# The Availability and Distribution of Dentists in Rural ZIP Codes and Primary Care Health Professional Shortage Areas (PC-HPSA) ZIP Codes: Comparison with Primary Care Providers

# Katherine K. Knapp, PhD; Kevin Hardwick, DDS, MPH

## Abstract

Objective: This paper maps dentists, primary care physicians, physician assistants, nurse practitioners, and nurse midwives in rural areas and rural areas meeting criteria as underserved for primary health care. Methods: Computerbased mapping was used to localize health care provider groups by five-digit ZIP code. For each rural and each rural primary care health professional shortage area (PC-HPSA) ZIP code, the number of providers in each group was determined. The different combinations of providers were determined. Results: All providers in rural areas were present at levels substantially lower than national averages, particularly in PC-HPSA areas. Dentists were approximately equal in number to primary care physicians in rural areas and the largest group in PC-HPSAs. Approximately 75 percent of rural residents lived in ZIP code areas with dentists available. Over 5.8 million rural residents and over 50 percent of rural PC-HPSA residents had no providers available in their ZIP code areas. Conclusions: Rural areas continue to have a short supply of primary care providers and dentists. Dentists were present in many areas where primary care provider presence was absent or very low. These data, including those relating to provider co-presence, can be used to develop strategies to overcome health care access problems due to provider shortages. [J Public Health Dent 2000;60(1):43-48]

Key Words: rural, dentist, primary care, primary care physician, physician assistant, nurse practitioner, nurse midwife, health professional shortage area, mapping.

Access remains an important issue for providing health care to Americans living in rural areas (1). Data suggest that many rural residents are underserved with respect to both general and oral health primary care. For example, geographic areas where the population-to-dentist ratio exceeds 10,000 to 1 are defined as Dental Health Professional Shortage Areas (Dental HPSAs). In 1997, of the 834 officially designated dental HPSAs in the United States, 68 percent were nonmetropolitan or rural (2). The underserved population for these dental HPSAs was estimated at 13,282,032

persons (2). Likewise, geographic areas where the population-to-primary care physician ratio exceeds 3,500 to 1 (or 3,000 to 1 in some cases) can be designated as Primary Care Health Professional Shortage Areas (PC-HPSAs) (1). At the end of 1994, 67 percent of HRSA-designated PC-HPSAs were rural, with a total population of 22,127,049 (3). In this study, we determined the distribution of dentists in rural areas and explored their co-presence with primary care providers, including primary care physicians, physician assistants, nurse practitioners, and nurse midwives (4-8).

#### Methods

For the purposes of this study, "rural" was defined as nonmetropolitan—that is, not in a metropolitan statistical area (MSA). An MSA is a county, or group of counties, that includes either: a city of 50,000 or more residents, or an urbanized area with at least 50,000 people that is itself part of a county or counties with at least 100,000 residents (1).

We used computer-based mapping to study the rural distribution of dentists and primary care providers. The rationale for using mapping software was twofold. First, mapping software was able to identify ZIP codes that met criteria for "rural" and "shortage areas" (1). Second, through mapping software, the ZIP code location of several groups—in this case, dentists and other primary care providers-could be linked through geographic codes and simultaneously portrayed. We elected to map at the five-digit ZIP code level (as opposed to the county or census tract level, for example) because the geographic units represented by ZIP codes were judged relevant to the access issues we were studying. Also, through licensing boards and professional associations, reasonably complete and current data were available for the health provider groups studied.

Data describing the ZIP code location of members of the five health professions groups studied were obtained from federal and private sources. For dentists, a ZIP code-based database of "all available licensed dentists" was received from the American Dental

Send correspondence and reprint requests to Dr. Knapp, School of Pharmacy and Health Sciences, University of the Pacific, 3601 Pacific Avenue, Stockton, CA 95211. E-mail: kknapp@uop.edu. Web site: http://www.uop.edu. Dr. Hardwick is with the Workforce Analysis and Research Branch, Bureau of Health Professions, US Public Health Service, Rockville, MD. This project was supported by two grants from the Bureau of Health Professions, Health Resources and Services Administration, Department of Health and Human Services, Rockville. The views expressed in this paper are strictly those of the authors. No official endorsement by the US Department of Health and Human Services or any of its components is intended or should be inferred. Manuscript received: 8/27/98; returned to authors for revision: 12/14/98; accepted for publication: 5/11/99.

