Special Populations, Special Services

The Effects of Geography and Spatial Behavior on Health Care Utilization among the Residents of a Rural Region

Thomas A. Arcury, Wilbert M. Gesler, John S. Preisser, Jill Sherman, John Spencer, and Jamie Perin

Objective. This analysis determines the importance of geography and spatial behavior as predisposing and enabling factors in rural health care utilization, controlling for demographic, social, cultural, and health status factors.

Data Sources. A survey of 1,059 adults in 12 rural Appalachian North Carolina counties.

Study Design. This cross-sectional study used a three-stage sampling design stratified by county and ethnicity. Preliminary analysis of health services utilization compared weighted proportions of number of health care visits in the previous 12 months for regular check-up care, chronic care, and acute care across geographic, sociodemographic, cultural, and health variables. Multivariable logistic models identified independent correlates of health services utilization.

Data Collection Methods. Respondents answered standard survey questions. They located places in which they engaged health related and normal day-to-day activities; these data were entered into a geographic information system for analysis.

Principal Findings. Several geographic and spatial behavior factors, including having a driver's license, use of provided rides, and distance for regular care, were significantly related to health care utilization for regular check-up and chronic care in the bivariate analysis. In the multivariate model, having a driver's license and distance for regular care remained significant, as did several predisposing (age, gender, ethnicity), enabling (household income), and need (physical and mental health measures, number of conditions). Geographic measures, as predisposing and enabling factors, were related to regular check-up and chronic care, but not to acute care visits.

Conclusions. These results show the importance of geographic and spatial behavior factors in rural health care utilization. They also indicate continuing inequity in rural health care utilization that must be addressed in public policy.

Key Words. Utilization, rural health, geographic factors, health behavior model, GIS

The goal of this analysis is to determine the importance of geographic and spatial behavior factors in the health care utilization of the residents of rural

communities. These geographic factors are part of a general conceptual framework of rural health care utilization. The health and health care of rural Americans are complex. Rural Americans are disadvantaged compared with their urban counterparts in several important ways that affect their health: they are disproportionately poorer, proportionately fewer are of working age, and they have less education (Ricketts 1999). The rural U.S. has 20 percent of the national population, but less than 11 percent of its physicians. Rural versus urban residents are more often uninsured (18.7 versus 16.3 percent), more likely to report being in fair or poor health, have restricted activity, and lower levels of access to a regular primary care provider (Ricketts 1999).

A major problem that rural dwellers face is access to care (Ricketts and Savitz 1994; Medicare Payment Advisory Commission 2001). Although access can be measured in many ways, geographic access is of primary concern in many rural areas. People who live in isolated places, relatively far from metropolitan areas or urban centers, often find it very difficult to contact health care personnel or facilities. In comparison with urban dwellers, rural residents have to travel farther to care and face other problems such as poor quality roads and lack of public transportation. These problems are well known and yet their solution eludes the efforts of the U.S. Congress, state legislatures, and regional governments (Ricketts 1999).

Conceptual Model

The conceptual model that organizes this study integrates concepts from health geography (Joseph and Phillips 1984) with the health behavior model (HBM) (Aday and Andersen 1974). The HBM considers three sets of utilization factors: (a) predisposing factors (e.g., family composition, social structure, and health beliefs), (b) enabling factors (e.g., income, health insurance status, physician availability), and (c) need for care. These three sets of factors

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Address correspondence to Thomas A. Arcury, Ph.D., Professor and Research Director, Department of Family and Community Medicine, Wake Forest University School of Medicine, Winston Salem, NC 27157-1084. Wilbert M. Gesler, Ph.D., Professor, and Jill Sherman, M.P.H., Graduate Research Assistant, are with the Department of Geography, University of North Carolina at Chapel Hill, Chapel Hill, NC. John S. Preisser, Ph.D., Research Associate Professor, and Jamie Perin, B.S., Graduate Research Assistant, are with the Department of Biostatistics, University of North Carolina at Chapel Hill, Chapel Hill, NC. John Spencer, M.A., is the Assistant Director for Spatial Analysis, Carolina Population Center, University of North Carolina at Chapel Hill, Chapel Hill, NC.

have been further specified to include the external environment (physical, political, and economic) as predisposing and enabling factors, and personal health factors as need factors (Andersen 1995).

We integrate two domains of health geography into HBM's predisposing and enabling factors: characteristics specific to the people of the rural region being studied, and measures of spatial behavior. Regional studies show the importance of understanding social and cultural factors in analyzing behavior (Raitz and Ulack 1984). Measures of geographic access and spatial behavior include distance measures and distance decay effects, as well as transportation availability and activity space (Joseph and Phillips 1984; Nemet and Bailey 2000). Accurate measurement of spatial factors is now attainable with geographic information system (GIS) analytical techniques (Higgs and White 1997). A GIS is a spatially informed information system that can be used to collect, analyze, and interpret spatially referenced data.

