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Geographic Distribution of Urologists Throughout the United States Using a County Level Approach

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Abbreviations and Acronyms

ARF = Area Resource File

HPSA = Health Profession Shortage Area

HSA = Health Service Area

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Purpose: The adequacy of the urologist work force in absolute numbers and relative distribution is unclear. To develop effective policies addressing the needs of an aging population we must better understand the urologist work force. We assessed the geographic distribution of urologists throughout the United States at the county level and determined the county characteristics associated with increased urologist density.

Materials and Methods: County level data from the Department of Health and Human Services Area Resource File and the United States Census were analyzed in this ecological study. Logistic regression and ordinal logistic regression models were built to identify predictors of urologist density, defined as the number of urologists per 100,000 individuals. National patterns of urologist density were mapped graphically at the county level.

Results: Overall 63% of the counties in the United States lack a urologist. Based on multivariate models urologists were less likely to be found in nonmetropolitan counties (OR 0.57, 95% CI 0.46–0.72) and rural counties (OR 0.03, 95% CI 0.02–0.06) than in metropolitan counties, which confirmed visually mapped models. Patterns of urologist density also appeared to be influenced by climate and county education levels rather than by traditional socioeconomic measures. Urologists younger than 45 years old were 3 times less likely to be located in nonmetropolitan and rural counties than their older counterparts.

Conclusions: The uneven distribution of urologists throughout the United States is likely to worsen as younger physicians continue to cluster in urban areas. Governing bodies must consider this distribution in their calls for increasing the number of training positions.

Key Words: urology; manpower; ecology; rural health services; specialties, surgical

THE adequacy of the future physician work force is in doubt with recent predictions of shortfalls leading the Council on Graduate Medical Education to reverse their 1999 recommendation to decrease the number of residency positions[1,2] and the Association of American Medical Colleges to recommend increasing United States medical school enrollment by 30% during the following decade.[3,4] However, these recommendations were built on nationwide demographic and gross domestic product projections, and they do not account for local physician distribution and accessibility. The accelerating growth of the

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elderly population in particular has led to calls to train more physicians and specialists. Others have argued that only an increased number of primary care practitioners improves outcomes.[5–7]

The last 30 years have seen a trend toward geographic equalization in hospital bed distribution, coupled with increasing inequality in physician distribution.[8] This maldistribution of the physician work force regardless of overall supply has been widely studied and the shortage of physicians in rural areas is a particular concern.[9,10] The disproportionately high metropolitan concentration of physicians has continued despite financial incentives and policies aimed at attracting physicians to rural areas.[8] This trend may be even more striking for younger physicians, for whom lifestyle may have a larger role in career decisions.[11]

While there is concern about the number of urologists in rural areas, to our knowledge there are no published data exploring urologist distribution using small geographic units. We assessed the geographic distribution of urologists throughout the United States at the county level to determine which county characteristics are associated with increased urologist density and whether the effects of these predictors vary with urologist age.

MATERIALS AND METHODS

We used an ecological study design in which the unit of observation was a group of individuals or a community to determine the demographic, geographic and environmental characteristics of an area that may be associated with the spatial distribution of urologists. The geographic unit of analysis was the county, as defined by the 2000 United States Census. Of the 3,141 counties in the United States all 32 counties in Alaska and Hawaii were excluded from study due to geographic isolation and the District of Columbia was excluded because, while it is considered a county equivalent, it does not share any other county characteristics. An additional 49 counties (1.6%) with missing data were excluded from analysis.

Because random variation among small geographic areas may mask real differences that exist at a larger scale, the remaining 3,060 counties were also aggregated into 802 HSAs, defined by the National Center for Health Statistics as counties that are relatively self-contained with respect to the provision of routine health care. All primary analyses were performed at the county level and confirmatory sensitivity analyses were performed at the HSA level to assess the effect of crossing county borders for care.

Data Sources

Demographic data and physician distribution were obtained from ARF 2006 (http://www.arfsys.com), which is published by the Health Resources and Services Administration of the United States Department of Health and Human Services. ARF is a resource for health policy researchers that aggregates and reports data from more than 50 sources, including the United States Census, Bureau of Economic Analysis, Bureau of Labor Statistics and others. ARF includes the number of urologists per county by age based on the American Medical Association Physician Masterfile, which we normalized to United States Census 2004 Population Estimates to calculate the number of urologists per 100,000 individuals. Only urologists who had completed residency training were counted.

