WWAMI RURAL HEALTH RESEARCH CENTER
Final Report #135 • June 2015

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Rural Health Research & Policy Centers
Funded by the Federal Office of Rural Health Policy
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Dentist Supply, Dental Care Utilization, and Oral Health Among Rural and Urban U.S. Residents

EXECUTIVE SUMMARY

BACKGROUND

Compared to their urban counterparts, adults in United States (U.S.) rural locations have higher rates of dental caries and permanent loss of teeth. The lower availability of dentists in rural communities may contribute to this situation. Because of these concerns, expansion of dentist supply has been recommended to increase access and improve oral health for rural Americans.

This national study examines whether adults in rural locations compared to those in urban locations reported lower dental care utilization, a higher prevalence of dental disease or both after accounting for socioeconomic and other factors. It also begins to explore whether dentist supply influences utilization and oral health outcomes in rural and urban locations.

METHODS

We examined data on dental care utilization and oral health outcomes from the 2006 Behavioral Risk Factor Surveillance System (BRFSS), a state-based survey of the non-institutionalized U.S. adult population conducted by the Centers for Disease Control and Prevention (CDC) (n=355,170). We used data from the American Dental Association (ADA) Masterfile and the U.S. Census Bureau to calculate per capita dentist supply.

We examined three dependent measures: (1) visit to a dentist or a dental clinic in the past year (yes, no); (2) teeth cleaned by a dentist or dental hygienist in the past year (yes, no); and (3) any permanent teeth removed because of tooth decay or gum disease (yes, no). Independent measures included: residence location, race, age, sex, marital status, income; education, employment, health insurance coverage; health status and smoking status (and, for the utilization models, edentulism). Rural residence was ascertained using the 2003 Urban Influence Code (UIC) groups of the Economic Research Service of the U.S. Department of Agriculture.

Chi-square tests and multivariate logistic regressions were performed and 95% confidence intervals (CIs) were calculated.

RESULTS

Generalist Dentist Supply: Generalist dentists represented 82.8% of the overall dentist workforce. While generalist dentists represented 81.9% of those in metropolitan locations, they made up 90.1% of dentists in non-metropolitan locations. The

per capita supply of dentists per 100,000 population varied from 30.1 in metropolitan areas to 21.9 in non-metropolitan areas overall, dropping to 21.6 in remote non-core counties.

Dental Visits, Teeth Cleaning, and Permanent Tooth Extraction: Compared to their metropolitan counterparts, adults in non-metropolitan locations were significantly less likely to report having a dental visit (64% rural vs. 71% urban, $p < .001$) or teeth cleaning (63% vs. 70%, $p < .001$) and significantly more likely to report ever having undergone permanent tooth extraction (51% vs. 44%, $p < .001$). In multivariate models, adults in non-metropolitan locations remained significantly less likely than their metropolitan counterparts to report having a dental visit (Adjusted Odds Ratio [AOR] 0.87, 95% Confidence Interval [CI] 0.84 to 0.91) and having their teeth cleaned (AOR 0.84, CI 0.81 to 0.87), and they were significantly more likely to report having had any permanent teeth extracted (AOR 1.19, CI 1.14 to 1.23).

Influence of Generalist Dentist Supply on Dental Visits, Teeth Cleaning, and Permanent Tooth Extraction: Comparison of locations with lower levels of generalist dentist supply to locations with higher levels of supply in both non-metropolitan and metropolitan locations shows that in low supply areas the proportion of adults receiving any dental visit or teeth cleaning was lower and the proportion reporting permanent tooth extraction due to dental decay or disease was higher ($p < .001$).

DISCUSSION

We observed that U.S. rural (non-metropolitan) adults utilized significantly fewer dental services and had more permanent tooth loss than their urban (metropolitan) counterparts. We further observed that lower socio-economic status among rural adults explained some of the rural-urban disparity. Lower levels of per capita generalist dentist supply in both rural and urban locations were related to impaired dental care utilization and worse outcomes.

