Do Ambulatory Sensitive Condition Admission Rates Identify Access Problems in Rural and Urban Areas?

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Abstract

Variations in hospitalization rates for selected medical conditions among small geographic areas have been used as indicators of problems with access to primary care. The use of these rates has gone forward without a clearly established causal link between access and the hospitalizations. This project tests how well Ambulatory Sensitive Condition (ASC) hospital admission rates relate to problems in access in rural and urban areas of North Carolina measured by the availability of primary care clinicians. This project created primary care service areas using detailed data sets describing the practice locations and clinical activity of all North Carolina licensed physicians, physician assistants and primary care nurse practitioners, and census-derived population characteristics at the ZIP code area level. The relationship between the locations of the active clinicians and the characteristics of the populations in the service areas were regressed on the ambulatory sensitive hospitalization rates for the primary care service areas. The data showed a much higher degree of correlation between the hospitalization rates and community income than a similar analysis run at the county level. However, the supply of providers, an indicator of primary care access, does not predict ambulatory sensitive condition admission rates in either urbanized or rural service areas. The use of ASC rates as indicators of primary care access problems should be examined in much greater depth prior to their acceptance as indicators of progress for projects intended to track access trends or as independent sentinel indicators of system problems.

INTRODUCTION

Americans think of their health care "system" as being the best in the world and those who use the system report satisfaction with their care. However, they also recognize that some groups have difficulty receiving the benefit of this excellence, their failure to participate is described as a problem with access (Aaron, 1991). This report describes a measure of access that relates to primary care; the underlying assumption of this measure, called ambulatory sensitive conditions (ASC), is that we can indirectly measure access by seeing the effects of inadequate access to primary care.

Access to primary care is one of the central objectives of the American health system. The recent national effort to reform the system led by President Clinton was described as having the primary goal "more universal access to medical care" (Aday, 1993). Access is a key term used by politicians who seek to improve the social performance of government programs and to better society. For example, from President Clinton's 1997 State of the Union Address: "We must continue, step by step, to give more families access to affordable, quality health care." (Clinton, 1997). Access to primary care is widely considered to be a central goal of a just and effective health care delivery system (Millman, 1993). But there is no clear acceptance of any one measure of access as the optimal indicator of system performance wither for primary care or other aspects of health care; the Institute of Medicine's Committee on Monitoring Access to Personal Health Care Services offers a range of 15 groups of indicators but together, they could not fulfill the need for an efficient measure of the key

construct of access (Millman, 1993; p.5, 18). Access is neither a direct marker of justice nor of the effectiveness of medical care in meeting the needs of people.

If any given measure were valid, sensitive, and specific to the underlying dimension of access, then programs, projects and structures whose aim is to establish, increase or improve access could be compared one to the other or to external measures of access. This issue of comparability has not been confronted on a broad scale. The reason for this is as much due to the lack of clear specificity and sensitivity in the measurement of access to primary care by current approaches as it is to the belief that the programs self-evidently do contribute materially and positively to access.

The notion of clinical indicators as measures of access has been compelling to some and even led some states and agencies to adopt the work of John Billings as part of their measuring of underservice; for example, Nebraska has used the measures to assess overall system adequacy (Nebraska Health Information Project, 1996) and New York has used it to evaluate a health professional recruitment and retention project (Schreiber & Zielinski, 1997). However, the ambulatory sensitive admissions criteria which have been proposed by Billings (Billings, Zeitel, Lukomnik, Carey & Blank, 1993) and adapted by others have not been shown to work consistently well in rural areas; that is, they have not been able to correlate well with small area indicators of income, much less function as a clear marker for access. We wish to explore in-depth the ability of this type of clinical indicator and how it might measure or not measure access in rural areas.

Background.

The notion of using indicator conditions for the identification of problems of access or underservice has a long history. Sentinel health events, as described by David D. Rutstein, and defined by the Working Group on Preventable and Manageable Diseases in collaboration with the National Center for Health Statistics, the Center for Disease Control, and the Veteran's Administration, represent a negative index of health (Rutstein, Berenberg, et al., 1976), or, what may, alternatively, be termed a positive indicator of low access. In the draft of a report of a study done by Lewin and Associates entitled *Incorporating Health Status Indicators into the Measurement of Medical Underservice* (Arnold & Zuvekas, 1989), several criteria for selecting sentinel events were stated:

- the sentinel event needs to be well defined and the condition easily diagnosable;
- primary care patient management must be effective in either preventing, treating, or controlling the condition;
- the event must be observable in the population;
- data must be routinely collected on the condition and be available within reasonable cost and time constraints; and,
- the events must represent different age and sex cohorts.

In the draft of the Lewin report the following sentinel events, representing morbidity, were used to identify areas of underservice:

- for infants, hospitalization for dehydration with gastroenteritis, and hyperbilirubinemia with exchange transfusion;

- for children, hospitalization for asthma, occurrence of measles, mumps, polio, tetanus, and rheumatic fever; and,
- for adults, advanced breast cancer, advanced colorectal cancer, invasive cervical cancer, low birth weight deliveries (for adult women), tuberculosis, uncontrolled diabetes, and uncontrolled hypertension.

The sentinel event work did not meet with wide acceptance in the policy or research fields and did not lead into studies of access. Not until the work of John Billings and others did the issue of sentinel events become firmly tied to measures of access (Billings and Hasselblad, 1989; Billings and Teicholz, 1990). The difference between sentinel events and the ambulatory sensitive measures proposed by Billings and others appears to be one of conceptual consistency in the ambulatory sensitive measures. There was no apparent empirical reason for the combination of multiple indicators conditions into an agglomerated rate, rather, an acceptance that the concept of "ambulatory sensitivity" would be better represented by a general set of indicators.