Counties were classified as metropolitan, nonmetropolitan and rural based on Department of Agriculture 2003 Rural/Urban Continuum Codes (see Appendix).[12] Counties were also classified in the ARF as primary care HPSA and retirement destinations, defined as such by the United States Department of Agriculture if the population older than 60 years grew by more than 15% due to immigration from Census 1990 to Census 2000. ARF was used to collect data on 2004 median per capita income, 2004 unemployment rates, and Census 2000 educational attainment levels, ethnicity and age. The proportion with health insurance was obtained from United States Census Small Area Health Insurance Estimates (http://www.census.gov/hhes/www/sahie).

We obtained 30-year average climate data from the National Oceanographic and Atmospheric Administration. We assessed climate extremes using degree-days, which is an index with 65F as the base temperature. Heating degree-days are the annual summation of the difference between average daily temperatures and the base temperature if average daily temperature is below the base temperature, while cooling degree-days are summed if the average daily temperature is above the base temperature (http://www.cdc.noaa.gov). To facilitate the interpretation of these standard measures in the context of our association study we transformed the metrics. Heating and cooling degree-days were divided by 365 to generate average heating and cooling degrees per day, respectively, which were used for analysis. For example, 5 average cooling degrees per day and 10 average heating degrees per day in a county indicates that when the daily temperature was above 65F, the average was 70F and when it was below 65F, the average was 55F.

Statistical Analysis

The primary outcome measure was the number of urologists per 100,000 individuals at the county level. Due to a highly skewed distribution with 63% of counties lacking any urologists 2 models were built. In model 1 urologist density was dichotomized (0 vs greater than 0) for a logistic regression model and in model 2 it was categorized as an ordinal variable (0, 0 to 2, 2 to 4, 4 to 6 and greater than 6 urologists per 100,000 population) for an ordinal logistic regression model. Univariate associations between predictors and urologist density were initially tested using the t or chi-square test and correlations between predictor variables were analyzed to identify potential collinearity. Backward stepwise selection was used with $p < 0.15$ as the initial inclusion cutoff and $p < 0.05$ as the final cutoff. Subgroup analysis was performed to compare urologists younger than 45 to those older than 45 years using cutoffs defined in ARF. Finally, for comparison the number of general surgeons per 100,000 individuals was calculated. Statistical analysis was performed using Stata®, version

10. Maps were generated using uDig GIS software (http://udig.refractions.net) and United States Census 2007 TIGER/Line Shapefiles (http://www.census.gov/geo/www).

RESULTS

In 2004 there were 9,742 urologists in the United States, representing 1.3% of the total of 746,681 physicians. Of all urologists 9,524 (98%) listed patient care as the primary activity. There were 3,358 (34.4%) urologists younger than 45 and 6,384 (65.6%) older than 45 years. Of the urologist population in 2004, 15% were older than 65 years. Nationwide there were 3.4 urologists and a total of 261.7 physicians per 100,000 individuals. Overall mean $\pm$ SD county level urologist density was 1.6 $\pm$ 2.8 urologists per 100,000 population with 63% of counties lacking any urologists. The mean number of urologists per 100,000 individuals was 2.4 $\pm$ 3.1 in metropolitan counties, 1.5 $\pm$ 2.7 in nonmetropolitan counties and 0.2 $\pm$ 2.1 in rural counties ($p < 0.0001$). To visualize urologist distribution throughout the United States urologist density in each county and the distribution of urologists younger than 45 years were mapped (figs. 1 and 2).

To better characterize the differences between counties with no urologists and those with at least 1 we performed univariate analysis (table 1). We found that urologists were twice as likely to practice in a metropolitan county compared to a nonmetropolitan county and only 2% of rural counties had any urologists. In comparison, 15.8% of rural counties had a general surgeon. On univariate regression urologist density correlated with overall physician density ($r^2 = 0.503$, $p < 0.001$). Counties with a larger insured population, a higher median income, a higher employment rate and a higher education level (percent of the population with 4 years of college) were more likely to have a urologist. Urologists were less likely to work in counties with a larger elderly population but there was no relationship between retirement destination counties and the presence of a urologist. Urologists were less likely to be found in counties with a high number of average heating and cooling degrees per day, which increases as the average daily temperature deviates from 65F.

