
Hills, Ridges, Mountains, and Roads: Geographical Factors and Access to Care in Rural Kentucky

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ABSTRACT: Access to health care remains an important issue facing many individuals. Barriers to health care include financial factors, characteristics of the individuals and of the health care delivery system, as well as geographical factors. Using a telephone survey of Kentucky residents, this study investigated the relationship between the road quality and county elevation and access to health care for individuals in rural and urban areas of the state. Controlling the comparison for known individual characteristics, community characteristics, and medical infrastructure characteristics, this study uncovered that worse road conditions, measured by a road "rideability" index, were associated with longer times to reach medical care. It also found an association between higher county elevations and shorter times to reach medical care.

Access to health care remains an important issue for many groups of people, including those living in rural areas, individuals who are poor or uninsured, and members of different minority groups. Lack of access to appropriate health care facilities or to physicians has been noted to have a negative effect on individual health status (Bindman, Keane, & Lurie, 1990; Lurie, Ward, Shapiro, & Brook, 1984). Reporting the results of a survey, Freeman, Blendon, Aiken, Sudman, Mullins, and Corey (1987) found that the overall gap in access to health care between individuals living in rural and urban areas had improved, although inequities remained for certain subgroups. Several barriers to access to health care are well recognized. Financial factors, not only lack of insurance but also out-of-pocket expenses and insurance that is not accepted or does not provide for the needed services, prevent many individuals from receiving health care (Bashshur, Homan, & Smith,

1994; Blendon, Aiken, Freeman, & Corey, 1989; Cornelious, Beauregard, & Cohen, 1991; Hayward, Bernard, Freeman, & Corey, 1990; Hayward, Shapiro, Freeman, & Corey, 1988; Makuc, Fried, & Kleinman, 1989; Robert Wood Johnson Foundation, 1987; Rowland & Lyons, 1989; Shapiro, Hayward, Freeman, Sudman, & Corey, 1989).

Characteristics of the individual seeking care, including gender, age, and perceived health status, play a role in the way in which each individual seeks health care and interacts with the health care delivery system (Bashshur, et al., 1994; Blendon, et al., 1989; Cornelius, et al., 1991; Hayward, et al., 1990; Hayward, et al., 1988; Makuc, et al., 1989; Robert Wood Johnson Foundation, 1987; Rowland & Lyons, 1989; Shapiro, et al., 1989). In addition, there is concern that geographic factors, such as distance to the physician's office or hospital, transportation, and road quality affect the ability of individuals to travel to the appropriate site to receive health care (Rowland & Lyons,

1989; Williams, Schwarz, Newhouse, & Bennett, 1983). A statewide survey in Michigan concluded that 17 percent of the population had experienced one or more obstacles to health care posed by geographical, temporal, attitudinal, or financial barriers (Bashshur, et al., 1994). For elderly individuals, many of whom have physical limitations and transportation difficulties, these barriers may represent a more serious problem.

Access to health care was studied using a matrix of variables describing societal health policy, characteristics of the health care delivery system, characteristics of the individual and the community, measures of utilization of health services, and measures of consumer satisfaction (Aday & Andersen, 1974). Using this model, this study investigated access to health care among Kentucky residents, focusing on differences in access for individuals who lived in rural areas and differences based on geographic factors, such as road quality and mountainous terrain. This question was posed: Is there any association between geographic variables and access to health care?

Methodology

Data from several sources were used to provide information concerning individuals, communities, and health care infrastructures. The Kentucky Health Survey is an annual, random digit dialing survey of Kentucky residents older than age 18. Each year, the Kentucky Health Survey includes questions regarding different health topics and issues. In 1991, 1,000 state residents were included in the sample. Interviews were completed with 685 individuals for a response rate of 68 percent. In 1991, the survey included basic demographic data and information about respondents' regular sources of medical care and their use of preventive measures. The 1990 census provided community-level characteristics. Other data were garnered from the 1990 American Medical Association Characteristics of Physicians, which provided data regarding the number of active physicians in each county. Additionally, the Kentucky Geological Survey was employed to provide county geographical data, and the Kentucky Department of Transportation Road Survey provided information concerning the roads in each county.

