A STATEWIDE SURVEY OF BICYCLE HELMET USE IN NORTH CAROLINA

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Introduction

With a background theme of a more balanced transportation system, the ISTEA legislation of 1991 has resulted in increased interest in bicycling and bicycling improvements. Many states and communities have taken advantage of the funding opportunities provided by ISTEA to plan and build bicycle facilities. North Carolina has one of the oldest state bicycle programs in the nation and many miles of excellent bicycling routes. However, 1998 figures show that 40 bicyclists were killed and 1,084 others injured in crashes with motor vehicles. Twenty-five percent of those killed and 30 percent of those injured were under 15 years old. These numbers underestimate the overall number of bicyclists injured, since they do not include bicyclists injured in crashes with motor vehicles that were not reported to the police, or those injured in single vehicle bicycle crashes. A 1990 North Carolina study revealed that only 10 percent of bicyclists treated in hospital emergency rooms were reported on state crash files (Stutts, Williamson, Whitley and Sheldon, 1990).

While North Carolina has a mandatory motorcycle helmet law, there is no such law for bicyclists. Many serious head injuries occur at low speeds and are preventable if helmets are worn. However, little is known about how many North Carolina bicyclists are wearing helmets, or who they are.

Rivara et al. (1998) cite six case-control studies of helmet effectiveness that find helmets are effective in preventing head injuries, brain injuries, and severe brain injuries. Bicycle helmets decrease the risk of head injury by 85% and brain injury by 88%. It is further stated that "the protective effect of helmets is present for riders of all ages, and appears to offer as much protection in crashes involving motor vehicles as it does in crashes without motor vehicle involvement. The different styles of helmets available, i.e. hard shell, thin shell, and no shell, appear to be equivalent in their effectiveness." Thompson et al. (1996) report that helmets appear to decrease the risk of injuries to the forehead and mid-face by two-thirds.

Helmets that do not fit improperly or are misused also increase the risk of head injury

(Rivara, et al., 1999). Helmets tipped backward exposing the forehead were associated with a 50% increase in risk of head injury when compared with helmets properly centered. Using another measure of poor helmet fit, it was also found that half of children wearing helmets 2 cm or more wider than their heads had experienced a head injury.

At present 16 states and more than 60 counties and communities have some form of a mandatory bicycle helmet law (Bicycle Helmet Safety Institute web site, 1999). The NC Governor's Highway Safety Commission has recommended mandatory bicycle helmet use by bicyclists under16 years old when traveling on a road or other public vehicular area. Such legislation was introduced in the 1995 session of the North Carolina General Assembly. The 1999 session had considerable debate about a statewide law. A bill was passed by the House of Representatives requiring bicyclists under 13 years of age to wear a helmet. This bill is eligible for consideration during the legislative short session in the spring of 2000. It is expected that the legislation will be enacted in the near future.

The purpose of this project was to gather bicyclist helmet use information for the state of North Carolina that could be used in its efforts to promote helmet use as well as to evaluate the effectiveness of a statewide helmet law if enacted. Ideally, these data would be gathered both before and after a law is implemented. At present no other state in the United States has carried out a statewide helmet survey using statistical sampling procedures to ensure that findings accurately represent the entire state. In 1995 HSRC helped to develop and conduct the only such study done in North America in the Canadian province of British Columbia prior to implementation of their bicycle helmet law (Foss, Beirness, and Wilson, 1996). This study continues North Carolina's progressive approach to transportation safety by providing a scientific basis for legislation as well as the potential to assess its effectiveness

Methods

Sample

To obtain a representative sampling of bicyclists throughout North Carolina a complex sampling plan was developed. To use limited resources efficiently, observing bicyclists' helmet use requires a concentration of bicyclists. Accordingly, we decided to collect helmet use data only in communities with a population of 5,000 or more. Based on 1997 data (NC Office of State Planning, 1998) there were 105 cities/towns in North Carolina with 5,000 or more residents. The state was divided into its three traditional regions - mountain (western), Piedmont (central), and coastal (eastern) - and communities were randomly sampled to represent each region. The plan was to select a sample of 20% of eligible communities and to select these from the regions in proportion to the populations in those regions. Some adjustments were made to this plan to ensure that at least four communities were sampled from each region of the state. Communities were sampled with probability proportionate to size, which means that the largest communities had a greater chance of selection than smaller communities. This procedure ensures that the sample does not overrepresent small towns, which would otherwise be the case.

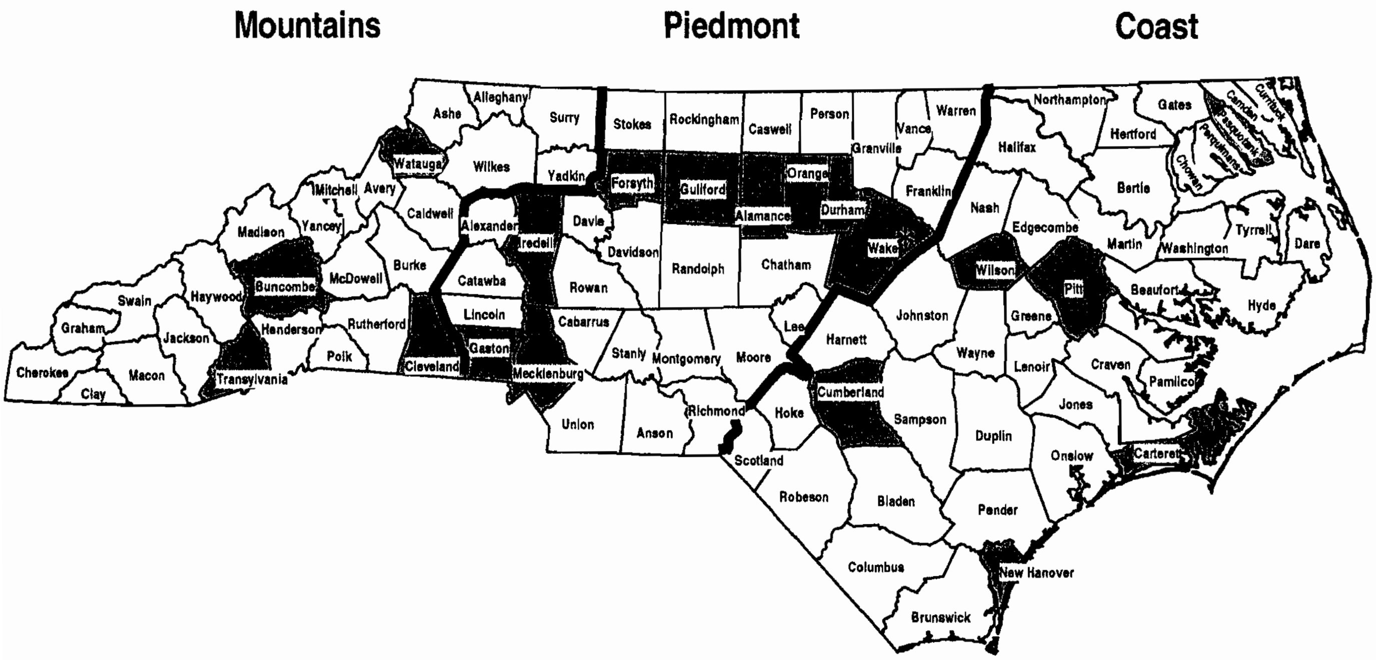
The result was that four, twelve and six communities were selected from the mountain, Piedmont, and coastal regions of the state. Figure 1 shows both the regions and the counties (shaded) containing the sample cities. Table 1 shows the number and percentage of observations within the regions. The mountain region was slightly oversampled (18% of cities vs. 6% of

Table 1. Distribution of observations by region.