To assess factors independently associated with the presence of a urologist we performed multivariate logistic regression analysis (table 2), which further highlighted the independent importance of urbanization in urologist location. Compared to metropolitan counties nonmetropolitan counties were less likely to have a urologist (OR 0.57, 95% CI 0.46–0.72) and rural counties were the least likely to have a urologist (OR 0.03, 95% CI 0.02–0.06). Counties defined as primary care HPSAs were also less likely to have a urologist independent of the urbanization level (OR 0.15, 95% CI 0.10–0.22). Counties with less temperature deviation from 65F were associated with urologist presence. Specifically we found a 31% decrease in the probability of a urologist in the county with each additional average cooling degree per day and an 18% decrease with each additional average heating degree per day. The percent of uninsured individuals in the county, per capita income and the unemployment rate had statistically significant but minimal effects on urologist density. Education levels were highly variable

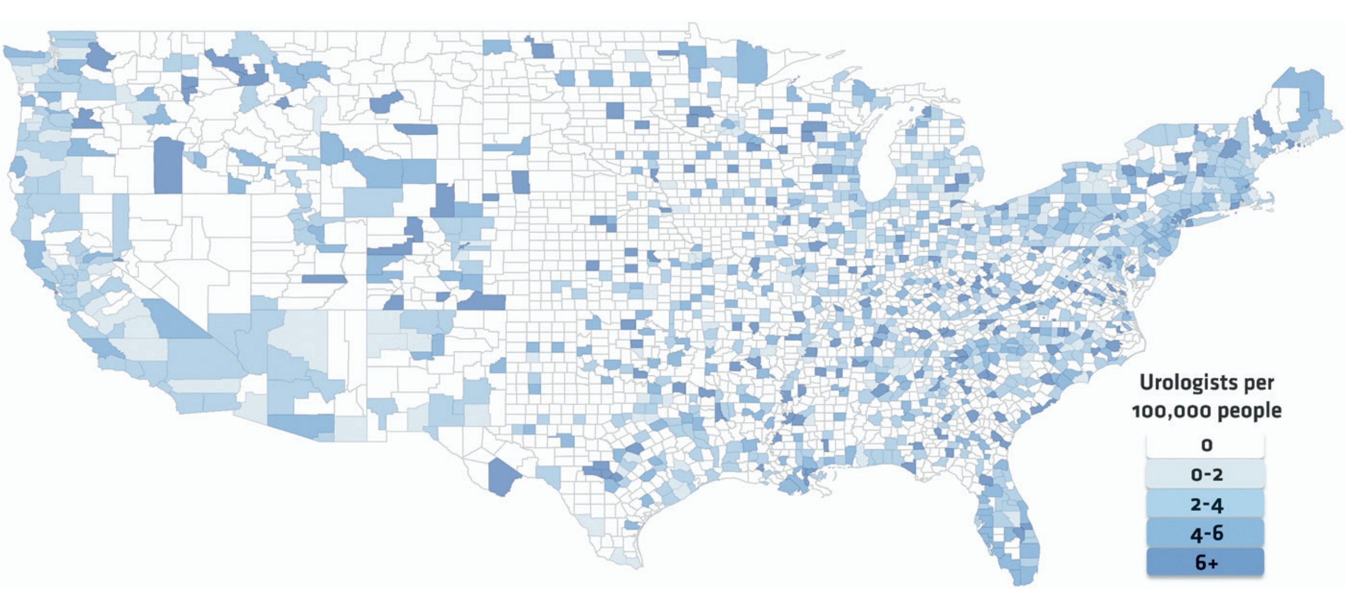

Figure 1. Population adjusted distribution of urologists throughout United States at county level

