An Examination of Motorcyclist Injuries and Costs Using North Carolina Motor Vehicle Crash and Trauma Registry Data

Final Report

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June 1992

UNC/HSRC-92/6/3

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Acknowledgments

The authors wish to thank the Motorcycle Industry Council, Inc. for providing funding for this research, and in particular Mr. Melvin Stahl and Ms. Pamela Amette for providing overall guidance to the effort and reviewing earlier drafts of this report. We also thank the Directors of the North Carolina Trauma Registry for their interest in the research and their willingness to make available the Trauma Registry data. Dr. Robert Rutledge of the UNC Department of Surgery, School of Medicine, was particularly helpful in producing the computer runs on the Trauma Registry data, and Dr. J. Richard Stewart of HSRC provided statistical support to the project. To all, we extend our thanks.

I. Introduction

Overview of Study

In February of 1990 the Board of Directors of the Motorcycle Industry Council, Inc. (MIC) approved a grant to the University of North Carolina Highway Safety Research Center (HSRC) to carry out "An Examination of Motorcyclist Injuries and Associated Costs Using North Carolina Motor Vehicle Crash and Trauma Registry Data." Funding of this research was largely in response to several studies appearing in the recent literature indicating that motorcyclists were less likely than other trauma victims to be medically insured and less likely to have a valid operator's license.

There were, however, a number of weaknesses in these studies, and the MIC wanted an opportunity to more thoroughly examine these issues. The HSRC was contacted to assist in this endeavor and prepared a proposal that included three principal tasks:

1. An examination of North Carolina police-reported motorcycle crash data over a three-year period (1987-1989);

2. An examination of motorcycle crash cases reported to the North Carolina Trauma Registry since the Registry's inception in October of 1987; and

3. A comparison of the North Carolina Trauma Registry and North Carolina police-reported motorcycle crash cases.

This report presents the results of these efforts. It begins with a review of the relevant literature, followed by sections on each of the three identified tasks. Each section includes a description of the available data, the data analysis methods, and a presentation of the findings. A final discussion section draws conclusions from the overall effort and makes recommendations regarding future research. Background information and supporting data tables are included in the appendices.

Summary of Findings

Analysis of 1987-1989 North Carolina police-reported crash data:

- 38% of motorcycle operators in police-reported crashes were killed or seriously injured. The actual number of seriously injured motorcyclists declined over the three-year study period, from 985 in 1987 to 720 in 1989. These numbers represent approximately six percent of the 13,000-14,000 motor vehicle occupants killed or seriously injured each year in North Carolina crashes.

- Half of the motorcyclists involved in police-reported crashes in North Carolina either were operating without a valid driver's license or did not have the required motorcycle endorsement to their driver's license;

- One-fourth were reported by police as not wearing a helmet, even though North Carolina law requires wearing of protective helmets for motorcyclists of all ages riding licensed vehicles on public roadways;

- 14% of motorcycle crashes were reported to involve alcohol. This compares to 9% for all motor vehicle crashes.

Analysis of North Carolina Trauma Registry Data:

- Injured motorcycle operators admitted to a trauma center had lower injury severity scores compared to other road trauma victims (motor vehicle operators and passengers, pedestrians, etc.). They required slightly longer hospital stays, but accrued lower hospital charges.

- Motorcyclists admitted to a trauma center for treatment of crash-related injuries were just as likely as other road trauma cases to be medically insured: 49% of motorcycle operators and passengers were either commercially or privately insured, compared to 51% of road trauma cases. The percentage for non-road trauma cases (victims of falls, cuts, etc.) was lower, at 42%. Motorcyclists were more likely than other road trauma victims to be uninsured (43% versus 35%), but had fewer cases dependent on Medicare/Medicaid (8% versus 14%).

Analysis of matched police and Trauma Registry data:

- Less than half (48%) of injured motorcyclists admitted to North Carolina trauma centers could be identified on the State motor vehicle crash file. Those identified tended to resemble the overall crash file cases in terms of age, but had more severe injuries and were more likely to have been at fault in their crash and to have been reported for drinking.

- For North Carolina Trauma Registry cases matched to the motor vehicle crash file, motorcyclists possessing the required endorsement on their driver's license were more likely to carry commercial or private insurance and less likely to be uninsured than motorcyclists not possessing an endorsement.

- Matched Trauma Registry cases reported as drinking were more likely to be seriously injured and more likely to die in the hospital or be discharged to a rehabilitation facility than those reported as not drinking.

Review of the Literature

The three studies that provided the primary impetus for this research were a 1985 University of California at Davis study (Bray, Szabo and Timmerman, 1985), a 1986 Boston, Massachusetts study (Bach and Wyman, 1986), and a 1988 Seattle, Washington study (Rivara, Dicker, Bergman et al., 1988). All three studies examined populations of crash-involved motorcyclists admitted for treatment at major trauma centers, and all three emphasized the public cost of treating motorcycle trauma patients.

The California study examined hospital costs and insurance status of 51 injured motorcyclists admitted to the orthopedic unit at the University of California at Davis Medical Center. Cases were identified retrospectively from a large scale study of open fractures carried out from 1980-1983. Examination of the medical and billing records for this population of injured motorcyclists showed that 75% carried no medical or accident insurance, resulting in 82% of their acute hospitalization costs being paid from public funds. Twenty-nine of the injured motorcyclists were tested for blood alcohol level, and of these 16 had levels in excess of 100 mg/dl. The authors called for mandatory helmet legislation, required motorcycle driver training, and "rigid enforcement of compulsory insurance."

The Boston study conducted by Bach and Wyman examined hospitalization charges, lengths of stay, medical insurance profiles, and patterns of injuries for 47 motorcyclists admitted to Massachusetts General Hospital over a one-year period beginning July 1, 1982. Cases were again retrospectively identified, using the hospital's trauma registry and emergency room logbook. Average hospital stay was 22.1 days (median, 15.5 days), resulting in an average charge of just over $15,000 (median, $8,000). These charges included room charges and operating room charges, but no professional fees. The authors reported that 46% of their sample of injured motorcyclists carried no medical insurance, and noted that "only 7% of all admitted patients at the Massachusetts General Hospital were medically uninsured."

The third study, entitled "The Public Cost of Motorcycle Trauma," was carried out by Rivara and his colleagues at the Harborview Medical Center. Harborview is the only Level I trauma center serving the four-state area of Washington, Alaska, Idaho, and Montana. The 107 motorcycle injury cases examined in this study were again identified through the hospital's trauma registry. The main distinction was that subjects were followed over a mean 20-month period and data were gathered on direct as well as indirect costs (the former including hospital charges, professional fees, and rehabilitation costs, the latter represented by lost wages). The authors reported that nearly two-thirds (63.4%) of the total (direct) costs of this population of injured motorcyclists were paid with public funds (half by Medicaid). Average direct cost per injured motorcyclist was over $25,000. Mandatory helmet laws were recommended as one approach for decreasing the public cost of motorcycle trauma.

Several additional studies were identified during the course of the present study. In an unpublished paper, Lloyd (undated) reported on the experience of 206 motorcyclists treated over a one-and-a-half year period at a major trauma center in Austin, Texas. Thirty-six percent of this population was uninsured. Lloyd also reported that the uninsurance rate was higher for motorcyclists not wearing a helmet at the time of their crash: 45% versus 23% for helmeted riders. She recommended that "policies designed to increase the accountability of motorcyclist. . . be explored."

In a 1984 study, Mortimer and Petrucelli examined records of 331 motorcyclists admitted to three regional Illinois trauma centers in 1981-82, and found a median hospital cost of $2,500 (mean $6,200), with 63.4 percent of the costs paid by insurance, 11.5 percent by individuals, and 25.1 percent by public aid funds. Total hospital costs were significantly higher for the 25 percent of riders sustaining head injuries. More recently, Shankar, Dischinger, Ramzy, et al. (1990) found that 31% of the 377 motorcyclists hospitalized in Maryland trauma centers following a crash were uninsured. For the latter study, helmeted and unhelmeted riders were equally likely to be insured. Average hospital charge was $21,500 per motorcyclist.

Limitations of Previous Research

With the exception of the Shanker et al study, all of the studies described are based on relatively small samples of injured motorcyclists reporting to a single large trauma center. As such, one can expect over-representation of the more severely injured. The hospitals were located primarily in major metropolitan areas, which might impact on the types of injuries seen, severities, age distribution, insurance status, etc.

Another consideration in these studies is the absence of comparisons with other populations, or the use of inappropriate comparison populations. While reporting on the insurance status of injured motorcyclists, the studies present no information on the percentage of all trauma patients uninsured, the percentage of motor vehicle trauma patients uninsured, the percentage of young male trauma patients uninsured, etc. For example, the Massachusetts based study (Bach and Wyman, 1986) reported that "only seven percent of all admitted patients at the Massachusetts General Hospital were medically uninsured," but certainly trauma patients represent a distinct group from all admitted patients. Similarly, average charges for injured motorcyclists were compared with average inpatient hospital charges, but a more appropriate comparison might have been with an average for motor vehicle crash victims.

The present study addresses these issues by comparing the injury experience, hospital costs, and insurance status of injured motorcyclists with that of other road traffic victims and to non-road trauma cases. Data for this aspect of the study are

derived from eight Level I and Level II North Carolina trauma centers and include information on 800 motorcyclists and over 9,000 motor vehicle crash victims. In addition, Trauma Registry data are linked to the North Carolina motor vehicle crash and licensed driver files to obtain information on factors that may be associated with more severe injuries and uncovered hospital costs, and to examine potential biases in the use of trauma registry data.

II. Analysis of North Carolina Motor Vehicle Crash and Driver History Data

The analysis of North Carolina motor vehicle crash and driver history data was carried out primarily to examine factors associated with increased injury severity for motorcyclists involved in crashes and to obtain information on the population of all such motorcyclists for later comparison with the subpopulation of injured motorcyclists admitted to North Carolina trauma centers. Factors of interest included motorcycle operator age, license status, years of riding experience, prior crash and violation history, alcohol involvement, and helmet use at the time of the crash. Other variables describing the circumstances of the crash (time of day, road condition, roadway type, vehicle speed, etc.) the vehicle characteristics (e.g., on-road or off-road vehicle) were also examined, since all of these would be useful in developing approaches for reducing the frequency and severity of injuries to motorcyclists.

The focus of this analysis was on the population of *crash-involved* motorcyclists. Conclusions from the study cannot be extended to the population of all motorcycle operators in the State, since motorcyclists who had not been involved in crashes during the three-year study period could not be definitively identified. A search of the North Carolina driver history file could locate those individuals who had obtained an endorsement on their driver's license to operate a motorcycle, but these persons may or may not be active motorcyclists; at the same time, others who *are* active motorcyclists but who do not possess an endorsement would not be identified as motorcyclists on State files. Also, no information on driving exposure (e.g., miles ridden) was available for consideration in the study.

Description of the Data

The primary data source for the analysis was all police-reported motorcycle crashes occurring in North Carolina during the years 1987-1989. In the State of North Carolina, a standard crash report form (see Appendix B) is required by law to be completed by an investigating officer (municipal police or State Highway Patrol) for each motor vehicle crash resulting in injury and/or property damage exceeding a threshold of $500. Of the nearly 200,000 total motor vehicle crashes reported each year in North Carolina, approximately 2,300 (1.2%) involve motorcyclists.

The HSRC maintains copies of the computerized accident tapes produced by the N.C. Division of Motor Vehicles. HSRC also maintains copies of the North Carolina driver history file, an evolving file containing information on the State's 4.5 million licensed drivers as well as all non-licensed drivers involved in reportable crashes. The file includes information on type of license, year first licensed, whether or not the license contains a motorcycle endorsement, license status (valid,

restricted, suspended, etc.), crash and violation history, alcohol arrests, and other pertinent information.

North Carolina law requires all persons operating a motorcycle or motor scooter on the public roadway to have a motorcycle endorsement added to their regular driver's license. The endorsement is obtained after passing an additional written test as well as road test. No formal motorcycle safety education is required. Once an endorsement is obtained, it is retained on the driver history record indefinitely, even if the person ceases to operate a motorcycle. For this reason, the number of motorcycle operators identified on the driver history file exceeds the number of registered motorcycles in the State.

As noted above, no information was sought on this total population of licensed motorcycle operators in the State, since this information would not necessarily pertain to current operators of motorcycles. Rather, the driver history data was linked to the crash file data to provide additional information on the population of crash-involved motorcyclists.

Analysis Methods

Analysis of the North Carolina motor vehicle crash and driver history data involved a descriptive examination of the data along with contingency table analyses of selected categorical variables. This approach allowed for the testing of a variety of hypotheses, such as

- Motorcyclists seriously or fatally injured in crashes are less likely than those not seriously or fatally injured to have a valid motorcycle license;
- Motorcyclists who are at fault in crashes have less riding experience than those judged not at fault;
- Motorcyclists involved in alcohol-related crashes are less likely to have a motorcycle endorsement; etc.

As a first step in the analysis, a master file was created of all crashes in the State involving a motorcycle during the three-year period 1987-1989. (A portion of the 1990 data was later extracted for matching with the Trauma Registry data, but was not retained in the main comparison file since a full crash year was unavailable at the time.) A total of 7,266 such crashes were identified, involving 7,077 motorcyclists (some drivers being involved in more than one crash over the three-year period).

An initial problem encountered was the large number of motorcycles of unknown model type, either road cycles, off-road cycles, or dual purpose vehicles. These unknown motorcycle types accounted for approximately 45% of the original

sample. To address this problem a computer generated listing of the vehicle identification numbers (VIN's) for all of the motorcycles identified on the three-year crash file was forwarded to the MIC's California office, where help was obtained in identifying the motorcycles as either on-road or off-road vehicles. While there were still some "undecodable" VIN's (due to errors in police recording, data keypunching, etc.), the result was a 50 percent increase in the sample size of identifiable on-road motorcycles, up to 5,374 or 74 percent of the total sample of motorcycles. Five percent of the motorcycles were identified as off-road vehicles, and for the remaining 21% of the sample no determination of vehicle type could be made.

After the crashes were identified, the recorded driver license number of the motorcycle operator was used to access the driver history files. A driver history file was identified for all but 357 (5%) of the total 7,077 motorcyclists involved in North Carolina crashes during the three-year period. These non-matches were primarily underage and out-of-state drivers. The primary analysis was based on this three-year matched file.

Results

Table 1 presents the distributions of a number of variables describing the motorcycle operator, the circumstances surrounding the crash, and the characteristics of the motorcycle. The results are based on the total of 7,077 motorcyclists involved in 7,266 crashes over the three-year period 1987-1989. All crashes occurred on a public roadway or in a "public vehicular area" which would include driveways, parking lots, public parks, etc.

Results are presented overall and separately for road/street motorcycles (74% of the total), off-road motorcycles (5.2% of the total), and for an unknown category where insufficient information was available for determining motorcycle type (20.8%). In most instances, values for the unknown category fall in between those for on-road and off-road vehicles, suggesting that it is comprised of a mixture of on-road and off-road, or dual purpose, motorcycles. It should not, however, include motor scooters, all-terrain vehicles, or mopeds, since all of these vehicle types are coded separately on the North Carolina crash file.

Key findings include the following:

- Half of the operators of road/street motorcycles involved in crashes are 20-29 years old, and a third are age 30 and above; the distribution for off-road motorcycles is considerably younger, with 80% under age 25.

- Nearly 3% of motorcycle operators involved in reported crashes are fatally injured, and 35% are seriously injured. Variation across motorcycle types is small.

Table 1. Selected Variable Distributions by Motorcycle Type - 1987-1989 North Carolina Motor Vehicle Crash Data.

	Road/Street Motorcycle	Off-Road Motorcycle	Unknown Motorcycle	Total
No. Motorcyclists	5,244	377	1,456	7,077
No. Crashes	5,374	378	1,514	7,266
%	74.0	5.2	20.8	--
Motorcycle Operator Characteristics				
Age				
< 16	0.2	28.7	15.4	4.8
16-19	15.7	29.5	18.3	17.1
20-24	30.9	22.1	24.2	29.1
25-29	19.3	7.9	15.9	18.0
30-34	14.4	4.9	11.1	13.2
35-39	8.2	2.5	5.5	7.4
40+	11.2	4.4	9.6	10.5
Injury Severity				
Fatal (K)	3.1	2.5	1.8	2.9
Serious (A)	33.8	36.3	32.4	34.8
Moderate (B)	34.0	35.3	29.4	34.2
Minor (C)	17.1	12.0	13.3	16.5
None (O)	11.6	12.8	9.5	11.6
Unknown	0.5	1.1	13.6	3.2
Helmet Use				
Yes	71.2	37.2	42.4	63.5
No	24.1	56.8	37.1	28.5
Unknown	4.6	6.0	20.5	8.0
Alcohol Involvement				
Yes	14.4	13.3	13.3	14.1
No	73.7	74.5	62.2	71.3
Unknown	11.9	12.2	24.6	14.5
MC Operator-at-Fault				
Yes	51.8	67.3	55.1	53.3
No	8.7	21.6	23.8	35.4
Unknown	39.5	11.1	21.1	11.3
State of Licensure				
N.C.	88.2	93.9	91.9	89.4
Other	11.8	6.1	8.1	10.6

(Cont.)

Table 1. Selected Crash File Variables. (Cont.)

	Road/Street Motorcycle	Off-Road Motorcycle	Unknown Motorcycle	Total
License Type				
Class A or B	8.8	1.9	5.7	7.8
Class C	69.0	45.1	53.7	64.6
Control No. (includes underage and out-of-state)	22.2	53.0	40.5	27.6
MC Endorsement (current)				
If Class A, B, C license	72.1	37.9	51.7	67.4
If Control No.	6.6	1.8	1.6	4.5
Overall	60.0	20.4	33.2	52.5
Prior Crashes (last 3 years)				
0	71.4	78.2	76.7	72.8
1	21.7	15.1	17.1	20.5
2	5.3	4.7	5.1	5.2
3+	1.6	2.0	1.1	1.5
Prior Violations (last 3 years)				
0	45.3	64.8	57.4	48.7
1	22.5	11.1	15.1	20.4
2	13.1	8.4	10.8	12.4
3+	19.1	15.7	16.7	18.4
"Stop" on License (at time of crash)				
Yes	6.3	6.4	8.1	6.7
No	93.7	93.6	91.9	93.3
Crash Characteristics				
Crash Type				
Ran off Road	26.3	19.6	20.6	24.8
Hit Fixed Object	0.9	2.4	1.5	1.1
Hit Non-Fixed Object	9.3	9.8	8.4	9.1
2+ Vehicles	4.1	1.9	3.3	3.8
Other, 1, 2 Veh. Crash	59.4	66.3	66.2	61.2
Urban/Rural Location				
Rural (< 30% developed)	35.1	44.3	33.5	35.3
Mixed (30-70% dev.)	18.6	15.7	14.7	17.6
Urban (> 70% developed)	46.2	39.8	37.0	43.9
Unknown	0.2	0.3	14.9	3.2

(Cont.)

Table 1. Selected Crash File Variables. (Cont.)

	Road/Street Motorcycle	Off-Road Motorcycle	Unknown Motorcycle	Total
Time of Day				
Midnight - 5:59 a.m.	9.0	6.4	7.2	8.5
6 - 9:59 a.m.	7.2	3.7	6.1	6.8
10 a.m. - 1:59 p.m.	16.7	14.9	16.3	16.5
2 - 5:59 p.m.	31.3	38.3	36.1	32.7
6 - 11:59 p.m.	35.8	36.7	34.2	35.5
Road Class				
Interstate	2.0	0.3	1.1	1.7
U.S. Route	16.0	6.6	9.3	14.1
N.C. Route	13.3	6.6	10.4	12.3
Secondary	31.9	48.0	31.7	32.7
Local	32.7	26.3	26.6	31.1
Other Public Road	3.0	7.4	3.6	3.3
Private Rd., Property	1.0	4.0	2.1	1.4
Unknown	0.2	0.8	15.3	3.3
Light Condition				
Daylight	65.1	68.4	58.4	63.9
Dusk	3.3	5.8	3.3	3.4
Dawn	0.8	0.3	0.6	0.7
Dark, Street Lighted	12.9	10.9	10.0	12.1
Dark, Street Not Lighted	17.7	14.1	13.3	16.6
Unknown	0.2	0.5	15.0	3.3
Speed of Accident				
0-29 MPH	17.9	33.2	35.1	22.3
30-49 MPH	46.2	47.0	37.9	44.5
50-79 MPH	29.5	14.9	22.0	27.2
Unknown	6.5	5.0	5.0	6.1
Motorcycle Characteristics				
Model Year				
< 1980	22.2	13.0	22.5	21.8
1980-1984	38.8	24.7	29.2	36.1
1985-1990	38.8	62.3	31.7	38.6
Unknown	0.2	0.0	16.7	3.6

(Cont.)

Table 1. Selected Crash File Variables. (Cont.)

	Road/Street Motorcycle	Off-Road Motorcycle	Unknown Motorcycle	Total
Engine Size				
< 125 cc.	0.2	36.1	0.0	2.1
125-349 cc.	3.8	49.9	0.4	5.6
350-449 cc.	5.2	1.9	0.3	4.0
450-749 cc.	29.9	7.2	0.1	22.6
750+ cc.	30.3	0.5	0.4	22.6
Unknown	30.5	4.5	98.8	43.2
Make				
BMW	0.7	0.5	0.0	–
Harley Davidson	15.1	0.0	0.6	–
Honda	32.1	57.6	0.0	–
Kawasaki	15.0	9.6	9.1	–
Suzuki	8.0	6.9	7.6	–
Triumph	0.1	0.0	0.0	–
Yamaha	15.2	21.2	16.2	–
Other/Unknown	14.0	4.0	66.4	–

- Despite a mandatory helmet use law in North Carolina for motorcycle riders of all ages, only 71% of the operators of road/street bikes are reported as helmeted; for off-road bikes being operated on the roadway (or in a public vehicular area as described above), the percentage drops to 37%.

- Approximately 14% or one out of every seven crash-involved motorcyclists is reported to have been drinking. Drinking status is unknown in an additional 14% of cases.

- The majority of riders (65%) hold a Class C license which in North Carolina is a regular driver's license. A smaller percentage hold Class A or B licenses, required for driving trucks over 30,000 lbs. gross vehicle weight or vehicles designed to carry more than 12 passengers. The remaining one quarter of drivers with control numbers (assigned in place of a license number) likely includes both underage and out-of-state riders.

- Only 52% of all motorcyclists on the crash file were found to have the required motorcycle endorsement on their motor vehicle operator's license. Considering only road/street motorcycles and excluding cases with a control number, 72% of crash-involved operators had motorcycle endorsements.

- Among road/street motorcycle operators, 71% have had no involvement in crashes over the three-year period preceding the case crash, and 45% have had no violations. Only 7% of motorcyclists have been involved in two or more crashes, while 19% have had three or more violations.

- 6% of motorcyclists had a "stop" on their license at the time of their crash, indicating that their license had been either temporarily or permanently suspended (e.g., for drunk driving or lapse in insurance).

Following this univariate examination of the data, a variety of crosstabulations were formulated to address specific research questions of interest. For example, we were interested in finding out whether motorcyclists who had the required endorsement on their license had less severe crashes or better crash/violation histories than riders who did not have the required endorsement. Since both endorsement status and crash/violation history are associated with age, these relationships were further examined within age levels.

Selected two-way crosstabulations are presented in Appendix C and summarized in Table 2. Results are reported for the full sample of motorcycles involved in N.C. crashes during the years 1987-1989. The same tables were also run for the subset of motorcycles identified as road/street cycles; where these results differ from the overall results, note is made in the table. Chi-square tests were used to assess the significance of the associations. The variables describing motorcycle operator age,

Table 2. Results of Two-way Crosstabulations of Selected Variables of Interest for Motorcycle Operators Involved in Police-reported North Carolina Crashes, 1987-1989.

