DOI: 10.1111/j.1475-6773.2005.00454.x

How Adults' Access to Outpatient Physician Services Relates to the Local Supply of Primary Care Physicians in the Rural Southeast

Donald E. Pathman, Thomas C. Ricketts III, and Thomas R. Konrad

Objective. To examine how access to outpatient medical care varies with local primary care physician densities across primary care service areas (PCSAs) in the rural Southeast, for adults as a whole and separately for the elderly and poor.

Data Sources. Access data from a 2002 to 2003 telephone survey of 4,311 adults living in 298 PCSAs within 150 rural counties in eight Southeastern states were linked geographically with physician practice location data from the American Medical and American Osteopathic Associations and population data from the U.S. Census.

Study Design. In a cross-sectional study design, we used a series of logistic regression models to assess how 26 measures of various aspects of access to outpatient physician services varied for subjects arranged into five groups based on the population-per-physician ratios of the PCSAs where they lived.

Principal Findings. Among adults as a whole, more individuals reported traveling over 30 minutes for outpatient care in PCSAs with more than 3,500 people per physician than in PCSAs with fewer than 1,500 people per physician (39.1 versus 18.5 percent, $p < .001$) and more reported travel difficulties. Otherwise, PCSA density of primary care physicians was unrelated to reported barriers to care, unrelated to people's satisfaction with care, and unrelated to indicators of people's use of services. Use rates of six recommended preventive health services varied in no consistent direction with physician densities. Among the elderly, only the proportion traveling over 30 minutes for care was greater in areas with lowest physician densities. Among subjects covered under Medicaid or uninsured, lower local physician densities were associated with longer travel time, difficulties with travel and reaching one's physician by phone, and two areas of dissatisfaction with care.

Conclusions. For adults as a whole in the rural South and for the elderly there, low local primary care physician densities are associated with travel inconvenience but not convincingly with other aspects of access to outpatient care. Access for those insured under Medicaid and the uninsured, however, is in more ways sensitive to local physician densities.

Key Words. Access to care, primary care physicians, rural health, physician underserved areas, outpatient care, patient satisfaction

---

Numerous studies have shown that an adequate primary care physician supply correlates with a variety of positive population health outcomes including lower mortality rates (Farmer et al. 1991; Shi and Starfield 2001; Shi et al. 2003), earlier cancer detection (Roetzheim et al. 2000), and better birth outcomes (Nesbitt et al. 1997; Vogel and Ackermann 1998). It is widely assumed, but with much less evidence, that where there are more primary care physicians people's access to outpatient medical care also is better (Hicks 1990; Patrick et al. 1988). The presumed link between an adequate primary care physician presence and access is a fundamental rationale for the many federal and state provider safety net programs, like the Title VII initiatives that support primary care physician training, the National Health Service Corps which entices physicians to needy areas with financial support for their training expenses, and Medicare's Incentive Payment Program for physicians in underserved areas (Berk, Bernstein, and Taylor 1983; GAO 1995; Grumbach, Vranizan, and Bindman 1997).

Available studies assessing the link in urban areas between local primary care physician availability and access to outpatient primary care services have found few and generally only weak associations (Berk, Bernstein, and Taylor 1983; Briggs et al. 1995; Grumbach, Vranizan, and Bindman 1997; COGME 1998). These studies conclude that health insurance and individuals' sociodemographics are much more important to access in cities than physician availability. It is reasonable to suspect that the link between physician availability and outpatient access is stronger in rural areas (Grumbach, Vranizan, and Bindman 1997; COGME 1998), as people and resources are more widely dispersed and people must rely more on the physicians within or near their communities to avoid the time, expense, and sometimes impossibility of long travel distances for office care. We know of only two studies—both with data from the 1970s—that compared access in rural areas with an adequate number versus too few physicians and both found meaningful differences on some measures of access (Kleinman and Wilson 1977; Berk, Bernstein, and Taylor

---

Address correspondence to Donald Pathman, M.D. M.P.H., Cecil G. Sheps Center for Health Services Research, UNC-CH CB#7590, Chapel Hill, NC 27599. Thomas C. Ricketts, III, Ph.D., and Thomas R. Konrad, Ph.D., are also with the Cecil G. Sheps Center for Health Services Research, UNC-CH CB#7590, Chapel Hill, NC.

1983). The significant disadvantages found in rural physician scarcity areas were longer travel times for care, longer office wait times, lower use rates for some preventive health services and, in one of the two studies, lower likelihood of having a usual source of medical care. Other access indicators differed little or none at all between rural shortage and nonshortage areas, including average number of physician visits, perceptions of barriers to care, and satisfaction with care.

How access to routine outpatient care relates to the local rural primary care physician supply more recently is not known and may differ from 30 years ago. Over the past three decades primary care physician-to-population numbers have more than doubled in large and medium-sized rural counties nationally (COGME 1998), medicine has become more specialized and technologically oriented, and regionalized systems of care have emerged (Birkmeyer et al. 2003; Radcliff et al. 2003). Improved roads have made travel easier (U.S. Department of Transportation 2000) and rural people now routinely travel further for work, shopping, and other needs (Aldrich, Beale, and Kassel 1996). With these changes access to medical care for rural communities may now depend less on the local primary care physician workforce. However, if this is true for rural inhabitants generally one might expect that access remains sensitive to the supply of local physicians for the rural elderly and poor, for whom transportation is more often a challenge and who historically have shown a preference for local care (Mathematica 1980; Adams et al. 1991; Coburn and Bolda 1999; Radcliff et al. 2003).

This study examines how local primary care physician density currently relates to adults' access to outpatient medical care in the rural Southeast, a region where physician numbers are lower than elsewhere (The Center for Evaluative Studies 1998; Larson et al. 2003) and access to medical care is poorer by some measures (Berk, Bernstein, and Taylor 1983; Larson and Fleishman 2003; Baicker and Chandra 2004). This study contributes to the literature by using recent data, incorporating subgroup analyses of the elderly and those covered under Medicaid and uninsured, and by assessing the link between physician availability and a wide variety of access indicators. Further, our analyses use a relatively new level of geographic aggregation, primary care service areas (PCSA), which are sub-county areas whose boundaries are created by linking data on where people live with where they actually receive outpatient care (Goodman et al. 2003). PCSAs are likely a better level of geographical aggregation for a study examining people's health care access and care seeking behaviors than the geopolitical borders of counties, which, despite their recognized weaknesses,

have been the standard in rural health care investigations (Gesler and Savitz 1994).