Predisposing Factors

Geographic access variables integrated into the model include distance, a special concern to many people who reside in rural areas. A distance decay effect in consumer travel behavior is often found; i.e., increasingly smaller proportions of populations use services at greater distances from them. The degree of distance decay varies by type of illness or illness severity (Girt 1973), level in a service hierarchy (Gesler and Cromartie 1985), and various population characteristics (Bronstein and Morissey 1990). Distance can be measured in many ways, including linear distance across a map, road distance, travel time, perceived distance, perceived travel time, and distance to nearest provider (Haynes 1991; Love and Lindquist 1995; Welch, Larson, and Welch 1997).

Another geographic consideration that influences people's utilization behavior is mobility. More mobile people have better access to health care and yet may use health care providers less because they are young or relatively healthy. One approach to considering mobility is through observing individuals' routine activity spaces; that space in which individuals normally act, including the locations of their homes, worksites, and where they shop, visit, or have recreational activities, as well as how often they went to these places (Hagerstrand 1982). Routine activity spaces can be represented by standard deviational ellipses (SDEs) (Yuill 1971). SDEs capture the spatial distribution of an individual's activity destinations around a mean center and an ellipse at one standard deviation from this center. This ellipse includes approximately two-thirds of the individual's activity destinations. An SDE is created in two

stages, first by calculating the mean center of the spread of destinations, in this case where respondents went for their activities, then calculating the standard deviation of the points from the mean location. In this way, SDEs provide a picture of the concentration or dispersion of activity destinations, and they illustrate the predominant direction of those destinations.

Culture constitutes another set of predisposing behaviors. This study was conducted in the Appalachian Region. This dictated the selection of health beliefs and practices to be included in the conceptual model, including detrimental health behaviors (Pearsall 1960), the use of folk medicine (Cavender and Beck 1995), the effects of conservative religion on medical care use (Humphrey 1988), and alienation from national society (Plaut 1988).

Enabling Factors

Transportation is an important enabling factor in the conceptual model. Finding the means to travel to care is a problem for people in any health care system, but more so in rural areas where public transportation networks are often poor and there is generally less access to personal vehicles (Kihl 1993; Gesler et al. 2001). However, little is known about transportation for health care in rural areas (Damiano et al. 1994; Gesler et al. 1999).

Among other enabling factors, those with low incomes and people of color make less use of health care services than do those who have higher incomes and are white (Gornick et al. 1996; Kaiser Family Foundation 1999). With Appalachia's widespread poverty, it is particularly important to consider income and insurance as enabling factors. While there are few persons of color in Appalachia, an effort was made to include a sufficient number in the study sample for analysis so that ethnicity is also included as an enabling factor.

Need Factors

An important focus for utilization studies is an examination of specific need-based conditions and types of utilization (Kasper 1998; Gelberg, Andersen, and Leake 2000; Field and Briggs 2001). The three types of utilization in our model, checkups, acute care, and chronic care, reflect this emphasis. Health care utilization depends at least partially on need, and a level of need measure is often included in utilization models as an independent or control variable. Need is often measured as health status, either by medical tests or by self-report (Ware, Kosinski, and Keller 1996).

Priority of Factors

In the ongoing development of the HBM, Aday and Awe (1997) have proposed that less-discretionary utilization, e.g., behaviors in response to disease or disorder, is influenced primarily by "need" factors. More discretionary utilization, e.g., behaviors that are preventive in nature, is influenced primarily by predisposing and enabling factors. Therefore, we expect the geographic and spatial behavior variables (which are predisposing and enabling factors, and not need factors) to have their strongest relationship to the number of regular check-up visits, which are most discretionary, and to have no relationship to the number of acute care visits, which are nondiscretionary. They may have some relationship to the number of chronic care visits, which are somewhat discretionary.

Research Design

The data for this analysis are based on 1,059 survey interviews completed by the Mountain Accessibility Project (MAP) in 12 rural North Carolina mountain counties in 1999 by Research Triangle Institute (RTI 2000). These 12 counties (Cherokee, Clay, Graham, Haywood, Henderson, Macon, McDowell, Mitchell, Polk, Swain, Transylvania, Yancey) are all in the four most rural Beale Code categories (Butler and Beale 1994).

Western North Carolina resembles other rural parts of the U.S. It contains some very isolated communities. For many residents distances to urban places of any size are relatively great, roads are often winding because of the mountainous terrain, and movement may be difficult in inclement weather. Thus some survey respondents will have experienced the extremes of rurality. Other parts of the region are accessible to towns and amenities, and some residents have good transportation availability and are quite mobile. Four lane highways, shopping malls, and expensive summer homes appear increasingly on the landscape.

