Identifying Communities with Low Dentist Supply in California

Elizabeth A. Mertz, MPA; Kevin Grumbach, MD

Abstract

Objectives: *This study estimates the supply and geographic distribution of dentists in California and examines the community characteristics associated with supply of dentists.* ***Methods:*** *The number of practicing dentists was estimated from American Dental Association data on licensed dentists in California. Each dentist's address was geocoded and matched to a Medical Service Study Area (MSSA). Dentist-to-population ratios were computed, and the association between dentist supply and community characteristics was analyzed in regression models.* ***Results:*** *Approximately 20 percent of California communities may have a shortage of dentists. Two-thirds of dental shortage communities are rural. Communities with a lower supply of dentists have higher percentages of minorities, children, and low-income persons. Minority dentists were more likely to practice in minority communities.* ***Conclusions:*** *Geographic maldistribution of dentists may contribute to poor access to dental care in many communities, especially in rural, low-income, and minority communities. Minority dentists are more likely to practice in minority communities, but are a small portion of the dental workforce. [J Public Health Dentistry 2001;61(3):172-77]*

Access to dental care services is a public health issue gaining national attention. Recent research on the extent of oral health problems has highlighted significant disparities by race and income, both in California and across the nation (1-3). Minorities and children from low-income families have higher rates of dental disease. African Americans and economically disadvantaged groups are less likely to have a dental visit in the past year and have higher percentages of untreated dental disease than their white and higher-income counterparts, even after adjusting for differences in dental insurance coverage (4). Policymakers are beginning to examine methods for increasing access to dental care. Recent actions include the release of the first Surgeon General's Report on Oral Health (5), an increase in dental coverage for children under the State Children's Health Insurance Program, and establishing a limited dental scholarship program in the National Health Service Corps. In addition, the Health Resource and Services Administration recently launched an Oral Health Initiative in recognition of the growing disparities in oral health (6).

One component of access is the local availability of dentists in a region. Although the maldistribution of physicians has been well documented, little research has been conducted on the geographic distribution of dentists. Much of the research on dentist supply has focused on overall numbers rather than on distribution (7-9). A 1995 Institute of Medicine report concluded "there is not a compelling case for predicting either an oversupply or undersupply of dental practitioners in the next quarter century" (10). However, the report highlighted concerns about dental workforce distribution and composition.

Prior research has shown that the supply of dentists per capita varies widely by state and large geographic regions, with rural areas tending to have a lower supply than urban areas (9,11). However, research has not examined variation in supply at the smaller geographic level, such as neighborhoods within large cities, nor has research systematically evaluated community characteristics associated with the local supply of dentists. Studies of the physician workforce have shown that communities with high proportions of minority residents tend to have fewer physicians practicing in the community (12). The racial and ethnic composition of the health care workforce also has emerged as a public health issue. Minority physicians are much more likely to practice in underserved communities (12-15). It is not known whether this pattern also holds for minority dentists.

We investigated the geographic distribution of dentists in California. The first objective of our study was to describe the overall geographic distribution of dentists in California and to identify the number of communities that may have a shortage of dentists. Our second objective was to evaluate the community characteristics that are associated with the supply of dentists. Our final objective was to examine the association between the race/ethnicity of dentists and of their communities of practice.

Methods

Data Sources. The American Dental Association (ADA) provided a computerized file of all licensed dentists in California. Data on population at the census tract level were obtained from a commercial vendor (16). The communities analyzed were Medical Study Service Areas (MSSAs), rational services areas developed by the California Health Manpower Commission for administering health workforce programs. MSSAs are geographic areas created by aggregating contiguous census tracts. They respect geographic and geopolitical boundaries (17). There are 487 MSSAs in California: 211

Send correspondence and reprint requests to Ms. Mertz, Center for California Health Workforce Studies, University of California, San Francisco, 3333 California Street, Suite 410, San Francisco, CA 94118. E-mail: bethm@itsa.ucsf.edu. Dr. Grumbach is with the Center for California Health Workforce Studies and the Department of Family and Community Medicine, University of California, San Francisco. Manuscript received: 6/15/00; returned to authors for revision: 8/16/00; accepted for publication: 2/2/01.

rural and 276 urban. The California Health Manpower Commission defines MSSAs as urban or rural based on population density and proximity to a city with a population of 50,000 or greater. Urban MSSAs, consisting of neighborhoods within cities, have a median population of 101,179. Although rural MSSAs cover much larger land areas, they have a much smaller median population (11,686).

