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Abstract

Objectives: Prior studies document increased numbers of nontraumatic dental condition (NTDC) visits to U.S. emergency departments (EDs). However, the influence of travel distance on ED use for NTDCs, particularly for Medicaid enrollees has hitherto received little attention. The authors examined the effect of travel distance on Wisconsin Medicaid enrollees' NTDC visits to EDs after adjustment for covariates.

Methods: NTDC-related visits claims data for Wisconsin Medicaid (2001-2009) was analyzed. For each enrollee, travel distance to the nearest of 130 EDs in Wisconsin was determined. The number of NTDC visits per person-year was aggregated by ZIP+4 of residence. Negative binomial regression adjusting for the expected number of visits based on race, sex, age of the residents and calendar year was used to evaluate the effect of travel distance, urbanicity, and dentist-population ratio on rate of visits.

Results: Enrollees residing in rural counties, entire dental health professional shortage areas, areas with dentist population ratios >20,000: 1 and non-Hispanic Whites travelled the furthest, compared to nearest mean ED distance of 2.9 miles. Enrollees residing 3 miles away or further had significantly lower rates of NTDC visits to EDs.

Conclusions: This study demonstrates that distance is a barrier to making NTDC-related visits to EDs. Rates of NTDC visits decreased as travel distance to the nearest ED increased for Medicaid enrollees.

Introduction

The United States health care system permits and provides for the location of primary, secondary, and tertiary healthcare facilities in almost every community to ensure that the receipt of quality and

appropriate health services is within acceptable travel distances by patients. These healthcare facilities provide medical and dental services. However, there have been increasing reports about people visiting hospital emergency departments (EDs) for care of nontraumatic dental conditions (NTDCs). As most hospital EDs can only provide temporary care for NTDCs, this phenomenon can be considered inappropriate, and is of public health concern.

A few studies have suggested that travel distances are an important predictor of the use of health care services.¹⁻⁴ In addition, while prior literature has documented the different characteristics associated with ED use for NTDCs, not much has been done regarding the influence of travel distances on the use of EDs for NTDCs at either the state or national levels. Furthermore, policymakers continue to work on different strategies to reduce the high costs incurred from the use of emergency departments (EDs) for chronic disease care, but little has been done to address the gap in knowledge related to travel distances and ED use for dental care. In their work, Blank and colleagues have suggested that improved geographic access to care is required to minimize program and policy challenges and to balance health care resource allocation with quality.⁵

At the national level, visits to EDs for nontraumatic dental conditions increased at an annual rate of 4 percent from 1997 to 2007.⁶ In Wisconsin, from 2001 to 2005, the rate of NTDC visits to EDs increased by 43 percent among Medicaid enrollees.⁷ These trends have significant cost and program implications to the health care system. In addition, studies have documented that Medicaid enrollees, adults 19-33 years old and uninsured patients are more likely to use emergency departments for nontraumatic dental condition (NTDC) visits.⁶⁻⁹ This information increases the list of conditions for which oral health disparities persist and for which data-driven practices will be required to eliminate or reduce disparities in access to dental care.

Geographic access to dental care and prevention of oral disease remain major policy and program challenges to all stakeholders. A report published by the Department of Health in London, United Kingdom documents that the physical location of health services is key to tackling health disparities especially in underserved communities.¹⁰ However, the extent to which the physical location of emergency

departments affects their use for services like NTDCs has not hitherto been investigated. Examining the travel distance covered by Medicaid enrollees to EDs for NTDC-related visits is one way to address this issue. Emergency departments are an integral part of the health system and are generally located within reasonable travel distances to various communities. As patients are required to travel to EDs to be seen by health or dental care providers, it is important to assess the influence of the distance of the ED facility from a patient's place of residence. This study examined the effect of travel distance to the nearest ED on Wisconsin Medicaid enrollees' NTDC visits to EDs after adjustment for covariates.

Methods

This study used claims data extracted from the Wisconsin Medicaid Evaluation and Decision Support (MEDS) database for 2001 to 2009 managed by the Division of Health Care Financing at the Wisconsin Department of Health Services. All claims data for NTDC visits to EDs, claims for service encounters submitted by ED hospitals, and data defining periods of enrollment (either in a fee-for-service program or through a managed care organization) for the entire Wisconsin Medicaid population were obtained. Medicaid eligibility periods were available with exact start and stop dates for each patient, so person-level lengths of eligibility was calculated with a precision of 1 day. As in previous studies, we defined nontraumatic dental condition (NTDC) visits based on the ICD-9-CM code supplied for the primary diagnosis.⁶⁻⁹ Claims associated with emergency department visits were identified through internal revenue codes used within the MEDS database.