Data Collection

Personal interviews were conducted in participants' homes by trained interviewers. Data collection began in June 1999, and continued through January 2000. The study protocol was approved by the Institutional Review Boards of the University of North Carolina at Chapel Hill, Wake Forest University School of Medicine, and RTI.

The questionnaire addressed demographic and socioeconomic characteristics, health status, heath insurance coverage, medical care options, location of health care providers, beliefs about health care, use of health care services, health prevention behavior, religious beliefs, location of daily activity, and degree of alienation. Respondents were also asked to locate places in which they engaged in a series of health related (e.g., a physical examination), and normal day-to-day activities (e.g., buy groceries, attend church) on a set of maps. The coordinates for each place were entered into a GIS. Interviewers used a GPS unit to record the exact latitude and longitude of the respondents' homes. All of this information, the household coordinates, the activity destinations, as well as other ancillary items such as county outlines, the road network for the study area and surrounding counties, and primary care provider locations were incorporated into a GIS database. The GIS was then used to calculate SDEs, derive distances between households and destinations (both routine and health care) as well as spatial analysis techniques such as point in polygon analysis, buffering, and estimating travel time from households to destinations.

Sample Design and Response Rate

The MAP survey employed a three-stage sampling design (RTI 2000). Field staff selected one adult (aged 18 years or older) and one eligible child (if any) within each household, using a random selection process. Interviews were completed in 1,060 households, including 948 nonminority and 112 black households (in one household only a child interview was completed, so that the total adult interviews completed was 1,059). The overall unweighted household response rate for all counties was 83.8 percent. Screening refusals accounted for 148 of the 179 refusals, or 83 percent of all refusals. RTI statisticians developed sampling weights for use in data analysis.

Measurement

Health Care Utilization. The outcome variables are the total number of health care visits in the past 12 months separately determined for regular check-up visits, chronic care visits, and acute care visits. Respondents were asked in separate questions how many times in the previous 12 months they had visited a health care provider or a health care facility, the reason for each visit ("regular check-up," "chronic condition, such as arthritis, diabetes, heart disease, cancer, asthma," or "acute condition, such as a heart attack, broken

bone, injury, sudden fever, severe chest pains, severe asthma attack"), and the number of visits for each reason. Because of outliers, the number of visits was truncated at the 99th percentile for the distributions of number of provider or facility visits for a specific reason. Finally, three outcome measures according to reason for visit were created by summing provider and facility visits.

Predisposing Factors. Predisposing factors include measures of geographic accessibility, demographic characteristics, family composition, aspects of culture, and health behaviors. The first geographic accessibility measure is routine activity space, the area in square kilometers of the one SDE that encompasses approximately two-thirds of each respondent's routine, nonhealth care activities (Yuill 1971). Minimum distance to a primary care service delivery point (PCSDP) is the road distance in kilometers from each respondent to the nearest PCSDP located in North Carolina. Minimum time to a PCSDP is the estimated travel time to the nearest PCSDP located in North Carolina. These are not necessarily the PCSDPs at which the respondents receive care. Number of PCSDPs located in routine activity space are not necessarily the PCSDPs at which the respondent receives care.

Distance to care characteristics were based on respondents stating which hospital, clinic, or doctor to which they would normally go for "a really bad emergency," "a less serious emergency," and "for regular medical care." The coordinates of these places were entered into the GIS and the distances in kilometers from the respondents' homes to each place were calculated.

Demographic measures are age, in years, and gender. Two measures of family composition are household size, the number of persons living in the respondents' households, and family structure, with the values single person, couple with no children, single person with children, couple with children, and other. Measures of culture include ethnicity, with the values white, black and other. Church attendance has the values of more than once a week, once a week, one or two times a month, one to four times a year, and none. Religiosity has the values of deeply, fairly, and slightly or not at all religious. Respondents believing that they had been cured through prayer is a dichotomous measure, as are respondent answers to the statement that they would choose to pray rather than go to a doctor. Use traditional remedies in the past year is a dichotomous measure (Arcury et al. 2004).

An Alienation score was constructed based on six standard dichotomous alienation items from the General Social Surveys (Davis, Smith, and Marsden 2001): (1) the people running this country don't really care what happens to you; (2) the rich get richer and the poor get poorer;

(3) what you think doesn't count very much anymore; (4) you're left out of things going on around you; (5) most people with power try to take advantage of people like yourself; and (6) the people in Washington, DC, are out of touch with the rest of the country. Responses (1 = yes, 0 = no) to these items were summed, and divided by the number of items answered. The scale had a range 0–1, with higher scores indicating more alienation. The mean for this scale for these survey data was 0.60 with a standard deviation of 0.32. Cronbach's α for this scale was 0.755.

Health behavior measures include current tobacco use, a dichotomous measure. Times per week respondents exercise so that the heart rate was accelerated for at least 20 minutes, is a continuous measure.