Estimates from 1998 were used to identify the demographic characteristics of each community, and were acquired from MapInfo (16). Data include estimates for racial groups (African American, Asian, Native American, and white) and residents of Hispanic origin. Household income estimates for 1998 were only available in $10,000 increments in our data; we selected <$25,000 as our threshold for low income. Data on actual poverty level by household were not available in the 1998 data; however, this cutoff is approximately 150 percent of the poverty level for a family of four in 1998 (18).

The ADA data contain continuously updated information on all dentists in the United States, including dentists who are not ADA members. We excluded from our analysis dentists without a California address and dentists in training programs. Also, to be consistent with conventions developed by federal agencies for determining dental shortage designations, we included only dentists in general practice and pediatric dentists, which represented 83 percent of all dentists in the state. Approximately 80 percent of all dentists in the file have a practice address listed. Only home address was available for the remainder of the dentists. The office address, or home address if the office address was unlisted, was used to geocode each dentist to an MSSA. MapMarker software was used to geocode the dentist file and MapInfo software was used to match the dentist's address to an MSSA. The file was coded at the individual street address level (60%) or, if no exact match was found, to the ZIP+4 level (30%) or to the ZIP code level (10%).

Dentists who were ADA members had a code indicating whether they were in active practice. We excluded ADA members who were not in active practice from our analyses. However, the active practice variable was not available for the dentists in the file who are not ADA members.

Estimating Dentist Supply. The exclusions noted above resulted in a data set containing 19,801 dentists. To attempt to better enumerate the active dentists practicing in each community in the state, we further categorized these dentists based on ADA membership and type of address (Table 1). Group A included active ADA members with an office address (n=10,641; 54%). Group B included nonmembers of ADA with an office address (n=5,429; 27%); because these dentists listed an office address, we assumed that they were all in active practice. Group C included active ADA members with a home address, but no practice address (n=1,796; 9%). Group D included nonmembers of ADA with a home address (n=1,935; 10%). We used data from the ADA member sample to estimate the probability that each ADA nonmember dentist in Group D was in active practice. Using the age, sex, and practice status information available on ADA member dentists (both active and inactive), we calculated the probability that an ADA member dentist with only a home address listed would be in active practice in five-year age and sex-specific strata. These probabilities were then applied as weights to the non-ADA members who listed only a home address. The final group, Dw, was Group D with these weights applied (n=1,239 after weighting).

Four models were created using these groups for estimating the supply of dentists in active practice in each community. The most "generous" model used groups A, B, C, and D; although about 80 percent of the dentists in this model had office addresses, this model included some dentists with home addresses and some non-ADA members who may not have been in active practice. The second model, our "best" estimate of active dentists, included groups A, B, C, and the weighted group Dw. The third model used only groups A, B, and C, excluding all the non-ADA members without an office address. The final, most restrictive model used only groups A and B, excluding all dentists without an office address.

Once dentists were geocoded to an MSSA, we used population estimates for each community to compute the supply of dentists per 100,000 population. We used Spearman rank correlation analysis to compare how these four models performed in estimating the relative patterns of dentist supply across MSSAs. A very high degree of correlation was found, ranging from 0.970 to 0.995 ($P \leq .001$ for all correlations). Separate correlation statistics were run for urban and rural communities, with similar results (R=0.983–0.998 for urban and 0.938–0.990 for rural). Given the high level of correlation between our models, we used our "best estimate" model (consisting of groups A, B, C, and Dw) for our main analyses.

