HSIS
HIGHWAY SAFETY INFORMATION SYSTEM

SUMMARY REPORT

Factors Contributing to Pedestrian and Bicycle Crashes on Rural Highways

Approximately 25 percent of nationwide pedestrian and bicycle fatal and injury accidents occur on rural highways. In contrast to urban highways, rural highways have certain characteristics that can be more hazardous to pedestrians and bicyclists, such as higher average vehicle speeds and a lack of sidewalk provisions. Limited research has been conducted on rural highways, where crash types have been defined with more detailed coding than exists on standard police forms and where crash data could be linked with roadway characteristics and traffic counts.

The goals of this study were to examine the differences between pedestrian and bicycle crashes in urban and rural settings in North Carolina and to identify problem areas (specific crash types and crash locations) on rural highways that are of high priority for safety treatment and treatment development.

Background

A 1996 study analyzed 5,000 pedestrian and 3,000 bicycle-vehicle crashes from five States.[1] This study used a crash-typing method developed by the National Highway Transportation Safety Administration to refine and update crash type distributions. The most common crash types were midblock dart/dash, other midblock, intersection-related, and vehicle turn/merge. The majority of bicycle-vehicle collisions occurred when the parties were crossing paths, and they were usually due to a failure to yield. The most common crossing-path crash types were drivers failing to yield, bicyclists failing to yield at an intersection, and bicyclists failing to yield midblock.

A recent review by Campbell, Zegeer, Huang, and Cynecki considered over 200 studies pertaining to pedestrian safety.[2] They found that while pedestrian crashes predominantly occur in urban areas, pedestrian crashes in rural areas more often lead to pedestrian deaths, possibly due to higher vehicle speeds. Pedestrian groups that were overrepresented were young pedestrians, pedestrians who had consumed alcohol, and older pedestrians. The most common crash types were dart-outs, intersection dashes, and turning-vehicle collisions.

Other studies of rural pedestrian crashes found that vehicle type, alcohol involvement, pedestrian age, weather, light conditions, nonintersection location, road curve and grade, and surrounding development type were all prominent characteristics in crash injury and frequency.[3–5]

While the previously mentioned studies examined the general characteristics of rural crashes, there is a need to investigate more detailed crash types and characteristics of rural pedestrian and bicycle crashes to determine potential treatments. This study explored these issues and addressed the role of countermeasures in rural environments.

The Highway Safety Information System (HSIS) is a multi-State safety database that contains crash, roadway inventory, and traffic volume data for a select group of States. The current participating States—California, Illinois, Maine, Minnesota, North Carolina, Ohio, and Washington—were selected based on the quality of their data, the range of data available, and their ability to merge the data from the various files. The HSIS is used by FHWA staff, contractors, university researchers, and others to study current highway safety issues, direct research efforts, and evaluate the effectiveness of accident countermeasures.

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Data

This study used data from pedestrian and bicyclist crashes in North Carolina and linked them with roadway data from the Highway Safety Information System (HSIS).[6] A subset of the North Carolina crash data were linked to urban and medium-to-high volume rural roadway data in HSIS to provide the dataset used in this study, which spans from 1997 to 2002. The data comprise 1,849 total bicycle-vehicle crashes (52 percent rural crashes and 48 percent urban crashes) and 3,598 pedestrian-vehicle crashes (54 percent rural crashes and 46 percent urban crashes).

General Comparison of Rural and Urban Crashes

The first objective of the study was to compare general descriptive statistics of rural versus urban crashes. This general comparison is useful for indicating which factors are common to both localities as well as which factors are over-represented in a rural environment. The rural to urban crash comparison can be found in table 1.

The most common crash types for bicyclists differed in rural and urban areas. The most common rural crashes included bicyclists turning/merging into the path of the driver and drivers overtaking the bicyclist. The most common urban crashes included drivers failing to yield, bicyclists failing to yield midblock, and bicyclists failing to yield at the intersection. One noticeable difference is that common rural crash types generally occurred at midblock segments, while urban crash types generally occurred at intersections. Both rural and urban areas had the same top four most common pedestrian crash types: (1) pedestrians walking along the roadway, (2) pedestrians failing to yield, (3) miscellaneous, and (4) pedestrians darting/dashing midblock. Similar to the comparison of bicycle crash types, the most common rural pedestrian crash type (pedestrians walking along the roadway) was more common at midblock segments, whereas the most common urban crash type (pedestrians failing to yield) was mostly found at intersections.

Table 1. General comparison of rural and urban crashes.

