a signal or stop-controlled intersection, data collectors identified late model cars (1986 and newer) for observation. For these cars with high-mounted rear brake lights, the data collectors recorded the driver's age (under 25, 25-54, 55 and older); gender; race (white, non-white); restraint type (e.g., motorized automatic shoulder belt vs manual three-point system); and usage of the shoulder and the lap belt. Also recorded was misuse of the shoulder belt such as belt being unhooked from the mounting position, excessive slack, or the belt placed under the arm of the driver, along with whether or not the restraint was used. In addition, the license plate number for cars with North Carolina license plates and the make, model and body style

of the car were also captured. The license plate number was then used to determine the Vehicle Identification Number (VIN) using the North Carolina vehicle registration file.

With the information supplied in the VIN, it was then necessary to use the VINDICATOR computer program to identify the specific type of automatic restraint system present in the vehicle. The output from this program specified that the system was either a three-point manual belt, automatic belt, or air bag with manual belt. However, this program does not provide the particular type of automatic restraint system found in the car.

Since evaluation of the several automatic seat belt systems was our primary focus, it was then necessary to use documentation distributed annually by the National Highway Traffic Safety Administration, the Insurance Institute for Highway Safety, and also the Geico Automobile Insurance Company. Using the vehicle description along with these references, the specific restraint type was identified for each car, with the automatic seat belts further categorized into motorized shoulder belt with manual lap belt, non-motorized shoulder belt only, and the non-motorized three-point belt.

Results

The distribution of the study sample of 8,175 late model passenger cars by restraint type system is shown in Table 4. The majority (74.8%) of the sampled vehicles had automatic seat belts, 8.5 percent had air bags with manual three-point belts and the remaining 16.7 percent had manual three-point belts without air bags. The column identified as 'Shoulder Belted %' represents drivers where the shoulder belt was in use. The next column, labeled 'Full System Usage %', indicates that the entire system was being used (e.g., if the system had a separate manual lap belt, then full system being used would mean that **both** the automatic shoulder belt **and** the manual lap belt were engaged). As will be seen, the main instance of misuse was when there was a manual lap belt that was not buckled.

The table is divided into three different time intervals: '1989-90' is composed of data collected in the periods January - March 1989, June - August 1989, and January - March 1990. Data labeled 'Fall 90' was collected September - November 1990 and that labeled 'Spring 91' collected April - June 1991. Detailed results from the '1989-90' survey are given in Reinfurt, St. Cyr, and Hunter (In Press).

Table 4. Percent shoulder belted and percent full system usage by restraint type.

	1989 - 90			Fall 90		
Restraint Type	Total	Shoulder Belted %	Full System Usage %	Total	Shoulder Belted %	Full System Usage %
Auto Belt	3079	79.6	68.7	1421	74.9	71.1
Motorized:						
Auto S/Manual L	413	94.2	28.6	137	90.5	37.2
Non-Motorized:						
Auto S	148	83.8	75.7	26	80.8	77.0
Auto S/Auto L	2518	76.9	74.9	1258	73.1	74.7
Air Bag	230	73.9	73.5	118	78.0	78.0
Manual Belt	831	76.3	73.8	81	81.5	82.7
Overall	4140	78.6	70.0	1620	75.5	71.8

	Spring 91			Overall		
Restraint Type	Total	Shoulder Belted %	Full System Usage %	Total	Shoulder Belted %	Full System Usage %
Auto Belt	1616	77.8	62.5	6116	77.1	68.5
Motorized:						
Auto S/Manual L	406	91.4	33.7	956	92.2	32.3
Non-Motorized:						
Auto S	76	77.6	30.3	250	80.4	62.0
Auto S/Auto L	1134	73.0	75.0	4910	74.0	75.9
Air Bag	344	64.8	65.7	692	70.2	70.5
Manual Belt	455	61.8	62.6	1367	71.0	71.6
Overall	2415	73.0	62.7	8175	75.5	68.2

It should be kept in mind that in both the air bag cars and the manual belt cars, the available restraint system was a manual three-point lap/shoulder belt.

Tables 4 and 5 show a marked decrease in full system usage as compared to shoulder belt usage in vehicles which have motorized automatic restraint systems. For example, the Ford Escort and Tempo in Table 5 show a marked decrease in overall percent usage from 89.0 and 98.7 to 26.3 and 37.2 percent,

respectively, between shoulder belted and full system use. Toyota Camry and Cressida show similar results with 97.7 and 92.9 percent overall shoulder belt use and 30.1 and 39.3 percent overall usage of the entire system, respectively. Looking at the non-motorized automatic shoulder belt category, the Volkswagen Jetta and Rabbit/Golf have the same rates of shoulder belt and full system use. However, due to the small sample size for the Volkswagen models in our data, it is difficult to make reliable conclusions concerning any differences in belt usage. The models listed in the non-motorized, automatic shoulder/automatic lap belt category show comparable percentages between shoulder versus full system use which is to be expected since it is an integrated three-point belt system mounted to the door.

Belt use by restraint type was also examined by age, gender, and race of the driver. As in the previous tables, restraint type categories include 'Auto Belts,' 'Air Bags,' and 'Manual Belts.'

Table 6 shows belt use by restraint type and age of driver. The age of the driver has been divided into three categories, under 25, 25 to 54, and greater than 54 years of age. Evaluation of shoulder belt use versus full system use in cars which have automatic seat belts shows a uniform pattern of lower full system usage rates compared to shoulder belted usage rates regardless of age. In the '1989-90' survey, 78.2 percent of drivers age 25 to 54 used the shoulder belt restraints while only 67.5 percent of this group used the full system. Similar results are also seen in 'Fall 90' and 'Spring 91' giving the corresponding overall results of 78.7 percent use versus 67.7 percent use, respectively. The other two age groups show similar results.

Use of manual belts in either air bag or non-air bag cars shows a strong correlation between shoulder belt and full system use in drivers over the age of 25. Due to the small sample size of drivers under the age of 25 as compared with the other categories, it is difficult to make definitive conclusions regarding their usage, although the data does suggest a lower percent usage of all restraint types for this age group.

Table 7 displays restraint usage rates by gender of driver. In vehicles which have the automatic system, a lower full system usage rate is seen compared to shoulder belt alone. This pattern holds for both males and females. That there is roughly a 10 percentage point difference in shoulder belt use versus full system use for both groups can be seen in the overall columns.

Table 5. Belt usage rate by type of automatic belt system for various make/model combinations.

Restraint Type	Make	Model	1989-1990 Total	1989-1990 Shoulder Belted %	1989-1990 Full System Usage %	Fall 90 Total	Fall 90 Shoulder Belted %	Fall 90 Full System Usage %
Motorized:	Ford	Escort	105	92.4	28.6	35	88.6	20.0
		Tempo	40	97.5	27.5	5	100.0	40.0
	Toyota	Camry	78	97.4	25.6	14	92.9	35.7
		Cressida	42	90.5	38.1	7	100.0	57.1
Non-Motorized:								
Auto S[1]	VW	Jetta	40	97.5	97.5	2	50.0	50.0
		Rabbit/Golf	46	80.4	80.4	3	66.7	66.7
Auto S/ Auto L	Buick	LaSabre	315	83.8	85.4	128	84.4	84.4
		Regal	114	71.1	73.7	58	74.1	75.9
	Chev.	Beretta	150	62.7	67.3	68	69.1	72.1
		Corsica	87	70.1	71.3	61	63.9	65.6
	Olds.	Calais	170	68.2	70.6	78	62.8	65.4
		Cutlass	99	74.7	77.8	43	72.1	72.1
	Pont.	Bonneville	195	80.5	81.0	61	85.2	85.2
		Grand AM	446	70.2	72.2	182	62.1	63.7
	Honda	Accord	106	71.7	72.6	61	75.4	75.4
		Prelude	67	83.6	83.6	28	82.1	85.7

[1]Most of these vehicles are not equipped with lap belts.

Table 5. Belt usage rate by type of automatic belt system for various make/model combinations. (Con't)

Restraint Type	Make	Model	Spring 91 Total	Spring 91 Shoulder Belted %	Spring 91 Full System Usage %	Overall Total	Overall Shoulder Belted %	Overall Full System Usage %
Motorized:	Ford	Escort	88	85.2	26.1	228	89.0	26.3
		Tempo	33	100.0	48.5	78	98.7	37.2
	Toyota	Camry	41	100.0	36.6	133	97.7	30.1
		Cressida	7	100.0	28.6	56	92.9	39.3
Non-Motorized:								
Auto S[1]	VW	Jetta	6	100.0	100.0	48	95.8	95.8
		Rabbit/Golf	1	0.0	0.0	50	78.0	78.0
Auto S/ Auto L	Buick	LaSabre	112	83.0	83.9	555	83.8	84.9
		Regal	46	71.7	73.9	218	72.0	74.3
	Chev.	Beretta	44	56.8	68.2	262	63.4	68.7
		Corsica	47	74.5	78.7	195	69.2	71.3
	Olds.	Calais	66	68.2	68.2	314	66.9	68.8
		Cutlass	57	73.7	73.7	199	73.9	75.4
	Pont.	Bonneville	57	78.9	78.9	313	81.2	81.5
		Grand AM	157	60.5	63.1	785	66.4	68.4
	Honda	Accord	32	78.1	81.3	199	73.9	74.9
		Prelude	44	72.7	75.0	134	79.9	81.3

[1]Most of these vehicles are not equipped with lap belts.

Table 6. Belt use by restraint type and age of driver.

Restraint Type	Age of Driver	1989-90 Total	1989-90 Shoulder Belted %	1989-90 Full System Usage %	Fall 90 Total	Fall 90 Shoulder Belted %	Fall 90 Full System Usage %
Auto Belts	< 25	335	71.6	53.4	315	66.0	59.7
	25-54	1997	78.2	67.5	765	77.3	73.1
	> 54	727	79.1	74.4	341	78.0	75.4
Air Bags	< 25	9	66.7	66.7	5	60.0	60.0
	25-54	162	75.3	75.3	62	75.8	75.8
	> 54	59	71.2	69.5	51	82.4	82.4
Manual Belts	< 25	55	81.8	80.0	8	12.5	25.0
	25-54	562	73.0	73.7	50	90.0	90.0
	> 54	214	78.0	78.0	23	87.0	87.0

Restraint Type	Age of Driver	Spring 91 Total	Spring 91 Shoulder Belted %	Spring 91 Full System Usage %	Overall Total	Overall Shoulder Belted %	Overall Full System Usage %
Auto Belts	< 25	257	66.5	47.9	907	68.2	54.0
	25-54	897	81.2	63.5	3659	78.7	67.7
	> 54	462	77.7	66.9	1530	78.4	72.4
Air Bags	< 25	36	33.3	36.1	50	42.0	44.0
	25-54	191	71.1	72.3	415	73.7	74.0
	> 54	123	64.2	65.0	233	70.7	70.0
Manual Belts	< 25	62	43.2	41.9	125	58.4	57.6
	25-54	256	63.3	64.1	868	71.1	71.8
	> 54	148	68.9	70.9	385	75.1	75.8

The usage rate for males drops from 77.7 percent shoulder belt to 67.2 percent full system while for females it goes from 76.7 percent to 66.6 percent, respectively. In the categories of manual belts either with or without air bags, the figures for shoulder belt use and full system use are very similar.

Belt use by restraint type and race of driver is displayed in Table 8. This data also shows a decline in full system use in cars with automatic shoulder belts. The percentages for non-white drivers do tend to be higher than for white drivers but the sample size differs greatly for the two groups with the larger sample size pertaining to white drivers. From this table, as with Tables 6 and 7, usage of shoulder belt versus full system is similar in automobiles with manual belts -- either with or without air bags.

Table 7. Belt use by restraint type and gender of driver.

Restraint Type	Gender	1989-90 Total	1989-90 Shoulder Belted %	1989-90 Full System Usage %	Fall 90 Total	Fall 90 Shoulder Belted %	Fall 90 Full System Usage %
Auto Belts	Male	1357	78.4	67.1	623	77.4	72.4
	Female	1702	77.4	68.0	798	73.1	69.3
Air Bags	Male	125	71.2	70.4	70	74.3	74.3
	Female	105	77.1	77.1	48	83.3	83.3
Manual Belts	Male	413	69.7	69.2	43	76.7	74.4
	Female	418	79.9	81.1	38	86.8	92.1

Restraint Type	Gender	Spring 91 Total	Spring 91 Shoulder Belted %	Spring 91 Full System Usage %	Overall Total	Overall Shoulder Belted %	Overall Full System Usage %
Auto Belts	Male	630	77.1	62.2	2610	77.7	67.2
	Female	983	78.3	62.0	3483	76.7	66.6
Air Bags	Male	187	59.9	60.4	382	66.2	66.2
	Female	163	71.2	72.4	316	75.0	75.6
Manual Belts	Male	172	58.1	57.0	628	67.0	66.2
	Female	294	65.0	67.0	750	74.4	76.1

Discussion

Since all 1990 and later model year cars are required to be equipped with passive restraints (i.e., automatic seat belts or air bags) following a gradual phase-in which started in 1987, and since relatively little is known about public acceptance of these new devices, an opportunity was seized upon to capture data on driver belt usage for new model cars in North Carolina. This survey was carried out in conjunction with our periodic statewide survey of belt use being done to help evaluate North Carolina's belt use law.

