# A Geographic and Statistical Analysis

# of the Effects of Rural and Urban Residence

# on Trauma Deaths in North Carolina

Robert Rutledge, M.D.
Elizabeth Bell, M.D.
Christopher C. Baker, M.D.
Thomas C. Ricketts, Ph.D.

June, 1990



The University of
North Carolina
Rural Health Research program

# A GEOGRAPHIC AND STATISTICAL ANALYSIS
## OF THE EFFECTS OF RURAL AND
## URBAN RESIDENCE ON TRAUMA DEATHS IN NORTH CAROLINA

Robert Rutledge, MD, Elizabeth Bell, M.D., Christopher C. Baker, MD, and Thomas C. Ricketts, Ph.D. Department of Surgery, University of North Carolina, School of Medicine, Chapel Hill, NC 27599

Injury is the leading cause of death among persons between birth and age 37 years (1). Unintentional injuries account for 4.6% of deaths and 19.6% of potential years of life lost before the age of 65 in the United States. Injury death rates vary dramatically among regions and states in America.(2) Injuries have been shown to affect a disproportionate number of rural and minority residents of the United States (3). Waller has shown that motor vehicle crashes injured 50% more people per 1,000 population in rural counties as in urban counties (4). Those injured in rural counties were almost four times as likely to die of their injuries as those injured in urban counties. Deaths in rural crashes occur more frequently at the scene of the injury, and occur sooner after injury, and of less serious injuries than those injured in urban crashes. Baker's recent study mapping geographic distribution of mortality due to motor vehicle crashes demonstrated the highest mortality in counties of low population density. Mortality was also inversely related to per capita income (5).

Residents of rural areas have been shown to be at higher risk for death from motor vehicle crashes, gun shot wounds, burns and drownings (2). Further study of injury mortality on a county level found that death rates from all unintentional injuries combined were highest in the West and South. Death rates were highest in rural, sparsely populated counties (5). Rural residents are more likely to be employed in hazardous occupations. Approximately 10% of employed rural residents work in the two very hazardous occupations: farming and mining. Work-related deaths occur 4 to 5 times more frequently among mining and agricultural workers than among workers as a whole, and disabling injuries occur 2 to 3 times more often. (6)

Although injury is clearly a devastating public health problem with significant associated morbidity and mortality, it is potentially amenable to interventions to prevent the injury and to ameliorate the resultant outcome (7). Interventions aimed

at both primary and secondary prevention must be based upon a complete and accurate description of the injury event and the medical system response to the injury. As described above rurality has been identified as an important factor in the variation in the death rates and morbidity associated with injury. The purpose of the present study was to analyze the relationship of trauma death rates in North Carolina counties comparing rural and urban counties. We had two hypotheses: 1) residence in rural counties is associated with an increased per capita trauma death rate; and 2) that various descriptors of county demographics, environment, socioeconomic status and medical resources are associated with the per capita trauma mortality rate.

## METHODS

Data on trauma deaths in North Carolina were obtained from the North Carolina Medical Examiner's Database. The North Carolina Medical Examiner's Database contains information on all intentional and unintentional injuries including approximately 15% of all the yearly deaths in North Carolina. All 12,417 North Carolina injury deaths from 1986 to 1988 were selected for study. Counties were divided into rural and urban based on the percent of the county that was rural using NC Office of Budget and Management information. Rural counties were defined as those that were at least 60% rural. Urban counties then were those counties that had less than 60% of their area classed as rural. This demonstrates a potential problem in this study, even counties defined as urban contain a large rural population. Using this definition of a rural county, 81 North Carolina counties were classified as rural and the remaining 19 were classified as urban. This definition allowed analysis of rurality as a discrete, categorical variable for purposes of statistical analysis. To eliminate some of the arbitrary nature of this definition of rurality and to take advantage of statistical techniques that utilize continuous variables, the Pearson correlation coefficient and Ordinary Least Squares (OLS) linear regression analysis, were used to describe relationships within percent rurality the percent rurality of each county was utilized in separate analyses. The data source for independent variables was the North Carolina Office of Budget and Management.

The data were analyzed using a relational database program (R:BASE for DOS) and an IBM PC compatible computer. The file was then transformed into a SAS (Statistical Analysis Systems) datafile for statistical analysis. Continuous variables were compared between rural and urban counties using Student's t test.

Multiple linear regression was used to compare the relationship of rurality and other county descriptors to per capita trauma death rates.

## RESULTS

A total of 12,784 trauma deaths occurred in North Carolina during the years of 1986-1988. Of these trauma deaths, 67% were classified as "accidental" (unintentional), 19% suicide and 14% as homicide.

## I. METHODS

### A. Etiology of Trauma Death

The mechanism of injury leading to death included motor vehicle crashes (42%), gun shot wounds (27%), fires (8%), falls (5%), drownings (5%), poisoning (excluding alcohol or barbiturates) (4%), Stab wounds (3%), motorcycle crashes (3%), and alcohol intoxication (2%). In motor vehicle crashes the victim was a driver in 28%, a pedestrian in 15%, and a passenger (14%).

### Race in Trauma Deaths

Of the 12,417 deaths from injury 69% were white, 28% were black, 1.7% were native American and 0.8% were of other racial origin. Blacks are over represented in this group of injury deaths. The proportion of blacks in the population of trauma deaths was similar in rural and urban areas (27% and 29% respectively). Eighty-eight percent of Indian deaths occurred in rural counties, reflecting the concentration of the Indian populations in rural areas in North Carolina.

### Gender and Trauma Deaths

As in other studies of trauma, males are over represented in this database of trauma deaths and this gender distribution was the same in both rural and urban counties (74% male for both).

### Population and Trauma Deaths

The mean population for the 81 rural counties was 40,900 $\pm$ 27,800 and 185,000 $\pm$ 126,500 (Fig. 1) for the 19 urban counties (p<0.00001). The mean number of injury deaths in rural counties was 27 $\pm$ 20 versus 89 $\pm$ 54 for urban counties (p<0.0001). Rural counties accounted for 56% of all trauma deaths.

A total of 24 county descriptors were used from data available form the State Office of Management and Budget to analyze the relationship of county rurality with county descriptors. The descriptors are listed in Table 1.

## II. UNIVARIATE ANALYSIS OF COUNTY DESCRIPTORS AND RURALITY

County rurality was analyzed in two ways. First as a categorical variable dividing counties into rural and urban based upon the percent of the county that is rural (> 60% rural classed as a rural county), and second using percent rurality as a continuous variable, analyzing it's correlation with other descriptor variables. County rurality ranged from 12% to 100%.

### A. Correlation Analyses of Rurality (Continuous Variable) (Table 2)

**Geographic Descriptors:** As might be expected percent county rurality was negatively correlated with the county population ($R = -0.76$, $p = 0.0001$) and population density ($R = -0.82$, $p = 0.0001$). Percent rurality was not related to the county size as measured by total acreage, or to farm acreage or forested acreage (Fig. 2.

**Educational Descriptors:** Rurality was negatively correlated with the percent of high school graduates in the county ($R = -0.66$, $p = 0.0001$) (Fig. 3), but was positively correlated with the percent of the population admitted to high school ($R = 0.23$, $p = 0.02$). The percent of students that dropout of high school was not associated with percent rurality.

**Socioeconomic Descriptors:** Measures of income status, including mean family income, and total personal income were negatively correlated with county rurality ($R = -0.63$, $p = 0.0001$, $R = -0.52$, $p = 0.0001$ respectively) (Fig. 4). The percent of the county population that was nonwhite, and the percent receiving aid for dependent children (AFDC) did not correlate with rurality. The percent of the county's population that was age 65 or older was correlated with rurality indicating an increased number of elderly in rural areas ($R = 0.46$, $p = 0.0001$). The percent of the county population below age 25 was not related to rurality of the county.

**Occupational Status:** Measures of employment status were correlated with rurality (percent of unemployment $R = 0.24$, $p = 0.02$) ((Fig. 5), percent employed in manufacturing occupations ($R = -0.22$, $p = 0.02$), percent employed in agricultural occupations ($R = 0.48$, $p = 0.0001$).

**Environment:** Highway miles were less in rural counties as shown by significant negative correlations with primary and secondary highways (R = -0.42 and -0.46 respectively, p=0.0001 for both). Total highway mileage exposure was significantly less for counties with greater rural area. (R = -0.44, p=0.0001).

**Medical Resources:** The number of physicians, hospital beds and nurses per capita were less in rural areas (R = -0.38, -0.39 and -0.67, respectively, p=0.0001 in each).

### B. Categorical Analysis of Rural and Urban Counties (Using > 60% Rural as the Definition of a Rural County) (Table 3)

**Geographic Descriptors:** Rural counties were 82.5% ± 16% rural compared to urban counties which were 36.4% + 19.1% rural (p=0.0001). The population density in rural counties was 82 +/- 45 people per square mile compared to 370 +/- 219 people per square mile in urban areas (p=0.0001). The total acreage in rural and urban counties was not significantly different (311,000 +/- 128,000 acres for rural counties as compared to 318,000 +/- 107,000 acres for urban counties (p=0.8). County acreage used for farming was not significantly different in rural and urban counties (52,000 +/- 46,000 in rural counties versus 47,700 +/- 34,000 acres in urban counties p=0.7). Forested acreage in rural and urban counties was also not significantly different (190,900 +/- 92,600 acres in rural counties as compared to 157,000 +/- 73,500 acres in urban counties.) These data demonstrate that even the "urban" counties in our series contain a good deal of rural area.