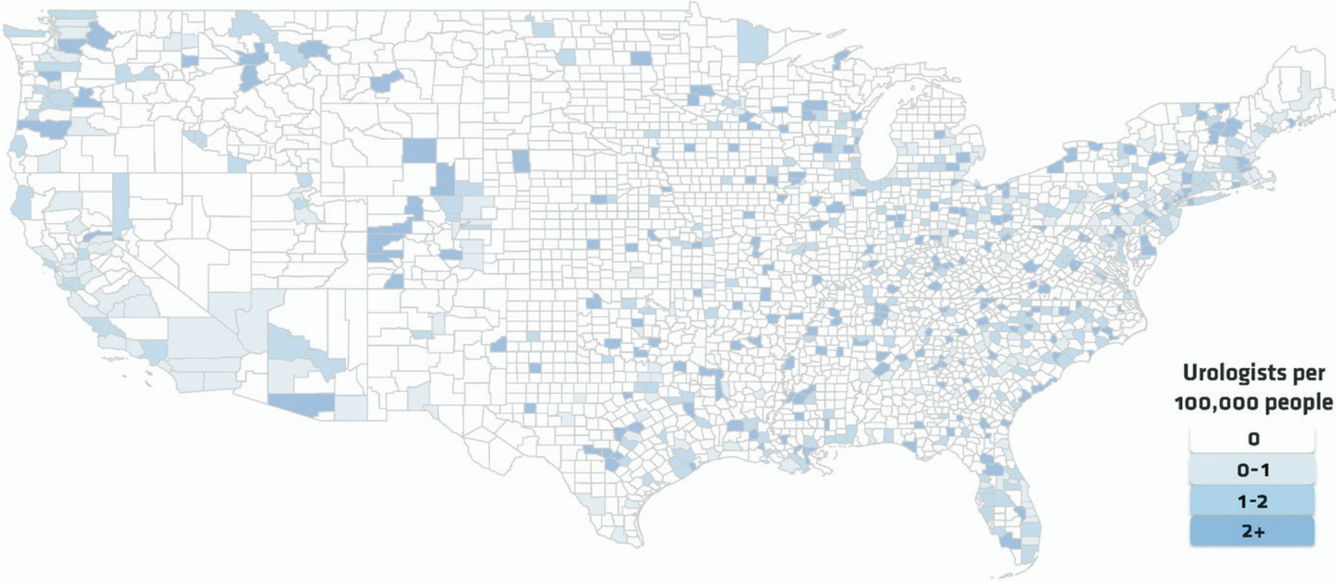

Figure 2. Population adjusted distribution of urologists younger than 45 years throughout United States at county level

among counties and higher education levels were associated with the presence of a urologist. The OR for each percent increase was 1.13, indicating that a 6% increase doubled the probability of having a urologist in that county.

Because highly correlated predictor variables may lead to inaccurate statistical estimates, we assessed for this correlation using variance inflation factors and found no significant collinearity. Sensitivity analysis was performed by aggregating data into HSAs and reanalyzed using the same model. There were no significance changes in the OR and all new ORs were within the 90% CIs of county level results. Similarly the ordinal logistic regression model revealed no significant changes with all ORs within the 90% CIs of the original model. The OR for increasing urologist density after there was already 1 present was 0.75 (95% CI 0.62–0.91) in a nonmetropolitan county compared to a metropolitan county compared to an OR of 0.57 (95% CI 0.46–0.72) for adding the first urologist. This suggests that, as the number of urologists in a county increases, it becomes progressively easier to add more urologists.

To determine whether urologist age differences affected location decisions we performed subgroup analysis comparing board certified urologists younger than 45 to those older than 45 years (table 2). The urban/rural distinction was the major factor determining where urologists younger than 45 years were located with an OR of having a urologist in a nonmetropolitan vs a metropolitan county of 0.23 (95% CI 0.17–0.30). For urologists older than 45 years the OR was 0.58 (95% CI 0.45–0.71), representing almost a 3-fold difference. Urologists younger than 45 years were also 3 times less likely to be located in a rural county. In addition, median per capita income and the proportion of uninsured patients were not significant predictors of young urologist location. The magnitude of associations among younger urologists, the 2 temperature deviations and the unemployment rate was less than that for urologists older than 45 years.