METHODS

Survey and Sample

This study uses telephone survey data collected as part of an evaluation of the Southern Rural Access Program (SRAP), a Robert Wood Johnson Foundation (RWJF) initiative to improve access to health care services in select rural areas of eight states: Alabama, Arkansas, Georgia, Louisiana, Mississippi, South Carolina, West Virginia, and Texas (Beachler, Holloman, and Herman 2003). Consortia of instate organizations implemented a range of initiatives intended to improve outpatient services in groups of contiguous counties in each state. Counties were selected for their perceived local health needs, the willingness of local organizations and providers to partner with the SRAPs efforts, political feasibility, and prospects for long-term program viability. The 150 nonmetropolitan counties selected for SRAP participation, and examined in this study, demonstrated greater socioeconomic need than other nonmetropolitan counties in these eight states: approximately 50 percent higher average poverty rates, 30 percent higher unemployment, and 40 percent greater minority proportions.

To establish baseline data for a contracted evaluation of the SRAP we surveyed by telephone 600 or more adults in the SRAP counties of each state to learn about people's access to outpatient physician services, which for the vast majority was through their reported usual source of care. The survey was fielded from November 2002 through July 2003 by Professional Research Consultants Inc. of Omaha, Nebraska (www.prconline.com) using accepted random digit dialing techniques modeled after those of the U.S. Centers for Disease Control and Prevention's annual Behavioral Risk Factor Surveillance System (BRFSS) survey (CDC 2004). Low-population counties were oversampled. Up to 10 calls were attempted to randomly generated numbers within telephone exchanges and active number blocks in each county. A second-stage randomization scheme (Salmon and Nichols 1983) was used to identify one specific eligible adult to be surveyed from each household reached. Eligible adults were 18 years of age or older who had lived in the immediate area for at least 12 months and spoke either English or Spanish. The participation rate was 51.0 percent with 4,879 respondents and 4,682 refusals (AAPOR 2004). Comparing respondent demographics against 2000 U.S. Census data for the targeted counties revealed that survey participation

rates were lower for males, persons 18–39 years of age, African Americans, and those with household incomes below $15,000.

We eliminated from our analyses respondents who (1) reported that they usually sought care from nurse practitioners and physician assistants ($n = 243$) or from physicians of specialties other than family practice, general internal medicine, general practice, obstetrics/gynecology, or geriatrics ($n = 205$); (2) provided inadequate geographic information on their residence to permit assignment to a specific PCSA ($n = 2$); or (3) were missing values for any of the outcome and explanatory variables used in this study ($n = 118$). Rather than eliminate the 622 (13 percent) subjects who did not report a household income, we imputed income based on a hotdeck procedure using respondents' reported education, age, sex, and race. In total, 568 respondents were eliminated and analyses were conducted on the remaining 4,311 subjects.

Data

The questionnaire's access concepts and dimensions incorporated the principal components of the prevailing models of access of Andersen, Aday, the Institute of Medicine, and others (Aday and Andersen 1974; Andersen et al. 1983; Institute of Medicine, Committee on Monitoring Access to Personal Health Care Services 1993). Survey items included many of the standard outpatient primary care access-relevant questions from national periodic surveys like the BRFSS and the National Health Interview Survey (CDC 2005), previous regional surveys (Patrick et al. 1988), and published studies (Penchansky and Thomas 1981), and included a few new items to address rarely queried access issues, for instance whether people perceived travel for outpatient care was generally difficult. The questionnaire also included measures of outcomes of care, specifically people's satisfaction with various aspects of the care they received and indicators of its quality as reflected by the clinical preventive health care services recommended for their age and gender (AHRQ 2004) they had, or had not, received. Twenty-one of the 26 access indicators specifically referred to people's experiences at the clinic or office where they usually received care, which for 89.9 percent was the office of a primary care physician. The other 10.1 percent of subjects who had no single usual source of care reported on their experiences overall at the places where they had received care in the previous one or few years. The questionnaire required about 25 minutes to complete and was administered in English or Spanish.

PCSA Aggregations

Researchers at Dartmouth Medical School and Virginia Commonwealth University recently created PCSAs for the entire U.S. by linking patient home and physician office zip codes from national Medicare outpatient visit claims data for 1996 (Goodman et al. 2003). PCSAs were created as the aggregation of the contiguous zip codes within which the majority of beneficiaries age 65 and older both lived and received care. A total of 6,102 PCSAs were created nationally, with a median population of 17,276 individuals. Nationally 63 percent of Medicare beneficiaries received care within the PCSAs of their home addresses: for the eight states of this study percentages ranged from 64 percent in Alabama to 81 percent in Arkansas, with a state median of 66 percent. Younger adults also generally received health care within their assigned PCSAs but not quite as regularly as the elderly.

From the Health Resources and Service Administration's (HRSA) Geospatial Data Warehouse (HRSA no date) we obtained a listing of zip codes in each PCSA and placed our survey respondents in specific PCSAs according to the home zip codes they reported. The same HRSA database also provided data characterizing the populations and physicians within each PCSA and identified the PCSAs that contained a federally qualified health center (FQHC) within their boundaries. Population and physician data on the HRSA file were derived from the 2000 U.S. Census and the American Medical Association's (AMA) and American Osteopathic Association's (AOA) rosters of practicing physicians in the U.S. in 2001, including both members and nonmembers of the AMA and AOA.

Analysis

For each PCSA, we determined the number of clinically active, nonmilitary adult primary care physicians, specifically family physicians, general internists, general practitioners, obstetrician/gynecologists, and geriatricians. We could not broaden our analyses to include primary care practitioners of all disciplines as there are no reliable national data on actively practicing nurse practitioners and physician assistants. PCSAs were separated into five groupings based on their population-to-primary care physician ratios (1–1,499; 1,500–1,999; 2,000–2,499; 2,500–3,499; 3,500 or more). We used ANOVA to test equality of means, nonparametric χ^2 tests to assess equality of medians, and χ^2 tests to assess equality of proportions in comparing PCSA groups on various sociodemographics of their populations according to U.S. Census data and of their respondents based on survey data. We calculated percentages of

respondents within PCSA strata who reported being challenged in each of a variety of aspects of access. We used logistic regression models accounting for the complex survey design to compare proportions of subjects in each PCSA population-per-physician group challenged in each aspect of access against proportions in the group with fewest people per physician (i.e., where physicians were most plentiful). Findings from logistic models which were run both unadjusted and adjusted for characteristics of respondents and their PCSAs were invariably close, so we present only the findings of the adjusted models.

We repeated the access comparisons of PCSA population-to-physician groups for the subset of respondents who were age 65 years and older and those age 18–64 who were Medicaid insured or uninsured. Because of smaller group sizes in these subpopulations they were arrayed into just three PCSA population-to-physician groups of 1,499 or fewer people per physician; 1,500–2,799; and 2,800 or more people per physicians.