To evaluate access to health care, several measures were employed from the 1991 Kentucky Health Survey: (1) having a regular physician, (2) reporting a physical examination within the last two years, (3)

estimated time to reach medical care in minutes, (4) for all women, having had a Pap smear within the previous two years, and (5) for women older than age 50, having ever had a mammogram. All of these variables were dichotomous (yes/no), except time to reach medical care, which was continuous and was analyzed using the natural log of time to reach medical care.

Individual characteristics used in the analysis included the respondent's gender, age, race, marital status, self-reported health status, household income, employment status, education, and type of health insurance. Race was defined as Caucasian or other, marital status as married or other, and employment status as employed or other. Health status was reported as excellent, good, fair, or poor. Respondents were classified as having no health insurance or one of the following types of health care insurance: Medicaid, Medicare, other government insurance, insurance through an employer, self-purchased health insurance, or other type of insurance.

To describe the community characteristics of respondents, information from the 1990 census was used, including the per capita income in the county, the percent of county residents who were unemployed, the percent of the county population whose household income fell below the criteria for the federal poverty limit, and the percent of the county population older than age 65. Rural counties were defined according to the federal designation of non-metropolitan service area (non-MSA), which in Kentucky is designated by county. Appalachian counties were also defined according to federal designation and served as a proxy to define communities that have a number of unique characteristics, including mining as the predominant industry. To describe the medical infrastructure in the community, the number of active physicians in the county where respondents lived was used.

Several measures were used to describe the county geography and roads. The county elevation was defined as the highest recorded point of elevation, and county-level indication of road quality was defined using the pavement index, which is a five-point scale developed by the Kentucky Department of Transportation, with 1 assigned to roads with the poorest quality and 5 assigned to roads with the best quality. This index is derived from the Kentucky

Department of Transportation's annual survey of roads during which each road is scored based on the result of driving a standard state care equipped with a sensor measuring the bumpiness of the road. In addition, information from the Kentucky Department of Transportation was used regarding the number of miles of roads in each county in each of the following classifications: state primary, state secondary, state supported, and rural secondary roads. In each county, each class of roads is given a separate pavement index. To obtain an overall county pavement index, the number of miles of roads in each category was totalled and then multiplied by the score for that classification and the total then divided by the total number of miles of roads in the county. For example, county A has 67 miles of state primary roads, with a pavement index of 3.30, 140 miles of state secondary roads with a pavement index of 3.19; 46 miles of state supported roads, with a pavement index of 2.67; and 235 miles of rural secondary roads with a pavement index of 2.56. The overall road pavement index, or "rideability" index, is 2.87.

Descriptive statistics were calculated for all respondents and, to compare between groups, student's t-test was used for continuous variables and *chi* square for categorical variables. Pearson's correlations, point biserial or phi coefficients, were calculated to describe the relationship between individual variables. Multiple linear or logistic regression was used to explore the relationship between the geographical variables and access to health care while controlling for known characteristics of individuals, communities, and health care infrastructures that are associated with differences in access to health care. In multiple linear regression, the coefficient (beta) for each geographical variable was computed as a measure of the association between the dependent variable describing access to health care and the geographical variables. In logistic regression, the odds ratio and corresponding confidence intervals for each geographical variable were computed as a measure of the association between the dependent variable describing access to health care and the geographic variables. Descriptive statistics and linear regression were performed using the Statistical Package for the Social Sciences (SPSS). Logistic regression was performed using the Epidemiologic Graphics, Estimation, and Testing package (EGRET). For comparisons between groups, a two-tailed alpha of $P < 0.05$ was considered significant.