Enabling Factors. Personal transportation measures include whether the respondent has a driver's license, the number of days per week the respondent drives a vehicle, whether any person in the respondent's household has a driver's license, the number of vehicles owned by persons in the respondent's household, and whether a member of the respondent's family used a provided ride from a relative or friend as transportation to health care. Public transportation measures include whether the respondent knew of organizations that provided transportation to health care and whether the respondent had used transportation to health care provided by an organization.

Employment has the values employed, home-maker or student, retired, and other. Education was recorded as actual number of years completed, and grouped into values less than high school, high school equivalent, and at least some college. Annual household income was collected as an ordinal variable and further grouped into three categories (less than $20,000, $20,000 to $40,000, more than $40,000). Health insurance coverage had four values: public (e.g., Medicare, Medicaid, VA benefits), private (including HMOs), public and private (e.g., an older adult with Medicare who purchases supplemental private insurance), and none.

Need Factors. Health status measures are the need factors. Two measures of health status are derived from the Short-Form 12 (SF-12) (Ware, Kosinski, and Keller 1996). The SF-12 mental health scale values for these survey data range from 9.90 to 66.92, with a mean of 51.36 and standard deviation of 9.25. The SF-12 physical health values range from 10.61 to 64.86, with a mean of 46.72 and standard deviation of 12.01. Total number of chronic conditions is based on respondents' responses to questions as to whether they had ever

been told by a doctor that they had each of 13 specific conditions plus an "other, specify" option.

Analysis

Analysis was completed in three distinct stages. All *p*-values reported adjust for the stratified cluster sampling design. In the first stage, the unadjusted weighted means and correlations were calculated with associated *p*-values, testing a zero association with the number of health care visits of each type. The weights, equal to the inverse of an individual's probability of selection into the sample, were applied to the sample data in order to provide unbiased population estimates of the mean number of regular check-up, chronic, and acute care visits by subgroups for the 12-county region of interest in western North Carolina. These means were equivalent to incidence densities because the exposure period of 1 year was the same for every adult in the sample. The incidence density was the number of visits per unit time, in this case, 1 year. For the categorical predictors, the means, standard errors, and *p*-values were calculated using survey log-linear regression fit with PROC LOGLINK, testing significantly different mean number of regular check-up, chronic, or acute care visits across categories. The *p*-values for continuous predictors with total regular check-up, chronic, and acute care visits were calculated using survey linear regression fit with PROC REGRESS in *SUDAAN* release 8.0.0 (Shah, Barnwell, and Bieler 2001). Certain continuous variables, routine activity space and the three distance to care measures, were log transformed because they were highly skewed toward large values. The predictors with *p*-values less than 0.10 for at least one outcome (regular check-up, chronic, or acute care visits) were passed on into the next stage of the analysis to be considered as candidates in the final model.

Parsimonious multivariate survey log-linear regression models were identified for the three outcomes. These models were analogues to poisson's regression in the nonsurvey setting and they provided adjusted estimates of the ratios of incidence densities that summarize differences in health care usage between subgroups (Stokes, Davis, and Koch 2000). Initially, two models were selected in the second stage using a backward model selection procedure applied to the predictors identified from stage one. The first model included the predisposing and enabling geographic and spatial behavior measures that passed the initial screening in stage one and had multivariable-adjusted *p*-values less than or equal to an α level of 0.10 for at least one outcome of regular check-up, chronic, and acute care visits. The second model was

similarly fit with all the other predisposing, enabling, and need variables that passed the screening in stage one. In the third and last stage, all of the predisposing, enabling, and need predictors (geographic-spatial behavior and others) were combined into one model. The final model was then selected using backwards selection with an α level of 0.05. Only if a predictor was nonsignificant for all three outcomes was it dropped from the final model. An exception to this rule was that gender, age, income, and type of insurance were retained in the final model regardless of their statistical significance because these personal characteristics were considered to be related to health care utilization. The final model consisted of the same set of predictors presented for each of the three outcomes.

RESULTS

Bivariate relationships of the predisposing, enabling, and need factors to the number of regular check-up, chronic, and acute health care visits are reported in Tables 1 and 2. Several of the enabling geographic or spatial behaviors had a significant relationship to the number of health care visits. Those with a driver's license had significantly greater number of regular check-up visits. Those who had a family member who used a provided ride, and who had used public transportation had a significantly greater number of chronic care visits. Number of motor vehicles in the household was negatively related to number of chronic and acute care visits. The number of PCSDPs within routine activity space and number of motor vehicles in the household were negatively related to number of acute care visits.

Being older and female, ethnicity (being white), smaller household size, not smoking, being outside the labor force (keeping house or student, retired), having poorer physical health (lower SF-12 physical health score, more chronic conditions), and type of health insurance were significantly related to number of regular check-up care visits. Being older and female, having poorer physical and mental health (lower SF-12 physical and mental health scores, more chronic conditions), and less exercise were also related to number of chronic care visits. Reporting one's income, poorer physical health, and having more chronic conditions were related to number of acute care visits.