Our findings suggest that policies and programs aimed at reducing financial barriers for rural patients might reduce rural/urban oral health disparities. Our findings also suggest that policies and programs aimed at increasing rural dentist supply might also reduce these rural disparities. A variety of interventions could be tried, such as providing competitive reimbursement for public dental insurance coverage and increasing the availability programs that have been shown to expand the generalist dentist pipeline, such as dental school rural training tracks, increased rural recruitment, and student loan repayment programs for dentists choosing rural dental practice. In locations in which the population or economic base is not sufficient to support dentist practice interventions could include increased use of advanced dental hygiene practitioners or community dental health coordinators, or funding for mobile clinics to extend the geographic reach of dentists.

CONCLUSIONS

Rural adults reported poorer dental care utilization and greater loss of permanent teeth than their urban counterparts. Our observations support the need for policies and programs to increase dental insurance coverage for adults with low socioeconomic status as well as policies and programs to increase the supply of dentists and other oral health professionals in low supply areas.

Dentist Supply, Dental Care Utilization, and Oral Health Among Rural and Urban U.S. Residents

INTRODUCTION

Rural populations have lower dental care utilization and higher rates of dental caries and permanent tooth loss than urban populations,[1-5] and oral health ranked 5th among 28 priority conditions according to Rural Healthy People 2010.[6] One reason for this disparity may be that shortages of dentists in rural communities persist despite growth in the dental education sector and the advent of programs designed to promote dental practice in these areas.[7] The imminent retirement of dentists over the coming years is expected to exacerbate the shortage of dentists in rural areas,[8] and new dentists may be increasingly unlikely to select rural careers. For example, a survey of pediatric dental residents at the Columbia University College of Dental Medicine demonstrated that only 22% of respondents were likely or very likely to practice in rural settings.[9] Additional barriers to delivery of oral health care services to rural communities include economic, socio-demographic and geographic factors.[10]

The question of whether having higher levels of dentist supply in rural locations results in improvements in dental care utilization, including uptake of preventive care services, reductions in adverse outcomes, or both has received little attention. One study of rural and urban children enrolled in Medicaid in Illinois showed that the supply of dentists was a greater predictor of utilization than rural-urban residence location.[11] A study of rural adults in Kansas showed that both low socio-economic status and low dentist supply were related to poorer access to dental care.[12] Examination of the prevalence of oral health conditions and unmet dental needs among patients presenting for routine care in a rural Oregon family practice clinic detected dental health conditions among half of the patients screened and unmet dental needs among 28% of patients.[13] Moreover, a correlation was observed between patient report of overall health and patient report of oral health. Further exploration of the role dentist supply plays in dental care utilization and in health outcomes is needed to inform policy directed at setting standards around the adequacy of rural and urban dentist supply.

Thus, we conducted a study in a national sample of adults to evaluate whether adults in rural locations report lower dental care utilization, including receipt of preventive care, or a higher prevalence of dental disease, and also to evaluate whether lower levels of dentist supply in rural and urban areas of the United States are associated with lower dental care utilization, including receipt of preventive care, or a higher prevalence of dental disease. Our analytical approach was informed by the Andersen behavioral model of health services access.[14] This conceptual model can be used to explain rural-urban differences in access to care as being due to population-level difference in *predisposing* factors, such as age and educational attainment, *enabling* factors, such as income and the availability oral health care providers, and *need* factors, such as smoking status and chronic illness.