**Education:** Rural counties were significantly different in educational measures available for analysis with fewer high school graduates, more high-school admissions and greater high school drop outs than urban counties (Table 3).

**Socioeconomic:** Rural counties had a lower average income and a greater percentage receiving AFDC. The percent nonwhite was not different in rural and urban counties. The percent over age 65 was greater in the rural counties and the number under age 25 was not significantly different. (Table 3)

**Occupational:** In contrast to the analysis of the continuous measure of rurality the differences in unemployment and percent of workers in manufacturing jobs did not reach statistical significance. The percent of workers who were involved in agricultural occupations was higher in the rural counties. (Table 3)

**Environment:** All of the measures of highway mileage were less in rural counties including primary and secondary roads as well as person mileage exposure (Table 3).

**Medical Resources:** There are eight designated trauma centers in the state 7 are in urban counties and only one is in a rural county. Rural counties had fewer physicians than urban counties (18 +/- 14.5 physicians per county in rural counties and 119 +/- 97 physician per county in urban counties, p = 0.0003) and had fewer physicians per capita (Table 3).

Rural counties had fewer hospital beds than urban counties (129 +/- 125 hospital beds per county in rural counties and 718 +/- 575 hospital beds per county in urban counties, p = 0.0003) and had fewer hospital beds per capita (Table 3).

Rural counties had fewer nurses than urban counties (147 +/- 173 nurses per county in rural counties and 1250 +/- 1119 nurses per county in urban counties, p = 0.0003) and had fewer nurses per capita (Table 3).

## III. UNIVARIATE ANALYSIS OF THE RELATIONSHIP OF PER CAPITA COUNTY TRAUMA MORTALITY RATES WITH COUNTY DESCRIPTORS

In separating counties in North Carolina into rural and urban counties based upon a percent rurality of 60%, 19 counties were classed as urban and 81 as rural. The mean death per capita in urban counties was $5.6 \pm 0.89$ and in rural counties was $6.9 \pm 1.9$ ( R = 0.32, p = 0.001) (Fig. 6). The number of trauma deaths per year in rural counties was $83.4 \pm 60$, compared to $297 \pm 184$ in urban counties (p = 0.001).

Pearson correlation coefficients were derived to analyze the relationship of per capita county injury mortality rate to county descriptors (table 4).

**Geographic:** All geographic county descriptors tested were significantly associated with per capita trauma death rates (% rural R = 0.31, Population density R = -0.33, total acreage R = 0.29, Farm acreage R = 0.27 and forested acreage R = 0.28, p < 0.007 in all).

**Education:** The percent high school graduates was negatively correlated with county trauma death rates and the number of high school admissions was positively correlated with county trauma death rates (Table 4). Drop out rates were not associated with trauma mortality rates.

**Socioeconomic:** Each and every socioeconomic measure of county status was significantly associated with per capita trauma death rates (table 4, Figs. 7-8).

Occupational: The percent unemployment and the percent of workers employed in agricultural jobs were both significantly associated with county per-capita death rates (R=0.33 and R=0.44 respectively, p < 0.0009 in both) (Fig. 9).

Environment: No measure of Highway miles or highway exposure was related to trauma death rates.

Medical Resources: All measures of medical resources were negatively correlated with trauma mortality rates but only the numbers of hospital beds per person and the number of nurses per person reached statistical significance (p=0.05 and p=0.03 respectively).

## IV. MULTIVARIATE ANALYSIS OF PER CAPITA TRAUMA DEATH RATES AND COUNTY DESCRIPTORS

Univariate analyses identified a number of county descriptors that were significantly associated with the per capita trauma death rates. The technique of Ordinary Least Squares (OLS) multiple linear regression was utilized to evaluate the association of various county descriptors (independent variables) on the county per capita trauma death rate per 10,000 population dependent variable.

The technique of developing the model for the regression analysis was initiated by identifying variables with the greatest association with per capita trauma mortality rate using univariate statistical analysis. These variables were included a multiple regression. The model was used to identify likely candidates for the final model. To avoid problems of collinearity correlation coefficients were derived for the candidate variables and variables excluding when there were high correlation among independent variables (i.e. mean total personal income and mean family income R = 0.74, p=0.0001).

The percent of the county population under age 25 was the most powerful predictor of outcome with an F value of 34.21 and p = 0.0001 for the type 1 sum of squares (table 5). This was followed by total county acreage, percent rural and the percent of the population that was not white as significant independent predictors in the model. The final model excluding problems with co-variance for co-linearity had an $R^2$ = 0.54 (Table 5).

## V. MAPPING OF INJURY DEATHS

North Carolina population by county (Fig. 10), total number of county deaths (Fig. 11), County Rurality (Fig. 12) and per Capita county death rate (Fig. 13).

Population and the death rate per 10,000 population were mapped by county. These maps graphically demonstrate the difference in trauma mortality between rural and urban counties.

### NC Population Distribution

Figure 10 demonstrates population distribution by counties in North Carolina. Much of North Carolina is rural with large areas of Eastern North Carolina being rural, agricultural areas and much of Western North Carolina being rural mountainous areas. There is what has been called an "urban crescent" beginning in Charlotte in the Southwestern part of the state proceeding in a Northeast direction to Winston-Salem, Greensboro and east across to Durham and Raleigh. This is a contiguous group of relatively highly populated North Carolina counties.

Figure 13 demonstrates the per capita trauma death rate in each county. The rural area of Eastern North Carolina has the highest per capita trauma death rates. The so called urban crescent of counties between Charlotte and Raleigh have the lowest death rate. The rural Western portion of the state is not as clearly associated with increased per capita trauma mortality rates. However, as can be seen in the maps and by reviewing the statistical analysis of the relation of rurality to per capita death rates, rurality does not explain all of the variation in trauma death rates. Other factors besides the rural nature of counties have important affects on trauma death rates.

## DISCUSSION

### Trauma as a Public Health Problem

As documented in Injury in America, injuries are the leading cause of death and disability for children and young adults (1). Injury is the fourth leading cause of death among persons of all ages in America and the leading cause of death for Americans between the ages of 1 and 37 years. The majority of studies of trauma have come from urban areas (8). The morbidity and mortality of injury is increased in rural areas. Studies by Baker and others continue to show that trauma in rural areas is associated with higher mortality rates than injury in urban areas. Other studies have attributed this higher mortality rate to differences in socioeconomic status, types of occupational and other exposures, and lower availability of prompt emergency care (9). While the excess mortality due to injury is known, the best use

of health care resources for the care of the injured rural patient have yet to be delineated.

Injury is amenable to primary and secondary prevention strategies, but appropriate targeting of these interventions must be based upon a solid knowledge of the injury event, medical system response and outcome. Primary prevention strategies are interventions to try and prevent the injury event from occurring. Examples of these would be better lighting on roadways, improved crash avoidance systems and brakes on automobiles, mandatory utilization of smoke alarms in all new construction, etc. Secondary prevention strategies are interventions to prevent the secondary morbidity and mortality that occurs following the injury event. Examples of secondary prevention strategies include improved emergency medical services response capabilities by changes in training or communication, changes in the trauma system by triaging severely ill patients to better staffed facilities and modification of the management of injuries such as head and spinal cord injuries. Selection of which of these strategies should be implemented demands a thorough understanding of the injury event, medical system response and ultimate patient outcome.

## Rurality as a Problem in Trauma Care

Rural trauma is a major problem in the United States. Fifty to 70% of trauma fatalities occur in rural areas, even though 70% of the population live in urban areas.(8) Over the past 3 decades, numerous studies have defined the concept of preventable trauma death and other studies have identified the fact that trauma systems can decrease the incidence of preventable death in trauma. But these studies in the use of trauma systems have come largely from urban areas. By its nature, rural trauma is difficult to study. Data sources have routinely focussed on injuries occurring in urban areas. With the development of large data sources that include greater numbers of patients, samples are now available with enough rural patients to draw conclusions about rural trauma.

During the past 10 years there have been major changes in the U.S. health care system. In rural areas, this change has been associated with a decline in local economy and closing of many of the rural hospitals. Since 1981, nearly 550 rural hospitals have closed (10). This is associated with loss of both hospital based care and emergency medical services.

Specific problems for rural trauma systems are the low population density in rural areas, poor roads can cause EMS transport delays, difficulty in public access because of limited implementation of 911 throughout the states. Available rural prehospital care providers often have only basic levels of training. Rural EMS providers have difficulty maintaining specialized skills to handle injuries. There are limited numbers of rural physicians trained to provide appropriate trauma care. Equipment is limited and aeromedical transport is available only in rare situations. Rural hospital emergency room physicians and nurses often do not have advanced trauma experience. Trauma systems and their implementation may not be available. Rural areas often lack the resources needed to address these problems.