To construct the regression models for access to health care, the variables describing individual

characteristics were entered first, followed by the characteristics of the community and the health care infrastructure. The variables describing the county, geography, and road quality were entered next to determine if any additional variance in the model could be explained by these variables. To test for significant differential effects, interaction terms between community characteristics and the relevant individual characteristic, such as age and the population percent older than age 65 and employment status, and the population percent unemployed, were added to the model. The model also was tested with interaction terms between the county, geographic, and road quality variables.

Results

More than one half of the respondents were women, with a mean age of 46.7 years. As reflects the population of Kentucky, the majority were Caucasian. Approximately 20 percent were older than age 65, and two thirds were married. One half of the respondents reported good or excellent health status. Only 9 percent reported no health insurance. Comparing the respondents in four categories of county descriptors (Appalachian rural, Appalachian urban, non-Appalachian rural, and non-Appalachian urban), rural Appalachian respondents were found to be older than their urban counterparts. Non-Appalachian rural respondents were more likely to be caucasian and less likely to be insured through an employer than their counterparts in non-Appalachian urban counties (Table 1).

Regular Physician. More than 85 percent of all respondents reported having a regular physician. No significant difference was found for having a regular physician when comparing respondents from Appalachian rural counties to those in Appalachian urban counties or when comparing respondents from non-Appalachian rural counties and non-Appalachian urban counties. The univariate correlation with having a regular physician was significant for several individual characteristics: age, female, having employer-based insurance, and reporting no health insurance (Table 2). There was no significant correlation for any of the community or health care infrastructure variables, nor for the county elevation or road rideability index.

In the regression model, to predict having a regular physician, controlling for individual charac-

Table 1. Demographic Characteristics of Respondents by County of Residence.

	Appalachian Counties		Non-Appalachian Counties	
	Rural n=158	Urban n=30	Rural n=236	Urban n=260

Individual Characteristics

Mean age	46.3	55.2'	45.9	45.8
Percent female	53	53	51	53
Percent white	96	100	96	89"
Percent employed	57	40	61	63
Percent married	66	57	64	57
Mean years of education	11.9	11.1	12.3	13.3"
Percent reporting good health	58	67	52	43
Mean household income (\$)	21,500	20,500	24,500	27,500'
Percent reporting medical insurance				
Employer	48	47	56	70**
Medicare	23	33	20	23
Medicaid	10	17	8	4
Self-purchased	20	30	29	23
Percent uninsured	18	10	9	5
Percent reporting outpatient coverage	67	57	81	87

Community Characteristics**

Percent unemployment	11.7	9.0**	10.7	5.3**
Per capita income (\$)	8,000	10,600"	10,600	13,800"
Percent below poverty level	30.2	19.9"	17.2	13.1"
Percent older than 65 years	29.8	18.5""	21.0	13.6"
Percent high school graduates	49.7	62.5""	64.6	75.0"
Lumber of MDs	27	48	37	1,068"
County elevation (in feet)	2,030	1,200""	910	969"
Road ridability index	2.78	3.03"	2.95	2.91"
Percent reporting a regular MD	84	90	84	87
Percent reporting a physical exam in past two years	63	48	70	72
Time to help (minutes)	28.9	22.0	20.5	14.6**
Percent of women reporting a Pap smear in two years	68	50	67	81*
Percent of women reporting a mammogram ever	62	73	52	73'

P<0.01
* P<0.001

Coding of individual and community characteristics:
Each of the following variables is dichotomous and is coded as 0=no, 1=yes; female; white; employed; married; good health; employer insurance; Medicare insurance; Medicaid

insurance; other government insurance; self-purchased insurance; uninsured; outpatient coverage; regular MD; physical exam in two years; pap smear in two years; mammogram ever; rural county; Appalachian county.
Each of the following variables is continuous: age; years of education; household income; percent unemployment; per capita income; percent living below the poverty level; percent 65 years or older; percent high school graduates; number of MDs; county elevation; time to medical help in minutes.
Other variables: The road ridability index is a continuous variable using a 5-point scale with 1=poorest quality to 5=best quality.