Table 1. *Univariate analysis of factors associated with urologist density*

County Characteristics	At Least 1 Urologist in County? Yes		No		p Value
No. metropolitan (%)	653	(62)	398	(38)	<0.0001
No. nonmetropolitan (%)	468	(35)	886	(65)	
No. rural (%)	16	(2)	639	(98)	
No. HPSA (%)	40	(5)	750	(95)	<0.0001
No. primary care physicians/100,000 individuals	59.0		36.6		<0.0001
No. overall physicians/100,000 individuals	219.6		63.7		<0.0001
% Uninsured	13.4		15.6		<0.0001
Median/capita income ($1,000)	29.3		24.5		<0.0001
% Unemployment	5.60		5.82		0.0249
% College degree	21.0		13.7		<0.0001
% White	83.4		86.0		<0.0001
% Older than 65	13.5		15.8		<0.0001
No. retirement destination (%)	432	(14.1)	2,628	(85.9)	0.2600
Av degrees/day:					
Cooling	3.18		3.38		0.0104
Heating	13.6		14.2		0.0036

DISCUSSION

We determined urologist density at the county level and factors associated with urologist density. Like

Table 2. *Multivariate logistic regression model of factors associated with having at least 1 urologist in county*

	All Urologists		Urologists Younger Than 45		Urologists Older Than 45	
	OR (95% CI)	p Value	OR (95% CI)	p Value	OR (95% CI)	p Value
Nonmetropolitan vs metropolitan	0.57 (0.46–0.72)	0.000	0.23 (0.17–0.30)	0.000	0.58 (0.45–0.71)	0.000
Rural vs metropolitan	0.03 (0.02–0.06)	0.000	0.01 (0.00–0.03)	0.000	0.03 (0.01–0.06)	0.000
HPSA?	0.15 (0.10–0.22)	0.000	0.05 (0.02–0.12)	0.000	0.15 (0.10–0.22)	0.000
Primary care physicians/100,000	1.02 (1.02–1.03)	0.000	1.02 (1.02–1.03)	0.000	1.02 (1.02–1.02)	0.000
Each 1% uninsured	0.97 (0.94–1.00)	0.027	1.01 (0.97–1.05)	0.740	0.98 (0.95–1.01)	0.168
Each $1,000/capita income	1.04 (1.00–1.08)	0.030	1.03 (0.99–1.07)	0.110	1.04 (1.00–1.07)	0.027
Each 1% unemployed	1.17 (1.12–1.23)	0.000	1.07 (1.00–1.13)	0.025	1.18 (1.13–1.24)	0.000
Each 1% college degree	1.13 (1.12–1.16)	0.000	1.11 (1.08–1.13)	0.000	1.12 (1.09–1.14)	0.000
Each additional av degree/day:						
Cooling	0.69 (0.62–0.78)	0.000	0.86 (0.76–0.97)	0.016	0.71 (0.64–0.80)	0.000
Heating	0.82 (0.78–0.85)	0.000	0.88 (0.84–0.92)	0.000	0.83 (0.80–0.87)	0.000

other specialists, urologists are unevenly distributed throughout the United States and clustered around metropolitan areas out of proportion with the increased population density inherent in such areas. In addition, urologist density is lower in nonmetropolitan counties and the average density is almost zero in rural counties. Almost 38 million Americans or 13% of the population live in a county without a urologist. The visual representation of these data is particularly striking, showing large portions of entire states without access to a urologist.

Multivariate regression models confirmed the clustering and distribution patterns seen in mapped data. Clustering may be driven by the need for sufficient preexisting medical infrastructure, referral patterns and the growth of group practices to share calls and assist with surgery. However, the distinction between metropolitan, nonmetropolitan and rural areas remains the strongest factor associated with urologist presence and density. While some investigators have attributed this clustering to resource allocation and earning maximization driven by economic forces,[13] we found that traditional population level economic factors, such as income, unemployment and insurance coverage, did not have a substantial role in urologist distribution. This may indicate changing demands and preferences of younger generations, and the growth of the creative class, as defined by Florida.[14] He stated, "Geographers and social scientists have viewed the economic geography of talent as a function of employment opportunities and financial incentives. A growing stream of research suggests that amenities, entertainment and lifestyle considerations are important elements in the ability of cities to attract both firms and individuals."