Analyses were performed using *Stata* statistical software programs (Version 8.2, Stata Corporation, College Station, TX), which allowed us to account for within-PCSA correlation of unknown form. All analyses were weighted to account for county sampling probabilities and differences between the demographic composition of respondents (age, gender, race, income) and the demographics of adults in the targeted counties of each state according to census data (CyBulski et al. 2005). We used a 0.05 cut-off level for statistical significance despite this study's numerous group comparisons; we felt that occasionally misidentifying an association because of a type 1 error—an association because of chance alone—was less of a problem given this study's goals than failing to identify a real association because of an overly stringent level of significance. This study was submitted for review and exempted by the Committee on the Protection of the Rights of Human Subjects of the School of Medicine of the University of North Carolina at Chapel Hill.

RESULTS

The most meaningful difference in population characteristics of the PCSAs of the five population-per-physician groups was their size, with PCSAs in the groups with fewer people per physician (greater physician availability) being generally larger (Table 1). There were also group-to-group differences in the proportions of non-Hispanic whites but the differences did not vary

Table 1: PCSA Population and Respondent Characteristics (Weighted) within Five Groups of PCSAs Stratified by Population-to-Physician Ratios

		Population-per-Physician Ratio Groups					
	All PCSAs Combined	*0–1,499 Greatest*	*1,500–1,999*	*2,000–2,499*	*2,500–3,499*	*3,500+ Least*	*p-value*
PCSA characteristics (n)	298	73	61	33	37	94	
Median PCSA population	11,622	21,506	16,934	14,367	12,053	5,779	<.001*
Mean PCSA % population below poverty	23.0	22.2	23.4	21.6	23.0	24.0	.34†
Mean PCSA % population non-Hispanic White	61.0	66.9	58.5	64.1	61.5	56.8	.06†
% of PCSAs with FQHCs	35.6	31.5	44.3	29.4	43.2	32.3	.34‡
Median PCSA population-per-physician	1,981	1,201	1,729	2,145	2,776	4,891	<.001*
Respondent characteristics (n)	4,311	1,432	1,119	504	511	745	
% over age 65	18.1	17.9	16.6	17.5	20.3	20.1	.36‡
% female	53.5	55.3	53.9	47.1	50.3	54.9	.07‡
% non-Hispanic white	61.7	64.9	60.4	59.9	56.3	60.8	.02‡
% with household income less than $25,000	45.0	43.8	45.1	43.8	48.9	45.8	.55‡
% without health insurance	24.5	21.8	26.6	23.5	27.1	26.7	.06‡
% fair or poor health	24.0	23.7	23.7	24.5	24.1	24.9	.58‡

*Based on nonparametric χ^2 tests.

†Based on ANOVA.

‡Based on Pearson χ^2 tests.

PCSA, Primary Care Service Area; FQHC, Federally Qualified Health Center.

in a consistent direction with physician densities. PCSAs of the five groups did not differ in their mean population poverty rates or in the household incomes and health status of their respondents.

There were very few statistically significant access differences in the direction anticipated among the five population-per-physician groups. The only differences related to travel to care (Table 2) and in the use rate of one preventive health service (Table 3). Specifically, incrementally more individuals reported traveling more than 30 minutes for outpatient care in the PCSA groups with increasingly more people per physician, ranging from 18.5 percent of those living in PCSAs with 1,499 or fewer people per physician up to 39.1 percent of those in PCSAs with more than 3,500 people per physician (Table 2). Subjects living in PCSAs with 3,500 or more people per physician were also more likely to report difficulty in traveling to care—a subjective measure of the burden of travel—than those living in PCSAs with fewer than 1,500 people per physician (15.5 versus 10.9 percent, respectively). These differences in travel time and perceived difficulty of travel remained statistically significant after adjusting for characteristics of respondents and PCSAs.

Subjects living in the five PCSA population-per-physician groups did not differ on any of the indicators of outpatient physician service use over the past year, including the proportions that had not seen a physician, had not had a routine check-up, or had not gotten or delayed care they thought they needed (Table 2). Other than travel difficulties the respondents of the five PCSA groups did not differ in their likelihood of reporting any of a variety of perceived barriers to care, including cost barriers, not having a usual source of care, or finding care generally difficult to obtain. Respondents of the five PCSA groups also reported comparable satisfaction with the care they received.

Reported use rates for only one of the seven preventive health services we assessed was lower for a PCSA group where physicians were scarcer (Table 3). Influenza immunizations were more often missed by subjects age 65 and older who lived in the PCSA group with most people per physician than in the group with fewest people per physician (42.1 versus 27.7 percent, $p = .019$). We found no group differences in rates of missed sigmoidoscopy/colonoscopy, mammography, diet and nutrition counseling, and exercise and activity counseling. Two statistically significant associations were found in the direction opposite of that anticipated: compared with those living in PCSAs where physicians were most plentiful, women in one mid-range physician density group were less likely to have missed a

Table 2: Subjects Who Experienced Impaired Access to Outpatient Care, Stratified by the Population-per-Physician Ratios of the PCSAs Where People Live: Unadjusted Percentages and Adjusted Odds Ratios† Relative to the Group with Smallest Population per Physician

	Population-per-Physician Ratio Groups				
Population-per-Physician Range (Availability)	*0–1,499 Greatest*	*1,500–1,999*	*2,000–2,499*	*2,500–3,499*	*3,500+ Least*
PCSA (*n*)	73	61	33	37	94
Unweighted observations (*n*)	1,432	1,119	504	511	745
Did not use services (%)					
Had no physician visit in past 12 months	19.7	19.6	22.0	18.7	17.2
	—‡	*0.90*	*1.01*	*0.83*	*0.73*
Had no routine check-up in past 12 months	23.9	22.7	26.3	21.2	21.4
	—‡	*0.87*	*1.06*	*0.79*	*0.77*
Had a time in past 12 months when subject did not get needed care	12.1	13.9	10.7	12.9	13.7
	—‡	*1.17*	*0.89*	*1.11*	*1.22*
Had a time in past 12 months when subject delayed getting needed care	30.2	30.5	29.1	25.7	31.0
	—‡	*1.09*	*1.06*	*0.92*	*1.21*
Reported barriers to care (%)					
Reports it is generally difficult to get routine care	13.6	14.9	11.6	15.3	14.6
	—‡	*1.10*	*0.82*	*1.17*	*1.09*
Reports that costs of care are more than a minor problem	23.2	26.3	25.1	20.9	26.8
	—‡	*1.12*	*1.19*	*0.93*	*1.31*
Has no usual source of medical care (other than emergency room)	16.3	12.9	14.6	11.9	13.6
	—‡	*0.75*	*0.86*	*0.68*	*0.85*
Travels 30 minutes or more from home to get care	18.5	24.9	30.0	38.6	39.1
	—‡	*1.46***	*1.94****	*2.75****	*2.69****
Finds travel to get care is difficult	10.9	10.1	11.7	12.5	15.5
	—‡	*1.03*	*1.30*	*1.43*	*1.85****