CRASH FACTORS	CRASH TYPE	PERCENT OF CRASHES	
		RURAL	URBAN
Resulted in fatality	Pedestrian	18	10
	Bicyclist	6	2
Pedestrian or bicyclist alcohol involvement	Pedestrian	24	19
	Bicyclist	8	6
Vehicle speed 41–60 mi/h	Pedestrian	46	20
	Bicyclist	47	9
Road speed limit 50 mi/h or higher	Pedestrian	57	11
	Bicyclist	54	3
Intersection-related	Pedestrian	18	39
	Bicyclist	23	48
Occurred on road with unpaved shoulders	Pedestrian	71	18
	Bicyclist	80	20
Occurred in daylight	Pedestrian	41	54
	Bicyclist	66	73

Exploration of Factors in Rural Crashes

The second objective of this study was to identify specific crash types and crash locations on rural highways that are of high priority for safety treatment and treatment development. This section examines rural crashes according to road class and crash type to identify problem areas. It also examines prominent characteristics of those problem areas.

Analysis of Rural Crashes by Road Class

Given the availability of roadway inventory data in HSIS, it was possible to examine rural pedestrian and bicycle crashes with respect to characteristics of the roads where they occurred. The roadway-miles and vehicle-miles in table 2 and table 3 are a statewide reflection and do not simply represent roads where crashes occurred.

Roads in rural areas were divided into classes according to number of lanes, level of access control, and other characteristics. It should be noted that 94 percent of North Carolina State-owned roads are rural two-lane roads.

For bicycle crashes, crash frequency and crashes per vehicle-mile indicate that rural two-lane roads had the highest number of crashes, even after vehicle exposure was accounted for. The crashes per roadway-miles indicate that rural multilane undivided nonfreeways would be the most cost-effective roadway class to treat on a per-mile basis.

For pedestrian crashes, crash frequency indicates that rural two-lane roads had the highest number of crashes. Crashes per roadway-mile indicate that rural multilane undivided nonfreeways would be the most cost-effective roadway class to treat on a per-mile basis. Crashes per vehicle-mile indicate that rural two-lane roads and rural multilane undivided nonfreeways had the highest number of crashes.

Overall, the rural two-lane roads class had the greatest need for safety improvements due to the large number and rate of crashes that occurred on these roads. While it is true that it would be costly to treat the extensive mileage of rural two-lane roads, funds for safety research and treatment development would be better spent if focused on this roadway class, and the treatments could be targeted to certain locations or segments within this class.

The lack of pedestrian and bicyclist volume data prevents researchers from knowing whether the crashes are distributed evenly in accordance with where people walk and ride or if they are disproportionately represented on certain road classes. However, given the available data on crashes and vehicle volumes, the North Carolina data indicate that treatments for rural pedestrian and bicycle crashes should focus on two-lane roads.

Table 2. Rural bicycle crashes by road class.

RURAL ROADWAY CLASS	6-YEAR CRASH FREQUENCY	CRASHES PER 1,000 ROADWAY-MI	CRASHES PER 100 MILLION VEHICLE-MI PER YEAR
Two-lane roads	725	23.9	0.51
Multilane divided	43	52.2	0.17
Multilane undivided	28	76.9	0.28
Freeways	3	3.3	0.01

Table 3. Rural pedestrian crashes by road class.

RURAL ROADWAY CLASS	6-YEAR CRASH FREQUENCY	CRASHES PER 1,000 ROADWAY-MI	CRASHES PER 100 MILLION VEHICLE-MI PER YEAR
Two-lane roads	1,331	43.9	0.93
Multilane divided	110	133.5	0.45
Multilane undivided	71	195.1	0.72
Freeways	118	131.1	0.20

Analysis of Rural Crashes by Crash Type

One of the most prominent features of the North Carolina pedestrian and bicycle crash database is the crash type data. Based on police crash report sketches and narratives, each crash is categorized as a particular crash type, such as drivers overtaking a bicyclist or pedestrians walking along the roadway. This study explored crashes according to type and road class. Frequently occurring combinations of crash type and road class were identified as problem areas (e.g., pedestrians walking along the roadway on rural two-lane roads or drivers overtaking a bicyclist on rural two-lane roads). These problem areas were then explored to determine recurring crash characteristics. Pedestrian, bicyclist, driver, environmental, and roadway characteristics of the problem area were compared to the characteristics of all crash types on that road class (e.g., all crash types on rural two-lane roads). This comparison indicated which characteristics were overrepresented in that problem area. Any overrepresentation of a particular characteristic indicated potential treatment areas. For example, if characteristics of a problem area indicated that younger pedestrians were more involved than the general distribution, treatments specific to younger pedestrians would be more appropriate for improving the problem area.

The characteristics of each problem area were compared to the characteristics of all crash types on that road class to determine how they differed. This study examined each of the 11 pedestrian problem areas and 5 bicycle problem areas. An example problem area (walking along roadway crashes on rural two-lane roads) has been included to show the results of the examination of the characteristics of the pedestrian, driver, environment, and location.

Discussion of Countermeasures for Rural Problem Areas

After the problem areas were identified, potential countermeasures were discussed to reduce those types of crashes. The Federal Highway Administration (FHWA) has sponsored two projects, PEDSAFE and

Example Examination of Problem Area Characteristics

- **Crash Type:** Pedestrians walking along the roadway.
- **Road Class:** Rural two-lane roads.
- **Number of Crashes:** 369 (27 percent of all rural two-lane road crashes).
- **Crash Type Definition:** The pedestrian was walking or running along the roadway and was struck from the front or from behind by a vehicle.