Analysis. The first objective of our

TABLE 1
Distribution of Dentists in California, by American Dental Association Membership Status and Type of Address

Group	ADA Status	Address Location	Number	% Unweighted Total	% Weighted Total
A	Active members	Office	10,641	54	56
B	Nonmembers	Office	5,429	27	28
C	Active Members	Home	1,796	9	9
D	Nonmembers	Home	1,935	10	—
Dw	Nonmembers	Home, weighted	1,239	—	7
Total			19,801	100	—
Weighted total			19,105	—	100

study was to describe the overall geographic distribution of dentists in California and to identify the number of communities that may have a shortage of dentists. A community with fewer than 20 dentists per 100,000 population was potentially eligible for a Dental Health Professional Shortage Area (DHPSA) designation by the federal government, and we used this level of supply to characterize areas as having a shortage (19). Although federal methodology requires a count of FTE dentists per population, our data were limited to head counts of dentists. Use of head counts results in a conservative estimate of shortage areas.

Our second objective was to evaluate the community characteristics that were associated with the supply of dentists. We tested the association between the racial/ethnic, income, and age characteristics of each community and its supply of dentists using Pearson correlation analyses. We further tested the independent effect of each of these community characteristics using least squares mean regression analysis.

Our final objective was to examine the association between the race/ethnicity of dentists and the racial/ethnic composition of the communities in which they practiced. For this analysis we identified self-reported race/ethnicity from the ADA file. We also limited our analysis to dentists with definite office addresses (groups A and B) when comparing practice communities according to dentist race/ethnicity. Data on race/ethnicity were available for 70 percent of the dentists reporting an office address. Dentists were grouped by their race/ethnicity. We then computed the proportion of residents of different race/ethnicity in the communities in which the dentists practiced. We used analysis of variance (ANOVA) to compare the mean proportion of residents in different racial/ethnic groups across the groups of dentists sorted by race-ethnicity.

Results

There was a wide variation in the supply of dentists across communities in California (Figure 1). Overall, 97 (20%) communities in California had a supply of dentists below the 20 per 100,000 "shortage" level. The supply of dentists was much lower in rural (mean=36 per 100,000) than in urban communities (mean=62 per 100,000; $P<.001$). Nearly one-third ($n=66$) of rural communities were in the shortage level range, and 31 of these rural communities had no dentists.

FIGURE 1
Number of Communities by Dentists per 100,000 Population and Urban/Rural Status, California, 1998

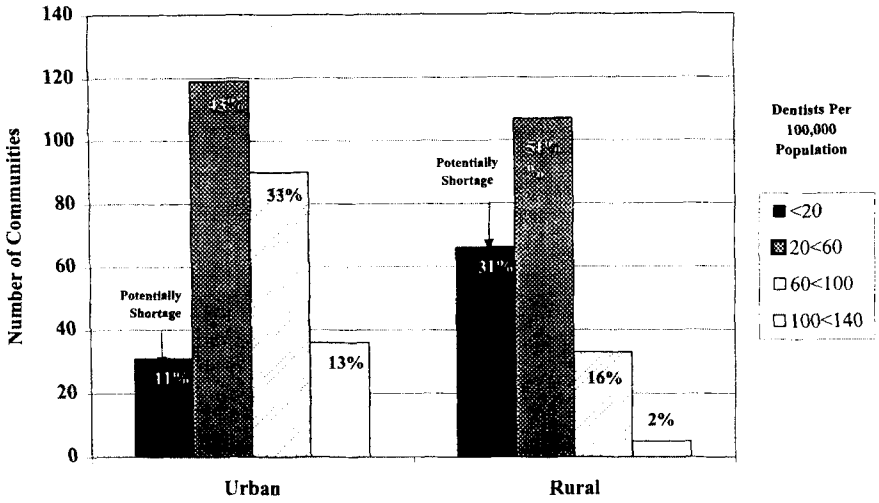

TABLE 2
Correlation Between Community Characteristics and Dentist Supply

	Communities	
	Urban (n=276)	Rural (n=211)
Percent African American	–0.272†	–0.036
Percent Hispanic	–0.481†	–0.224†
Percent Asian	0.044	–0.007
Percent Native American	–0.295†	–0.153*
Percent aged ≤17 years	–0.665†	–0.229†
Percent aged ≥65 years	0.478†	0.154*
Percent with income <$25,000/year	–0.291†	–0.099
Median household income	0.348†	0.054
Population density	NA	0.062