#### **FIGURE 1**

Five-digit ZIP Code Areas of Colorado by Type and Presence of Providers (The cross-hatched sections are MSAs. A: Starred areas represent rural ZIP codes. Note that ZIP codes partially within MSAs are not included as rural ZIPs. B: Starred areas represent rural PC-HPSA ZIP codes. C: Starred areas represent rural ZIP codes where dentists are present. D: Starred areas represent rural ZIP codes where no providers are present.)



Association in June 1996 as a frequency distribution by ZIP code. Fivedigit ZIP code locations for primary care physicians (n=236,669) were provided by the Bureau of Primary Health Care, Health Resources and Services Administration, Department of Health and Human Services. These data were provided by primary care specialty: family practice (n=52,857), internal medicine (n=81,836), general (n=17,956), pediatrics practice (n=40,863), obstetrics/gynecology (n=31,921),obstetrics/surgery (n=3,960), and federal primary care all specialties (n=7,276). For nurse practitioners (n=29,340), data were provided by the American Academy of Nurse Practitioners. For physician assistants (n=27,495), data were provided by the American Academy of Physician Assistants. For nurse midwives (n=5,037), data were provided by the American College of Nurse Midwives. We requested that ach data provider include all known licensed practitioners. Primary care physician data were received in June 1995; all other data except for dentists were received in late 1994. In all cases, the providers of the data were not able to tell us whether the ZIP code locations represented a place of residence or practice or for primary care providers, the extent to which the practitioner was engaged in primary care.

We used mapping software (Map-Info Corporation, Troy, NY 12180-8399) to identify ZIP codes that were not in MSAs and thus, by definition, "rural." Briefly, a ZIP code boundary map for the entire United States was "layered" over a reference map of MSAs for the entire United States and a query was designed to select all ZIP codes completely outside of MSAs. This procedure, which has been described previously, yielded a set of "rural" ZIP codes (9). Using the mapping software, we "layered" the ZIP code-based frequency distributions for each of the five health professions groups studied over the rural ZIP code map and a query was designed to add to each rural ZIP code record the number of providers from each group. The process yielded a single, mappable database that described, for each rural ZIP code, the number of dentists, primary care physicians, physician assistants, nurse practitioners, and nurse midwives. Through reference maps, we also added to each database record the population, area, and state.

To identify rural PC-HPSA ZIP codes for this exercise, we selected from all rural ZIP codes those that met the criterion of a population-to-primary care physician ratio of 3,500 to 1

	National			Rural			PC-HPSA		
Provider Group	n	Providers/ 100,000 Pop.	n	% of Total	Providers/ 100,000 Pop.	n	% of Total	Providers/ 100,000 Pop.	
Primary care physicians (PCP)	236,669	95.2	18,368	7.8	53.6	521	0.2	4.2	
Family practice	52,857	21.3	7,667	14.6	22.4				
General practice	17,956	7.2	2,602	14.7	7.6				
Internal medicine	81,836	32.9	3,830	4.7	11.2				
Pediatrics	40,863	16.4	1,810	4.5	5.3				
Obstetrics/gynecology	31,921	12.8	1,759	5.5	5.1				
Obstetrics/surgery	3,960	1.6	126	3.2	0.4				
Federal PCP, all specialties	7,276	2.9	574	8.3	1.7				
Dentists	188,853	75.9	18,822	10.0	55.0	3,351	1.8	29.1	
Nurse practitioners	29,340	11.8	2,619	9.0	7.6	692	2.4	6.0	
Physician assistants	27,495	11.1	3,415	12.9	10.0	756	2.7	6.6	
Certified nurse midwives	5,037	2.0	354	7.1	1.0	66	1.3	0.6	
Population	248,709,873		34,242,699	13.8		11,525,663	4.6		

