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Demographics and distribution of dentists in Mississippi

A dental work force study

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Oral health is an integral part of general health.¹ Awareness of this connection is growing, and increasing emphasis has been placed by the U.S. surgeon general on addressing the issues contributing to the nation's poor oral health status. According to the 2001-2002 Report Card released by Oral Health America,² the United States received a national grade of C for its overall oral health status. The report showed that policy-

makers need to place more emphasis on oral health across the nation and called attention to areas in need at the state and national levels. The state of Mississippi received an overall grade of C-. In one individually scored category, availability of dentists, Mississippi received an F on the basis of a dentist-to-population ratio greater than 1:2,501,² which we believe is substandard for delivering adequate access to dental care.

In 2000, the U.S. Department of Health and Human Services reported that Mississippi ranked 35th in the nation in dentists per capita.³ There were 1,056 professionally active dentists in Mississippi in that year, with a population-to-dentist ratio of 1:2,694.⁴ In the United States in 2000, there were 166,383 professionally active dentists⁵ to serve an estimated population of 281,421,906,⁶ with a national population-to-dentist ratio of 1:1,691. This is significantly more favorable than the population-to-dentist ratio in Mississippi.

The majority of Mississippians live in rural settings.

Results of this study can assist current and future dentists, dental school administrators and policy-makers in making informed decisions about dental work force needs.

ABSTRACT

Background. Many segments of the population experience one or more barriers to accessing quality oral health care, including availability of licensed dentists. The purpose of the authors' study was to analyze the availability of dentists in Mississippi by county over four decades to determine the geographic distribution of dentists, shifts in their distribution over time and how this distribution relates to population demographics.

Methods. Dentist-to-population ratios were determined by county from 1970 through 2000. The authors analyzed these data using standardized *z* scores and geographic information systems (GIS) technology. Results are presented graphically and geographically.

Results. Results showed that 55 counties were designated as dental health professional shortage areas in 1970, 51 counties in 1980, 30 in 1990 and 40 in 2000. Counties that have a more favorable ratio of providers to population were determined, indicating areas in which dentists are more likely to practice.

Conclusions. Many geographic areas in Mississippi remain underserved. Identifying these areas is a critical first step when addressing the current state of Mississippi's dental work force. This type of information is useful for decision making as well as responding to the population's oral health care needs.

Practice Implications. Results of this study can assist current and future practicing dentists, dental school administrators and policy-makers in making informed decisions for determining suitable practice locations, dental school admissions criteria and areas to target for public health initiatives. This model also is useful for studying work force disparities in other health care professions.

Key Words. Work force; geographic information systems; access to care; underserved populations.

The latest figures available from the U.S. Department of Agriculture (for 2003) reveal that approximately 57 percent of Mississippians reside in nonmetropolitan areas.⁷ In contrast, less than one-fifth (17 percent) of the total U.S. population lives in nonmetropolitan areas nationwide.⁸ Currently, 63 areas in Mississippi are designated as dental health professional shortage areas (DHPSAs), including whole counties, partial counties, population groups and facilities.¹⁰

(According to the Health Resources and Services Administration,¹⁰ a geographic area is designated as having a dental professional shortage if the area is a rational area for the delivery of dental services and one of the following conditions prevails in the area:

- the area has a population-to-full-time-equivalent dentist ratio of at least 5,000:1;
- the area has a population-to-full-time-equivalent dentist ratio of less than 5,000:1 but greater than 4,000:1 and has unusually high needs for dental services or insufficient capacity of existing dental providers;
- dental professionals in contiguous areas are overutilized, excessively distant or inaccessible to the population of the area under consideration.)

The critical shortages may be caused by actual work force shortages of dentists, or by a perceived shortage caused by a maldistribution of practicing dentists. In 1999, for example, approximately 40 percent of active Mississippi dentists were practicing in only two major metropolitan areas: the city of Jackson in the tricounty area of Hinds, Madison and Rankin counties and the Mississippi Gulf Coast on the southernmost border of the state,¹¹ while only 28 percent of the state's total population resides in these two areas.¹²

To promote and provide for oral health, especially among rural and otherwise underserved populations, it is useful to assess the historical and current distribution of the dental work force in relation to population demographics. Geographic information systems (GIS) are one viable tool to aid in that assessment. GIS computer technology allows the user to visualize, explore, query and analyze data geographically in the form of presentation-quality maps. The mapping allows the researcher to visualize spatial relationships in data in ways that may reveal new relationships, patterns and trends that might not be evident in other data presentation formats. These computer-based technologies have been applied to gathering geographical data, but they are proving

to be an effective tool for exploring health data relationships.