Earlier work on the direct measurement of access for individuals was led by Lu Ann Aday and Ronald Andersen who proposed measures that were described with terms such as: "Symptoms Response Ratio" and the "Use Disability Ratio" (Aday and Andersen, 1974). Both were used in studies of comparative access in evaluations of major projects to promote new delivery forms for primary care and sponsored by the Robert Wood Johnson Foundation (Shortell, Wickizer and Wheeler, 1984; Sheps, Wagner and Gillings, 1984); the latter study focused on rural areas alone, while the Shortell, et al. study

examined urban communities. The measures presented real problems of scaling and normalization. The ratios were given scales that showed deviation from what experts felt should occur with a given set of symptoms. Individual responses were summed and adjusted for age and sex to provide population descriptors. However, the variation was not fully explainable by problems with access, and could have been due to local medical cultures which set varying standards for clinical response to a set of symptoms or disabling conditions or to some other component of community. The issue of choosing to delay seeking care complicates the issue of access because there are behavioral as well as structural issues that affect care seeking. Weissman and colleagues (1991, 1992) examined the phenomenon of delayed access to health care and found that a person's not having a regular physician, lacking insurance or being covered by Medicare or Medicaid, were very significantly correlated with the decision or behavior of delaying care. The conclusion of the paper was that the strongest reason for this was failure to recognize the severity of the problem. However, the results showed, for those people who did not have a regular doctor or were uninsured or covered by one of the federal health insurance programs, that the issue of cost was a much stronger factor than perceived severity.

The use of ambulatory sensitive indicators as markers of problems in access has become popular and has been used in program evaluations in several states despite a lack of clear academic consensus on their utility and validity. For example, the following states have produced reports—Utah (Silver, Babitz and Magill, 1996); Virginia (Shukla & Pestian, 1996); Nebraska (Nebraska Health

Information Project, 1996); New York (Schreiber and Zielinski, 1997); and West Virginia (Cockley, 1996). Fleming (1995) reviewed the literature on the relationship between primary care and avoidable hospitalizations and outcomes and described problems with the linkage of ambulatory visits and subsequent events. That review did not address the question of whether rates of avoidable hospitalizations accurately reflected primary care access problems.

There are four potential problem areas in the use of these rates:

1. The influence of variations in hospitalization rates associated with physician decision making, so called, practice variations;

2. The conditions chosen to reflect problems with access;

3. The choice and treatment of the population's attributes (denominators) used to create rates;

4. The problem of ecological fallacy.

Practice Variations

The phenomenon of practice variations has been described by some as having motivated much of the present work in health services research. Much of the credit for the observation of variations has been given to John Wennberg, who, with Alan Gittelsohn described this phenomenon in New England in a ground breaking article in *Scientific American*. The existence of variations was observed many times before, dating well back into the early parts of the century (Wennberg & Gittelsohn, 1972). Variations in use of medical services and the way physicians practice medicine have been the subject of research in the fields of geography, medical anthropology and sociology.

The potential for the practice variation phenomenon to independently affect rates of ambulatory sensitive admissions has been considered by the team that examined California data (Komaromy, Lurie et al., 1996). That group took into consideration that admission rates might vary for "social" reasons—the patient would be better off in the hospital than not because of factors not directly related to their medical condition—and that practice "style" might affect the rate of hospitalization for key diagnoses that made up the ambulatory sensitive rate

Ambulatory Sensitive Conditions and their relationship to access

In the analysis of indicators such as ASC, there are problems with the "dose response effect"—if there is lower access there should be a relationship between the ambulatory sensitive measure and the degree of access. Billings has found that the relationship between measures of access which are measured by income levels and hospitalization rates for ASCs to vary from city to city and to be less reliable when examining cities that are more rural or associated with rural regions (Billings, 1995). There is a problem with infrequency of the diseases and the numerators in ASC and rural areas are, by necessity, small. For many of these conditions described as ambulatory sensitive, significant latency period problems remain; hospitalization for hypertension, for example, may come long after a failure of early and effective primary care treatment. Many of the sequelae of lack of access do not appear until much later in the life course, even for elderly people. Since the idea is to identify contemporaneous measures, the issue of response to lack of access will have to receive close attention.

The selection of the conditions which are included as indicators of access problems have varied across studies. For example, the California analysis (Bindman, et al, 1996) used the number of hospital discharges in each ZIP code cluster with a principal diagnosis of asthma, chronic obstructive pulmonary disease, congestive heart failure, diabetes mellitus, or hypertension with the addition of some secondary diagnoses of asthma and COPD if the primary diagnosis was pneumonia or acute bronchitis. The Virginia study (Shukla & Pestian, 1996) used asthma, breast cancer, invasive cervical cancer, low birth weight, measles, mumps, other respiratory tuberculosis, pulmonary tuberculosis, rheumatic fever, tetanus, uncontrolled diabetes, and uncontrolled hypertension. The New York study used diagnoses that aligned more closely with those recommended by the Institute of Medicine in its monograph, "Access to Health Care in America" (Millman, 1993) of "Ambulatory-Care-Sensitive Conditions." These variations reflect a real lack of consensus of what constitutes ambulatory or primary care sensitive conditions.