Variables	Outcome	Significance
Association of motorcycle operator age with:		
Injury severity	Approx. 37% serious (A+K) injury for all age groups.	n.s.
Gender	Females <3% of mc operators, with highest percentage of females in the youngest (<16) age category.	p = 0.0
Helmet use	Helmet use 30% for riders <16 and approx. 70% for all other age groups (75% for road motorcycle operators).	p = 0.0
License status	Percentage with valid license for 3+ years increases with age, up to 44% for motorcycle operators age 40+.	p = 0.0
Endorsement status	Percentage with mc endorsement increases with age, from 37% for ages 16-19 to 70% for ages 40+.	p = 0.0
"Stop" on license	20-34 year age groups have highest percentage of "stops" on licenses (approx. 8%).	p = 0.0
Prior crashes (past 3 years)	Percentage with no prior crashes increases with age. Highest prior crash rate for 16-19 and 20-24 year age groups.	p = 0.0
Prior violations (past 3 years)	Percentage with 3+ violations highest for 20-24 age group; decreases sharply with age.	p = 0.0
Alcohol involvement	Alcohol involvement highest for 25-39 year age groups (~24%); lower for other age groups.	p = 0.0
At fault in crash	Sharp decrease in at fault status with age, from 68% for 16-19 year-olds to 43% for ages 40+.	p = 0.0
Association of motorcycle operator gender with:		
Injury severity	Males higher likelihood of serious injury (38% vs. 31%).	p = 0.05
Helmet use	Females less likely to wear helmet (55% vs. 70%).	p = 0.03
License status	Females less likely to have had a mc license for 3+ years (8% vs. 20%), but only slightly less likely to have had a mc license for <3 years (28% vs. 31%).	p = 0.0
Endorsement status	51% of males have endorsement, 36% of females. (For street mc's only, males 56%, females 51%, p = n.s.)	p = 0.0
"Stop" on license	Males higher percentage with "stop" on license (7% vs. 3%). (For street mc's only, males 6.5%, females 5%, p = 0.51)	p = 0.07

Table 2. Results of Two-way Crosstabulations. (Cont.)

Prior crashes (past 3 years)	Higher percentage of females with no crashes (83% vs. 72%). (For road mc's, 75% vs. 71%, p = n.s.)	p = 0.0
Prior violations (past 3 years)	Higher percentage of females with no violations (67% vs. 47%), lower percentage with 3+ violations (6% vs. 19%).	p = 0.0
Alcohol involvement	17% of males, 9% of females reported as drinking. (similar results for road mc's only, but p = 0.12).	p = 0.01
At fault in crash	Female operators at fault in 57% of crashes, males 61% (assumes operator in single vehicle crash is at fault).	n.s.
Association of helmet use with:		
Injury severity	Helmet use not significantly associated with overall injury severity: 37% helmeted, 38% unhel. A+K (serious) injury.	n.s.
License status	Operators with no license or no motorcycle endorsement less likely to wear a helmet. (p = n.s. for road mc's)	p = 0.0
Endorsement status	75% of operators with endorsement, 64% without endorsement reported wearing a helmet. (p = n.s. for road mc's)	p = 0.0
"Stop" on license	6% of helmeted riders, 8% of non-helmeted riders had "stop" on license at time of crash. (p = 0.08 for road mc's)	p = 0.0
Prior crashes (past 3 years)	No significant helmet effects.	n.s.
Prior violations (past 3 years)	No significant helmet effects.	n.s.
Alcohol involvement	Helmeted operators slightly less likely to be reported as drinking (16% vs. 18%). (n.s. for road mc's)	p = 0.02
At fault in crash	Helmeted riders less likely to be at fault (58% vs. 67%). (n.s. for road mc's)	p = 0.0
Association of motorcycle operator license status with:		
Injury	Operators with mc license (either <3 years or 3+ years) least likely to be seriously injured (approx. 35% vs. 40%).	p = 0.0
Prior crashes (past 3 years)	Operators with mc license 3+ years or with no license least likely to have been involved in previous crashes.	p = 0.0
Prior violations (past 3 years)	Operators with mc license 3+ years least likely to have been convicted of ≥2 violations.	p = 0.0
Alcohol involvement	Operators with mc license <3 years lowest percentage of alcohol involvement, those with no licenses the highest.	p = 0.0
At fault in crash	Operators with mc license (either <3 years or 3+ years) less likely at fault than non validly licensed (~ 45% vs. 75%).	p = 0.0

Table 2. Results of Two-way Crosstabulations.

Association of mc operator endorsement status with:		
Injury	Operators with mc endorsement on their license less likely to be seriously injured (35% vs. 40%).	p = 0.0
Prior crashes (past 3 years)	Operators with mc endorsement more likely to have been involved in prior crashes (31% vs. 24%).	p = 0.0
Prior violations (past 3 years)	Operators with mc endorsement more likely to have been convicted of 1 or 2 violations, but less likely 3+ violations.	p = 0.0
Alcohol involvement	Operators without endorsement nearly twice as likely to be cited for alcohol involvement (22% vs. 11%).	p = 0.0
At fault in crash	Operators without endorsement at fault in 75% of crashes, compared to 44% for operators with endorsement.	p = 0.0
Association of "stop" on mc operator license with:		
Injury	37% of operators with no stop on license seriously injured, compared to 42% with stop. (n.s. for road mc's)	p = 0.07
Prior crashes (past 3 years)	74% of operators with no stop on license had no prior crashes, compared to 61% with stop.	p = 0.0
Prior violations (past 3 years)	52% of operators with no license stop had no prior violations, compared to only 10% of those with a stop.	p = 0.0
Alcohol involvement	14% of operators with no license stop were cited for alcohol, compared to 56% of drivers with a stop.	p = 0.0
At fault in crash	58% of operators with no license stop were at fault in their crash, compared to 90% of operators with a stop in place.	p = 0.0

sex, helmet use, and license status were examined with respect to each other as well as to injury severity, prior crashes and violations, alcohol involvement, and fault (responsibility for crash).

Motorcycle operator **age** was significantly associated with all of the variables listed except for injury severity: the percentage of riders with serious (A+K) injury held consistently near 37% across all age categories. However, the likelihood of having a motorcycle endorsement on a valid driver's license increased with age, as did the likelihood of having had a motorcycle endorsement for three or more years. Overall, the percentage of riders with a valid driver's license and motorcycle endorsement increased from 37% for riders age 16-19 to 70% for riders ages 40+. (These percentages only reflect those riders who could be identified on the North Carolina driver history file. Non-matches were recorded as missing cases and excluded from the table totals.)

Age was also associated with helmet use. The very youngest riders, those under 16 years of age, were significantly less likely to be wearing a helmet at the time of their crash. Helmet use increased substantially for the 16-19 year-old riders (to 67%), before leveling off at 71-74% for riders age 20 and above.

Younger crash-involved motorcyclists were also much more likely than older motorcyclists to be at fault in their crash. Percentage at fault decreased from 68% for riders age 20-24 to 43% for riders age 40+. Alcohol use, however, and having a "stop" on one's license at the time of the crash, were more characteristic of middle-aged cyclists -- those in the 25-39 year age groups.

Finally, the likelihood of being involved in one or more crashes (either while operating a motorcycle or driving an automobile or other motor vehicle) during the three-year period preceding the incident crash was greatest for 20-24 year-old motorcyclists and decreased with age. Similarly, the likelihood of a traffic violation and conviction peaked for 20-24 year-olds and declined thereafter.

With respect to motorcycle operator **gender**, overall, less than three percent of the crash-involved motorcyclists were female. The only age group where this percentage was significantly higher was the under 16 year-olds, where females comprised nearly nine percent of the total. Compared to males, female motorcyclists were less likely to be seriously injured (31% versus 38%), less likely to have worn a helmet (55% versus 70%), and less likely to have been drinking at the time of their crash (9% versus 17%). They were, however, nearly as likely to have been at fault in their crash (57% versus 61%).

Other gender differences include lower prior crash and violation rates for females and a lower percentage of females properly licensed. Nearly 83% of female operators had experienced no crashes during the three years preceding their motorcycle crash, compared to 72% for the males. Similarly, 67% of females, but only 47% of males, had no convictions for traffic violations on their driving records. Finally,

with regard to licensure, 51% of males, but only 36% of females, had the required motorcycle endorsement on their North Carolina license at the time of their crash. Female motorcycle operators were much more likely than males to have a valid license but not a motorcycle endorsement with this license.

Helmet use was not found to be associated with overall injury severity as measured by the five-point KABCO scale (K=Killed, A=serious injury, B-moderate injury, C=minor injury, O=no injury). Both helmeted and unhelmeted motorcyclists experienced serious injury in just over a third of their crashes. Information on the location of injury was not available, so that no analysis of helmet effectiveness in reducing head injuries was possible; however, this type of analysis *was* possible with the North Carolina Trauma Registry data and is reported in the following chapter.

Helmet use was not significantly associated with either prior crash involvement or prior violations. Usage was, however, associated with the various license status variables and the alcohol and at fault variables on the full file. Helmeted motorcyclists, for example, were more likely to have the required motorcycle endorsement on their license (54% versus 41% for unhelmeted riders), less likely to be drinking at the time of their crash (16% versus 18%), and less likely to be at fault (58% versus 67%). These differences were not great, however, and were no longer significant for the reduced sample of road/street motorcycles only.

The variable **license status** was coded at four levels: no valid driver's license; valid license but no motorcycle endorsement; valid license with motorcycle endorsement for less than three years; and valid license with motorcycle endorsement for three years are more. In addition to its already noted association with operator age, sex and helmet use, license status was also associated with the severity of injury sustained by the motorcyclist: operators in the two categories having a motorcycle endorsement were less likely to be seriously injured than motorcyclists who did not have a valid license and/or endorsement (35% A+K or serious injury for motorcyclists having an endorsement, compared to 40% for motorcyclists without an endorsement).

License status was also associated with prior crashes and violations: operators with *no* valid license were the least likely to have been involved in prior crashes or convicted of traffic violations during the previous three years, while those with a valid license but no motorcycle permit were the most likely. Here, it should be noted that while unlicensed operators had a lower overall violation rate, they had one of the highest percentages of 3+ violations over the three-year reference period, approaching that of motorcyclists with a valid license but no motorcycle permit.

Finally, motorcycle operators with no valid license were the most likely to have been drinking at the time of their crash, based on the judgment of the investigating officer. They and motorcyclists with a valid license but no motorcycle endorsement were also much more likely to be at fault in their collision: nearly

three-fourths of motorcyclists without a valid license and/or motorcycle permit were responsible for their crash, compared to only 45% for motorcyclists having the required endorsement.

These findings with regard to license status are reinforced when one looks more simply at **endorsement** status, obtained by collapsing the four license status categories into just two: no endorsement (no valid license + valid license but no endorsement) and endorsement (valid license + endorsement either <3 years or ≥ 3 years). Thus, motorcyclists *without* an endorsement on their license were more likely to have been seriously injured (40% versus 35%), less likely to have been involved in prior crashes (24% versus 31%), less likely to have been convicted of traffic violations (48% versus 55%), more likely to have been reported as drinking at the time of their crash (22% versus 11%), and more likely to have been at fault in their crash (75% versus 44%). Again, there is a switch in the direction of the association for endorsement status with prior violations, such that riders without the endorsement, even though less likely to have had one or two previous violations, were more likely to have had 3+ violations.

A final variable related to license status notes whether or not the motorcyclist had a "**stop**" in effect for his license at the time of the crash. While a "stop" can be placed on a license for any number of reasons, it is most often associated with alcohol convictions and/or a poor crash or violation record. Motorcycle operators ages 20-34 were the most likely to have a stop on their license, and had some of the highest percentages of alcohol involvement as well. Presence of a "stop" was also strongly associated with prior crashes and violations: 39% of riders with a stop on their license had been involved in one or more crashes during the previous three years, compared to 26% of riders without a stop. Even more significantly, 90% of riders with a stop had been convicted of one or more violations, compared to 52% of riders without a stop on their license. Presence of a stop was also strongly associated with alcohol involvement and with crash culpability: 56% of drivers with a stop on their license were judged to have been drinking by the investigating officer, compared to only 14% of operators with no license stop, and 90% of operators with a stop were judged at fault in their crash, compared to 58% of operators without a stop.

Since the variable **age** was shown to be strongly associated with many of the motorcycle operator characteristic and crash variables of interest, some additional three-way crosstabulations of the data were generated to determine whether age might be confounding the observed relationships. In particular, we examined whether the following associations significant in the bivariate analyses remained significant after controlling for age of motorcyclist:

Helmet use and alcohol
Helmet use and fault
License/endorsement status and injury
License/endorsement status and prior crashes

License/endorsement status and prior violations
License/endorsement status and alcohol
License/endorsement status and fault

Results of these analyses showed that all of the associations remained significant at the $p < 0.01$ level. Thus, for example, helmeted riders were significantly less likely than unhelmeted riders to have been drinking at the time of their crash, irrespective of age.

Summary

To better define the population of motorcyclists involved in crashes and possible factors contributing to these crashes or increasing their severity, a descriptive analysis was carried out using three years of North Carolina motorcycle crash data, linked to driver history data. Primary variables of interest were motorcyclist age and license status, prior crashes and violations, reported helmet use, severity of injury, alcohol involvement, and crash culpability (fault). Results showed that younger riders were less likely to have the required endorsement on their driver's license, more likely to be at fault in a crash, more likely to be in an alcohol-related crash (highest for ages 25-39), and slightly less likely to wear a helmet (required by North Carolina law). They were also more likely to have been involved in crashes over the previous three-year period and more likely to have been convicted of traffic violations. In these respects, young motorcyclists are not unlike the overall population of young drivers, who have long been identified as an "at risk" population.

Crash-involved motorcyclists who had the required endorsement on their driver's license were somewhat less likely to be seriously injured, more likely to wear a helmet, and much less likely to be at fault in their crash or to be in an alcohol-related crash. They were also less likely to have been convicted of traffic violations during the previous three years, but more likely to have been involved in previous crashes. Except for fewer violations for motorcyclists having an endorsement for three or more years, there were no practical differences between motorcyclists who had had their endorsement three years or more versus those who had had it less than three years. These results held even after controlling for age in the analysis.

The results suggest that increasing the percentage of motorcyclists properly licensed and increasing helmet use may have beneficial effects in terms of reducing both the likelihood and severity of crashes. Still, many questions remained unanswered, primarily because of the lack of exposure information for the crash-involved motorcyclists, as well as information on the population of *non* crash--involved motorcyclists. Thus, if one assumes that those riders who possess the required motorcycle endorsement ride their cycles more than those who do not, then this would increase the apparent benefits of motorcycle licensure in terms of reduced crashes per mile driven. Licensed motorcyclists may also differ from unlicensed motorcyclists in other ways which could impact on crash likelihood (e.g.,

willingness to comply with traffic laws). Further research, ideally comparing crash-involved to non crash-involved motorcyclists and incorporating information on riding exposure, is needed to clarify the issue.

III. Analysis of North Carolina Trauma Registry Data

A primary purpose of the current study was to examine the severity of motorcycle crash injuries and their associated costs. Information available from standard police accident report forms is not adequate for this purpose, as injury is only described in broad severity categories and there is no follow-up information on medical treatment outcomes or costs. To address this question, data was sought from an alternative source, the North Carolina Trauma Registry (NCTR). This chapter describes that data base and the results of the analyses.

Description of the Data

The NCTR was initiated in the fall of 1987. The Registry captures information on all trauma patients admitted for a period of 24 hours or longer, or those who die in the emergency department at one of the State's eight regional trauma centers. Trauma is defined as an injury or wound caused by the application of force or violence, and can result from unintentional events such as motor vehicle or other transport accidents, falls, or accidents involving machinery; or from intentional acts such as suicide, homicide, or assault.

The UNC Department of Surgery developed the hardware and software system, and serves as the Central Data Collection Agency and reporting system for the NCTR. HSRC contacted Dr. Robert Rutledge, director of the NCTR, to obtain data for the current analyses. All runs on the full NCTR file were made by Dr. Rutledge using the Registry hardware and software. In addition, Trauma Registry Directors agreed to make available to HSRC the computerized records for all motorcycle cases on the file, so that these data could be linked with the motor vehicle crash data housed at HSRC.

For purposes of this study, NCTR data were current through June 30, 1990, for a total period of 2.75 years. There were 25,282 trauma cases on file at that time, including 706 motorcycle operators (2.8%), 68 motorcycle passengers (0.3%), 8,961 other road crash victims (35.4%), and 15,547 non-road trauma victims (61.5%). Variables of interest on the NCTR file included the following:

Abbreviated Injury Score (AIS) - a score of 1-6 for injury to each of five body regions, where 1 represents least severe and 6 represents maximum severity.

Injury Severity Score (ISS) - an overall measure of injury severity, equal to the sum of the squares of the three most severely injured body regions (head/neck, chest, abdomen, extremities, or soft tissue).

Emergency Room Disposition - discharge from emergency room to home, intensive care unit, operating room, floor, hospital transfer, morgue (death), other.

Days in Hospital - total number of days in hospital.

Days in Intensive Care - total number of days in intensive care unit.

Discharge Facility - home, rehabilitation facility, hospital transfer, death, other.

Hospital Charges - the cost of the patient's stay in the hospital. Excludes doctors' and other professional fees, outpatient treatment, and other non-hospital charges.

Insurance Status - health insurance carried by the patient or responsible party. Categories include self-pay (uninsured), Medicare, Medicaid, Blue Cross Blue Shield, Champus, commercial, EDS, Workmans Compensation, HMO, and others.

Safety Equipment - use or non-use of motorcycle helmet.

Patient Demographics - age, sex and race.

Analysis Methods

International Classification of Diseases codes for cause of injury were used to identify the following four categories of trauma patient: (1) motorcycle operators (ICD9-CM codes 810-825 with a suffix of .2); (2) motorcycle passengers (ICD9-CM codes 810-825 with a suffix of .3); (3) other road transport victims including motor vehicle drivers and passengers, pedestrians, and bicyclists (ICD9-CM codes 810-825 without the .2 or .3 suffixes, codes 826-829); and (4) other non-road trauma victims (all other categories). The latter includes, for example, victims of gunshot wounds, stabbings, and falls.

Analyses were carried out using the R-Base database program especially adapted for application to the NCTR. Descriptive tables were generated examining each variable of interest cross-classified by trauma population (motorcycle operator or passenger, other road trauma, non-road trauma). Additional cross-tabulations were examined within age level categories.

Results

Tables presented in this section summarize comparisons across the various NCTR populations, most often by presenting average values or percentage distributions within each category. To facilitate comparisons across the populations, unknown values have generally been excluded from the percentage calculations. Full tables containing cell counts and unknown categories are presented in Appendix D.

Demographic Characteristics

Table 3 summarizes information on the demographic characteristics of the various Trauma Registry populations. Compared to other road trauma patients, injured motorcycle operators tended to be younger (mean age 27.7) and were more likely to be white and male. Their passengers tended to be even younger (mean age 22.9), and were more likely to be female (53%).

Table 4 presents a more detailed breakdown of the age distribution of each of the four trauma categories. Nearly half (49%) of the motorcycle operators and 64% of motorcycle passengers were under age 25, compared to 43% for other road trauma victims and only 30% for non-road trauma victims. Nine percent of injured motorcyclists were age 45 or above, and only two percent age 65 or above. Corresponding percentages for all other road trauma cases were 23% and 8%, respectively.

Insurance Status

Insurance status of the NCTR patients is summarized in Table 5. Insurance categories are uninsured (self-pay), public assistance (Medicare or Medicaid), and private or commercial (Blue Cross and Blue Shield, Champus, HMO's, and Workman's Compensation). As a group motorcycle operators were significantly more likely to be uninsured than other road trauma cases -- 42.7% compared to 35.3% ($p<.01$). However, they were just as likely as other road trauma victims to carry commercial or private insurance. The source of the difference is the percentage of patients relying on Medicare and Medicaid, which was 7.9% for motorcycle operators, but 13.9% for other road trauma cases (27.0% for non-road trauma cases). Motorcycle passengers, although having an uninsurance rate of 37.9%, had the highest commercial/private insurance rate of any group at 56.1%.

Since insurance status is associated with age, the percentage of uninsured and percentage of Medicare/Medicaid cases for each category of trauma were examined within age categories. This information is presented in Table 6. Age categories where motorcycle operators are the most likely to be uninsured compared to other road trauma victims are the 16-19 and 45-64 year age groups. These two age categories comprise one-fifth of the total sample. In the 20-24 and 25-44 year age categories (two-thirds of injured motorcyclists), uninsurance rates were only three to four percentage points higher, producing differences which were marginally significant

Table 3. Comparison of NCTR Populations Across Selected Demographic Variables.

Variable	Motorcycle Operator	Motorcycle Passenger	Other Road Trauma	Non-Road Trauma
Age (Mean)	27.7	22.9	32.0	38.9
Gender (% Male)	95.0	47.1	63.4	68.1
Race (% White)	78.2	85.3	70.0	60.9

Table 4. Percentage Distribution of NCTR Populations by Age.

Age	Motorcycle Operator (N=704)	Motorcycle Passenger (N=67)	Other Road Trauma (N=8,865)	Non-Road Trauma (N=24,869)	Total
<16	10.1	25.4	14.6	13.9	14.1
16-19	13.2	14.9	14.1	6.2	9.2
20-24	25.9	23.9	14.5	10.2	12.2
25-44	41.6	26.9	34.2	36.0	35.5
45-64	7.2	7.5	14.9	15.5	15.0
65+	2.0	1.5	7.7	18.2	13.9

Table 5. Percentage Distribution of NCTR Populations by Insurance Status.

Insurance Status	Motorcycle Operator (N=680)	Motorcycle Passenger (N=66)	Other Road Trauma (N=8,835)	Non-Road Trauma (N=15,056)	Total
Commercial/Private	49.4	56.1	50.9	41.5	45.0
Medicare/Medicaid	7.9	6.1	13.9	27.0	21.8
Uninsured (Self-Pay)	42.7	37.9	35.3	31.5	33.2

Table 6. Percentage Distribution of Insurance Status of NCTR Populations by Age.

Age	Insurance Status	Motorcycle Operator (N=679)	Other Road Trauma (N=8,539)	Non-Road Trauma (N=14,766)
<16	Commercial/Private	78.3	52.7	51.5
	Medicare/Medicaid	4.3	15.5	23.4
	Uninsured (Self-Pay)	17.4	31.8	24.1
16-19	Commercial/Private	53.3	63.0	54.5
	Medicare/Medicaid	5.6	5.6	9.7
	Uninsured (Self-Pay)	41.1	31.5	35.8
20-24	Commercial/Private	43.3	48.3	44.4
	Medicare/Medicaid	5.1	4.6	6.1
	Uninsured (Self-Pay)	51.7	47.1	49.5
25-44	Commercial/Private	47.8	52.0	47.3
	Medicare/Medicaid	7.6	6.8	7.5
	Uninsured (Self-Pay)	44.6	41.2	45.2
45-64	Commercial/Private	44.0	59.9	55.9
	Medicare/Medicaid	10.0	10.6	16.7
	Uninsured (Self-Pay)	46.0	29.5	27.4
65+	Commercial/Private	14.3	10.5	8.1
	Medicare/Medicaid	78.6	77.6	88.1
	Uninsured (Self-Pay)	7.1	11.9	3.7

(p=0.08). The higher overall levels of Medicaid and Medicare by the other road trauma and non-road trauma populations primarily reflects their larger population proportions under age 16 and greater than age 65.