For the most part, the sample of 8,175 drivers were driving 1986 and later model year cars selected on the basis of having center, high-mounted rear brake lights. Some 74.8 percent of the sample were in automatic belt cars, 8.5 percent in air bag cars with manual three-point belts and the remaining 16.7 percent in cars equipped with manual three-point belts.

Table 8. Belt use by restraint type and race of driver.

Restraint Type	Race of Driver	1989-90 Total	1989-90 Shoulder Belted %	1989-90 Lap Belted %	Fall 90 Total	Fall 90 Shoulder Belted %	Fall 90 Lap Belted %
Auto Belts	White	2710	77.4	68.8	1291	74.4	70.8
	Non-White	349	79.9	58.5	129	80.6	69.8
Air Bags	White	217	74.2	73.7	111	77.5	77.5
	Non-White	13	69.2	69.2	7	85.7	85.7
Manual Belts	White	719	75.4	76.2	71	80.3	81.7
	Non-White	112	71.4	68.8	10	90.0	90.0

Restraint Type	Race of Driver	Spring 91 Total	Spring 91 Shoulder Belted %	Spring 91 Lap Belted %	Overall Total	Overall Shoulder Belted %	Overall Lap Belted %
Auto Belts	White	1431	77.3	63.2	5432	76.7	67.8
	Non-White	185	82.2	53.0	663	80.7	59.1
Air Bags	White	323	63.5	64.4	651	69.4	69.7
	Non-White	27	85.2	85.2	47	80.9	80.9
Manual Belts	White	429	62.7	63.6	1219	71.2	72.1
	Non-White	37	59.5	59.5	159	69.8	67.9

Overall shoulder belt usage rates for all systems (automatic belts 77.1 percent, air bag cars 70.2 percent, manual belts 71.0 percent) exceeded the statewide average of approximately 60 percent largely because these vehicles were nearly all new model cars. Within the automatic belt group, shoulder belt usage was highest (92.2%) for the motorized automatic shoulder/manual lap belt system, intermediate (80.4%) for the non-motorized system with automatic shoulder belts and lowest (74.0%) for the non-motorized automatic shoulder/automatic lap belt system.

This survey looked at several types of automatic seat belt misuse by drivers. The main type of misuse consisted of drivers not fully utilizing the restraint system available. This area of misuse was examined with respect to several different categories: age, gender, and race of driver.

As mentioned above, the main type of misuse, failing to utilize the full restraint system provided, is primarily seen in vehicles which have motorized shoulder belts and manual lap belts such as the Ford Escort and Tempo and the Toyota Camry and Cressida. Overall, with automatic belt systems, we have

detected a decline of shoulder belted use from 77.1 percent to 68.5 percent full system usage. The three-point system found in vehicles with and without air bags shows shoulder belt and full system use to be within one percentage point of one another.

Evaluation of shoulder belt use versus full system use in cars which have automatic seat belts shows a uniform pattern of less full system usage compared to shoulder belt usage regardless of driver age. Overall shoulder belt usage for drivers between the age of 25 and 54 in vehicles with automatic belts is 78.7 percent with only 67.7 percent using the full system. The other two age groups show a similar pattern. Overall shoulder belt usage for vehicles with air bags with the manual three-point system show a relatively high percentage of drivers who use the full system for drivers over the age of 25. The results are similar for vehicles which are not equipped with air bags but do have the manual three-point system. Data for drivers under the age of 25 show a reduced use of both the shoulder belt and full system when compared with drivers over the age of 25 but it is difficult to draw any definitive conclusions regarding this age group due to the smaller sample size.

Our sample also looked at seat belt usage rates for males and females. The data show that persons which have the automatic system have a lower full system usage rate compared to the use of the shoulder belt alone, regardless of gender. There is roughly a 10 percentage point difference in shoulder belt use versus full system use for both groups. In the categories of manual belts either with or without air bags, the figures for shoulder belted use and full system use are very similar.

Seat belt usage by race of driver was also examined. The results again show a decline in full system use in cars which have automatic shoulder belts. The data does suggest a higher percentage of non-white drivers using the full system when compared to white drivers.

Throughout our surveys, the data show a decreased use of the full system in vehicles which have automatic shoulder belts and manual lap belts (down to 32.3%). There is little difference in use of the full system compared to shoulder belted use alone in vehicles with manual belts -- either with or without air bags. Since air bags are designed to be supplemental systems, it is also necessary for occupants to use their vehicle's full system in order to get the maximum protection. This survey has found that 70.5 percent of

drivers do receive this maximum protection in vehicles which are equipped with air bags.

IV. STATEWIDE ACCIDENT DATA

Background

The evaluation by Reinfurt, Campbell, Stewart and Stutts (1988) documented the decrease in injuries to occupants covered by the seat belt law during the first three years of implementation. In that study of reportable crashes in North Carolina for the period January 1981 to June 1988, they used descriptive analyses for particular study groups of interest which showed a downward trend during this period for persons covered by the law. In addition, time series models confirmed the results demonstrating the success of the statewide seat belt law in reducing motor vehicle injuries.

Three study groups have been of interest in examining the changes in injuries from motor vehicle crashes over the period since the seat belt law became effective. These groups include the following:

(1) Covered occupants: front seat occupants of vehicles targeted by the law;

(2) Non-covered occupants: rear seat occupants of vehicles targeted by the law; occupants of other vehicles not covered by the law; and

(3) Non-occupants: pedestrians, bicyclists, etc.

The extent to which the shift in injuries was seen only by covered occupants **and** only at the outset of the warning ticket phase or at the beginning of the citation phase would provide evidence of the effectiveness of the law. Certainly a law targeted at front seat occupants should have no effect on either the second group (rear seat occupants and occupants of vehicles not covered by the law) or non-occupants who do not have seat belts available. Thus, HSRC's analyses of injury reductions have focused on these three study groups.

Results

Various injury distributions for the three study groups are presented in Figures 3-7. The data points outlined in bold represent the 12 months of this current project period. Injury data are included for nearly five years prior to the law (1981 through September 1985), 15 months of the warning ticket phase, and then 4-1/2 years into the citation phase.

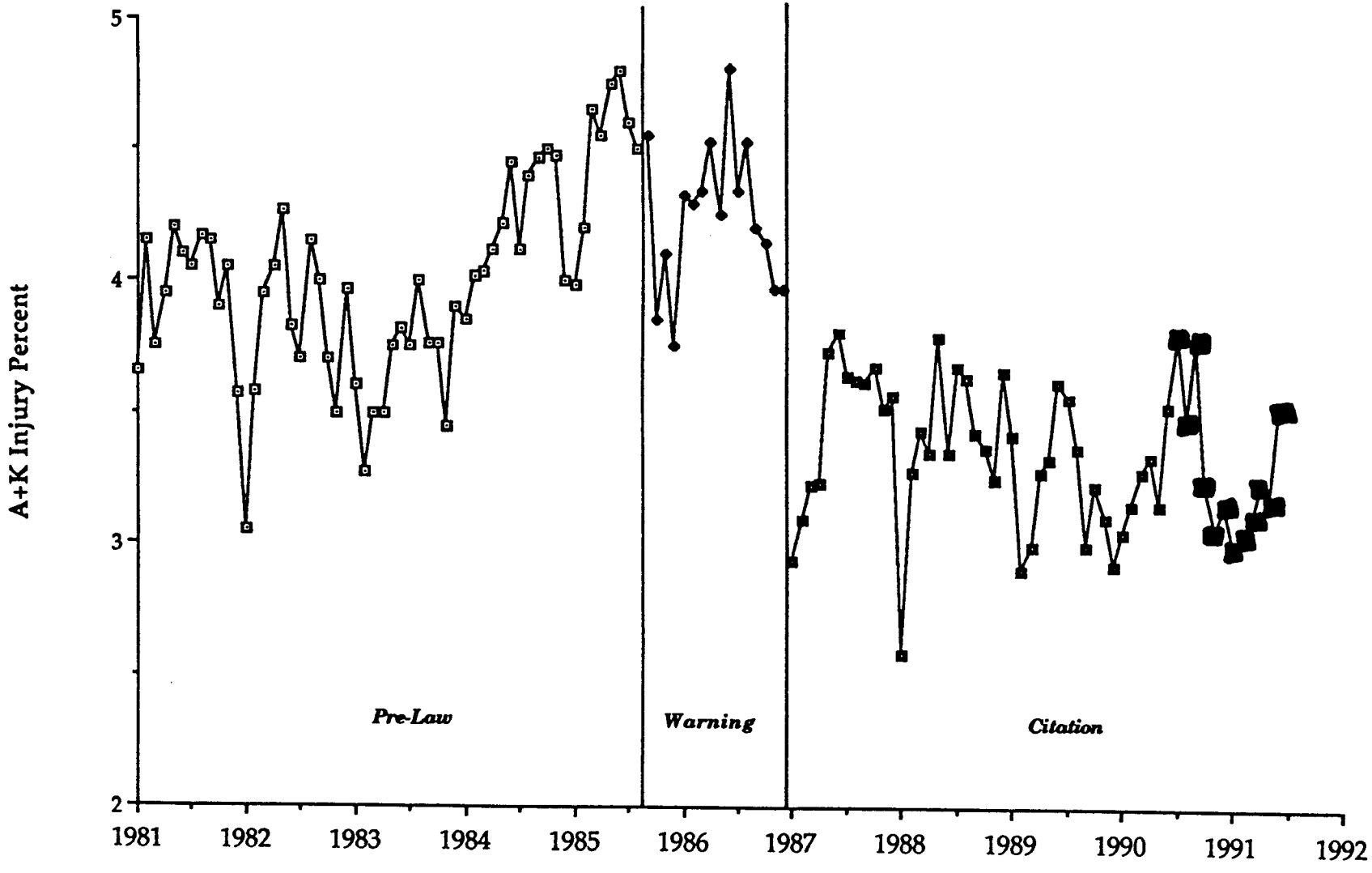


Figure 3. A+K Injury distribution for covered occupants.

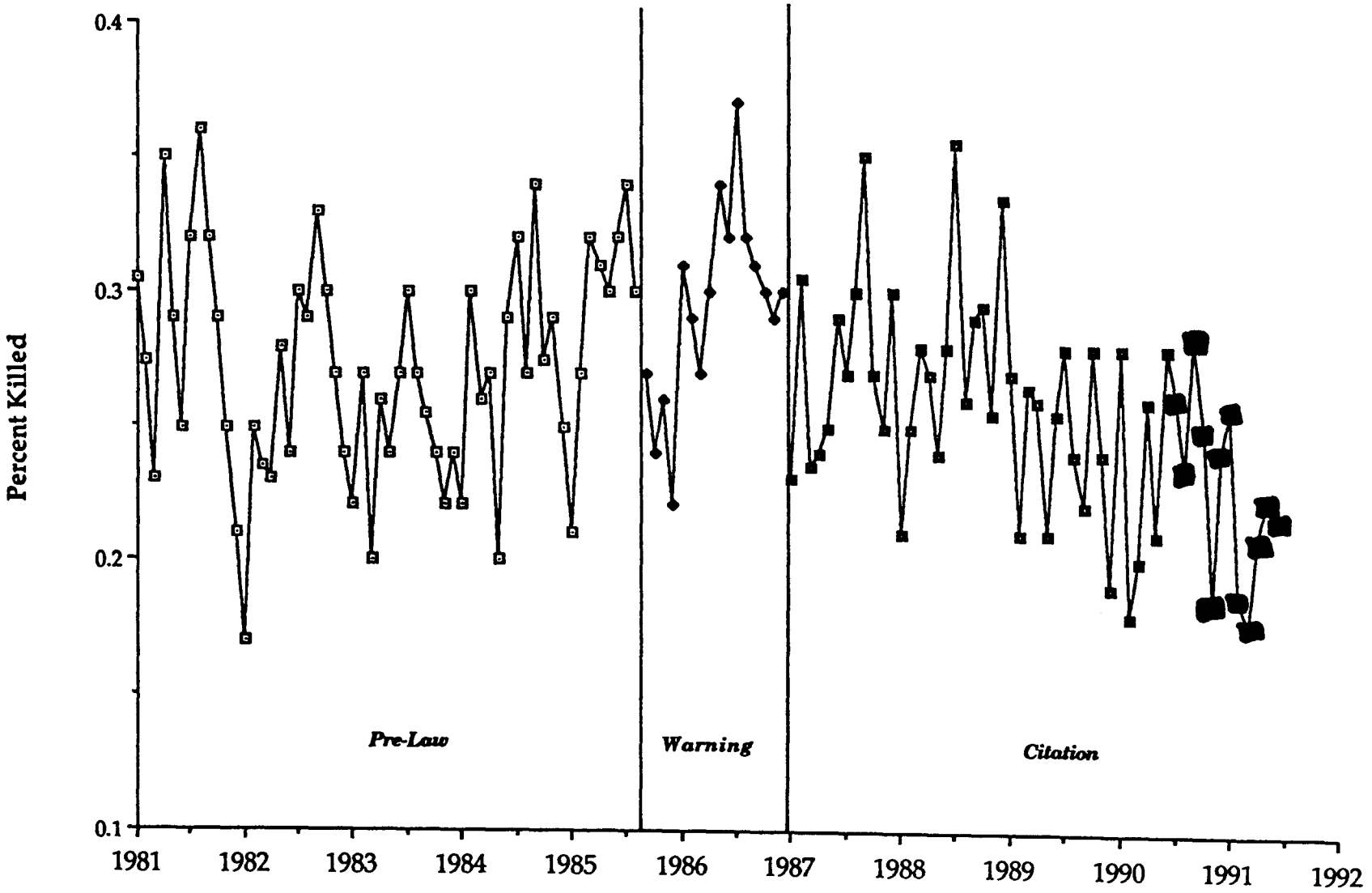


Figure 4. Percent killed injury distribution for covered occupants.