Demographic and geographic-level variables

The study population consisted of children and adult enrollees (classified as 2 years old or younger, 3-7 years, 8-17 years, 18-39 years, 40-59 years, and 60 years and older). Additional demographic information linked to each proxy ID included sex, race/ethnicity (reported as Caucasian, Black, Hispanic, American Indian/Alaskan Native, Asian, Other Race/Ethnicity, or not reported), and ZIP+4 code of residence. Based on the ZIP code of residence, we constructed two

county-level classification variables for each enrollee, the 2003 Urban Influence Codes (UIC: metropolitan, micropolitan, or noncore/rural), and population to dentist full time equivalent (FTE) ratio (3,000:1 to 3,999:1, 4,000:1 to 7,999:1, 8,000:1 to 19,999:1, and $\geq 20,000:1$). UICs, which are computed by the U.S. Department of Agriculture based on commuting and census data, were used as a measure of rurality for each county.¹¹ The dentist FTE ratio (which is used in designating Dental Health Professional Shortage Areas) represents a population to provider ratio, comparing the size of the low-income population to the number of FTE dentists submitting Medicaid claims in 2007.¹² It is important to note that no counties in Wisconsin met the minimum federal recommendation of a 3,000:1 ratio or lower, while 69 out of 72 counties had ratios surpassing the federal threshold for designating a dental shortage area ($\geq 4,000:1$).

Distance calculation

A list of all EDs in Wisconsin as of November 20, 2013 was obtained from emergency room Express (www.erexpress.com) as a list of hospitals with street addresses. ED addresses and Medicaid enrollee's ZIP+4 codes were geocoded using ESRI's ArcGIS Online geocoding service. Of the 231,196 unique ZIP+4 codes, 165 (0.07 percent) were unable to be geocoded. Distance from the Medicaid enrollee's location to the nearest ED was calculated using ESRI's ArcMap Network Analyst, version 10, and TomTom's 2007 Street Map, North America. 47 (0.02 percent) ZIP+4 codes could not be successfully networked to an ED facility. Zip Code Tabulation Area boundaries were obtained from the U.S. Census Bureau's TIGER/Line files.

Statistical analysis

Population characteristics were tabulated by category, the distribution of distances to the nearest ED were summarized using the median and first and third quartiles, and the observed rate of ED visits per person-year of Medicaid enrollment was calculated overall and by each patient subgroup. For the multivariable analysis, the numbers of NTDC visits were aggregated by each ZIP+4 of residence. In each year and for each group of enrollees with the same ZIP +4 of residence, we

calculated the travel distance to the nearest of the 130 EDs in Wisconsin, the observed number of NTDC visits and the expected number of NTDC visits based on race, sex, age, and calendar year of the group.

For the calculation of the expected number of visits, we first tabulated the number of visits and person-years of eligibility for each combination of sex, age rounded to the nearest integer, race, and calendar year, and calculated the observed rate for each combination. Then the expected number of visits for each person and each year was computed by multiplying the rate expected based on his or her age, sex, and race by the person-years of eligibility within that year. Finally, these expected values were summed over each ZIP+4 of residence over all Medicaid recipients and calendar years to obtain a zip-code specific expected number of ED visits for NTDC adjusted for the population makeup of the zip-code. Negative binomial regression was performed to estimate the effect of distance, urbanicity, and dentist-population ratio on the zip-code level rate of NTDC visits to EDs, adjusting for the expected number of visits via an offset.