Region	Eligible Population	Sampled Cities	Proportion of Sample	Proportion of Observations	Proportion of Observation Time*
Mountain	6%	4	18%	8.6% (n=214)	13.4%
Piedmont	71%	12	55%	63.8% (n=692)	62.8%
Coastal	23%	6	27%	27.7%(n=1,596)	23.8%
Totals	100%	22	100%	100% (n=2,502)	100%

*Roadways only.

eligible population). The Piedmont was somewhat underrepresented (55% of cities vs. 71% of population), and the 6 cities from the coastal region very closely represented the proportion of the population in that region (27% of cities vs. 23% of population). The time spent observing on roadways also closely matched the proportion of observations within the regions.



<u>Mountains</u>
Asheville
Shelby
Boone
Brevard

<u>Piedmont</u>
Charlotte
Raleigh
Greensboro
Winston-Salem
Durham
Cary
Gastonia
Burlington
Statesville
Mint Hill
Graham
Mebane

<u>Coastal</u>
Fayetteville
Wilmington
Greenville
Wilson
Elizabeth City
Morehead City

Figure 1. NC Regions and the Counties (shaded) Containing the Sampled Cities

Data Collection

Obtaining information about a population across a large geographic region, such as a state, represents a challenge. When the population is both mobile and sparsely distributed, as is the case with bicyclists, the challenge becomes more formidable. Collecting data only at locations where bicyclists are concentrated, such as off-road biking locations or in and around a community park, risks having information from a highly unrepresentative sample of the bicycling population. To address this problem we adapted an approach that proved to be workable and useful in an earlier study of bicycle helmet use in the Canadian province of British Columbia (Foss, Beirness and Wilson, 1996). This involves having observers systematically drive a route through randomly sampled areas of a community, recording helmet use for all bicyclists observed. In order to structure this task and to ensure that all types of bicyclists would be observed, two kinds of observation routes were developed in each sampled city: neighborhood routes and "cross-town" collector routes. Besides these locations, data were also collected at greenways and mountain biking trails, as described below.

Neighborhood Routes

It was not possible to cover all areas of larger communities in the time available for this study. To identify areas of communities for observers to tour, we sampled particular neighborhoods and then asked observers to drive every street in the neighborhood looking for bicyclists. Each city was divided into neighborhoods based on the "catchment" or service areas of elementary schools in the community. For communities with fewer than 60,000 residents, two elementary schools were randomly sampled. In larger communities, four schools were sampled to give better geographic representation. For each school we obtained the boundaries of the area served, drew these on a local map, then sent observers to drive the areas. Observers were instructed to drive every street within the selected neighborhoods, spending approximately two hours in each neighborhood.

Collector Routes

In addition to riding within neighborhoods, which may be more characteristic of riding by children, some bicyclists venture out on longer rides. These longer rides may be functional (i.e., commuting to work, school, or a trip to a store) or recreational. Based on previous experience observing bicyclists, as well as discussions with local planners and bicycle coordinators in several NC communities, we believe that bicyclists venturing out of their own neighborhoods are more likely to use routes that are relatively direct routes, but which do not carry heavy automobile traffic. Using the standard roadway functional class designation, these routes would most likely be "collector" roads. We had hoped to obtain community maps with designated collector routes. Unfortunately, this kind of map was not available for most of the sampled communities. Consequently, for many cities we had to develop our own maps.

Using geographic information system (GIS) software, researchers can obtain maps of almost any location in the U.S. We used the U.S. Census Bureau's *Topologically Integrated Geographic Encoding and Referencing (*TIGER*)* system maps, which are more current than U.S. Geological Survey maps (which proved too old to be of any value for this project). Unfortunately, the roadway classification scheme used in the TIGER system did not discriminate between short streets found in local neighborhoods and longer streets that serve as "collector" routes to move traffic between local areas.

We used information in the TIGER data files to create proxies for collector routes by identifying roadways with a specified length (generally greater than one mile but less than three miles). Using the GIS software with the TIGER maps, a special program was written that calculated road length inside the city limits. The map was then displayed, highlighting the road segments that fell within the designated length. The range was adjusted to take into account the difference between small cities and larger cities, with 100,000 populations generally being the break point. By varying the ranges and examining the distribution of selected roads for a given city, a reasonable number of "collectors" could be sampled and used for data collection. The maps and lists of names for the selected roads in each community were printed, transferred to copies of city maps, and given to the data collectors. Observers were instructed to drive every "collector" street shown on the map, spending approximately two hours to cover the route.

Greenways and Mountain Biking Trails

Because considerable bicycling takes place on greenways and mountain biking trails, it was important to collect data at these locations as well. Conversations with local planners, bicycle coordinators, and bicycle shop owners were used to identify these facilities for the cities in the sample. Some communities, particularly in the coastal section, had no such facilities. Larger cities, such as Charlotte, Raleigh, Greensboro, and Winston-Salem, had a variety of greenways and trails. We limited the number of greenways and trails to four for any city in the sample. Observers were instructed to collect data for approximately two hours at each greenway and mountain biking location.

Data Collected

A data form was developed based on the earlier British Columbia project. The form is presented in Appendix A. For each bicyclist observed, each of the following was recorded:

- Helmet use - yes, no, or misused
- Estimated age - 0-5, 6-13, 14-18, 19-30, 31-50, and 51+
- Bicyclist gender - male, female
- Bicycle type - mountain, road, child's, or other bike
- Use of bicycling gloves - yes, no
- Use of back pack - yes, no

Data collectors were trained to use the comment portion of the form to write in various kinds of information, such as whether the bicyclist was in an off-street area (e.g., driveway, parking lot); whether equipment such as a basket, saddlebag, or child seat was present; and the way the helmet was misused (e.g., loose/too big, chin strap unhooked). Besides these items for observed bicyclists, other logistical data such as date, site identification number and name, observer, beginning and ending time, weather, and temperature, were entered on a cover sheet for each location.

For each city in the sample, data were collected for approximately two hours on "collector" streets, in each of the sampled elementary school-based neighborhoods, and at the selected greenways and mountain biking trails on both a weekday and a weekend day. Depending on the number of sites to be covered in any given city, times of data collection were usually from 11 a.m. to 8 p.m. during the week and 9 a.m. to 6 p.m. on weekends. Data collection lasted from late-May to mid-August, 1999.

To avoid any bias in sampling, every cyclist observed by the data collectors was to be included. In those rare instances where the number of cyclists to be observed was large (e.g., at a busy greenway), data were recorded first on helmet use, and then on all other items, with priority given to gender, age, and bike type. This procedure maximized the number of observations for the primary item of interest - helmet use.

Data Collector Training

The project data collectors were comprised of HSRC staff and two other two-person teams. One team covered Charlotte and nearby cities, and the other team covered Asheville and Brevard in the mountains. HSRC staff collected data in all other cities. Training took place during a day-long session in Chapel Hill in late May, and data collection began shortly thereafter. Prior to training, observers were provided with a detailed training manual which explained the study and procedures to be followed. Training included a detailed explanation of data collection procedures, making accurate judgments, and locating the observation sites. The last part of training was supervised practice in driving "collector" and neighborhood routes and actually filling out data collection forms.