The 1987 NC population of 6.4 million was 25% minority (mostly Black) 16% poor and 52% rural (9). Only one other state has a larger non-metropolitan population (Pennsylvania). As a predominantly rural state with higher than average proportions of minority and poor population, North Carolina's injury mortality rates exceed the national average in all categories except falls and non-firearm suicides (11). There are at least 59,000 hospitalizations due to injury per year in North Carolina, with an estimated annual cost of $500 million for motor vehicle injuries alone (12). The leading cause of injury death in North Carolina is motor vehicle injury (1600 deaths per year), followed by suicide (800), homicide (600), falls (200), fires and burns (200) and drownings (150). Agricultural injuries are an important problem resulting in 50 deaths per year in this predominantly rural state.

The North Carolina Medical Examiner's Database provides an excellent opportunity to evaluate trauma deaths in a population based database which includes information on greater than 90% of trauma deaths in North Carolina. North Carolina is well suited for evaluation of rural and urban trauma deaths because of its large rural population as well as multiple urban areas that are present within the state. A combination of a large population based database with previous validation of information in the database and a state with both large urban and rural populations provides a unique opportunity for an analysis of the differences in trauma deaths in rural and urban areas.

The primary purpose of this study was to perform an initial analysis of the trauma death rates in rural and urban areas in North Carolina, and a subsequent analysis of the various descriptors of individual rural and urban counties to determine if there was an association between demographic, environmental socioeconomic or medical resource information and county per capita trauma death rates. Because of the number of potentially confounding variables that are present,

this remains only a preliminary study, but rurality is clearly associated with an increased per capita mortality rate and other county descriptors are significantly related to outcome. This suggests that further studies of this type maybe fruitful for identifying areas for both primary and secondary interventions to decrease the frequency of injury and to improve its outcome when it does occur.

As in other studies, residents of rural counties in our series were found to face significantly higher per capita trauma death rates than their urban counterparts. For the purpose of this study rurality was defined as having a county with greater than 60% rurality. This points out that even the counties selected as urban include large rural areas, and therefore dilutes the analysis and limits its ability to clearly distinguish between the effects of rurality and trauma death rates. Rurality, as can be seen from both the maps as well as from the multivariate analysis, is not the only predictor of trauma death rates.

## Association of Rurality and Other County Descriptors

This study confirms that rural areas are associated with a cluster of other county descriptors that all have potentially negative impacts on maintenance of adequate health status. Rural counties have lower mean county populations and population densities by definition but the size of the county was not related to it's rural or urban nature. Rural counties had lower percent of high school graduates even though they had a greater number of individuals enrolled in high school. All measures of socioeconomic status were lower in rural areas, with rural areas having lower incomes and increased frequency of need for Aid for Dependent Children and higher unemployment. This constellation of findings describes a population group that has been shown to be at higher risk of sustaining injury and death (1). These same groups rural, elderly and minorities are also less likely to recover after injury (13).

## Trauma Death Rates

Trauma death rates varied throughout the state. The absolute number of trauma deaths being greatest in counties with the highest populations. Because of concentration of deaths in relatively small areas, urban trauma has received more attention, more study and research and appears to have been more successfully addressed. Unfortunately solutions to problems of urban trauma do not necessarily apply to the rural situation.

Per-capita Trauma death Rates

A number of different variables were associated with per-capita county trauma death rates. Using univariate analysis many of the county descriptors were found to be associated with per-capita trauma death rates including measures of geographic nature of the county (i.e. rurality), the educational and socioeconomic descriptors, occupational and medical resource variables.

Multivariate analysis confirmed these findings and identified the most powerful associations found in the number of variables tested, percent of the population under age 25, the size of the county, its rurality and the percent of the population that was nonwhite. These variables describe a population that is most at risk to suffer trauma death: the poor, rural, young or old, minority individual.

## CONCLUSIONS

Residents of rural North Carolina counties face significantly higher rates of trauma death than their urban counterparts. This study confirms as have others that there is a group of descriptive variables that identify populations at increased risk of trauma death. This group is made up largely of society's disadvantaged, poor, minority, young or old, residing in a rural area with poor health care and limited medical resources. Although this profile was again confirmed in this study there were significant variations that suggest that all the important predictors of outcome have not been identified. This is best seen in the difference in mortality seen in rural eastern NC as compared to rural western NC. Rurality alone clearly is not the only reason for the increased trauma death rates.

How these individuals should be targeted for prevention and intervention efforts remains unclear. Because of geographic factors solutions that have successfully decreased trauma death in urban areas may not be effective in rural areas or may be prohibitively expensive. Further studies are needed to delineate means to prevent and treat trauma in rural areas. These needed solutions must be sensitive to the needs of the rural population as well as to the realities of America's changing health care system in the 90's.

# REFERENCES

1) Institute on Medicine: *Injury in America: A Continuing Health Problem.* Washington, DC, National Academy Press, 1985.

2) Baker SP, Whitfield PA and O'Neill B. Geographic Variations in Mortality From Motor Vehicle Crashes. *NEJM* 316:1384-7. 1987.

3) Differences in death rates due to injury among blacks and whites, 1984. *JAMA*, 261:214-216. 1989.

4) Waller JA, Curran R and Noyes F. Traffic Deaths: A Preliminary Study of Urban and Rural Fatalities in California. *California Medicine* 101 (4)272-76 1964.

5) Baker SP, Whitfield PA, and O'Neill B, County Mapping of Injury Mortality, *J Trauma*, 28:741-745. 1988

6) Cox J. Risks to Health in Rural Areas, *Practitioner.* 1983, Sep. 227(1383)1473-7.

7) Trunkey DD, Overview of Trauma, in Symposium on Trauma, Surgical Clinics of North America, 62(1):3-8.

8) US Congress, Office of Technology Assessment, *Rural Emergency Medical Services--Special Report* OTA-H-445 Washington, DC: U.S. Government Printing Office, November 1989, page 5.

9) Cales RH, Trauma Mortality in Orange County: The Effect of Implementation of a Regional Trauma System, *Ann Emer Med* 1984, 13(1):15-24.

10) Merlis M: Rural Hospitals, Congressional Research Service (CRS) Report for Congress, CRS, Washington, DC, May 2, 1989.

11) North Carolina State Research and Planning Services. North Carolina State Government Statistical Abstract (Fifth Edition, 1984) Raleigh, NC: NC State Data Center, 1985, page 15.

12) Governor's Task Force on Injury Prevention and Control, *Injury in North Carolina*, October 1989, pages 14-15.

13) MacKenzie EJ, Steinwachs DM and Shankar BS. An ICD-9CM to AIS Conversion Table: Development and Application. Proceedings of the American Association for Automotive Medicine, p. 135., 1986.

**TABLE 1**

## COUNTY DESCRIPTORS

### Geographic
% Rural area in county
Population Density
Total Acreage
Farm Acreage
Forested Acreage

### Education
% Population graduated from High school
% Individuals Admitted to High School
% Drop out Rate

### Socioeconomic
Mean Family Income
Mean Personal Income
% Population Receiving Aid for Dependent Children
% Non-White
% of population Greater than 65 years old
% Population Below Age 25.

### Occupational
% Unemployed
% Employed in Manufacturing Occupations
% Employed in Agricultural Occupations
% Employed in Farming

### Environment
# Miles of Primary Highways
# Miles of Secondary Highways
Total Highway Exposure (person miles driven)

### Medical Resources
Trauma Center in county
Number Physicians/Person
# Hospital Beds/Person
# Nurses/Person

**Table 2**

## CORRELATION BETWEEN RURALITY AND COUNTY DESCRIPTORS

| Variable | Mean | Pearson Corr. Coeff. R | p Value |
|---|---|---|---|
| **Geographic** | | | |
| Pop Density | 132 | -0.82 | 0.0001 |
| Total Acreage | 312,636 | -0.09 | 0.3 |
| Farm Acerage | 51,300 | -0.1 | 0.3 |
| Forrested Acerage | 184,503 | 0.11 | 0.27 |
| | | | |
| **Educational** | | | |
| % H.S. Grad | 49.0% | -0.66 | 0.0001 |
| % H.S. Adm. | 5.0% | 0.23 | 0.02 |
| % H.S. Drop Out | 0.4% | 0.13 | 0.2 |
| | | | |
| **Socioeconomic** | | | |
| Family Income | $15,328 | -0.63 | 0.0001 |
| Personal Income | $8,850 | -0.52 | 0.0001 |
| % AFDC | 3% | 0 | 0.9 |
| % Nonwhite | 23% | -0.1 | 0.4 |
| % Age > 65 | 14% | 0.46 | 0.0001 |
| % Age < 25 | 57% | 0.14 | 0.2 |
| | | | |
| **Occupational** | | | |
| % Unemployment | 2% | 0.24 | 0.02 |
| % Mfg Jobs | 11% | -0.22 | 0.02 |
| % Agri. Workers | 2% | 0.48 | 0.0001 |
| | | | |
| **Enviornment** | | | |
| Miles Primary Roads | 139 | -0.42 | 0.0001 |
| Miles Secondary Roads | 622 | -0.46 | 0.0001 |
| Highway Exposure | 4877 | -0.44 | 0.0001 |
| | | | |
| **Medical Resources** | | | |
| Trauma Center | | | |
| MDs / person | 0.0005 | -0.38 | 0.0001 |
| Nurses/person | 0.003 | -0.67 | 0.0001 |
| Hospital Beds/person | 0.003 | -0.38 | 0.0001 |