Results

Study population characteristics are shown in Table 1. Almost one million (997,567) participants were enrolled in dental Medicaid for a total of over 4.5 million person-years during the study period. There were over eighty thousand visits to the emergency department for non-traumatic dental conditions. The rate of NTDC visits to EDs was 17.7 per 1,000 person years, the median distance to the nearest emergency department was 2.9 miles with an interquartile range was 1.6-7.0 miles. Majority of the participants were females (57 percent), non-Hispanic Whites (55 percent), and resided in a metropolitan area (72 percent), or partial dental health shortage area (50 percent). The rate of ED visits per 1,000 person-years was highest among females (21.2), non-Hispanic blacks (19.9), communities with dentist-population ratios of 8,000:1 to 19,999:1, metropolitan areas (18.4), and in partial dental health shortage areas (18.7). In general, the higher the median travelled distance to EDs for NTDC visits, the lower the ED visits per 1,000 person years. Examining the quartiles of the distance to the nearest emergency department indicated that patients

who lived <1.6 miles (Q1), had ED visits per 1,000 person years of 20.1; 1.6-2.9 miles (Q2), 20.2; 2.8-7.0 miles 16.8 (Q3); >7.0 miles (Q4), 13.2.

Table 2 shows the results for the multivariable negative binomial regression analysis adjusted for race/ethnicity, sex, age, and calendar year. Compared to enrollees living less than 0.5 miles from the nearest emergency department, those living 3 miles away or further had significantly lower rates of NTDC visits to emergency department. Urbanicity and dentist-population ratio were not significant predictors after adjusting for distance to emergency department. Figure 1 shows the estimated effect of travel distance to the nearest emergency department on the rate of NTDC visits visually. The rate ratio decreased significantly as the distance increased. Figure 2 is a map that depicts the mean distance a Wisconsin Medicaid enrollee with a non-traumatic dental condition would have to travel to reach the closest emergency department.

Discussion

This study analyzed Wisconsin Medicaid claims data from 2001 to 2009 to provide generalizable estimates for states with similar demographics and enrollment pools regarding distances travelled for nontraumatic dental condition visits to emergency departments (EDs). In this study, the median distance to the nearest ED was 2.9 miles and the interquartile range was 1.6-7.0 miles among Medicaid enrollees. Another study based on a nationally representative sample of all ED visits indicated that the average travel distance from a patient's residence to an ED was 6.8 miles and the nearest ED was an average of 3.9 miles away.¹³ Results from our study may suggest that Medicaid enrollees do not travel long distances to emergency departments for dental care. However, both studies clearly indicate the potential distances patients have to travel to EDs for care.

Previous research on travel distance to emergency departments indicate that geography is a key determinant of utilization of health services and access to care^{10,14} which have cost and program implications. In our study, the rates of NTDC visits decreased significantly as distance increased. Compared to enrollees living less than 0.5 miles from the nearest ED, those living 3 miles away or

further had significantly lower rates of NTDC visits to Wisconsin EDs. This result unfortunately reinforces already documented challenges faced by community dwellers who live far away from a regular source of care as well as the issue of mal-distribution or inadequate dental workforce.

Another interesting result was that Medicaid enrollees in rural counties, those in areas with a dentist population ratio of >20,000:1, and non-Hispanic Whites lived the furthest distance from EDs. Probst et al. reported that rural residents and racial and ethnic minorities are more likely to experience barriers to transportation and have longer commutes to receive medical and dental care.¹⁵⁻¹⁸ Our finding on residents of rural counties is fairly consistent with that of Probst et al. In addition, our results could be a reflection of the disproportionate burden of dental disease that exists in populations living further away from primary and emergency health care facilities. Notwithstanding the foregoing, it is important to recognize that the willingness of enrollees to seek care in emergency departments for nontraumatic dental conditions is influenced by a number of other factors such as the severity of the condition, the time when the condition occurs, whether the patient has a primary physician or dentist, and whether they have the required insurance.

In this study, Hispanics had the lowest rates of visits to the ED for NTDCs, even though 72.5 percent lived <2.9 miles from an ED, which was higher than any other ethnic group. Our results possibly indicate the significant barriers that Hispanics face in trying to obtain both medical and dental care, despite documented evidence that Hispanics have higher burden of dental and medical disease. Furthermore, in general, females had a 1.68 times higher rate of making visits to EDs for NTDCs than their male counterparts. This finding is not surprising considering that women are also more likely than men to visit a dentist for regular care.

In the regression analysis, enrollees who lived less than 1 mile from the nearest ED had significantly higher rates of NTDC visits to EDs compared to those living 3 miles away or further. In addition, it is worth mentioning that even in metropolitan areas where some enrollees lived as close as 3-5 miles from an ED, there was a noticeable drop in the rate of NTDC visits (data not included). While

this study did not include data on the distribution of Wisconsin Medicaid dental providers by urbanicity or rurality, it did examine the effect of dentist: population ratios and urbanization category. However, neither of these variables was significantly associated with rates of NTDC visits after adjustment for travel distance and individual factors such as race/ethnicity, sex, age, and calendar year.