METHODOLOGY

SAMPLE AND SUBJECTS

Three sources of data were used to examine per capita dentist supply and dental care. First, dentist supply was calculated using 2008 data on 239,262 dentists from the American Dental Association (ADA) Masterfile. The ADA Masterfile records information on U.S. dentists, including measures of their age, sex, race, specialty, type of practice, dental school, graduation year and ADA

membership type. The data set also identifies dentists with county-level Federal Information Processing Standards (FIPS) codes with which we were able to classify urban or rural residence as described below. Those with documented office addresses in the 50 U.S. states and District of Columbia were included in the study. This was recorded for 125,719 individuals. Among these, 111,541 (88.7%) had documentation of full- or part-time professional employment. We further excluded those who were unlikely to be highly engaged in clinical practice (10,968, or 8.7%), such as those over the age of 75 or who were missing specialty or age information. Finally, we excluded dentists whose practice patterns were unlikely to reflect typical community dentistry practice, as study outcome measures (receipt in the past year of a dental visit or teeth cleaning, or loss of one or more permanent teeth) were recorded for non-institutionalized civilian U.S. adults. Thus excluded were dental school faculty and dentists in residency training (2194, or 1.7%), and those working for governmental agencies, such as the Department of Defense, the Veterans Administration, the Indian Health Service and local government (1016, or 0.8%). (Note that dentists who worked in federally qualified community health centers or were National Health Service Corp participants are not governmental employees, so are included in this study). Dentist supply was, therefore, determined for 104,523 (83.4%) dentists, of whom 86,576 (82.8%) were categorized as "generalist" dentists (general dentists, and pediatric and public health dentists), and 17,947 (17.2%) were categorized as specialist dentists.

Second, per capita dentist-to-population ratios were calculated at the county level, using 2007 population data estimates obtained from the U.S. Census Bureau's Population Estimates Program county population data set (U.S. Census Bureau, http://www.census.gov/popest/datasets.html). Population estimates from 2007 were employed since these were the most current data available at the time of analysis.

Third, dental care behaviors were determined by using data from the 2006 Behavioral Risk Factor Surveillance System (BRFSS), a national sample of rural and urban adults conducted by the Centers for Disease Control and Prevention (CDC).[15] By collecting data annually on health-related behaviors, BRFSS is useful for planning, initiating, monitoring, and evaluating health promotion and disease prevention programs. The Oral Health section of the BRFSS questionnaire is available every 2 years; 2008 data were not yet available at the time of this study. BRFSS is a state-based, random-digit-dialed telephone survey of the non-institutionalized adult population aged 18 years and older in the 50 states as well as the District of Columbia, Guam, Puerto Rico, and the Virgin Islands; this study is limited to the 50 states and the District of Columbia. Data retaining all county-level FIPS codes were obtained from the CDC. In 2006, the BRFSS sample size was 355,710 and the median response rate was 51.4% (range across states: 35.1% to 66.0%). Additional information describing the BRFSS data collection process, BRFSS publications, and data can be accessed at http://www.cdc.gov/brfss/index.htm#about_BRFSS.

DEPENDENT MEASURES

Each BRFSS respondent was asked about dental care utilization (visits to a dentist or dental clinic), preventive care (teeth cleaning), and oral health (permanent tooth loss), as follows:

1. "How long has it been since you last visited a dentist or a dental clinic for any reason?" which was classified as being within the past year (yes/no);
2. "How long has it been since you had your teeth cleaned by a dentist or dental hygienist?" which was classified as being within the past year (yes/no);
3. "How many of your permanent teeth have been removed because of tooth decay or gum disease?" which was classified as being any (yes/no).

INDEPENDENT MEASURES

Rural residence was ascertained using the 2003 Urban Influence Code (UIC) groups of the Economic Research Service of the

United States Department of Agriculture[16] as follows: "Metropolitan"—large and small metropolitan counties (codes 1-2); "Adjacent Non-Metro"—geographically adjacent to a metropolitan area, including both micropolitan and non-core counties (codes 3-7); "Remote Micropolitan"—not adjacent to a metropolitan county and with a town/urban cluster of 10,000 residents or greater (code 8); and "Remote Non-Core"—not adjacent to a metropolitan county and without a city of 10,000 residents or greater (codes 9-12). UIC adjacency is determined by county boundaries and a minimum work commuting criterion. Geography was also classified by state. A county-level data set with UIC codes and data from the ADA Masterfile, including dental supply, were submitted to the CDC, who then provided 2006 BRFSS data merged with these variables. In this report, the term "rural" is defined as being in a non-metropolitan location, while the term "urban" is defined by being in a metropolitan location.