teristics, community characteristics, and health care infrastructure characteristics, living in a non-Appalachian rural county was negatively associated with having a regular physician, but county elevation was not significant. The road ridability index also was negatively associated with having a regular physician. However, when both county designations and the road ridability index were entered into the model, only road ridability remained significantly associated with having a regular physician. Interaction terms between the county designations and the road rideability index were not significant. In this study's model, controlling for individual, community, and health care infrastructure characteristics, as the road rideability index improved, the individual was more likely to have a regular physician (Table 3).

Physical Exam in the Past Two Years. Sixty-eight percent of all respondents reported having had a physical exam in the two years prior to the survey. No significant difference was found in having a physical exam when comparing respondents from Appalachian rural counties to those in Appalachian urban counties or when comparing respondents from non-Appalachian rural counties and non-Appalachian urban counties (Table 1). The univariate correlation with having had a physical exam was significant for three individual characteristics: having a regular physician, having no health insurance, and having outpatient health care. There was no significant correlation of having had a physical exam with community characteristics; however, the county designator of Appalachian was significantly negatively correlated with having had a physical exam in the past two years. There was no significant correlation with having had a physical exam for the county elevation or road ridability index (Table 2).

In the regression model, to predict having had a physical exam in the past two years, controlling for individual characteristics, community characteristics

Table 2. Correlation Matrix for Measures of Access and Individual and Community Characteristics.

	Physical Exam in Past Two Years	Has a Regular MD	Time to Reach Medical Care	Pap Smear in Past two Years	Mammogram Ever
Individual Characteristics					
Age	0.03	0.12'	0.14'''	-0.30''	0.03
Female	0.01	0.12'	0.05	—	—
White	-0.05	0.03	0.04	-0.06	0.06
Employed	-0.06	-0.01	-0.15''	0.18'''	-0.06
Married	-0.07	0.06	0.07	0.09	0.03
Education	0.05	0.06	-0.20**	0.22**	0.11
Good health	0.01	-0.04	0.12'	-0.11	-0.10
Household income	0.02	0.09	-0.19**	0.22'''	0.25''
Insurance					
Employer insurance	-0.01	0.11''	-0.17''	0.17''	0.08
Medicare	0.08	0.05	0.09	-0.19**	-0.02**
Medicaid	0.04	-0.02	0.06	-0.13'	-0.16
Other gov't insurance	0.06	-0.08	0.01	-0.09	0.04
Self-purchased	-0.03	0.06	0.08	-0.03	0.05
Other insurance	-0.02	-0.01	0.01	-0.05	0.14
Uninsured	-0.10'	-0.16''	0.10'	-0.03	-0.03
Outpatient coverage	0.12'	0.03	-0.02	0.05	0.08
Community Characteristics					
% unemployment	-0.05	-0.01	0.10'	-0.03	0.05
Per capita income	0.06	0.03	-0.26''	0.13''	0.11
% below poverty level	-0.08	-0.04	0.20''	-0.11	-0.09
% 65 years or older	0.01	0.04	0.01	-0.11	-0.21'
% high school graduate	0.07	0.02	-0.26''	0.12	0.10
Number of MDs	0.01	0.01	-0.18**	0.09	0.05
County elevation	-0.04	-0.05	0.07	-0.07	0.12
Rural county Appalachian	-0.02	-0.05	0.18**	-0.11	-0.17
county	-0.10	0.0,	0.15''	-0.09	0.03
Road r&ability index	0.02	-0.03	0.22''	0.05	0.06

* P<0.01

** P<0.001

Coding of individual and community characteristics:

Each of the following variables is dichotomous and is coded as 0=no, 1=yes: female; white; employed; married; good health; employer insurance; Medicare insurance; Medicaid insurance; other government insurance; self-purchased

insurance; uninsured; outpatient coverage; regular MD; physical exam in two years; Pap smear in two years; mammogram ever; rural county; Appalachian county.