Injury

The Abbreviated Injury Scale (AIS) scores injury severity on a six-point scale, from 1 (least severe) to 6 (unsurvivable). Table 7 shows the number and percent of cases experiencing moderately severe (AIS≥2) injuries to each of five body regions. Thus, 35.1% of the total sample of 678 motorcycle operators with known injury severity experienced serious head injury. The table shows that, compared to other road trauma victims, motorcycle operators are less likely to have a serious head or chest injury, but more likely to have a serious injury to their arms or legs. Whereas 35.1% of injured motorcyclists had serious head injuries, 61.1% had serious extremity injuries.

An often used estimate of overall injury severity is the Injury Severity Score (ISS), calculated by summing the squares of the AIS scores of the three most severely injured body regions. For example, AIS 2 (moderately severe) injuries to the head and the chest would produce an ISS of eight, while an AIS 3 (severe) injury to the extremities coupled with moderate (AIS 2) abdominal and head injuries would produce an ISS of 17. Maximum ISS is 75, corresponding to AIS 5 (critical) injury to three or more body regions. (AIS 6 injury is by definition unsurvivable.)

Average ISS for motorcycle operators was **12.1**, for motorcycle passengers **12.0**, and for other road trauma victims **12.7**. Thus, motorcyclists admitted for treatment at North Carolina trauma centers were, as a group, slightly less severely injured than other road trauma victims. Both motorcyclists and other road trauma victims were *more* severely injured than non-road trauma victims, who had an average ISS of only **8.4**. This reflects the fact that road trauma victims are much more likely to incur multiple injuries than are non-road trauma victims.

Table 8 presents the distribution of ISS scores for the four trauma populations. Injured motorcycle operators had a higher percentage of ISS scores under 10, and a lower percentage over 20 than other road trauma patients. The differences between the two populations were significant at the .05 level (p=.022).

Since head injuries can be particularly serious, the likelihood of their occurrence was examined with respect to helmet use. Table 9 is based on results for 382 motorcycle operators identified on the NCTR file with known helmet use and head injury status (helmet use information was missing for 44% of the cases). The results show that the likelihood of a moderately severe (or worse) head injury is nearly 70 percent higher in unhelmeted riders (54.9% versus 32.3%). The likelihood of a severe head injury is 118% higher (33.6% versus 15.4%). The odds ratio for helmet effectiveness in preventing AIS≥2 head injury is 2.5, and for preventing AIS≥3 head injury is 2.8 based on the raw data.

Table 7. Percentage of Cases on NCTR with Serious (AIS≥2) Injury by Location of Injury.

Location of Injury	Motorcycle Operator (N=678)	Motorcycle Passenger (N=65)	Other Road Trauma (N=8,644)	Non-Road Trauma (N=14,956)	Total
Head	35.1	38.5	41.8	15.6	25.5
Chest	19.2	20.0	25.7	8.8	15.1
Abdomen	15.4	13.9	17.0	10.0	12.7
Extremity	61.1	49.2	46.0	44.2	45.3
Soft Tissue	3.4	6.2	4.1	13.1	9.6

Table 8. Percentage Distribution of Injury Severity Scores for NCTR Populations.

ISS	Motorcycle Operator (N=676)	Motorcycle Passenger (N=64)	Other Road Trauma (N=8,570)	Non-Road Trauma (N=14,825)	Total
<10	55.6	51.6	50.3	76.8	66.7
10-19	27.5	29.7	29.9	16.6	21.6
≥20	16.9	18.7	19.9	6.7	11.7

Table 9. Percentage of Motorcycle Operators on NCTR with Moderately Severe or Severe Head Injuries, by Helmet Use.

Helmet Use	AIS≥2 Head Injury	AIS≥3 Head Injury
Helmet	32.3	15.4
No Helmet	54.9	33.6

Treatment Outcomes

A variety of injury-related measures were examined including emergency room disposition, days in intensive care unit, days in hospital, total hospital charges, and discharge facility. Results pertaining to emergency room disposition are summarized in Table 10. Approximately equal percentages of motorcycle operators and other road trauma patients were discharged from the emergency room to the floor, i.e., a room at the hospital (38.0% for motorcyclists, 38.9% for other road trauma). Motorcyclists were more likely to be sent directly to the operating room (35.8% versus 23.4%), whereas other road trauma victims were more likely to be placed in intensive care (31.4% versus 21.1%). A comparison of emergency room disposition between motorcycle operators and other road trauma cases yielded significant differences at $p<.01$. The greater need for operating room services on the part of motorcyclists may result at least in part from their high rate of extremity injuries, possibly requiring setting of broken bones.

Information on average number of days in intensive care unit (ICU) and average length of hospital stay is presented in Table 11. Motorcycle operators spent an average of four days in intensive care, compared with five days for other road trauma victims. Average length of hospital stay, however, was 13 days for motorcyclists and 12 for other road trauma victims. For both ICU and hospital days, length of stay increased with age. For motorcycle operators, average hospital days increased from eight days for riders under age 16, to 17 days for riders age 45-64 and 19 days for those age 65 and up. Non-road trauma patients had shorter ICU and hospital stays, in keeping with their generally less severe injuries.

Although motorcyclists had slightly longer hospital stays, their average hospital charges were lower. Table 12 shows that the average hospital charge (exclusive of doctors' fees) was $15,800 for motorcycle operators, $17,900 for other road trauma victims, and $9,600 for non-road trauma victims. As with hospital days, hospital charges increased with age, and one explanation for the higher average hospital charge for the other road trauma category could be its higher proportion of older victims -- eight percent of other road trauma victims were age 65+, compared to only two percent of motorcycle operators. Still, injured motorcyclists had lower hospital charges in the 16-19, 20-24 and 25-44 year age categories that comprise 80 percent of their membership.

Multiplying average hospital charges by the total number of victims, one can obtain overall estimates of treatment costs for the various trauma registry populations. For motorcyclists, this figure was just over 11 million dollars over the nearly three-year study period; for other road trauma patients 160 million dollars, and for non-road trauma patients nearly 150 million dollars.

A final outcome table (Table 13) shows the percentage of cases requiring admittance to a rehabilitation facility or other hospital or medical facility after leaving the trauma center. (Outpatient rehabilitation is *not* represented, as this

Table 10. Percentage Distribution of NCTR Cases by Emergency Room Disposition.

Emergency Room Dispostion	Motorcycle Operator (N=702)	Motorcycle Passenger (N=66)	Other Road Trauma (N=8,866)	Non-Road Trauma (N=15,328)	Total
Floor	38.0	31.8	38.9	48.9	45.0
Intensive Care	21.1	24.2	31.4	14.1	20.5
Operating Room	35.8	34.8	23.4	30.0	27.8
Morgue	1.4	3.0	2.8	1.8	1.8
Other	3.7	6.1	3.5	5.2	4.6

Table 11. Average Number of Days in Intensive Care Unit and Average Length of Hospital Stay for NCTR Patients by Age.

Age	Hospital Outcome	Motorcycle Operator	Other Road Trauma	Non-Road Trauma	Total
<16	Days ICU	3	3	3	3
	Days in Hosp.	8	8	6	7
16-19	Days ICU	3	5	3	4
	Days in Hosp.	12	11	6	9
20-24	Days ICU	3	4	2	3
	Days in Hosp.	13	12	6	9
25-44	Days ICU	5	4	3	3
	Days in Hosp.	13	12	7	9
45-64	Days ICU	4	6	4	5
	Days in Hosp.	17	15	10	12
65+	Days ICU	5	7	4	5
	Days in Hosp.	19	15	14	14
Overall	Days ICU	4	5	3	4
	Days in Hosp.	13	12	9	10

Table 12. Average Hospital Charges for NCTR Populations by Age.

Age Group	Motorcycle Operator	Other Road Trauma	Non-Road Trauma
<16	$12,599	$9,738	$6,238
16-19	14,731	15,227	7,792
20-24	15,343	16,579	8,117
25-44	15,877	18,137	9,518
45-64	20,016	18,816	10,847
65+	28,592	38,945	12,459
Overall	$15,801	$17,892	$9,559

Table 13. Percentage Distribution of NCTR Cases by Discharge Facility.

Discharge Facility	Motorcycle Operator (N=638)	Motorcycle Passenger (N=62)	Other Road Trauma (N=8,158)	Non-Road Trauma (N=14,270)	Overall
Home	85.0	80.6	81.6	82.9	82.5
Rehabilitation	7.4	8.1	6.6	2.8	4.3
Hosp/Medical	3.8	3.2	4.0	9.0	7.1
Death	3.9	8.1	7.8	5.3	6.1

information is not available on the NCTR.) Overall, 7.4% of motorcycle operators and 8.1% of motorcycle passengers were discharged to a rehabilitation facility, compared to 6.6% for other road trauma patients. Differences in requirements for discharge to a rehabilitation facility for motorcyclists compared to other road trauma victims were not significantly different.

Follow-up Analysis of North Carolina Trauma Registry Data

At the time the initial request was made for access to the NCTR, data were available from the inception of the Registry in October 1987 through July 1990, a period of just under three years. By the completion of the study, however, the Registry contained data current through December 1991, an additional one-and-a-half years. A decision was therefore made to carry out a limited analysis of this expanded data base, to ascertain whether key study findings held.

Summary tables from this analysis are contained in Appendix E. They are based on a total of 43,299 trauma cases, including

1,380	motorcycle operators
102	motorcycle passengers
15,375	other transport trauma cases
26,442	non-transport trauma cases

Results based on this expanded data base confirm and strengthen the findings already reported. They show that, compared to other road transport patients admitted to North Carolina trauma centers, motorcycle operators

- Experience slightly lower injury severities, as measured by average ISS (11.2 for motorcycle operators, 11.9 for other transport cases);

- Accrue lower overall hospital charges (an average of $14,993 for motorcycle operators, $16,396 for other transport cases);

- Are slightly more likely than other road transport cases to carry commercial or private insurance (53.5% versus 50.8%). (Corresponding figures from the earlier analysis were 49.4% for motorcycle operators and 50.9% for other transport cases). Motorcyclists continue to have a slightly higher uninsured/self-pay rate (38.1%, versus 33.1% for other transport trauma cases), and remain less likely to be dependent on Medicare or Medicaid (8.4% versus 16.2%), $p<.001$;

- For the follow-up sample, injured motorcyclists were also more likely to be discharged home and less likely to be discharged to a rehabilitation facility, transferred to another medical facility, or die after being hospitalized ($p<.001$). 84.8% of motorcyclists were discharged home and 6.7% to a

rehabilitation facility; for other road trauma cases, the corresponding percentages were 80.2% home, 8.0% rehabilitation.

The follow-up analysis also examined the severity of head/neck and extremity injuries, both overall and separately for helmeted and unhelmeted riders (Tables E.7-E.10). These results reinforced earlier findings that motorcyclists admitted for treatment to North Carolina trauma centers have a slightly lower rate of serious head/neck injury compared to other trauma victims, but are much more vulnerable to serious injury to an extremity: 33.7% of motorcycle operators experienced a serious (AIS≥2) head or neck injury, compared to 40.0% of other transport cases. In contrast, 57.9% experienced serious injury to an extremity, compared to only 44.0% for other road transport cases.

For the 716 motorcycle operators with recorded helmet use (71.7% helmeted, 28.4% unhelmeted), the risk of a severe (AIS≥3) head or neck injury remained more than twice as high for the unhelmeted motorcyclist: 35.5% for unhelmeted operators, compared to 16.0% for helmeted. Unhelmeted motorcyclists, on the other hand, were *less* likely to experience serious or severe injuries to the extremities: 14.8% versus 35.7%. This latter finding reflects the biased nature of the Trauma Registry data, i.e., helmeted riders, protected from head injury, are more likely to appear in the Registry as the result of some other (serious) injury, in this case injury to an arm or leg.

The reader is referred to the appendix tables for more complete documentation of the follow-up analysis of the NCTR file.

Summary

To summarize the comparisons between the various NCTR populations, motorcyclists treated at North Carolina trauma centers experienced generally lower injury severities than other road trauma patients. Their average hospital stay was slightly longer, but average hospital charges were lower. Injured motorcyclists were more likely to be uninsured, but less likely to rely on Medicare/Medicaid, and were just as likely as other road trauma patients to be commercially or privately insured. Finally, they were no more likely than other road trauma patients to require continued medical services at a rehabilitation facility following hospitalization.

IV. Analysis of Matched Trauma Registry and Motor Vehicle Crash File Data

While examinations of the injury outcomes and costs of motorcycle crashes have most often relied on hospital-based data, there are clearly biases in the use of trauma registry data. Trauma centers, by their nature, capture the upper end of the injury severity continuum. They also exclude cases that die at the scene or before ever reaching the emergency room. Trauma centers are heavily represented by larger hospitals and hospitals associated with teaching universities, both of which tend to serve a greater proportion of lower income and uninsured patients. Thus, motorcycle crash cases appearing on a trauma registry file may differ in important ways from the overall population of crash-involved motorcyclists, and it may be inappropriate to draw inferences from this sample to the larger population.

To explore these issues, a final component of the project involved linkage of the NCTR cases to the police-reported motor vehicle crash file cases and comparison of characteristics across the files. The linkage also made possible the addition of crash-related variables to the NCTR cases, so that, for example, injury severity and insurance status could be examined with respect to licensure, alcohol involvement, etc. These latter results could have important implications for programs and policies to better promote motorcycle safety.

Methods

Due to issues of confidentiality, no identifying information is available from North Carolina's centralized trauma registry. NCTR cases were therefore matched to motor vehicle crash file cases on the basis of the date and time of the crash and the date of birth, sex and race of the motorcycle operator. (A similar procedure had been used by Stutts, et al. (1990) to link hospital emergency room data to crash file data to study the completeness of police-reported bicycle crashes.) Following this approach it was possible to identify a police crash report for 309 or 47.9 percent of the 645 motorcycle operators with completed records on the NCTR file. No attempt was made to identify a crash report for the motorcycle passengers.

For the remaining cases, it was not possible to determine whether the lack of match was the result of no police report being filed or simply a failure in the matching process (e.g., an error in recorded operator date of birth). Theoretically any motorcycle crash occurring on a public roadway and resulting in injury severe enough to require medical treatment should be reported on the statewide crash file. However, previous research has shown that a substantial proportion of such crashes are not reported (Popkin, Waller and Hansen, unpublished). Also, motor scooters and all-terrain vehicles (ATVs), which might appear on the NCTR file, would not have been found on the crash file, since these are coded separately from

motorcycles. Finally, crashes involving motorcycles being used off of public roadways or public vehicular areas would also not be reported on the crash file, but could have been included in the NCTR file.

Results

Comparison of Matched and Unmatched NCTR Cases

Before making comparisons between the NCTR cases matched to the motor vehicle crash file and the full crash file, it is important to examine differences between the matched and unmatched NCTR cases. These differences are highlighted in Table 14. They show that the matched cases had a significantly ($p<.001$) lower percentage of motorcyclists under age 16 (4.3% versus 16.7%) and age 45 and above (6.9% versus 12.2%). Matched cases were more severe, with a higher percentage of Injury Severity Scores of 10 or above (51.3% versus 42.9%, $p<.05$) and longer hospital stays (46.2% over 10 days, compared to 33.3% for unmatched cases, $p<.01$). Mean and median values for these variables were as follows:

	Matched Cases	Unmatched Cases
Age		
Mean	27.8	27.8
Median	26	24
ISS Injury Severity		
Mean	12.9	11.7
Median	10	9
Hospital Days		
Mean	13.9	12.7
Median	9	6

Finally, matched cases were more likely to be uninsured (45.1% versus 36.8%) and less likely to rely on Medicaid/Medicare (5.8% versus 10.6%, $p<.05$), a finding that likely reflects their lower percentages of younger and older riders.

These differences in the matched and unmatched NCTR cases will limit the conclusions that can be made regarding overall differences in the NCTR and motor vehicle crash file populations, since this analysis must rely solely on comparisons with the matched sample.

Table 14. Comparison of Matched Versus Unmatched NCTR Cases.

Variable	Matched NCTR Cases (N=309)	Unmatched NCTR Cases (N=336)	P-value
Age			
<16	4.3	16.7	
16-19	16.1	9.6	
20-24	28.2	25.7	p<.01
25-44	44.6	35.8	
45+	6.9	12.2	
ISS			
<10	48.7	57.1	
10-19	33.1	25.4	p<.05
20+	18.2	17.5	
Insurance Status			
Commercial/Private	49.2	52.6	
Medicare/Medicaid	5.8	10.6	p<.05
Uninsured (Self-Pay)	45.1	36.8	
Hospital Days			
None	3.3	3.1	
1-9	50.5	63.7	p<.01
10-19	25.9	17.1	
20+	20.3	16.2	

On-road Versus Off-road Motorcycles

Both the North Carolina Trauma Registry and motor vehicle crash files include cases involving on-road and off-road motorcycle types. However, regulations regarding operator licensure, helmet use, and age apply only to on-road vehicles (or to mixed use vehicles being ridden on the public roadway), so that it would be desirable to distinguish between vehicle types in the analyses.

As noted in the earlier presentation of the motor vehicle crash file results, a decoding of Vehicle Identification Numbers (VINs) resulted in 74.1% of the crash file motorcycles being identified as on-road vehicles, 5.3% as off-road vehicles, and 20.6% as unknown vehicle types.

On the NCTR, there is no code to distinguish between on-road and off-road vehicle types. However, it is possible to distinguish between events occurring on

the road and those occurring off the road, using the cause of injury codes (ICD9-CM 810-819 are for events occurring *in traffic* and codes 810-820 are for *non-traffic* events). Overall, 91% of the identified motorcycle operators were injured in on-road events. However, these crashes do not necessarily involve only on-road (or on-road and dual purpose) vehicles.

When the NCTR and motor vehicle crash file cases were matched, the matched cases were found to have an almost identical distribution of vehicle types to the crash file cases (75.7% on-road vehicles, 4.5% off-road vehicles, and 19.7% unknown). Thus, vehicle type should not confound any observed differences in variables of interest across these two populations. However, it remains uncertain to what extent the composition of the overall Trauma Registry file differs from the motor vehicle crash file. That it likely includes a higher proportion of off-road vehicles is suggested by the finding that matched cases involved a higher percentage of road traffic events (as determined by the cause of injury codes) than did unmatched cases (95.8% vs. 86.3%). This difference may again limit the extent to which results for our matched sample may be extended to the full NCTR file.

Comparison of Trauma Registry and Police-Reported Motorcycle Crashes

With these differences in mind, Table 15 compares distributions of selected variables on the motor vehicle crash file to the matched NCTR cases. (Unknown categories have been excluded to facilitate comparison.) Whereas the full NCTR file had included greater proportions of younger and older motorcyclists, the **age** distribution of the matched file did not differ significantly from the age distribution for the overall crash file (p=.813). As expected, however, the Trauma Registry cases were much more seriously **injured** -- 81.7% suffered a fatal or A-level (severe) injury, as compared to 37.4% for the crash file cases.

Information on police-reported **helmet use** shows that 68.5% of the matched NCTR cases were reported as wearing a helmet at the time of their crash. This is virtually identical to the 69.2% use rate for motorcycle operators on the motor vehicle crash file, a finding which is surprising given the generally higher injury severities associated with trauma center populations.

An issue that has received considerable attention in the literature is that of **licensure**. In North Carolina motorcyclists are required to have a motorcycle endorsement in addition to a regular (Class A, B or C) motor vehicle operator's license. This is obtained only after passing a written exam and an on-road test. Overall, 48.5% of the motorcyclists on the NCTR file had a valid motorcycle license at the time of their crash, which is not significantly lower than the 53.0% licensure rate for the full crash file (p=.176).

Just under six percent of the matched NCTR cases had a **"stop"** on their license at the time of their crash, meaning that it had been either temporarily or

Table 15. Percentage Distribution of Variables for Matched Trauma Registry Cases and Comparison with N.C. Crash File

Variable	Matched Trauma Registry Cases (N=309)	N.C. Crash File 1987-1989 (N=7,224)	P-value
Age			
<16	4.3	4.8	
16-19	16.1	17.1	
20-24	28.2	29.4	p=.813
25-44	44.6	42.6	
45-64	5.9	5.7	
65+	1.0	0.5	
Injury Severity			
K - Killed	7.2	2.8	
A - Serious	74.5	34.6	
B - Moderate	15.4	34.2	p<.001
C - Minor	2.3	16.6	
O - None	0.7	11.8	
Helmet Use			
Yes	68.5	69.2	p=.421
No	31.5	30.8	
MC License			
Yes	48.5	53.0	p=.176
No	51.5	47.1	
"Stop" on License			
Yes	5.9	6.7	p=.586
No	94.1	93.3	
Crashes (3 yrs.)			
0	69.2	72.8	
1	22.6	20.5	p=.224
2	7.2	5.2	
3+	1.0	1.5	
Violations (3 Yrs.)			
0	45.9	48.7	
1	23.0	20.4	p=.641
2	11.5	12.4	
3+	19.7	18.4	
At Fault Status			
Yes	64.9	53.2	
No	26.9	35.6	p<.01
Can't Determine	8.2	11.2	
Alcohol Cited			
Yes	28.5	16.4	p<.001
No	71.5	83.6	

permanently suspended. Although a "stop" can be issued for a number of reasons, one of the most common is a license suspension following conviction for driving while intoxicated. The "stop" rate for the NCTR sample was slightly lower than that for the population of all crash-involved motorcyclists, but again the differences were not significant (p=.586).

Motorcyclists identified on the NCTR file were no more likely than those on the full crash file to have been involved in **crashes** over the previous three-year period (p=.224) or to have been cited for traffic **violations** during this time (p=.641). However, they were more likely to have been judged at fault in their crash (64.9% versus 53.2%, p<.01).

A final variable examined was that of **alcohol** involvement. Although blood alcohol level is one of the variables available on the NCTR, the information is often missing or not reliable. This can be due to the time lag between the crash event and arrival at the trauma center, as well as to patient transfers from other medical facilities. The alcohol variable on the North Carolina motor vehicle crash report form is based on the investigating officer's judgment at the time of the crash, and has been shown to be highly correlated with measured blood alcohol levels (Waller, Stewart, Hansen et al., 1985). The current data suggest that over a fourth of all motorcycle operators treated at North Carolina trauma centers are impaired by alcohol. This is higher than the 16.4% for crash-involved motorcyclists overall (p<.001), and again is indicative of the more serious nature of the Trauma Registry cases.

To summarize this section, when matched to the motor vehicle crash file nearly two-thirds of motorcyclists treated at North Carolina trauma centers were found to have been wearing a helmet at the time of their crash. Just under half had the required motorcycle endorsement on their North Carolina driver's license. Nearly half had not been cited for traffic violations over the previous three-year period, and two-thirds had not been involved in another motor vehicle crash. Compared to the crash file cases, the NCTR cases were more severely injured, more likely to have been in an alcohol-related crash, and more likely to have been at fault in their crash. Age, helmet use, license status, and prior crashes/violations did not differ significantly across the two populations.

Analysis of Matched Trauma Registry Cases with Added Crash File Variables

A variety of crosstabulations were generated to examine relationships between the crash file variables identified in Table 15 and various outcome measures for the sample of matched NCTR cases. The analysis included crosstabulations of each of the crash file variables with Insurance Status, Injury Severity Score, Days in Hospital, and Discharge Facility. Results of the significance tests are summarized in Table 16.

Table 16. Significance of Associations between Crash File Variables and NCTR Variables for Matched Cases.

Variable	Insurance Status	Injury Severity Score	Days in Hospital	Discharge Facility
Helmet Use	n.s.	n.s.	n.s.	n.s.
Motorcycle License	p<.01	n.s.	n.s.	n.s.
Stop on License	p=.08	n.s.	p=.07	n.s.
Prior Crashes	n.s.	n.s.	n.s.	n.s.
Prior Violations	n.s.	n.s.	n.s.	n.s.
At Fault	n.s.	n.s.	n.s.	n.s.
Alcohol	n.s.	p<.01	n.s.	p=.01

Only a few of the crosstabulations yielded significant findings. Police-reported helmet use, prior crashes, prior violations, and fault were not significantly associated with insurance status or any of the three injury-related variables. License status and presence of a "stop," however, were significantly associated with insurance status. Motorcyclists possessing the required motorcycle endorsement on their driver's license were significantly *more* likely than those without the endorsement to carry commercial insurance (60.0% versus 39.3%), and significantly *less* likely to be uninsured (35.2% versus 54.0%). Motorcyclists with a stop on their license, in contrast, were *more* likely to be uninsured (64.7% versus 43.6%). Both of these findings are likely confounded by age.