*P≤.05.
†P≤.01.
Data shown are Pearson correlation coefficients for variables listed and supply of dentists per 100,000 population. (NA=not applicable.)

The supply of dentists was associated with many of the demographic characteristics of the communities (Table 2). In urban communities, the supply of dentists was negatively correlated with the percent of residents who were African American, Hispanic, or Native American, the percent who were children (aged 0–17 years), and percent of population whose income was <$25,000 per year ($P<.001$ for all). Urban dentist supply was positively correlated with the percent of residents who were aged 65 years and older and the median household income ($P<.001$). In rural communities, the supply of dentists was negatively correlated with the percent of residents who were Hispanic ($P<.001$), Native American ($P<.05$), and the percent who were children ($P<.001$), and positively correlated with the percent who were elderly ($P<.05$). We also examined the correlation of population

TABLE 3
Predictors of Supply of Dentists: Results of Regression Analysis

	Communities			
	Urban		Rural	
	Regression Coefficient	95% CI	Regression Coefficient	95% CI
Percent African American	–0.45	(–0.73, –0.17)	–0.20	(–1.12, 0.72)
Percent Hispanic	–0.13	(–0.34, 0.08)	–0.21	(–0.40, –0.01)
Percent Asian	–0.01	(–0.27, 0.25)	0.04	(–0.90, 0.98)
Percent Native American	–0.61	(–12.42, –0.80)	–0.44	(–0.84, –0.05)
Percent aged ≤17 years	–3.39	(–4.48, –2.29)	–0.72	(–1.82, 0.39)
Percent aged ≥65 years	0.91	(–0.47, 2.28)	0.06	(–0.91, 1.04)
Percent with income <$25,000/year	0.14	(–0.31, 0.59)	0.01	(–0.39, 0.41)
Population density	NA		0.06	(0.01, 0.12)
	Adj. R^2=0.46		Adj. R^2=0.09	

TABLE 4
Mean Racial or Ethnic Composition of Communities (%) by Race or Ethnicity of Dentists*

	Community Race/Ethnicity			
Dentist Race/Ethnicity†	Mean % Asian/Pacific Islander	Mean % African American	Mean % Hispanic	Mean % White
Asian/Pacific Islander (*n*=3,477)	20.57	5.72	24.66	72.87
African American (*n*=212)	13.83	25.21	22.44	59.68
Hispanic (*n*=755)	12.63	5.29	31.61	81.18
White (*n*=6,818)	9.48	3.86	16.64	85.70

*Analysis limited to dentists with an office address.
†The mean racial/ethnic composition of communities in which dentists practiced varied significantly ($P<.001$) by the race/ethnicity of the dentists using ANOVA to test for differences across dentist groups.

density to the supply of dentists for rural communities; population density was not significantly associated with dentist supply in rural communities in crude analysis. To test the robustness of these analyses, we repeated the same correlations using the other models for estimating dentist supply. The results were consistent across models.