The adjusted incidence density ratios for the mean number of chronic, regular, and acute number of visits for the final model are reported in Table 3. Two geographic predictors were significantly related to health care visits:

Table 1: Estimated Population Means (Incidence Densities) and Their Standard Errors (SE) of Number of Regular, Chronic, and Acute Health Care Visits in Previous Year: Categorical Predisposing and Enabling Factors

		Regular Check-Up Care Visits			*Chronic Care Visits*			*Acute Care Visits*		
Characteristics	*N*	*Mean*	*SE*	*p*	*Mean*	*SE*	*p*	*Mean*	*SE*	*p*
Predisposing factors										
Gender				.023			.041			.104
Male	397	2.59	0.27		1.96	0.45		1.22	0.13	
Female	662	3.35	0.23		3.35	0.40		1.55	0.14	
Family structure				.173			.759			.125
Single	291	3.37	0.33		3.16	0.51		1.38	0.21	
Couple, no child	383	3.42	0.28		2.96	0.42		1.66	0.19	
Single with child	97	2.54	0.50		2.41	0.75		0.62	0.23	
Couple with child	260	2.56	0.34		2.50	0.63		1.31	0.14	
Other	28	3.83	1.28		3.98	1.33		1.79	0.70	
Ethnicity				.002			.123			0.414
White	923	3.16	0.19		2.73	0.29		1.46	0.10	
Black	113	1.29	0.34		7.58	3.77		1.09	0.30	
Other	16	1.53	0.86		2.05	1.51		0.79	0.55	
Church attendance				.471			.198			0.075
More than once per week	263	3.12	0.45		3.47	0.61		1.70	0.24	
Once per week	255	2.99	0.26		3.07	0.76		1.02	0.15	
1–2 times per month	279	3.43	0.32		2.12	0.39		1.52	0.22	
1–4 times per year	129	2.81	0.41		3.33	1.05		1.84	0.40	
None	129	2.61	0.41		2.02	0.52		1.14	0.23	
Religiosity				.750			.957			0.990
Deep	423	2.94	0.21		2.74	0.50		1.44	0.18	
Fair	482	3.07	0.25		2.92	0.41		1.42	0.13	
Slight, not at all	152	3.43	0.68		2.78	0.53		1.40	0.29	
Cured through prayer				.158			.076			0.152
Yes	347	3.40	0.34		3.66	0.69		1.67	0.21	
No	703	2.90	0.20		2.49	0.29		1.33	0.11	
Rather pray than go to doctor				.195			.947			0.473
Yes	275	2.64	0.37		2.85	0.81		1.31	0.17	
No	775	3.18	0.20		2.80	0.03		1.47	0.12	
Use traditional remedies				.557			.212			0.473
Yes	527	2.96	0.26		3.21	0.46		1.51	0.16	
No	529	3.16	0.23		2.50	0.37		1.36	0.13	
Current tobacco use				.002			.095			0.974
Yes	370	2.22	0.28		2.32	0.35		1.42	0.18	
No	689	3.51	0.23		3.09	0.37		1.43	0.12	
Enabling factors										
Has driver's license				.048			.394			.807
Yes	912	3.16	0.20		2.89	0.33		1.37	0.09	
No	137	2.22	0.38		2.38	0.45		1.48	0.42	

continued

Table 1: *Continued*

		Regular Check-Up Care Visits			*Chronic Care Visits*			*Acute Care Visits*		
Characteristics	*N*	*Mean*	*SE*	*p*	*Mean*	*SE*	*p*	*Mean*	*SE*	*p*
Any household member has a driver's license				.611			.703			.222
Yes	969	3.05	0.19		2.81	0.31		1.44	0.10	
No	90	3.40	0.71		3.12	0.74		1.04	0.27	
Family use of provided ride				.118			.048			.513
Yes	201	3.80	0.57		4.25	0.89		1.30	0.20	
No	848	2.97	0.19		2.63	0.31		1.46	0.11	
Knowledge of public transportation				.325			.670			.215
Yes	608	3.22	0.25		2.67	0.31		1.30	0.11	
No	446	2.92	0.23		2.94	0.53		1.53	0.16	
Use of public transportation				.872			<.001			.248
Yes	48	2.89	1.09		6.96	1.50		2.02	0.60	
No	1,011	3.07	0.19		2.70	0.30		1.41	0.10	
Education				.461			.446			.463
0–11 years	325	3.05	0.36		2.35	0.44		1.56	0.23	
High school or GED	357	2.79	0.30		2.80	0.66		1.51	0.20	
At least some college	368	3.27	0.24		3.19	0.44		1.29	0.13	
Employment				<.001			.100			.126
Employed	547	2.55	0.20		2.07	0.42		1.20	0.11	
Homemaker or student	189	3.37	0.38		3.28	0.60		1.71	0.31	
Retired	267	4.17	0.43		3.82	0.55		1.62	0.21	
Other	56	1.80	0.37		4.16	2.13		1.91	0.79	
Annual household income				.438			.503			<.001
Less than $20,000	417	3.09	0.34		2.59	0.37		1.58	0.20	
$20,000–$40,000	244	2.64	0.34		2.59	0.49		1.94	0.29	
More than $40,000	302	3.16	0.28		3.32	0.60		1.16	0.12	
Missing	96	3.75	0.61		2.01	0.60		0.64	0.15	
Type of health insurance				.030			.199			.081
Public	208	3.43	0.36		4.11	0.88		1.74	0.31	
Private	481	2.91	0.27		2.51	0.47		1.28	0.12	
Public and private	199	3.75	0.28		3.22	0.53		1.83	0.27	
None	165	2.37	0.52		2.14	0.58		1.10	0.21	