Denominators and Small Areas

Early in the process of developing sentinel events for the study of access, the problem of denominators was identified. Some attempts to structure an appropriate method to analyze low-frequency events were made and tested on a population of veterans (Patrick and Manton, 1987). However, there has not been a satisfactory resolution of the small denominator problem for rates despite the application of very sophisticated methods (Manton et al., 1989). Again, this issue will have to receive close scrutiny in any study of the phenomenon in rural

places. For example, in a study of the Medicare population in Utah, Silver, Babitz & McGill (1996) created a rate based on "estimated total admissions (inflated by the region-specific out-of-state admission factor) were standardized by the direct method (Fleiss, 1981) using US 1990 population as the standard population. ... Because standard rate analysis underestimates the variance when applied to recurrent outcomes, variance estimates used in the computation of confidence intervals were inflated by a multiple admission factors (Diehr, Cain, Kreuter, & Rosenkrantz, 1992; Stukel , et al., 1994) estimated using the average readmission rate for all regions, diagnoses and study years combined.

Rural areas will undoubtedly have problems with small denominators—that is the nature of rural places. However, there will be other problems inherent to the rural situation, for example, the unit of analysis for the denominator. Most previous work has used the ZIP code area and assumes relative homogeneity within those areas. These conditions do not hold in rural places. The ASC indicators are also scarce diagnoses. For example, an earlier work involving NC RHRP staff found only 0.96% of the sample of 25,000 respondents to the National Medical Expenditure Survey (NMES) had an ASC hospitalization in 1987 (Lambrew, Carey and Billings, 1993). A multivariate analysis of the 240 relevant cases compared to the rest revealed a relationship between race and income but no relationship between ASC admissions and having a regular source of care.

The work reported by Grumbach, Seifer, et al., (1995; Komaromy, Lurie, et al., 1995) used Medical Service Study Areas (MSSAs) that were created in

California in the 1970s to assess needs for primary care physicians (Smeloff & Kelzer, 1981). Those clusters represented "communities" in the study. Their validity as primary care service areas was not tested in the study but their characteristics and attributes were examined closely. The analysis done in California aggregated 2,000 ZIP areas into 394 clusters, 250 urban and 144 rural. These clusters of ZIP "approximated" the MSSAs since the MSSAs were created from census tracts or census geography. The report of the study does not indicate whether the MSSAs were updated from their creation in 1978 or what baseline ZIP area maps were used for the analysis of data. Despite the problems inherent in creating usable primary care service areas, the California study did work toward creating a geography that could produce relevant denominators for the analysis of primary care access-related phenomena.

There are other, more technical problems with the analysis of rates that use the same population denominators on the left and right hand sides of multivariate analyses. This includes the analysis of rates of ambulatory sensitive hospital admissions using per caita income, employment rates, or any other population-based rate as a predictor or correlate. Kronmal (1993) warns against this type of analysis pointing out that there will inevitably be "spurious correlations" and that tests of association in analyses using ratio or rate variables should be avoided. Firebaugh and Gibbs (1985) also described this phenomenon and suggested adjustments. Nevertheless, health services researchers have moved ahed with analysis of rates without considering these warnings. The

analysis described here also makes no adjustment for this potential "artifactuality."

Border Crossing, Rate Adjustment, and Multiple Admissions

There are two other issues important to the construction of rates of admission for ambulatory sensitive conditions these are the effects of border crossing and multiple admissions of individuals in the index time period(s). The numerators can be adjusted without great difficulty when there are compatible data sets for the adjacent regions or states. In the study by Bindman, et al., (1996) discharge data sets were available for adjacent states and the appropriate admissions added to or subtracted from the numerator. Changes in the denominator are less of a concern, although, if the primary care access area crosses borders, then the denominators should be allocated to the appropriate cluster or area.

The issue of multiple admissions has been noted by some researchers, but not all. For example, Bindman, et al. (1996) simply stated that they were unable to adjust for this since individual identifiers were not available in their data sets. In the New York study by Schreiber and Zielinski (1997), there was no indication of concern with either the problem of border crossing or of multiple admissions.

Summary of the Literature

The problems associated with ambulatory sensitive conditions have been noted by other researchers and analysts who are using these measures. There needs to be much more analysis of their meaning and performance as indicators of access if these indices or rates are going to be used to guide policy or evaluate

programs. This study is one attempt to address some of the issues raised in this review especially the problems of denominator populations and the applicability of ASC to rural populations.

ANALYSIS

The analysis was developed with the primary hypothesis that ambulatory sensitive condition admission rates in primary care service areas in North Carolina were related to the relative supply of primary care physicians controlling for characteristics of the population in the service areas including age, sex, income, and employment status.

Primary Care Service Areas

In order to analyze the North Carolina data, physician location data were used to create geographic areas that would also reflect primary care service areas or "communities" where patient behavior and health care outcomes would be related to a restricted set of primary care resources. The intention was to create areas that were probably smaller than most of the state's counties and reflected the relative access to primary care for residents. The data that were available for this were Census data for ZIP areas and all census divisions, hospital patient origin by ZIP, physician location and activity by ZIP, a transportation base-map for the state, and a ZIP-based list of locations of primary care clinics and related programs. Any analysis using the complex transportation system data would require substantial programming and was not well-adapted to multiple, iterative queries which were necessary in the development of the areas and that approach

was not used in the final study. The use of address-to-address time and distance measures combined with commuting and travel for leisure data which are included in these data may prove useful in more targeted analyses. The hospital discharge data were drawn from a 100-percent discharge data system maintained by the state. Preliminary analysis of service areas by procedures and reasons for admission yielded many multiple overlapping areas where the dominance of large places would exclude the identification of smaller places given one algorithm and would disproportionately emphasize smaller place (hospital) influence in others.

Since the resource of interest was the primary care provider, and since the study also had access to detailed data that described the location (by ZIP area) and practice activity of all North Carolina physicians for 1994. That combined with the detailed ZIP estimates based on census data, a cluster approach was considered. Cluster analysis to identify service areas had been used in the original structuring of the California MSSAs, Makuc and colleagues (1985, 1991) used clustering to create hospital service areas that have been analyzed in studies of primary care labor market areas (Brasure, 1997). To create the service areas for analysis of the ambulatory sensitive conditions, we chose a clustering approach using the ZIP code areas.