We used GIS technology as a tool to help illustrate and visually analyze the current work force situation and the time-series shifts of dentists and population distributions. Information presented in our report may be useful for determining

- suitable locations for dentists to establish practices;
- areas to target for effective community outreach programs;
- underserved regions from which to recruit dental students, who ideally will return to a shortage area within the state.¹³

Findings from our study and its model of investigation will be useful to educators and policymakers in addressing underserved populations' burden of access to dentists. In addition, our model could be used to address the work force status and needs of other health care professionals, including physicians, nurses, pharmacists and allied health care professionals.

REVIEW OF THE LITERATURE

Numerous studies in the literature address the issues of geographic distribution of the health care work force in various professions, especially medicine. Only a handful of studies, however, address the geographic distribution of dentists. As in physician work force planning, it is not possible to precisely determine an exact number of dentists needed to provide services to a certain population. Because of this, dental work force issues can be particularly challenging to address, especially when one attempts to make predictions for the future.

One factor contributing to the complexity of dental work force planning is the predominance of individual practices and the subsequent lack of large institutionalized practice settings. Limitations exist in studying the availability of providers without addressing a number of additional variables that can influence productivity, such as the characteristics and work patterns of individual dentists. Other limitations are an inability to address cultural and socioeconomic factors of the population and other access issues. Because of this complexity, "health manpower planning ... is a process of continual 'suboptimization'—that is, making the best of what data are available."¹⁴

The use of GIS in health work force studies is

in its early infancy. In dentistry, only two studies investigating dental services used GIS as an analysis tool. White and colleagues¹⁵ conducted a study of the usefulness of using GIS in the investigation of the provision of dental services. To assess the utility of GIS, these authors used it to answer three study questions pertaining to dental provision in a particular region. They found that while a GIS increases the usefulness of information, it may not be a viable solution in many areas because of financial and training issues.

In another study, Susi and Mascarenhas¹⁶ used GIS to map the distribution of dentists in Ohio. The purpose of their study was to analyze the state's distribution of dentists in terms of variability, availability and accessibility. The GIS maps were useful for visualizing dental practice locations geographically, mapping the population-to-dentist ratio and illustrating dentists' rural-to-urban ratio. The GIS assisted the researchers in identifying disparities in the distribution of dentists throughout Ohio.

Mertz and Grumbach¹⁷ conducted a study to determine the geographic distribution of dentists in California, and the community characteristics associated with the supply of dentists. They used a GIS to "geocode," or pinpoint geographically, the location of dentists and to match them to a geographic study area. They created a GIS to identify the number of communities that they thought might have a shortage of dentists, but they published no maps in their report for clearer visualization. Mertz and Grumbach used regression analysis and Pearson correlation analyses to examine the associations between dentist supply and community characteristics. This observational study provided a good example of using GIS in conjunction with other statistical analyses to reinforce findings and to identify relationships, patterns or trends that might not otherwise be detectable.

There are only a few studies using GIS to study health work force availability and accessibility issues. In addition, there do not appear to be any studies using GIS to map work force changes over time. We used a GIS and traditional descriptive statistics in our study to examine the geographic distribution of dentists in Mississippi.

METHODS

We obtained secondary data sets from the Mississippi Department of Health¹⁸ and the U.S. Census Bureau¹⁹ on the dentist work force in Mississippi

from the years 1970, 1980, 1990 and 2000. These data were collected to provide a historical perspective of growth trends and geographic distribution patterns of the availability of primary dental services. From the U.S. Census Bureau and the Environmental Systems Research Institute (ESRI) (Redlands, Calif.), we obtained historical population data,²⁰ Census 2000 population demographics for the state of Mississippi²¹ and Topologically Integrated Geographic Encoding and Referencing (TIGER)/Line files^{22,23} for use in building the GIS. TIGER/Line files contain boundary information for both legal and statistical entities and are used by the Census Bureau for statistical data collection and tabulation purposes only. We obtained additional data for building the GIS infrastructure from the Mississippi Automated Resource Information System,²⁴ an agency of the state of Mississippi. Finally, we obtained data from the Mississippi State Board of Dental Examiners²⁵ on all licensed dentists practicing in Mississippi in the year 2002, including age, race, sex, alma mater, specialty and practice locations.