Our multivariate, age stratified analysis revealed associations that are similar to those shown by survey based investigations indicating that younger trainees are increasingly weighing lifestyle in career choices.[11]

Studies assessing the distribution of primary care providers and pediatric specialists have shown widespread inequality between clinician distribution and patient populations.[15–17] Others have suggested that general surgeon density may in part be driven by the preference of younger surgeons and women for urban areas.[18] To our knowledge this is the first study to thoroughly assess the geographic characteristics driving nationwide distribution at the county level for a surgical subspecialty. It is important to note that the associations identified do not prove causality and additional research is required to confirm factors influencing practice locations.

The adequacy of the physician supply can only be properly assessed by comparing it to objective patient outcomes. The only published study addressing urologist density and outcomes analyzed prostate cancer mortality but its state level approach may have obscured important local variation.[19] Further detailed studies focusing on additional patient outcomes in smaller geographic units are necessary to provide target urologist density metrics.

Rural work force policies have generally been piecemeal and under funded with limited results. Broadly increasing medical school enrollment and residency positions may only exacerbate the current disparity because only 3% of trainees choose rural practice.[13] In contrast, rural specific tracks place and retain 26% to 92% of trainees in rural areas.[20] These methods appear to be the most efficient way of addressing rural access to clinicians. However, it may be impossible and ineffective to evenly distribute urologists or other specialists. Creative solutions are needed to address workforce issues, such as providing more basic urological training to primary care practitioners who are more evenly distributed and further exploring teleconsultation/telementoring programs. The American Board of Urology, the American Urological Association and the Residency Review Committee must carefully address urologist maldistribution in their assessment of the need to increase the number of trainees.

CONCLUSIONS

The uneven distribution of urologists throughout the United States may worsen as younger physicians continue to cluster in urban areas. It remains uncertain how this urologist maldistribution affects patients. Any discussion of an overall urologist shortage must be based on specific patient outcome metrics to verify that an increased number of urologists will indeed improve outcomes.

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APPENDIX

2003 Rural Urban Continuum Code Definitions[12]

Rural Urban Continuum Code	
	Metropolitan Counties
1	Counties in metropolitan areas of 1 million population or more
2	Counties in metropolitan areas of 250,000 to 1,000,000 population
3	Counties in metropolitan areas of fewer than 250,000 population
	Nonmetropolitan Counties
4	Urban population of 20,000 or more adjacent to a metropolitan area
5	Urban population of 20,000 or more not adjacent to a metropolitan area
6	Urban population of 2,500 to 19,999 adjacent to a metropolitan area
7	Urban population of 2,500 to 19,999 not adjacent to a metropolitan area
	Rural Counties
8	Completely rural or less than 2,500 urban population adjacent to a metropolitan area
9	Completely rural or less than 2,500 urban population not adjacent to a metropolitan area

United States Department of Agriculture (http://www.ers.usda.gov/Data/RuralUrbanContinuumCodes/)

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EDITORIAL COMMENT

These authors describe the relatively recent distribution patterns of urologists in the United States using a county or HSA model. Not unexpectedly the data demonstrate a clustering of urologists in metropolitan areas with nonmetropolitan and rural areas having progressively fewer urologists. Positive correlates for the presence of a urologist included larger insured populations, higher incomes, higher employment and higher educational levels along with the presence of another urologist in the area.

However, their conclusions may raise more questions than answers. They suggest that metropolitan clustering may represent pure lifestyle issues and health care planners may need to look at ways to place urologists in under served areas. The authors also suggest that outcomes metrics may be the best reflector of quality urological care.

There is clearly a trend toward urologists entering practice to join larger groups, which are located by nature in larger metropolitan areas.[1] These factors may not be entirely understood but they include economics, call coverage and the ability to subspecialize, while providing a full array of urological services as a group. Along with the shift toward larger population centers there is an increased tendency toward the regionalization of health care services. We also know what urologists do at the time of recertification from their case logs. These data point out that many larger cases are performed relatively infrequently. What we do not know is the effect of larger groups and performance of the more complex surgical procedures. Rather than calling for more urologists or dictating their practice venues, we need data on the dynamics of those practices. This would also allow a rational discussion of future manpower needs.

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