As part of the training, data collectors were asked to view a videotape of approaching bicyclists gathered as part of another bicycling research project, and to fill out the data collection form as they would normally. This allowed an examination of interobserver reliability. Kappa statistics based on the ratings showed excellent agreement for bicyclist helmet use, gender, bicycle type, and accessories, and moderate agreement on age group. Nonetheless, interobserver agreement on age was still in excess of 68 %. Age was somewhat difficult to estimate from the videotape, in that the bicyclist was viewed in the oncoming direction, and a close-up view of the face was of short duration. Estimating age was much easier in the field, where a longer time duration and better view of the cyclist's face were generally available.

Results

Statewide Helmet Use Sample

A total of 2,448 bicyclists was observed in the 22 sampled cities. Figure 2 shows the characteristics of the sample.

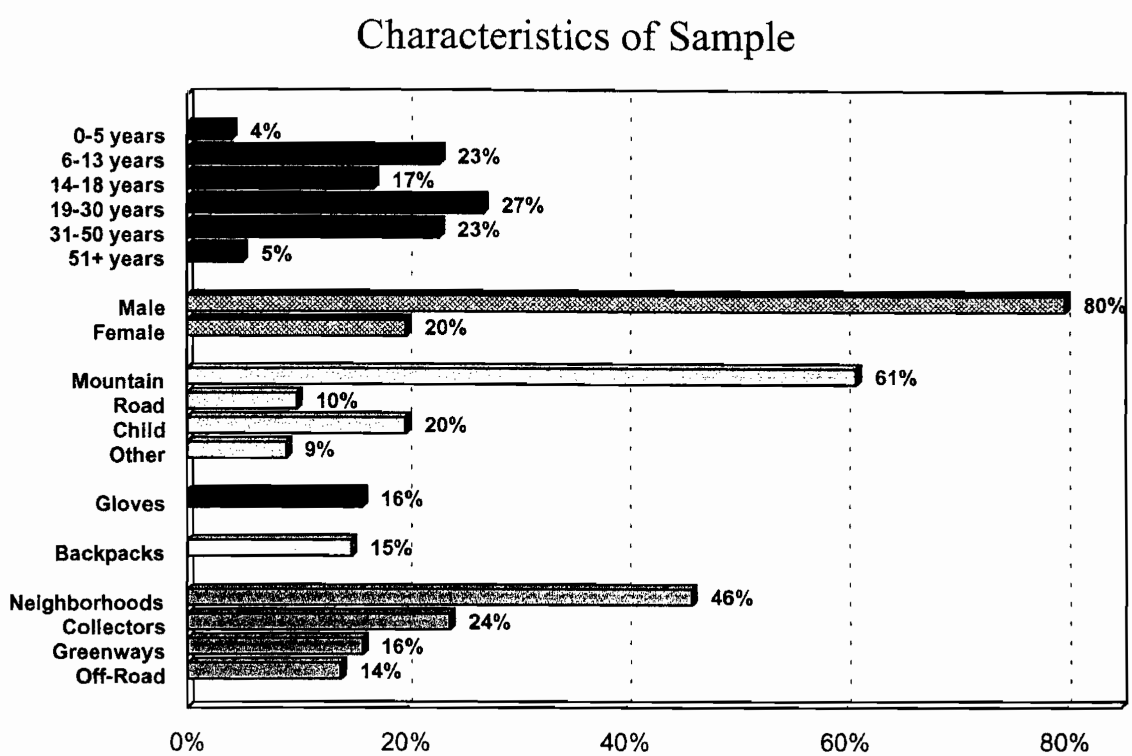


Figure 2. Sample Characteristics

Highlights include:

- Ages of the cyclists were fairly evenly split into groups between the ages of 6 to 50.
- Male cyclists made up nearly 80% of the total.
- Slightly more than 60% of the bicycles were mountain bikes.
- Bicycling gloves were worn by 16% of the cyclists and backpacks by 15%.

- 46% of the cyclists were observed in neighborhoods, 24% on collector streets, 16% on greenways, and 14% on mountain biking trails.
- Slightly more than half of the observations were collected on weekends.

In the results that follow, chi-square statistics were used to test the association between helmet use and other observed variables.

Helmet Use by Type of Data Collection Site

Helmet use varies substantially by the type of site where data were collected (see Table 2). Using unweighted data, helmet use rates were highest on mountain biking trails (80%) and greenways (37%), and lower on collector (22%) and neighborhood (13%) streets. Misuse was greatest on greenways but varied only slightly across type of site.

Table 2. Helmet use by type of site.

Type of site	Helmet Used	Helmet Not Used	Helmet Misused	Total
Collector streets	129 (21.8%)	445 (75.2%)	18 (3.0%)	592
Neighborhoods	146 (13.1%)	941 (84.3%)	29 (2.6%)	1116
Greenways	149 (36.9%)	235 (58.2%)	20 (5.0%)	404
Mountain biking trails	270 (80.4%)	54 (16.1%)	12 (3.6%)	336
Total	694 (28.4%)	1675 (68.4%)	79 (3.2%)	2448

The 95% confidence intervals for **correct** and **overall** (which combines misuse with correct use) use rates by type of site are:

	Correct Use	Overall Use
• Collector streets	18-25%	21-28%
• Neighborhoods	11-15%	14-18%
• Greenways	32-42%	37-47%
• Mountain biking trails	76-84%	80-88%

Statewide Helmet Use Rate

The probability sample for this data collection focused on collector and neighborhood streets. It is thus appropriate to report a statewide helmet use rate only for data associated with these types of sites. With the data for collector and neighborhood streets equally weighted, the statewide helmet use rate was 17% +/- 4% for **correct use** and 20% +/- 4.5% for **overall use** with 95% confidence intervals.

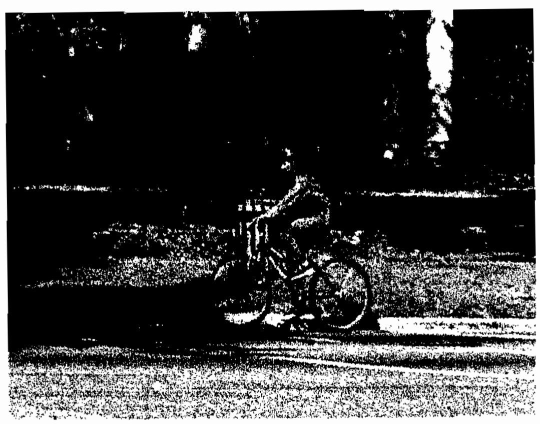
Helmet Use by Region of the State

Helmet use rates for the three regions of the state were also calculated using the data from collector and neighborhood streets. These data are region-specific and thus unweighted. The percent and 95% confidence intervals for correct and overall use rates by region are:

	Correct Use	Overall Use
• Coastal	6% +/- 4.5%	8% +/- 5%
• Mountains	42% +/- 20%	50% +/- 20%
• Piedmont	21% +/- 6%	24% +/- 6%

Helmet use varies significantly by region of the state ($p<.001$). The helmet use rate was high in the mountains due to a combination of factors. The majority of observations were taken from Asheville and Boone. In addition, Asheville is considered to be a progressive pedestrian/bicycling city, and Boone has a helmet ordinance that applies to all ages. Thus, helmet use was higher than the norm in these two locations. The wide confidence intervals for the mountain region are due to small sample size.

Association of Helmet Use with Other Variables



Several other variables were examined to determine if there was an association with helmet use. These data were weighted to adjust for regional over- and under-sampling.

Gender of bicyclist - Across the full sample, helmet use was not related to gender of the cyclist.

However, among those observed on collector routes (Figure 3), females were more likely than males to be wearing a helmet (38% vs. 23%; $p < .01$). At off-road locations, the reverse was true, and males were more likely than females to be wearing a helmet (86% vs. 71%; $p < .01$). On greenways and local (neighborhood) streets, there was no significant difference in helmet use between males and females.