We calculated population-to-dentist ratios to examine growth trends of Mississippi's dentist population as compared with the state's general population during a period from 1970 through 2000. For each 10-year interval between the years 1970, 1980, 1990 and 2000, we determined the aggregated population-to-dentist ratio per 100,000 people by geographic region. We used counties as the geographic regional boundaries for statewide data. We also calculated the population-to-dentist ratio by county, the percentage of dentists practicing in each county, the percentage of the total population residing in each county, median family income and *z* scores. Using the statistical method of *z* scores enabled us to identify counties that were more than two standard deviations from the mean of the distribution. We obtained these data using the following equation:

$$\frac{\text{Observed} - \text{Expected}}{\sqrt{\text{Expected}}}$$

Additionally, we calculated growth rates of the number of dentists by county for the periods from 1972 through 1980, 1981 through 1990 and 1991 through 2000.

We created a GIS using ArcGIS 8.2.1 software (ESRI). In turn, we used that GIS to create a geodatabase that would provide a visual representation of population demographic variables and

dental practice locations for the state of Mississippi, and that would assist in determining patterns of distributional shift of dentists over time.

RESULTS

The number of active dentists practicing in Mississippi has nearly doubled from 1970 to 2000, increasing the state's overall ratio of dentists per 100,000 people from 27 to 37 dentists per 100,000 (Figure 1). Comparing this information with data for the number of dentists per 100,000 population, there is a continuous rise in the ratio, and the number of dentists per 100,000 for the United States overall is significantly higher than in Mississippi for all years we studied (Figure 1). A limitation of this comparison is that it does not take into account characteristics of the population that would seek dental care.

We obtained from the U.S. Census Bureau a ranking of Mississippi counties in descending order by rate of population growth from 1990 to 2000. We correlated the faster-growing counties with growth in the number of dentists and growth in median family income for those counties. Figures 2 and 3 provide graphic representation of population growth and loss correlated with the growth of dentists and median family income.

Figure 2 illustrates that of the 10 counties with more than 20 percent growth, five of them (Hancock, Greene, Lamar, Pearl River and Pontotoc) actually had negative growth in the number of dentists. These may be counties in which conditions would be favorable to locate a dental practice. They also have relatively high median family incomes. DeSoto was the fastest-growing county and also had the highest growth rate of dentists, but it did not show growth as significant in median family income. Madison County, however, was high in all three categories. Greene County experienced 30.13 percent population growth, but had a loss in dentists. Lafayette County had the highest median family income and high population growth, but no change in the number of dentists.

None of the counties that had negative population growth between 1990 and 2000 gained any

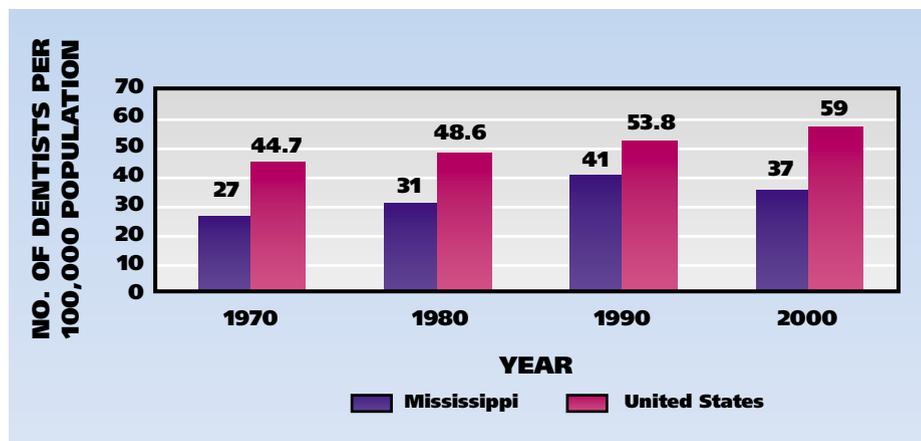


Figure 1. Dentists per 100,000 population, Mississippi and national average.

dentists during that period (Figure 3). Hinds County had by far the largest population of all Mississippi counties, but lost population and dentists during this period. Hinds County also experienced less growth of median family income than did most other counties. It is interesting to note that Montgomery and Sharkey Counties experienced more than 100 percent increase of median family income.