Reports difficulty getting appointment within 1 or 2 days for illness or injury	13.6 —‡	12.8 *0.99*	10.9 *0.86*	8.9 *0.70*	13.0 *1.04*
Reports difficulty contacting medical person by phone	16.4 —‡	18.0 *1.17*	17.9 *1.20*	16.9 *1.12*	17.7 *1.21*
Reports more than 40 minute office wait before seeing the practitioner	21.5 —‡	21.7 *1.11*	19.3 *1.02*	17.2 *0.88*	19.3 *0.97*
Does not feel people should get regular medical exams or see a physician early with symptoms	13.9 —‡	12.4 *0.89*	14.4 *1.04*	12.9 *0.97*	13.3 *0.98*
Not satisfied with care received (%)					
Not satisfied overall with care received	7.7 —‡	9.1 *1.22*	6.6 *0.85*	7.0 *0.94*	8.9 *1.26*
Not satisfied with quality of care received	7.6 —‡	6.5 *0.85*	7.1 *0.91*	4.7 *0.62*	5.6 *0.74*
Not satisfied with the concern shown by their doctor	7.8 —‡	6.0 *0.85*	7.7 *0.91*	5.5 *0.62*	4.8 *0.74*
Not satisfied with getting their health questions answered during office visits	7.0 —‡	6.6 *0.97*	5.8 *0.83*	4.8 *0.70*	6.0 *0.89*
Not satisfied with how welcome and comfortable they are made to feel where they get care	6.7 —‡	7.3 *1.14*	6.8 *1.08*	5.6 *0.88*	6.9 *1.10*
Not satisfied with their physician's ability to help	21.6 —‡	19.1 *0.82*	20.8 *0.92*	19.6 *0.86*	20.6 *0.93*

†Odds ratios (in italics) based on logistic regression models with the following control variables: gender, age (over versus under 65 years), age (continuous), race/ethnicity (non-Hispanic white versus others), employed/unemployed, household income, self-perceived health status (excellent/good versus fair/poor), insured/uninsured, PCSA population size, percentage of population in PCSA that is minority, percentage of households below poverty in PCSA.

‡Referent group for odds ratio calculations.

*$p<.05$;

**$p<.01$;

***$p<.001$.

PCSA, primary care service area.

Pap smear for cervical cancer detection and tobacco users in another mid-range group were less likely to not have been counseled about tobacco use.

Robustness/Explanatory Checks

We examined four modifications of the full models to test several possible reasons why so few associations were found between PCSA population-per-primary care physician ratios and indicators of access to office physician care. We first added a dichotomous indicator of the presence of FQHCs within each subject's PCSA to the full logistic models of each access indicator to assess if the presence of FQHCs somehow blunted the measured associations between physician availability and access. (*Note*: FQHCs were not accounted for in the original models because of concerns of model endogeneity, in that FQHCs are intended to attract new physicians into shortage areas for the specific purpose of improving access.) The model findings did not change.

Secondly, we added a variable to the full logistic models indicating the number of square miles within each PCSA to control for the effects PCSA size might have on travel times and other access indicators. Again, the model findings were not different.

Thirdly, we wondered if state-to-state variations in either population-per-physician ratios or access indicators added background "noise" to the analyses obscuring associations. We added state indicator variables to the full models, and again the findings of the original models of Tables 2 and 3 held, with two exceptions: (1) people living in PCSAs with more than 3,500 people per physician were now found to more often report that costs of care were a problem for them than people in PCSAs with fewest people per physician (odds ratio 1.34, $p = .04$); and (2) the paradoxical finding of the original models of a higher Pap smear rate for women in PCSAs of 2,500–3,499 people per physician now dropped below the level of statistical significance (odds ratio 0.21, $p = .082$).

Lastly, it is possible that model findings are at least partially driven by spatial correlations in that counties are correlated in unobserved ways with nearby counties, an expression of Tobler's First Law of Geography (Sui 2004)—"everything is related to everything else, but near things are more related than distant things." We looked, therefore, for evidence of unobserved factors influencing the measured associations between physician densities and access. We first calculated standardized Pearson residuals (Hosmer and Lemeshow 1989) from the logistic models for a sample of six access

Table 3: Subjects Who Didn't Get Recommended Preventive Health Services, Stratified by the Population-per-Physician Ratios of the PCSAs Where They Live: Unadjusted Percentages and Adjusted Odds Ratios[†] Relative to the Group with Smallest Population per Physician

		Population-per-Physician Ratio Groups				
Physician Density (Availability)	*n*	*0–1,499 Greatest*	*1,500–1,999*	*2,000–2,499*	*2,500–3499*	*3,500+ Least*
Adults ≥ 65 years without a flu shot in past year	588	27.7	34.3	21.2	28.1	42.1
		—[‡]	*1.36*	*0.64*	*1.08*	*2.15**
Adults ≥ 50 years who have never had a sigmoidoscopy or colonoscopy	1,461	45.9	49.8	47.6	48.4	55.0
		—[‡]	*1.07*	*0.99*	*1.06*	*1.32*
Women ≥ 50 years who had no mammogram in the past year	827	37.4	37.6	31.8	36.1	40.2
		—[‡]	*1.0*	*0.78*	*1.04*	*1.16*
Women 18–65 years without a hysterectomy who had no Pap smear in the past 3 years	1,137	5.4	4.2	4.7	1.3	10.9
		—[‡]	*0.69*	*0.73*	*0.17**	*1.63*
Adults >18 years who received no diet or nutrition counseling in past year	2,941	51.6	55.1	54.5	53.2	50.6
		—[‡]	*1.16*	*1.14*	*1.05*	*0.93*
Adults ≥ 18 years who received no advice about exercise or physical activity in past year	2,946	49.7	51.0	53.4	51.6	49.9
		—[‡]	*1.02*	*1.13*	*1.02*	*0.93*
Adults >18 years who use tobacco and were not advised to quit in past year	815	35.0	41.1	23.8	35.4	28.0
		—[‡]	*1.19*	*0.46**	*0.68*	*0.54*

[†]Odds ratios (in italics) based on logistic regression models with the following control variables: gender, age (over versus under 65 years), age (continuous), race/ethnicity (non-Hispanic white versus others), employed/unemployed, household income, self-perceived health status (excellent/good versus fair/poor), insured/uninsured, PCSA population size, percentage of population in PCSA that is minority, percentage of households below poverty in PCSA.

