Density of pediatric dentists and preventive dental care utilization for Medicaid-enrolled children in Washington State

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Abstract

Density of pediatric dentists and preventive dental care utilization for Medicaid-enrolled children in Washington State

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Purpose: This study evaluates the relationship between pediatric dentist density and dental care use for Medicaid-enrolled children in Washington.

Methods: This is a cross-sectional analysis of 604,885 children ages 0-17 enrolled in Washington State Medicaid for 11 months or more in 2012. The relationship of pediatric dentist density, defined as the number of pediatric dentists per 10,000 Medicaid-enrolled children, and preventive dental care utilization by county was evaluated using linear regression models.

Results: In 2012, 179 pediatric dentists practiced in 16 of the 39 counties in Washington. County-level pediatric dentist density varied from zero to 5.98 pediatric dentists per 10,000 Medicaid-enrolled children. County-level preventive dental care utilization ranged from 32% to 81%, with 62% of Medicaid-enrolled children in

Washington receiving preventive dental services. After adjusting for confounders, county-level density was significantly associated with county-level dental care use (β =1.67, 95% CI = (0.02, 3.32), p=0.047).

Conclusions: There is a significant relationship between pediatric dentist density in a Washington State county and the proportion of Medicaid-enrolled children who receive preventive dental care services. Policies aimed at improving pediatric oral health disparities should include strategies to increase the number of pediatric dentists who practice in counties with large numbers of Medicaid-enrolled children.

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Chapter 1 : Introduction

1.1 Background

1.1.1 *Child Oral Health Disparities*

There are significant disparities in oral health care among children in the United States. Dental disease affects a disproportionate number of poor Americans. Economically disadvantaged children are a particularly vulnerable group[1]. 75% of dental disease among children ages 2 to 5 occurs in approximately 8% of the population. Poor oral health among children and adolescents affects school activity, home life, and general health, diminishing overall quality of life[2]. Untreated dental disease that extends from childhood into adulthood can affect growth, nutrition, economic productivity and have long-lasting negative psychological effects[3]. Despite efforts to increase dental coverage to poor children through expansion of Medicaid and the State Children's Health Insurance Program (SCHIP), 16% of eligible children remained uninsured[4]. These factors underscore the importance of identifying population-based strategies to reduce oral health disparities that affect vulnerable populations.

1.1.2 Dental Care Use

One way to improve oral health of children is to ensure adequate access to dental care services. An estimated 37% of Medicaid-enrolled children access any dental services in a year[5]. Fifteen percent of children in Medicaid report not receiving needed dental care because the dental provider refused to accept Medicaid[5]. Medicaid dental

utilization rates may be even lower among certain child subgroups, such as preschool-age children from low-income families[6].

1.1.3 *Role of Health Provider Density*

There are a number of policies aimed at reducing such disparities in dental care utilization by increasing the dental workforce in areas of high need. Traditionally, the basis for defining these areas has been the geographic density of all dentists among the total population[7]. This method of measurement, however, may not accurately estimate dental need among pediatric populations. As pediatric dentists receive additional training beyond general dentists that equip them to address the unique dental needs of underserved pediatric populations, the availability of pediatric dentists may be a better measure of resources available to low-income families with children. Currently, the lowest pediatric dentist-to-child ratios occur largely in rural states[8]. Recruitment and retention of dentists to these underserved communities remains difficult[9,10]. Pediatric dentists are most likely to practice in populated areas with higher numbers of general dentists and higher percentages of the adult population with a college degree[11]. This distribution of the pediatric dental workforce, however, does not reflect the distribution of dental need and use among underserved pediatric populations.

Government-funded programs aim to increase the dental workforce in areas of greater need to improve access, although there is no evidence that such efforts improve access to care for underserved pediatric patients. An increased pediatric dentist-to-child ratio may simply redistribute the existing patients who already have sufficient access. A study of pediatric dentist density and its association with dental care utilization will help bring to

light how pediatric dentists are improving access to care for underserved children, and provide evidence for policies and programs to improve the oral health of Medicaid-enrolled children

1.1.4 *Caries incidence and preventive dental services utilization*

Data from National Health and Nutrition Examination Survey (NHANES) shows an uneven distribution of the caries incidence among children and adolescents in the United States[12], presumably more concentrated among children from economically disadvantaged families. An investigation of the insurance status of Virginia schoolchildren as it relates to untreated dental caries revealed a significantly higher incidence of untreated decay among children with no dental insurance[13]. Rates of untreated decay in children generally reflect economic and racial disparities[14].

Other factors may contribute to the increase in caries incidence observed among children enrolled in public dental insurance programs. A retrospective analysis of Virginia kindergarteners found a significantly lower proportion of caries-free children among those enrolled in Medicaid compared to SCHIP[15]. In Virginia, SCHIP is administered by a private dental insurance company that reimburses dentists at rates comparable to those of other private insurances, whereas the Medicaid dental program has reimbursement rates that are 44-62% lower than the usual fees.

With rising rates of decay now being seen in children ages 2-5[14], the focus is shifting towards primary prevention and the dental home concept to stem the tide of early childhood caries. In a study by Savage et al, it was found that children in Medicaid who had an earlier first preventive dental visit had lower subsequent dental costs[16]. This

finding suggests that an earlier first preventive dental visit translates to a better likelihood of using preventive services in the future with fewer emergency and restorative dental treatments. A recent study revealed that between 12-49% of U.S. children enrolled in their state Medicaid program had any dental care visit in a year[17]. Low dental utilization rates may be even more pronounced among certain age groups, such as preschool-age children from low-income families. This was found to be the case in one study comparing dental service utilization among a group children based on Head Start enrollment status[6]. Further research is needed to identify factors that can improve the use of preventive dental services among children who suffer the greatest burden of disease.