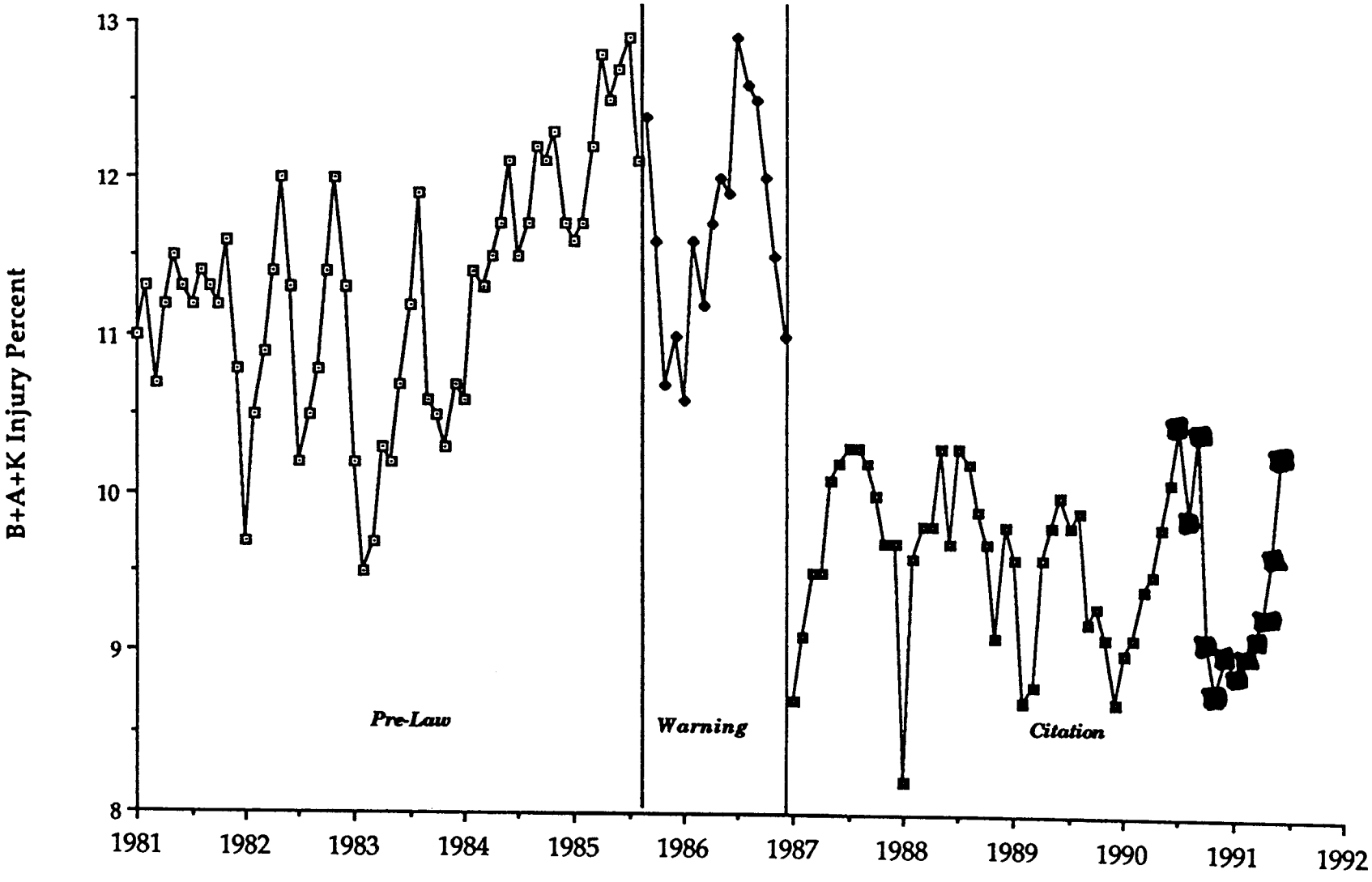


Figure 5. B+A+K Injury distribution for covered occupants.

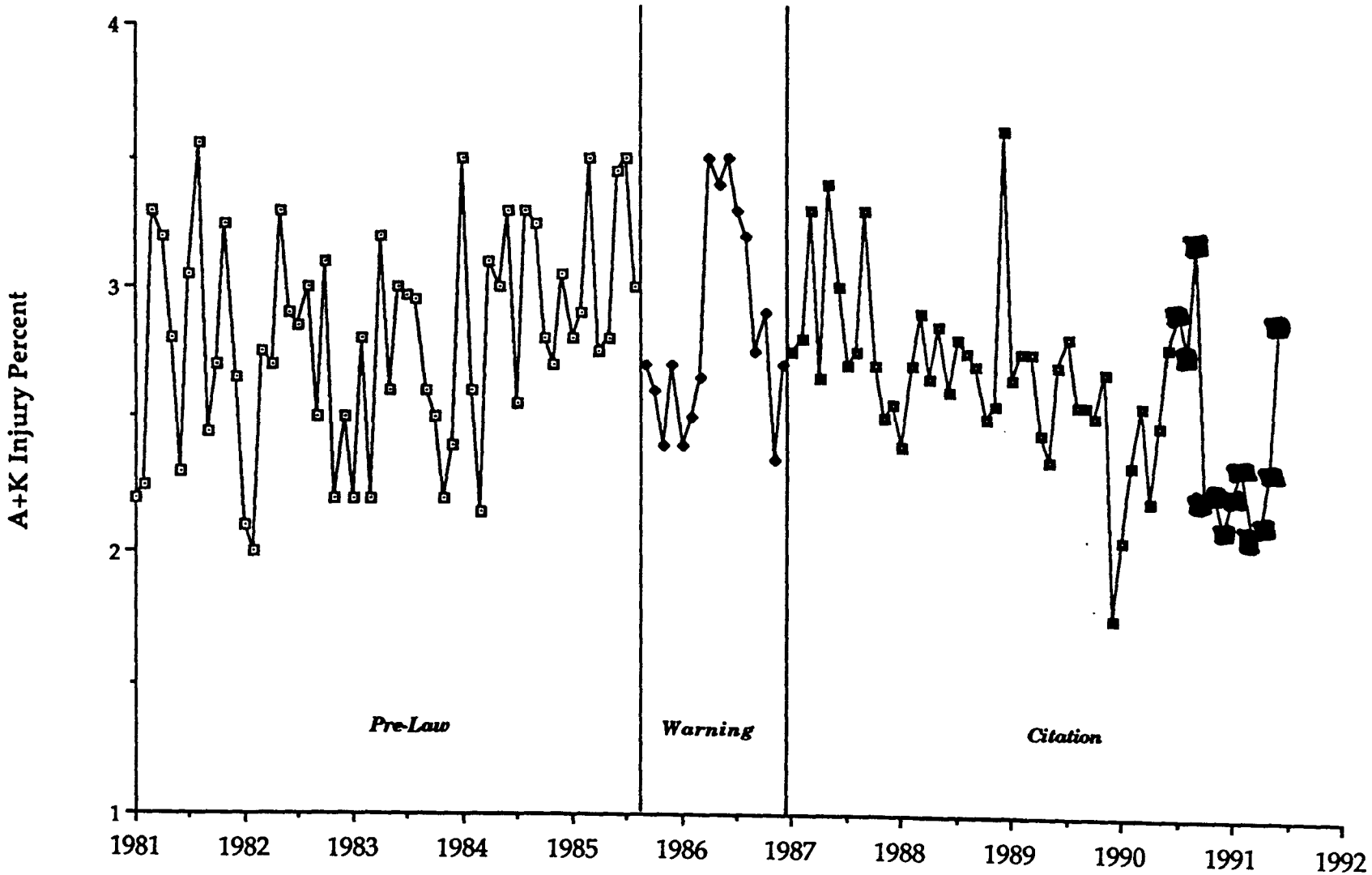


Figure 6. A+K injury distribution for non-covered occupants.

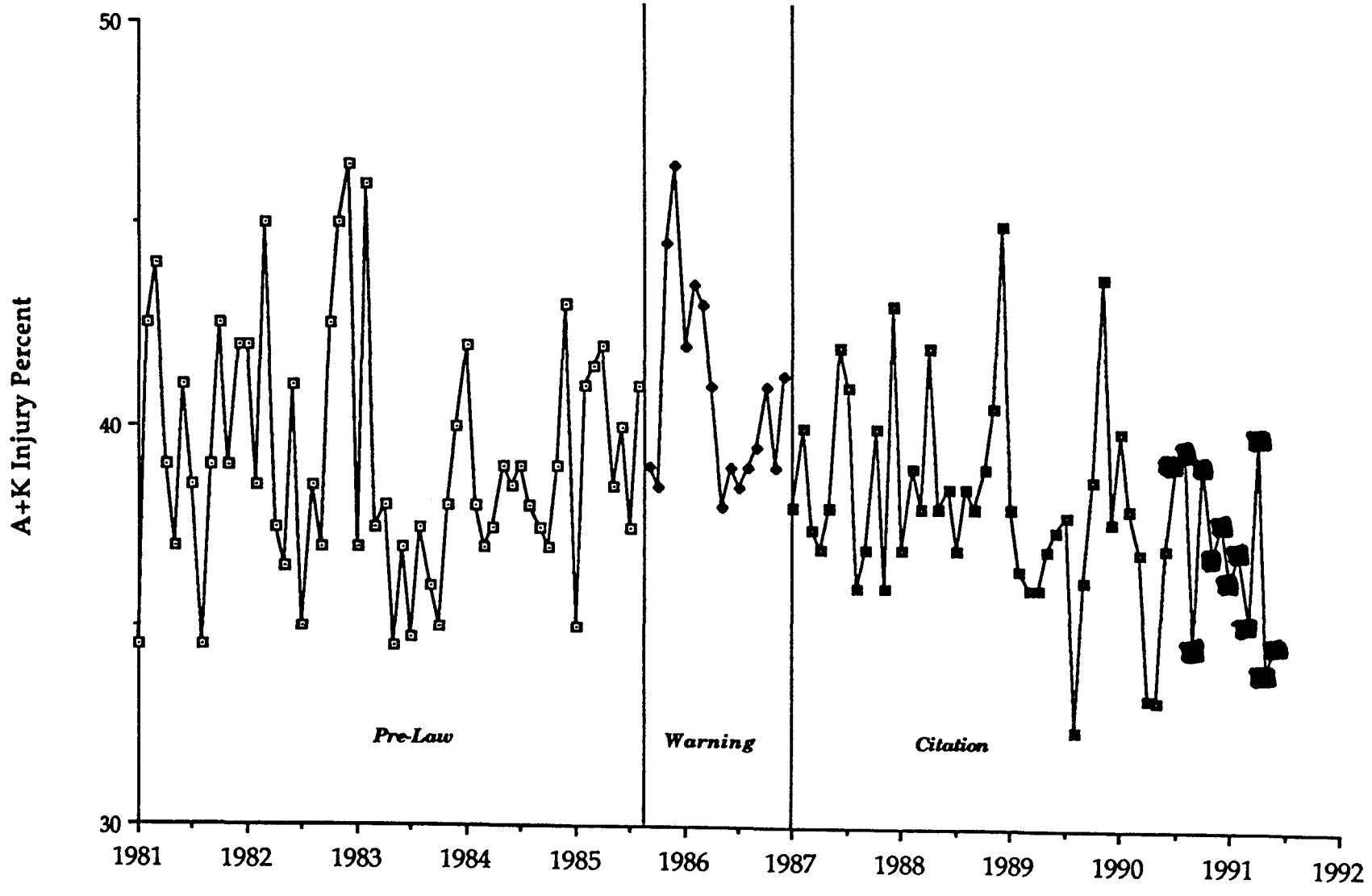


Figure 7. A+K injury distribution for non-occupants.