Other BRFSS measures included: race/ethnicity (non-Hispanic white, African American, American Indian, Asian/Pacific Islander, and Hispanic); sex; age (18-44, 45-64, and 65 years or older); educational attainment (less than high school degree, high school degree or equivalent, greater than high school degree); annual household income (less than $25,000, $25,000-$49,999, $50,000-$74,999, $75,000 or greater); employment status (employed, unemployed, out of the workforce), self-reported health (excellent, good, fair or poor) and smoking status (current smoker, former smoker, never smoked).

ANALYTICAL PLAN

Analyses were conducted at the individual level on BRFSS respondents. County-level dentist supply decile was merged into the BRFSS data for each respondent. Dentist supply was calculated using ADA Masterfile data for the numerator and census population data for the denominator. Multivariate models examining the role of socio-demographic factors on each of the three dependent measures were built using independent variables classified into 3 categories according to the Andersen behavioral model of health services access that was conceived in the 1960s and has been revised and expanded over the last 40 years.[14] The conceptual model's overall classifications are *predisposing* (those that exist prior to disease), *enabling* (resources affecting one's ability to access the health care system), and *need* factors. The logistic regression models were built sequentially, including predisposing variables first (race, age, sex, marital status, education, employment, edentulism), then adding enabling (income, insurance), and finally, need variables (health and smoking status). We use this model to conceptualize dentist supply as being an enabling factor that would predict increased use of oral health care resources.

The design of the BRFSS employs multistage cluster sampling in each participating state in order to sample non-institutionalized adults living in a residence that had a telephone. Accordingly, estimates were weighted using the BRFSS weighting formulas, which account for differences in probability of selection among strata. All analyses were conducted using STATA software (StataCorp. 2007. *Stata Statistical Software: Release 10.* College Station, TX: StataCorp LP), using code to adjust the standard errors to account for the complex sample design of the BRFSS. Analyses were performed for each of the 3 dependent measures, to assess their relationships with rural or urban status. Chi-square testing and 95% confidence intervals (CIs) were calculated. For multivariate assessment, logistic regression models were built.

This study was approved by the University of Washington Institutional Review Board.

RESULTS

GENERALIST DENTIST SUPPLY

Generalist dentists represented 82.8% of the overall dentist workforce and this percentage was higher in non-metropolitan locations: for example, 81.9% of dentists in urban areas were generalists, while 95.7% were generalists in remote non-core locations (Table 1). However, the per capita supply of generalist dentists was lower in non-metropolitan locations. Based on the

Table 1. Percent of U.S. Dentists Who Are Generalists or Specialists by Urban/Rural (Metropolitan/ Non-metropolitan) Status, 2008