TABLE 1 National/Rural/HPSA Distribution of Primary Care Physicians, Dentists, Nurse Practitioners, Nurse Midwives, and Physician Assistants Rank-ordered by Total Group Size, United States

or greater. We used this ratio because the study focused on areas where primary care providers were in short supply and this ratio is one criterion that the Secretary of Health and Human Services uses in designating primary care shortage areas (1) (Note that this is only one criterion in the process of official designation, and the discussion in the rest of this paper refers to potential or simulated primary care shortage areas, rather than officially designated ones.) Using this criterion, we built a simulated rural PC-HPSA ZIP code database and, as in the rural ZIP code database, included the number of dentists, primary care physicians, physician assistants, nurse practitioners, and nurse midwives for each ZIP code as well as the population, area, and state.

The rural and PC-HPSA databases were used to determine the number of different provider combinations throughout rural areas. For example, of the 32 possible combinations of presence or absence for the five groups, one combination would be the presence of dentists and primary care physicians with the absence of nurse practitioners, physician assistants, and nurse midwives. The rationale for this analysis was to determine which providers would be available in each ZIP code if an effort to build health care teams were to occur. Because ZIP codes do not overlap, we were able to uniquely characterize the combinations of providers available in each of the rural and PC-HPSA ZIP codes. More details of the methodology are available (9).

## Results

Over 95 percent of the ZIP codes for each provider database were mappable. Those ZIP codes meeting "rural" criteria (n=12,591 ZIP codes) were found to encompass a population of 34,242,699 persons (13.8 percent of total). The state of New Jersey and the District of Columbia had no rural ZIP codes. Those ZIP codes meeting PC-HPSA criteria (n=9,284 ZIP codes) encompassed a population of 11,525,663. Figure 1 presents examples of ZIP code-based mapping of rural and rural PC-HPSA areas for the state of Colorado. We used Colorado as an example because of its large ZIP code areas and because a substantial portion of the state is rural.

Table 1 describes provider groups by number, percent, and providerper-100,000 population ratio on three levels: national, in rural ZIP codes, and in rural PC-HPSA ZIP codes. For all the health professions studied, the density of providers fell off in rural and particularly in PC-HPSA areas. For dentists, the provider-per-100,000 population ratio dropped from 75.9 to 55 to 29.1 for the national, rural, and rural PC-HPSA regions, respectively.

Table 2 describes the presence of various combinations of providers, the total population and the land area of ZIP codes for each combination. The most common co-presence was primary care physician and dentist without other primary care providers. Of the 12,591 rural ZIP codes, dentists were present in 3,573 (28.4%) with a population of 25,839,411 persons, 75.5 percent of the total rural population. The scarcity of providers in rural areas was demonstrated by the 7,512 ZIP codes with no providers. These ZIP codes represented a population of over 5.8 million persons and were found in all states except New Jersey and the District of Columbia. Average population density for all rural ZIP codes was 13.4 persons per square mile. By comparison, the population density in areas with no providers was four persons per square mile.