**Table 3**

## COMPARISON BETWEEN RURAL AND URBAN COUNTIES

| Variable | Rural Counties | | Urban Counties | | |
| --- | --- | --- | --- | --- | --- |
| | Mean | Std | Mean | Std | p Value |
| Per Capita Death Rate | 6.9 | 1.9 | 5.6 | 0.9 | 0.005 |
| **Geographic** | | | | | |
| % Rural | 82.5% | 0.16 | 0.36 | 0.19 | 0.0001 |
| Pop Density | | | | | |
| Total Acreage | 311,278 | 128,074 | 318,423 | 107,058 | NS |
| Farm Acerage | 52,146 | 46,105 | 47,689 | 34,512 | NS |
| Forrested Acerage | 190,902 | 92,585 | 157,219 | 73,512 | NS |
| **Educational** | | | | | |
| % H.S. Grad | 47.0% | 6.0% | 58.0% | 9.0% | 0.0001 |
| % H.S. Adm. | 5.2% | 0.6% | 4.9% | 0.7% | 0.015 |
| % H.S. Drop Out | | | | | |
| **Socioeconomic** | | | | | |
| Family Income | $14,771 | $1,900 | $17,700 | $2,355 | 0.0001 |
| Personal Income | $8,523 | $1,266 | $10,245 | $1,521 | 0.0001 |
| % AFDC | 2.7% | 1.8% | 2.0% | 1.0% | 0.07 |
| % Nonwhite | 23.0% | 17.0% | 23.0% | 10.0% | NS |
| % Age > 65 | 14.7% | 2.7% | 12.0% | 3.0% | 0.001 |
| % Age < 25 | 58.0% | 58.9% | 49.0% | 7.0% | NS |
| **Occupational** | | | | | |
| % Unemployment | 2.5% | 1.0% | 2.0% | 0.7% | NS |
| % Mfg Jobs | 10.9% | 6.0% | 12.5% | 7.3% | NS |
| % Agri. Workers | 1.6% | 1.0% | 0.6% | 0.5% | 0.0001 |
| **Enviornment** | | | | | |
| Miles Primary Roads | 130 | 64 | 175 | 58 | 0.006 |
| Miles Secondary Roads | 565 | 311 | 867 | 291 | 0.0002 |
| Highway Exposure | 3900 | 3011 | 9039 | 7832 | 0.011 |
| **Medical Resources** | | | | | |
| Trauma Center | | | | | |
| MDs / person | 0.0004 | 0.00019 | 0.00069 | 0.00054 | 0.06 |
| Nurses/person | 0.003 | 0.002 | 0.0067 | 0.003 | 0.001 |
| Hospital Beds/person | 0.0029 | 0.0023 | 0.004 | 0.0018 | 0.046 |

**Table 4**

CORRELATION BETWEEN PER CAPITA TRAUMA DEATH AND COUNTY DESCRIPTORS

| Variable | Mean | Pearson Corr. Coeff. R | p Value |
|---|---|---|---|
| **Geographic** | | | |
| % Rural | 73.8% | 0.31 | 0.001 |
| Pop Density | 132 | -0.33 | 0.0007 |
| Total Acreage | 312,636 | 0.29 | 0.003 |
| Farm Acerage | 51,300 | 0.27 | 0.006 |
| Forrested Acerage | 184,503 | 0.28 | 0.004 |
| | | | |
| **Educational** | | | |
| % H.S. Grad | 49.0% | -0.3 | 0.002 |
| % H.S. Adm. | 5.0% | 0.25 | 0.01 |
| % H.S. Drop Out | 0.4% | 0.07 | 0.4 |
| | | | |
| **Socioeconomic** | | | |
| Family Income | $15,328 | -0.31 | 0.0014 |
| Personal Income | $8,850 | -0.19 | 0.056 |
| % AFDC | 3% | 0.32 | 0.001 |
| % Nonwhite | 23% | 0.36 | 0.0002 |
| % Age > 65 | 14% | 0.19 | 0.05 |
| % Age < 25 | 57% | 0.49 | 0.0001 |
| | | | |
| **Occupational** | | | |
| % Unemployment | 2% | 0.33 | 0.0008 |
| % Mfg Jobs | 11% | 0 | 0.5 |
| % Agri. Workers | 2% | 0.44 | 0.0001 |
| | | | |
| **Enviornment** | | | |
| Miles Primary Roads | 139 | 0.1 | 0.4 |
| Miles Secondary Roads | 622 | -0.1 | 0.3 |
| Highway Exposure | 4877 | -0.16 | 0.1 |
| | | | |
| **Medical Resources** | | | |
| Trauma Center | | | |
| MDs / person | 0.0005 | -0.16 | 0.1 |
| Nurses/person | 0.003 | -0.22 | 0.03 |
| Hospital Beds/person | 0.003 | -0.2 | 0.05 |

**Table 5**

R-Square
0.536

| Variable | Type I SS | F Value | p Value |
|---|---|---|---|
| % < 25 | 55.896 | 34.21 | 0.0001 |
| Total Acreage | 34.092 | 20.87 | 0.0001 |
| % Rural | 32.619 | 19.97 | 0.0001 |
| % Nonwhite | 28.547 | 17.47 | 0.0001 |
| Farm Acreage | 8.161 | 5.00 | 0.0278 |
| % > 65 | 8.045 | 4.92 | 0.0289 |
| % Unemployment | 6.792 | 4.16 | 0.0443 |