Presence of a license "stop" was also marginally associated with number of days in hospital. Only 22.2% of riders with a stop on their license were hospitalized less than 10 days, compared to 52.7% of motorcyclists without a stop.

This latter finding may be confounded by alcohol status, since although not significantly associated with days in hospital, alcohol status was associated with both Injury Severity and Discharge Facility. Only 43.3% of motorcyclists who were judged unimpaired had an overall ISS of 10 or greater, compared to 61.3% of those judged impaired. Also, more impaired cases died (6.7% versus 3.3%) or were discharged to a rehabilitation facility (9.3% versus 5.4%).

Summary

In summary, the analysis of crash file variables added to the matched NCTR

cases (N=309) suggests that motorcycle operators who have the required endorsement on their driver's license and those who do not have a stop on their license are less likely to be uninsured. Also, crashes in which the motorcyclist has been drinking result in more serious injuries and less favorable discharge status. Both findings have implications for motorcycle safety programs and policies.

V. Summary and Discussion

Purpose of the Study

Research was carried out to (1) examine the severity and costs of injuries to crash-involved motorcyclists; (2) draw comparisons to other trauma populations; and (3) examine factors associated with motorcycle crashes to suggest approaches for reducing their frequency and severity. Impetus for the study grew from several recently published papers declaring to varying degrees that motorcyclists are "disproportionate consumers of public health care funds" who fail to protect themselves (and society) by carrying adequate medical insurance, wearing a safety helmet, refraining from drinking while riding, etc.

There were, however, a number of limitations in these early studies. Central was their failure to include a comparison population or, on some occasions, the use of an inappropriate comparison population. A finding that 40% of treated motorcyclists are uninsured may appear to offer strong support for labelling motorcyclists as "disproportionate consumers," but what if 45% of motor vehicle drivers in crashes are also uninsured? Furthermore, is it reasonable to expect that crash-involved motorcyclists would be insured to the same extent that hospital inpatients are, many of whom are admitted for elective or planned surgeries?

The present study attempted to address these limitations by including in the analyses the full sample of trauma center utilizers, with a particular emphasis on comparing motorcycle operators to other road trauma victims. The study also incorporated data from a larger number of trauma centers (eight), and included a larger number of cases than had previous studies. This facilitated the consideration of possible confounding variables, such as age. Finally, trauma registry data were linked with the motor vehicle crash data to provide additional information on factors associated with motorcycle crashes that could be useful in developing programs and polices for increasing motorcycle safety.

Summary of Key Findings

There were three parts to the study: an analysis of North Carolina motorcycle crash data; an analysis of North Carolina Trauma Registry (NCTR) data; and an analysis of trauma registry cases matched to the motor vehicle crash file. Key study findings from each area are summarized below.

Analysis of North Carolina Crash Data

The analysis of North Carolina crash data required linkage of three years of police-reported motorcycle crash records with the driver histories of the motorcycle

operators involved in the crash. The time span for the analysis was 1987-1989, during which time 7,077 motorcyclists were involved in 7,266 crashes.

Results showed that half of the crash-involved motorcyclists were 20-29 years old, that over a third were seriously injured, and that alcohol was a factor in 14% of the crashes. The analysis also showed that only two-thirds of all crash-involved motorcyclists had the required motorcycle endorsement on their driver's license; however, this percentage increased to nearly three-fourths for motorcyclists identified as riding on-road cycles. Age was significantly associated with many of the variables. The percentage of operators with motorcycle endorsements increased from only 37% for riders age 16-19 to 70% for riders age 40+. Older riders were also less likely to be at fault in their crash, and less likely to be in an alcohol-related crash.

Helmet use was not found to be associated with overall injury severity, as measured on the five-point KABCO scale. However, it was associated with license status, alcohol involvement, and crash culpability (fault). These and other associations held after controlling for age in the analysis.

Analysis of North Carolina Trauma Registry (NCTR) Data

The analysis of NCTR data was based on nearly three years of data collected at eight regional trauma centers in the State. The Registry was divided into four comparison populations: (1) motorcycle drivers (N=706); (2) motorcycle passengers (N=68); (3) other road trauma (N=8,961); and (4) non-road trauma (N=15,547).

Of particular interest were variables describing the location and severity of injury, the cost of treatment, and insurance status. Compared to other road trauma cases, motorcyclists admitted for treatment at the trauma centers were less severely injured and had lower hospital costs. They were more likely to be uninsured (43% versus 35%) but less likely to rely on Medicare or Medicaid, and were about equally likely to carry commercial or private insurance (49% versus 51%). Finally, injured motorcyclists were slightly more likely to require discharge to a rehabilitation facility following hospitalization, but the difference was not significant.

Examining the impact of helmet use on head injury, results showed that 34% of unhelmeted riders suffered a serious (AIS≥3) head injury, compared to 15% of helmeted riders. Overall, motorcyclists admitted to North Carolina trauma centers were less likely than other road trauma cases to experience serious head injury, but more likely to experience serious injury to the extremities.

A limited analysis of an expanded NCTR file, current through December 1991, confirmed and strengthened these findings. This follow-up analysis was based on 1,380 motorcycle operators and 102 passengers.

Analysis of NCTR Cases Matched to the Motor Vehicle Crash File

A final analysis task involved linkage of motorcycle cases on the NCTR to the motor vehicle crash and driver history files. This task was undertaken to explore differences in the files and to expand the list of variables available for analysis. Unfortunately, only 309, or just under half of the available cases, could be matched.

A comparison of the matched and unmatched cases showed that the matched file had fewer riders less than age 16 or greater than age 44, more serious injuries, longer hospital stays, and a higher uninsurance rate. The matched cases also included a higher percentage of traffic (as compared to non-traffic) events. These differences would tend to limit the extent to which results from the matched file could be extended to the full NCTR file.

Compared to the overall crash file, the matched NCTR cases were more severe, were more likely to involve alcohol, and were more likely to involve an at-fault motorcyclist. When Trauma Registry variables were added to the crash file records, analyses showed that motorcycle operators who have the required endorsement on their driver's license are less likely to be uninsured. Also, operators reported to be drinking at the time of the crash were more likely to be seriously injured (as measured by Injury Severity Scores) and were more likely to die in the hospital or be discharged to a rehabilitation facility.

Conclusions and Recommendations

The present analysis fails to support earlier studies suggesting that motorcyclists injured in traffic crashes disproportionately rely on public health care funds to pay for their hospitalization. While injured motorcyclists are significantly more likely to be uninsured, they are also less likely to rely on Medicaid and Medicare, and have about the same level of commercial or private insurance. For the 20-44 year age group that comprises two-thirds of motorcyclists treated in trauma centers, uninsurance rates were only marginally higher ($.05<p<.10$).

Earlier studies failed to report on the total medical insurance profile, and either did not incorporate a comparison population or utilized an inappropriate comparison population (e.g., all hospital admissions).

The North Carolina data also showed that motorcyclists admitted to trauma centers may be less severely injured than other road trauma victims, and that they accrue lower hospital charges, both overall and within identified age categories. The study was not able, however, to examine the long-term consequences of motorcyclists' injuries, or to incorporate the full spectrum of injury "costs."

Overall, motorcyclists represent only about one percent of the reported motor vehicle crashes occurring in North Carolina. In 1990, there were 2,043 reported motorcycle crashes, compared to 165,962 motor vehicle crashes. Motorcyclists, however, like pedestrians, bicyclists, and other unprotected road users, are more vulnerable to injury once in a crash. Three percent of North Carolina's crash-involved motorcyclists are killed, and over a third are seriously injured. This compares to less than one percent of motor vehicle drivers killed and three-and-a-half to four percent seriously injured. This greater vulnerability to injury re-emphasizes the need for continued efforts to improve motorcycle safety.

The analyses of North Carolina motor vehicle crash and Trauma Registry data carried out as part of this overall study effort suggest several areas that warrant increased attention. Alcohol was involved in 14% of the reported motorcycle crashes and was associated with increased injury severity and less favorable treatment outcomes. Helmets were not associated with overall injury severity, but were shown to significantly reduce the risk of serious head injury; yet one-third of crash-involved riders were reported to be unhelmeted. And while the reasons are not clear, motorcyclists who had obtained the required endorsement on their driver's license were less likely to be in an alcohol-related crash and less likely to be cited at fault. There was also some evidence from the matched file analyses that properly licensed motorcyclists were less likely to be uninsured.

Further research is needed to more fully explore the range of factors associated with motorcycle crashes, and to develop effective programs and policies to reduce their frequency and severity. The UNC Highway Safety Research Center supports the Motorcycle Industry Council's efforts in this important area.

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APPENDIX A

Background Information on the
UNC Highway Safety Research Center
and the
North Carolina Trauma Registry

UNIVERSITY OF NORTH CAROLINA
HIGHWAY SAFETY RESEARCH CENTER

The University of North Carolina Highway Safety Research Center (HSRC) was created by an Act of the North Carolina General Assembly in 1965, and began operations in 1966. The Center is now in its 26th year of service. The HSRC mission is the same as that of the rest of the University -- teaching, research, and public service.

Teaching: HSRC staff conduct workshops, provide lectures to regular classes on-campus, and make many other presentations in North Carolina and elsewhere.

Research: HSRC is primarily a research center, and annually its staff is involved in numerous research projects. As a result, HSRC staff publishes each year a number of technical reports, scientific articles, and other formal papers. Since 1966, HSRC staff have conducted more than 350 research projects and produced more than 700 papers, reports, and other publications.

Public Service: Highway safety is of practical concern to most people. HSRC staff is active in the translation of research knowledge into a form for action, and participates in this process through public education and by providing technical support to action programs in various communities.

A key continuing activity, but one of substantial importance (and one that is rather difficult to document) is the extensive role HSRC plays in providing sound technical advice/information to a large array of citizens, officials, legislators, etc. from N.C., elsewhere in the USA, and internationally. Providing this technical information is a significant task, and is a service rendered in addition to funded project activities. These inquiries -- written, by telephone, or in person -- number in the thousands per year. This demand stems from a general understanding that sound, unbiased information can be obtained by calling on HSRC.

HSRC has a technical staff with professional backgrounds in several areas including engineering, epidemiology, communications, computer systems, psychology, medicine, and statistics. In any year, HSRC is likely to be involved in 25-35 projects. Currently, HSRC has 23 projects underway, funded by 14 private and government agencies. Total expenditures come to approximately 2.5 million dollars.

Each such project involves a multidisciplinary team approach utilizing the capabilities and expertise of HSRC professionals in their specialty areas. Every member of the HSRC professional staff is involved in multiple projects. Each project has a leader, and therefore, a given professional will simultaneously be both project leader and team member on different projects.

THE NORTH CAROLINA TRAUMA REGISTRY

The North Carolina Trauma Registry (NCTR) is a collaborative effort among trauma centers, interested hospitals, the North Carolina Office of Emergency Medical Services (NCOEMS) and the State of North Carolina. Committed trauma surgeons and other health care professionals help to collect accurate and timely information on injured patients in North Carolina.

The NCTR is a database system that includes all eight designated Level I and Level II trauma centers in North Carolina:

Duke University Medical Center
Moses H. Cone Memorial Hospital
UNC Hospitals
New Hanover Regional Medical Center
Wake Medical Center
Durham Regional Hospital
Carolinas Medical Center
Forsyth Memorial Hospital
Memorial Mission Hospital
North Carolina Baptist Hospital
University Medical Center for Eastern Carolina
Wesley Long Community Hospital

Data collection began on October 1, 1987, and includes all patients admitted to the hospital for at least one day as well as all patients declared dead in the Emergency Department. Data on trauma patients were entered into a database using a microcomputer at each hospital, and at intervals this data was sent to the central collection agency at the University of North Carolina at Chapel Hill. Data were validated on entry by the trauma registrar and the physician staff at each hospital. Trauma patients included in the NCTR were defined as patients with the International Classification of Diseases Supplementary Classification of Diagnosis (ICD-9-CM) codes between 800 and 959.9. Abbreviated Injury Scale (AIS) and Injury Severity Scores (ISS) were derived from the patient's ICD-9 diagnosis codes using the method developed by Ellen MacKenzie (ref: MacKenzie, E.J., Steinwachs, D.M., and Shankar, B.S. An ICD-9CM to AIS Conversion Table: Development and Application. Proceedings

of the *American Association for Automotive Medicine,* p. 135, 1986).

The Trauma Registry has become an effective means to document and analyze information specific to the trauma population. The interpretation of the Trauma Registry data allows:

1) Improvements to be made in trauma care delivery,

2) Contributions to be made for utilization review,

3) Documentation of quality assurance information as required by the JCAHCO,

4) Fulfillment of ACS and the State of North Carolina trauma center requirements,

5) Assistance in hospital marketing by tracking referral information,

6) Reports from the collaborative Trauma Registry group to be provided to local and state agencies to educate them regarding the injury population and assist them in making informed financial and legislative decisions,

7) Information to be provided regarding major trauma,

8) A network of interested researchers to collaborate on studies using increased and standardized data from a variety of service areas.

ACCESSING THE NORTH CAROLINA TRAUMA REGISTRY

To access the North Carolina Trauma Registry an applicant must complete a data access form. Any use of the data must be approved through the North Carolina Trauma Registry Task force.

The Trauma Director at each designated Level I or Level II Trauma Center will serve as a primary investigator or site leader for that Institution. The primary investigator (Note: This is not the same as a principle investigator in the usual context) has the responsibility to 1) evaluate all applications for access to NCTR data; 2) serve as a liaison between an applicant and the NCTR for each project application or to serve as the lead or secondary author of the project; 3) identify the project participants and their roles in the project; 4) assume the responsibility of assuring the

quality of the projects from their initial conception to their submission and completion; and 5) initiate the application process.

Successful applicants who intend to use the material obtained from the North Carolina Trauma Registry have the responsibility to promulgate a high level of ethical consideration in their work. In accordance with this scientific integrity, no data which risks the breaking of patient or hospital confidentiality will be made available to any investigator.

The completed Scientific Project application for Data form and ten copies are sent to the NCOEMS. These will be distributed to the Primary Investigators to be reviewed and approved or disapproved. The Primary Investigators must unanimously approve the request. If the request is not approved initially, requested changes in the application must be changed, and the application can then be resubmitted.

Although this process may seem overly complex on paper, our past experience shows that the vast majority of requests are approved promptly and uneventfully with this approach, while maintaining the security of each center and their objectives will be heard and acted upon if concerns arise over a data request.

Following approval of a data request, the data will be extracted from the registry and forwarded to the primary investigator.

In addition to access limitations, no publications or major presentations can be made of the results of the data analysis without going through a similar publication approval process. Briefly, ten copies of the abstract or publication for consideration should be submitted to NCOEMS. These copies will be forwarded to the four members of the Publication Committee who will initiate the review process.

APPENDIX B

North Carolina
Police Accident Report Form

DMV-349 (Rev. 1/92)

☐ No. of Units Involved

☐ Supplemental Report

THIS REPORT IS FOR THE USE OF THE DIVISION OF MOTOR VEHICLES. THE DATA IS COLLECTED FOR STATISTICAL ANALYSIS AND SUBSEQUENT HIGHWAY SAFETY PROGRAMMING. DETERMINATIONS OF "FAULT" ARE THE RESPONSIBILITY OF INSURERS OR OF THE STATE'S COURTS.

Do not write in these spaces
DMV REPORT #

Date (MONTH DAY YEAR)	Day of Week	County	Time (24 Hour Clock)	Local Use / Patrol Area	Date Received by DMV

LOCATION

☐ In
Collision occurred ☐ Near _____ (Municipality) or ___ . ___ ___ Miles ☐ N ☐ S ☐ E ☐ W outside municipality

on _____ (Highway Number, or Highway, Street. (If ramp or service road, indicate on line)) (R.R.Crossing # _____) ___ . ___ ___ Miles _____ ft. (0 ft.-Intersection) ☐ N ☐ S ☐ E ☐ W

at or from _____ (Use Highway Number, Street Name or Adjacent County or State Line) toward _____ (Use Highway Number, Street Name or Adjacent County or State Line)

☐ VEHICLE 1 ☐ HIT & RUN

Driver 1 _____ (First / Middle / Last)

Address _____

City _____ State _____ Zip _____

Same Address on Driver's License? ☐Yes ☐ No Driver's Phone No ( ) _____

D.L.# _____ State _____ DOB _____ (month/day/year)

Vision 1. Obstruction _____ Physical 2. Condition _____ 3. Intoxication _____ Restrictions _____

Owner _____

Address _____

City _____ State _____ Zip _____

VIN _____

Plate # _____ State _____ Year _____

Veh. Year _____ Veh. Make _____ Veh. Type Code _____

Commercial Vehicle ☐ Yes ☐ No Trailer Type Code _____

Air Bag ☐ Yes ☐ No **1st** Trailer No. of Axles _____

Deployed ☐ Yes ☐ No Width _____ inches

Vehicle Drivable ☐ Yes ☐ No Length _____ feet

Post Crash Fire ☐ Yes ☐ No **2nd** Trailer No. of Axles _____

Rollover ☐ Yes ☐ No Width _____ inches

Hazardous Cargo ☐ Yes ☐ No Length _____ feet

Spilled ☐ Yes ☐ No TAD _____

Crossed Median ☐ Yes ☐ No Est. Damage $ _____

Removed to _____

By _____ Authority _____

☐ VEHICLE 2 ☐ PEDESTRIAN ☐ HIT & RUN ☐ OTHER

Driver 2 _____ (First / Middle / Last)

Address _____

City _____ State _____ Zip _____

Same Address on Driver's License? ☐ Yes ☐ No Driver's Phone No. ( ) _____

D.L.# _____ State _____ DOB _____ (month/day/year)

Vision 1. Obstruction _____ Physical 2. Condition _____ 3. Intoxication _____ Restrictions _____

Owner _____

Address _____

City _____ State _____ Zip _____

VIN _____

Plate # _____ State _____ Year _____

Veh. Year _____ Veh. Make _____ Veh. Type Code _____

Commercial Vehicle ☐ Yes ☐ No Trailer Type Code _____

Air Bag ☐ Yes ☐ No **1st** Trailer No. of Axles _____

Deployed ☐ Yes ☐ No Width _____ inches

Vehicle Drivable ☐ Yes ☐ No Length _____ feet

Post Crash Fire ☐ Yes ☐ No **2nd** Trailer No. of Axles _____

Rollover ☐ Yes ☐ No Width _____ inches

Hazardous Cargo ☐ Yes ☐ No Length _____ feet

Spilled ☐ Yes ☐ No TAD _____

Crossed Median ☐ Yes ☐ No Est. Damage $ _____

Removed to _____

By _____ Authority _____

Other Property Damaged _____

Estimated Damage $ _____

Owner Name _____

Address _____

OCCUPANT SECTION INSTRUCTIONS: Give Injury Class, Belt/Helmet Usage, Race/Sex and Age of **all occupants** in the space corresponding to the seat occupied (see codes at top). Names and addresses are necessary for persons who were **injured**.

Seat	4. Inj. Class	5. Belt /Hel.	Race /Sex	Age	Injured Names and Addresses: First Name / Last Name	Seat	4. Inj. Class	5. Belt /Hel.	Race /Sex	Age	Injured Names and Addresses: First Name / Last Name
Left Front					**DRIVER 1**	Left Front					**DRIVER 2, PEDESTRIAN, OTHER**
Center Front						Center Front					
Right Front						Right Front					
Left Rear						Left Rear					
Center Rear						Center Rear					
Right Rear						Right Rear					

Total Number Occupants _____ Total Number Injured _____ Total Number Occupants _____ Total Number Injured _____

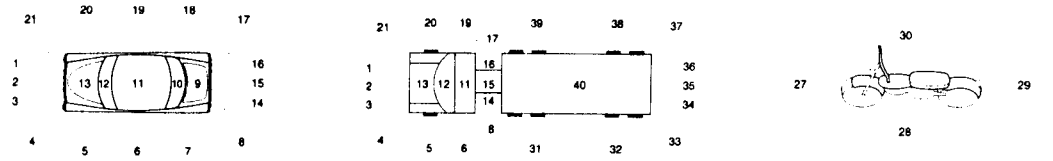
Ambulance Requested ☐ Yes ☐ No If yes, Ambulance Arrived At ___ ___ ___ ___ (24 Hour Clock)

Injured Taken To _____ (Treatment Facility *and* City or Town)

N.C. COLLISION REPORT FORM — Send To: N. C. Division of Motor Vehicles Raleigh, N. C. 27697-0001

MARKS > **< ADDED BY** _____ (Initial)

POINTS OF INITIAL CONTACT (Write In Codes)	
VEH. 1	VEH. 2



Motorcycle, Bicycle or Moped

ACCIDENT SEQUENCE	Veh. 1	Veh. 2 or Ped.
6. Vehicle Maneuver/Pedestrian Action		
7. First Harmful Event		
7. Most Harmful Event		
8. Object Struck		
9. Distance to Object Struck		
10. Vehicle Defects		

UNDERNEATH: 22. Front 23. Center 24. Rear 26. Unknown

	Veh. 1	Veh. 2 or Ped.
Speed Limit (for each vehicle)		
Estimated Original Traveling Speed		
Estimated Speed at Impact		
Tire Impressions Before Impact (ft.)		
Distance Traveled After Impact (ft.)		