[‡]Referent group for odds ratio calculations.

*$p < .05$;

**$p < .01$;

***$p < .001$.

PCSA, Primary Care Service Area.

measures—the three indicators with positive findings (traveling more than 30 minutes for care, finding travel to care generally difficult, and having not been immunized against influenza) and three measures with null findings that are among the key indicators of each of the three principal dimensions of access, specifically use of services, barriers to care and satisfaction (having no physician visit in the past 12 months, finding it generally difficult to get care, and overall satisfaction with care). We then computed the county average of these residuals and analyzed them subjectively by mapping and visually examining them for clustering and objectively by computing Moran's I (Waller and Gotway 2004). Only one of the six measures—finding it generally difficult to get care—exhibited evidence of positive spatial correlation. This means that for this variable the estimated standard error of the initial measured association is likely biased downward making the p-value we calculated smaller than it should be, but this merely strengthens our conclusion that people's assessment of their overall difficulty in obtaining care is unrelated to local primary care physician availability.

Subgroup Analyses: Elderly and Medicaid/Uninsured Populations

Among subjects age 65 and older arrayed into three population-per-physician groups, there was only one significant association in the direction anticipated between group membership and an access measure (Table 4, top). Elderly in PCSAs with 2,800 or more people per physician were more likely to report traveling more than 30 minutes for care than those in PCSAs with fewest people per physician (33.3 versus 24.5 percent). One new association was found in the unanticipated direction: elderly women in the middle PCSA group with 1,500–2,499 people per physician had less often missed their mammograms in the past year than those in PCSAs with fewest people per physician (40.3 versus 50.2 percent).

More significant associations were found for subjects insured under Medicaid or uninsured (Table 4, bottom). Within this population, those who lived in PCSAs with more people per physician more often reported (1) traveling more than 30 minutes for outpatient care, (2) difficulty traveling to care, (3) difficulty contacting a medical person by phone, (4) dissatisfaction overall with the care they received, and (5) dissatisfaction with how welcome and comfortable they felt where they received care. There were no differences in the rates at which preventive health services were received across the three population-per-physician PCSA groups for this population.

Table 4: Sub-Group Analyses: Subjects Age 65 Years and Older and Subjects Age 18–64 Insured under Medicaid or Uninsured Who Experienced Impaired Access to Outpatient Care, Stratified by the Population-per-Physician Ratios of the PCSAs Where They Live: Unadjusted Percentages and Adjusted Odds Ratios[†] Relative to the Group with Smallest Population per Physician Ratio

	Population-per-Physician Ratio Groups		
Physician Density (Availability)	*0–1,499 Greatest*	*1,500–2,799*	*2,800+ Least*
Subjects age 65 years and older			
PCSAs (*n*)	67	88	84
Unweighted observations (*n*)	310	385	226
Travels 30 minutes or more from home to get care	24.5 —[‡]	28.9 *1.50*	33.3 *2.41***
Women ≥ 50 years who had no mammogram in the past year (*n* = 483)	50.2 —[‡]	40.3 *0.54**	48.8 *0.84*
Subjects age 18–64 years covered under Medicaid or uninsured			
PCSAs (*n*)	58	88	87
Unweighted observations (*n*)	309	456	246
Travels 30 minutes or more from home to get care	17.1 —[‡]	29.3 *1.99*[§]**	36.4 *2.68****
Finds travel to get care is difficult	13.8 —[‡]	16.9 *1.39*	25.0 *2.40***
Reports difficulty contacting medical person by phone	22.8 —[‡]	25.2 *1.51*	27.0 *1.89**
Not satisfied overall with care received	10.8 —[‡]	13.01 *1.58*	17.0 *2.59***
Not satisfied with how welcome and comfortable they are made to feel where they get care	8.1 —[‡]	13.1 *1.96**	13.8 *2.09**

[†]Odds ratios (in italics) based on logistic regression models with the following control variables: gender, age (continuous), race/ethnicity (non-Hispanic white versus others), employed/unemployed, household income, self-perceived health status (excellent/good versus fair/poor), PCSA population size, percentage of population in PCSA that is minority, percentage of households below poverty in PCSA.

[‡]Referent group for odds ratio calculations.

*$p < .05$;

**$p < .01$;

***$p < .001$.

Only statistically significant findings are shown. PCSA, primary care service area.

DISCUSSION

This study finds that in 2002 and 2003 access to outpatient primary health care services for adults as a whole in these 150 Southern rural counties and their 298 PCSAs had little relationship to the local presence of primary care physicians. Apart from longer travel time to care for many and difficulty in travel for some, access was not sensitive to primary care physician densities in ranges from the national average of 1,500 people per primary care physician (HRSA 2002) to above 3,500 per physician, the threshold that, with pediatricians added, qualifies an area for health professional shortage area (HPSA) designation (BHPr 2004). The local availability of primary care physicians was unrelated to people's likelihood of having visited a physician in the past year, having seen a physician when they thought they needed to and other indicators of people's actual use of health services, arguably the most important aspects of access. Other than travel challenges, there were no greater reported barriers to care or dissatisfaction with care for people living where there were relatively fewer physicians. The findings were mixed for the use rates of the seven preventive health services we assessed, with only influenza immunization rates being lower. Access for the elderly was similarly only related to local physician densities by more needing to travel longer for care. Longer travel did not seem to bother these elderly, who somehow were able to handle it without feeling an added burden.

For working age adults who were covered under Medicaid or uninsured, on the other hand, primary care physician availability was associated with more aspects of outpatient access. For this group, living where physicians were relatively scarce meant more often traveling over 30 minutes for care, finding travel difficult and being dissatisfied with some aspects of care. These findings are consistent with our expectations and with a previous study (Dutton 1986) that found distance to care is a greater access barrier for the poor than the nonpoor. Greater dissatisfaction with care in areas with physician scarcities may be because of a vulnerable population feeling less comfortable with care when forced to find it outside of their communities or perhaps because of service and quality issues in the particular offices and clinics willing to provide care to Medicaid and uninsured populations from outlying communities. Previous studies have found that physicians in shortage areas are more likely to participate in Medicaid than physicians in nonshortage areas (Perloff, Kletke, and Neckerman 1987; Fossett and Peterson 1989), which may have blunted an otherwise stronger challenge to access in shortage areas for this population.