<u>Age of bicyclist</u> - Across the full sample, helmet use varied significantly ($p<.001$) by age of the cyclist, as presented below:

- Age 0-5 31%
- Age 6-13 16%
- Age 14-18 9%
- Age 19-30 45%
- Age 31-50 48%
- Age 51+ 34%

Helmet use was generally higher for cyclists older than 18 years, as well as for children 0-5 years old. The lowest use rate was 9% for cyclists age 14-18.

Several other significance tests were performed:

- Combined helmet use for the 6-13 and 14-18 age groups was significantly lower than the helmet use for all other age groups combined ($p<.001$).
- Helmet use for the 51+ age group was significantly lower than the helmet use for the combined 19-30 and 31-50 age groups ($p<.02$).

Helmet use differed by age group at each of the four types of sites ($p<.001$) (Figure 4). The pattern by type of site was similar to that for the full sample shown above with the exception of off-road sites.

<u>Type of bicycle</u> - Across the full sample, helmet use was highest for cyclists using road bikes (54%) and mountain bikes (37%) and lowest for those on "other" (9%) and child bikes (16%) ($p<.001$). Figure 5 shows the relationship between helmet use and bike type for each type of site. Although helmet use varies by type of bike and site, it is always highest among those on

Figure 3. Helmet Use by Gender and Observation Site Type

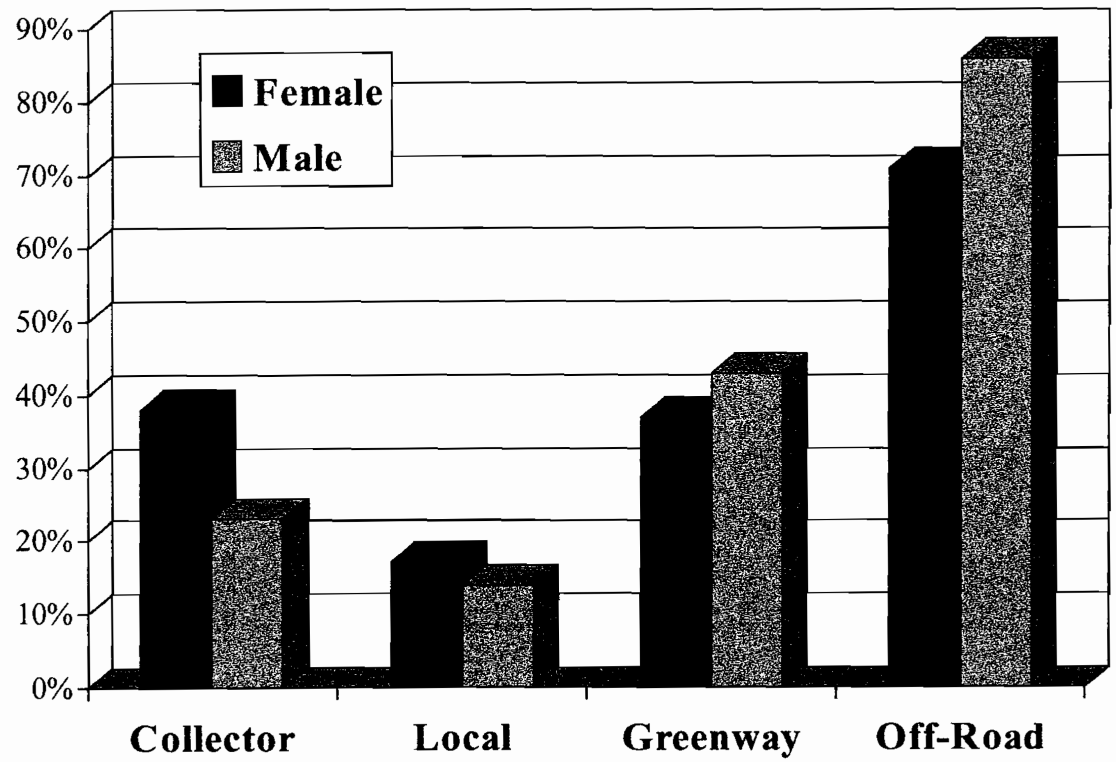


Figure 4. Helmet Use by Age and Observation Site Type

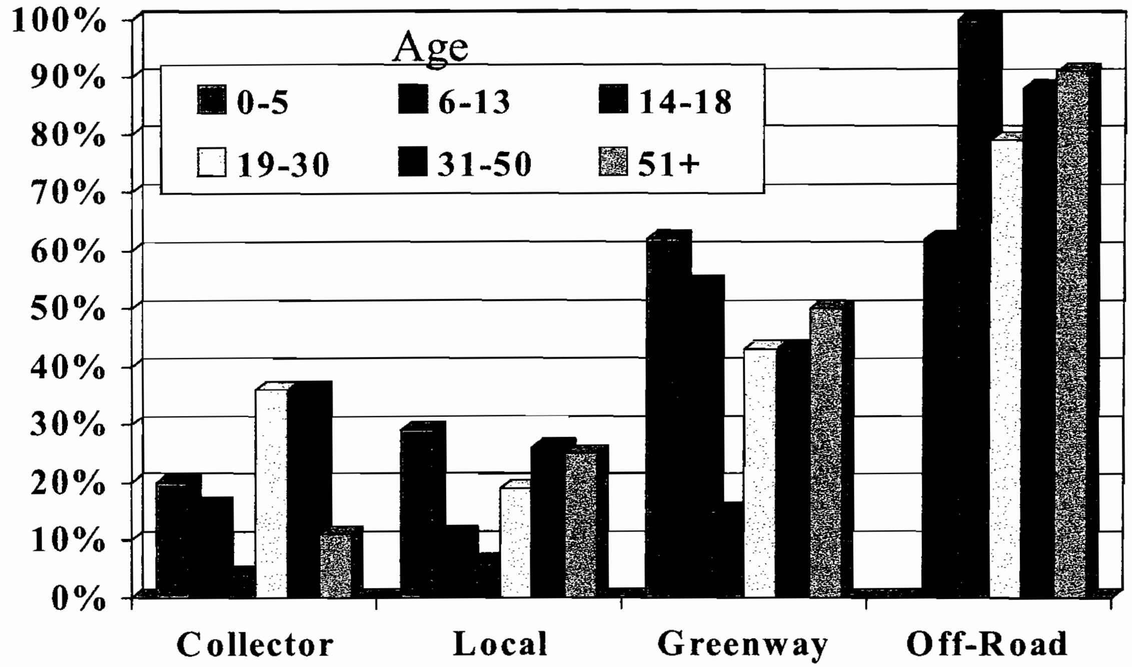
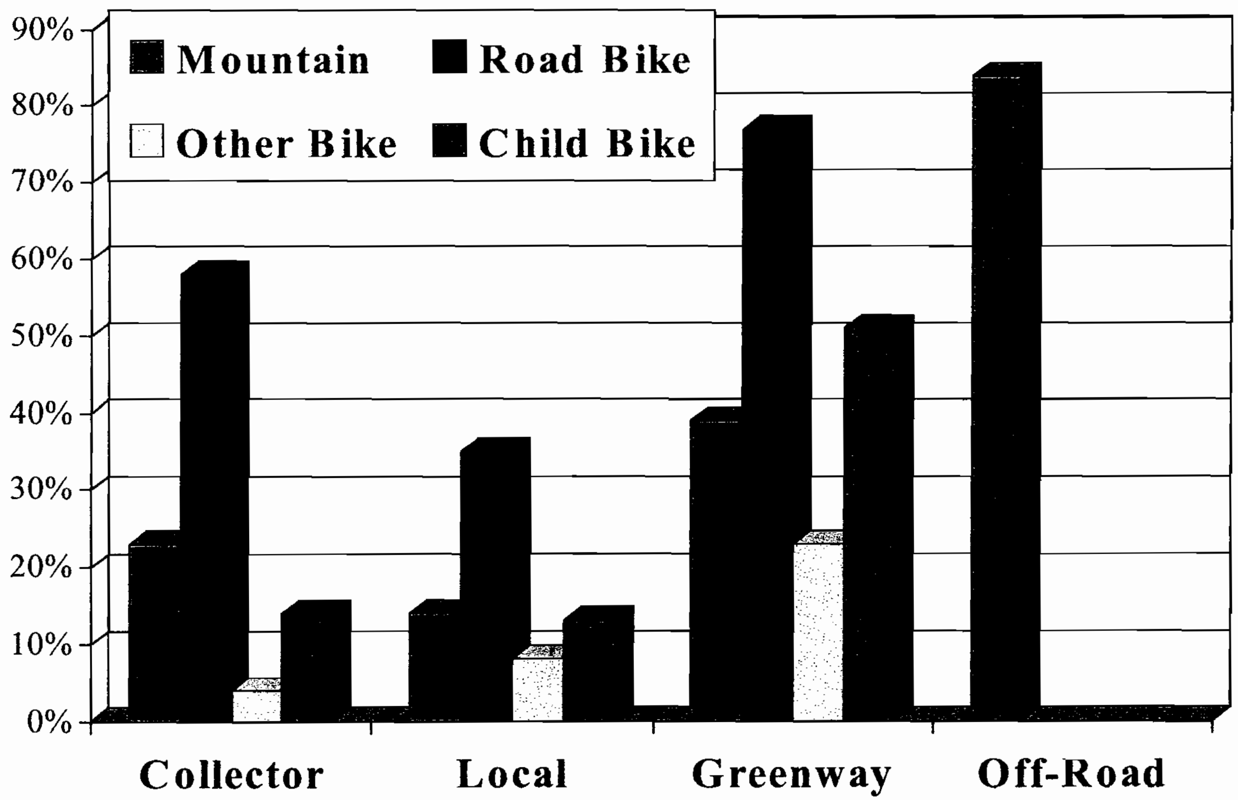