Cluster analysis is an assortment of procedures used to organize a sample or population into relatively homogeneous groups. Members of a population are most commonly measured by one of three methods in cluster analysis: distance measures, correlation coefficients, and association coefficients. A

method based on distance was considered most appropriate in this case since the emphasis was on access to care. Cluster analysis, in general, uses measures of difference and distance can be considered a difference measure. The variables available for creating primary care service area clusters were primarily demographic data and physician licensure data. The data from the North Carolina Medical Board is comprised of one record per physician and contains several useful variables, such as the street address and mailing address for the physician's practice location, the specialty and subspecialty of the physician, and the average amount of office hours per week by ZIP code practice location. Physicians included in the dataset were active, non-resident, non-federal, licensed physicians with primary specialties of Family Practice, General Practice, or General Internal Medicine who reported twenty or more hours office hours per week. The demographic data used were the 1995 estimates from Claritas Corporation. The demographic data are also reported at the ZIP code level and are formatted for the MapInfo desktop mapping system, which provides the tabular demographic data associated with graphical data representing the borders between ZIP code regions. The population and household data in the tabular data were enhanced with location data for the ZIP codes. The MapInfo system can generate latitude and longitude coordinates for the location of the ZIP code by generating the centroids—or centers of gravity—from the ZIP code boundaries. The latitude and longitude variables were added to the demographic database and written to a data format that could be read by the SAS statistical package that would be running the cluster analysis.

The individual-level physician data was summarized to the ZIP code level and merged with the demographic data. The Euclidean distance between all pairs of ZIP codes were determined and added to the analysis data; then the mathematical sums, differences, maxima and minima of the sociodemographic and physician descriptor values representing each ZIP area were calculated. To move to the next step a judgment concerning the resultant number of clusters had to be made, the clustering technique will function only with such an a priori estimate. A target of 80 to 120 clusters were chosen, this reflected the apparent number of medical "communities" in the state. This number relates to the number of acute care hospitals in the state (117) which are located in 81 of the 100 counties and considers the location of "clusters" of physicians in or near the larger towns in the state.

ZIP code Clusters were created with the SAS system's "Cluster" and "Tree" procedures using the average link agglomerative hierarchical method. The data was then written to a format which could be returned to the MapInfo desktop mapping package. The cluster designations and physician data were associated with the Claritas tabular and graphic data by the ZIP code variable that is common to both files. The clusters could then be inspected by creating thematic maps in MapInfo. The ZIP code boundaries between polygons belonging to the same cluster were removed to create service area polygons. These service areas could then be shaded different colors and overlaid with reference layers such as ZIP code boundaries, county boundaries, and major city locations for visual examination.

Testing several clustering methods, numbers of clusters, and distance functions resulted in service areas that conformed with empirical knowledge of the service areas throughout the state, except that some of the service areas were not well centered on places where physician density was high. It was decided that using demographics and physician supply from pairs of ZIP codes was diluting the centralizing effects of activity centers. We then allowed the dominant ZIP code (measured by greater numbers of physicians per population) would have more influence in the clustering. The distance formula that was used is described by the formula:

$$Dist = 20\left(\frac{EuclideanDistance}{MaxEuclideanDistance}\right) - \left(\frac{GreaterNumberPhysicians}{MaxNumberPhysicians}\right) + \left(\frac{GreaterPopulation}{MaxPopulation}\right)$$

This was applied with a 120-cluster average-linkage model. Targeted refinement of the clusters for the largest and most complex metropolitan areas in the state were considered. These included some very small (in geographic size) clusters and four clusters which did not include a full time primary care physician. The choice was made to keep the metro clusters intact due to the inability to reliably isolate patterns of outpatient or primary care use. The clusters with no physicians were retained with FTE physician time allocated to the clusters based on ZIP practice location data and time in practice maintained by the Cecil G. Sheps Center for Health Services Research based on data reported to the N.C. Medical Board as part of the license renewal process. The geographic distribution of the ZIP code clusters is displayed in Figure 1 and a summary of their characteristics in Table 1.