Each of the following variables is continuous: age; years of education; household income; percent unemployment; per capita income; percent living below the poverty level; percent 65 years or older; percent high school graduates; number of MDs; county elevation; time to medical help in minutes.

Other variables: The road ridability index is a continuous variable using a 5-point scale with 1=poorest quality to 5=best quality

and health care infrastructure characteristics, the county descriptors Appalachian and rural-Appalachian added significantly to the model. However, county elevation and the road ridability index did not add significantly to the model (Table 3). No significant interactions were identified.

Time to Reach Medical Care. Overall, respondents reported an average of 15.4 minutes to reach medical care. No significant difference was found in the time to reach medical care when comparing respondents from Appalachian rural counties to those in Appalachian urban counties, but there was a significant difference when comparing respondents from non-Appalachian rural and urban counties (Table 1). The univariate correlation with time to reach medical care was significant for many variables, including individual characteristics of age, number of years of education, being employed, household income, having employer-based insurance, and being uninsured. The correlation also was significant for the community characteristics of percent unemployed, percent of the population living below federal poverty level, per capita income, and percent of high school graduates. Further, the correlation was significant for the health care infrastructure characteristic of number of physicians in the county. In addition, there were significant correlations for time to reach medical care with the county descriptors, rural and Appalachian, and the road ridability index but not the county elevation (Table 2).

In the regression model, to predict the reported time to reach medical help, controlling for individual characteristics, community characteristics, and health care infrastructure characteristics, the county descriptors did not significantly add to the model. County elevation did significantly add to the model, as did interaction terms between county elevation and the county descriptors of Appalachian and rural-Appalachian. Controlling for individual, community, and health care infrastructure characteristics and the

Table 3. Adjusted* Odds Ratio to Predict Different Measures of Access to Care for County Geographical Descriptors.

	County		Geographical		Descriptor	
	Rural	Appalachian	Rural-Appalachian	County Elevation	Road Rideability Index	
Adjusted [†] odds ratio for having a:	Odds Ratio	95% CI	Odds Ratio	95% CI	Odds Ratio	95% CI
Regular MD Physician examination	0.02	0.1, 0.9	0.4	0.1, 2.2	0.2	0.5, 2.3
Pap smear	0.7	0.4, 1.6	0.3	0.1, 0.9	3.4	1.0, 11.0
Mammogram	0.3	0.1, 1.9	0.5	0.1, 1.8	5.5	0.9, 33.0
	0.4	0.1, 2.3	1.8	0.2, 1.6	0.9	0.1, 11.0
					1.0	0.9, 1.0
					1.5	0.4, 5.8
					6.5	0.7, 62.0
					10.4	4.1, 26.0

* The odds ratio is adjusted for the individual characteristics of age, gender, race, education, marital status, household income, work status, health status, and type of medical insurance; and the community characteristics of percent living below poverty level, percent unemployment, per capita income, percent high school graduates, percent 65 years or older, and the number of physicians in the county.

** Confidence interval.

Coding of individual and community characteristics:

- Each of the following variables is dichotomous and is coded as 0=no, 1=yes: female; white; employed; married; good health; employer insurance; Medicare insurance; Medicaid insurance; other government insurance; self-purchased insurance; uninsured; outpatient coverage; regular MD; physical exam in two years; Pap smear in two years; mammogram ever; rural county; Appalachian county.
- Each of the following variables is continuous: age; years of education; household income; percent unemployment; per capita income; percent living below the poverty level; percent 65 years or older; percent high school graduates; number of MDs; county elevation; time to medical help in minutes.
- Other variables: The road ridability index is a continuous variable using a 5-point scale with 1=poorest quality to 5=best quality.

county descriptors, the road ridability index added significantly to the model. Furthermore, with the addition of the road rideability index to the model, the county descriptor for rural Appalachian counties became significant. Interaction terms between road ridability index and the county descriptors were not significant. Controlling for individual characteristics, community characteristics, and health care infrastructure characteristics, respondents in counties with higher elevations reported shorter times to reach medical care than respondents from counties with lower elevations. In addition, controlling for individual characteristics, community characteristics and medical infrastructure characteristics, as the county road rideability index worsened (a lower score), the reported time to reach medical care was longer (Table 4).