SE = standard error.

distance to regular care was significantly associated with the number of regular check-up care visits, and those with a 1 km larger distance to regular care had 95 percent the number of regular check-up care visits, as did residents with a shorter distance to care. Those with a driver's license had an estimated 1.58 times more regular care visits and 2.30 times more chronic care visits, than

Table 2: Population Means and Correlations with Number of Regular, Chronic, and Acute Health Care Visits in Previous Year: Continuous Predisposing, Enabling, and Need Factors

Characteristic	*N*	*Mean*	*SE*	*Median*	*Range*	*Correlation with Regular Check-Up Care Visits (p-Value)*	*Correlation with Chronic Care Visits (p-Value)*	*Correlation with Acute Care Visits (p-Value)*
Predisposing factors								
Routine activity space*	1,059	247.89	17.52	94.46	0, 8228	− 0.04 (.163)	− 0.03 (.210)	0.00 (.915)
Minimum road distance to PCSDP	1,059	6.36	0.44	4.67	.01, 27.8	− 0.06 (.107)	− 0.04 (.189)	0.01 (.867)
Minimum time to PCSDP	1,047	6.04	0.39	4.62	.01, 30.6	− 0.06 (.105)	− 0.04 (.211)	0.03 (.517)
Number PCSDP within routine activity space	1,052	9.88	0.82	4.71	0, 104	0.02 (.667)	− 0.02 (.520)	− 0.07 (.013)
Distance to care for regular visit*	1,022	14.10	0.87	8.40	0, 638	− 0.09 (.095)	− 0.02 (.567)	0.01 (.654)
Distance to care for less serious emergency*	1,054	17.75	1.21	10.12	0, 638	− 0.06 (.302)	− 0.01 (.793)	0.03 (.248)
Distance to care for serious emergency*	1,056	18.58	1.03	11.56	0, 254	0.02 (.737)	− 0.01 (.808)	− 0.02 (.620)
Age	1,057	51.92	0.79	50.43	18, 93	0.19 (<.001)	0.13 (<.001)	0.03 (.424)
Household size	1,059	2.57	0.06	1.81	1, 5	− 0.09 (.023)	− 0.04 (.380)	− 0.05 (.071)
Alienation	1,057	0.58	0.01	0.53	0, 1	− 0.05 (.215)	0.07 (.079)	0.04 (.260)
Times per week exercise	1,051	2.25	0.06	1.3	1, 4	− 0.05 (.220)	− 0.11 (.010)	− 0.06 (.122)
Enabling factors								
Days per week drives a vehicle	1,040	5.17	0.13	7.00	0, 7	− 0.04 (.383)	− 0.04 (.349)	0.01 (.794)
Number of motor vehicles in household	1,055	2.41	0.07	1.68	0, 11	− 0.03 (.569)	− 0.07 (.012)	− 0.07 (.011)
Need factors								
SF-12 mental health	1,028	51.75	0.44	54.80	9.9, 67.7	− 0.01 (.849)	− 0.14 (.012)	− 0.05 (.267)
SF-12 physical health	1,028	47.88	0.45	52.78	10.6, 64.9	− 0.22 (<.001)	− 0.25 (<.001)	− 0.26 (<.001)
Number of chronic conditions	1,059	2.10	0.09	0.94	0, 11	0.23 (<.001)	0.20 (<.001)	0.14 (.001)

*Correlations are reported for log transformed variables, while means, SEs medians and ranges are for untransformed values.

SE = standard error; PCSDP = primary care service delivery point.