Table 3 describes the presence of various combinations of nonphysician

Primary Care Physician	Dentist	Physician Assistant	Nurse Practitioner	Cert. Nurse Midwife	ZIP Codes (#)	Population These ZIPs	Area (sq. mi.)
x	x	x	x		422	5,796,843	152,853
x	x				1,032	5,593,367	200,679
x	x	x			641	5,017,354	166,098
x	x		х		372	3,684,461	89,456
x	х	x	x	x	117	2,537,545	56,177
	x				649	1,390,503	92,758
x					591	1,103,130	86,039
x	x	x		x	34	471,697	6,579
x	x		х	x	36	405,764	6,926
			x		288	395,367	35,476
		x			287	386,048	74,616
	x	х			125	369,554	34,014
x		x			116	251,941	19,352
x	x			x	32	244,572	4,655
	x		x		68	233,636	8,099
х			x		83	158,960	9,240
	x	x	х		39	79,924	15,090
x		x	x		29	79,810	4,623
		x	x		58	75,843	16,410
				x	23	32,757	1,545
			х	x	10	24,146	17,539
x				х	10	21,852	2,089
x		x		x	3	17,416	1,546
x		x	x	x	4	9,572	318
	x		x	x	2	5,179	75
		x		x	2	5,084	82
	x	x		x	2	5,055	256
	x			x	2	3,957	303
x			x	x	1	1,999	20
		х	x	x	1	1,239	27
	x	x	x	x	0	0	0
No providers					7,512	538,124	1,446,170

 TABLE 2

 Co-presence of Provider Groups in Rural ZIP Codes in Order of Population Served, United States

providers in PC-HPSA ZIP codes and the population and land area encompassed by the ZIP code groups. We noted that physicians were present in some PC-HPSAs, but at a very low density-only 521 primary care physicians were identified in total. The most common combination was dentists alone in 88 ZIP codes with a population of 2.4 million persons, 21.4 percent of the rural PC-HPSA population. Of the 7,550 rural PC-HPSA ZIP codes, dentists were present in 473 (6.3%) with a population of 4,494,828 persons, 39 percent of the total rural PC-HPSA population. In rural PC-HPSAs, over 6 million persons (52.1%) had no nonphysician providers present. These PC-HPSAs without providers

were found in all states except New Jersey and the District of Columbia. The average population density in rural PC-HPSAs was 6.4 persons per square mile. For those ZIP codes with no providers, the average population density was 4.1 persons per square mile.

## Discussion

The data showed that primary care provider presence continues to be substantially lower in rural and particularly in rural PC-HPSA areas than national averages. This shortfall presents a challenge to providing adequate health care access to rural residents. Dentists were the most highly represented provider group for both rural and PC-HPSA ZIP codes. Provider numbers were approximately equal for primary care physicians and dentists in rural areas; however, physician presence fell off sharply in PC-HPSAs relative to dentist presence. The smaller numbers of other primary care providers appeared to be due to the small overall sizes of the provider groups rather than their being located primarily in metropolitan areas. Dentists were found to have a substantial presence in both rural and rural PC-HPSA areas. This presence raises the question of the dentist's role in overall health care teams serving these rural underserved areas. While it is obvious that dentists cannot replace other health providers, the presence of this Vol. 60, No. 1, Winter 2000

Dentist	Physician Assistant	Nurse Practitioners	Cert. Nurse Midwives	ZIP Codes (#)	Pop. These ZIPs	Area (sq. mi)
x				88	2,462,610	118,494
x	x			191	814,775	51,431
x		x		113	608,449	15,764
	x			297	432,817	75,682
		x		295	424,905	36,144
x	x	x		59	347,194	20,622
x	x	х	x	6	120,791	1,246
	x	x		60	83,133	16,718
x			x	6	68,332	920
x	x		x	5	37,633	538
			x	24	36,583	1,609
x		x	x	5	35,044	1,998
		x	x	10	24,146	17,539
	x		x	3	15,122	725
	x	x	x	2	4,903	109
No providers				7,550	6,009,226	1,452,613

TABLE 3 Co-presence of Nonphysician Provider Groups in Rural PC-HPSAs in Order of Population Served, United States

highly trained and relatively well-distributed provider group in underserved areas is an asset that should not be ignored. For example, it is possible that, in primary care provider-deficient areas, dentists may be the first to recognize general health problems and can refer or counsel patients to seek appropriate care.

If efforts to utilize available health providers in rural areas through the formation of multidisciplinary teams were to occur, the methods used in this study and the resulting data could be used to predict which providers are available to participate. It is likely that additional training would be required, as many providers do not currently coordinate efforts with other providers to overcome gaps in care due to insufficient provider presence.