ROADWAY INFORMATION (See Front)			
11. Locality		19. Road Defects	
12. Development Type		20. Road Condition	
13. Road Feature		21. Light Condition	
14. Road Character		22. Weather	
15. Road Class		23. Traffic Control	
16. Number of Lanes		Operating ❑ Yes ❑ No	
17. Road Configuration		Visible ❑ Yes ❑ No	
18. Road Surface			

INDICATE NORTH

Vehicle 1 was Traveling ❑ N ❑ S ❑ E ❑ W on

Vehicle 2 was Traveling ❑ N ❑ S ❑ E ❑ W on

DESCRIBE WHAT HAPPENED:

CIRCUMSTANCES CONTRIBUTING TO THE COLLISION (Check as many as apply)

DRIVER 1	DRIVER 2		DRIVER 1	DRIVER 2		DRIVER 1	DRIVER 2	
❑	❑	1. None	❑	❑	10. Pass stopped school bus	❑	❑	19. Safe movement violation
❑	❑	2. Alcohol use	❑	❑	11. Passing on hill	❑	❑	20. Following too closely
❑	❑	3. Drug use	❑	❑	12. Passing on curve	❑	❑	21. Improper backing
❑	❑	4. Yield	❑	❑	13. Other improper passing	❑	❑	22. Improper parking
❑	❑	5. Stop sign	❑	❑	14. Improper lane change	❑	❑	23. Unable to determine
❑	❑	6. Signal	❑	❑	15. Use of improper lane	❑	❑	24. Left of center
❑	❑	7. Exceeding speed limit	❑	❑	16. Improper turn	❑	❑	25. Right turn on red
❑	❑	8. Exceeding safe speed	❑	❑	17. Improper or no signal	❑	❑	26. Other _____
❑	❑	9. Failure to reduce speed	❑	❑	18. Improper vehicle equipment			_____

RESERVED FOR CITY OR OTHER USE

RESERVED FOR STATE USE

	Driver 1	Driver 2
24. Direction		
25. Violation		
26. Misc. Action		
27. Charges		
28. Investigating Agency		

WIT- Name _____ Address _____ Phone No. (____) _____

NESSES: Name _____ Address _____ Phone No. (____) _____

ARRESTS: Name _____ Charge(s) _____

Name _____ Charge(s) _____

Print Here _____

Officer's Rank and Name | Number | Department | Date of Report

ACCIDENT SEQUENCE CODES

6. VEHICLE MANEUVER/ PEDESTRIAN ACTION: VEHICLE
1. Stopped in travel lane
2. Parked out of travel lanes
3. Parked in travel lanes
4. Going straight ahead
5. Changing lanes or merging
6. Passing
7. Making right turn
8. Making left turn
9. Making U turn
10. Backing
11. Slowing or stopping
12. Starting in roadway
13. Parking
14. Leaving parked position
15. Avoiding object in road
16. Other (describe)

PEDESTRIAN
17. Crossing at intersection
18. Crossing not at intersection
19. Coming from behind parked vehicle
20. Walking with traffic
21. Walking against traffic
22. Getting on or off vehicle
23. Standing in road
24. Working in road
25. Playing in road
26. Lying in road
27. Other in road
28. Not in road

7. FIRST/MOST HARMFUL EVENT: RAN OFF ROAD
1. Right
2. Left
3. Straight ahead

NON-COLLISION
4. Overturn
5. Other

COLLISION OF MOTOR VEHICLE WITH
6. Pedestrian
7. Parked vehicle
8. Train
9. Bicycle
10. Moped
11. Animal
12. Fixed object
13. Other object

COLLISION OF MOTOR VEHICLE WITH ANOTHER MOTOR VEHICLE
14. Rear end, slow or stop
15. Rear end, turn
16. Left turn, same roadway
17. Left turn, different roadways
18. Right turn, same roadway
19. Right turn, different roadways
20. Head on
21. Sideswipe
22. Angle
23. Backing

8. OBJECT STRUCK (excluding another motor vehicle in traffic)
1. None
2. Parked vehicle
3. Bicycle, moped
4. Pedestrian
5. Animal
6. Tree
7. Utility pole (with or without light)
8. Luminaire pole (non-breakaway)
9. Luminaire pole (breakaway)
10. Official highway sign (non-breakaway)
11. Official highway sign (breakaway)
12. Commercial sign
13. Guardrail end on shoulder
14. Guardrail face on shoulder
15. Guardrail end in median
16. Guardrail face in median
17. Shoulder barrier end } Non-Guardrail
18. Shoulder barrier face } Non-Guardrail
19. Median barrier end } Non-Guardrail
20. Median barrier face } Non-Guardrail
21. Bridge rail end
22. Bridge rail face
23. Overhead part of underpass
24. Pier on shoulder of underpass
25. Pier in median of underpass
26. Abutment (supporting wall of underpass)
27. Curb, median or traffic island
28. Catch basin or culvert on shoulder
29. Catch basin or culvert in median
30. Ditch bank
31. Mailbox
32. Fence or fence post
33. Construction barrier
34. Crash cushion
35. Other object (write in narrative)

9. DISTANCE TO OBJECT STRUCK
1. In road
2. Right of road, 0-10 ft.
3. Right of road, 11-30 ft.
4. Right of road, over 30 ft.
5. Left of road, 0-10 ft.
6. Left of road, 11-30 ft.
7. Left of road, over 30 ft.
8. None or N/A
9. Straight ahead, 0-10 ft.
10. Straight ahead, 11-30 ft.
11. Straight ahead, over 30 ft.

10. VEHICLE DEFECTS (List one or more)
1. Defective brakes
2. Defective headlights
3. Defective rear lights
4. Defective steering
5. Defective tires
6. Other defects
7. Not known if defective
8. No defects detected

ACCIDENT SEQUENCE CODES

6. VEHICLE MANEUVER/ PEDESTRIAN ACTION: VEHICLE
1. Stopped in travel lane
2. Parked out of travel lanes
3. Parked in travel lanes
4. Going straight ahead
5. Changing lanes or merging
6. Passing
7. Making right turn
8. Making left turn
9. Making U turn
10. Backing
11. Slowing or stopping
12. Starting in roadway
13. Parking
14. Leaving parked position
15. Avoiding object in road
16. Other (describe)

PEDESTRIAN
17. Crossing at intersection
18. Crossing not at intersection
19. Coming from behind parked vehicle
20. Walking with traffic
21. Walking against traffic
22. Getting on or off vehicle
23. Standing in road
24. Working in road
25. Playing in road
26. Lying in road
27. Other in road
28. Not in road

7. FIRST/MOST HARMFUL EVENT: RAN OFF ROAD
1. Right
2. Left
3. Straight ahead

NON-COLLISION
4. Overturn
5. Other

COLLISION OF MOTOR VEHICLE WITH
6. Pedestrian
7. Parked vehicle
8. Train
9. Bicycle
10. Moped
11. Animal
12. Fixed object
13. Other object

COLLISION OF MOTOR VEHICLE WITH ANOTHER MOTOR VEHICLE
14. Rear end, slow or stop
15. Rear end, turn
16. Left turn, same roadway
17. Left turn, different roadways
18. Right turn, same roadway
19. Right turn, different roadways
20. Head on
21. Sideswipe
22. Angle
23. Backing

8. OBJECT STRUCK (excluding another motor vehicle in traffic)
1. None
2. Parked vehicle
3. Bicycle, moped
4. Pedestrian
5. Animal
6. Tree
7. Utility pole (with or without light)
8. Luminaire pole (non-breakaway)
9. Luminaire pole (breakaway)
10. Official highway sign (non-breakaway)
11. Official highway sign (breakaway)
12. Commercial sign
13. Guardrail end on shoulder
14. Guardrail face on shoulder
15. Guardrail end in median
16. Guardrail face in median
17. Shoulder barrier end } Non-Guardrail
18. Shoulder barrier face } Non-Guardrail
19. Median barrier end } Non-Guardrail
20. Median barrier face } Non-Guardrail
21. Bridge rail end
22. Bridge rail face
23. Overhead part of underpass
24. Pier on shoulder of underpass
25. Pier in median of underpass
26. Abutment (supporting wall of underpass)
27. Curb, median or traffic island
28. Catch basin or culvert on shoulder
29. Catch basin or culvert in median
30. Ditch bank
31. Mailbox
32. Fence or fence post
33. Construction barrier
34. Crash cushion
35. Other object (write in narrative)

9. DISTANCE TO OBJECT STRUCK
1. In road
2. Right of road, 0-10 ft.
3. Right of road, 11-30 ft.
4. Right of road, over 30 ft.
5. Left of road, 0-10 ft.
6. Left of road, 11-30 ft.
7. Left of road, over 30 ft.
8. None or N/A
9. Straight ahead, 0-10 ft.
10. Straight ahead, 11-30 ft.
11. Straight ahead, over 30 ft.

10. VEHICLE DEFECTS (List one or more)
1. Defective brakes
2. Defective headlights
3. Defective rear lights
4. Defective steering
5. Defective tires
6. Other defects
7. Not known if defective
8. No defects detected

APPENDIX C

Selected Data Tabulations for 1987-1989 North Carolina
Police-Reported Motorcycle Crashes

Directory of Tables

ALL MOTORCYCLES

TABLE OF DRAGE BY SEX

DRAGE((121) AGE - DRIVER) SEX

FREQUENCY / PERCENT / ROW PCT / COL PCT	F	M	TOTAL
N	236	0	0	.
	.	.	.	.
	.	.	.	
	.	.	.	
<16	50	25	257	282
	.	0.37	3.78	4.15
	.	8.87	91.13	
	.	13.66	3.88	
16-19	37	33	1130	1163
	.	0.49	16.61	17.10
	.	2.84	97.16	
	.	18.03	17.07	
20-24	36	43	1976	2019
	.	0.63	29.05	29.68
	.	2.13	97.87	
	.	23.50	29.85	
25-29	37	31	1190	1221
	.	0.46	17.49	17.95
	.	2.54	97.46	
	.	16.94	17.98	
30-34	26	33	865	898
	.	0.49	12.71	13.20
	.	3.67	96.33	
	.	18.03	13.07	
35-39	13	10	488	498
	.	0.15	7.17	7.32
	.	2.01	97.99	
	.	5.46	7.37	
40+	28	8	714	722
	.	0.12	10.50	10.61
	.	1.11	98.89	
	.	4.37	10.79	
TOTAL	.	183	6620	6803
	.	2.69	97.31	100.00

FREQUENCY MISSING = 463

ROAD/STREET MOTORCYCLES

TABLE OF DRAGE BY SEX

DRAGE((121) AGE - DRIVER) SEX

FREQUENCY / PERCENT / ROW PCT / COL PCT	F	M	TOTAL
N	151	0	0	.
	.	.	.	.
	.	.	.	
	.	.	.	
<16	0	1	9	10
	.	0.02	0.17	0.19
	.	10.00	90.00	
	.	0.94	0.18	
16-19	4	16	804	820
	.	0.31	15.47	15.78
	.	1.95	98.05	
	.	15.09	15.80	
20-24	7	28	1591	1619
	.	0.54	30.62	31.16
	.	1.73	98.27	
	.	26.42	31.26	
25-29	4	25	974	999
	.	0.48	18.75	19.23
	.	2.50	97.50	
	.	23.58	19.14	
30-34	6	26	715	741
	.	0.50	13.76	14.26
	.	3.51	96.49	
	.	24.53	14.05	
35-39	1	6	417	423
	.	0.12	8.03	8.14
	.	1.42	98.58	
	.	5.66	8.19	
40+	5	4	580	584
	.	0.08	11.16	11.24
	.	0.68	99.32	
	.	3.77	11.39	
TOTAL	.	106	5090	5196
	.	2.04	97.96	100.00

FREQUENCY MISSING = 178

ALL MOTORCYCLES

TABLE OF DRAGE BY INJURY

DRAGE((121) AGE - DRIVER) INJURY

FREQUENCY / PERCENT / ROW PCT / COL PCT		A+K	E+C+O	TOTAL
N	236	0	0	.
	.	.	.	.
	.	.	.	
	.	.	.	
<16	50	108	174	282
	.	1.59	2.56	4.15
	.	38.30	61.70	
	.	4.25	4.08	
16-19	37	416	747	1163
	.	6.12	10.98	17.10
	.	35.77	64.23	
	.	16.37	17.54	
20-24	34	744	1277	2021
	.	10.94	18.77	29.71
	.	36.81	63.19	
	.	29.27	29.98	
25-29	34	461	763	1224
	.	6.78	11.22	17.99
	.	37.66	62.34	
	.	18.14	17.91	
30-34	25	356	543	899
	.	5.23	7.98	13.22
	.	39.60	60.40	
	.	14.00	12.75	
35-39	12	197	302	499
	.	2.90	4.44	7.34
	.	39.48	60.52	
	.	7.75	7.09	
40+	36	260	454	714
	.	3.82	6.67	10.50
	.	36.41	63.59	
	.	10.23	10.66	
TOTAL		2542	4260	6802
		37.37	62.63	100.00

FREQUENCY MISSING = 464

- ROAD/STREET MOTORCYCLES

TABLE OF DRAGE BY INJURY

DRAGE((121) AGE - DRIVER) INJURY

FREQUENCY / PERCENT / ROW PCT / COL PCT		A+K	E+C+O	TOTAL
N	151	0	0	.
	.	.	.	.
	.	.	.	
	.	.	.	
<16	0	3	7	10
	.	0.06	0.13	0.19
	.	30.00	70.00	
	.	0.16	0.21	
16-19	4	274	546	820
	.	5.27	10.50	15.78
	.	33.41	66.59	
	.	14.35	16.60	
20-24	5	592	1029	1621
	.	11.39	19.80	31.19
	.	36.52	63.48	
	.	31.01	31.29	
25-29	2	364	637	1001
	.	7.00	12.25	19.26
	.	36.36	63.64	
	.	19.07	19.37	
30-34	6	296	445	741
	.	5.69	8.56	14.26
	.	39.95	60.05	
	.	15.51	13.53	
35-39	0	170	254	424
	.	3.27	4.89	8.16
	.	40.09	59.91	
	.	8.91	7.72	
40+	8	210	371	581
	.	4.04	7.14	11.18
	.	36.14	63.86	
	.	11.00	11.28	
TOTAL		1909	3289	5198
		36.73	63.27	100.00

FREQUENCY MISSING = 176

ALL MOTORCYCLES

TABLE OF DRAGE BY HELMET

DRAGE((121) AGE - DRIVER) HELMET

FREQUENCY / PERCENT / ROW PCT / COL PCT	NO	YES	TOTAL
N	236	0	0	.
	.	.	.	.
<16	65	188	79	267
	.	2.90	1.22	4.12
	.	70.41	29.59	
	.	9.42	1.76	
16-19	88	364	748	1112
	.	5.62	11.55	17.18
	.	32.73	67.27	
	.	18.24	16.70	
20-24	134	544	1377	1921
	.	8.40	21.27	29.67
	.	28.32	71.68	
	.	27.25	30.75	
25-29	94	341	823	1164
	.	5.27	12.71	17.98
	.	29.30	70.70	
	.	17.08	18.38	
30-34	72	251	601	852
	.	3.88	9.28	13.16
	.	29.46	70.54	
	.	12.58	13.42	
35-39	40	128	343	471
	.	1.98	5.30	7.28
	.	27.18	72.82	
	.	6.41	7.66	
40+	63	180	507	687
	.	2.78	7.83	10.61
	.	26.20	73.80	
	.	9.02	11.32	
TOTAL	.	1996	4478	6474
	.	30.83	69.17	100.00

FREQUENCY MISSING = 792

ROAD/STREET MOTORCYCLES

TABLE OF DRAGE BY HELMET

DRAGE((121) AGE - DRIVER) HELMET

FREQUENCY / PERCENT / ROW PCT / COL PCT	NO	YES	TOTAL
N	151	0	0	.
	.	.	.	.
<16	0	9	1	10
	.	0.18	0.02	0.20
	.	90.00	10.00	
	.	0.72	0.03	
16-19	31	188	605	793
	.	3.77	12.14	15.91
	.	23.71	76.29	
	.	14.98	16.23	
20-24	78	382	1166	1548
	.	7.67	23.40	31.07
	.	24.68	75.32	
	.	30.44	31.28	
25-29	45	242	716	958
	.	4.86	14.37	19.23
	.	25.26	74.74	
	.	19.28	19.21	
30-34	42	197	508	705
	.	3.95	10.19	14.15
	.	27.94	72.06	
	.	15.70	13.63	
35-39	19	105	300	405
	.	2.11	6.02	8.13
	.	25.93	74.07	
	.	8.37	8.05	
40+	25	132	432	564
	.	2.65	8.67	11.32
	.	23.40	76.60	
	.	10.52	11.59	
TOTAL	.	1255	3728	4983
	.	25.19	74.81	100.00

FREQUENCY MISSING = 391

ALL MOTORCYCLES

TABLE OF DRAGE BY EXP

DRAGE((121) AGE - DRIVER) EXP

FREQUENCY / PERCENT / ROW PCT / COL PCT	NO VALID LICE	VALID,ML IC 3+	VALID,ML IC<3	VALID,NO MLIC	TOTAL
N	29	128	17	37	25	.
	.	.	.	.	.	.
	.	.	.	.	.	
	.	.	.	.	.	
<16	54	231	0	0	47	278
	.	3.47	0.00	0.00	0.71	4.17
	.	83.09	0.00	0.00	16.91	
	.	13.43	0.00	0.00	2.82	
16-19	36	265	11	425	463	1164
	.	3.98	0.17	6.38	6.95	17.48
	.	22.77	0.95	36.51	39.78	
	.	15.41	0.86	21.27	27.79	
20-24	131	502	181	621	620	1924
	.	7.54	2.72	9.32	9.31	28.89
	.	26.09	9.41	32.28	32.22	
	.	29.19	14.18	31.08	37.21	
25-29	74	289	227	354	314	1184
	.	4.34	3.41	5.32	4.71	17.78
	.	24.41	19.17	29.90	26.52	
	.	16.80	17.79	17.72	18.85	
30-34	35	180	338	257	114	889
	.	2.70	5.08	3.86	1.71	13.35
	.	20.25	38.02	28.91	12.82	
	.	10.47	26.49	12.86	6.84	
35-39	13	93	204	149	52	498
	.	1.40	3.06	2.24	0.78	7.48
	.	18.67	40.96	29.92	10.44	
	.	5.41	15.99	7.46	3.12	
40+	27	160	315	192	56	723
	.	2.40	4.73	2.88	0.84	10.86
	.	22.13	43.57	26.56	7.75	
	.	9.30	24.69	9.61	3.36	
TOTAL	.	1720	1276	1998	1666	6660
	.	25.83	19.16	30.00	25.02	100.00

FREQUENCY MISSING = 606

FCAC/STREET MOTCFCYCLES

TABLE CF DRAGE BY EXP

DRAGE((121) AEE - DRIVER) EXP

FREQUENCY / PERCENT / ROW PCT / COL PCT	NC VALID LICE	VALID,ML IC 3+	VALID,ML IC<3	VALID,NC MLIC	TOTAL
N	5	79	15	34	18	.
	.	.	.	.	.	.
	.	.	.	.	.	
	.	.	.	.	.	
<16	3	6	C	0	1	7
	.	0.12	0.00	0.00	0.02	0.14
	.	85.71	0.0C	0.00	14.29	
	.	0.58	0.0C	0.00	C.09	
16-19	23	143	8	353	297	801
	.	2.87	0.16	7.09	5.96	16.C8
	.	17.85	1.0C	44.07	37.08	
	.	13.78	0.73	20.75	26.01	
20-24	105	362	156	531	472	1521
	.	7.27	3.13	10.66	9.47	30.53
	.	23.80	10.26	34.91	31.03	
	.	34.87	14.17	31.22	41.33	
25-29	58	214	195	312	224	945
	.	4.30	3.91	6.26	4.50	18.97
	.	22.65	20.63	33.02	23.70	
	.	20.62	17.71	18.34	19.61	
30-34	31	130	285	214	83	716
	.	2.61	5.8C	4.30	1.67	14.37
	.	18.16	40.36	29.89	11.59	
	.	12.52	26.25	12.58	7.27	
35-39	10	69	181	124	40	414
	.	1.38	3.63	2.49	0.80	8.31
	.	16.67	43.72	29.95	9.66	
	.	6.65	16.44	7.29	3.50	
40+	11	114	272	167	25	578
	.	2.29	5.46	3.35	0.50	11.60
	.	19.72	47.06	28.89	4.33	
	.	10.98	24.70	9.82	2.19	
TOTAL	.	1038	1101	1701	1142	4982
	.	20.84	22.10	34.14	22.92	100.00

FREQUENCY MISSING = 392

ALL MOTORCYCLES

TABLE OF DRAGE BY ENDORSE

DRAGE((121) AGE - DRIVER) ENDORSE

FREQUENCY / PERCENT / ROW PCT / COL PCT	NO	YES	TOTAL
N	29 . . .	153 . . .	54 . . .	. .
<16	54 . . .	278 4.17 100.00 8.21	0 0.00 0.00 0.00	278 4.17
16-19	36 . . .	728 10.93 62.54 21.50	436 6.55 37.46 13.32	1164 17.48
20-24	131 . . .	1122 16.85 58.32 33.14	802 12.04 41.68 24.50	1924 28.89
25-29	74 . . .	603 9.05 50.93 17.81	581 8.72 49.07 17.75	1184 17.78
30-34	35 . . .	294 4.41 33.07 8.68	595 8.93 66.93 18.17	889 13.35
35-39	13 . . .	145 2.18 29.12 4.28	353 5.30 70.88 10.78	498 7.48
40+	27 . . .	216 3.24 29.88 6.38	507 7.61 70.12 15.49	723 10.86
TOTAL	.	3386 50.84	3274 49.16	6660 100.00

FREQUENCY MISSING = 606

FOAD/STREET MOTORCYCLES

TABLE OF DRAGE BY ENDORSE

DRAGE((121) AGE - DRIVER) ENDORSE

FREQUENCY / PERCENT / ROW PCT / COL PCT	NO	YES	TOTAL
N	5 . . .	97 . . .	49 . . .	. .
<16	3 . . .	7 0.14 100.00 0.32	0 0.00 0.00 0.00	7 0.14
16-19	23 . . .	440 8.83 54.93 20.18	361 7.25 45.07 12.88	801 16.08
20-24	105 . . .	834 16.74 54.83 38.26	687 13.79 45.17 24.52	1521 30.53
25-29	58 . . .	438 8.79 46.35 20.09	507 10.18 53.65 18.09	945 18.97
30-34	31 . . .	213 4.28 29.75 9.77	503 10.10 70.25 17.95	716 14.37
35-39	10 . . .	109 2.19 26.33 5.00	305 6.12 73.67 10.89	414 8.31
40+	11 . . .	139 2.79 24.05 6.38	439 8.81 75.95 15.67	578 11.60
TOTAL	.	2180 43.76	2802 56.24	4982 100.00

FREQUENCY MISSING = 392

ALL MOTORCYCLES

TABLE OF DRAGE BY STOP

DRAGE((121) AGE - DRIVER) STOP

FREQUENCY / PERCENT / ROW PCT / COL PCT	.	NO	YES	TOTAL
N	29	204	3	.
	.	.	.	.
	.	.	.	
	.	.	.	
<16	54	277	1	278
	.	4.16	0.02	4.17
	.	99.64	0.36	
	.	4.47	0.22	
16-19	36	1105	59	1164
	.	16.59	0.89	17.48
	.	94.93	5.07	
	.	17.81	12.91	
20-24	131	1761	163	1924
	.	26.44	2.45	28.89
	.	91.53	8.47	
	.	28.39	35.67	
25-29	74	1088	96	1184
	.	16.34	1.44	17.78
	.	91.89	8.11	
	.	17.54	21.01	
30-34	35	810	79	889
	.	12.16	1.19	13.35
	.	91.11	8.89	
	.	13.06	17.29	
35-39	13	468	30	498
	.	7.03	0.45	7.48
	.	93.98	6.02	
	.	7.54	6.56	
40+	27	694	29	723
	.	10.42	0.44	10.86
	.	95.99	4.01	
	.	11.19	6.35	
TOTAL	.	6203	457	6660
	.	93.14	6.86	100.00

FREQUENCY MISSING = 606

ROAD/STREET MOTORCYCLES

TABLE OF DRAGE BY STOP

DRAGE((121) AGE - DRIVER) STOP

FREQUENCY / PERCENT / ROW PCT / COL PCT	.	NO	YES	TOTAL
N	5	144	2	.
	.	.	.	.
	.	.	.	
	.	.	.	
<16	5	7	0	7
	.	0.14	0.00	0.14
	.	100.00	0.00	
	.	0.15	0.00	
16-19	25	761	40	801
	.	15.27	0.80	16.08
	.	95.01	4.99	
	.	16.33	12.38	
20-24	105	1414	107	1521
	.	28.38	2.15	30.53
	.	92.97	7.03	
	.	30.35	33.13	
25-29	58	872	73	945
	.	17.50	1.47	18.97
	.	92.28	7.72	
	.	18.72	22.60	
30-34	31	655	61	716
	.	13.15	1.22	14.37
	.	91.48	8.52	
	.	14.06	18.89	
35-39	10	385	25	414
	.	7.81	0.50	8.31
	.	93.96	6.04	
	.	8.35	7.74	
40+	11	561	17	578
	.	11.26	0.34	11.60
	.	97.06	2.94	
	.	12.04	5.26	
TOTAL	.	4655	323	4982
	.	93.52	6.48	100.00