Figure 1

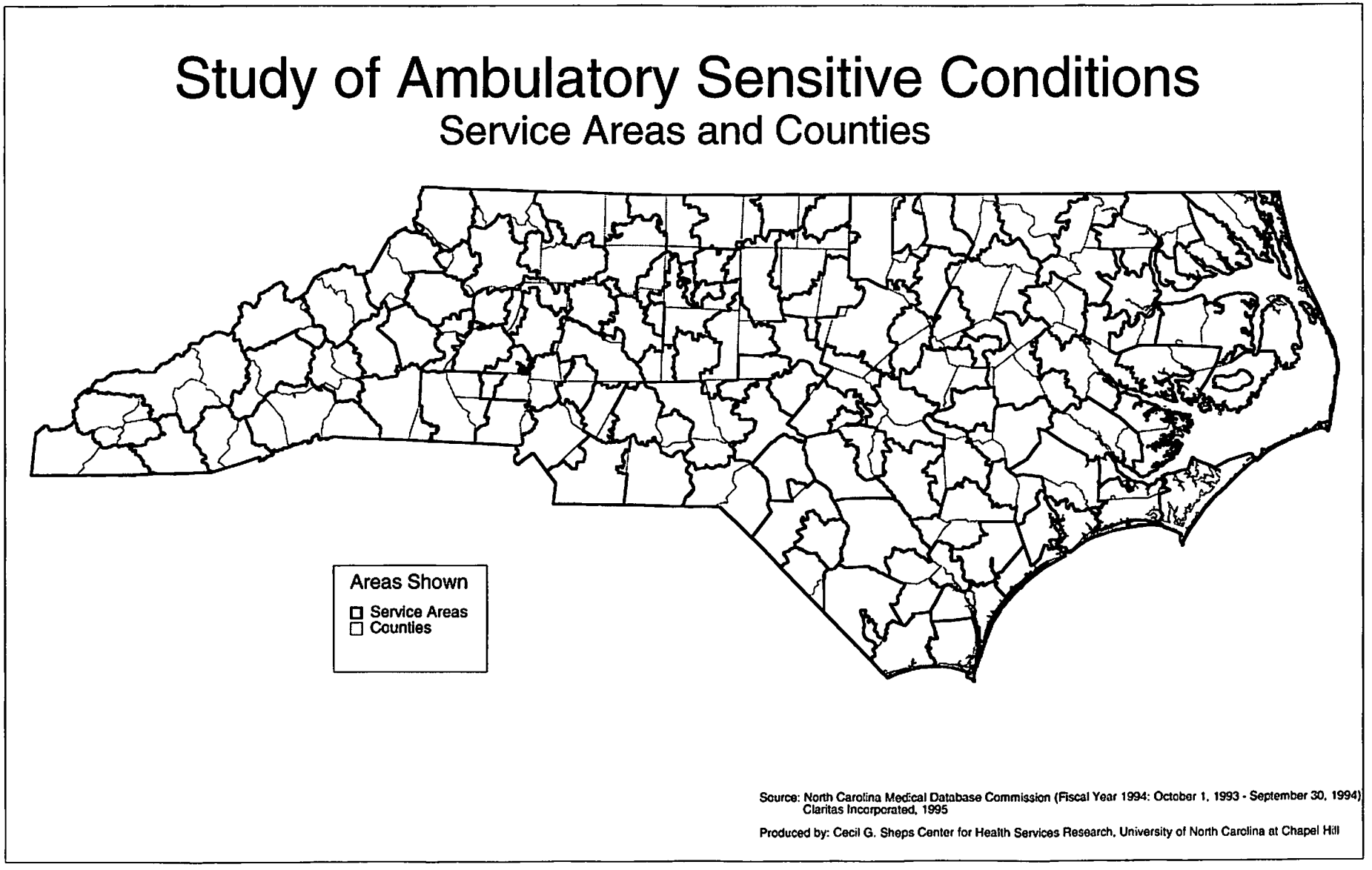

Study of Ambulatory Sensitive Conditions
Service Areas and Counties
Areas Shown
Service Areas
Counties
Source: North Carolina Medical Database Commission (Fiscal Year 1994: October 1, 1993 - September 30, 1994)
Claritas Incorporated, 1995
Produced by: Cecil G. Sheps Center for Health Services Research, University of North Carolina at Chapel Hill

Table 1. Characteristics of the Primary Care Service Clusters (N=120)

Variable	Mean	Std. Deviation	Minimum	Maximum
Population per FTE primary care clinician	3371.682	3112.56	441.7541	21611.27
primary care clinician/ 1000	4.505631	2.855645	.4627216	22.63703
Pop. per square	180.3568	260.6417	10.5464	2081.863
Percent Employed	94.6509	1.764664	88.1579	97.93282
Percent Nonwhite	25.34317	17.53396	.7669929	74.22971
Per capita income	15131.25	2572.41	9824.706	25787.58
Percent Urban	27.36867	25.78349	0	90.53381
1995 Population	59561.6	78178.1	846	536635
FTE MDs	35.86175	77.91965	.75	616.85

Analysis of Patient Admission Rate Data

The inpatient discharge data were drawn from data reported by the North Carolina Medical Database Commission for all discharges from North Carolina Hospitals for the period October 1, 1993 through September 30, 1994. The data were required to be reported to the Commission by statute and all hospitals reported using UB-92 forms. The data were cleaned and edited for consistency and accuracy by the Commission prior to delivery to the project. The data set included 835,348 discharges, 138,509 were to psychiatric or specialty hospitals and were dropped from the analysis leaving a total of 696,839. Of these, 117,444

(16.87%) were for ambulatory sensitive conditions. This compares to 13.8% of Nebraska discharges in 1994-1995, the only other study to use a similar listing of conditions (Nebraska Health Information Project, 1996).

Border crossing for hospital care is a problem for this analysis in one area of the state, the extreme northeast part which includes several small, rural counties which use the Norfolk area for the majority of their hospitalization. This amounts to less than 2 percent of the total of admissions for North Carolina residents. The rates for the clusters most affected by out-migration were adjusted by using Medicare patient origin data for the index year under the assumption that there was an equal probability of ambulatory sensitive admissions to out-of-state hospitals as to in-state hospitals.

This study followed the specification of ambulatory sensitive conditions proposed by the Institute of Medicine (Millman, 1993). The specific diagnoses included:

Table 2: Ambulatory Sensitive Condition Discharges, North Carolina, 1993-1994

Condition and ICD-9-CM Code(s)	Comments	Number of Discharges	Percent of ASC Discharges
Congenital Syphilis (090)	Secondary diagnosis for newborns only	140	0.1
Immunization-related and preventable conditions (033, 037, 045, 320.0, 390, 391)	Hemophilus meningitis (320.2) age 1-5 only	283	0.2
Grand mal status and other epileptic convulsions (345)		1331	1.1
Convulsions "A" (780.3)	Age 0-5	747	0.6
Convulsions "B" (780.3)	Age >5	2806	2.4
Severe ENT infections (382, 462, 463, 465, 472.1)	Exclude Otitis media cases (382) with myrigotomy with insertion of tube (20.01)	1761	1.5
Chronic obstructive pulmonary	Acute bronchitis only with	10728	9.1

disease (491, 492, 494, 496, 466.0)	secondary diagnosis of 491, 492, 494, 496.		
Bacterial pneumonia (481, 482.2, 482.3, 482.9, 483, 485, 486)	Exclude case with secondary diagnosis of sickle cell (282.6) and patients <2 months	21818	18.6
Asthma (493)		10398	8.9
Congestive heart failure (428, 402.01, 402.11, 402.91, 518.4)	Exclude cases with the following surgical procedures: 36.01, 36.02, 36.05, 36.1, 37.5, or 37.7)	20671	17.6
Hypertension (401.0, 401.9, 402.00, 402.10, 402.90	Exclude cases with the following surgical procedures: 36.01, 36.02, 36.05, 36.1, 37.5, or 37.7)	1702	1.4
Angina (411.1, 411.8, 413)	Exclude cases with surgical procedure (01-86.99)	9991	8.5
Cellulitis (681-3, 686)	Exclude cases with a surgical procedure (01-86.99), except incision of skin and subcutaneous tissue (86.0) where it is the only listed surgical procedure	3892	3.3
Skin grafts with cellulitis (263-4)	Exclude admissions from SNF/ICF	1321	1.1
Diabetes "A" (250.1-3)		3385	2.9
Diabetes "B"(250.8-9)		2444	2.1
Diabetes "C" (250.0)		2287	1.9
Hypoglycemia (251.2)		234	0.2
Gastroenteritis (558.9)		5365	4.6
Kidney/urinary tract infection (590, 599.0, 599.9)		9399	8.0
Dehydration-volume depletion (276.5)	Examine principal and secondary diagnoses separately	6291	5.4
Dental conditions (521-3, 525, 528)		450	0.4

Analysis of Rates

Rates of ambulatory sensitive conditions admissions were calculated for the North Carolina ZIP clusters using the discharge data which included ZIP code addresses for each case. The rates were age-sex adjusted using an indirect method and the 1980 US Census population data for North Carolina as the standard population (Remington & Schork, 1985). The adjustments took into consideration the age-limited diagnoses. Rates were calculated for two groups,

those less than 65 years of age and those older. This was done because it has been suggested that the access problems for persons with Medicare coverage would be less sensitive to income effects than for those who may be at higher risk of being uninsured (Bindman, et al., 1996). The admission rates for the 65 and over group (19.0/1000) were approximately twice those of the younger group (10.15/1000). Ambulatory sensitive condition admissions were 16.87% of all admissions and 22.7% of admissions for those 65 and over.

The make up of the ambulatory sensitive rates was skewed toward a small number of admission diagnoses. Pneumonia, Congestive Heart Failure, Chronic Obstructive Pulmonary Disease, asthma, and angina made up 62.7 percent of the discharges with the 17 other conditions making up the remainder

The ambulatory sensitive rates were included in a correlation analysis of the cluster demographic characteristics for the 120 clusters. The matrix showed high correlations between the ASC rates and the per capita income of the service clusters and indices of rurality for the areas. Per capita income was moderately correlated with the population density (r=0.58) and proportion urban measures (r=0.55). The full correlation matrix of the variables is described in table 3.

Table 3. Correlation Matrix of Dependent and Independent Variables

	rate<65	totrate	pop/MD	MD/K	density	unemp	nonwhite	percap	pcturb	pop95
ASC rate <65	1.0000									
ASC rate tot	0.9325	1.0000								
popperfteMD	0.0227	0.0034	1.0000							
fteMDper1000	-0.1507	-0.0909	-0.5890	1.0000						
poppersq	-0.4242	-0.4438	-0.0489	0.1994	1.0000					
%unemployed	-0.1055	-0.1688	-0.0275	0.0301	0.1549	1.0000				
%nonwhite	0.2966	0.1996	0.2260	-0.1309	-0.0957	-0.4088	1.0000			
percapincome	-0.5058	-0.4910	-0.1550	0.3212	0.5330	0.4131	-0.3201	1.0000		
%urban	-0.2628	-0.3059	-0.1573	0.3473	0.5241	0.0985	0.1158	0.5476	1.0000	
pop95	-0.2762	-0.3089	-0.2210	0.4077	0.5019	0.1979	0.0341	0.5817	0.6832	1.0000

The two rates were mapped into the primary care service areas and those maps are displayed as Figures 2 and 3. The maps show clustering of high rate areas in the more rural areas of the state. The population in North Carolina is concentrated in a crescent that originates in the Raleigh area in the geographic center of the state, arcs north and westward to the Greensboro, Winston-Salem area then south and westward to the Charlotte area which is located on the southern border in the "corner" which juts at an angle into South Carolina. This clustering identifies three areas which have high rates of ASC admissions, in the northeast, the northwest and from the east central South Carolina border in a wide band northeastward in the coastal plain region of the state.

The combined relationship of the key physician supply variables and the controlling socioeconomic descriptors to the ASC admission rates was explored using a linear regression model in Stata®. The models took the form:

> Ambulatory Sensitive Admission Rate (Total) = $\beta_0 + \beta_1$*FTE primary physicians per 1000 + β_2*population/mi^2 + β_3*percent unemployed + β_4*percent nonwhite + β_5*percapita income + ε.