# Population of NC Counties
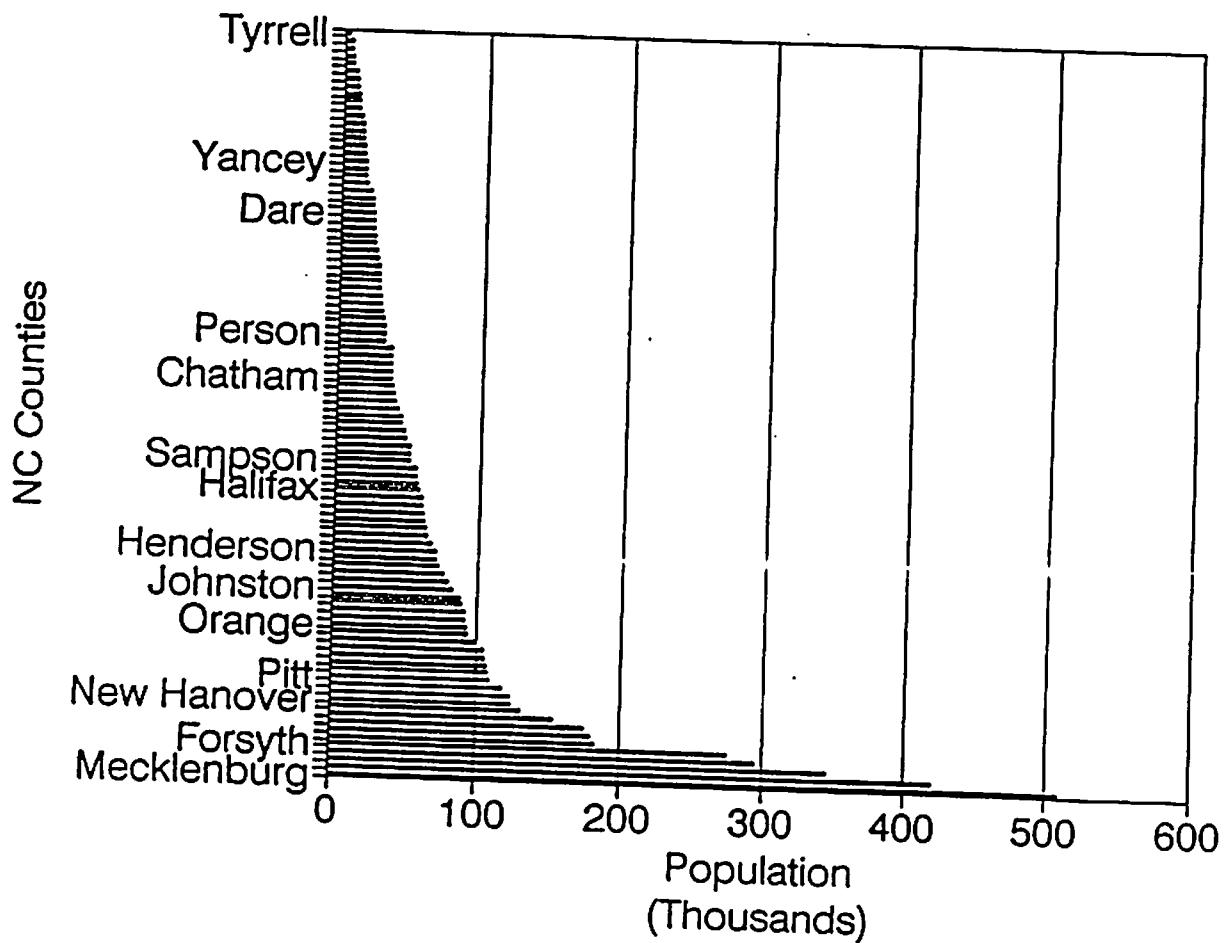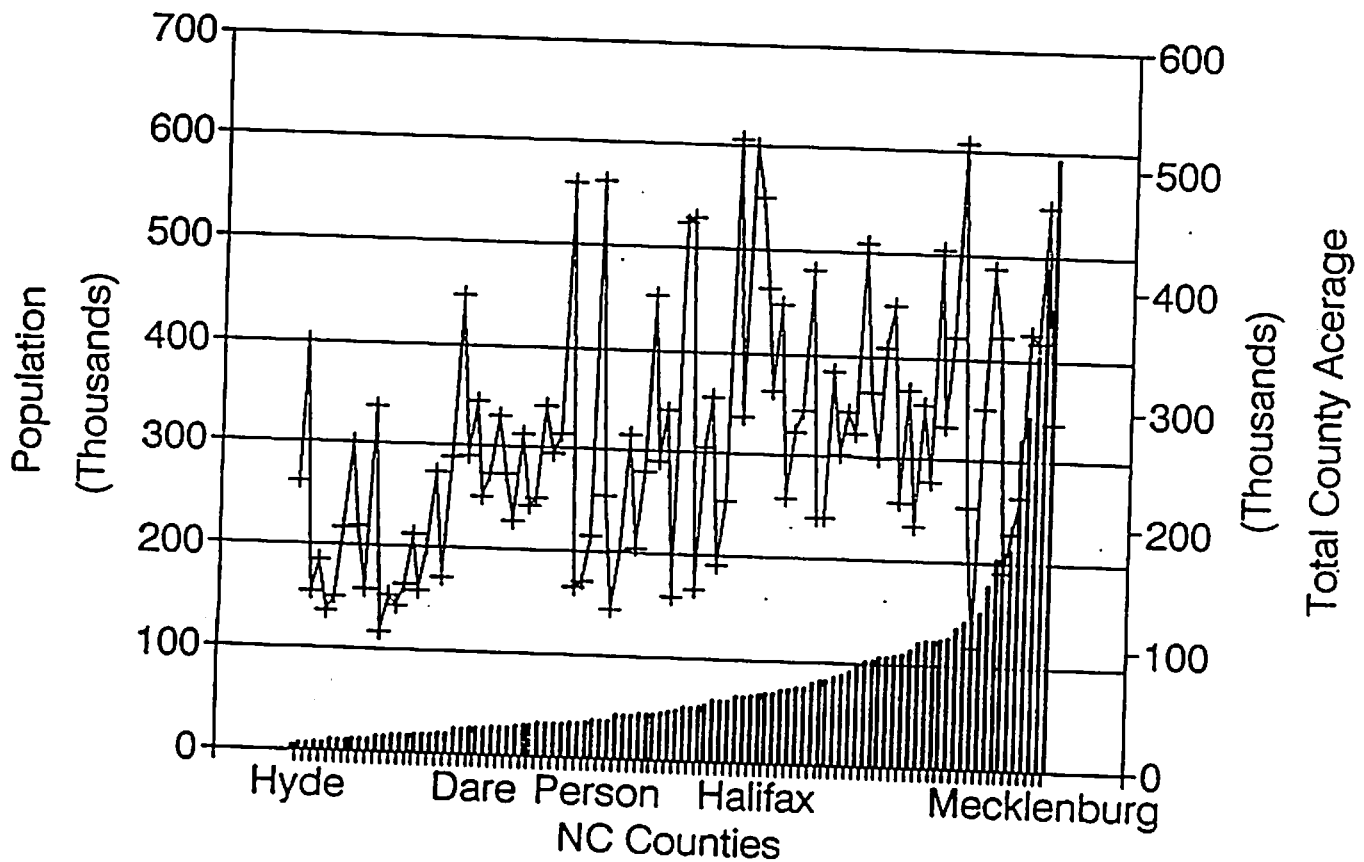


Figure 1

# Population and Acerage
## of NC Counties



Figure 2

# Rurality and HS Graduation
## of NC Counties
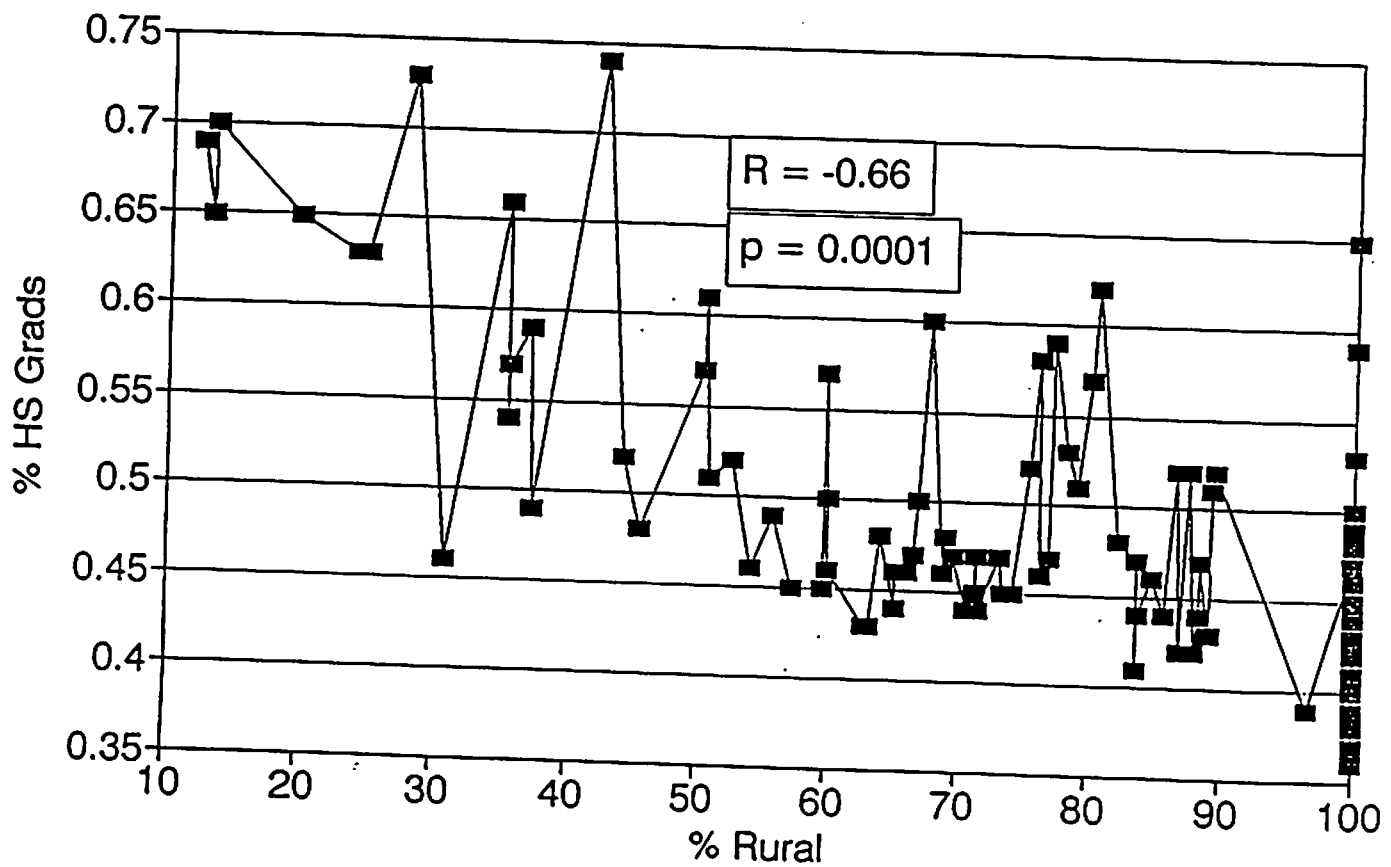