Pap Smear in the Past Two Years. Of the 358 women among the survey respondents, 72 percent

reported having had a Pap smear in the two years prior to the survey. No significant difference was found in having had a Pap smear when comparing respondents from Appalachian rural counties to those in Appalachian urban counties, but there was a significant difference when comparing respondents from non-Appalachian rural counties and non-Appalachian urban counties (Table 1). The univariate correlation with having had a Pap smear was significant for several individual characteristics, including age, education, being employed, household income, and type of insurance. In addition, the univariate correlation with having had a Pap smear was significant for one variable that describes the community—per capita income. There was no significant correlation for the county descriptors of county elevation and road ridability index (Table 2).

In the regression model, to predict having ever had a Pap smear, controlling for individual character-

Table 4. Adjusted Regression Coefficients to Predict Time to Reach Medical Care by County Geographical Descriptors.

County Descriptors	Standardized Beta	t	P Value	Model r ²
Rural county	0.0154	0.10	0.9	0.20
Appalachian county	0.0333	0.17	0.8	0.20
Rural-Appalachian	-0.4164	-1.87	0.06	0.20
County elevation	-0.2053	3.19	0.002	0.21
Road rideability index	-0.1178	-2.40	0.017	0.21

The regression equation adjusts for the individual characteristics of age, gender, race, education, marital status, household income, work status, health status, and type of medical insurance; and the community characteristics of percent living below poverty level, percent unemployment, per capita income, percent high school graduates, percent 65 years or older, and the number of physicians in the county.

Coding of individual and community characteristics:

- Each of the following variables is dichotomous and is coded as 0=no, 1=yes: female; white; employed; married; **good** health; employer insurance; Medicare insurance; Medicaid insurance; other government insurance; self-purchased insurance; uninsured; outpatient coverage regular MD; physical exam in two years; Pap smear in two years; mammogram ever; rural county; Appalachian county.
- Each of the following variables is continuous: age; years of education; household income; percent unemployment; per capita income; percent living below the poverty level; percent 65 years or older; percent high school graduates; number of MDs; county elevation; time to medical help in minutes.
- Other variables: The road rideability index is a continuous variable using a 5-point scale with 1=poorest quality to 5=best quality.

istics, community characteristics, and health care infrastructure characteristics, the county descriptors, county elevation and the road rideability index did not add significantly to the model (Table 3). No significant interactions were identified.

Mammogram. Of the 177 women older than age 50 among the survey respondents, 62 percent reported having ever had a mammogram prior to the survey. No significant difference was found in having had a mammogram when comparing respondents from Appalachian rural counties to those in Appalachian urban counties, but there was a significant difference when comparing respondents from non-

Appalachian rural counties and non-Appalachian urban counties (Table 1). The univariate correlation with having ever had a mammogram was significant for one individual characteristic, household income, and one community characteristic, percent of population older than age 65. There was no significant correlation for the county descriptors, county elevation, or road rideability index (Table 2).

In the regression model, to predict having ever had a mammogram, controlling for individual characteristics, community characteristics, and health care infrastructure characteristics, the county descriptors and county elevation did not add significantly to the model. No significant interactions were identified. The road rideability index did significantly add to the model; however the wide confidence interval around the odds ratio indicates that the actual value of the odds ratio should be interpreted with caution. Respondents living in counties with better roads (higher score) were more likely to report having had a mammogram than respondents who lived in counties with worse roads. There were no significant interactions identified between the road rideability index and county descriptors (Table 3).