The calculation of z scores for dentists showed that there were a growing number of counties that exceeded two standard deviations from the mean from one decade to the next, meaning that these counties could be considered extreme “outliers” during a particular period. In 1970, four counties had z scores of 2.0 or higher. There were eight counties in 1980, 10 in 1990 and 15 in 2000. Of these, only two had negative z scores (DeSoto in 1980 and Lamar in 2000). These findings suggest that there is a growing number of counties with a maldistribution of dentists. DeSoto County had the lowest negative z score overall in 1980, at 2.31 standard deviations below the mean. This indicates that there was a high population-to-dentist ratio in that county—that, in other words, there were significantly fewer dentists per person in DeSoto County. DeSoto has not been more than two standard deviations from the mean since that time. In 2000, Lamar County was the only county with a negative z score (-2.17).

The remainder of z scores more than two standard deviations from the mean were positive, indicating a lower population-to-dentist ratio, or a higher number of dentists per person in these counties. (**Editor's note:** A table showing the specific scores is available from the corresponding author.) Hinds County has consistently main-

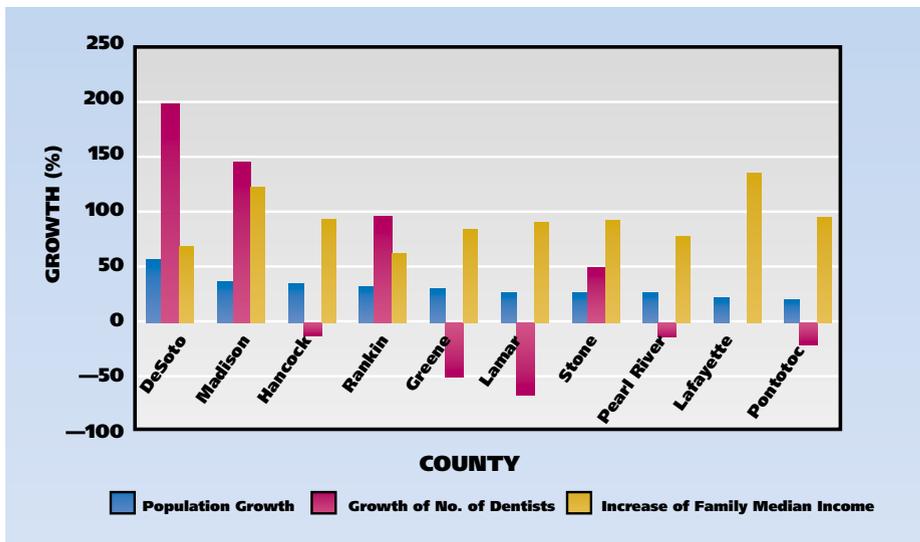


Figure 2. Mississippi counties with population growth greater than 20 percent, growth of number of dentists and family median income, 1990 through 2000.

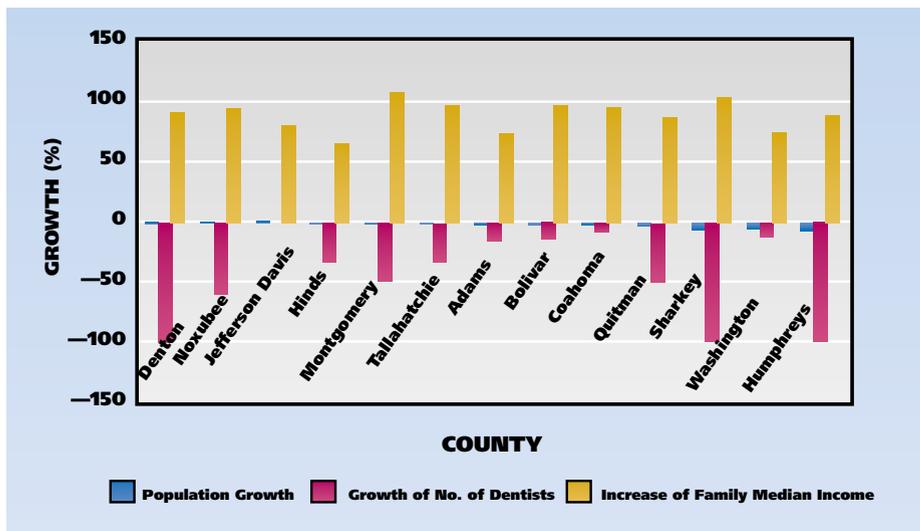


Figure 3. Mississippi counties with negative population growth, growth of number of dentists and family median income, 1990 through 2000.

tained the highest *z* score, showing the lowest need for additional dentists. Madison County had a *z* of score more than 2 for the first time in 2000.