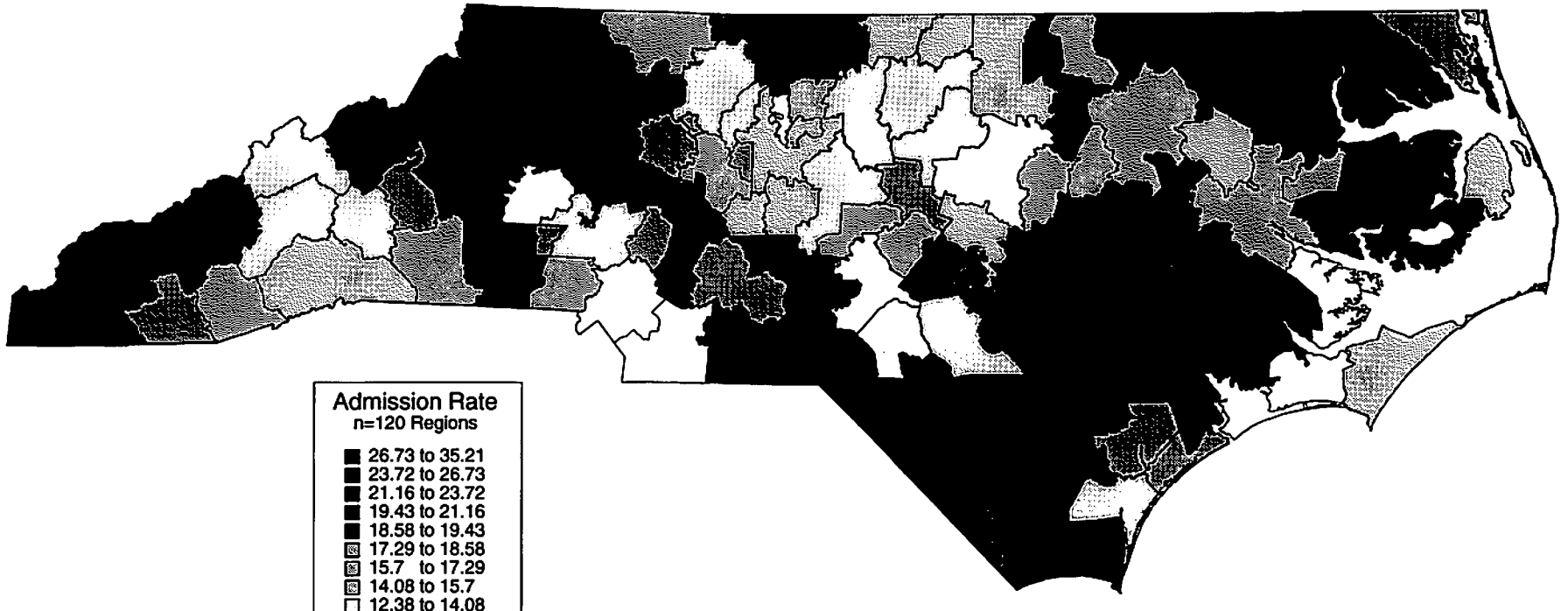
The analysis model for the rate for the population younger than 65 was tested in the same manner.

The regression models showed no relationship between physician supply and the rate of ambulatory sensitive admissions for either rate but did show strong and significant relationships between the rate for those younger than 65 and per capita income—the lower the income the higher the rate; the percentage of the cluster population that was nonwhite—the higher the percentage, the

Figure 2

Admission Rates for Ambulatory Sensitive Conditions

Age-Adjusted Rates for All Residents per Standard 1000 Population



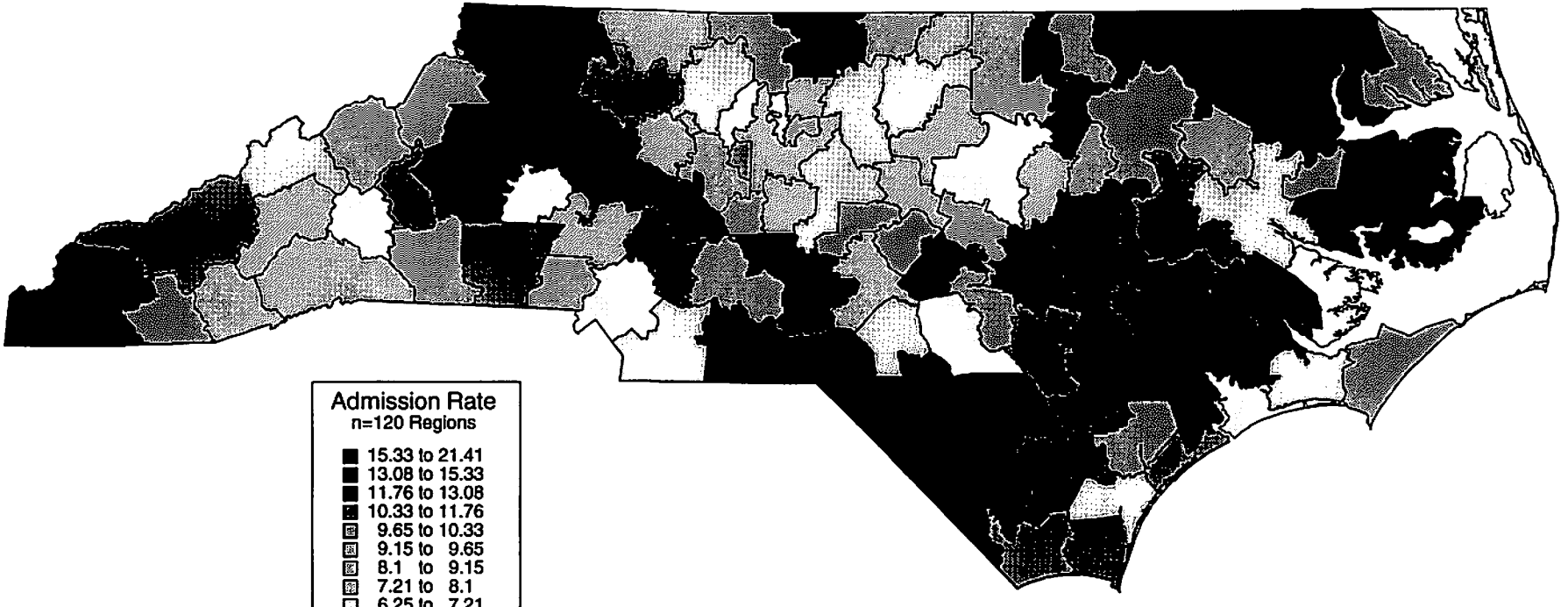
Source: North Carolina Medical Database Commission (Fiscal Year 1994: October 1, 1993 - September 30, 1994)
Claritas Incorporated, 1995