Table 3: Model-Predicted Incidence Density Ratios (IDR) and 95% Confidence Intervals (CI) for Number of Regular, Chronic, and Acute Health Care Visits in Previous Year

	Regular Check-Up Care Visits		*Chronic Care Visits*		*Acute Care Visits*	
	IDR (CI)	*p*	*IDR (CI)*	*p*	*IDR (CI)*	*p*
Predisposing factors						
Distance to care for regular visit (km)	0.95 (0.90, 1.00)	.0386	0.99 (0.91, 1.08)	.8149	1.02 (0.95, 1.10)	.5543
Age (divided by 10)	1.11 (0.99, 1.23)	.0729	1.19 (1.03, 1.38)	.0201	0.86 (0.78, 0.96)	.0053
Gender (reference: Male)	1.19 (0.99, 1.43)	.0592	1.67 (1.01, 2.77)	.0457	1.05 (0.78, 1.42)	.7268
Ethnicity (reference: White)		.0062		.0192		.3879
Black	0.41 (0.24, 0.71)		2.31 (1.29, 4.13)		0.72 (0.41, 1.29)	
Other	0.77 (0.29, 2.01)		1.17 (0.29, 4.83)		0.57 (0.16, 2.03)	
Tobacco use	0.72 (0.54, 0.97)	.0299	0.92 (0.64, 1.32)	.6367	0.93 (0.68, 1.26)	.6188
Enabling factors						
Has a driver's license	1.58 (1.10, 2.26)	.0138	2.30 (1.41, 3.76)	.0010	1.34 (0.75, 2.40)	.3230
Household income (reference: Less than $20,000)		.4065		.0042		.0024
$20,000 –$40,000	1.06 (0.78, 1.44)		1.60 (0.96, 2.66)		1.28 (0.79, 2.07)	
More than $40,000	1.24 (0.93, 1.65)		2.93 (1.64, 5.21)		0.99 (0.59, 1.65)	
Missing	1.26 (0.81, 1.97)		1.02 (0.55, 1.92)		0.45 (0.24, 0.83)	
Type of insurance (reference: None)		.9225		.8069		.0800
Public	0.85 (0.46, 1.55)		0.87 (0.36, 2.06)		1.59 (0.92, 2.76)	
Private	0.95 (0.60, 1.50)		0.73 (0.36, 1.46)		1.17 (0.70, 1.97)	
Public and private	0.87 (0.50, 1.53)		0.80 (0.36, 1.79)		1.95 (1.12, 3.39)	
Need factors						
Mental health (divided by 10)	0.98 (0.82, 1.18)	.8621	0.74 (0.63, 0.88)	.0008	0.97 (0.81, 1.15)	.7002
Physical health (divided by 10)	0.84 (0.76, 0.94)	.0023	0.66 (0.52, 0.85)	.0014	0.72 (0.61, 0.84)	$<.001$
Number of chronic conditions	1.07 (1.01, 1.13)	.0199	1.02 (0.93, 1.13)	.6313	1.02 (0.95, 1.11)	.5635

IDR = incidence density ratios; CI = confidence intervals.

those with no driver's license; having a driver's license was not significantly associated with having more acute care visits.

These adults had 1.11 times more regular care visits for every 10-year advance in age. Women had 1.19 times more regular care visits than men, while black respondents had 41 percent of the number of regular care visits of white respondents. Tobacco users had 72 percent the number of regular care visits as nonusers. For every 10-unit increase in the SF-12 scale of physical health, these adults had 84 percent of the number of visits for regular check-up care. Those with an additional chronic condition had 1.07 times the number of regular care check-up visits.

Participants had 1.19 times more visits for chronic care for every 10-year advance in age. Women had 1.67 times more chronic care visits than did men. Black respondents had 2.31 as many chronic care visits as white respondents. Those with an annual household income of more than $40,000 had 2.93 as many chronic care visits as adults with a household income of less than $20,000. For every 10-unit increase in the SF-12 scale of mental health, adults had 74 percent the number of visits for chronic care. For every 10-unit increase in the SF-12 scale of physical health, adults had 66 percent of the number of visits for chronic care.

Respondents had 86 percent fewer acute care visits for every 10-year advance in age. Those whose household income was not reported had 45 percent of the acute care visits of adults in households with income less than $20,000. For every 10-unit increase in the SF-12 scale of physical health, they had 72 percent of the number of visits for acute care.

DISCUSSION

The objective of this paper was to determine the importance of geographic and spatial behavior factors as predisposing and enabling factors in the health care utilization of rural communities, controlling for demographic, social, cultural, and health status factors. Distance to care has been cited as an important variable in several utilization studies. The multivariate analysis showed that distance to care was important in determining the number of regular health care visits a person had in a year, with greater distance resulting in fewer regular check-up visits. However, distance is not significant in determining the number of chronic care and acute care visits. Using a measure of travel time to care as a spatial behavior variable in place of the distance measure did not substantially change the results of the analysis. Having a

driver's license, indicating an ability to traverse distance, is important in determining the number of regular check-up care visits and chronic care visits; it is not significant in determining the number of acute care visits. Recent literature suggests it is important to break out utilization into its various components (e.g., Gelberg, Andersen, and Leake 2000). This study found that geographic variables were associated with regular check-up and chronic care visits, but not for acute health care. As proposed in the HBM (Aday and Awe 1997), geographic and spatial variables as predisposing and enabling factors are related to regular and chronic care visits, which are discretionary, rather than to acute care visits, which are not discretionary.