FREQUENCY MISSING = 392

ALL MOTORCYCLES

TABLE OF DRAGE BY CRASHES

DRAGE((121) AGE - DRIVER) CRASHES

FREQUENCY / PERCENT / ROW PCT / COL PCT	.	0	1	2+	TOTAL
N	29	179	21	7	.
	.	.	.	.	.
<16	54	278	0	0	278
	.	4.17	0.00	0.00	4.17
	.	100.00	0.00	0.00	
	.	5.77	0.00	0.00	
16-19	36	780	274	110	1164
	.	11.71	4.11	1.65	17.48
	.	67.01	23.54	9.45	
	.	16.18	19.80	24.23	
20-24	131	1241	509	174	1924
	.	18.63	7.64	2.61	28.89
	.	64.50	26.46	9.04	
	.	25.74	36.78	38.33	
25-29	74	883	227	74	1184
	.	13.26	3.41	1.11	17.78
	.	74.58	19.17	6.25	
	.	18.31	16.40	16.30	
30-34	35	663	172	54	889
	.	9.95	2.58	0.81	13.35
	.	74.58	19.35	6.07	
	.	13.75	12.43	11.89	
35-39	13	396	79	23	498
	.	5.95	1.19	0.35	7.48
	.	79.52	15.86	4.62	
	.	8.21	5.71	5.07	
40+	27	581	123	19	723
	.	8.72	1.85	0.29	10.86
	.	80.36	17.01	2.63	
	.	12.05	8.89	4.19	
TOTAL	.	4822	1384	454	6660
	.	72.40	20.78	6.82	100.00

FREQUENCY MISSING = 606

ROAD/STREET MOTORCYCLES

TABLE OF DRAGE BY CRASHES

DRAGE((121) AGE - DRIVER) CRASHES

FREQUENCY / PERCENT / ROW PCT / COL PCT	.	0	1	2+	TOTAL
N	5	127	17	2	.
	.	.	.	.	.
<16	1	7	0	0	7
	.	0.14	0.00	0.00	0.14
	.	100.00	0.00	0.00	
	.	0.20	0.00	0.00	
16-19	23	515	207	79	801
	.	10.34	4.15	1.59	16.08
	.	64.29	25.84	9.86	
	.	14.57	18.87	22.57	
20-24	105	979	406	136	1521
	.	19.65	8.15	2.73	30.53
	.	64.37	26.69	8.94	
	.	27.69	37.01	38.86	
25-29	58	708	179	58	945
	.	14.21	3.59	1.16	18.97
	.	74.92	18.94	6.14	
	.	20.03	16.32	16.57	
30-34	31	536	138	42	716
	.	10.76	2.77	0.84	14.37
	.	74.86	19.27	5.87	
	.	15.16	12.58	12.00	
35-39	10	326	69	19	414
	.	6.54	1.38	0.38	8.31
	.	78.74	16.67	4.59	
	.	9.22	6.29	5.43	
40+	11	464	98	16	578
	.	9.31	1.97	0.32	11.60
	.	80.28	16.96	2.77	
	.	13.13	8.93	4.57	
TOTAL	.	3535	1097	350	4982
	.	70.96	22.02	7.03	100.00

FREQUENCY MISSING = 392

ALL MOTORCYCLES

TABLE OF DRAGE BY VIOLS

DRAGE((121) AGE - DRIVER) VIOLS

FREQUENCY / PERCENT / ROW PCT / COL PCT	.	0	1	2	3+	TOTAL
N	29	158	30	9	10	.
	.	.	.	.	.	.
<16	54	278	0	0	0	278
	.	4.17	0.00	0.00	0.00	4.17
	.	100.00	0.00	0.00	0.00	
	.	8.72	0.00	0.00	0.00	
16-19	36	506	225	178	255	1164
	.	7.60	3.38	2.67	3.83	17.48
	.	43.47	19.33	15.29	21.91	
	.	15.87	16.41	21.07	20.32	
20-24	131	652	429	283	560	1924
	.	9.79	6.44	4.25	8.41	28.89
	.	33.89	22.30	14.71	29.11	
	.	20.45	31.29	33.49	44.62	
25-29	74	502	270	170	242	1184
	.	7.54	4.05	2.55	3.63	17.78
	.	42.40	22.80	14.36	20.44	
	.	15.74	19.69	20.12	19.28	
30-34	35	463	199	105	122	889
	.	6.95	2.99	1.58	1.83	13.35
	.	52.08	22.38	11.81	13.72	
	.	14.52	14.51	12.43	9.72	
35-39	13	289	107	61	41	498
	.	4.34	1.61	0.92	0.62	7.48
	.	58.03	21.49	12.25	8.23	
	.	9.06	7.80	7.22	3.27	
40+	27	499	141	48	35	723
	.	7.49	2.12	0.72	0.53	10.86
	.	69.02	19.50	6.64	4.84	
	.	15.65	10.28	5.68	2.79	
TOTAL	.	3189	1371	845	1255	6660
	.	47.88	20.59	12.69	18.84	100.00

FREQUENCY MISSING = 606

FCAC/STREET MOTORCYCLES

TABLE OF DRAGE BY VIOLS

DRAGE((121) AGE - DRIVER) VIOLS

FREQUENCY / PERCENT / ROW PCT / COL PCT	.	0	1	2	3+	TOTAL
N	5	103	27	9	7	.
	.	.	.	.	.	.
<16	1	7	0	0	0	7
	.	0.14	0.00	0.00	0.00	0.14
	.	100.00	0.00	0.00	0.00	
	.	0.32	0.00	0.00	0.00	
16-19	23	311	175	129	186	801
	.	6.24	3.51	2.59	3.73	16.08
	.	38.83	21.85	16.10	23.22	
	.	14.00	15.56	19.40	19.16	
20-24	105	508	344	230	439	1521
	.	10.20	6.90	4.62	8.81	30.53
	.	33.40	22.62	15.12	28.86	
	.	22.87	30.58	34.59	45.21	
25-29	58	398	219	137	191	945
	.	7.99	4.40	2.75	3.83	18.97
	.	42.12	23.17	14.50	20.21	
	.	17.92	19.47	20.60	19.67	
30-34	31	362	173	86	95	716
	.	7.27	3.47	1.73	1.91	14.37
	.	50.56	24.16	12.01	13.27	
	.	16.30	15.38	12.93	9.78	
35-39	10	236	97	49	32	414
	.	4.74	1.95	0.98	0.64	8.31
	.	57.00	23.43	11.84	7.73	
	.	10.63	8.62	7.37	3.30	
40+	11	399	117	34	28	578
	.	8.01	2.35	0.68	0.56	11.60
	.	69.03	20.24	5.88	4.84	
	.	17.96	10.40	5.11	2.88	
TOTAL	.	2221	1125	665	971	4982
	.	44.58	22.58	13.35	19.49	100.00

FREQUENCY MISSING = 292

ALL MOTORCYCLES

TABLE OF DRAGE BY ALC

DRAGE((121) AGE - DRIVER) ALC

FREQUENCY / PERCENT / ROW PCT / COL PCT	NO	YES	TOTAL
N	221	14	1	.
	.	.	.	.
	.	.	.	
	.	.	.	
<16	68	261	3	264
	.	4.23	0.05	4.28
	.	98.86	1.14	
	.	5.07	0.30	
16-19	139	967	94	1061
	.	15.68	1.52	17.21
	.	91.14	8.86	
	.	18.78	9.25	
20-24	237	1535	283	1818
	.	24.89	4.59	29.48
	.	84.43	15.57	
	.	29.81	27.85	
25-29	162	838	258	1096
	.	13.59	4.18	17.77
	.	76.46	23.54	
	.	16.27	25.39	
30-34	107	623	194	817
	.	10.10	3.15	13.25
	.	76.25	23.75	
	.	12.10	19.09	
35-39	50	357	104	461
	.	5.79	1.69	7.48
	.	77.44	22.56	
	.	6.93	10.24	
40+	101	569	80	649
	.	9.23	1.30	10.53
	.	87.67	12.33	
	.	11.05	7.87	
TOTAL	.	5150	1016	6166
	.	83.52	16.48	100.00

FREQUENCY MISSING = 1100

ROAD/STREET MOTORCYCLES

TABLE OF DRAGE BY ALC

DRAGE((121) AGE - DRIVER) ALC

FREQUENCY / PERCENT / ROW PCT / COL PCT	NO	YES	TOTAL
N	139	12	0	.
	.	.	.	.
	.	.	.	
	.	.	.	
<16	0	10	0	10
	.	0.21	0.00	0.21
	.	100.00	0.00	
	.	0.25	0.00	
16-19	69	695	60	755
	.	14.73	1.27	16.00
	.	92.05	7.95	
	.	17.59	7.81	
20-24	162	1257	207	1464
	.	26.64	4.39	31.02
	.	85.86	14.14	
	.	31.81	26.95	
25-29	105	703	195	858
	.	14.90	4.13	19.03
	.	78.29	21.71	
	.	17.79	25.39	
30-34	74	516	157	673
	.	10.93	3.33	14.26
	.	76.67	23.33	
	.	13.06	20.44	
35-39	37	297	90	387
	.	6.29	1.91	8.20
	.	76.74	23.26	
	.	7.52	11.72	
40+	57	473	59	532
	.	10.02	1.25	11.27
	.	88.91	11.09	
	.	11.97	7.68	
TOTAL	.	3951	768	4719
	.	83.73	16.27	100.00

FREQUENCY MISSING = 655

ALL MOTORCYCLES

TABLE OF DRAGE BY FAULT

DRAGE((121) AGE - DRIVER) FAULT

FREQUENCY / PERCENT / ROW PCT / COL PCT	N	Y	TOTAL
N	89 . . .	89 . . .	58 . . .	. .
<16	116 . . .	15 0.25 6.94 0.64	201 3.38 93.06 5.59	216 3.63
16-19	165 . . .	331 5.56 31.98 14.06	704 11.84 68.02 19.59	1035 17.40
20-24	298 . . .	648 10.89 36.88 27.53	1109 18.64 63.12 30.86	1757 29.54
25-29	192 . . .	408 6.86 38.27 17.33	658 11.06 61.73 18.31	1066 17.92
30-34	127 . . .	372 6.25 46.68 15.80	425 7.15 53.32 11.83	797 13.40
35-39	72 . . .	216 3.63 49.20 9.18	223 3.75 50.80 6.20	439 7.38
40+	112 . . .	364 6.12 57.05 15.46	274 4.61 42.95 7.62	638 10.73
TOTAL	. .	2354 39.58	3594 60.42	5948 100.00

FREQUENCY MISSING = 1318

FCAC/STREET MOTORCYCLES

TABLE OF DRAGE BY FAULT

DRAGE((121) AGE - DRIVER) FAULT

FREQUENCY / PERCENT / ROW PCT / COL PCT	N	Y	TOTAL
N	35 . . .	72 . . .	44 . . .	. .
<16	4 . . .	0 0.00 0.00 0.00	6 0.13 100.00 0.23	6 0.13
16-19	95 . . .	256 5.60 35.12 13.07	473 10.35 64.88 18.13	729 15.96
20-24	221 . . .	547 11.97 38.93 27.92	858 18.78 61.07 32.89	1405 30.76
25-29	125 . . .	347 7.60 39.52 17.71	531 11.62 60.48 20.35	878 19.22
30-34	86 . . .	314 6.87 47.50 16.03	347 7.60 52.50 13.30	661 14.47
35-39	54 . . .	185 4.05 50.00 9.44	185 4.05 50.00 7.09	370 8.10
40+	70 . . .	310 6.79 59.73 15.82	209 4.58 40.27 8.01	519 11.36
TOTAL	. .	1955 42.85	2609 57.11	4568 100.00

FREQUENCY MISSING = 806

ALL MOTORCYCLES

TABLE OF HELMET BY INJURY

HELMET / INJURY	A+K	E+C+O	TOTAL
FREQUENCY / PERCENT / ROW PCT / COL PCT			
	454	224	.
	.	.	.
	.	.	
	.	.	
NO	3	766	1227	1993
	.	11.85	18.98	30.83
	.	38.43	61.57	
	.	31.55	30.40	
YES	7	1662	2809	4471
	.	25.71	43.46	69.17
	.	37.17	62.83	
	.	68.45	69.60	
TOTAL	.	2428	4036	6464
	.	37.56	62.44	100.00

FREQUENCY MISSING = 802

FCAC/STREET MOTORCYCLES

TABLE OF HELMET BY INJURY

HELMET / INJURY	A+K	E+C+O	TOTAL
FREQUENCY / PERCENT / ROW PCT / COL PCT			
	171	71	149	.
	.	.	.	.
	.	.	.	
	.	.	.	
NO	2	456	797	1253
	.	9.16	16.01	25.17
	.	36.39	63.61	
	.	24.81	25.38	
YES	3	1382	2343	3725
	.	27.76	47.07	74.83
	.	37.10	62.90	
	.	75.19	74.62	
TOTAL	.	1838	3140	4978
	.	36.92	63.08	100.00

FREQUENCY MISSING = 396

ALL MOTORCYCLES

TABLE OF HELMET BY EXP

HELMET	EXP					
FREQUENCY / PERCENT / ROW PCT / COL PCT		NO VALID LICE	VALID,ML IC 3+	VALID,ML IC<3	VALID,NO ML IC	TOTAL
	73	298	104	146	171	.
	.	.	.	.	.	.
	.	.	.	.	.	
	.	.	.	.	.	
NO	111	603	321	456	505	1885
	.	9.81	5.22	7.42	8.21	30.66
	.	31.99	17.03	24.19	26.79	
	.	38.90	27.00	24.14	33.22	
YES	215	947	868	1433	1015	4263
	.	15.40	14.12	23.31	16.51	69.34
	.	22.21	20.36	33.61	23.81	
	.	61.10	73.00	75.86	66.78	
TOTAL	.	1550	1189	1889	1520	6148
	.	25.21	19.34	30.73	24.72	100.00

FREQUENCY MISSING = 1118

FOAD/STREET MOTORCYCLES

TABLE OF HELMET BY EXP

HELMET	EXP					
FREQUENCY / PERCENT / ROW PCT / COL PCT		NO VALID LICE	VALID,ML IC 3+	VALID,ML IC<3	VALID,NO ML IC	TOTAL
	19	124	74	111	63	.
	.	.	.	.	.	.
	.	.	.	.	.	
	.	.	.	.	.	
NO	59	269	272	388	267	1156
	.	5.66	5.72	8.16	5.61	25.15
	.	22.49	22.74	32.44	22.32	
	.	27.09	26.10	23.89	24.34	
YES	168	724	770	1236	830	3560
	.	15.22	16.15	25.99	17.45	74.85
	.	20.34	21.63	34.72	23.31	
	.	72.91	73.90	76.11	75.66	
TOTAL	.	993	1042	1624	1097	4756
	.	20.88	21.91	34.15	23.07	100.00

FREQUENCY MISSING = 618

ALL MOTORCYCLES

TABLE OF HELMET BY ENDORSE

HELMET	ENDORSE		
FREQUENCY / PERCENT / ROW PCT / COL PCT	NO	YES	TOTAL
	73	469	250	.
	.	.	.	.
	.	.	.	
	.	.	.	
NO	111	1108	777	1885
	.	18.02	12.64	30.66
	.	58.78	41.22	
	.	36.09	25.24	
YES	215	1962	2301	4263
	.	31.91	37.43	69.34
	.	46.02	53.98	
	.	63.91	74.76	
TOTAL	.	3070	3078	6148
	.	49.93	50.07	100.00

FREQUENCY MISSING = 1118

ROAD/STREET MOTORCYCLES

TABLE OF HELMET BY ENDORSE

HELMET	ENDORSE		
FREQUENCY / PERCENT / ROW PCT / COL PCT	NO	YES	TOTAL
	19	187	185	.
	.	.	.	.
	.	.	.	
	.	.	.	
NO	59	536	660	1196
	.	11.27	13.88	25.15
	.	44.82	55.18	
	.	25.65	24.76	
YES	168	1554	2006	3560
	.	32.67	42.18	74.85
	.	43.65	56.35	
	.	74.35	75.24	
TOTAL	.	2090	2666	4756
	.	43.94	56.06	100.00

FREQUENCY MISSING = 618

ALL MOTORCYCLES

TABLE OF HELMET BY STOP

HELMET / STOP	.	NO	YES	TOTAL
FREQUENCY	73	676	43	.
PERCENT	.	.	.	.
ROW PCT	.	.	.	
COL PCT	.	.	.	
NO	111	1730	155	1885
	.	28.14	2.52	30.66
	.	91.78	8.22	
	.	30.15	37.17	
YES	215	4001	262	4263
	.	65.08	4.26	69.34
	.	93.85	6.15	
	.	69.81	62.83	
TOTAL	.	5731	417	6148
	.	93.22	6.78	100.00

FREQUENCY MISSING = 1118

ROAD/STREET MOTORCYCLES

TABLE OF HELMET BY STOP

HELMET / STOP	.	NO	YES	TOTAL
FREQUENCY	15	358	14	.
PERCENT	.	.	.	.
ROW PCT	.	.	.	
COL PCT	.	.	.	
NO	59	1105	91	1196
	.	23.23	1.91	25.15
	.	92.39	7.61	
	.	24.86	29.26	
YES	168	3340	220	3560
	.	70.23	4.63	74.85
	.	93.82	6.18	
	.	75.14	70.74	
TOTAL	.	4445	311	4756
	.	93.46	6.54	100.00

FREQUENCY MISSING = 618

ALL MOTORCYCLES

TABLE OF HELMET BY CRASHES

HELMET	CRASHES				
FREQUENCY / PERCENT / ROW PCT / COL PCT	.	0	1	2+	TOTAL
	73	569	110	40	.
	.	.	.	.	.
	.	.	.	.	
	.	.	.	.	
NO	111	1386	379	120	1885
	.	22.54	6.16	1.95	30.66
	.	73.53	20.11	6.37	
	.	31.27	29.27	28.50	
YES	215	3046	916	301	4263
	.	49.54	14.90	4.90	69.34
	.	71.45	21.49	7.06	
	.	68.73	70.73	71.50	
TOTAL	.	4432	1295	421	6148
	.	72.09	21.06	6.85	100.00

FREQUENCY MISSING = 1118

ROAD/STREET MOTORCYCLES

TABLE OF HELMET BY CRASHES

HELMET	CRASHES				
FREQUENCY / PERCENT / ROW PCT / COL PCT	.	0	1	2+	TOTAL
	19	289	67	16	.
	.	.	.	.	.
	.	.	.	.	
	.	.	.	.	
NO	59	853	260	83	1196
	.	17.94	5.47	1.75	25.15
	.	71.32	21.74	6.94	
	.	25.29	24.83	24.70	
YES	168	2520	787	253	3560
	.	52.99	16.55	5.32	74.85
	.	70.79	22.11	7.11	
	.	74.71	75.17	75.30	
TOTAL	.	3373	1047	336	4756
	.	70.92	22.01	7.06	100.00

FREQUENCY MISSING = 618

ALL MOTORCYCLES

TABLE OF HELMET BY VIOLS

HELMET	VIOLS					
FREQUENCY / PERCENT / ROW PCT / COL PCT	.	0	1	2	3+	TOTAL
	73	443	130	59	87	.
	.	.	.	.	.	.
	.	.	.	.	.	
	.	.	.	.	.	
NO	111	925	364	246	350	1885
	.	15.05	5.92	4.00	5.69	30.66
	.	49.07	19.31	13.05	18.57	
	.	31.85	28.64	30.94	29.71	
YES	215	1979	907	549	828	4263
	.	32.19	14.75	8.93	13.47	69.34
	.	46.42	21.28	12.88	19.42	
	.	68.15	71.36	69.06	70.29	
TOTAL	.	2904	1271	795	1178	6148
	.	47.23	20.67	12.93	19.16	100.00

FREQUENCY MISSING = 1118

ROAD/STREET MOTORCYCLES

TABLE OF HELMET BY VIOLS

HELMET	VIOLS					
FREQUENCY / PERCENT / ROW PCT / COL PCT	.	0	1	2	3+	TOTAL
	19	208	78	38	48	.
	.	.	.	.	.	.
	.	.	.	.	.	
	.	.	.	.	.	
NO	55	520	271	169	236	1196
	.	10.93	5.70	3.55	4.96	25.15
	.	43.48	22.66	14.13	19.73	
	.	24.57	25.23	26.57	25.38	
YES	168	1596	803	467	694	3560
	.	33.56	16.88	9.82	14.59	74.85
	.	44.83	22.56	13.12	19.49	
	.	75.43	74.77	73.43	74.62	
TOTAL	.	2116	1074	636	930	4756
	.	44.49	22.58	13.37	19.55	100.00

FREQUENCY MISSING = 618

ALL MOTORCYCLES

TABLE OF HELMET BY ALC

HELMET / ALC FREQUENCY PERCENT ROW PCT COL PCT	NO	YES	TOTAL
	448 . . .	292 . . .	52 . . .	. .
NO	203 . . .	1465 25.10 81.71 30.07	328 5.62 18.29 33.99	1793 30.72
YES	434 . . .	3407 58.37 84.25 69.93	637 10.91 15.75 66.01	4044 69.28
TOTAL	.	4872 83.47	965 16.53	5837 100.00

FREQUENCY MISSING = 1429

ROAD/STREET MOTORCYCLES

TABLE OF HELMET BY ALC

HELMET / ALC FREQUENCY PERCENT ROW PCT COL PCT	NO	YES	TOTAL
	163 . . .	200 . . .	28 . . .	. .
NO	121 . . .	938 20.83 82.72 24.93	196 4.35 17.28 26.49	1134 25.18
YES	359 . . .	2825 62.74 83.85 75.07	544 12.08 16.15 73.51	3369 74.82
TOTAL	.	3763 83.57	740 16.43	4503 100.00

FREQUENCY MISSING = 871

ALL MOTORCYCLES

TABLE OF HELMET BY FAULT

HELMET	FAULT		
FREQUENCY / PERCENT / ROW PCT / COL PCT	N	Y	TOTAL
	327	216	249	.
	.	.	.	.
	.	.	.	
	.	.	.	
NO	273	576	1147	1723
	.	10.23	20.37	30.60
	.	33.43	66.57	
	.	25.86	33.71	
YES	571	1651	2256	3907
	.	29.33	40.07	69.40
	.	42.26	57.74	
	.	74.14	66.29	
TOTAL	.	2227	3403	5630
	.	39.56	60.44	100.00

FREQUENCY MISSING = 1636

ROAD/STREET MOTORCYCLES

TABLE OF HELMET BY FAULT

HELMET	FAULT		
FREQUENCY / PERCENT / ROW PCT / COL PCT	N	Y	TOTAL
	67	161	163	.
	.	.	.	.
	.	.	.	
	.	.	.	
NO	154	463	638	1101
	.	10.62	14.63	25.25
	.	42.05	57.95	
	.	24.76	25.62	
YES	469	1407	1852	3259
	.	32.27	42.48	74.75
	.	43.17	56.83	
	.	75.24	74.38	
TOTAL	.	1870	2490	4360
	.	42.89	57.11	100.00

FREQUENCY MISSING = 1014

ALL MOTORCYCLES

TABLE OF EXP BY INJURY

EXP / INJURY FREQUENCY PERCENT ROW PCT COL PCT	A+K	B+C+O	TOTAL
	55 . . .	116 . . .	228 . . .	. .
NO VALID LICE	231 . . .	662 10.25 40.94 27.25	955 14.79 59.06 23.65	1617 25.04
VALID,MLIC 3+	33 . . .	435 6.74 34.52 17.93	825 12.77 65.48 20.46	1260 19.51
VALID,MLIC<3	55 . . .	695 10.76 35.10 28.65	1285 19.90 64.90 31.87	1980 30.66
VALID,NO MLIC	90 . . .	634 9.82 39.60 26.13	967 14.97 60.40 23.98	1601 24.79
TOTAL	.	2426 37.57	4032 62.43	6458 100.00