Figure 4 illustrates the changes of distribution of practicing dentists for each decade. The counties are divided into three groups: low, medium and high distributions. To determine these distributions, we divided total numbers of dentists per 100,000 into three groups so that these groups are relative to each other and not to a national comparison. DeSoto County had relatively low distributions of dentists until 2000, when it changed to a high distribution of dentists and also was the fastest-growing county in terms of popu-

lation from 2000. There was a high distribution of dentists per population for all years in 15 counties, while there were low distributions for all years in eight counties. All other counties have changed their status at least once over the four decades. By examining the maps showing changes in distribution over time, we found what may be a growing tendency for dental practices to locate in closer proximity to interstate highways.

Fifty-five Mississippi counties qualified for designation as DHPsAs in 1970, 51 counties in 1980, 30 in 1990 and 40 in 2000 (Figure 5, page 674), using the criteria defined by the Health Resources and Services Administration.¹⁰ Five counties with relatively low total populations had no dentists in 2000, though all of them except Issaquena did have a population greater than 4,000. Figure 6 (page 675) provides a detailed view of the population-to-dentist ratio and the changes in distribution over time. In Hinds County, for example, there was a ratio of 1,348 people per dentist in 2000. In Amite County in the southernmost part of the state, there were 13,599 people and only one dentist in 2000.

DISCUSSION

Health work force planning can be complex and challenging, but it is important to address the issue to be able to better respond to the health needs of the population. A logical starting point is to create a model, which we did to determine the number of dentists by specified geographic areas (in our case, all counties in Mississippi), the total population of these areas and population demographics. Rather than examine distribution at a single point in time, it is useful to look at it over a