As pointed out previously, there is clearly a significant decrease in the serious or worse injury percentages for covered occupants following the implementation of both the warning ticket phase and the citation phase (see Figure 3). Less dramatic but still evident is a decrease in fatality rates particularly during the citation phase for covered occupants (see Figure 4). The most dramatic decrease is seen for moderate or worse (i.e., B+A+K) injuries as is seen in Figure 5.

Comparing Figure 3 for serious injuries to covered occupants with Figures 6 and 7 for similar injuries to non-covered occupants and non-occupants, respectively, one sees no similar abrupt changes in serious injury for the latter two groups.

Previous analyses using time series methods have shown statistically significant injury reductions for covered occupants at all three injury levels at both the onset of the warning ticket phase and more dramatically at the beginning of the citation phase. The only exception is for fatality reduction at the beginning of the warning ticket phase. No corresponding significant reductions were seen for either the non-covered occupants or for the non-occupants.

Conclusion

Comparing the trends seen in Figures 3-5 with those in Figures 6 and 7, it is clear that the seat belt law has maintained a positive effect on motor vehicle crash injuries.

V. ENFORCEMENT EVALUATION

After the seat belt law became effective, principal questions to be addressed were: How are the police departments enforcing this law? What techniques are being used? To what level or extent is it being enforced? The Governor's Highway Safety Program has been studying the patterns of this enforcement for the past several years. These questions have been addressed from both the state and local level.

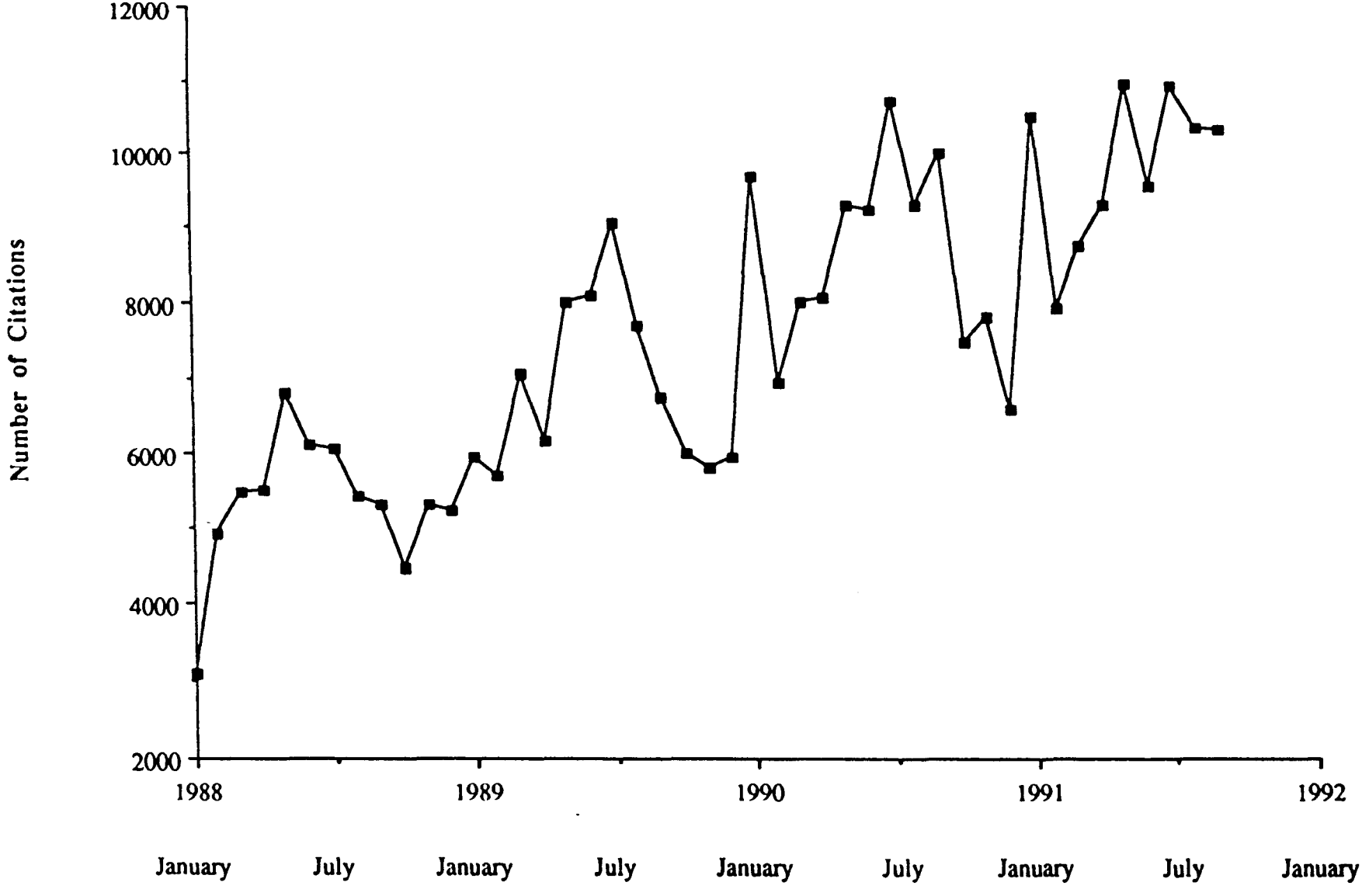
To assess the degree to which the North Carolina State Highway Patrol has been enforcing this law, the number of warnings and citations have been documented since October 1, 1985. To target the local enforcement activities, a questionnaire has been sent annually to all police and sheriffs' departments in the State of North Carolina since 1987.

During the warning phase of the seat belt law, the monthly totals of Highway Patrol warnings were compiled from October 1, 1985 through December 31, 1986. Since January 1, 1987, the number of $25 citations have similarly been recorded. In evaluating the seat belt law statewide, Reinfurt, et al. (1988) noted that the average monthly **warnings** were approximately 10,000 and that in 1987, over 3,100 **citations** were issued each month.

Monthly seat belt citations issued by the Highway Patrol since January 1, 1988, are shown in Figure 8. Note the general trend of increasing citations. The monthly average increased from 3,135 in 1988 to 8,966 in 1990, which shows a strong commitment to enforce this law by the State Highway Patrol. Also note in Figure 8 the occasional peaks, which generally correspond to Memorial Day, July 4th and Labor Day, when enforcement activities are greater. Two of the highest points span Memorial Day weekends that fell within the month designated as North Carolina Lifesavers' Month.

To understand enforcement activities at the local level, a mail survey was sent to all police departments in North Carolina. In designing the survey instrument, it was of importance to also gain feedback concerning air bags and automatic seat belts, in addition to information regarding seat belt law enforcement activities. Questions addressing these newer restraint systems focused on assessing the departments' degree of exposure to these systems and inquiring about any significant experiences related to crashes involving these systems. Since the officers are actually involved with investigating these accidents, their responses in this area proved to be very useful. Other areas

Figure 8. Monthly seat belt citations issued by the North Carolina State Highway Patrol.



covered by the questionnaire included community seat belt education activities and approaches to issuing citations. See Appendix B for details on both the questionnaire and the letters sent to the local police chiefs.

Of the 387 surveys sent, responses were received from 227 departments, providing an overall response rate of 59 percent. Table 9 lists the response rate by population grouping, showing an increase in response rate associated with an increase in population size. It should be mentioned that in each year

Table 9. Distribution of 1991 enforcement survey returns by population of community.

Population	Surveys Mailed	Surveys Returned	Response Rate %
< 2,500	225	102	45.3
2,500 - 9,000	109	77	70.6
10,000 - 49,000	42	36	87.8
> 50,000	12	12	100.0
Overall	387	227	58.7

of the survey, different departments as well as different departmental officers within departments have responded. This leads to some yearly variation in the synthesis of the survey information and should be kept in mind while reviewing the various results across years.

With respect to enforcement activities, it is clear that departments have varying opinions about enforcing the seat belt law. One completed survey stated that citations are not issued for "a law he doesn't believe in"; however, in contrast, another police department replied that the "overall attitude towards seat belt enforcement has improved." In addition, some departments only issue warning tickets for seat belt violations, whereas others vigorously enforce seat belt non-use as a primary violation.

Of the departments that responded, 42.7 percent said that their officers only occasionally stop vehicles to issue seat belt citations without other violations such as speeding being involved. And 40.5 percent reported that they use seat belt violations occasionally to establish probable cause for stopping vehicles suspected of other violations such as DWI or possession of drugs. Of these, 20.0 percent found this approach to be very effective.

Table 10 shows the average number of monthly citations by size of community. Since some questionnaires were incomplete, totals less than 227 for 1991 indicate missing or unavailable information -- likewise for earlier surveys. Smaller communities generally had a monthly citation average of less than one, while most communities greater than 10,000 issued more than ten citations. However, on a per capita basis (denoted in brackets in Table 11), the rates are quite variable. As is shown, the smaller communities are not always less active in their seat belt law enforcement. Note that in 1991, Statesville had an enforcement rate of 5.7 per 10,000 population and Charlotte, the largest of these communities, had a relatively low citation rate of 1.1 per 10,000 population.

Turning to the topic of automatic restraint systems, 49 percent of the responding departments reported that none of their fleet of police cars was equipped with an air bag while 42 percent had between one and ten cars with air bags. It is, of course, the larger departments that have the newer vehicles equipped with air bags. In their accident investigation, 62.1 percent of the police departments reported that they had not investigated any accidents involving an air bag, while almost 20 percent of the departments had reported on at least three crashes involving an air bag car. When asked whether they had observed any problems with the newer automatic seat belts such as the motorized shoulder belt found in recent model Fords and Toyotas, 71 percent responded that they had.

When asked to respond to open-ended questions regarding the effectiveness of the air bag, the responses were positive. One southern county police department reported that while en route to an armed robbery and murder, an officer lost control of his automobile and hit a pole head on, traveling at 75 mph. Amazingly the officer was uninjured. Another success story reported that the air bag prevented "loss of life or serious injury" to an officer in their police department. Most of the respondents were optimistic about its role in traffic safety, noting successful deployment when necessary and corresponding reduced injury.

With respect to the automatic seat belts, concerns ranged from comfort to usage. One police department noted that "Citizens express fear that automatic seat belts without manual fasteners could be dangerous in the event of fire or overturn." Another department reported that there had been minor complaints of injuries to neck and face due to the belt failing to retract

Table 10. Average number of seat belt citations issued monthly by population of community.

Ave. No. Citations Per Month	Communities with Population < 2,500	2,500-9,999	10,000-49,999	50,000+	Total
1987 Seat Belt Citations					
< 1	57 (83.8)[1]	24 (54.6)	6 (22.2)	0 (0.0)	87 (59.2)
1-4	10 (14.7)	15 (34.1)	7 (25.9)	1 (12.5)	33 (22.4)
5-9	0 (0.0)	3 (6.8)	6 (22.2)	2 (25.0)	11 (7.4)
10+	1 (1.5)	2 (4.5)	8 (29.7)	5 (62.5)	19 (12.8)
Total	68	44	27	8	147[2]
1988 Seat Belt Citations					
< 1	55 (78.6)	29 (58.0)	2 (7.1)	0 (0.0)	86 (54.4)
1-4	12 (17.1)	14 (28.0)	10 (35.7)	1 (10.0)	37 (23.4)
5-9	2 (2.9)	4 (8.0)	4 (14.3)	4 (40.0)	14 (8.9)
10+	1 (1.4)	3 (6.0)	12 (42.9)	5 (50.0)	21 (13.3)
Total	70	50	28	10	158[2]
1989 Seat Belt Citations					
< 1	61 (71.8)	30 (53.4)	2 (6.5)	0 (0.0)	93 (50.8)
1-4	21 (24.7)	20 (35.8)	12 (38.7)	2 (18.2)	55 (30.1)
5-9	2 (2.4)	3 (5.4)	8 (25.8)	2 (18.2)	15 (8.2)
10+	1 (1.1)	3 (5.4)	9 (29.0)	7 (63.6)	20 (10.9)
Total	85	56	31	11	183[2]
1990 Seat Belt Citations					
< 1	64 (64.7)	28 (46.7)	2 (6.3)	1 (9.1)	95 (47.0)
1-4	30 (30.3)	23 (38.3)	15 (46.9)	2 (18.2)	70 (34.7)
5-9	3 (3.0)	5 (8.3)	3 (9.4)	1 (9.1)	12 (5.9)
10+	2 (2.0)	4 (6.7)	12 (37.5)	7 (63.6)	25 (12.4)
Total	99	60	32	11	202[2]
1991 Seat Belt Citations					
< 1	58 (60.4)	33 (44.0)	6 (17.1)	1 (8.3)	98 (45.0)
1-4	32 (33.3)	29 (38.7)	8 (22.9)	2 (16.7)	71 (32.6)
5-9	4 (4.2)	8 (10.7)	6 (17.1)	1 (8.3)	19 (8.7)
10+	2 (2.1)	5 (6.6)	15 (42.9)	8 (66.7)	30 (13.7)
Total	96	75	35	12	218[2]

[1]Column percent
[2]Citation data not available from all questionnaires

Table 11. Average number of seat belt citations issued each month for larger North Carolina communities. [Rates per 10,000 population given in brackets.]