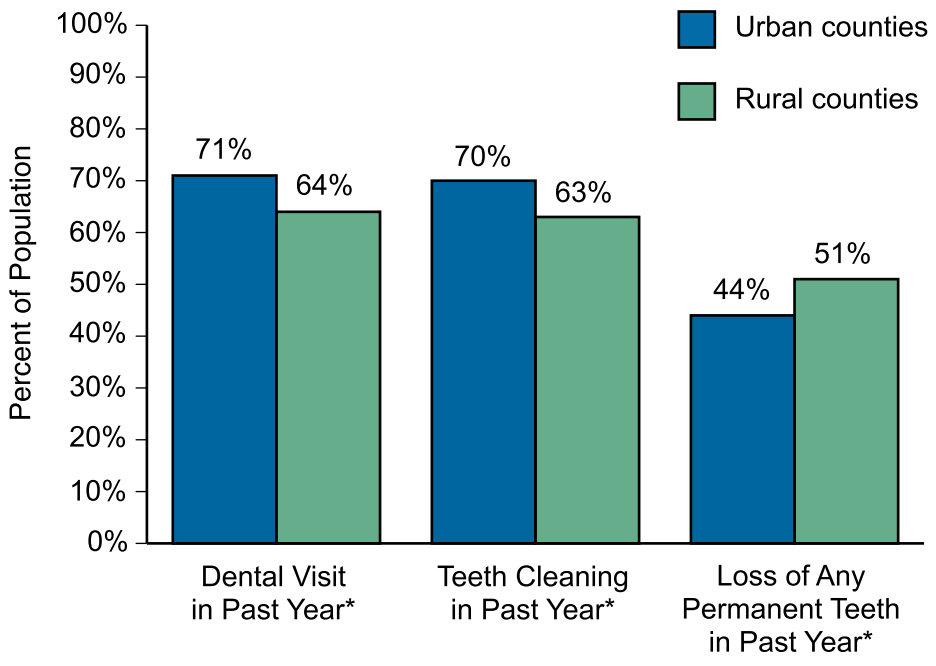
				Rural		
	Total	Urban	Rural	Adjacent Non-Metro	Remote Micro	Remote Non-Core
Dentists	104,523	92,343 (88.4%)	12,180 (11.7%)	7,414 (7.1%)	3,039 (2.9%)	1,727 (1.7%)
Generalists	86,576 (82.8%)	75,599 (81.9%)	10,977 (90.1%)	6,722 (90.7%)	2,603 (85.7%)	1,652 (95.7%)
Specialists	17,947 (17.2%)	16,744 (18.1%)	1,203 (9.9%)	692 (9.3%)	436 (14.4%)	75 (4.3%)
Population, 2007	301,621,157	251,599,047	50,022,110	33,005,519	9,365,433	7,651,158
Supply per 100,000 population						
Generalists	28.7	30.1	21.9	20.4	27.8	21.6
Specialists	6.0	6.7	2.4	2.1	4.7	1.0

UIC grouping used in this analysis, 16.7% of the total 2007 U.S. population resided in non-metropolitan areas, but only 12.7% of generalist dentists worked in these settings (data not shown). The overall per capita supply of generalist dentists was 28.7 per 100,000 population, and per capita supply varied by non-metropolitan/metropolitan category: it was 30.1 in metropolitan areas and 21.9 in non-metropolitan areas (Table 1). Among the non-metropolitan categories, remote micropolitan counties had the highest generalist/population ratio, 27.8, while this ratio in remote non-core counties dropped to 21.6.

DENTAL VISITS, TEETH CLEANING, AND PERMANENT TOOTH EXTRACTION

Seventy percent of all adults reported having one or more dentist visits in the past year, 68% reported having their teeth cleaned in the past year, and 46% reported they had ever undergone extraction of one or more permanent teeth due to dental decay or disease. Compared to their metropolitan counterparts, adults in non-metropolitan locations were significantly less likely to report having a dental visit (64% rural vs. 71% urban, $p < .001$) or teeth cleaning (63% vs. 70%, $p < .001$) and significantly more likely to report ever having undergone permanent tooth extraction (51% vs. 44%, $p < .001$) (Figure 1).

Figure 1. Dental Services by Rural-Urban Status, United States, 2006.



*p < .001.

Table 2 shows unadjusted and adjusted odds ratios for the 3 outcomes (dental visits, teeth cleaning, and permanent teeth extraction) for socio-demographic characteristics of respondents in non-metropolitan areas compared to metropolitan ones in 2006. The first data column depicts the unadjusted non-metropolitan/metropolitan odds ratios for each outcome. The second data column shows this odds ratios for each outcome after multivariate adjustment for the socio-demographic characteristics of the Anderson conceptual model and demonstrates that results persisted for each measure: non-metropolitan residents remained significantly less likely than their urban peers to report having a dental visit (Adjusted Odds Ratio [AOR] 0.87, 95% Confidence Interval [CI] 0.84 to 0.91) and having their teeth cleaned (AOR 0.84, CI 0.81 to 0.87), and non-metropolitan residents were significantly more likely to report having had any permanent teeth extracted (AOR 1.19, CI 1.14 to 1.23).