Several of these variables remained independently associated with the supply of dentists in the regression analyses (Table 3). The percent of residents who were African American ($P=.002$) or Native American ($P=.026$), and the percent who were children ($P<.001$) remained independent predictors of urban dental supply. To illustrate the interpretation of the regression coefficients, the coefficient of –0.451 for the African American variable indicates that a community with a percentage of African Americans residents that is 10 percent greater (in absolute terms) than that of another community would be expected to have 4.5 fewer dentists per 100,000 population. Although the percent Hispanic and percent low-income variables were significantly associated with urban dentist supply in the crude correlation analyses, they were not independent predictors of dentist supply in the regression model. The percent of residents who were Hispanic was strongly correlated with the percent of residents who were children ($R=0.684$, $P<.001$). The percent children variable emerged as the independent predictor of urban dentist supply when confounding between these variables was controlled for in the regression model. In a regression model predicting rural dental supply, the percent of residents who were Hispanic ($P=.043$) or Native American ($P=.026$), and population density ($P=.022$) remained independent predictors.

The adjusted R^2 (0.46) for the urban model was much higher than that for the rural model (R^2=0.09). The demographic composition of communities accounted for much more of the variation in dentist supply in the urban setting than the rural setting.

Analysis of the race/ethnicity of dentists included the 11,262 dentists with a reported race/ethnicity as well as an office address. Forty-two percent were white, 22 percent were Asian/Pacific Islander, 5 percent were Hispanic, and fewer than 2 percent were African American; 4,788 dentists did not indicate race. The race/ethnicity of dentists was significantly associated with the racial/ethnic characteristics of the communities in which they practiced (Table 4). For example, African American dentists' practices were located in communities that had, on average, 25.2 percent African American residents. In contrast, Asian/Pacific Islander dentists' practices were located in communities that had, on average, 5.7 percent African American residents. Overall, compared with white dentists, minority dentists were more likely to practice in communities with larger proportions of minority residents. This association between dentist and community race/ethnicity was particularly strong for African American dentists, who practiced in communities that had a mean percentage of African American residents that was five times greater than the mean percentage in the communities in which dentists of other racial or ethnic groups practice.

Discussion

Our study demonstrates the wide variation in the supply of dentists across communities in California, confirming evidence from prior research

that rural areas tend to have fewer dentists per capita than urban areas (11). Results of our regression analysis suggest that sparsely populated rural communities are especially likely to have fewer dentists per capita. The plight of rural communities in recruiting and retaining health professionals is not a new one (20). California has a variety of strategies in place, including state and federal National Health Service Corps loan repayment placements and rural rotations for dental students. Our research indicates that the undersupply of dentists in rural areas of California is extensive and is not adequately addressed by existing policies to recruit dentists to rural practice.

Our study advances prior research by also demonstrating a systematic relationship between the racial and ethnic characteristics of communities and the supply of dentists. Communities with higher proportions of minority residents tend to have a lower supply of dentists. The racial and ethnic composition of a community appears to be a stronger predictor of dentist supply than the level of income in the community, consistent with patterns found for physician distribution in California (12). In fact, once a community's racial and ethnic characteristics are accounted for, the income status of a community does not have an independent association with the supply of dentists.

The predictors of dentist supply were different in rural communities than they were in urban communities and merit some discussion. The percent of residents who were African American or Hispanic was significant in both urban and rural correlation analyses, but results diverged in the regression analyses. In urban areas, the percent of residents who were African American remained an independent predictor, but the percent who were Hispanic did not. In rural areas, the percent of residents who were Hispanic remained an independent predictor, but the percent of residents who were African American did not. This is not surprising because most African Americans in California are urban residents, and a substantial percentage of the rural population is Hispanic. The urban and rural regression models also differed in their ability to explain variation in dentist supply across communities. The overall strength of the urban model (R^2=0.46) was greater than for rural (R^2=0.09). Simply being a rural community was the greatest predictor of low dentist supply, and individual community characteristics appeared to matter less than in urban areas.

It is of particular concern that communities with many minorities and children are the most geographically underserved because these communities tend to have the greatest oral health needs. Minorities and children from poor and low-income families are less likely to have a dental visit in the past year and have more untreated dental disease than their white and higher-income counterparts (2,4).