Taken at face value these data suggest that the availability of local primary care physicians measured by population to physician ratios is now not an important factor in access to outpatient physician services for adults in the rural South as a whole, although it is still somewhat important for the rural poor. The association between physician availability and rural access was not particularly strong even 30 years ago (Kleinman and Wilson 1977; Berk, Bernstein, and Taylor 1983). The fewer associations found in this study using current data may indicate that the local physician availability-access relationship has further weakened with time as rural physician numbers have increased broadly and people in small towns have become accustomed to traveling further for their various needs (Aldrich, Beale, and Kassel 1996). Alternatively, because of differences in some of the specific survey items, the particular regional focus and the geographical level of analysis between this and previous studies, the differences in findings over time may be because of measurement and analytic differences.

We wonder how it could be possible that greater primary care physician availability does not lead to better access for adults as a whole but does lead to better health outcomes for populations, as shown in other studies (Farmer et al. 1991; Nesbitt et al. 1997; Roetzheim et al. 1999; Roetzheim et al. 2000; Shi et al. 2003). One possibility is that the health of poorer adults, who suffer a disproportionate disease burden, is disproportionately reflected in community-wide indicators of health; our study finds that for this subpopulation access is sensitive to physician availability. Alternatively, perhaps physician availability affects health not by increasing office visit capacity and improving access, but through other mechanisms. Local physicians may contribute to a community's health in ways distant physicians cannot, such as through health interventions they undertake at the community level (IOM 1983; Mullan and Epstein 2002), by augmenting the social capital of small towns (Shortt 2004) or by supporting the local health care infrastructure—local hospitals, pharmacies, home health agencies—which fosters community-wide attention to health behavior and health care. It is also possible that the association between primary care physician density and population health, demonstrated repeatedly but only through observational, cross-sectional study designs, is not a causal association and that the size of the physician workforce affects neither access nor health.

Limitations

Even though we used many of the standard, outpatient primary care-relevant access-to-care questionnaire items from prominent national surveys, these

items may not accurately reflect access in all ways relevant. We did not examine, for example, how physician densities were associated with the quality of chronic disease management and the frequency and appropriateness of referrals to subspecialist physicians and to ancillary outpatient services.

From this cross-sectional study design, it is impossible to know if the access indictor differences observed across physician-density groups are due, in fact, to the different physician densities. However, given the "dose–response" relationship found between physician densities and the proportion of individuals who reported traveling more than 30 minutes for care, it is likely that causality underlies this particular association. Further, this relationship provides a measure of convergent validity for how these PCSAs were created, in that we would expect more people would need to travel afar for care in service areas with more people per physician.

There were very few Hispanics among our subjects and no truly large counties or PCSAs, thus this study's findings might not hold true in southern U.S. border counties and states where Hispanics are more numerous or in the far West and northern midwest where counties, PSCAs, and travel distances are exceptionally large (Goodman et al. 2003). We anticipate that associations between physician density and access would be similar in midatlantic and New England states to that found here for the South, as travel distances and industries are not dissimilar and there are no wholly different racial-ethnic groups; this should be confirmed empirically.

We estimate that this study's physician data sources, the AMA and AOA physician files as included in the HRSA's Geospatial Data Warehouse (HRSA no date), misrepresented the county practice locations of 5–10 percent of physicians in our study counties and misrepresented the specialties of a smaller number of these physicians (Konrad et al. 2000). These inaccuracies generally will occur randomly across rural areas and will tend to weaken measured associations between physician densities and access measures. The presence of nurse practitioners and physician assistants in these counties may also affect local access indicators and weakened measured associations between physician densities and access.

Several associations for preventive health service use rates were found in the opposite direction of that anticipated, each with a statistical significance level not much under the 0.05 cut-off. We suspect that these findings are because of multiple testing and chance. But for the same reasons the finding of more missed influenza immunizations in physician scarcity areas may also be spurious.

This study's 51.0 percent response rate introduces the possibility of response bias; however, this rate is comparable with recent response rates for the CDCs similarly structured annual BRFSS survey, for which the median state response rate in 2000 was 48.9 percent (CDC 2003). The BRFSSs validity and reliability are not felt to have suffered by declining response rates in recent years (CDC 2003). With U.S. Census data as a comparison standard, the demographic group participation rates in our study more closely matched the population composition of the surveyed counties than do participation rates in the BRFSS (CDC 2003). The two studies adjust for group response rates similarly with weights (CDC 2004).

Stata does not allow one to account for second-stage sampling. Our study's second stage of sampling, however, was to randomly select among eligible adults within each household and we have no information on nonsurveyed members, even the number in each household; consequently, adjustments for this stage would not be possible with any statistical program.

Conclusions and Implications

This study finds that for adults as a whole in the rural Southeast, local primary care physician densities are associated with longer travel times and inconvenience but with no other barriers to outpatient physician care and, in the end, no measured differences in use, no differences in satisfaction and only modest and mixed differences in the amount of preventive care received. Apart from travel issues, access to health care in the rural South is now significantly related to local physician availability only for those with Medicaid and the uninsured. This suggests that decades of federal and state investments in building and distributing the primary care physician workforce and bolstering the rural infrastructure for health, transportation and economies are paying off. We cannot know with available data if past gains would be lost without ongoing support for these initiatives. But with rural people's demonstrated ability to find care in adjacent communities—nationally, visit rates in rural and urban areas are comparable and have been for 15 years (Freeman et al. 1987; Stearns, Slifkin, and Edin 2001)—it seems no longer as important to correct all remaining imbalances in local physician numbers.

If the importance of local primary care physician availability to access in rural areas is minimal, then increasing local physician numbers is not the appropriate policy response when access indicators for a community are poor. Poor access indicators most often suggest the need to make health care more affordable (Berk, Bernstein, and Taylor 1983; Grumbach, Vranizan, and

Bindman 1997; Mueller, Patil, and Boilesen 1998; Cunningham and Hadley 2004). Current best evidence suggests that increasing primary care physician numbers may be part of the appropriate response for communities where *health* indicators are poor and physician numbers are low. The federal HPSA designation criteria, which combine population health indicators, measures of physician densities, and assessments of people's ability to reach care in adjacent communities, would appear to be appropriate for targeting the resources of programs that bolster physician numbers (Sawada 2004).

Because travel distances are often far greater in the large frontier counties and PCSAs of western and northern midwestern states than in the generally small counties and PCSAs of the South, it may still be appropriate to build local physician numbers there in response to physician shortages and demonstrated access problems. Providing transportation services to care in neighboring towns might be an appropriate intervention in all regions and local areas where there is evidence that travel issues impede appropriate use of care, especially among the poor. Future studies should test how physician densities relate to access in other regions and to previously untested dimensions of access, particularly the quality of care people receive, and should assess how the relationship between physician density and access is affected by physicians' willingness to participate in Medicaid and Medicare.