Our results clearly expand the literature on inadequate access to dental care, reflect the population groups that are more likely to use the ED for NTDC visits and demonstrate that longer travel distances is a barrier for NTDC visits to EDs. Thus, this study reaffirms the need to allocate more resources towards the creation/expansion of dental care facilities to meet the needs of different communities. Also, it highlights a need to create opportunities for collaboration between dental schools and community health centers through their outreach programs to address issues related to distance and oral health disparities at local and state levels.

Limitations and conclusion

Our study has several limitations. The study includes only Medicaid patients in the State of Wisconsin. This limits our ability to generalize the results nationally and to non-Medicaid enrollees, as some differences may exist. Also, the effect of referrals from physicians and dental offices was not examined. This patient population underutilizes primary medical care, and is more likely to utilize emergency services than their out-of-pocket and private insurance counterparts. The home addresses used in this study were the "permanent residence" as reported by patients to Medicaid at the time of enrollment, and these may have changed at the time of visiting the ED. Also, it is possible that patients visited the ED from work, or another location, thereby changing the actual distance to the nearest ED. Furthermore, we were unable to identify the location of the ED that the patient actually visited – it is possible that an ED other than the nearest was selected. However, the distance to the nearest source of care is a commonly used measure of access to care as opposed to a patient's choice of source of care. Additionally, we did not have access to information about the transportation options available to the enrollees, such as car ownership or public transportation.

In conclusion, this study demonstrates that distance is a driver for NTDC visits to EDs. Rates of NTDC visits decrease as the travel distance to the nearest ED increases. Thus, proximity of patients to EDs in urban areas, and the larger distances in rural areas seem to explain the rural-urban differences in Wisconsin Medicaid enrollee visits to EDs for NTDCs. Therefore, oral health policies and community-based coordinated care programs could reduce NTDC visits to EDs particularly in communities where Medicaid enrollees reside closer to emergency departments.

Acknowledgments

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Table 1. Study Population Characteristics, NTDC Visits to ED per 1,000 Person-Years and Median Distance Travelled to ED

Variable	Participant (%)	Person-years	ED visits	ED visits per 1,000 person-years	Median distance to ED, miles	Q1 of distance to ED, miles	Q3 of distance to ED, miles
Overall	100	4,565,594	80,742	17.7	2.9	1.6	7.0
Urbanization category							
Metropolitan	72	3,315,407	60,968	18.4	2.6	1.6	4.9
Micropolitan	12	529,491	9,233	17.4	4.3	1.7	10.8
Noncore/rural	16	717,925	10,535	14.7	8.8	1.9	15.5
Dentist population ratio							
3,000:1 to 3,999:1	9	1,472,745	26,393	17.9	2.1	1.4	3.4
4,000:1 to 7,999:1	19	820,353	12,554	15.3	3.0	1.6	7.5
8,000:1 to 19,999:1	39	1,703,026	32,336	19.0	3.7	1.7	9.4
≥20,000:1	13	566,700	9,453	16.7	6.2	1.9	11.8
DHPSA designation							
Entire	15	702,000	12,638	18.0	6.2	1.8	13.4
Non-DHPSA	35	1,464,934	23,252	15.9	3.7	1.6	9.4
Partial	50	2,395,890	44,846	18.7	2.4	1.6	4.5
Sex							
Female	57	2,704,934	57,280	21.2	2.9	1.6	6.8
Male	42	1,860,660	23,462	12.6	3.0	1.6	7.2
Race/ethnicity							
Hispanic	10	431,218	4,763	11.0	2.0	1.4	3.5
Non-Hispanic Black	17	927,205	18,413	19.9	2.3	1.5	3.7
Non-Hispanic White	55	2,412,565	45,920	19.0	4.0	1.8	10.2
Other/unknown	17	794,606	11,646	14.7	2.7	1.6	5.9
Distance to nearest ED, quartile							
<1.6 miles (Q1)	25	1,166,325	23,415	20.1	1.0	0.7	1.3
1.6-2.9 miles (Q2)	25	1,188,700	24,007	20.2	2.1	1.9	2.5
2.9-7.0 miles (Q3)	25	1,145,318	19,258	16.8	4.4	3.5	5.5
>7.0 miles (Q4)	25	1,065,250	14,062	13.2	12.3	9.4	16.2