FREQUENCY MISSING = 808

ROAD/STREET MOTORCYCLES

TABLE OF EXP BY INJURY

EXP / INJURY FREQUENCY PERCENT ROW PCT COL PCT	A+K	B+C+O	TOTAL
	8 . . .	76 . . .	162 . . .	. .
NO VALID LICE	87 . . .	416 8.39 40.39 22.70	614 12.38 59.61 19.64	1030 20.77
VALID,MLIC 3+	17 . . .	378 7.62 34.39 20.62	721 14.54 65.61 23.06	1099 22.16
VALID,MLIC<3	43 . . .	598 12.06 35.34 32.62	1094 22.06 64.66 34.99	1692 34.11
VALID,NO MLIC	21 . . .	441 8.89 38.72 24.06	698 14.07 61.28 22.32	1139 22.96
TOTAL	.	1833 36.96	3127 63.04	4960 100.00

FREQUENCY MISSING = 414

ALL MOTORCYCLES

TABLE OF EXP BY ENDORSE

EXP / ENDORSE		NO	YES	TOTAL
FREQUENCY / PERCENT / ROW PCT / COL PCT	399	0	0	.
	.	.	.	.
	.	.	.	
	.	.	.	
NO VALID LICE	0	1848	0	1848
	.	26.91	0.00	26.91
	.	100.00	0.00	
	.	52.22	0.00	
VALID,MLIC 3+	0	0	1293	1293
	.	0.00	18.83	18.83
	.	0.00	100.00	
	.	0.00	38.85	
VALID,MLIC<3	0	0	2035	2035
	.	0.00	29.63	29.63
	.	0.00	100.00	
	.	0.00	61.15	
VALID,NO MLIC	0	1691	0	1691
	.	24.63	0.00	24.63
	.	100.00	0.00	
	.	47.78	0.00	
TOTAL		3539	3328	6867
		51.54	48.46	100.00

FREQUENCY MISSING = 399

ROAD/STREET MOTORCYCLES

TABLE OF EXP BY ENDORSE

EXP / ENDORSE		NO	YES	TOTAL
FREQUENCY / PERCENT / ROW PCT / COL PCT	246	0	0	.
	.	.	.	.
	.	.	.	
	.	.	.	
NO VALID LICE	0	1117	0	1117
	.	21.78	0.00	21.78
	.	100.00	0.00	
	.	49.06	0.00	
VALID,MLIC 3+	0	0	1116	1116
	.	0.00	21.76	21.76
	.	0.00	100.00	
	.	0.00	39.14	
VALID,MLIC<3	0	0	1735	1735
	.	0.00	33.83	33.83
	.	0.00	100.00	
	.	0.00	60.86	
VALID,NO MLIC	0	1160	0	1160
	.	22.62	0.00	22.62
	.	100.00	0.00	
	.	50.94	0.00	
TOTAL		2277	2851	5128
		44.40	55.60	100.00

FREQUENCY MISSING = 246

ALL MOTORCYCLES

TABLE OF EXP BY STOP

EXP / STOP FREQUENCY PERCENT ROW PCT COL PCT	.	NO	YES	TOTAL
	399 . . .	0 . . .	0 . . .	. .
NO VALID LICE	0 . . .	1388 20.21 75.11 21.66	460 6.70 24.89 100.00	1848 26.91
VALID,MLIC 3+	0 . . .	1293 18.83 100.00 20.18	0 0.00 0.00 0.00	1293 18.83
VALID,MLIC<3	0 . . .	2035 29.63 100.00 31.76	0 0.00 0.00 0.00	2035 29.63
VALID,NO MLIC	0 . . .	1691 24.63 100.00 26.39	0 0.00 0.00 0.00	1691 24.63
TOTAL	. .	6407 93.30	460 6.70	6867 100.00

FREQUENCY MISSING = 399

FOAD/STREET MOTORCYCLES

TABLE OF EXP BY STOP

EXP / STOP FREQUENCY PERCENT ROW PCT COL PCT	.	NO	YES	TOTAL
	246 . . .	0 . . .	0 . . .	. .
NO VALID LICE	0 . . .	792 15.44 70.90 16.49	325 6.34 29.10 100.00	1117 21.78
VALID,MLIC 3+	0 . . .	1116 21.76 100.00 23.24	0 0.00 0.00 0.00	1116 21.76
VALID,MLIC<3	0 . . .	1735 33.83 100.00 36.12	0 0.00 0.00 0.00	1735 33.83
VALID,NO MLIC	0 . . .	1160 22.62 100.00 24.15	0 0.00 0.00 0.00	1160 22.62
TOTAL	. .	4803 93.66	325 6.34	5128 100.00

FREQUENCY MISSING = 246

ALL MOTORCYCLES

TABLE OF EXP BY CRASHES

EXP / CRASHES	.	0	1	2+	TOTAL
FREQUENCY	399	0	0	0	.
PERCENT	.	.	.	.	.
ROW PCT	.	.	.	.	
COL PCT	.	.	.	.	
NO VALID LICE	0	1564	209	75	1848
	.	22.78	3.04	1.09	26.91
	.	84.63	11.31	4.06	
	.	31.27	14.88	16.27	
VALID,MLIC 3+	0	932	278	83	1293
	.	13.57	4.05	1.21	18.83
	.	72.08	21.50	6.42	
	.	18.64	19.79	18.00	
VALID,MLIC<3	0	1374	494	167	2035
	.	20.01	7.19	2.43	29.63
	.	67.52	24.28	8.21	
	.	27.47	35.16	36.23	
VALID,NO MLIC	0	1131	424	136	1691
	.	16.47	6.17	1.98	24.63
	.	66.88	25.07	8.04	
	.	22.62	30.18	29.50	
TOTAL	.	5001	1405	461	6867
	.	72.83	20.46	6.71	100.00

FREQUENCY MISSING = 399

ROAD/STREET MOTORCYCLES

TABLE OF EXP BY CRASHES

EXP / CRASHES	.	0	1	2+	TOTAL
FREQUENCY	246	0	0	0	.
PERCENT	.	.	.	.	.
ROW PCT	.	.	.	.	
COL PCT	.	.	.	.	
NO VALID LICE	0	937	134	46	1117
	.	18.27	2.61	0.90	21.78
	.	83.89	12.00	4.12	
	.	25.59	12.03	13.07	
VALID,MLIC 3+	0	797	247	72	1116
	.	15.54	4.82	1.40	21.76
	.	71.42	22.13	6.45	
	.	21.76	22.17	20.45	
VALID,MLIC<3	0	1175	418	142	1735
	.	22.91	8.15	2.77	33.83
	.	67.72	24.09	8.18	
	.	32.09	37.52	40.34	
VALID,NO MLIC	0	753	315	92	1160
	.	14.68	6.14	1.79	22.62
	.	64.91	27.16	7.93	
	.	20.56	28.28	26.14	
TOTAL	.	3662	1114	352	5128
	.	71.41	21.72	6.86	100.00

FREQUENCY MISSING = 246

ALL MOTORCYCLES

TABLE OF EXP BY VIOLS

EXP / VIOLS	.	0	1	2	3+	TOTAL
FREQUENCY	399	0	0	0	0	.
PERCENT	.	.	.	.	.	.
ROW PCT	.	.	.	.	.	
COL PCT	.	.	.	.	.	
NO VALID LICE	0	1170	183	140	355	1848
	.	17.04	2.66	2.04	5.17	26.91
	.	63.31	9.90	7.58	19.21	
	.	34.96	13.06	16.39	28.06	
VALID,MLIC 3+	0	654	328	151	160	1293
	.	9.52	4.78	2.20	2.33	18.83
	.	50.58	25.37	11.68	12.37	
	.	19.54	23.41	17.68	12.65	
VALID,MLIC<3	0	849	532	291	363	2035
	.	12.36	7.75	4.24	5.29	29.63
	.	41.72	26.14	14.30	17.84	
	.	25.37	37.97	34.07	28.70	
VALID,NO MLIC	0	674	358	272	387	1691
	.	9.82	5.21	3.96	5.64	24.63
	.	39.86	21.17	16.09	22.89	
	.	20.14	25.55	31.85	30.59	
TOTAL	.	3347	1401	854	1265	6867
	.	48.74	20.40	12.44	18.42	100.00

FREQUENCY MISSING = 399

ROAD/STREET MOTORCYCLES

TABLE OF EXP BY VIOLS

EXP / VIOLS	.	0	1	2	3+	TOTAL
FREQUENCY	246	0	0	0	0	.
PERCENT	.	.	.	.	.	.
ROW PCT	.	.	.	.	.	
COL PCT	.	.	.	.	.	
NO VALID LICE	0	642	136	98	241	1117
	.	12.52	2.65	1.91	4.70	21.78
	.	57.48	12.18	8.77	21.58	
	.	27.62	11.81	14.54	24.64	
VALID,MLIC 3+	0	559	289	125	143	1116
	.	10.90	5.64	2.44	2.79	21.76
	.	50.09	25.90	11.20	12.81	
	.	24.05	25.09	18.55	14.62	
VALID,MLIC<3	0	719	460	252	304	1735
	.	14.02	8.97	4.91	5.93	33.83
	.	41.44	26.51	14.52	17.52	
	.	30.94	39.93	37.39	31.08	
VALID,NO MLIC	0	404	267	195	290	1160
	.	7.88	5.21	3.88	5.66	22.62
	.	34.83	23.02	17.16	25.00	
	.	17.38	23.18	29.53	29.65	
TOTAL	.	2324	1152	674	978	5128
	.	45.32	22.46	13.14	19.07	100.00

FREQUENCY MISSING = 246

ALL MOTORCYCLES

TABLE OF EXP BY ALC

EXP / FREQUENCY / PERCENT / ROW PCT / COL PCT	NO	YES	TOTAL
	101 . . .	238 . . .	60 . . .	. .
NO VALID LICE	410 . . .	1036 17.61 72.04 21.03	402 6.83 27.96 42.01	1438 24.44
VALID,MLIC 3+	143 . . .	991 16.85 86.17 20.12	159 2.70 13.83 16.61	1150 19.55
VALID,MLIC<3	189 . . .	1670 28.39 90.47 33.90	176 2.99 9.53 18.39	1846 31.38
VALID,NC MLIC	242 . . .	1229 20.89 84.82 24.95	220 3.74 15.18 22.99	1449 24.63
TOTAL	. .	4926 83.73	957 16.27	5883 100.00

FREQUENCY MISSING = 1383

ROAD/STREET MOTORCYCLES

TABLE OF EXP BY ALC

EXP / FREQUENCY / PERCENT / ROW PCT / COL PCT	NO	YES	TOTAL
	41 . . .	164 . . .	41 . . .	. .
NO VALID LICE	204 . . .	633 13.99 69.33 16.66	280 6.19 30.67 38.51	913 20.17
VALID,MLIC 3+	111 . . .	865 19.11 86.07 22.77	140 3.09 13.93 19.26	1005 22.21
VALID,MLIC<3	155 . . .	1428 31.55 90.38 37.59	152 3.36 9.62 20.91	1580 34.91
VALID,NC MLIC	132 . . .	873 19.29 84.92 22.98	155 3.42 15.08 21.32	1028 22.71
TOTAL	. .	3799 83.94	727 16.06	4526 100.00

FREQUENCY MISSING = 848

ALL MOTORCYCLES

TABLE OF EXP BY FAULT

EXP / FAULT FREQUENCY PERCENT ROW PCT COL PCT	N	Y	TOTAL
	399 . . .	0 . . .	0 . . .	. .
NO VALID LICE	252 . . .	379 6.22 23.75 15.51	1217 19.97 76.25 33.32	1596 26.19
VALID,MLIC 3+	138 . . .	654 10.73 56.62 26.77	501 8.22 43.38 13.72	1155 18.95
VALID,MLIC<3	177 . . .	1020 16.74 54.90 41.75	838 13.75 45.10 22.95	1858 30.48
VALID,NC MLIC	205 . . .	390 6.40 26.24 15.96	1096 17.98 73.76 30.01	1486 24.38
TOTAL	.	2443 40.08	3652 59.92	6095 100.00

FREQUENCY MISSING = 1171

FOAE/STREET MOTORCYCLES

TABLE OF EXP BY FAULT

EXP / FAULT FREQUENCY PERCENT ROW PCT COL PCT	N	Y	TOTAL
	246 . . .	0 . . .	0 . . .	. .
NO VALID LICE	86 . . .	286 6.11 27.74 14.08	745 15.91 72.26 28.08	1031 22.01
VALID,MLIC 3+	103 . . .	574 12.25 56.66 28.26	439 9.37 43.34 16.55	1013 21.63
VALID,MLIC<3	150 . . .	878 18.74 55.39 43.23	707 15.09 44.61 26.65	1585 33.84
VALID,NC MLIC	105 . . .	293 6.26 27.77 14.43	762 16.27 72.23 28.72	1055 22.52
TOTAL	.	2031 43.36	2653 56.64	4684 100.00

FREQUENCY MISSING = 690

ALL MOTORCYCLES

TABLE OF ENDORSE BY INJURY

ENDORSE	INJURY		
FREQUENCY / PERCENT / ROW PCT / COL PCT	A+K	E+C+O	TOTAL
	55	116	228	.
	.	.	.	.
	.	.	.	
	.	.	.	
NO	321	1296	1922	3218
	.	20.07	29.76	49.83
	.	40.27	59.73	
	.	53.42	47.67	
YES	88	1130	2110	3240
	.	17.50	32.67	50.17
	.	34.88	65.12	
	.	46.58	52.33	
TOTAL	.	2426	4032	6458
	.	37.57	62.43	100.00

FREQUENCY MISSING = 808

ROAD/STREET MOTORCYCLES

TABLE OF ENDORSE BY INJURY

ENDORSE	INJURY		
FREQUENCY / PERCENT / ROW PCT / COL PCT	A+K	E+C+O	TOTAL
	8	76	162	.
	.	.	.	.
	.	.	.	
	.	.	.	
NO	108	857	1312	2169
	.	17.28	26.45	43.73
	.	39.51	60.49	
	.	46.75	41.96	
YES	60	976	1815	2791
	.	19.68	36.59	56.27
	.	34.97	65.03	
	.	53.25	58.04	
TOTAL	.	1833	3127	4960
	.	36.96	63.04	100.00

FREQUENCY MISSING = 414

ALL MOTORCYCLES

TABLE OF ENDORSE BY STOP

ENDORSE / STOP	.	NO	YES	TOTAL
FREQUENCY	399	0	0	.
PERCENT	.	.	.	.
ROW PCT	.	.	.	
COL PCT	.	.	.	
NO	0	3079	460	3539
	.	44.84	6.70	51.54
	.	87.00	13.00	
	.	48.06	100.00	
YES	0	3328	0	3328
	.	48.46	0.00	48.46
	.	100.00	0.00	
	.	51.94	0.00	
TOTAL	.	6407	460	6867
	.	93.30	6.70	100.00

FREQUENCY MISSING = 399

ROAD/STREET MOTORCYCLES

TABLE OF ENDORSE BY STOP

ENDORSE / STOP	.	NO	YES	TOTAL
FREQUENCY	246	0	0	.
PERCENT	.	.	.	.
ROW PCT	.	.	.	
COL PCT	.	.	.	
NO	0	1952	325	2277
	.	38.07	6.34	44.40
	.	85.73	14.27	
	.	40.64	100.00	
YES	0	2851	0	2851
	.	55.60	0.00	55.60
	.	100.00	0.00	
	.	59.36	0.00	
TOTAL	.	4803	325	5128
	.	93.66	6.34	100.00

FREQUENCY MISSING = 246

ALL MOTORCYCLES

TABLE OF ENDORSE BY CRASHES

ENDORSE / CRASHES	.	0	1	2+	TOTAL
.	399	0	0	0	.
	.	.	.	.	.
	.	.	.	.	
	.	.	.	.	
NO	0	2695	633	211	3539
	.	39.25	9.22	3.07	51.54
	.	76.15	17.89	5.96	
	.	53.89	45.05	45.77	
YES	0	2306	772	250	3328
	.	33.58	11.24	3.64	48.46
	.	69.29	23.20	7.51	
	.	46.11	54.95	54.23	
TOTAL		. 5001	1405	461	6867
		. 72.83	20.46	6.71	100.00

FREQUENCY MISSING = 399

ROAD/STREET MOTORCYCLES

TABLE OF ENDORSE BY CRASHES

ENDORSE / CRASHES	.	0	1	2+	TOTAL
.	246	0	0	0	.
	.	.	.	.	.
	.	.	.	.	
	.	.	.	.	
NO	0	1690	449	138	2277
	.	32.96	8.76	2.69	44.40
	.	74.22	19.72	6.06	
	.	46.15	40.31	39.20	
YES	0	1972	665	214	2851
	.	38.46	12.97	4.17	55.60
	.	69.17	23.33	7.51	
	.	53.85	59.69	60.80	
TOTAL		. 3662	1114	352	5128
		. 71.41	21.72	6.86	100.00

FREQUENCY MISSING = 246

ALL MOTORCYCLES

TABLE OF ENDORSE BY VIOLS

ENDORSE / VIOLS	.	0	1	2	3+	TOTAL
FREQUENCY	399	0	0	0	0	.
PERCENT	.	.	.	.	.	.
ROW PCT	.	.	.	.	.	
COL PCT	.	.	.	.	.	
NO	0	1844	541	412	742	3539
	.	26.85	7.88	6.00	10.81	51.54
	.	52.11	15.29	11.64	20.97	
	.	55.09	38.62	48.24	58.66	
YES	0	1503	860	442	523	3328
	.	21.89	12.52	6.44	7.62	48.46
	.	45.16	25.84	13.28	15.72	
	.	44.91	61.38	51.76	41.34	
TOTAL	.	3347	1401	854	1265	6867
	.	48.74	20.40	12.44	18.42	100.00

FREQUENCY MISSING = 399

ROAD/STREET MOTORCYCLES

TABLE OF ENDORSE BY VIOLS

ENDORSE / VIOLS	.	0	1	2	3+	TOTAL
FREQUENCY	246	0	0	0	0	.
PERCENT	.	.	.	.	.	.
ROW PCT	.	.	.	.	.	
COL PCT	.	.	.	.	.	
NO	0	1046	403	297	531	2277
	.	20.40	7.86	5.79	10.35	44.40
	.	45.94	17.70	13.04	23.32	
	.	45.01	34.98	44.07	54.29	
YES	0	1278	749	377	447	2851
	.	24.92	14.61	7.35	8.72	55.60
	.	44.83	26.27	13.22	15.68	
	.	54.99	65.02	55.93	45.71	
TOTAL	.	2324	1152	674	978	5128
	.	45.32	22.46	13.14	19.07	100.00

FREQUENCY MISSING = 246

ALL MOTORCYCLES

TABLE OF ENDORSE BY ALC

ENDORSE	ALC		
FREQUENCY / PERCENT / ROW PCT / COL PCT	NO	YES	TOTAL
	101	238	60	.
	.	.	.	.
	.	.	.	
	.	.	.	
NO	652	2265	622	2887
	.	38.50	10.57	49.07
	.	78.46	21.54	
	.	45.98	64.99	
YES	332	2661	335	2996
	.	45.23	5.69	50.93
	.	88.82	11.18	
	.	54.02	35.01	
TOTAL	.	4926	957	5883
	.	83.73	16.27	100.00

FREQUENCY MISSING = 1383

ROAD/STREET MOTORCYCLES

TABLE OF ENDORSE BY ALC

ENDORSE	ALC		
FREQUENCY / PERCENT / ROW PCT / COL PCT	NO	YES	TOTAL
	41	164	41	.
	.	.	.	.
	.	.	.	
	.	.	.	
NO	336	1506	435	1941
	.	33.27	9.61	42.89
	.	77.59	22.41	
	.	39.64	59.83	
YES	266	2293	292	2585
	.	50.66	6.45	57.11
	.	88.70	11.30	
	.	60.36	40.17	
TOTAL	.	3799	727	4526
	.	83.94	16.06	100.00

FREQUENCY MISSING = 848

ALL MOTORCYCLES

TABLE OF ENDORSE BY FAULT

ENDORSE / FAULT	N	Y	TOTAL
	399	0	0	.
	.	.	.	.
	.	.	.	
	.	.	.	
NO	457	769	2313	3082
	.	12.62	37.95	50.57
	.	24.95	75.05	
	.	31.48	63.34	
YES	315	1674	1339	3013
	.	27.47	21.97	49.43
	.	55.56	44.44	
	.	68.52	36.66	
TOTAL		.	2443	3652	6095
		.	40.08	59.92	100.00

FREQUENCY MISSING = 1171

ROAD/STREET MOTORCYCLES

TABLE OF ENDORSE BY FAULT

ENDORSE / FAULT	N	Y	TOTAL
	246	0	0	.
	.	.	.	.
	.	.	.	
	.	.	.	
NO	191	579	1507	2086
	.	12.36	32.17	44.53
	.	27.76	72.24	
	.	28.51	56.80	
YES	253	1452	1146	2598
	.	31.00	24.47	55.47
	.	55.89	44.11	
	.	71.49	43.20	
TOTAL		.	2031	2653	4684
		.	43.36	56.64	100.00

FREQUENCY MISSING = 690

APPENDIX D

Selected Data Tables from the
North Carolina Trauma Registry
October 1987 - June 1990

Table D.1. Comparison of NCTR Populations by Age.

Age	Motorcycle Operator	Motorcycle Passenger	Other Road Trauma	Non-Road Trauma	Total
<16	71 (10.1)	17 (25.0)	1,298 (14.5)	2,118 (13.6)	3,504 (13.9)
16-19	93 (13.2)	10 (14.7)	1,248 (13.9)	941 (6.1)	2,292 (9.1)
20-24	182 (25.8)	16 (23.5)	1,283 (14.3)	1,560 (10.0)	3,041 (12.0)
25-44	293 (41.5)	18 (26.5)	3,036 (33.9)	5,479 (35.2)	8,826 (34.9)
45-64	51 (7.2)	5 (7.4)	1,318 (14.7)	2,364 (15.2)	3,738 (14.8)
65+	14 (2.0)	1 (1.5)	682 (7.6)	2,771 (17.8)	3,468 (13.7)
Unk.	2 (0.3)	1 (1.5)	96 (1.1)	314 (2.0)	413 (1.6)
Total	706	68	8,961	15,547	25,282

Table D.2. Comparison of NCTR Populations by Sex.

Sex	Motorcycle Operator	Motorcycle Passenger	Other Road Trauma	Non-Road Trauma	Total
Male	6.71 (95.0)	36 (52.9)	5,673 (63.4)	10,577 (68.1)	16,957 (67.1)
Female	35 (5.0)	32 (47.1)	3,281 (36.6)	4,954 (31.9)	8,302 (32.9)
Total	706	68	8,954	15,531	25,259

Table D.3. Comparison of NCTR Populations by Race.

Race	Motorcycle Operator	Motorcycle Passenger	Other Road Trauma	Non-Road Trauma	Total
White	552 (78.3)	58 (86.6)	6,229 (70.1)	9,402 (60.9)	16,241 (64.7)
Black	147 (20.9)	9 (13.4)	2,446 (27.5)	5,730 (37.1)	8,332 (33.2)
Other	6 (0.8)	0 (0.0)	217 (2.4)	301 (2.0)	524 (2.1)
Total	705	67	8,892	15,433	25,097

Table D.4. Comparison of NCTR Populations by Insurance Status.

Insurance Status	Motorcycle Operator	Motorcycle Passenger	Other Road Trauma	Non-Road Trauma	Total
Self Pay	290 (43.2)	25 (38.5)	3046 (35.8)	4741 (32.0)	8102 (33.6)
Medicare	20 (3.0)	1 (1.5)	673 (7.9)	2962 (20.0)	3656 (15.2)
Medicaid	34 (5.1)	3 (4.6)	523 (6.1)	1102 (7.4)	1662 (6.9)
Commercial	218 (32.5)	27 (41.5)	2707 (31.8)	2732 (18.4)	5684 (23.6)
BCBS	87 (13.0)	6 (9.2)	1104 (13.0)	1401 (9.4)	2598 (10.8)
HMO	6 (0.9)	1 (1.5)	79 (0.9)	107 (0.7)	193 (0.8)
Work. Comp	2 (0.3)	1 (1.5)	215 (2.5)	1586 (11.0)	1804 (7.5)
EDS	4 (0.6)	0 (0.0)	56 (0.7)	90 (0.6)	150 (0.6)
Champus	10 (1.5)	1 (1.5)	117 (1.4)	126 (0.8)	254 (1.1)
Total	671	65	8,520	14,847	24,103

Table D.5. Comparison of NCTR Populations by Emergency Room Disposition.