ACKNOWLEDGMENTS

This study was funded by evaluation grant #036829 from the Robert Wood Johnson Foundation and grant #1-U79-HP00035-01 from the National Center for Health Workforce Analysis, Bureau of Health Professions, Health Resources and Services Administration. The authors are grateful to Jennifer Albright, M.P.H., and the staff of Professional Research Consultants, Inc., for their determined work gathering these data; Jennifer Groves for managing all data and programming for this study; Mark Holmes, Ph.D., for his expert assistance with statistical issues; and Larry Green, M.D., Larry Logan, M.A., and the fellows of UNC's Primary Care Research Fellowship Program for their comments and suggestions strengthening this article.

The authors report no financial or other conflicts of interest, nor any disclaimers, related to this study and paper.

Since the original submission of this paper, selected data from this study were presented at a breakout, concurrent paper session at the Association of

the American Medical College's (AAMC) Physician Workforce Research Conference in Washington, DC.

REFERENCES

Adams, E. K., R. Houchens, G. E. Wright, and J. Robbins. 1991. "Predicting Hospital Choice for Rural Medicare Beneficiaries: The Role of Severity of Illness." *Health Services Research* 26 (5): 583–612.

Aday, L. A., and R. Andersen. 1974. "A Framework for the Study of Access to Medical Care." *Health Services Research* 9 (3): 208–20.

Agency for Healthcare Research and Quality. (no date). "US Preventive Services Task Force (USPSTF)" [accessed on March 23, 2005]. Available at http://www.ahrq.gov/clinic/uspstfix.htm

Aldrich, L., C. Beale, and K. Kassel. 1996. "Commuting and the Economic Functions of Small Towns and Places." *Rural Development Perspectives* 12 (3): 26–31.

Andersen, R. M., A. McCutcheon, L. A. Aday, G. Y. Chiu, and R. Bell. 1983. "Exploring Dimensions of Access to Medical Care." *Health Services Research* 18 (1): 49–74.

Baicker, K., and A. Chandra. 2004. "Medicare Spending, the Physician Workforce, and Beneficiaries' Quality of Care." *Health Affairs-Web Exclusive* (April 7): W4-184–97.

Beachler, M., C. Holloman, and J. Herman. 2003. "Southern Rural Access Program: An Overview." *Journal of Rural Health* 19 (suppl): 301–7.

Berk, M. L., A. B. Bernstein, and A. K. Taylor. 1983. "The Use and Availability of Medical Care in Health Manpower Shortage Areas." *Inquiry* 20 (Winter): 369–80.

Birkmeyer, J. D., A. E. Siewers, N. J. Marth, and J. Goodman. 2003. "Regionalization of High-Risk Surgery and Implications for Patient Travel Times." *Journal of the American Medical Association* 290 (20): 2703–8.

Briggs, L. W., J. E. Rohrer, R. L. Ludke, P. E. Hilsenrath, and K. T. Phillips. 1995. "Geographic Variation in Primary Care Visits in Iowa." *Health Services Research* 30 (5): 657–71.

Centers for Disease Control and Prevention. 2003. "Public Health Surveillance for Behavioral Risk Factors in a Changing Environment. Recommendations from a Behavioral Risk Factor Surveillance Team. No. RR-9." *Morbidity and Mortality Weekly Reports* 52 (May 23).

———. 2004. "2003 Behavioral Risk Factor Surveillance System Summary Data Quality Report" [accessed on March 22, 2005]. Available at http://www.cdc.gov/brfss/technical_infodata/pdf/2003SummaryDataQualityReport.pdf

Centers for Disease Control and Prevention, National Center for Health Statistics. 2005. "National Health Interview Survey (NHIS)" [accessed on March 22, 2005]. Available at http://www.cdc.gov/nchs/nhis.htm

Coburn, A. F., and E. J. Bolda. 1999. "The Rural Elderly and Long-Term Care." In *Rural Health in the United States*, edited by T. C. Ricketts III, pp. 179–89. New York: Oxford University Press.

Council on Graduate Medical Education, Health Resources and Services Administration. February 1998. "Tenth Report. Physician Distribution and Health Care Challenges in Rural and Inner-City Areas." Bound Report from the U.S. Department of Health and Human Services.

Cunningham, P., and J. Hadley. 2004. "Expanding Care versus Expanding Coverage: How to Improve Access to Care." *Health Affairs* 23 (4): 234–44.

CyBulski, K. A., M. Sinclair, F. Potter, and A. B. Ciemnecki. 2005. "Adjusting for Nonresponse among Medicaid Households That Could Not Be Located or Were Located but Did Not Participate in the Minnesota Managed Care Survey" [accessed on March 22, 2005]. Available at http://www.jpsm.umd.edu/icsn/papers/cybulski.htm

Dutton, D. 1986. "Financial, Organizational and Professional Factors Affecting Health Care Utilization." *Social Sciences and Medicine* 23 (7): 721–35.

Farmer, F. L., C. S. Stokes, R. H. Fiser, and D. P. Papini. 1991. "Poverty, Primary Care and Age-Specific Mortality." *Journal of Rural Health* 7 (1): 153–69.

Fossett, J. W., and J. A. Peterson. 1989. "Physician Supply and Medicaid Participation. The Causes of Market Failure." *Medical Care* 27 (4): 386–96.

Freeman, H. E., R. J. Blendon, L. H. Aiken, S. Sudman, C. F. Mullinix, and C. R. Corey. 1987. "Americans Report on Their Access to Health Care." *Health Affairs* 6 (Spring): 6–18.

General Accounting Office. 1995. "Health Care Shortage Areas. Designations Not a Useful Tool for Directing Resources to the Underserved." GAO/HEHS-95-200. Washington, DC.

Gesler, W. M., and L. A. Savitz. 1994. "Health Professions Distribution." In *Geographic Methods for Health Services Research: A Focus on the Rural–Urban Continuum*, edited by T. C. Ricketts III, pp. 121–58. Lanham, MD: University Press of America.

Goodman, D. C., S. S. Mick, D. Bott, T. Stukel, C. Chang, N. Marth, J. Poage, and H. J. Carretta. 2003. "Primary Care Service Areas: A New Tool for the Evaluation of Primary Care Services." *Health Services Research* 38 (1): 287–309.

Grumbach, K., K. Vranizan, and A. B. Bindman. 1997. "Physician Supply and Access to Care in Urban Communities." *Health Affairs* 16 (1): 71–86.

Health Resources and Services Administration (HRSA). (no date). "HRSA Geospatial Data Warehouse. Primary Care Service Areas (PCSA)" [accessed on March 22, 2005]. Available at http://datawarehouse.hrsa.gov/pcsa.htm

———. 2002. "Number of Active Physicians (MDs) and Physician-to-Population Ratios by Specialty, Selected Years: 1970–2000" [accessed on March 22, 2005]. Available at http://bhpr.hrsa.gov/healthworkforce/reports/factbook02/FB102.htm

Hicks, L. L. 1990. "Availability and Accessibility of Rural Health Care." *Journal of Rural Health* 6 (4): 485–505.