Table 2. Unadjusted and Adjusted Odds Ratios for Three Outcomes (Dental Visits, Teeth Cleaning, and Permanent Teeth Extraction) for Respondents in U.S. rural (non-metropolitan) Areas Compared to Metropolitan Areas, 2006

Outcome Measure	Unadjusted		Adjusted for Socio-Demographic Characteristics*	
	OR	CI, p Value	OR*	CI, p Value
Any dental visit in the last year	0.73	(0.70, 0.75) p < .001	0.87	(0.84, 0.91) p < .001
Teeth cleaned in the last year	0.73	(0.70, 0.76)) p < .001	0.84	(0.81, 0.87) p < .001
Any permanent teeth extracted	1.39	(1.35, 1.44) p < .001	1.19	(1.14, 1.23) p < .001

*Adjusted for race, age, sex, marital status, education, employment, smoking status, income, health insurance and health status. (The measure any dental visit also adjusted for edentulism.)

INFLUENCE OF GENERALIST DENTIST SUPPLY ON DENTAL VISITS, TEETH CLEANING, AND PERMANENT TOOTH EXTRACTION

Figures 2, 3, and 4 examine dentist supply, an enabling factor in the Andersen model, on the dependent measures. These figures show that at lower deciles of dentist supply, dental care utilization (proportion of adults with any visit in the past year and proportion reporting that their teeth had been cleaned in the past year) was lower and oral health outcomes (proportion reporting permanent tooth extraction due to dental decay or disease) were worse. These relationships were statistically significant ($p < .001$) for both non-metropolitan and metropolitan locations.

DISCUSSION

These analyses indicate that U.S. non-metropolitan (rural) adults utilized significantly fewer dental services and had more permanent tooth loss than their metropolitan (urban) counterparts. The multivariate models demonstrate that accounting for the socio-demographic status of rural adults explained some of the rural-urban disparity, which is consistent with other studies.[17-19] Furthermore, stratification of the data by deciles of dentist supply revealed that lower levels of generalist dentist supply in both rural and urban locations was related to reduced dental care utilization and worse outcomes.

These findings have implications for policy makers, educators and other stakeholders who are in a position to influence U.S. dentist production and distribution. A variety of strategies could be implemented. For example, providing competitive reimbursement for public dental insurance coverage could entice dentists to establish, or remain in, practice in rural locations and provide services to economically disadvantaged adults.[19,20] Similarly, support for dental services provided in publicly funded clinics could lead to improvements in access and outcomes.[7] Also, educational institutions and government could increase the number and size

Figure 2. Adjusted Percentages for Any Dental Visit in Past Year by Rural-Urban Status, United States, 2006.

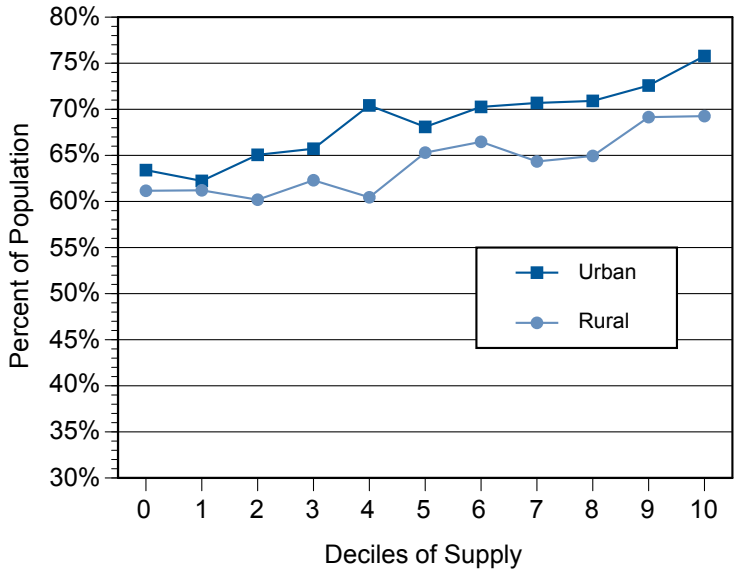


Figure 3. Adjusted Percentages for Any Teeth Cleaning in Past Year by Rural-Urban Status, United States, 2006.