Emergency Room Disp.	Motorcycle Operator	Motorcycle Passenger	Other Road Trauma	Non-Road Trauma	Total
Home	5 (0.7)	0 (0.0)	43 (0.5)	36 (0.2)	84 (0.3)
Intensive Care	148 (21.1)	16 (24.2)	2791 (31.4)	2163 (14.1)	5118 (20.5)
Operating Room	251 (35.8)	23 (34.8)	2077 (23.4)	4598 (30.0)	6949 (27.8)
Floor	267 (38.0)	21 (31.8)	3454 (38.9)	7504 (48.9)	11,246 (45.0)
Transfer	2 (0.3)	0 (0.0)	22 (0.2)	66 (0.4)	90 (0.4)
Morgue	10 (1.4)	2 (3.0)	251 (2.8)	269 (1.8)	522 (2.1)
Other	19 (2.7)	4 (6.1)	248 (2.8)	692 (4.5)	963 (3.9)
Total	702	66	8,886	15,328	24,972

Table D.6. Comparison of NCTR Populations by Discharge Facility.

Discharge Facility	Motorcycle Operator	Motorcycle Passenger	Other Road Trauma	Non-Road Trauma	Total
Home	542 (85.0)	50 (80.6)	6653 (81.4)	11826 (82.8)	19071 (82.4)
Rehab. Facility	47 (7.4)	5 (8.1)	542 (6.6)	401 (2.8)	995 (4.3)
Hospital Transfer	15 (2.4)	2 (3.2)	205 (2.5)	337 (2.4)	559 (2.4)
Other, Unknown	9 (1.4)	0 (0.0)	135 (1.7)	971 (6.8)	1115 (4.8)
Death	25 (3.9)	5 (8.1)	633 (7.7)	754 (5.3)	1417 (6.1)
Total	638	62	8,168	14,289	23,157

Table D.7. Frequency of Serious (AIS≥2) Injury by Location of Injury and Trauma Registry Population.

Injury Location	Motorcycle Operator	Motorcycle Passenger	Other Transp. Trauma	Non-Transp. Trauma	Total
Head	238 (35.1)	25 (38.5)	3613 (41.8)	2336 (15.6)	6212 (25.5)
Chest	130 (19.2)	13 (20.0)	2222 (25.7)	1311 (8.8)	3676 (15.1)
Abdomen	104 (15.4)	9 (13.9)	1474 (17.0)	1497 (10.0)	3084 (12.7)
Extremity	678 (61.1)	32 (49.2)	3975 (46.0)	6605 (44.2)	11026 (45.3)
Soft Tissue	23 (3.4)	4 (6.2)	355 (4.1)	1953 (13.1)	2335 (9.6)

Table D.8. Average Hospital Charge by Emergency Room Disposition and Trauma Registry Population.

Emergency Room Disposition	Motorcycle Operator	Motorcycle Passenger	Other Road Trauma	Non-Road Trauma
Home	$798 (5) *	-- (0)	$1,392 (43)	$3,487 (36)
Intensive Care	$24,200 (148)	$8,190 (16)	$26,752 (2,791)	$20,573 (2,163)
Operating Room	$23,847 (251)	$20,749 (23)	$30,005 (2077)	$11,567) (4598)
Floor	$5,245 (267)	$3,560 (21)	$5,967 (3454)	$5,835 (7504)
Transfer	-- (2)	-- (0)	$2,708 (22)	$1,185 (66)
Other	$1,551 (19)	$1,389 (4)	$5,469 (248)	$5,516 (692)
Morgue	$16,572 (10)	$999 (2)	$1,940 (251)	$1,185 (269)
Overall	$15,801 (702)	$11,368 (66)	$17,892 8,886)	$9,559 15,328

* Sample size.

Table D.9. Comparison of NCTR Populations by Average Hospital Charge and Age (for cases admitted to hospital ≥24 hours).

Age	Motorcycle Operator	Motorcycle Passenger	Other Road Trauma	Non-Road Trauma
<16	$ 12,599	$ 5,765	$ 9,738	$ 6,238
16-19	14,731	13,743	15,227	7,792
20-24	15,343	21,839	16,579	8,117
25-44	15,877	7,016	18,137	9,518
45-64	20,016	8,778	18,816	10,847
65+	28,592	5,548	38,945	12,459
Unk.	--	13,139	12,518	10,730
Overall	$15,801	$11,368	$17,892	$9,559

Table D.10. Comparison of NCTR Populations by Average Hospital Days and Age.

Age	Motorcycle Operator	Motorcycle Passenger	Other Road Trauma	Non-Road Trauma
<16	8	5	8	6
16-19	12	12	11	6
20-24	13	13	12	6
25-44	13	6	12	7
45-64	17	6	15	10
65+	19	1	15	14
Unk.	7	32	9	14
Overall	13	8	12	9

Table D.11. Comparison of NCTR Populations by Average Injury Severity Score and Age.

Age	Motorcycle Operator	Motorcycle Passenger	Other Road Trauma	Non-Road Trauma
<16	10	9	11	7
16-19	13	15	13	7
20-24	10	12	12	8
25-44	11	11	12	8
45-64	14	7	12	8
65+	11	41	12	8
Unk.	5	4	12	7
Total	11	11	12	8

Table D.12 Age by Insurance Status Comparison for NCTR Populations.

a) Motorcycle Operator

Age	Private/ Commercial*	Uninsured/ Self-Pay	Medicare/ Medicaid	Other/ Unknown	Total
<16	54 (76.1)	12 (16.9)	3 (4.2)	2 (2.8)	71
16-19	48 (52.2)	37 (40.2)	5 (5.4)	2 (2.2)	92
20-24	77 (42.1)	92 (50.3)	9 (4.9)	5 (2.7)	183
25-44	133 (45.4)	124 (42.3)	21 (7.2)	15 (5.1)	293
45-64	22 (43.1)	23 (45.1)	5 (9.8)	1 (2.0)	51
65+	2 (14.3)	1 (7.1)	11 (78.6)	0 (0)	14
Unk.	0 (0)	1 (50.0)	0 (0)	1 (50.0)	2
Total	336 (47.6)	290 (41.1)	54 (7.6)	26 (3.7)	706

b) Other Road Trauma

Age	Private/ Commercial*	Uninsured/ Self-Pay	Medicare/ Medicaid	Other/ Unknown	Total
<16	664 (51.2)	400 (30.8)	195 (15.0)	39 (3.0)	1298
16-19	768 (61.5)	384 (30.8)	68 (5.4)	28 (2.2)	1248
20-24	588 (45.8)	574 (44.7)	56 (4.4)	65 (5.1)	1283
25-44	1516 (49.9)	1203 (39.6)	198 (6.5)	119 (3.9)	3036
45-64	762 (57.8)	375 (28.5)	135 (10.2)	46 (3.5)	1318
65+	71 (10.4)	80 (11.7)	524 (76.8)	7 (1.0)	682
Unk.	24 (25.0)	30 (31.3)	20 (20.8)	22 (22.9)	96
Total	4393 (49.0)	3046 (34.0)	1196 (13.3)	326 (36)	8961

(Continued)

Table D.12. Age by Insurance Status Comparison for NCTR Populations. (Cont.)

c) Non-Road Trauma

Age	Private/ Commercial*	Uninsured/ Self-Pay	Medicare/ Medicaid	Other/ Unknown	Total
<16	1070 (50.5)	522 (24.6)	487 (23.0)	39 (1.8)	2118
16-19	500 (53.1)	329 (35.0)	89 (9.5)	23 (2.4)	941
20-24	665 (42.6)	742 (47.6)	91 (5.8)	62 (4.0)	1560
25-44	2473 (45.1)	2364 (43.1)	392 (7.2)	250 (4.6)	5479
45-64	1282 (54.2)	629 (26.6)	382 (16.2)	71 (3.0)	2364
65+	223 (8.0)	103 (3.7)	2423 (87.4)	22 (0.8)	2771
Unknown	38 (12.1)	52 (16.6)	200 (63.7)	24 (7.6)	314
Total	6251 (40.2)	4741 (30.5)	4064 (26.1)	491 (3.2)	15547

* Includes BCBS, Champus, EDS, Other Commercial

Table D.13. Age by Discharge Status Comparisons for NCTR Populations.

a) Motorcycle Operator

Age	Home	Hospital Transfer	Other Medical	Rehab. Facility	Died	Other/ Unknown	Total
<16	61 (85.9)	1 (1.4)	2 (2.8)	3 (4.2)	2 (2.8)	2 (2.8)	71
16-19	64 (69.6)	1 (1.1)	0 (0)	9 (9.8)	3 (3.3)	15 (16.3)	92
20-24	154 (84.2)	4 (2.2)	2 (1.1)	8 (4.4)	5 (2.7)	10 (5.5)	183
25-44	213 (72.7)	5 (1.7)	3 (1.0)	25 (8.5)	13 (4.4)	34 (11.6)	293
45-64	40 (78.4)	4 (7.8)	0 (0)	2 (3.9)	1 (2.0)	4 (7.8)	51
65+	9 (64.3)	0 (0)	2 (14.3)	0 (0)	1 (7.1)	2 (14.3)	14
Unk.	1 (50.0)	0 (0)	0 (0)	0 (0)	0 (0)	1 (50.0)	2
Total	542 (76.8)	15 (2.1)	9 (1.3)	47 (6.7)	25 (3.5)	68 (9.6)	706

b) Other Road Trauma

Age	Home	Hospital Transfer	Other Medical	Rehab. Facility	Other/ Unknown*	Total
<16	996 (76.7)	19 (1.5)	7 (0.5)	76 (5.9)	200 (13.9)	1298
16-19	946 (75.8)	26 (2.1)	9 (0.7)	84 (6.7)	183 (12.7)	1248
20-24	953 (74.3)	34 (2.7)	14 (1.1)	103 (8.0)	179 (12.5)	1283
25-44	2356 (77.6)	59 (1.9)	40 (1.3)	164 (5.4)	417 (29.0)	3036
45-64	952 (72.2)	41 (3.1)	22 (1.7)	75 (5.7)	228 (15.9)	1318
65+	413 (60.6)	24 (3.5)	29 (4.3)	35 (5.1)	181 (12.6)	682
Unk.	37 (38.5)	2 (2.1)	4 (4.2)	5 (5.2)	48 (3.3)	96
Total	6653 (74.2)	205 (2.3)	125 (1.4)	542 (6.1)	1436 (16.0)	8961

(Continued)

Table D.13. Age by Discharge Status Comparisons for NCTR Populations. (Cont.)

c) **Non-Road Trauma**

Age	Home	Hospital Transfer	Other Medical	Rehab. Facility	Other/ Unknown*	Total
<16	1789 (84.5)	48 (2.3)	57 (2.7)	31 (1.5)	193 (9.5)	2118
16-19	773 (82.1)	10 (1.1)	20 (2.1)	26 (2.8)	112 (5.5)	941
20-24	1274 (81.7)	26 (1.7)	23 (1.5)	25 (1.6)	212 (10.4)	1560
25-44	4480 (81.8)	108 (2.0)	120 (2.2)	122 (2.2)	649 (32.0)	5479
45-64	1830 (77.4)	59 (2.5)	72 (3.0)	66 (2.8)	337 (16.6)	2364
65+	1559 (56.3)	83 (3.0)	567 (20.5)	121 (4.4)	441 (21.7)	2771
Unk.	121 (38.5)	3 (1.0)	93 (29.6)	10 (3.2)	87 (4.3)	314
Total	11826 (76.1)	337 (2.2)	952 (6.1)	401 (2.6)	2031 (13.1)	15547

* Includes those who died.

APPENDIX E

Selected Data Tables from Follow-up Analysis of
North Carolina Trauma Registry Data

Table E.1. Injury Outcome Measures for N.C. Trauma Registry Cases, October 1987 - December 1991.

Outcome Variable	Motorcycle Operator	Motorcycle Passenger	Other Transp. Trauma	Non-Transp. Trauma
Average Hospital Days	11.0	9.6	11.2	8.3
Average Trauma Score	12.7	12.7	12.2	11.0
Average Injury Severity Score	11.2	11.3	11.9	7.8
Average Hospital Charges	$14,993	$13,209	$16,396	$9,671

Table E.2. Gender of N.C. Trauma Registry Cases, October 1987 - December 1991.

Sex	Motorcycle Operator	Motorcycle Passenger	Other Transp. Trauma	Non-Transp. Trauma	Total
Male	1,228 (89.0)	50 (49.0)	9,764 (63.4)	18,077 (68.4)	29,101 (67.2)
Female	152 (11.0)	52 (51.0)	5,624 (36.6)	8,348 (31.6)	14,176 (32.8)
Unk.	0 --	0 --	5 --	17 --	22 --
Total	1,380	102	15,375	26,442	43,299

Table E.3. Insurance Status of N.C. Trauma Registry Cases, October 1987 - December 1991.

Insurance Status	Motorcycle Operator	Motorcycle Passenger	Other Transp. Trauma	Non-Transp. Trauma	Total
Commercial/ Private	704 (53.5)	58 (58.6)	7,489 (50.8)	10,286 (40.7)	18,537 (44.7)
Medicare/ Medicaid	110 (8.4)	6 (6.1)	2,390 (16.2)	7,516 (29.7)	10,022 (24.2)
Uninsured (Self-Pay)	501 (38.1)	35 (35.4)	4,877 (33.1)	7,476 (29.6)	12,889 (31.1)
Other, Unk.	65 --	3 --	619 --	1,164 --	1,851 --
Total	1,380	102	15,375	26,442	43,299

Table E.4. Helmet Use by Motorcyclists on N.C. Trauma Registry, October 1987 - December 1991.

Helmet Use	Motorcycle Operator	Motorcycle Passenger	Total
Helmet	513 (71.7)	38 (71.7)	551 (71.7)
No Helmet	203 (28.4)	15 (28.3)	218 (28.3)
Unknown Helmet Use	664 --	49 --	713 --
Total	1,380	102	1,482

Table E.5. Emergency Room Disposition of N.C. Trauma Registry Cases, October 1987 - December 1991.

Emergency Room Disp.	Motorcycle Operator	Motorcycle Passenger	Other Transp. Trauma	Non-Transp. Trauma	Total
Floor	564 (42.9)	33 (34.4)	5,860 (39.9)	12,536 (50.7)	18,993 (46.5)
Intensive Care	290 (22.1)	21 (21.9)	4,927 (33.6)	3,854 (15.6)	9,092 (22.3)
Operating Room	440 (33.5)	40 (41.7)	3,471 (23.6)	7,841 (31.7)	11,792 (28.9)
Morgue	21 (1.6)	2 (2.1)	428 (2.9)	484 (2.0)	935 (2.3)
Other	65 --	6 --	689 --	1,727 --	2,487 --
Total	1,380	102	15,375	26,442	43,299

Table E.6. Hospital Discharge Status of N.C. Trauma Registry Cases, October 1987 - December 1991.

Discharge Facility	Motorcycle Operator	Motorcycle Passenger	Other Transp. Trauma	Non-Transp. Trauma	Total
Home	1,094 (84.8)	78 (81.3)	11,278 (80.2)	19,971 (82.9)	32,421 (82.0)
Rehabilation Facility	86 (6.7)	8 (8.3)	1,060 (7.5)	690 (2.9)	1,844 (4.7)
Hospital/ Other Medical	43 (3.3)	2 (2.1)	598 (4.3)	2,056 (8.5)	2,699 (6.8)
Death	67 (5.2)	8 (8.3)	1,120 (8.0)	1,371 (5.7)	2,566 (6.5)
Other, Unk.	90 --	6 --	1,319 --	2,354 --	3,769 --
Total	1,380	102	15,375	26,442	43,299

Table E.7. Severity of Head/Neck Injury for N.C. Trauma Registry Cases, October 1987 - December 1991.

AIS Head/Neck	Motorcycle Operator	Motorcycle Passenger	Other Transp. Trauma	Non-Transp. Trauma	Total
0	897 (65.0)	66 (64.7)	9,050 (58.9)	22,266 (84.2)	32,279 (74.6)
1	18 (1.3)	3 (2.9)	173 (1.1)	278 (1.1)	472 (1.1)
2	182 (13.2)	16 (15.7)	2,482 (16.1)	1,030 (3.9)	3,710 (8.6)
3	100 (7.3)	0 (0.0)	1,237 (8.1)	833 (3.2)	2,170 (5.0)
4	115 (8.3)	11 (10.8)	1,395 (9.1)	1,450 (5.5)	2,971 (6.9)
5	68 (4.9)	6 (5.9)	1,030 (6.7)	541 (2.1)	1,645 (3.8)
6	0 (0.0)	0 (0.0)	8 (0.1)	44 (0.2)	52 (0.1)
Total	1380	102	15,375	26,442	43,299

Severity of Head/Neck Injury	Motorcycle Operator	Motorcycle Passenger	Other Transp. Trauma	Non-Transp. Trauma	Total
Serious Head/Neck Injury (AIS≥2)	465 (33.7)	33 (32.4)	6,152 (40.0)	3,898 (14.7)	10,548 (24.4)
Severe Head/Neck Injury (AIS≥3)	283 (20.5)	17 (16.7)	3,670 (23.9)	2,868 (10.9)	6,838 (15.8)
Total	1,380	102	15,375	26,442	43,299

Table E.8. Severity of Head/Neck Injury by Helmet Use for Motorcyclists on N.C. Trauma Registry, October 1987 - December 1991.

AIS Head / Neck	Motorcycle Operator			Motorcycle Passenger			All Motorcyclists		
	Helmet	No Helmet	Unk. Helmet	Helmet	No Helmet	Unk. Helmet	Helmet	No Helmet	Unk. Helmet
0	351 (68.4)	85 (41.9)	461 (69.4)	29 (76.3)	7 (46.7)	30 (61.2)	380 (69.0)	92 (42.2)	491 (68.9)
1	6 (1.2)	7 (3.5)	5 (0.8)	1 (2.6)	0 (0.0)	2 (4.1)	7 (1.3)	7 (3.2)	7 (1.0)
2	74 (14.4)	39 (19.2)	69 (10.4)	4 (10.5)	1 (6.7)	11 (22.4)	78 (14.2)	40 (18.3)	80 (11.2)
3	31 (6.0)	22 (10.8)	47 (7.1)	0 (0.0)	0 (0.0)	0 (0.0)	31 (5.6)	22 (10.1)	47 (6.6)
4	34 (6.6)	31 (15.3)	50 (7.5)	1 (2.6)	4 (26.7)	6 (12.2)	35 (6.4)	35 (16.1)	56 (7.9)
5	17 (3.3)	19 (9.4)	32 (4.8)	3 (7.9)	3 (20.0)	0 (0.0)	20 (3.6)	22 (10.1)	32 (4.5)
Total	513	203	664	38	15	49	551	218	713

Severity of Head/Neck Injury	Motorcycle Operator			Motorcycle Passenger			All Motorcyclists		
	Helmet	No Helmet	Unk. Helmet	Helmet	No Helmet	Unk. Helmet	Helmet	No Helmet	Unk. Helmet
Serious Head/Neck Injury (AIS≥2)	156 (30.4)	111 (54.7)	198 (29.8)	8 (21.1)	8 (53.3)	17 (34.7)	164 (29.8)	119 (54.6)	215 (30.2)
Severe Head/Neck Injury (AIS≥3)	82 (16.0)	72 (35.5)	129 (19.4)	4 (10.5)	7 (46.7)	6 (12.2)	86 (15.6)	79 (36.2)	135 (18.9)
Total	513	203	664	38	15	49	551	218	713

Table E.9. Severity of Extremity Injury for Motorcyclists on N.C. Trauma Registry, October 1987 - December 1991.

AIS Extremities	Motorcycle Operator	Motorcycle Passenger	Other Transp. Trauma	Non-Transp. Trauma	Total
0	557 (40.6)	50 (49.0)	8,437 (54.9)	15,140 (57.3)	21,142 (52.5)
1	21 (1.5)	1 (1.0)	159 (1.0)	392 (1.5)	573 (1.4)
2	409 (29.8)	19 (18.6)	3,742 (24.4)	5,810 (22.0)	9,980 (24.8)
3	383 (27.9)	32 (31.4)	3,000 (19.5)	5,058 (19.1)	8,473 (21.1)
4	2 (0.1)	0 (0.0)	21 (0.1)	42 (0.2)	65 (0.2)
5	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Unknown	8 --	0 --	16 --	0 --	3,066 --
Total	1,380	102	15,375	26,442	43,299

Severity of Extremity Injury	Motorcycle Operator	Motorcycle Passenger	Other Transp. Trauma	Non-Transp. Trauma	Total
Serious Extremity Injury (AIS≥2)	794 (57.9)	33 (32.4)	6,763 (44.0)	10,910 (41.3)	18,500 (42.8)
Severe Extremity Injury (AIS≥3)	385 (28.1)	17 (16.7)	3,021 (19.7)	5,100 (19.3)	8,523 (19.7)
Total *	1,372	102	15,359	26,442	43,275

* Unknown injury cases omitted from totals.

Table E.10. Severity of Extremity Injury by Helmet Use for Motorcyclists on N.C. Trauma Registry, October 1987 - December 1991.

AIS Extremities	Motorcycle Operator			Motorcycle Passenger			All Motorcyclists		
	Helmet	No Helmet	Unk. Helmet	Helmet	No Helmet	Unk. Helmet	Helmet	No Helmet	Unk. Helmet
0	168 (32.7)	108 (53.2)	281 (42.8)	15 (39.5)	6 (40.0)	29 (59.2)	183 (33.2)	114 (52.3)	310 (44.0)
1	8 (1.6)	3 (1.5)	10 (1.5)	1 (2.6)	0 (0.0)	0 (0.0)	9 (1.6)	3 (1.4)	10 (1.4)
2	154 (30.0)	62 (30.5)	193 (29.4)	7 (18.4)	2 (13.3)	10 (20.4)	161 (29.2)	64 (29.4)	203 (28.8)
3	182 (35.5)	30 (14.8)	171 (26.1)	15 (39.5)	7 (46.7)	10 (20.4)	197 (35.8)	37 (17.0)	181 (25.7)
4	1 (0.2)	0 (0.0)	1 (0.2)	0 (0.0)	0 (0.0)	0 (0.0)	1 (0.2)	0 (0.0)	1 (0.1)
5	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)	0 (0.0)
Unknown	0 --	0 --	8 --	0 --	0 --	0 --	0 --	0 --	8 --
Total	513	203	664	38	15	49	551	218	713

Severity of Extremity Injury	Motorcycle Operator			Motorcycle Passenger			All Motorcyclists		
	Helmet	No Helmet	Unk. Helmet	Helmet	No Helmet	Unk. Helmet	Helmet	No Helmet	Unk. Helmet
Serious Head/Neck Injury (AIS≥2)	337 (65.7)	92 (45.3)	365 (55.6)	22 (57.9)	9 (60.0)	20 (40.8)	359 (65.2)	101 (46.3)	385 (54.6)
Severe Head/Neck Injury (AIS≥3)	183 (35.7)	30 (14.8)	172 (26.2)	15 (39.5)	7 (46.7)	10 (20.4)	198 (35.9)	37 (17.0)	182 (25.8)
Total *	513	203	656	38	15	49	551	218	705

* Unknown injury cases omitted from totals.