Figure 3

# Rurality and Family Income
## of NC Counties



R = -0.63

p = 0.0001

Family Income (Thousands)
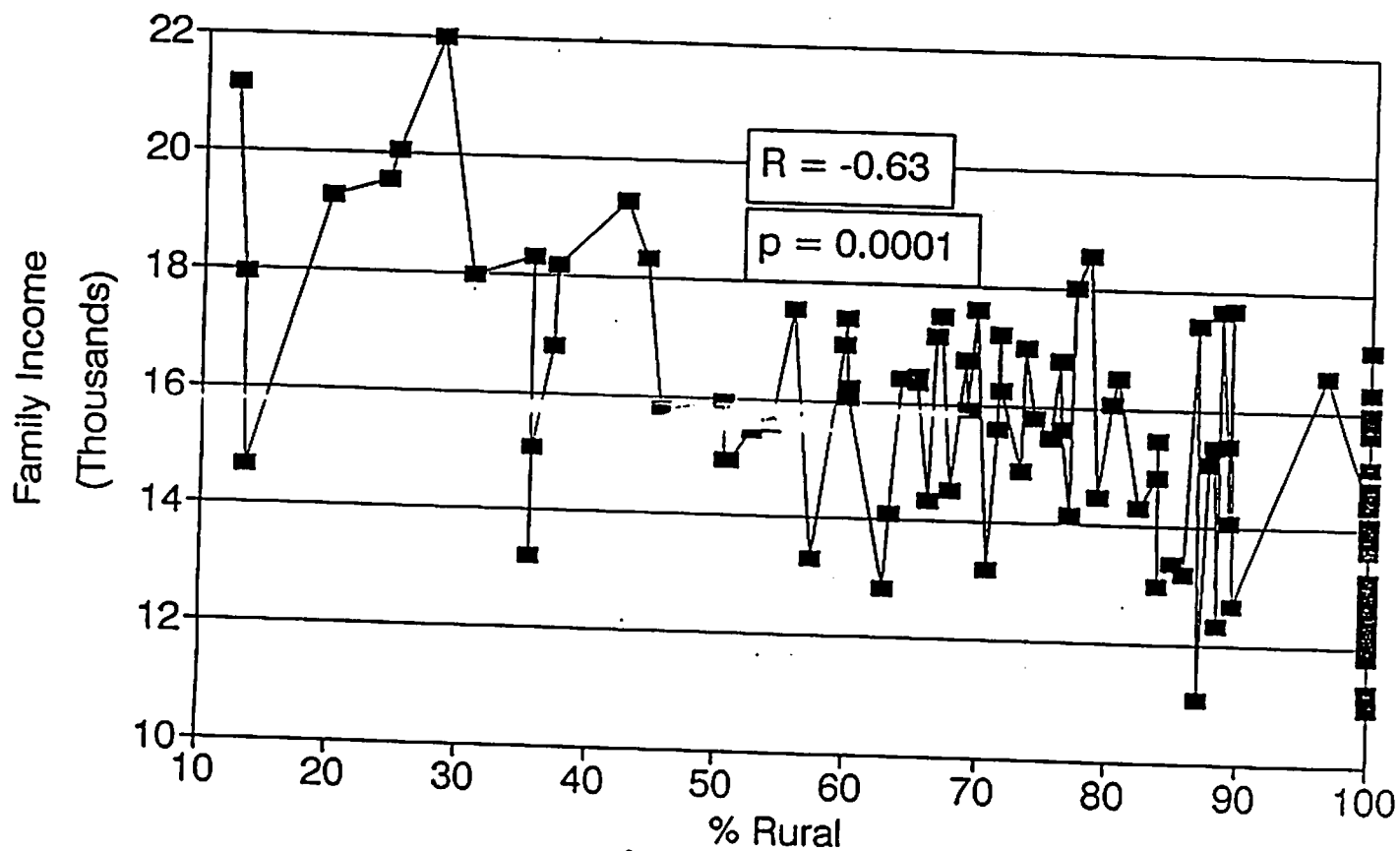
% Rural

Figure 4

# Rurality and Unemployment
## of NC Counties
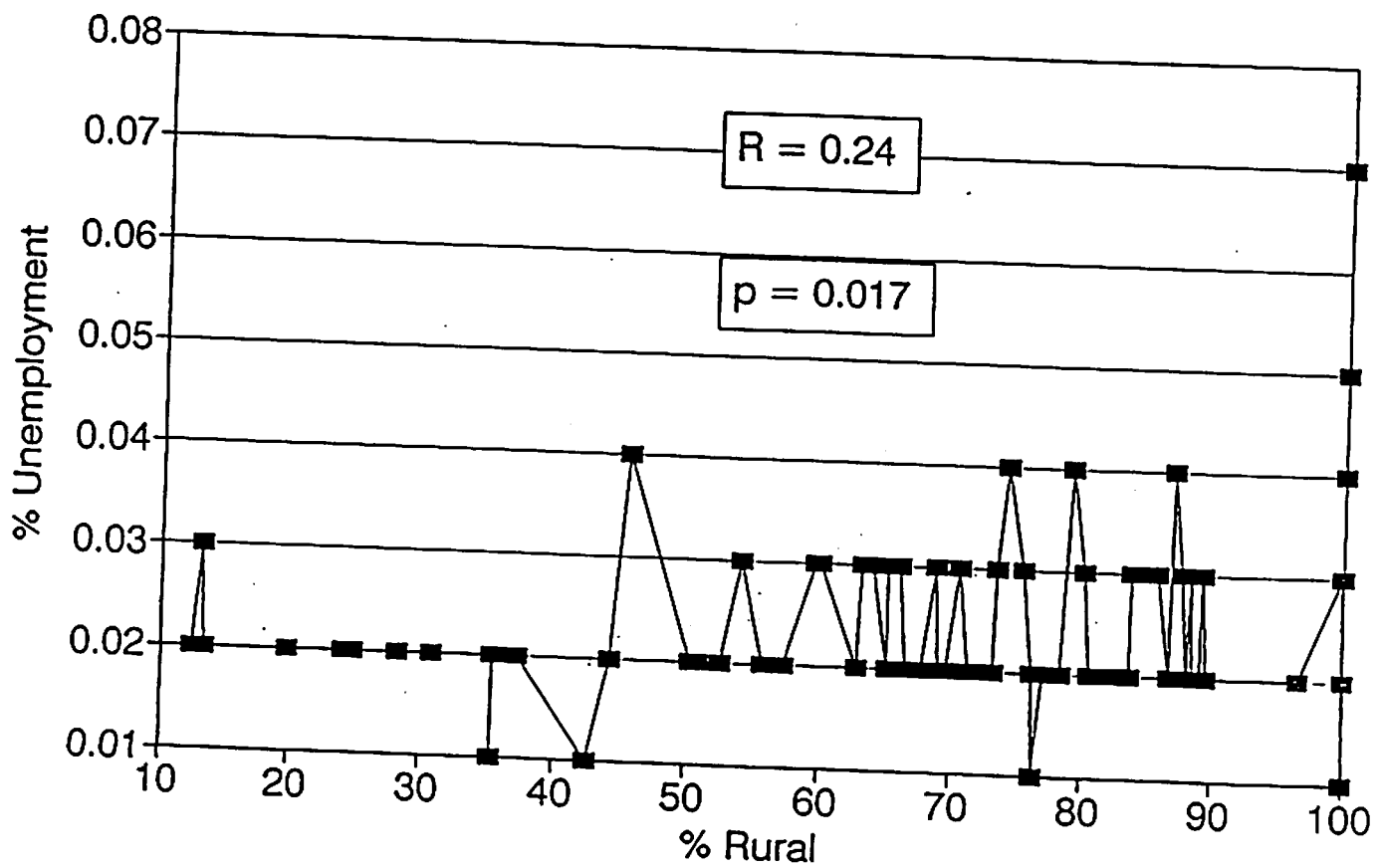