The large percentage of the rural and rural PC-HPSA population that has no providers available is a continuing problem. Relative to oral health care, existing programs through Title VII and the National Health Service Corps that increase the number of dentists and other health professionals in underserved areas, either on a temporary or permanent basis, need to be maintained and even expanded. New initiatives such as the Child Health Insurance Program, which have the potential to help provide access to a new cohort of Medicaid eligible children, also may alleviate problems related to personnel shortage.

The total count for dentists (n=188,853) based on data received was less than Bureau of Labor Statistics counts for the year 1996 (n=210,000) (10,11). No explanation was apparent for the difference. However, the difference suggests that our mapping underestimates actual numbers of dentists. National totals for five primary care providers were in good agreement with other studies (4).

The rural population count was lower than other estimates (1). We believe that the difference was due principally to our methodology, which excluded any ZIP code even partly in an MSA. The result was an underestimation of the rural population with our data being "more rural." Because PC-HPSAs can be officially designated through criteria other than the 3,500 to one ratio cited, the rural PC-HPSA population also is underestimated. Our study also was limited by uncertainty regarding whether the ZIP code location of the various practitioners represented a place of residence or work. We hypothesized, however, that rural providers were more likely to work in the same ZIP code where they lived than metropolitan providers, which would tend to reduce the effect of this limitation. This thesis was

supported by data gathered for a related study, in which 78 to 90 percent of rural practitioners lived and worked in the same ZIP code area (12).

In conclusion, the study found a shortfall of primary care providers and dentists in rural areas and particularly in rural PC-HPSA areas when compared to national averages. Dentists were found to be present in many areas where primary care providers were in short supply. These data can be used in developing strategies to overcome health care access problems due to provider shortages.

## Acknowledgments

We wish to acknowledge Judy Arndt, RN, USPHS, and Dr. Marcia Brand, Health Resources and Services Administration, for insight into and support of the project.

#### References

- US Congress, Office of Technology Assessment. Health care in rural America. Washington, DC: US Government Printing Office, 1990; OTA-H-434.
- Division of Shortage Designation, Bureau of Primary Health Care. Selected statistics on health professions shortage areas. Washington, DC: Health Resources Service Administration, 1997.
- 3. Division of Shortage Designation, Bureau of Primary Health Care. Washington, DC: Health Services Resource Agency, December 1994.
- Sekscenski ES, Sansom S, Bazell C, Salmon ME, Mullan F. State pratice environments and the supply of physician assistants, nurse practitioners, and certi-

fied nurse-midwives. N Engl J Med 1994;331:1266-71.

- Brown SA, Grimes DE. Nurse practitioners and certified nurse-midwives: a meta-analysis of studies on nurse primary care roles. Washington, DC: American Nurses, 1993.
- Schaft GE, Cawley J. The physician assistants in a changing health care environment. Rockville, MD: Aspen Publications, 1987.
- 7. Clawson DK, Osterweis M, eds. The roles of physician assistants and nurse practi-

tioners in primary care. Washington, DC: Association of Academic Health Centers, 1993.

- 8. Mundinger MO. Advanced-practice nursing—good medicine for physicians? N Engl J Med 1994;330:211-14.
- Knapp KK, Paavola FG, Maine L, Sorofman B, Politzer RM. Availability of primary care providers and pharmacists in the United States. J Am Pharm Assoc 1999;39:127-35.
- 10. Anonymous. Employed person by detailed occupation, 1983-1996 CPS annual

averages (in thousands). Washington, DC: Bureau of Labor Statistics, 1997.

- Anonymous. Self-employed person by detailed occupation, 1983-1996 CPS annual averages (in thousands). Washington, DC: Bureau of Labor Statistics, 1997.
- 12. Sorofman BA, Knapp KK, Paavola FG. Health care teams in rural America: interprofessional communication [Abstract]. Final program for the 143rd American Pharmaceutical Association annual meeting and exposition, 1996;1:79.