	Population (June 1987) Estimate	1987	1988	1989	1990	1991
Charlotte	388,995	94.2 [2.4]	36.1 [0.9]	37.3 [1.0]	7.0 [0.2]	42.8 [1.1]
Raleigh	213,879	157.9 [7.4]	160.3 [7.5]	101.3 [4.7]	296.7 [13.9]	535.2 [25.0]
Greensboro	184,098	--[1] [--]	122.8 [6.7]	342.9 [18.6]	404.3 [22.0]	218.8 [11.9]
Winston-Salem	150,246	-- [--]	-- [--]	88.3 [5.9]	107.0 [7.1]	269.0 [17.9]
Fayetteville	73,043	26.7 [3.7]	99.2 [13.6]	57.5 [7.9]	113.5 [15.5]	50.0 [6.8]
High Point	67,060	12.3 [1.8]	12.8 [1.9]	25.6 [3.8]	15.3 [2.3]	43.8 [6.5]
Asheville	60,429	2.8[2] [0.5]	1.2[2] [0.2]	1.0[2] [0.2]	0.5[2] [0.1]	13.3 [2.2]
Wilmington	55,458	12.7 [2.3]	8.5 [1.5]	3.8 [0.7]	2.8 [0.5]	3.0 [0.5]
Gastonia	54,606	8.3[2] [1.5]	8.3 [1.5]	7.2 [1.3]	3.5 [0.6]	5.7 [1.0]
Rocky Mount	49,191	13.4 [2.7]	5.6 [1.1]	1.0 [0.2]	0.3 [0.1]	1.5 [0.3]
Greenville	43,130	21.3 [4.9]	3.3 [0.8]	5.2 [1.2]	11.0 [2.6]	20.2 [4.7]
Cary	39,094	20.0[2] [5.1]	20.0[2] [5.1]	30.0[2] [7.7]	30.0[2] [7.7]	45.8 [11.7]
Burlington	38,798	30.2 [7.8]	18.9 [4.9]	32.1 [8.3]	28.5 [7.4]	54.3 [14.0]
Chapel Hill	37,688	8.6 [2.3]	4.2 [1.1]	1.3 [0.3]	1.5 [0.4]	0.5 [0.1]
Goldsboro	34,722	6.8 [2.0]	10.2 [3.0]	8.3 [2.3]	8.0 [2.3]	10.0 [2.9]
Kannapolis	32,431	16.8 [5.2]	18.8 [5.8]	31.0 [9.6]	62.5 [19.3]	70.8 [21.8]
Jacksonville	29,547	0.3[2] [0.1]	0.2[2] [0.1]	1.8[2] [0.6]	1.3[2] [0.5]	-- [--]
Concord	28,408	8.0 [2.8]	3.6 [1.3]	4.2 [1.5]	3.5 [1.2]	8.3 [2.9]
Salisbury	23,966	-- [--]	3.6 [1.5]	41.3 [17.2]	46.5 [19.4]	51.0 [21.3]
Lumberton	20,087	1.3 [0.6]	1.0 [0.5]	2.9 [1.4]	1.8 [0.9]	0.8 [0.4]
Statesville	19,755	8.0 [4.0]	9.0 [4.6]	6.5 [3.3]	28.5 [14.4]	11.3 [5.7]

[1]Indicates information not available or unknown.
[2]Numbers reported as "approximate".

rapidly enough as passengers attempt to exit the car. Lastly, one respondent wrote that one victim reported being choked by the shoulder belt.

In the arena of public education, a variety of activities were listed in the survey to which the respondent answered "often", "sometimes", or "never". The percent of those who answered in each category is listed in Table 12. As was the case in previous years, the most widely participated-in activities

Table 12. Participation by local police departments in other seat belt enforcement or education activities since January, 1991.

	% Responding		
Seat Belt Enforcement/Education Activity	Often	Sometimes	Never
Conducted seat belt checks at roadblocks, etc.	16	47	34
Issued press releases, news stories etc. about seat belts	7	33	56
Made presentations to school, civic, business or church groups	18	44	35
Sponsored special activities or events in conjunction with Child Passenger Safety Awareness Week in February 1991	8	26	62
Sponsored special activities or events in conjunction with Buckle Up America Week or Lifesavers' Month, May 1991	6	26	63
Conducted public education programs concerning air bags or automatic seat belts	5	8	82

were seat belt checks at roadblocks, with 16 percent of departments responding "often" and 47 percent responding "sometimes"; and presentations to school, civic, business or church groups, with 18 percent responding "often" and 44 percent responding "sometimes". The most neglected activity appears to be public education programs concerning air bags or automatic seat belts, as is shown by the 82 percent of departments who conveyed that they had never participated in this activity.

Other activities mentioned were programs carried out by the Boy Scouts, and providing information booths at various local events. Many of the smaller departments, indicated that they could not, however, afford to carry out extensive education programs due to limited resources, but reported that they "would if they could". Even with constrained finances and few officers, the smaller communities are working at educating the public. One survey from a

small town replied that word of mouth was the most effective means of education. So clearly varying approaches are being used to communicate the importance of seat belts.

In summary, the levels of enforcement of the seat belt law remain quite variable among North Carolina communities. However, the general trend is that enforcement activities are on the rise. Police officers are very optimistic about the effectiveness of the air bag, and relayed that the public has been quite positive to this new device. With respect to automatic seat belts, many problems need to be "ironed out". The bottom line is that the need still exists for local police departments to identify the most effective means of educating the public and enforcing these laws in their own unique setting.

VI. A FOLLOW-UP STUDY OF THE OVERREPRESENTATION OF SEAT BELT NON-USERS IN ACCIDENTS AND VIOLATIONS[1]

Background

For a number of years researchers from the University of North Carolina Highway Safety Research Center (HSRC) have estimated statewide seat belt use rates from field observations made at 72 locations across the state. During the months of June and July 1987, while making the field observations the same researchers also distributed some 10,000 mailback seat belt use questionnaires (shown in Figure 9). The questionnaires were color-coded to distinguish between drivers who were using seat belts at the time of the survey from those who were not. A total of 5,074 questionnaires were returned, and of these, 4505 questionnaires could be linked via name and address to a corresponding driver history record. Thus, the seat belt observation, the questionnaire responses, and the driving record over the 1983-1986 time period formed the basis of a study file for investigating relationships between seat belt use and crash involvement.

Results from analyses on the data file were presented by Hunter, Stutts, Stewart, and Rodgman (1988A) and (1988B). Among the findings was that drivers who did not use seat belts had higher accident and violation involvement rates than those who did. This was found to hold both in terms of observed belt use at the time of the survey, and in terms of the respondents' self-reported belt use, where higher reported use rates corresponded to lower accident and violation rates. Moreover, these results could not be attributed solely to differences in the driver characteristics of age, gender, and reported annual mileage, though seat belt users and non-users did, in fact, differ with respect to each of these characteristics.

For the current study, information from the driver history files covering the time period from January 1987 through June 1990 was added to the existing study file. A primary goal in the analysis was to examine the extent to which the overrepresentation previously reported, based on prior accidents and violations, persisted over a time period following the seat belt observations and the survey.

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[1]Prepared and written by Dr. J. Richard Stewart.

UNC Seat Belt Survey

1. A N.C. law that began Oct. 1985 requires drivers and front seat passengers of motor vehicles to wear seat belts. What is your opinion of this law?
   - ☐1 strongly oppose
   - ☐2 moderately oppose
   - ☐3 not sure
   - ☐4 moderately support
   - ☐5 strongly support

2. **Before** the law went into effect Oct. 1985, how often did you wear your seat belt when driving?
   - ☐1 never
   - ☐2 rarely
   - ☐3 sometimes
   - ☐4 most of the time
   - ☐5 always

3. Between Oct. 1985 and Jan. 1987, there was no fine for not wearing a seat belt. **During this "grace" period** how often did you wear your seat belt when driving?
   - ☐1 never
   - ☐2 rarely
   - ☐3 sometimes
   - ☐4 most of the time
   - ☐5 always

4. Since Jan. 1987 drivers not wearing seat belts may be fined $25. How often do you wear a seat belt **now** when driving?
   - ☐1 never
   - ☐2 rarely
   - ☐3 sometimes
   - ☐4 most of the time
   - ☐5 always

5. What is your opinion of the $25 fine?
   - ☐1 There should not be a fine
   - ☐2 There should be a lower fine → $ _____
   - ☐3 There should be a higher fine → $ _____
   - ☐4 The $25 fine is about right

6. Were you wearing your seat belt at the time this survey was given to you?
   - ☐1 no ☐2 yes ☐3 no belts in vehicle

7. How many total miles was the trip you were making at the time this survey was given to you?
   - ☐1 Less than 5 miles
   - ☐2 5 - 9 miles
   - ☐3 10 - 19 miles
   - ☐4 20 - 49 miles
   - ☐5 50 miles or more

8. For those times that you **do** wear a seat belt, please check the **one** most important reason.
   - ☐1 To avoid the $25 fine.
   - ☐2 Because it's the law.
   - ☐3 To prevent injury if in an accident.
   - ☐4 Because my friends/family want me to.
   - ☐5 It's a habit; I don't think about it.
   - ☐6 Because of my own experience in an accident.
   - ☐7 Because of someone else's experience in an accident.
   - ☐8 *Check here if you never wear a seat belt.*

9. For those times that you do **not** wear a seat belt, please check the **one** most important reason.
   - ☐1 Seat belts don't prevent injuries.
   - ☐2 Seat belts are likely to cause injuries.
   - ☐3 Seat belts are uncomfortable; they don't let me move around.
   - ☐4 I'm afraid of being trapped in my car if it catches on fire or goes under water.
   - ☐5 I only wear seat belts on long trips or in bad weather.
   - ☐6 I'm a careful driver; I don't need to wear seat belts.
   - ☐7 I forget; I'm not in the habit.
   - ☐8 *Check here if you always wear a seat belt.*

10. About how many total miles do you drive or ride each year?
    - ☐1 Less than 5,000 miles
    - ☐2 5,000 - 9,999 miles
    - ☐3 10,000 - 14,999 miles
    - ☐4 15,000 - 19,999 miles
    - ☐5 20,000 - 29,999 miles
    - ☐6 30,000 - 39,999 miles
    - ☐7 40,000 - 49,999 miles
    - ☐8 50,000 or more miles

11. Out of 100 N.C. drivers, how many do you think are likely to be in an accident in the next 2 years?

    _____ drivers

12. On a scale from 0 to 100, please tell us how likely you think **you** are to be in an accident in the next two years.

    (0 means that you certainly will not be in an accident and 100 that you certainly will.)

    0 10 20 30 40 50 60 70 80 90 100
    ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐ ☐
    Certainly will not — Certainly will

13. How much control do you feel you have in preventing an accident?
    - ☐1 Almost total control
    - ☐2 A lot of control
    - ☐3 Moderate control
    - ☐4 A little control
    - ☐5 Very little control

14. If you could vote today, would you vote to keep the N.C. seat belt law?
    - ☐1 yes ☐2 no ☐3 not sure

15. What is your highest level of education?
    - ☐1 grade school
    - ☐2 attended high school
    - ☐3 graduated high school
    - ☐4 attended college
    - ☐5 graduated college
    - ☐6 post college degree

16. Your marital status?
    - ☐1 married
    - ☐2 separated or divorced
    - ☐3 widowed
    - ☐4 never married

17. Your date of birth?

    _____ _____ _____
    month day year

Please complete the following. This part of the survey will be your entry for the drawing and our way of notifying you if you win, so please print clearly. We would also like to contact a few of you later by telephone for a brief follow-up interview. Those who are interviewed will have a chance to win **an additional $500.** If willing to be called, be sure to give us your telephone number and a best time to call.

Name _____ (First) (Middle) (Last)

Address _____ (Street name, P.O. Box, etc.)

_____ (City or Town) (State) (Zip Code)

Telephone Number: Home ( ) _____

Work ( ) _____

Best time to call:
☐ Morning ☐ Evening
☐ Afternoon ☐ Weekend

Preferred hours:
_____ to _____ ☐ a.m. ☐ p.m.

Thank you!

Figure 9. UNC Seat Belt Survey.

Results

Basics

A total of 4499 of the original 4505 subjects were located on the 1990 driver history file. Information concerning accidents and violations involving these subjects during the 3-1/2 year period January 1987 - June 1990 was extracted and added to the study file. Interestingly, over the 4-year '83-'86 period, the 4505 drivers were involved in 1,038 accidents and 1,848 violations, while in the 3-1/2 year '87-June '90 period the 4499 drivers were involved in 1,068 accidents and 1,869 violations. Thus, average accidents per driver per year increased from .0576 to .0678, and average violations per driver per year increased from .1026 to .1187 from the earlier to the later period. As will be discussed later, these increases seem, for the most part, to be due to increased exposure among drivers in the youngest age category.