Figure 5. Helmet Use by Bike Type and Observation Site Type



road bikes, followed by mountain bikes, then child bikes and other bikes. Because of very low numbers of road, child, and other bikes at off-road trails, helmet use only for mountain bikes is presented in Figure 5.

Presence of bicycling gloves - Helmet use across the full sample was much more likely when bicycling gloves were present, likely indicating an increased seriousness about bicycling. More than 92% of the cyclists wearing gloves were using helmets ($p<.001$). This same pattern held across all types of sites (Figure 6), although the difference was less pronounced on greenways and off-road trails.

Presence of a backpack - Helmet use across the full sample was also much more likely when a backpack was present, although to a lesser extent than for gloves. More than 60% of the cyclists wearing a backpack were using helmets ($p<.001$). This pattern also held across all types of sites (Figure 7).

Presence of gloves and/or backpack - As would be expected from the above, helmet use was also associated with an index of bicycling "seriousness" with values ranging from 0 (no gloves or backpack) to 2 (both gloves and backpack present) ($p<.001$). Excluding children under age 13, for whom these items are less of an issue, does not change the basic finding. Almost 18% of cyclists with neither gloves or backpack were wearing a helmet, compared to 63% of those with one of the pieces of equipment, and 98% for those with both gloves and backpack. The same pattern held across all types of sites (Figure 8).

Weekday versus weekend - Across the full sample, helmet use was significantly greater ($p<.001$) on weekends (36%) than weekdays (28%). This was also true by type of site (Figure 9), with the exception of greenways, where helmet use was significantly greater ($p<.05$) on weekdays (47%) compared with weekends (37%).

Statewide Helmet Misuse

Helmet misuse was examined *only* among those wearing a helmet, since one cannot misuse a helmet that is not worn. Thus, a series of conditional associations were examined.