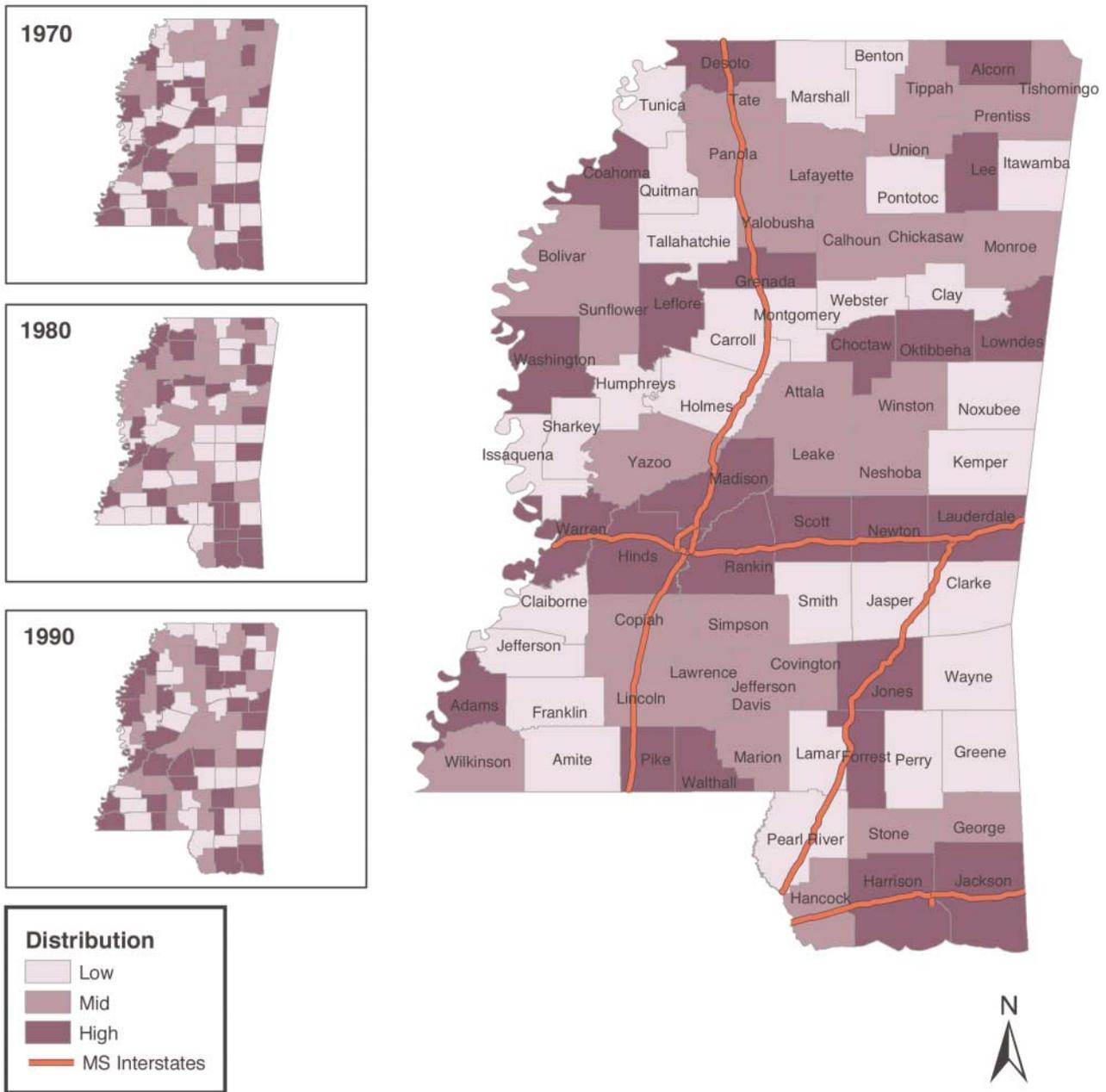
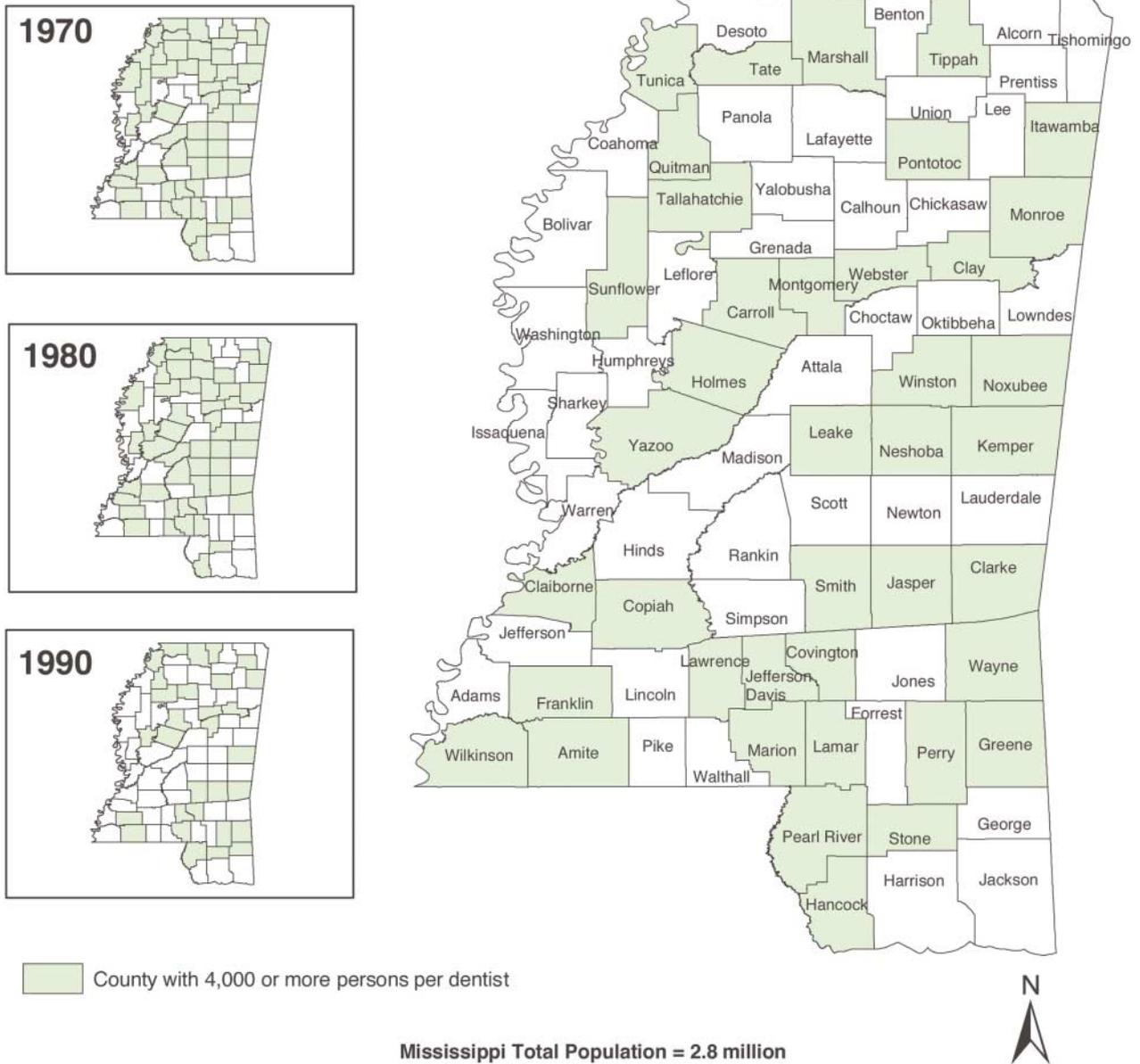


Figure 4. High, medium and low distributions of Mississippi dentists by county, 2000. MS Interstates: Mississippi interstate highways.

period, which makes evident any significant changes that have occurred and, if they did occur, where. Are there any noticeable trends? What might be expected for the future if trends continue? How do these data compare with national averages? Yet, a limitation of this study is that we did not take into consideration dentists' migration across state and county boundaries.