Additional geographic and spatial behavior variables, not significant in the multivariate analysis, were related to number of health care visits in the bivariate analysis. The use of transportation obtained from an informal (family member or friend) or formal (public transportation) source increased the number of chronic care visits. Thus, although distance is not a barrier to chronic care, lack of access to transportation may lead to less utilization. Contrary to expectation, the number of vehicles in the home (a measure of wealth as well as transportation access) was related to fewer chronic care visits and acute care visits. The number of primary care providers in a person's normal activity space was associated with fewer acute care visits, and not related to regular check-up or chronic care visits. This contradicts Nemet and Bailey's (2000) finding that having a provider located within one's activity space was a significant predictor of number of visits to a physician over a 12-month period. However, the negative association between number of primary care providers and acute care visits is consistent with the underlying tenet of preventive care, that better access to primary care can prevent the need for acute care.

The lack of statistical significance of geographic and spatial behaviors factors in the multivariate models is partially because of their interrelationship with other predisposing and enabling factors. For the predisposing factor gender, women had more regular check-up care visits and chronic care visits (George 2001). Women are less likely than men to work outside the home, and, particularly among older rural women, to drive. Older persons are also more like to have more regular check-up and chronic health care visits than younger people, and to have restricted access to transportation (Nemet and Bailey 2000). As shown in the bivariate analysis, use of a ride to care, from either an informal or formal source, was related to greater number of chronic care visits. Therefore, while provided rides did not remain significant in the multivariate analysis, this may be the result of confounding of gender and age

with the transportation measures. Future analyses need to consider these spatial behavior factors for young and middle aged adults separately from older adults.

One of the innovative aspects of this study was the inclusion of routine activity spaces. It was expected that those with larger activity spaces would have better access to care and therefore use various types of care more frequently, but this was not the case. Again, this variable may interact with nongeographic variables. For example, older people and women, who used care more often, are likely to have smaller activity spaces than their counterparts. It is notable that Nemet and Bailey (2000) found that size of activity space, as well as distance to a doctor, was not a significant predictor of number of visits to a physician over a 12-month period.

Other predisposing and enabling factors related to health care visits may not be directly related to geographic and spatial behavior. However, they are related to other factors in the final model. For example, small household size is related to more health care visits. Household size is related to age; older adults, who use more health care visits, live in smaller households—those without children. A particularly interesting finding is that white respondents get more regular care visits and fewer chronic care visits than black respondents in this region. This suggests that whites are engaging in more preventive activities than blacks and, perhaps as a result, black are making more visits to find care for preventable problems. Ethnicity may be related to other SES measures, such as annual income, which are in the final model. Those with the occupations "keeping house" and "retired" have more health care visits of regular and chronic care; occupations related to being female and older. Less income is related to fewer regular care and more acute care visits. Finally, those with healthy behaviors such as engaging in exercise have fewer chronic care visits than those who do not. The unhealthy behavior of tobacco use is related to fewer regular check-up care visits.

The measures of health care need remain in the final model. Those with lower physical health status (score higher SF-12 physical health, more chronic conditions), have more regular, chronic, and acute care visits. Those with lower mental health status (score higher SF-12 mental health), have more chronic care visits.

Andersen (1995) defined "equitable access as occurring when demographic and need variables account for most of the variance in utilization. Inequitable access occurs when social structure (e.g., ethnicity), health beliefs, and enabling resources (e.g., income) determine who gets medical care" (pp. 4–5). Demographic variables, including age and gender, as well as such need

variables as poor mental and physical health and chronic conditions, were important factors in this study. However, the results of this analysis clearly show that health care utilization in rural western North Carolina remains inequitable, especially for regular and chronic care. This inequity includes geographic components such as distance to care and access to transportation as well as social and cultural determinants that include ethnicity, income, and health behaviors. Policies to address equitable health care access and utilization in rural areas must address these spatial factors, as well as other structural determinants.

Some limitations must be considered in interpreting these results. Survey participants could be subject to recall bias in recounting the number of health care visits that they had over a year, and the purpose for these visits. Interviewers and supervisory staff were aware of this problem, and interviewer instructions included directions for probing participants on these issues. The study is focused on one rural region. This region has many characteristics, which make it typical of rural areas in the U.S., but it also has some unique characteristics. However, the strength of the study's sample design and data collection procedures compensate for these limitations. The MAP data provide some of the best rural health spatial behavior data currently available.

This analysis has furthered the process of specifying the place of geographic and spatial behavior variables in determining rural health care utilization. As Andersen (1995) argues, these results indicate that policy change is needed to provide more equitable health care utilization in this and other rural regions.

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