Since only six subjects were lost from the study group, descriptions of the subjects in terms of demographics, attitudes, etc. are the same as presented in Hunter, et al. (1988A).

Overrepresentation

In addition to the color coding which indicated the subject's seat belt status at the time the questionnaires were distributed, the survey instrument also asked questions concerning the subjects current seat belt use. Five response options were listed: never, rarely, sometimes, most of the time, always. Table 13 shows a cross-tabulation of reported vs observed seat belt use. In terms of observed belt use, the reported belt use categories

Table 13. Reported belt use by observed belt use.

	Observed Belt Use		
Reported Belt Use	Belted	Not Belted	Total
Never	13 (6%)	223 (94%)	236
Rarely	24 (7%)	336 (93%)	360
Sometimes	73 (17%)	350 (83%)	423
Most-of-the-time	463 (48%)	496 (52%)	959
Always	2178 (87%)	327 (13%)	2505

of Never and Rarely were, virtually, identical, and since their sample sizes were relatively small, it seemed quite logical to combine these two categories. It was not so clear-cut if any further collapsing was warranted, and, if so, which other categories should be combined. For many of the statistical analyses presented by Hunter, et al. (1988A), the Sometimes and Most-of-the- time categories were also combined to yield a three level characterization of reported belt use.

With respect to investigating accident and violation involvement in the '87-'90 data, Tables 14 and 15 show percents of drivers having specified numbers of accidents (violations) from 0 to 3 or more, classified by observed belt use, the five-level reported belt use, three variations of reported belt use based on combining different response categories, and, finally, a classification based on both reported and observed belt use. This last classification contains two categories, one consisting of those who said they always use seat belts and who were also, observed wearing belts (N=2178), and the other consisting of those who said they rarely or never use belts and who were, in fact, not belted when observed (N=559). The tables also show the results of X^2 tests of association between seat belt use and accident (violation) involvement as well as average number of accidents (violations) per driver for each belt use classification.

Continued overrepresentation in accidents and violations by seat belt non-users is quite clear from the tables. Based on average numbers per driver, observed belt non-users had 45 percent higher accident rates and 69 percent higher violation rates than did the belt users. This compares with 35 percent and 69 percent, respectively, from the earlier data. From the combined observed/reported classification, the never users had accident and violation rates that were 61 percent and 129 percent, respectively, higher than the rates of the always users.

Hunter, et al. (1988A) further investigated the question of overrepresentation by noting that seat belt users and non-users differed with respect to several demographic and other factors (e.g, age, gender, and reported annual mileage), and developed statistical models to take into account certain of these factors. Seat belt use or non-use was found to have a significant effect on accident and violation rates even after making adjustments for these other factors.

Table 14. Follow-up accidents for seat belt users and nonusers.

		Number of Accidents					
	Belt Use Group	0	1	2	3+	X^2-Test P-Value	Avg/Driver
I.	Observed not belted	76.1%	19.4%	3.6%	0.9%	.000	.293
	Observed belted	82.3%	15.4%	2.0%	0.3%		.202
II.	Responded - Never	76.3%	19.5%	3.4%	0.9%		.288
	Rarely	75.3%	18.9%	4.7%	1.1%		.322
	Sometimes	77.1%	19.4%	2.8%	0.7%		.272
	Most of the time	78.5%	18.4%	2.5%	0.6%	.017	.252
	Always	82.0%	15.5%	2.2%	0.3%		.209
III.	Responded Never or Rarely	75.7%	19.1%	4.2%	1.0%		.309
	Sometimes	77.1%	19.4%	2.8%	0.7%	.005	.272
	Most of the time	78.5%	18.4%	2.5%	0.6%		.252
	Always	82.0%	15.5%	2.2%	0.3%		.209
IV.	Responded Never or Rarely	75.7%	19.1%	4.2%	1.0%		.309
	Sometimes Mostly	78.1%	18.7%	2.6%	0.7%	.001	.258
	Always	82.0%	15.5%	2.2%	0.3%		.209
V.	Responded Never Rarely Sometimes	76.3%	19.2%	3.6%	0.9%		.293
	Mostly	78.5%	18.4%	2.5%	0.6%	.002	.252
	Always	82.0%	15.5%	2.2%	0.3%		.209
VI.	Combined Never, Rarely & Not Belted	75.1%	19.5%	4.3%	1.1%	.000	.317
	Always & Belted	83.0%	14.7%	2.1%	0.3%		.197

Table 15. Follow-up violations for seat belt users and nonusers.

		Number of Violations					
	Belt Use Group	0	1	2	3+	X^2-Test P-Value	Avg/Driver
I.	Observed not belted	68.7%	19.1%	7.1%	5.1%		.553
	Observed belted	78.4%	15.3%	4.0%	2.4%	.000	.328
II.	Responded - Never	61.0%	23.7%	8.9%	6.4%		.724
	Rarely	63.6%	21.9%	8.1%	6.4%		.664
	Sometimes	69.0%	19.2%	7.8%	4.0%		.511
	Most of the time	75.2%	15.5%	4.9%	4.4%		.440
	Always	78.4%	15.3%	4.1%	2.3%	.000	.325
III.	Responded Never or Rarely	62.6%	22.7%	8.4%	6.4%		.688
	Sometimes	69.0%	19.2%	7.8%	4.0%		.511
	Most of the time	75.2%	15.5%	4.9%	4.4%	.000	.440
	Always	78.4%	15.3%	4.1%	2.3%		.325
IV.	Responded Never or Rarely	62.6%	22.7%	8.4%	6.4%		.688
	Sometimes Mostly	73.3%	16.6%	5.8%	4.3%	.000	.462
	Always	78.4%	15.3%	4.1%	2.3%		.325
V.	Responded Never Rarely Sometimes	65.3%	21.2%	8.2%	5.4%		.614
	Mostly	75.2%	15.5%	4.9%	4.4%	.000	.440
	Always	78.4%	15.3%	4.1%	2.3%		.325
VI.	Combined Never, Rarely & Not Belted	61.5%	23.1%	8.8%	6.6%		.710
	Always & Belted	79.0%	15.3%	3.6%	2.1%	.000	.310

Again models were fit to accident and violation rates based on the more recent data. As in the earlier work, the variables included in the analyses along with belt use were age (at the time of the '87 survey), gender, and reported annual miles driven. Five age categories (16-20), (21-25), (26-35), (36-55), (56 & over) and eight mileage categories (< 5,000), (5,000-9,999), (10,000-14,999), (15,000-19,999), (20,000-29,999), (30,000-39,999), (40,000-49,999), (50,000 & over) were used in the analyses. Logistic categorical regression models were fit to the accident and violation rates. Thus, the dependent variables

$$\log\left(\frac{\text{Proportion of drivers with one or more accidents}}{\text{Proportion of drivers with no accidents}}\right)$$

and

$$\log\left(\frac{\text{Proportion of drivers with one or more violations}}{\text{Proportion of drivers with no violations}}\right)$$

were fit as linear functions of seat belt use, driver gender, the age categories, and mileage categories. The age and mileage variables were treated in some models as purely categorical variables and in others as continuous variables with values 1-5 and 1-8 respectively.

The analysis of variance table for a model of accident involvement as a function of observed belt use is shown in Table 16. Note that annual

Table 16. Model for accident involvement as a function of observed belt use.

Source	DF	X^2	Prob.
Intercept	1	7.47	.0063
Age	1	73.53	.0000
Gender	1	8.50	.0035
Belt Use	1	15.85	.0001
Lack of fit	16	20.66	.1919

mileage does not appear in the above model due to its lack of statistical significance. This was the case for all accident involvement models. Based on the estimated coefficients from the model of Table 16, the relative risk of

an unbelted driver being involved in a crash was 35.7 percent higher than that of a belted driver. Other model effects showed males to have a 25.3 percent higher risk of crash than females, and the relative crash risk decreased by a factor of .744 with each increasing age category, (e.g., risk (age group n+1) = .744 risk (age group n)).

Results from a similar model based on reported belt use are presented in Table 17. The original five belt use categories were used in this model but

Table 17. Model for accident involvement as a function of self-reported seat belt use.

Source	DF	X^2	Prob.
Intercept	1	2.16	.1419
Age	1	73.54	.0000
Gender	1	7.61	.0058
Reported Belt Use	1	6.66	.0099
Lack of fit	46	43.82	.5641

were treated as a continuous variable with values 1-5. The estimated belt use effect shows relative crash risk to decrease by the factor .924 with each increasing belt use category.

Models based on the other belt use classifications of tables 14 and 15 lead to quite similar results.

In models for the relative risk of violation involvement, reported annual miles driven was a significant factor. Results based on observed belt use are given in Table 18. From the model coefficients, non-belted drivers

Table 18. Analysis of variance for violation involvement as a function of observed seat belt use.

Source	DF	X^2	Prob.
Intercept	1	0.72	.3954
Age	1	241.66	.0000
Mileage	1	57.44	.0000
Gender	1	50.11	.0000
Belt Use	1	26.46	.0000
Lack of Fit	154	161.20	.3293

were estimated to have a 46.2% higher relative risk of violation than belted drivers, males were at 74.5% higher relative risk than females, relative risk increased by the factor 1.176 for each increasing mileage category, and decreased by the factor .584 with each increasing age category.

It was necessary to collapse some of the mileage categories in models using more than two categories of reported belt use. For example, some results from a model using three levels of reported belt use (never or rarely, sometimes or most of the time, always) and three mileage categories (under 20,000, 20,000-39,000, 40,000 & over) are shown in Table 19.

Table 19. Analysis of variance for violation involvements as a function of reported seat belt use.

Source	DF	X^2	Prob.
Intercept	1	119.92	.0000
Age	1	246.96	.0000
Gender	1	50.91	.0000
Mileage	2	59.18	.0000
Belt Use	2	19.96	.0000
Lack of fit	81	93.52	.1614

In this model both mileage and belt use were treated as categorical variables. The estimated model coefficients show the relative risk of violation for Sometimes or Most-of-the-time seat belt users to be 21.6% higher than for Always users. The rate for Rarely or Never users was 58.2% higher than for Always users.

Overrepresentation in terms of average numbers of accidents and violations per driver was also investigated by fitting linear models to the data. These models, essentially analyses of covariance, provide estimates of average accidents (violations) per driver within belt use categories after making adjustments for differences in the covariates, age, gender, and annual mileage (violations only). Results of these analyses are given in Table 20.

Table 20. Overrepresentation of average accidents and violations per driver.

Seat Belt Use Status	Adjusted Accidents/Driver	Adjusted Violations/Driver
Observed belted	.208	.353
Not Belted	.282	.506
Reported never or rarely	.288	.576
Sometimes or mostly	.258	.450
Always	.213	.352
Combined Always & Belted	.202	.338
Never, Rarely & Not Belted	.295	.592

It should be noted that the results of Table 20 were taken from six different models. In each case, the belt use factor was statistically significant ($p < .002$). Comparison of the values of Table 20 with the raw averages of tables 14 and 15 show that the adjustments tend to shift, slightly, the extreme values toward more central values. The overrepresentation of the non-belt users both in terms of accidents and violations, however, remains quite clear.

As in the earlier study, it was also of interest to investigate the extent to which certain characteristics of the accidents involving non-belt users and belt users differ. It was found for the 1983-1986 accidents that the non-user group differed in having a higher proportion of single vehicle accidents, a higher proportion of rollover accidents and a higher proportion of accidents in which the driver was charged with a violation. The 1987-1990 accidents of seat belt users and non-users did not differ significantly with respect to any of these variables. In addition to these variables, no significant differences were likewise found with respect to the variables -- accident severity, region of impact, vehicle deformation, or vehicle drivability. Significant differences were found, however, with respect to

light condition, accident speed, and driver injury. The distributions of these variables by observed and reported belt use are shown in Table 21.

Table 21. Differences in accident characteristics between seat belt users and non-users.

Characteristics	Observed Belt Use		Reported Belt Use		
	No	Yes	Never+	Sometimes+	Always
1. Light Cond.					
Daylight	73.6%	79.6%	70.7%	76.2%	79.2%
Not Daylight	26.4%	20.4%	29.4%	23.8%	20.8%
2. Driver Injury					
O - None	74.9%	76.6%	76.5%	75.6%	75.6%
C - Minor	12.8%	15.4%	10.9%	11.8%	16.9%
B - Moderate	7.7%	5.3%	7.1%	9.0%	4.5%
A or K Serious or Fatal	4.7%	2.7%	5.5%	3.6%	3.1%
3. Accident Speed					
0-29	35.3%	45.4%	30.6%	43.7%	42.0%
30-49	50.6%	43.8%	53.0%	44.3%	46.9%
50 & over	14.1%	10.8%	16.4%	12.0%	11.1%

never+ indicates the combined Never and Rarely groups
sometimes+ indicates the combined Sometimes and Most-of-the-time groups

Relationships Between Changes in Seat Belt Use Status and Changes in Accident and Violation Involvement

A second question of interest involved an examination of both the 1983-1986 and the 1987-1990 driver histories to see if there was any evidence that drivers who did not use seat belts prior to the law and then became belt users as a result of the law, became worse drivers in the sense of having more accidents or violations. Changes in belt use were derived from two questionnaire items from the 1987 surveys. One question asked about current (June, July 1987) seat belt use; the other asked about seat belt use prior to the seat belt law of October 1985. Using the responses to these questions,

three driver groups were identified: one group consisted of those who responded that they never or rarely used seat belts both before the law and currently; a second group responded that they always used seat belts both before the law and currently; and a third group who responded that before the law they rarely or never used seat belts and that currently they always used seat belts. These groups are referred to as no/no, yes/yes, and no/yes, respectively.