The population in Mississippi from 1970

through 2000 has shown continual growth, though the trend is not as rapid as for the nation as a whole. The median family income in the state continues to rise, but it remains well below the national average.²¹ The number of dentists has continued to increase, but has begun leveling off since 1990. The number of dentists per 100,000 population in Mississippi decreased from 1990 to 2000, as the growth rate of the number of



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Figure 5. Dental Health Professional Shortage Areas by county, 2000.

dentists has not kept pace with population growth in the state (Figure 1). The ratio of dentists to population in the United States has increased steadily, and across all four decades, there have been more dentists per 100,000 in the U.S. population than there have been in Mississippi. On the basis of numbers alone and assuming that graduates of the University of Mississippi School of Dentistry stay in the state to practice, there may be a case for increasing the

number of dental school admissions to narrow the gap in provider-to-population ratio.

Several variables were not addressed in this study. What factors may be contributing to this dramatic slowdown? It is possible that fewer dentists are coming to Mississippi from other states. Perhaps more University of Mississippi School of Dentistry graduates are leaving the state to practice elsewhere. It could be that more dentists have retired recently. Even if a dentist is actively

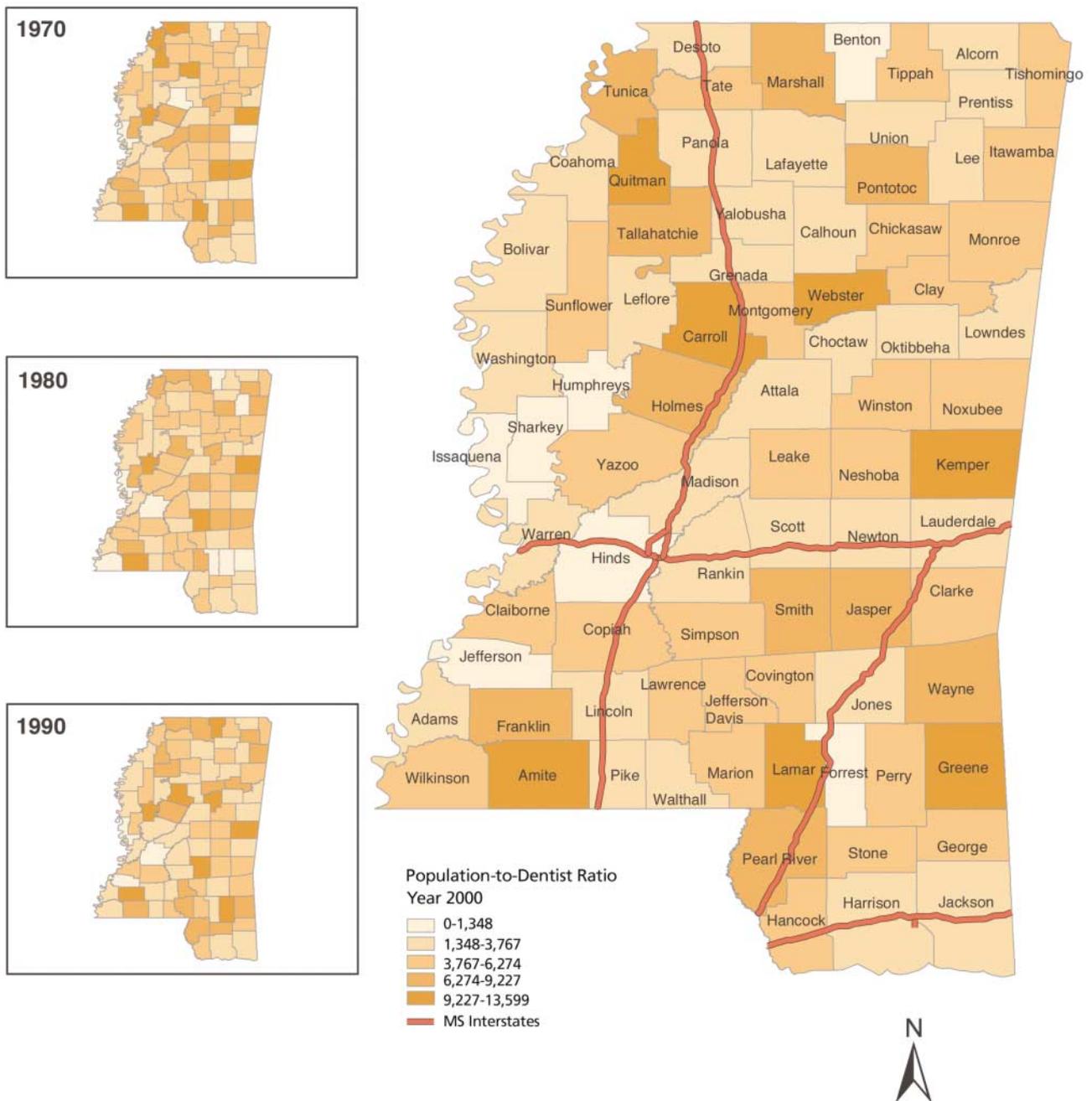


Figure 6. Mississippi population-to-dentist ratio, 1970 through 2000. MS Interstates: Mississippi interstate highways.

practicing in the state, how can his or her productivity be measured? How many dentists do not work full-time? How is full-time defined? How many dentists work full-time but complete fewer procedures and see fewer patients than do dentists who work part-time? Although these variables are not addressed in this study, it may be important to collect data on them, especially as

accountability issues move to the forefront.

Many variables factor into Mississippi work force planning issues. Some of these may be measurable, such as the number of dentists from Mississippi as opposed to those coming from out of state, practice locations of graduates of the University of Mississippi School of Dentistry and ages of the state's active dentists. Still, the issue

is further complicated because it is impossible to predict accurately at what age a dentist will retire to define forecasting models. It can be determined (and graphically represented) where older dentists are practicing, and projections can be made that dentists soon may be needed in those areas to replace those who retire. Regardless of the complexities, one variable that can be measured is the number of dentists practicing in a certain area, or the availability of dentists.