Discussion

The association between geographic factors and access to care for Kentucky residents was studied. The road rideability index, as defined by the Kentucky Department of Transportation, was found to be associated with certain aspects of obtaining medical care. Specifically, longer times to reach medical care were associated with worse road conditions. In addition, better road conditions were associated with having a regular physician and, for women older than age 50, having had a mammogram. This finding was independent of the rural or urban location of the county. Moreover, this finding was significant despite the fact that several other community descriptors were entered into the model that describe community sociodemographics, suggesting that the association between the road condition and access to medical care is not fully explained by measures of the wealth of the community.

County elevation also was found to be only significantly associated with the time to reach medical care. Higher county elevations were associated with shorter times to reach medical care.

Only a crude measure of county elevation, the highest elevation in the county, was usable. How-

ever, it is not descriptive of the changes in the elevation due to the local geography nor does it reflect the county elevation of each individual person. One explanation for this finding is that the counties with higher elevations in Kentucky are primarily in the southeastern region, the Appalachian region, of the state. While many people live in rural settings, they tend to be congregated into communities. In addition, the Appalachian Regional Health Association has been active in this part of Kentucky for more than 50 years. As part of the effort to provide access to health care for the individuals who work in eastern Kentucky, the association has established a network of hospitals and clinics. In contrast, many of the areas of Kentucky that are at relatively lower elevation are primarily farming regions where there are a few central communities and many people who live in less densely populated areas. Thus, an individual from a farming community at a lower elevation might live a greater distance from health care than an individual in a community at a higher elevation in the Appalachian region. The greater distance takes longer to cover to reach medical care than the shorter distance, even if there are more curving, mountain roads at the higher elevation. Unfortunately, information was unavailable about the actual distance traveled to reach medical care.

When using the county descriptors of rural and Appalachian, some significant associations with the different measures of access to care at the univariate level were found. However, few significant associations were found when these terms were added to the regression models that adjusted the comparison for individual and community characteristics, including several measures of community sociodemographics. Adding the general terms of "rural" and "Appalachian" did not explain any additional variance, suggesting that much of the difference seen between rural and urban individuals, and those in Appalachian and non-Appalachian communities, is explained by the use of the community sociodemographic measures.

There are several limitations to this study. First, as noted above, some of the variables (e.g., the road readability index) are measured at the community level not the individual level. This study was conducted as a multilevel analysis that investigated the association between individual access to health care in terms of individual and community variables (Von Korff, Koepsell, Curry, & Diehr, 1992). While the study would have benefited from individual data concerning the road quality, and would perhaps have

shown a stronger association between road quality and access, the community measurement holds some validity because all individuals from the community must use the roads. Second, the survey was conducted by telephone. According to the 1990 census, in Kentucky the percent of people in each county who do not have telephone varies from about 2 percent to a maximum of 29 percent. Individuals who do not have a telephone could not be included in the survey. This systematic exclusion of certain state residents may bias the results. Because the counties that have the higher rates of people living without telephones are rural and Appalachian counties, the bias introduced may make differences more difficult to detect. Finally, although survey respondents from Appalachian urban counties were included, their number was much lower than for the other three county groups, making it more difficult to find significant differences for this group of people.

Despite these limitations, this study suggests that road conditions and geography are associated with reported receipt of health care. While there may be different health beliefs among people who chose to live in areas with worse road conditions and those who chose to live in sparsely populated rural communities, these results generate many questions concerning the relationship among individuals, their environments, and access to health care. Clearly, further study is needed that addresses some of the limitations noted in this study. Public health officials often have been concerned with the influence of environmental factors, such as water quality and the availability of sewage treatment, on the health of community residents. In the study of access to health care, the influence of the community and environmental factors, such as road quality and geography, on the access of individuals must be understood as improvement in access for all community residents is sought.

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