Changes in driving behavior were characterized in terms of differences in the proportions of drivers having accidents and violations in 1987-1990 as compared to 1983-1986, and in changes in mean numbers of accidents and violations per driver between these two time periods. Driver age, gender, and average annual mileage (from 1987 survey) were again considered as potential covariates. Preliminary analyses showed that among these covariates, the only significant relationship with changing driving behavior was that increased (83-86 to 87-90) accident and violation rates were found for the youngest (16-20 yr. old) drivers versus all other age groups. No significant effects were found between other age groups, nor for driver gender, nor by reported annual mileage.

To test for significant changes in driving behavior associated with changes in seat belt usage, log-linear categorical models were fit to the ratios of proportions of drivers having accidents (violations) in 87-90 relative to proportions having accidents (violations) in 83-86 within categories defined in terms of age (16-20 vs older), and the three seat belt before/after categories. Predicted values of these ratios are shown in Table 22. The effect of the young age group is quite clear from the predicted values which indicate that this group has substantially higher accident and violation rates in the 87-90 period. This would seem to be a reflection of this group's increased driving exposure in the second time interval. While the ratios for the no/yes belt use group are slightly higher than for the other belt use groups, these effects are not statistically significant ($p = .856$ for accident ratios and $p = .930$ for violation ratios).

Similar results were obtained from analyses of changes in average numbers of accidents (violations) from the first time interval to the second. Specifically, in analysis of variance models for changes in average numbers of accidents and violations, the significance levels of the estimated effects

Table 22. Predicted values of ratios of proportions of drivers having accidents and violations in 87-90 compared to 83-86.

Age	Belt Use	P (acc. in 87-90) / P (acc. in 83-86)	P (viol. in 87-90) / P (viol. in 83-86)
16-20	no/no	1.58	1.58
	no/yes	1.68	1.65
	yes/yes	1.52	1.63
21+	no/no	0.98	0.94
	no/yes	1.00	0.97
	yes/yes	0.94	0.96

due to seat belt (before law/after law) use groups were p = .602 and p = .833, respectively. Thus, we find no evidence that the drivers who became seat belt users as a result of the seat belt law had increased accident or violation rates relative to drivers who continued to use or not use seat belts.

Observed and Reported Seat Belt Use Versus Police-Reported Seat Belt Use in Accidents

A final item of interest was to see how police-reported belt use in accidents differed between the 1983-86 accidents and the 1987-90 accidents for various user groups based on the 1987 questionnaire and observational data. Table 23 shows frequencies and percents of drivers reported as belted or not belted in accidents by time period and by belt use status based on survey responses and observations. Of particular interest is the last line of the table which pertains to drivers who in the summer of 1987 were observed not using seat belts and who stated that they rarely or never did so. In their pre-law (83-86) accidents, 21.7 percent of these drivers were reported as belted. In their post-law (87-90) crashes, however, over 80 percent were reported as belted. These findings lend further support to the general feeling that accident reported restraint use can no longer be considered a valid indicator of true restraint use in crashes.

Table 23. Seat belt use reported in accidents.

	Reported in Accidents			
Survey Data (1987)	1983-1986		1987-1990	
Observed Use	Belted	Not Belted	Belted	Not Belted
Belted	238 (43.4)	310 (56.6)	519 (96.3)	20 (3.7)
Not Belted	129 (28.6)	322 (71.4)	419 (85.7)	70 (14.3)
Reported Use				
Always Use	242 (47.5)	267 (52.5)	487 (96.8)	16 (3.2)
Most of the time, Sometimes	88 (26.8)	240 (73.2)	306 (88.7)	39 (11.3)
Rarely, Never	33 (21.2)	123 (78.8)	140 (80.0)	35 (20.0)
Observed/Reported				
Belted/Always	199 (46.5)	229 (53.5)	403 (97.6)	10 (2.4)
Not Belted/ Rarely or Never	33 (21.7)	119 (78.3)	135 (80.4)	33 (19.6)

Summary

Drivers classified as seat belt non-users based upon a 1987 survey and field observations, were found to be overrepresented in accidents and violations during the 3 1/2 year period of January '87 - June '90. The extent of this overrepresentation was very consistent with the overrepresentation of these same non-users over the 4-year period of January '83 - December '86, as reported by Hunter, et al. (1988A). In neither of these periods could the overrepresentation of seat belt non-users in accidents and violations be attributed solely to differences in driver age, gender, or average annual mileage driven.

In each of the two time periods ('83-'86, '87-'90), the accidents of the seat belt non-users differed in certain characteristics from the accidents involving seat belt users. While the two sets of differentiating characteristics did not overlap, both tended to indicate more serious accidents for the non-user group (i.e., more single vehicle and rollover accidents in '83-'86, more high speed accidents and more accidents in which the driver was seriously injured or killed in '87-'90).

Using self-reported information concerning seat belt use prior to the N.C. seat belt law, and seat belt use during the summer of 1987, analyses were carried out to see if the accident and violation rates of drivers who changed from non-users prior to the law to belt users after the law, increased more than the comparable rates of drivers who remained non-users or who were already seat belt users. No statistically significant differences in rate changes were found.

Finally, the rates at which drivers were reported by the police as being belted in accidents during the two time periods were examined for different seat belt user categories. The reported belt use rate in accidents for the most unlikely user group, increased from 22 percent before the law to over 80 percent after the law.

VII. DISTRIBUTION OF TAD MANUALS

Funding has been made available from previous GHSP projects to purchase TAD Damage Rating Manuals from the National Safety Council for distribution to the State Highway Patrol, local police departments, community colleges teaching accident investigation, and various state agencies. This project has provided funding for distribution of these manuals to the various departments upon request.

During this year, some 1,574 TAD manuals were distributed to 11 police departments, the Highway Patrol, 1 sheriff's department, 4 community colleges, and 3 State agencies. The police departments that received copies of TAD manuals include: Charlotte, Wrightsville Beach, Jacksonville, Gastonia, Burlington, Garner, Greensboro, Mt. Airy, Lake Lure, Lexington, and Fayetteville. Community colleges to whom TAD manuals were sent include: Pitt County Community College, Davidson County Community College, Central Piedmont Community College and Isothermal Community College. In addition, quantities of TAD manuals were supplied to the State Highway Patrol on several occasions.

As North Carolina is one of the few states that include TAD damage ratings in their police-reported accident data, this is a much sought after source of crash data both within the State and across the country. And this project has facilitated the continued input of vehicle damage ratings in the North Carolina statewide crash data.

VIII. SUMMARY

As should be clear from the preceding narrative, this has been a most ambitious project examining belt usage and subsequent crash injury reductions in North Carolina. First, in the area of population-at-risk data, a full survey of 72 sites was conducted during the Spring of 1991. Driver belt usage from that survey continues at approximately 60 percent statewide. As has been true since the baseline period, belt usage has been highest in urban areas; in the piedmont region followed by the coast; during commuting hours; in cars as opposed to pickups; among females; and also higher since the beginning of the citation period for the non-white drivers.

In conjunction with the North Carolina Operation Buckle-Down Program, two mini-waves of belt observations were carried out at 12 of the permanent sampling sites. The first was conducted in July while the other was carried out in September following Labor Day. As can be seen in the corresponding tables, the data here is consistent with previous mini-surveys and shows belt usage for drivers at slightly under 60 percent.

Data were also collected on usage of automatic seat belts in new model cars as part of the Spring 1991 survey. The results here are reasonably consistent with previous HSRC studies with respect to automatic seat belts as well as belts in air bag cars. The most recent survey of 2415 drivers showed usage rates for shoulder belts at around 76 percent for automatic systems and 65 percent for cars equipped with air bags. With respect to lap belt use, similar results hold for the 3-point integrated systems found in General Motors cars; however, lap belt usage in both the motorized and non-motorized automatic shoulder belt/manual lap belt system is much lower with levels of 34 percent and 20 percent, respectively.

Examination of various injury levels (K, A+K, B+A+K) by comparison group (i.e., (1) occupants covered by the seat belt law, (2) occupants and vehicles that are not covered, and (3) non-occupants), shows a continued reduced injury experience only for those covered by the law. The injury pattern for the other two groups has remained virtually unchanged from what it was prior to the law.

The State Highway Patrol continues a very high level of enforcement. For the first nine months of 1991, an average of 9,803 citations were issued each month as opposed to nearly 3,300 per month issued by the Highway Patrol

during the first quarter of 1987 when the citation phase began. Reports from the various municipal departments by way of the statewide questionnaire show considerable variability in enforcement -- some most active such as Raleigh, Greensboro, and Cary and some other cities with reported low levels of citations such as Charlotte, High Point and Asheville.

A sizeable number (1,574) of TAD manuals were distributed to local police departments, the Highway Patrol, community colleges that offer courses in police accident investigation, sheriff's offices, and several state agencies. We continue to benefit from having TAD Vehicle Damage Severity Ratings in the statewide crash data which provide a very useful tool for carrying out program evaluation and research.

Finally, a statistical examination was made using existing data to address the hypothesis of overrepresentation of non-belt users in crashes. In brief, the results from this follow-up study are most consistent with the findings in the initial study.

In summary, a coordinated variety of efforts aimed at examining belt usage rates and corresponding injury reductions along with enforcement efforts have been supported by this project. Overall it would appear that these efforts have continued to be most useful.

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APPENDIX A:

Statewide Press Release on Results of Spring 1991 Survey of Passive Restraints

CAROLINA

NEWS

NEWS SERVICES
Clifton Metcalf, *Director*
210 Pittsboro Street, Campus Box 6210
Chapel Hill, NC 27599-6210
(919) 962-2091 FAX: (919) 962-2279

For Immediate Use

Nov. 4, 1991

Note: Included is a graphic showing N.C. safety belt figures and a list of counties in the six regions surveyed.

N.C. motorists neglecting lap belts, study shows

By CAROL B. COLE
UNC-CH News Services

CHAPEL HILL -- More than a third of N.C. motorists in cars with automatic restraint systems fail to fasten their lap belts, according to the nation's most comprehensive study of lap and shoulder belt use in cars with automatic systems.

Figures released today (Nov. 4) by the University of North Carolina Highway Safety Research Center in Chapel Hill show that automation does not guarantee improved seat belt usage.

"Although lap belt use is high in cars with completely automatic lap-and-shoulder belts, it is extremely low in cars in which the shoulder belt is automatic and the driver has to manually buckle the lap belt," said Dr. Donald W. Reinfurt, associate center director.

"More than six out of 10 drivers in cars with motorized automatic shoulder belts fail to buckle their manual lap belts," Reinfurt said. "These people are not getting all the protection their cars have to offer and all the protection they need."

Automatic restraint systems come in three types. In one, lap and shoulder belts fit automatically around the motorist. In the second, shoulder belts fasten automatically, but lap belts must be buckled manually. The third system combines an air bag and manual lap-and-shoulder belts.

UNC center researchers have observed more than 8,000 N.C. drivers in newer cars over the last three years. The surveys, conducted for the Governor's Highway Safety Program, monitor the effect of the state's 6-year-old seat belt law and related safety trends.

(More)

In the latest survey, researchers observed 2,415 N.C. motorists between mid-March and early June. They recorded automatic safety belt use at 36 sites in six regions: Asheville, Charlotte, the Greensboro/Winston-Salem/High Point Triad, Greenville, Raleigh-Durham and Wilmington. At the same time, researchers monitored overall belt use in all types of vehicles at 72 other sites across the state.

Overall safety belt use ranged from 66 percent in the Raleigh-Durham region to 47 percent in the Asheville region, according to the survey. The Triad region was second at 63 percent, followed by the Charlotte region (61 percent), the Greenville region (58 percent) and the Wilmington region (50 percent). Urban area drivers posted higher use rates than rural drivers.

Among N.C. motorists with automatic systems, 76 percent had their shoulder belts fastened, and 64 percent wore their lap belts.

But motorists with certain types of automatic belts rated much lower in lap belt usage. For instance, only 20 percent of those whose cars were equipped with non-motorized automatic shoulder belts and manual lap belts had fastened their lap belts. When the shoulder belt was motorized, 34 percent wore their manual lap belts.