The trends in growth rates of Mississippi's dentist population over time might suggest that more providers are necessary to meet the needs of the public. While this may be true, it is important to look more closely at the data. There may be an issue with the distribution, not just the total number, of dentists. The density ranking of counties by high, medium or low distributions of number of dentists per 100,000 provides useful information, especially when one looks at changes over time (Figure 4). Population-to-dentist ratios also make it easier to determine areas that may be in need of attention. Future dental school graduates considering potential practice locations may find promising opportunities in counties that have high numbers of people per dentist (in Figure 5, for example, the counties with the darkest shades of orange).

There may be many other barriers besides dentist availability that hinder access to health care and thus contribute to racial, ethnic and geographic disparities in oral health. Existing data are insufficient to address many of these barriers. However, by means of studying these and similar maps, specific areas can be targeted that may need dentists or that may be well-suited for outreach programs from dental schools or the dental community. To answer these and other questions specifically for Mississippi, it will be important for an oral health needs assessment to be conducted with data gathered across the state.

CONCLUSIONS

Disparities in access to health care affect many segments of the U.S. population. It can be difficult to attract health care providers to rural areas, which contributes to geographic disparities.^{1,26} However, even in areas with adequate availability of dentists, other barriers may exist that inhibit people from gaining access to care, such as economic issues, cultural barriers, physical disabilities or confinement in institutionalized settings.

The type of information provided in this study may be useful for dental school administrators taking a proactive approach to oral health workforce planning. Administrators may be better able to determine the number of students to accept into programs, as well as admissions criteria. Additionally, this information may assist in determining locations throughout the state from which students might be selected to get a representative group from different geographic regions. With this type of framework, dental schools also could make informed decisions about locations or populations for which to target community outreach initiatives. Dental students could use this information as a tool for determining suitable locations in which to establish practices after graduation. The findings also may be of interest to policy-makers and public health officials when addressing oral health and access-to-care issues in Mississippi. This study provides a foundation on which to continue building and integrating more data as they become available for decision making about, and responding to, the oral health care needs of Mississippians. Still, it is important to emphasize that the usefulness and practicality of this type of model is not limited to Mississippi. It could be used in any state or geographic region as a tool for analyzing and visualizing dental workforce and oral health data, and for improving access to quality oral health care. ■

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