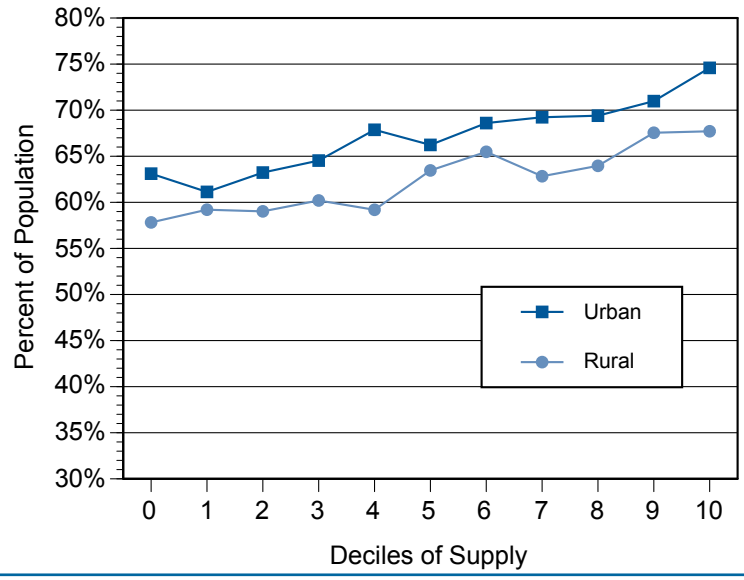
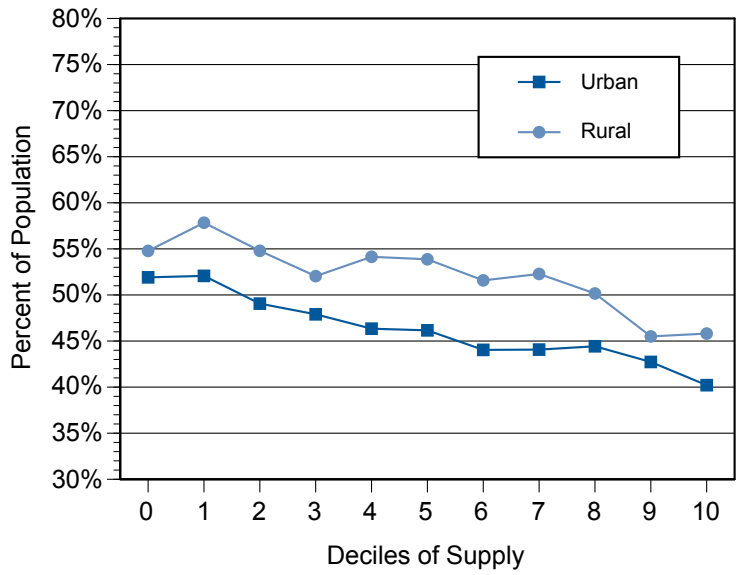


Figure 4. Adjusted Percentages for Any Loss of Permanent Teeth by Rural-Urban Status, United States, 2006.



of programs shown to expand the generalist dentist pipeline. Examples include dental school rural training tracks, efforts to recruit dental students from rural areas, and student loan repayment programs for dentists choosing rural dental practice.[19,21] Community-led efforts to help create a favorable practice environment also could have a role in recruiting and retaining dentists in shortage locations.