Figure 6. Helmet Use by Gloves and Observation Site Type

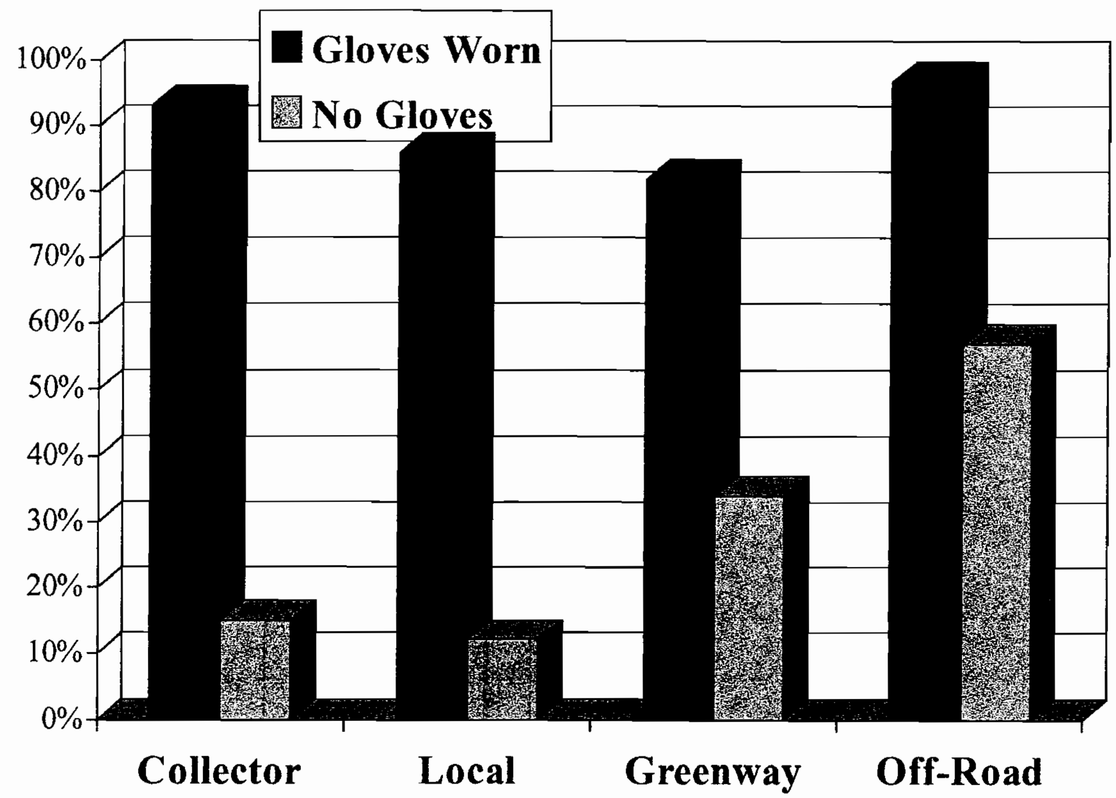


Figure 7. Helmet Use by Backpack and Observation Site Type

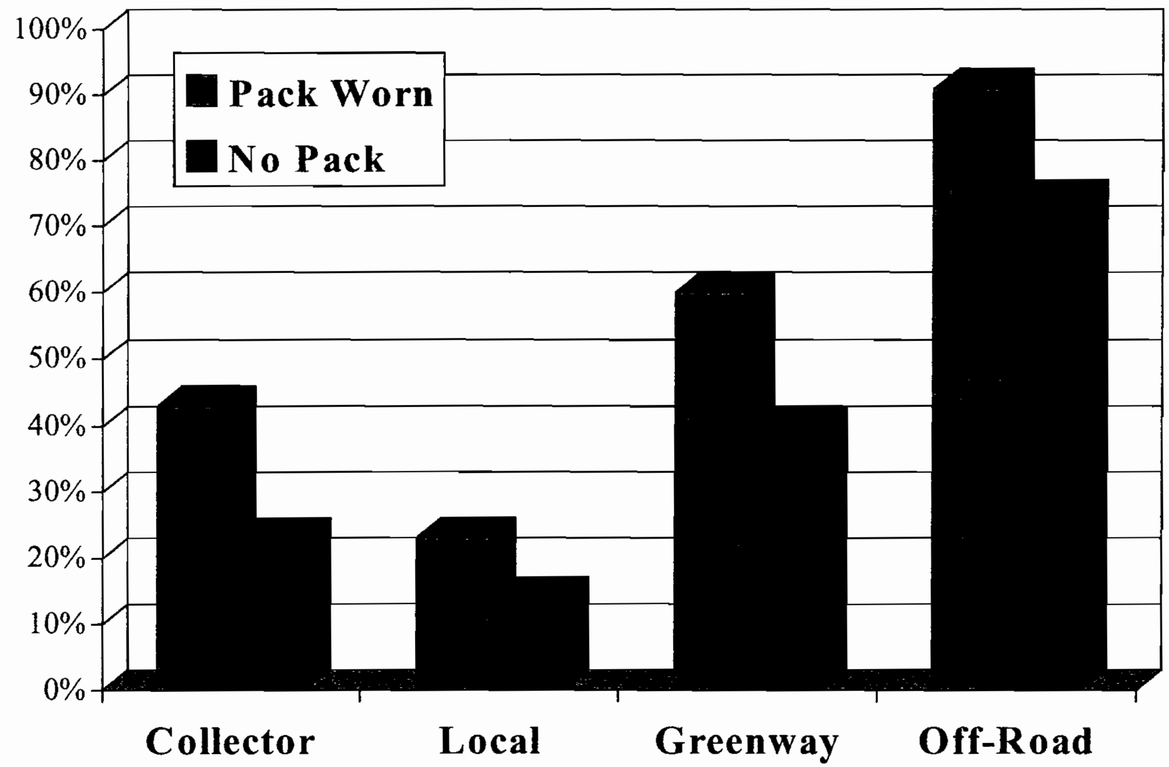


Figure 8. Helmet Use by Seriousness Index and Observation Site Type

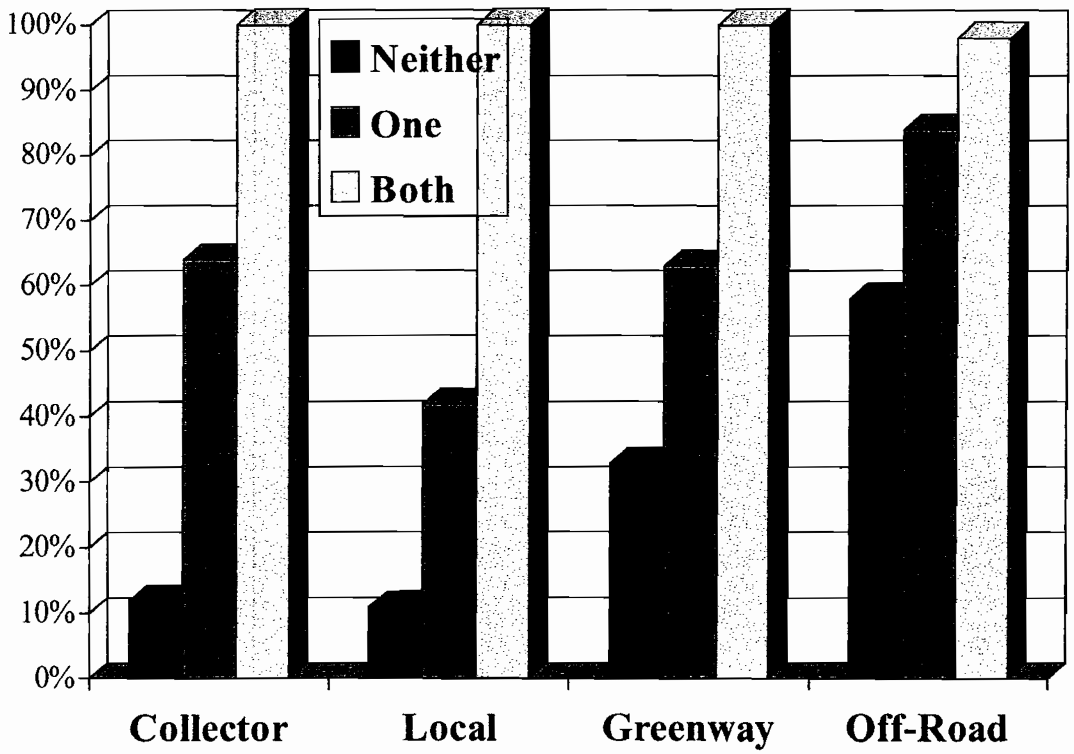
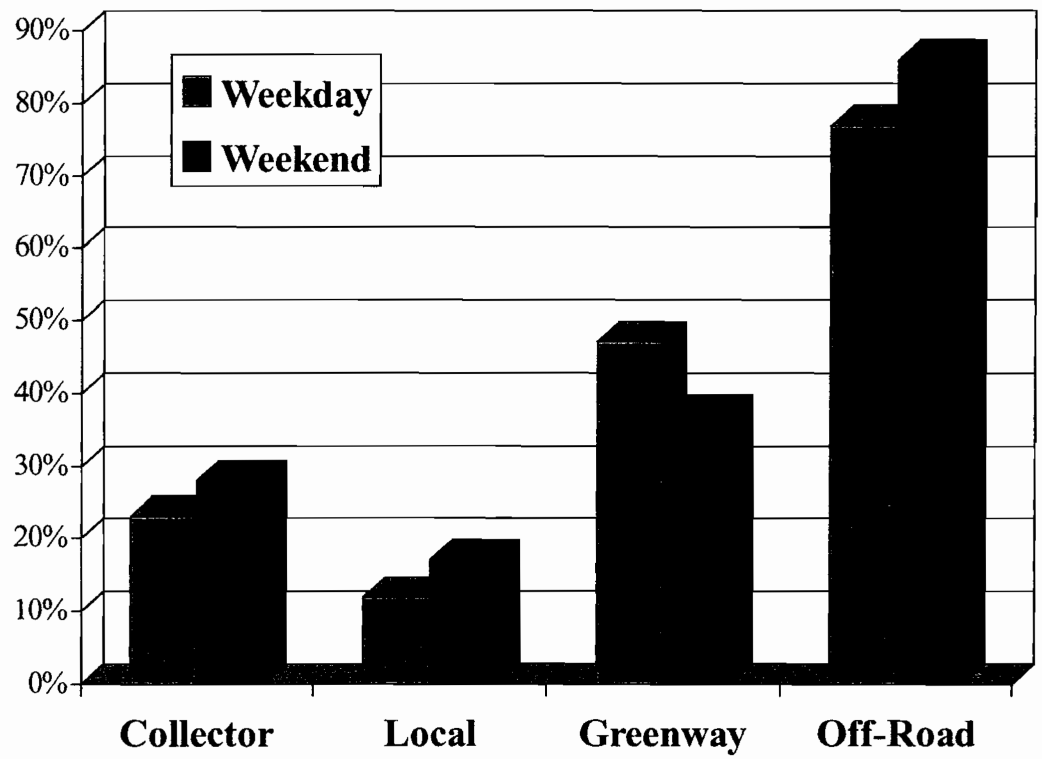


Figure 9. Helmet Use by Time of Week and Observation Site Type



Given that a helmet is worn, the relationship between misuse and bicyclist gender and age, bike type, type of site, etc. was explored. Of the 773 cyclists wearing a helmet, 79 (10%) exhibited some form of misuse.