Figure 5

# Rurality and Trauma Deaths/10,000
## in NC Counties
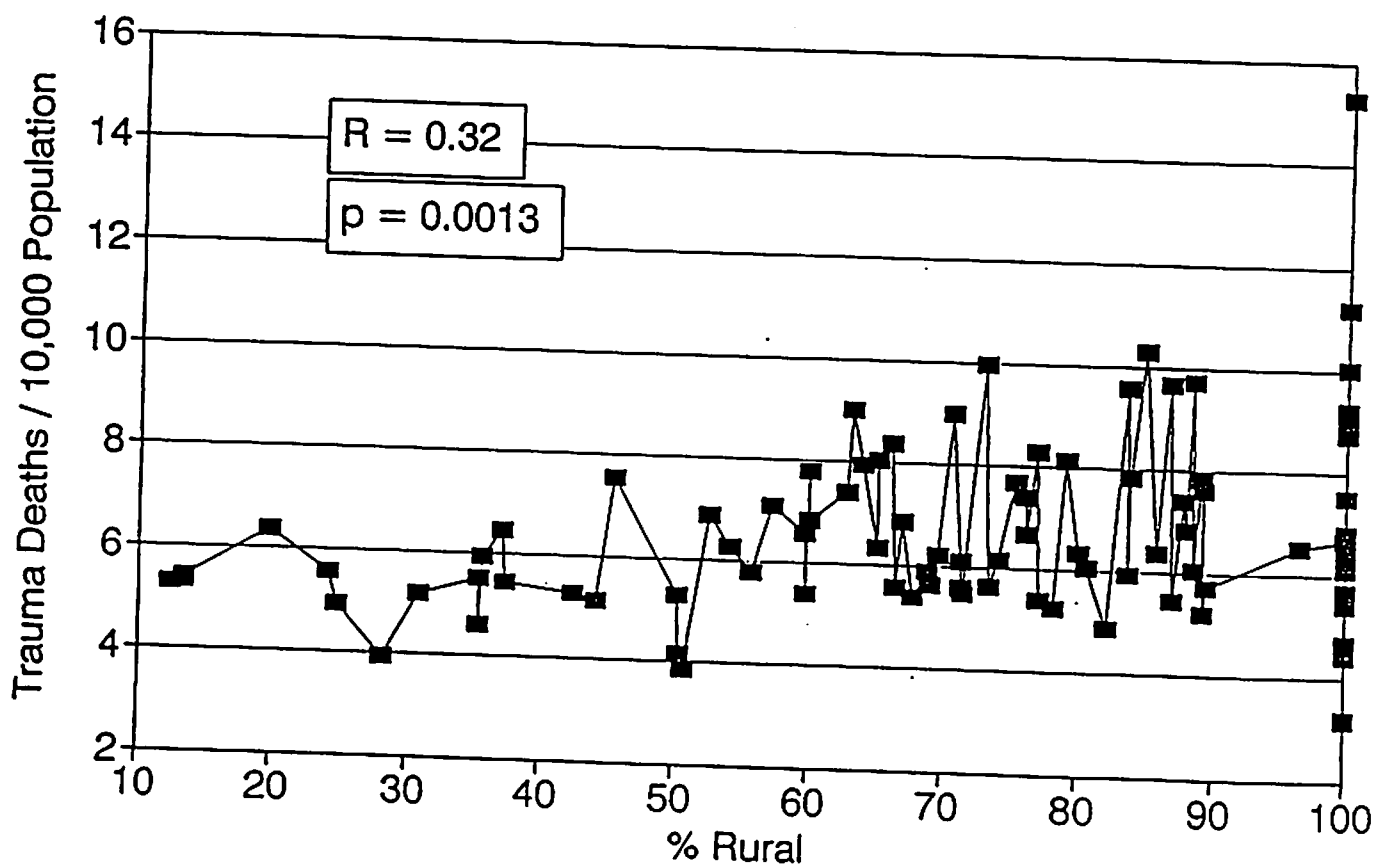


Figure 6

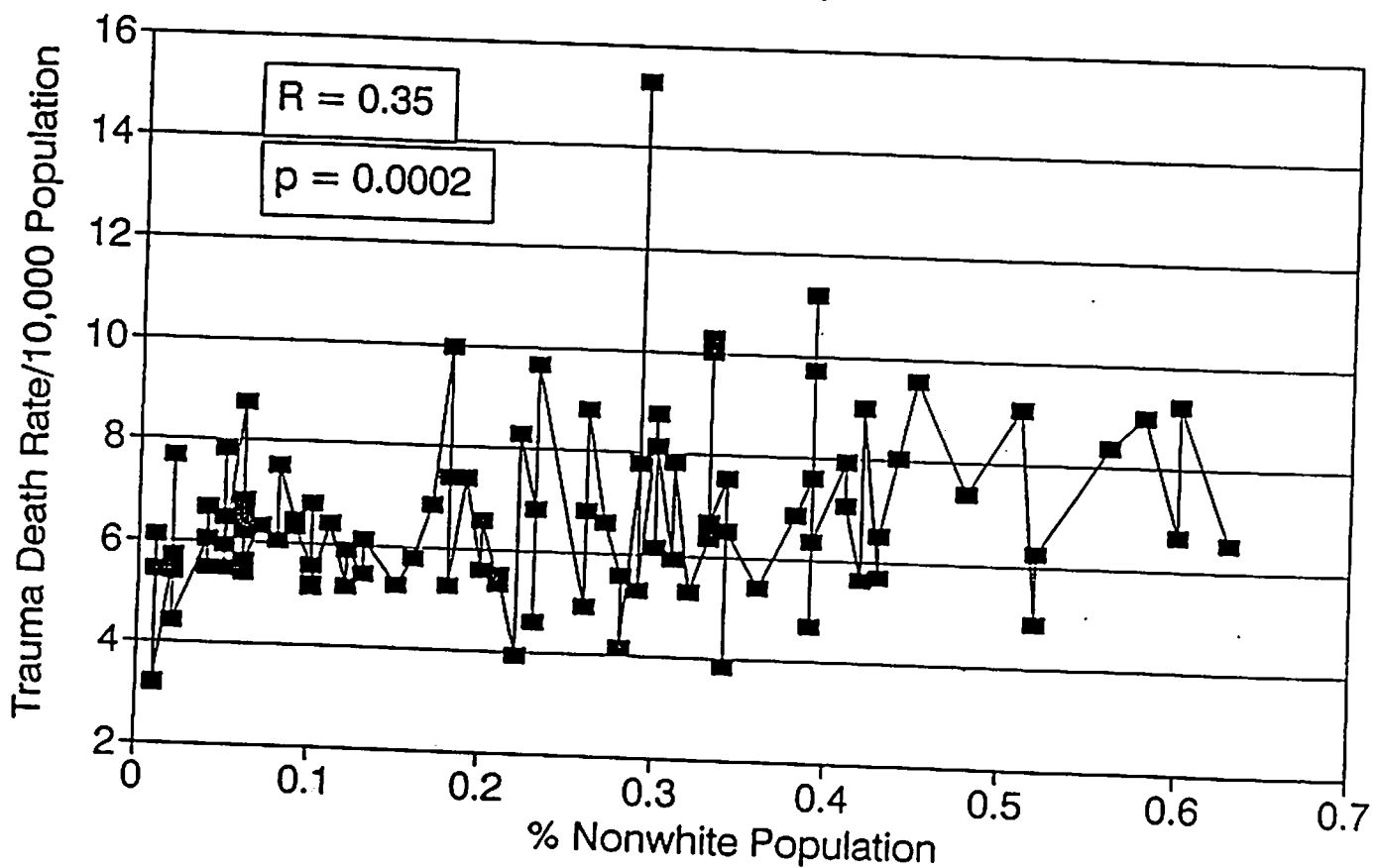# Per Capita Trauma Death Rate and
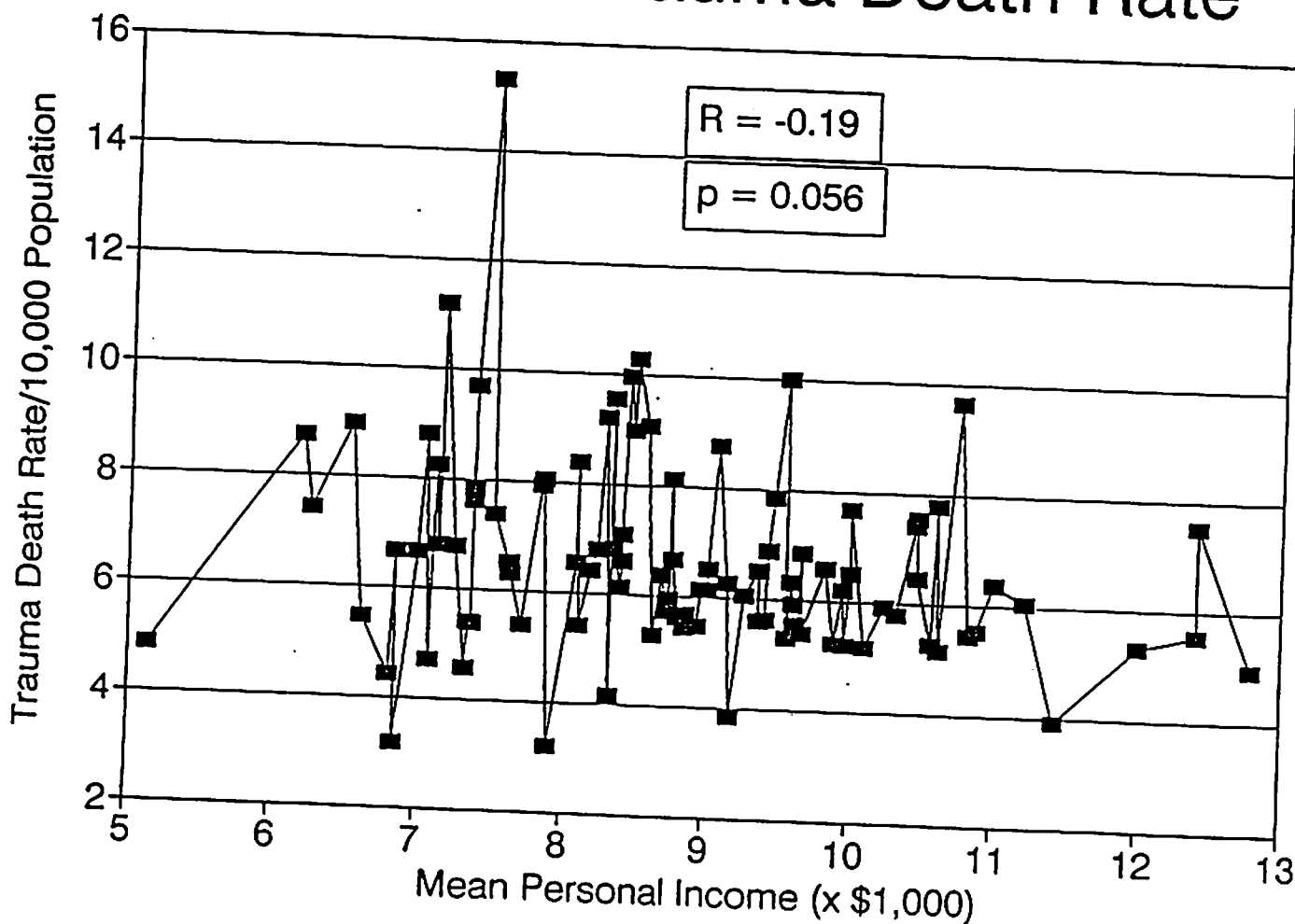## % Nonwhite Population