Prior research has shown that minority physicians are more likely to serve minority communities (12-15). Our study is the first to document that this pattern is also true for dentists. Hispanic dentists also tend to practice in communities with higher percentages of Hispanic residents compared with dentists of other race/ethnicity. The same pattern holds true for Asian/Pacific Islander and for white dentists. Clearly, minority dentists play an important role in delivering dental services to many underserved, minority communities.

Many minority groups are underrepresented in the dental workforce. A recent report on California dentists found that 75 percent are white, 4 percent are Hispanic, 18 percent are Asian/Pacific Islander, 2 percent are African American, and fewer than 1 percent are Native American (21). These data compare with an overall population in California that is 52 percent white, 29 percent Hispanic, 11 percent Asian/Pacific Islander, 7 percent African American, and 1 percent Native American (22). Although the proportion of Asian/Pacific Islanders is growing among younger dentists, Hispanics and African Americans remain underrepresented even among this younger cohort of dentists.

Limitations

Our study has several limitations. Reasonably precise information about both active practice status and location of practice was available for at least 80 percent of the dentists meeting our study inclusion criteria. However, for some dentists we relied on home addresses and probability estimates of being in active practice. This may bias our analyses by falsely identifying some dentists as contributing to our enumeration of active dentists in areas where these dentists are either inactive or reside but do not work. In addition, some dentists may have more that one practice location, which is not reflected in the ADA data. This would not affect the overall supply estimates, but may affect the distribution component.

We performed sensitivity tests on different models of dentist supply using different degrees of strictness of dentist eligibility for inclusion in our enumeration. The supply across areas was highly correlated among all these models, suggesting that estimates of relative supply were not highly sensitive to these different enumeration approaches. Moreover, the associations between community characteristics and dentist supply also did not substantially differ according to the model of dentist supply used.

An additional limitation in estimating supply was that we did not know the number of hours worked by the dentists. We relied on head counts, with the result that our measures overestimate the full-time-equivalent supply of dentists. There may be differences in number of hours worked between dentists in rural and urban practices. However, it is unlikely that these differences are of sufficient magnitude to alter the general pattern of our results or meaningfully reduce the workforce differences between urban and rural communities.

We also do not know the number of dental auxiliaries working in any of these areas, which may increase the availability of dental services. However, in California, dental hygienists and assistants do not have expanded practice rights (except under supervision of a physician or dentist for preventive dental services for specific underserved populations). Therefore, dentist practice location is most likely a reasonable measure of the availability of dental services.

We did not measure all the possible provider, financial, and community factors that may predict dentist supply. Most importantly, rates of dental insurance coverage by MSSA were not available. Dental insurance coverage is associated with household income and race/ethnicity (4). Some of the associations between these demographic characteristics and supply of

dentists may therefore be mediated by differences in insurance coverage.

Our study has several policy implications. Policies to improve the geographic distribution of dentists are an important element in improving access to oral health care. The National Health Service Corps and many state agencies administer scholarship and loan repayment programs linked to practice in underserved areas. Although dentists are eligible for many of these programs, these programs are often undersubscribed among dentists. In addition, many communities have been more active in seeking shortage designations for placement of physicians and other medical practitioners than for placement of dentists. A comparison of the results of our geographic analyses with information on formal dental shortage area designations in California suggests that many communities that might meet the federal standard for a shortage of dentists have not applied for official shortage designation. These official designations allow areas to receive placements of health professionals under programs such as the National Health Service Corps. Federal and state workforce agencies should collaborate with both dental schools and underserved communities in optimizing use of existing scholarship and loan repayment programs for dentists.

It is equally important to recognize that racial and ethnic diversity in the dental profession is a public health issue. Minority dentists are more likely to practice in minority communities, but are a small portion of the dental workforce. Policies to promote greater participation of underrepresented minorities in dentistry are essential for producing a dental workforce that is responsive to the needs of underserved populations. Repeal of affirmative action policies in California and other states, including policies that afford underrepresented minorities special consideration for admission to colleges and health professions schools, may be contributing to the recent decline in minority enrollment in health professions schools (23). As such, these recent policy decisions are contrary to public health objectives.

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