Types of helmet misuse - When it could be observed, type of misuse was coded by data collectors as helmet being loose/too big, tipped back exposing the forehead, chin strap unhooked, or wearing a hat underneath the helmet. There were quite a few missing observations as data collectors tended to forget to record the type of misuse. For the 32 cases where this information was recorded, frequency and percent of misuse was:

Category	Frequency	Percent
Loose/too big	11	34
Tipped back exposing forehead	16	50
chin strap unhooked	1	3
Hat underneath helmet	4	13
Total (excluding missing)	32	100

*Note: Misuse category was not available for 47 cases.

Thus, the vast majority of misuse was associated with wearing an improperly fitted helmet or wearing the helmet tipped back to expose the forehead. It is likely that much of the "exposed forehead" misuse is also due to an improperly fitted helmet.

Conditional associations of misuse with other variables - Highlights of these analyses are presented below:

- Among those wearing a helmet, misuse was 9% in the Piedmont, 13% in the mountains, and 18% in the coastal region ($p<.06$).
- The percent of misuse was 12% on collector streets, 17% on neighborhood routes, 12% on greenways, and 4% on off-road trails ($p<.001$).
- Females (16%) had significantly more misuse than males (8%) ($p<.01$).
- Misuse generally declined with age, although it increased slightly in the oldest age group ($p<.001$):

Age Group	Percent of Misuse
0-5	32%
6-13	25%
14-18	18%
19-30	5%
31-50	7%
51+	12%

- Misuse was significantly associated with type of bicycle (p<.001), with misuse for cyclists on road bikes at 2%, mountain bikes 8%, child bikes 31%, and other bikes 30%.
- Misuse was significantly lower (p<.001) for cyclists wearing gloves (4%) than for those with no gloves (16%).
- Misuse was significantly lower (p<.001) for cyclists wearing a backpack (3%) than for those with no backpack (13%).
- Misuse was significantly associated (p<.001) with the "seriousness" index with misuse at 1% for cyclists with both gloves and backpack, 6% with one of the pieces of equipment, and 18% for those cyclists with neither.
- Misuse was not associated with weekday versus weekend riding.

Discussion

Helmet Use

The central finding of this study is that most bicyclists riding in NC do not wear a bicycle helmet. Using data collected at "collector" and neighborhood streets, the statewide **correct helmet use rate** was 17% (+/- 4%), while the **overall helmet use rate** (which includes instances of misuse) was 20% (+/- 4.5%). In addition, there was considerable variation in helmet use depending on the type of site at which the bicyclist was observed. The overall helmet use rate was lowest in neighborhoods (13%), followed by collector streets (22%), greenways (37%), and mountain biking trails (80%).

Helmet use was also related to the characteristics of the observed cyclists. For example, across the full sample, the lowest helmet use rate was 9% for the 14-18 age group. The use rate was generally higher for cyclists older than 18 years, as well as for children 0-5 years old. This same finding held on collector and neighborhood streets. On greenways, helmet use was higher for cyclists in age groups 0-5 and 6-13, while on mountain biking trails helmet use was greater than 60% for all age groups but greater than 90% for the age groups 31-50 and 51+. Although there was no difference between male and female use across the full sample, females were more likely than males to be wearing a helmet on collector streets (38% vs. 23%), while males were more likely to be wearing a helmet at off-road mountain biking trails (86% vs. 71%).

Further results show greater helmet use among cyclists who treat bicycling as a serious activity. This is reflected in higher use rates for riders of road bikes, and for those who use gloves and/or a backpack when bicycling. Nearly every bicyclist (98%) who was observed with both gloves and a backpack was wearing a helmet.

Helmet Misuse

Some 10% of the bicyclists who were observed wearing a helmet were misusing the device. The vast majority of misuse resulted from wearing an improperly fitted helmet (usually too loose or too big) or wearing the helmet tipped back so as to expose the forehead. Misuse was also greatest on neighborhood streets, among females, and among the youngest age groups. A related age effect shows misuse to be highest on child and "other" bikes. And as would be expected, misuse was significantly less likely among riders using gloves and/or a backpack.

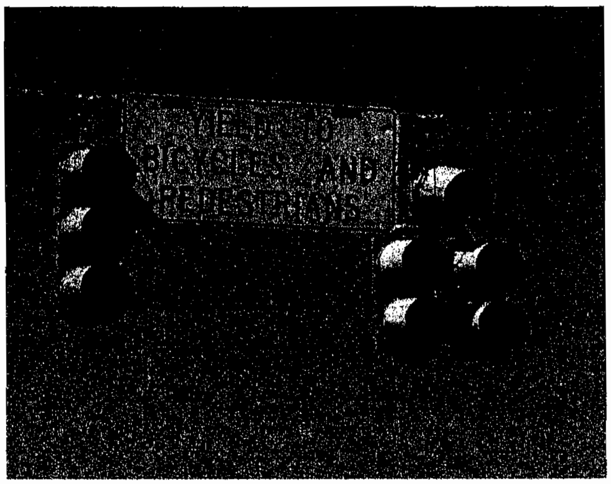
Target Groups

There appear to be several potential target groups for helmet campaigns. One would be **less serious cyclists**, who tend to ride in neighborhoods. Helmet use was lowest on neighborhood streets. Another target group would appear to be **school-aged children**, particularly those aged 14-18, who have not only the lowest use rate but also a high misuse rate. Many statewide helmet laws are crafted with the purpose of protecting young children, but adolescent riders need protection as well. In addition, cyclists of all ages could benefit from knowledge about wearing a helmet properly.

Yet another target group would be **lower socioeconomic status riders** who use a bicycle for basic transportation. These cyclists were usually observed in the inner city areas, and their helmet use was exceedingly low. Even with a statewide helmet law in effect, increasing helmet use among this group may be a difficult proposition. Helmet giveaways or low-cost sales, coupled with education and enforcement campaigns, would likely be necessary to increase use markedly in this population.

The Future

It appears that NC is well on the way to passing a statewide helmet law. The pre-law use rate is similar to the rates observed in other states and counties in the United States. There is certainly potential for increasing helmet use substantially. Victoria, Australia had a helmet use rate of 6% in 1983 and increased the rate to 36% in 1990 through a massive campaign that included education, mass media publicity, support by professional associations and community groups, involvement of bicycling groups, and a $10 government rebate for a helmet purchase. After helmet legislation was introduced in 1990, the helmet use rate increased from 36% to 73% (Centers for Disease Control and Prevention, 1995).



This use rate increase is similar to that seen for motor vehicle occupant restraints in the United States after the introduction of belt use laws by many of the states. Similar to seat belt use, there is probably a "critical mass" that must be reached before bicycle helmet use approaches the level of occupant restraint use, and mandatory use legislation is one way of moving toward this threshold. If NC enacts a helmet use law, follow-up observational surveys will be necessary to monitor the effect of the legislation.