Produced by: Cecil G. Sheps Center for Health Services Research, University of North Carolina at Chapel Hill

Figure 3

Admission Rates for Ambulatory Sensitive Conditions

Age-Adjusted Rates for Residents Less than 65 Years Old per Standard 1000 Population



June 5, 1997 TCR.RR

Source: North Carolina Medical Database Commission (Fiscal Year 1994: October 1, 1993 - September 30, 1994)
Claritas Incorporated, 1995

Produced by: Cecil G. Sheps Center for Health Services Research, University of North Carolina at Chapel Hill

higher the rate; and the population density—the less dense, the higher the rate. For the total population, the percent nonwhite variable was no longer significantly correlated. The results of the regressions analysis for the under 65s is included in Table 4, for the total group in Table 5.

Table 4. Regression Analysis of Under 65 ASC Admission Rate

Variable	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
primary MDs/1,000	.0499733	.1087333	0.460	0.647	-.1654678	.2654144
pop/miles square	-.0031379	.001375	-2.282	0.024	-.0058623	-.0004135
percent unemployed	.3498586	.1998009	1.751	0.083	-.0460212	.7457384
percent nonwhite	.0441546	.0194505	2.270	0.025	.0056159	.0826933
per capita income	-.0006047	.000163	-3.709	0.000	-.0009277	-.0002817
percent urban	-.004353	.020454	-0.213	0.832	-.04488	.0361739
log population	.2918367	.4573416	0.638	0.525	-.614327	1.198
constant	-17.53421	17.48937	-1.003	0.318	-52.18715	17.11872

Number of obs. = 120; F(7, 112) = 8.40; Prob. > F = 0.0000; R-squared = 0.3444;
Adj. R-squared = 0.3034

Table 5. Regression Analysis of Total ASC Admission Rate

Variable	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
primary MDs/1,000	.1873733	.1714702	1.093	0.277	-.1523729	.5271195
pop/miles square	-.005442	.0021683	-2.510	0.014	-.0097382	-.0011457
percent unemployed	.1756401	.3150819	0.557	0.578	-.4486542	.7999344
percent nonwhite	.0303623	.030673	0.990	0.324	-.0304124	.091137
per capita income	-.0008069	.0002571	-3.139	0.002	-.0013163	-.0002976
percent urban	-.0088436	.0322555	-0.274	0.784	-.0727537	.0550665
log population	.1434372	.7212183	0.199	0.843	-1.285564	1.572439
constant	12.69678	27.58037	0.460	0.646	-41.95018	67.34375

Number of obs. = 120; F(7, 112) = 6.90; Prob. > F = 0.0000; R-squared = 0.3014;
Adj. R-squared = 0.2578

Both of the models were tested for multicollinearity using the Stata® *vif* procedure and there were no indicators of problems in the model specification.

One key provider of primary care to underserved and poor populations are the Community Health Centers funded by the federal government. North Carolina has 20 separately funded centers which operate and additional 41 satellite sites for a total of 61 primary care clinics. The model was expanded to include a variable indicating whether the cluster had a CHC located in its boundaries. The results of the analysis were not affected and the presence of the CHC was not a significant predictor of higher or lower ASC admission rates.

DISCUSSION

The analysis indicates that the relationship between primary care physician supply as an indicator of primary care access and ambulatory sensitive condition admissions cannot be supported. The relationship with per capita income is consistent with the observations made in other studies (Billings & Teicholz, 1990; Billings et al., 1993: Bindman et al., 1995; Grumbach, et al, 1995; Nebraska Health Information Project, 1996; Shukla & Pestian, 1996; Silver, Babitz & Magill, 1996). This does not indicate that the ambulatory admission rates are not indicative of overall problems of access. When the rates are displayed on a choroplethic, or shaded map, the pattern of high and low rates agrees with general assumptions about problems of access to primary care held by experts familiar with health care delivery in North Carolina. The maps of the rates have been displayed to individuals including the state Medicaid Director, the director

of the statewide AHEC system, the director of the state Medical Society's rural primary care support project, the leadership in family practice and internal medicine in the state and the leadership of the state health department. These experts recognize the differences in rates displayed on the map as identifying problem areas where they agree that there are shortages of primary care services, difficulties in insurance coverage, and eligibility for Medicaid.

CONCLUSIONS

The use of ambulatory sensitive admission rates as a measure of access to primary care is problematic and ought to be approached with care. There are multiple potential problems with the accuracy and meaning of the rates including their sensitivity to denominators, the logic behind the admission conditions chosen for the rate, the availability of data at a logical and reasonable level, and the determination of primary care service areas. The remains, however, a face validity to the rates evidenced by their differentiation of places that have a gestalt of underservice or system pathology. This appears to hold in both urban and rural places. The rates need to be examined more closely and the complexity of their relationship to the medical-social structure of communities examined in depth and over time.

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