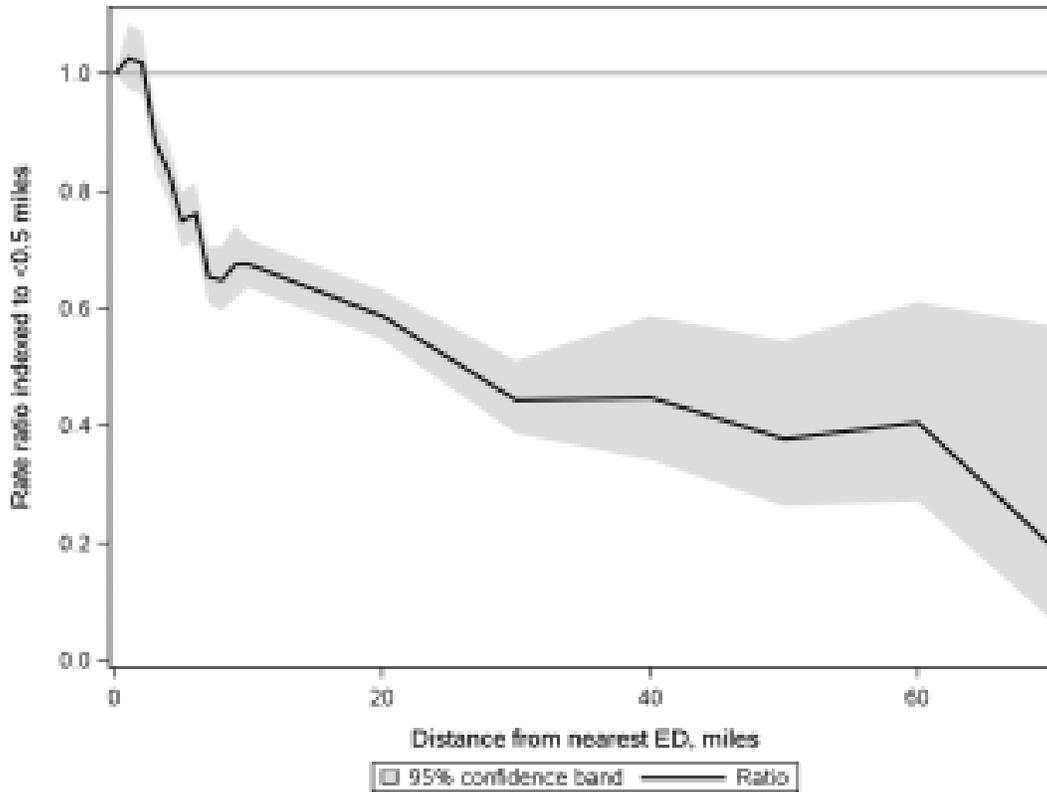


Figure 1. Represents the relationship between the effect of distance travelled to nearest ED on the rate of NTDC visits adjusted for race/ethnicity, sex, age, and calendar year.