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APPENDIX A

Data Collection Form

NC Bicycle Helmet Use Observation Form

Observer ________ Site ID ________ Site Location ____________________ Page ____ OF ____

Case	A. Helmet Use	B. Age Group	C. Bicyclist Sex	D. Bicycle Type	E. Accessories		F. Comments
	Y / N / M	(1 - 6)	M / F	(M / R / O / C)	Gloves	Back pack	
1	+ – M		M F	M R O C	+ –	+ –	
2	+ – M		M F	M R O C	+ –	+ –	
3	+ – M		M F	M R O C	+ –	+ –	
4	+ – M		M F	M R O C	+ –	+ –	
5	+ – M		M F	M R O C	+ –	+ –	
6	+ – M		M F	M R O C	+ –	+ –	
7	+ – M		M F	M R O C	+ –	+ –	
8	+ – M		M F	M R O C	+ –	+ –	
9	+ – M		M F	M R O C	+ –	+ –	
10	+ – M		M F	M R O C	+ –	+ –	
11	+ – M		M F	M R O C	+ –	+ –	
12	+ – M		M F	M R O C	+ –	+ –	
13	+ – M		M F	M R O C	+ –	+ –	
14	+ – M		M F	M R O C	+ –	+ –	
15	+ – M		M F	M R O C	+ –	+ –	
16	+ – M		M F	M R O C	+ –	+ –	
17	+ – M		M F	M R O C	+ –	+ –	
18	+ – M		M F	M R O C	+ –	+ –	
19	+ – M		M F	M R O C	+ –	+ –	
20	+ – M		M F	M R O C	+ –	+ –	

Misuse = Loose; Unhooked; Tipped back exposing forehead

Bike Type:
M = Mountain (straight bars; fat tires)
R = Road (curved bars; narrow tires)
O = Other adult
C = Child's (small wheels)

Age Groups:
1 = 0-5
2 = 6-13
3 = 14-18
4 = 19-30
5 = 31-50
6 = 5[illegible]

APPENDIX B

Helmet Use Rates for Cities in the Sample

Helmet Use in Sampled Communities

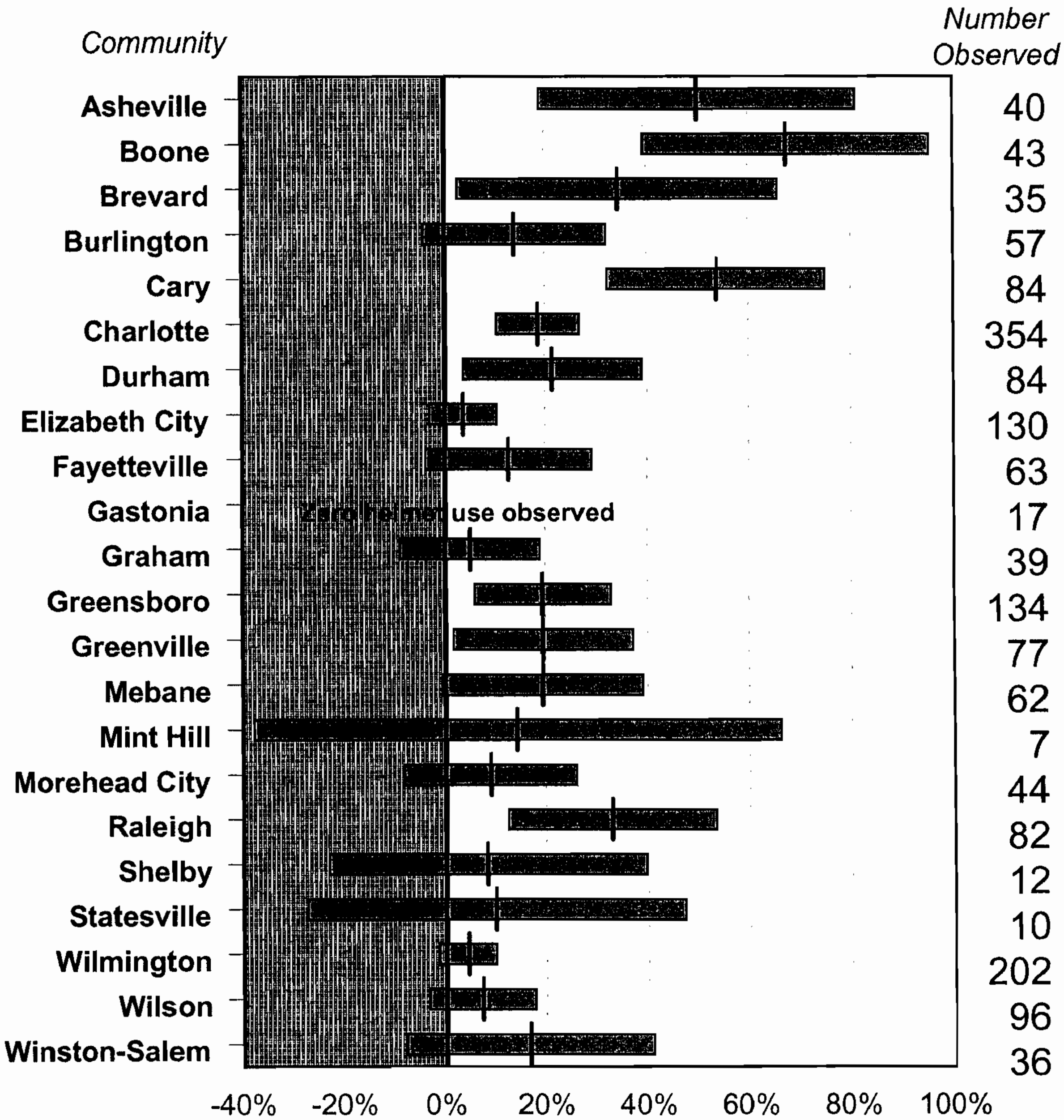
The sample for this study was designed to obtain an accurate representation of the variety of bicycling that occurs throughout North Carolina, rather than in the individual communities visited. As a result, the data collected within individual communities may not be a good representation of bicycling in those communities. There are two reasons for this. First, in most of the communities, we did not see a large enough number of bicyclists to be able to make confident estimates of helmet use in the individual community. Second, the areas of the community where we spent time observing bicyclists may not be a good representation of the community as a whole.

In order to provide a reliable and valid estimate of helmet use within a community, it is desirable to have at least 100 observations that have been obtained from at least 10 randomly selected areas of the community. The data we obtained from most cities do not meet these criteria. Consequently, the estimates of helmet used provided below should be taken with great caution.

Figure B1 presents the 95% confidence interval for helmet use in each of the communities where data were collected, as well as the number of cyclists observed. These data exclude greenways and off-road data, since many communities did not have these kinds of riding locations. This interval gives the range within which we can be 95% sure the true bicycle helmet use rate falls. For many communities, this range is extremely wide, reflecting the fact that we obtained small numbers of observations in those communities. For example, in Brevard, where only 37 bicyclists were observed riding on community streets, helmet use is somewhere between 3% and 66%. By contrast, in Greensboro where 137 bicyclists were observed we can be sure that the helmet use rate falls within a much smaller range, from 6% to 33%.

Figure B1

95% Confidence Intervals for Helmet Use in Cities Where Observations Were Conducted



Note. Vertical line indicates observed use. Horizontal bar indicates range within which true use rate is likely to fall. Although helmet use less than 0% is not possible, confidence intervals are symmetric. Since many are wide, and use rates are low, several of these extend to negative values.