Hosmer, D. W., and S. Lemeshow. 1989. *Applied Logistic Regression.* New York: John Wiley & Sons. pp. 155.

Institute of Medicine. 1983. *Community Oriented Primary Care. New Directions for Health Services Delivery*, edited by E. Connor, and F. Mullan. Washington, DC: National Academy Press.

Institute of Medicine, Committee on Monitoring Access to Personal Health Care Services. 1993. "Summary." In *Access to Health Care in America*, edited by Michael Millman. Washington, DC: National Academy Press.

Kleinman, J. C., and R. W. Wilson. 1977. "Are 'Medically Underserved Areas' Medical Underserved?" *Health Services Research* 12 (Summer): 147–62.

Konrad, T. R., R. T. Slifkin, C. Stevens, and J. Miller. 2000. "Using the American Medical Association Physician Masterfile to Measure Physician Supply in Small Towns." *Journal of Rural Health* 16 (2): 162–7.

Larson, S. L., and J. A. Fleishman. 2003. "Rural–Urban Differences in Usual Source of Care and Ambulatory Service Use." *Medical Care* 41 (7, suppl): III-65–74.

Larson, E. H., K. E. Johnson, T. E. Norris, D. M. Lishner, R. A. Rosenblatt, and L. G. Hart. 2003. *State of the Health Workforce in Rural America. Profiles and Comparisons.* Seattle: WWAMI Rural Health Research Center.

Mathematica Policy Research. 1980. *Evaluation of Health Manpower Shortage Area Criteria*, DHEW Publication No. (HRA) 80-20.

Mueller, K. J., K. Patil, and E. Boilesen. 1998. "The Role of Uninsurance and Race in Healthcare Utilization in Rural Minorities." *Health Services Research* 33 (3, part 1): 597–610.

Mullan, F., and L. Epstein. 2002. "Community-Oriented Primary Care: New Relevance in a Changing World." *American Journal of Public Health* 92 (11): 1748–55.

Nesbitt, T. S., E. H. Larson, R. A. Rosenblatt, and L. G. Hart. 1997. "Access to Maternity Care in Rural Washington: Its Effects on Neonatal Outcomes and Resource Use." *American Journal of Public Health* 87 (1): 85–90.

Patrick, D. L., J. Stein, M. Porta, C. Q. Porter, and T. C. Ricketts. 1988. "Poverty, Health Services, and Health Status in Rural America." *Milbank Quarterly* 66 (1): 105–36.

Penchansky, R., and J. W. Thomas. 1981. "The Concept of Access: Definition and Relationship to Consumer Satisfaction." *Medical Care* 19 (2): 127–40.

Perloff, J. D., P. R. Kletke, and K. M. Neckerman. 1987. "Physicians' Decisions to Limit Medicaid Participation: Determinants and Policy Implications." *Journal of Health Politics, Policy and Law* 12 (2): 221–35.

Radcliff, T. A., M. Brasure, I. S. Moscovice, and J. T. Stensland. 2003. "Understanding Rural Hospital Bypass Behavior." *Journal of Rural Health* 19 (3): 252–9.

Roetzheim, R. G., N. Pal, E. C. Gonzalez, J. M. Ferrante, D. J. Van Durme, J. Z. Ayanian, and J. P. Krischer. 1999. "The Effects of Physician Supply on the Early Detection of Colorectal Cancer." *Journal of Family Practice* 48 (11): 850–8.

Roetzheim, R. G., N. Pal, D. J. Van Durme, D. Wathington, J. M. Ferrante, E. C. Gonzalez, and J. P. Krischer. 2000. "Increasing Supplies of Dermatologists and Family Physicians Are Associated with Earlier Stage of Melanoma Detection." *Journal of the American Academy of Dermatology* 43 (2): 211–8.

Salmon, C. T., and T. S. Nichols. 1983. "The Next-Birthday Method of Respondent Selection." *Public Opinion Quarterly* 47: 270–6.

Sawada, M. 2004. "Global Spatial Autocorrelation Indices—Moran's I, Geary's C and the General Cross-Product Statistic" [accessed on November 19, 2004].

Available at http://www.uottawa.ca/academic/arts/geographie/lpcweb/newlook/publs_and_posters/reports/moransi/moran.htm

Shi, L., J. Macinko, B. Starfield, J. Xu, and R. Politzer. 2003. "Primary Care, Income Inequality, and Stroke Mortality in the United States." *Stroke* 34 (August): 1958–64.

Shi, L., and B. Starfield. 2001. "The Effect of Primary Care Physician Supply and Income Inequality on Mortality among Blacks and Whites in US Metropolitan Areas." *American Journal of Public Health* 91 (8): 1246–50.

Shortt, S. E. D. 2004. "Making Sense of Social Capital, Health and Policy." *Health Policy* 70: 11–22.

Stearns, S. C., R. T. Slifkin, and H. M. Edin. 2000. "Access to Care for Rural Medicare Beneficiaries." *Journal of Rural Health* 16 (1): 31–42.

Sui, D. Z. 2004. "Tobler's First Law of Geography: A Big Idea for a Small World?" *Annals of the Association of American Geographers* 94 (2): 269–77.

The American Association for Public Opinion Research. 2004. "Standard Definitions: Final Dispositions of Case Codes and Outcome Rates for Surveys" [accessed on March 22, 2005]. Available at http://www.aapor.org/pdfs/standarddefs_ver3.pdf

The Center for the Evaluative Clinical Studies. 1998. *Dartmouth Medical School. The Dartmouth Atlas of Health Care 1998*, edited by J. E. Wennberg, and M. M. Cooper. Chicago: American Hospital Publishing Inc.

U.S. Bureau of Health Professions (BhPr). (no date). "Health Professional Shortage Area Primary Medical Care Designation Criteria" [accessed on March 22, 2005]. Available at http://bhpr.hrsa.gov/shortage/hpsacritpcm.htm

U.S. Department of Transportation, Bureau of Transportation Statistics. 2000. *The Changing Face of Transportation (BTS00-007)*. Washington, DC: U.S. Department of Transportation, Bureau of Transportation Statistics.

Vogel, R. L., and R. J. Ackermann. 1998. "Is Primary Care Physician Supply Correlated with Health Outcomes?" *International Journal of Health Services* 28 (1): 183–96.

Waller, L. A., and C. A. Gotway. 2004. *Applied Spatial Statistics for Public Health Data*. Hoboken, NJ: John Wiley & Sons.