Comparison of pedestrian walking along the roadway to all pedestrian crash types.

CRASH CHARACTERISTICS	CRASH TYPE (PERCENT)	
	PEDESTRIANS WALKING ALONG THE ROADWAY ON RURAL TWO-LANE ROADS	ALL PEDESTRIAN CRASH TYPES ON RURAL TWO-LANE ROADS
Pedestrians 25–44 years old	45	34
Pedestrian alcohol involvement	35	24
Estimated vehicle speeds of 45–55 mi/h	39	31
Dark unlighted roadways	76	50
Road Speed limits of 50 mi/h or higher	68	60
Undeveloped area	64	54
Unpaved shoulders	92	86

BIKESAFE, to provide comprehensive information on pedestrian and bicyclist safety, specifically focusing on crash types and countermeasures.[7,8] This current study examined crash types from pedestrian and bicyclist problem areas, considered the countermeasures that PEDSAFE or BIKESAFE suggests for that crash type, and discussed the suitability of the countermeasure with respect to the rural setting. Through careful consideration and discussion with a limited group of pedestrian and bicycle experts who were involved in the development of PEDSAFE and BIKESAFE, the suitability of the countermeasure for rural settings was given a consensus-based rating for two measures—the potential safety effectiveness of the countermeasure and the feasibility of its implementation in rural areas.

Summary of Countermeasure Discussion

The countermeasures that rated high for potential safety effectiveness and feasibility in rural areas for each crash type are listed below. Pedestrian and bicycle activity can be relatively low on some rural roads. Thus, certain countermeasures (indicated in the following list with the word "targeted") may only be suitable for rural areas where there are higher levels of pedestrian and bicycle activity. Note that a full discussion of possible treatments, including those not considered feasible, is in the final report (Transportation Research Board Annual Meeting 2007 Paper #07-2457).

Rural pedestrian crash types and their solutions include the following:

- Pedestrians walking along the roadway.
  - Add sidewalks (targeted).
  - Add paved shoulders.
  - Add roadway lighting (targeted).
- Pedestrians failing to yield midblock.
  - Educate pedestrians.
- Pedestrians darting/dashing midblock.
  - Improve signing (targeted).
  - Educate pedestrians.
  - Utilize traffic-calming measures (targeted).
- Disabled vehicle-related.
  - Educate drivers.
- Pedestrians failing to yield at the intersection.
  - Educate pedestrians.
  - Install pedestrian signal (targeted).
  - Improve roadway lighting (targeted).
- Pedestrians crossing the expressway.
  - Improve roadway lighting (targeted).
  - Install fence or barrier (targeted).

Rural bicycle crash types and their solutions include the following:

- Bicyclists turning/merging into the path of the driver midblock.

- Provide marked pavement space for bicyclists (locations with suitable pavement width).
- Add paved shoulder.

- Drivers overtaking midblock.
  - Provide marked pavement space for bicyclists (locations with suitable pavement width).
  - Improve roadway lighting (targeted).

- Bicyclists failing to yield midblock.
  - Reduce lane width to minimize crossing distance and slow vehicles (targeted).
- Bicyclists failing to yield at the intersection.
  - Improve sight distance.
  - Improve school zones.

Conclusions

The goal of this study was to gain additional knowledge on rural pedestrian and bicycle crashes. A general comparison of rural and urban crashes in North Carolina found that rural crashes were typified by higher fatality rates, higher vehicle speeds, less roadway lighting, unpaved shoulders, and more nonintersection locations than urban crashes.

An examination of rural crashes by road class showed that rural two-lane roads had the greatest needs for safety improvements due to their high raw crash frequencies and crash rates per vehicle-mile.

Specific problem areas were identified and described in terms of characteristics of the crash participants and crash location. The study identified 11 pedestrian problem areas, such as walking along roadway crashes on rural two-lane roads, and 5 bicycle problem areas, such as bicyclists turning/merging into the path of drivers midblock on rural two-lane roads.

Potential countermeasures for these problem areas were discussed to determine their potential safety effectiveness and feasibility for rural areas. Potential pedestrian crash countermeasures for rural areas included improving roadway lighting, educating pedestrians and drivers, and adding sidewalks and paved shoulders. Potential bicycle crash countermeasures for rural areas included providing marked pavement space for bicyclists, adding paved shoulders, and improving roadway lighting.

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FOR MORE INFORMATION

Additional information can be found in the full report that was presented on this study. It can be obtained as follows:

Carter, D. and Council, F. (2007). ***Factors Contributing to Pedestrian and Bicycle Crashes on Rural Highways*****, Transportation Research Board 86th Annual Meeting Paper #07-2457, Transportation Research Board, Washington, DC. Obtained from: http://gulliver.trb.org/news/blurb_detail.asp?id=7286.**

The full report can also be found at www.hsisinfo.org.

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