Figure 7

Figure 8

# Unemployment and Trauma Death Rate



Figure 9

Figure 10
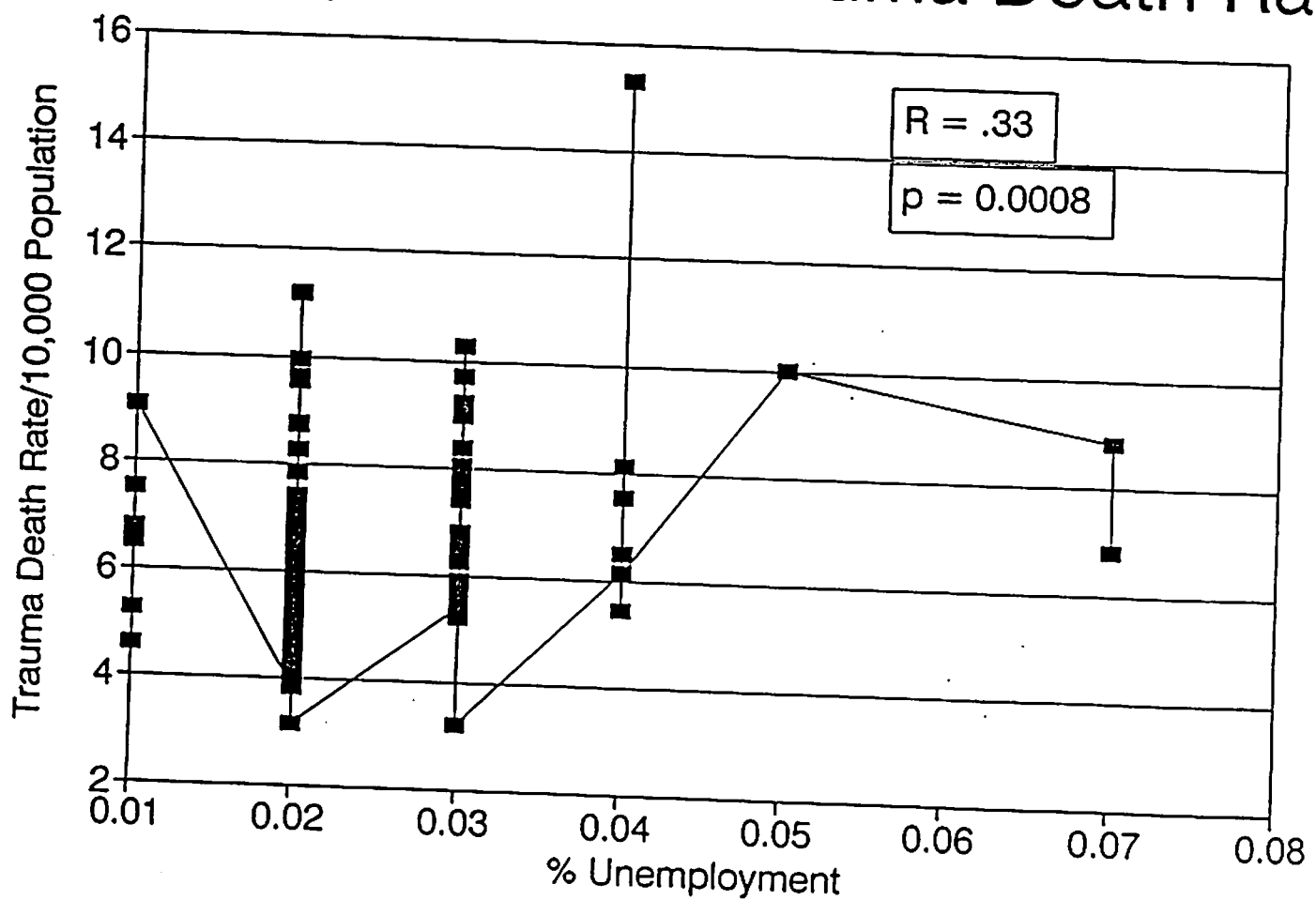
Urban Cresent

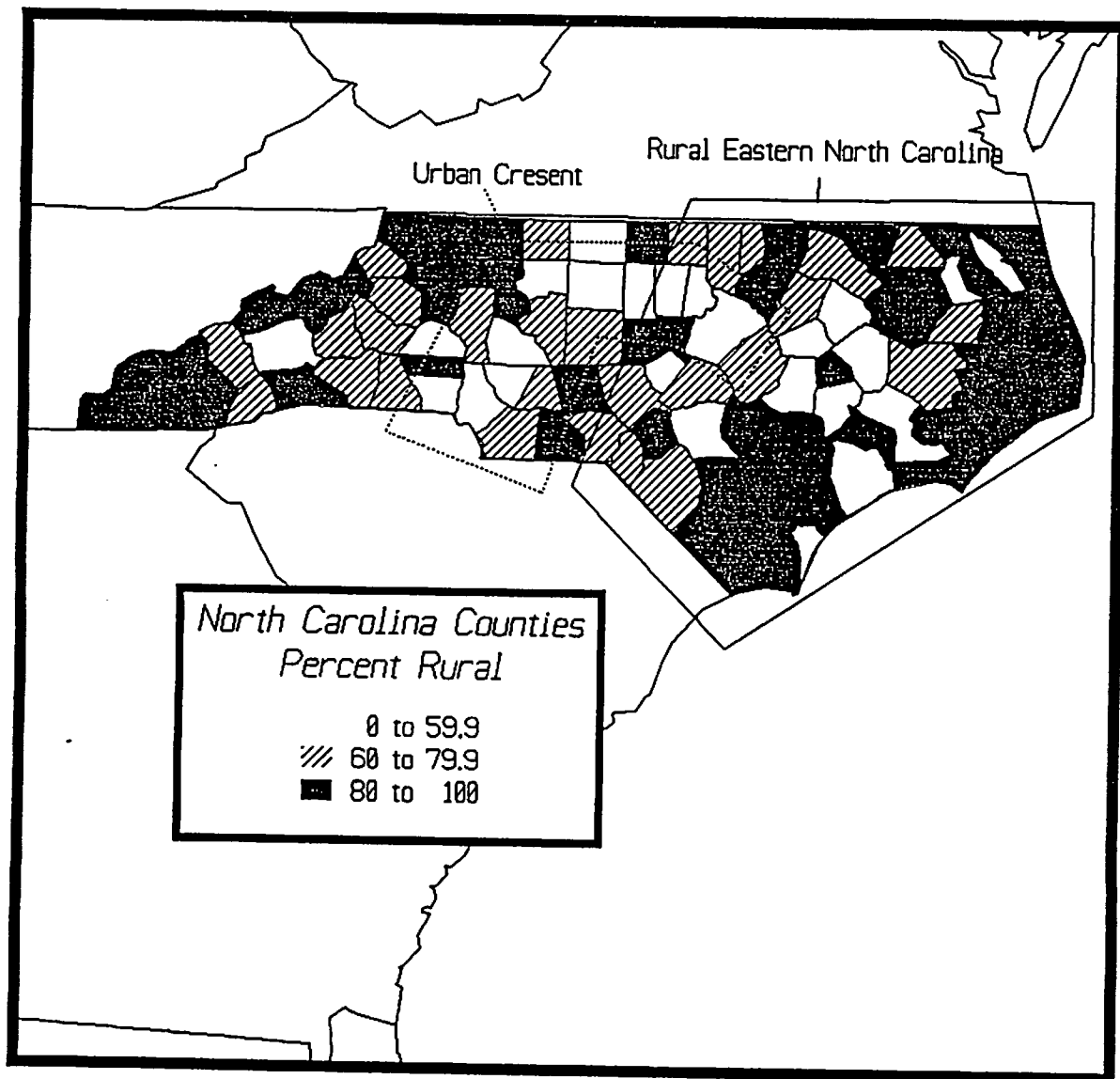Rural Eastern North Carolina

NC Trauma Deaths (1986-8)
Total Number of Deaths

0 to 79
80 to 139
140 to 900

Figure 11

Urban Cresent

Rural Eastern North Carolina

**North Carolina Counties Percent Rural**

| | |
|---|---|
| | 0 to 59.9 |
| /// | 60 to 79.9 |
| ■■■ | 80 to 100 |

Figure 12

Figure 13

Map labels:
- Urban Cresent
- Rural Eastern North Carolina

Legend:

1986-88 North Carolina
Per Capita County Deaths

0 to 5.9
6 to 6.9
7 to 25