We also observed that remote-micropolitan counties support the highest generalist dentist/population ratios of any rural setting. This makes sense in that typically micropolitan counties have towns with populations of roughly 10,000 to 50,000 persons, which is a sufficient base to be able to support dental practice. Research is needed to explore the extent to which these towns serve or could potentially serve as hubs for persons living in surrounding, more remote rural locations where shortages are greatest. Of course, many rural communities will lack the population or economic base needed to support dentist practice. One strategy in such locations would be to increase the use of non-dentist providers, such as advanced dental hygiene practitioners or community dental health coordinators who could extend the service area of dentists serving rural populations.[10,20] Given that these providers can perform a range of services, creative incentives that attract more non-dentist oral health care providers to rural shortage locations might lead to improvements in oral health, although research examining the impact of non-dentist providers on oral health in rural locations is needed.[19,20] In remote towns, the funding of traveling dentists and non-dentist providers who provide services periodically, mobile clinics or both might be reasonable.[10,22]

LIMITATIONS

Findings in this report are subject to several limitations. The BRFSS data are from 2007, but we have no reason to suspect that more recent data would have yielded different results, as the underlying factors for rural-urban disparities in health care access persists. The outcome measure characterizing permanent tooth loss reflects long-term processes that cannot be captured in this cross-sectional study. Longitudinal assessment of oral health outcomes among a cohort of rural-residing patients could address this problem, but the cost of such a study could be prohibitive. BRFSS does not sample persons living in institutions or persons living in households without a landline telephone, both of which may be subgroups at higher risk for not receiving dental care. Findings also could have been affected by the trend towards lower response rates in telephone-based surveys. However, BRFSS employs post-stratification weights to minimize the problem of non-response (see, www.cdc.gov/brfss/technical_infodata/surveydata/2000/Overview_00.rtf). Also, care must be taken in drawing conclusions based on data aggregated by county, as there is a significant degree of variation in population characteristics within many counties. For example, counties classified as urban may also encompass rural populations. This aggregation may attenuate the observed rural-urban difference in access to care. Another limitation is the use of self-report for oral health access and outcomes. The extent to which this might bias findings, if at all, is not known, but it seems unlikely that it would alter our major conclusions about rural-urban differences. Finally, dentist supply was calculated using ADA Masterfile data. As this study focuses on rural-urban comparisons, dentist supply estimates excluded those in the ADA Masterfile data set who lacked geographic identifiers (county FIPS codes). Thus, the estimated per capita dentist supply is less than the dentist supply estimates included in reports to the Institute of Medicine and others.[23,24] Because there is no reason to suspect that the capture of county FIPS code would vary systematically between rural and urban dentists, the exclusion of those without county FIPS codes would not be expected to bias rural-urban comparisons. Despite its shortcomings, the ADA Masterfile data set is the most readily available source of information on dentists for national workforce policy making and thus is likely to continue to be used to obtain estimates of geographic access to dental care.

CONCLUSIONS

Rural adults reported poorer dental care utilization and greater loss of permanent teeth than their urban counterparts even after adjustment for socio-demographic factors. These observations support the need for policies to increase timely oral health access

for rural-residing adults. Many rural communities struggle to recruit and retain sufficient numbers of health care professionals and our findings show that the per capita supply of generalist dentists in rural locations was only about two thirds of the supply in urban locations. Policies that aim to increase the supply of generalist dentists who choose to work in rural locations might help reduce rural-urban disparities in oral health care access and outcomes.

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FUNDING

This project was supported by the Health Resources and Services Administration (HRSA) of the U.S. Department of Health and Human Services (HHS) under grant number HRSA U1CRH03712, Rural Health Research Grant Program Cooperative Agreement to the WWAMI Rural Health Research Center at the University of Washington. This study was 100% funded from governmental sources. This information or content and conclusions are those of the author and should not be construed as the official position or policy of, nor should any endorsements be inferred by HRSA, HHS or the U.S. Government.

SUGGESTED CITATION

Doescher M, Keppel G. *Dentist Supply, Dental Care Utilization, and Oral Health Among Rural and Urban U.S. Residents.* Final Report #135, Seattle, WA: WWAMI Rural Health Research Center, University of Washington, 2015.

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