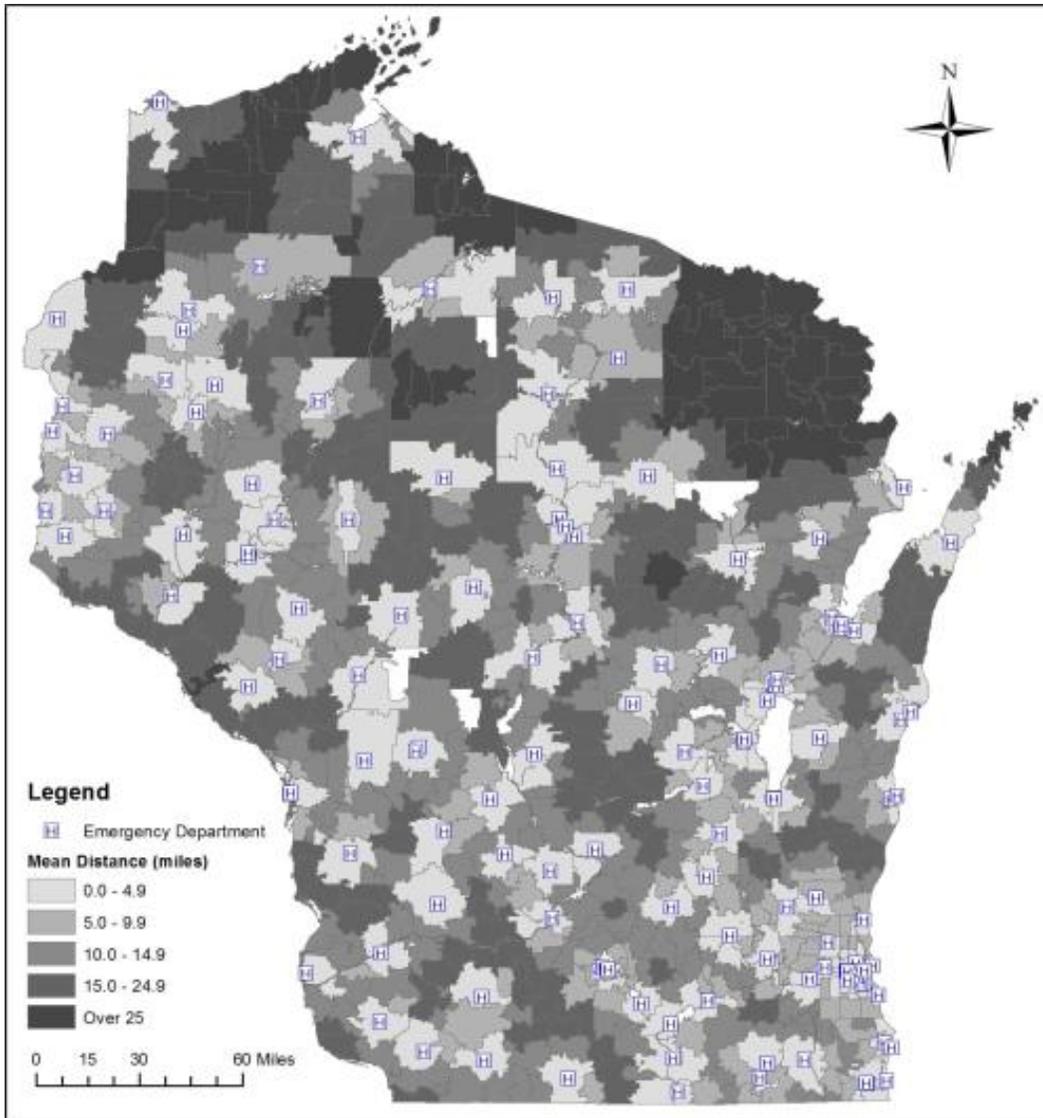


Figure 2. Mean distances to closest Wisconsin emergency department by zip code tabulation area. The map depicts the mean distance a Wisconsin Medicaid enrollee with an NTDC would have to travel to the closest ED. Means are presented by zip code tabulation area.

Table 2. The Effect of Distance on NTDC Visits to EDs: Results from Negative Binomial Regression Analysis Adjusted for the Expected Number of Visits Based on Race, Sex, Age, and Calendar Year

Effect	Rate ratio	Lower 95% CI limit	Upper 95% CI limit	P-value
Distance (mile)				
0	1.00			
1	1.03	0.97	1.08	0.320
2	1.02	0.97	1.07	0.502
3	0.88	0.84	0.93	<0.001
4	0.83	0.78	0.88	<0.001
5	0.75	0.70	0.80	<0.001
6	0.76	0.71	0.81	<0.001
7	0.66	0.61	0.71	<0.001
8	0.65	0.60	0.71	<0.001
9	0.68	0.62	0.74	<0.001
10	0.68	0.64	0.72	<0.001
20	0.59	0.55	0.63	<0.001
30	0.44	0.39	0.51	<0.001
40	0.45	0.34	0.59	<0.001
50	0.38	0.26	0.55	<0.001
60	0.41	0.27	0.61	<0.001
70	0.20	0.07	0.57	0.003
Dentist population ratio				
3,000:1 to 3,999:1	1.08	0.70	1.68	0.726
4,000:1 to 7,999:1	1.00			
8,000:1 to 19,999:1	1.10	0.89	1.36	0.397
≥20,000:1	1.06	0.83	1.34	0.647
Urbanization category				
Metropolitan	0.96	0.75	1.22	0.719
Micropolitan	1.00			
Noncore/rural	0.94	0.74	1.18	0.587