In cars where shoulder and lap belts were both automatic, lap belt usage jumped to 75 percent. Sixty-five percent of motorists in air bag-equipped vehicles wore their lap belts.

Regardless of the type of restraint system, drivers under age 25 posted the lowest shoulder and lap belt use rates of all age groups. In general, females' use of all belt systems surpassed males'. Black drivers posted higher shoulder belt and lap belt use rates than white drivers, except for using manual lap belts with motorized automatic shoulder belts.

Automatic seat belts and air bags have become standard equipment in many American-made cars. Most new Chrysler Corp. and Ford Motor Co. cars already come with driver-side air bags. General Motors Corp., the world's largest automaker, plans to install both driver- and passenger-side air bags in all new cars sold in North America by September 1994.

Motorists who rely on just shoulder belts or air bags are compromising their safety, said Paul B. Jones, director of the Governor's Highway Safety Program.

"When they have a choice people are obviously forgetting to buckle their manual lap belts," Jones said. "We are seeing more and more crash reports where people were severely injured or killed because they weren't wearing their manual lap belts."

Educating drivers of cars with automatic shoulder belts is a top priority in a yearlong statewide educational effort that began last summer, said Lauren M. Marchetti, the UNC center's public information manager.

(More)

"Air bags alone are not good enough," she said. "We want everyone to know to use all they've got. The combination of an air bag and lap and shoulder belts is currently the best protection available."

Last June and July, as the recent monitoring period concluded, the UNC center and the governor's program kicked off the educational program about automatic seat belts and air bags. North Carolina was one of two states to receive funding for the effort from the National Highway Traffic Safety Administration.

The most recent study results have been shared with each region's program leaders, who include auto dealers, health educators, insurance agents and law enforcement and emergency medical personnel.

"They will be able to take these numbers and use them to aim local public information activities toward the people who need this information -- those who aren't using all of the protection they bought," Marchetti said.

A new survey that began Oct. 1 may show the impact of the program. Results are expected next spring, said Reinfurt.

"To a great extent, North Carolina's numbers should be representative of the nation's automatic seat belt use," he said. "A U.S. Department of Transportation study that was conducted in 19 cities and looked only at shoulder belt use arrived at numbers very similar to those found here."

-30-

(Cole is a second-year graduate student at the UNC-Chapel Hill School of Journalism and Mass Communication and a Carrboro resident.)

Print Contact: Mike McFarland
Broadcast Contact: Barbara Thompson

Counties in the six regions surveyed

Asheville region: Avery, Buncombe, Cherokee, Clay, Haywood, Henderson, Graham, Jackson, Macon, Madison, McDowell, Mitchell, Polk, Rutherford, Swain, Transylvania and Yancey.

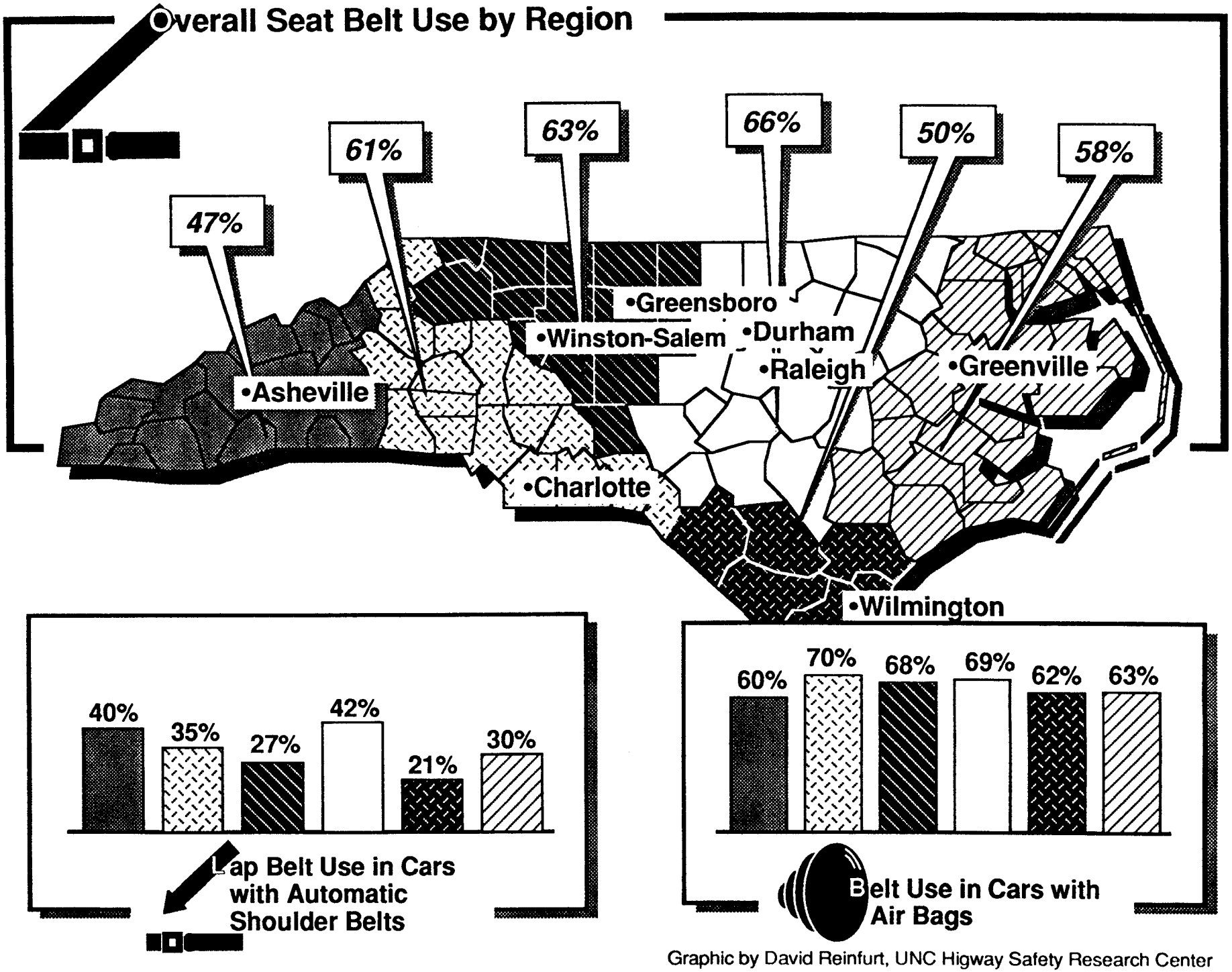
Charlotte region: Alexander, Anson, Burke, Cabarrus, Caldwell, Catawba, Cleveland, Gaston, Iredell, Lincoln, Mecklenburg, Montgomery, Rowan, Scotland, Stanly, Union and Watauga.

Greensboro-High Point-Winston-Salem region: Alamance, Alleghany, Ashe, Caswell, Davidson, Davie, Forsyth, Guilford, Randolph, Rockingham, Stokes, Surry, Wilkes and Yadkin.

Greenville region: Beaufort, Bertie, Camden, Carteret, Chowan, Craven, Currituck, Dare, Duplin, Gates, Greene, Hertford, Hyde, Jones, Lenoir, Martin, Onslow, Pamlico, Pasquotank, Perquimans, Pitt, Tyrell and Washington.

Raleigh-Durham region: Chatham, Cumberland, Durham, Edgecombe, Franklin, Granville, Halifax, Harnett, Hoke, Johnston, Lee, Moore, Nash, Northampton, Orange, Person, Sampson, Vance, Wake, Warren, Wayne and Wilson.

Wilmington region: Bladen, Brunswick, Columbus, New Hanover, Pender and Robeson.



Graphic by David Reinfurt, UNC Higway Safety Research Center

APPENDIX B:

North Carolina Seat Belt Law Enforcement Survey Form and Accompanying Letters to the Chiefs of Police

N.C. Seat Belt Law Enforcement Survey
July 1991

1. Name of Department: _____

2. Please tell us the total number of $25 citations issued by your department for non-compliance with the N.C. Seat Belt Law (G.S. 20-135.2A) and Child Passenger Protection Law (G.S. 20-137.1):

Are these numbers approximate? If so, put a check (✓) in the small box.

	1990	Jan. - June 1991
Total Number of $25 Seat Belt Citations	☐	☐
Total Number of $25 Child Restraint Citations	☐	☐

3. How often do your officers stop vehicles to issue seat belt citations without other violations such as speeding being involved?

☐ Often ☐ Occasionally ☐ Rarely ☐ Never

Any comments? _____
_____
_____

4. How often do officers in your department use seat belt violations to establish probable cause for stopping vehicles suspected of other violations such as DWI or possession of drugs?

☐ Often ☐ Occasionally ☐ Rarely ☐ Never

In general, how effective do you find this approach? _____
_____
_____

5. How many police cars in your fleet are equipped with an air bag?_____

Have any of these vehicles been involved in a crash? _____ If so, please explain _____
_____
_____

6. How many crashes involving vehicles equipped with an air bag has your department investigated? ☐None ☐One ☐ Two ☐ Three or more

Please describe any outstanding successes with an air bag, such as lives saved or protected from serious injury. _____

_____

Please describe any problems identified with air bags, such as failure to deploy in a moderate to severe frontal crash, or bags that have caused injuries. ____

_____

7. Has your Department observed any problems with the newer automatic seat belts, such as the motorized seat belt found in recent model Fords and Toyotas? (Examples might include a belted occupant being ejected, an injury caused by the belt, or an injury caused by a shoulder belt worn without the manual lap belt fastened.) Please describe. _____

_____

_____

8. Below are listed some seat belt enforcement/education activities. Please indicate how often your Department has engaged in any of these since January 1,1991:

	Often	Sometimes	Never
Conducted "seat belt checks" at roadblocks, etc.	___	___	___
Issued press releases, news stories, etc. about seat belts.	___	___	___
Made presentations about seat belts to school, civic, business, or church groups.	___	___	___
Sponsored special events or activities in conjunction with Child Passenger Safety Awareness Week in February 1991.	___	___	___
Sponsored special events or activities in conjunction with Buckle Up America Week or Lifesavers Month, May 1991.	___	___	___
Conducted public education programs concerning air bags or automatic belt systems.	___	___	___

Other? _____

_____

** ** ** ** ** ** ** ** ** ** ** ** ** ** ** **

Please provide the name and address of a person we may contact for additional information if necessary:

_____

_____

_____

Telephone: Area Code (____) Number _____

THANK YOU !! Please use the back of this form for additional comments or suggestions. Return in the enclosed stamped envelope or mail to:

Dr. Donald Reinfurt, Associate Director
UNC Highway Safety Research Center, CB #3430
Chapel Hill, N.C. 27599-3430

The University of North Carolina
Highway Safety Research Center

134 1/2 East Franklin Street
CB 3430
Chapel Hill, North Carolina 27599-3430

B.J. CAMPBELL
Director

TELEPHONE
(919) 962-2202

July 9, 1991

Dear Chief:

The UNC Highway Safety Research Center has been working with the N.C. Governor's Highway Safety Program (GHSP) in evaluating our state's seat belt and child restraint laws. The success of these laws in saving lives and preventing injuries depends to a great extent on their effective enforcement at the local level.

Did you know that:

- Memorial Day began the BUCKLE DOWN program that is geared toward increasing enforcement of seat belt laws nationally?
- The $25 fine that is issued in N.C. for non-compliance with the Seat Belt Law, is given to the county school system and used for educational purposes?
- The seat belt wearing rate in N.C. has increased to 60% since the law became effective?
- Serious injuries decreased dramatically in January of 1987, the effective date of the Seat Belt Law, and have remained at the lower level?

Thus, as you can see, the occupant restraint issue is an important highway safety priority. As part of our continuing evaluation for the Legislature, we are again contacting all police departments in North Carolina for information on enforcement activities with respect to these laws. It will be most helpful if you would fill out the brief questionnaire enclosed. Results from this survey will be summarized and presented in a report to the GHSP this fall.

Your input into this matter is greatly appreciated. If you have questions, please feel free to call us at 1-800-672-4527.

Sincerely,

Nancy L. Weaver
Research Assistant
for Analysis Studies

Donald W. Reinfurt
Associate Director
for Analysis Studies

Enclosure

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(919) 962-2202

August 5, 1991

Dear Chief:

The implementation of the N.C. seat belt and child restraint laws brought with them many questions to be answered: How well do they work? How are they enforced? How are they supported by the judicial system? Fortunately, you and your department are in a prime position to help answer these questions.

On July 9, 1991, we sent a brief questionnaire to all N.C. police departments. The response has been most encouraging. However, we have not yet received a completed survey from your department. It would help our study very much for you to take a few minutes and fill out and return the enclosed survey form. Remember, precise numbers or lengthy responses are not necessary. And even if your department does not have much involvement with these activities, we still need to hear from you.

Thank you in advance for your time and contribution. Any questions can be addressed by calling 1-800-672-4527.

Sincerely,

Donald W. Reinfurt
Associate Director for
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Nancy L. Weaver
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DWR/NLW:pj