Chapter 2 : Literature Review

2.1.1 *Dentist density and utilization*

Currently no studies have looked specifically at pediatric dentist density and its effect on utilization of preventive dental services among the Medicaid population. Early work by Groenewegen and Postma found that a small but significant increase in the demand for dental services among publically insured patients corresponding to an increase in the dentist density of the area in which they lived[18]. Several more recent studies have used Medicaid dental claims data for children and adolescents to examine the relationship between various aspects of dental care with general dentist density. One study in Alabama found that for Medicaid-enrolled children, availability of a Medicaid-accepting dentist in the county of residence was a significant predictor of receiving dental sealants, but did not distinguish between pediatric and general dentistry[19]. In other areas of the dental literature, the relationship of dental services utilization to provider density varies greatly. In Iowa, analysis of Medicaid enrollment and claims data indicated that oral exam by primary care dentist was a significant factor in utilization of orthodontic services by children and adolescents. While it was surprising to find that orthodontic services were more frequently used by Medicaid enrollees whose mean travel time to the orthodontist was greater, a sub-analysis found a high degree of variability in treatment rates across service areas, suggesting that for publically insured patients, provider availability may be a greater barrier to care than travel distance[20]. Unlike similar studies in France and Northern Ireland[21,22], no significant relationship between orthodontic provider density and utilization of orthodontic services among children was found in the

Iowa Medicaid population[20]. Low-income elderly are another vulnerable population whose use of dental services may be affected by dentist density. In France, one study revealed that density of dental providers is a significant factor in access to dental care for low-income elderly living at home[23]. A study of women of childbearing age in Ohio found no significant relationship between general dental provider ratio and dental services utilization. Likewise, caries incidence among young adults in Finland was unaffected by dentist density[24], which may signify that preventive or restorative dental services are not affected by provider availability.

2.1.2 Healthcare consumption and physician density

Provider density and its effect on healthcare service utilization have been investigated in the medical field. There is a general assumption that the supply and distribution of physicians in an area can induce demand for healthcare services, independent of the health status of the population. The concept of supplier-induced demand (SID) began in the 1960s, where a correlation was discovered between the density of hospital beds and rate of hospitalization. SID implies that physicians in highly saturated areas provide a higher rate of unnecessary care in order to survive the competitive market and is commonly blamed for the increasing cost of healthcare. Several alternative theories may explain the association between physician-to-population ratio and utilization, including market forces inducing lower prices that influence patient demand, a response to variations in health status across areas, and improvements in availability[25]. A meta-analysis of 25 studies found a consistent relationship between physician density and health care

consumption, but was not able to identify causal factors explaining this relationship[26].

There are several examples of physician density and its effect on demand for preventive healthcare services. A study of individuals from 6 counties in upstate New York found that the local supply of primary care physicians affects the probability of having a primary care physician, and in turn affects the utilization of healthcare services [27]. Among women of reproductive age in Pennsylvania, primary care physician density at the county level was found to be a strong predictor of having received the appropriate preventive screenings and vaccinations.

2.1.3 *Pediatric dentists and access to care*

Low pediatric dentist density may lead to lower utilization of preventive services in Medicaid-enrolled children, especially among those with difficult to manage behavior or special health care needs. A number of government- and locally-funded programs are aimed at increasing the pediatric dental workforce in areas of greater need to improve access, although there is no evidence that such efforts actually increase utilization of preventive dental services. An increased pediatric dentist-to-child ratio may simply redistribute the existing patients who already have sufficient access. More evidence is required to help support programs and policies aimed and increasing the number of pediatric dentists in rural areas.

Analysis of Medicaid claims data has been an effective tool in evaluating various aspects of pediatric dental care in a state[6,17,28–31]. Comparing Medicaid utilization rates at the county-level based on factors such as number of pediatric dentists per capita may help to

answer the question of how pediatric dentists are affecting access to dental care for economically disadvantaged children.

Chapter 3 : Methods

3.1 Objective and Hypothesis

3.1.1 Objective

This study evaluates the relationship between the pediatric dentist-to-child ratio and preventive dental care use among Medicaid-enrolled children through a cross-sectional, secondary data analysis of Medicaid claims data. In doing so, this analysis may help clarify the role of pediatric dental workforce distribution in improving geographic disparities in access to dental care. A positive association between provider density and preventive services utilization supports current and developing pediatric dental workforce programs and initiatives such as federal public health and training grants and state-funded rural dental health education programs. Alternatively, a null effect may suggest the need to redirect resources in favor of new fronts in oral health care access and utilization.

This analysis will involve pediatric dental utilization in the State of Washington for the year 2012.

3.1.2 Hypotheses

Our hypothesis is that in Medicaid-enrolled children living in a county with a higher pediatric dentist-to-child ratio are more likely to receive preventive dental services within any given year of continuous enrollment. Specifically, this study will test the following relationship:

- In Washington State, county-level pediatric dentist density is positively associated with county-level dental care use among Medicaid-enrolled children.

This study is not designed to detect a causal relationship between pediatric dentist density and preventive dental services utilization. Nonetheless, a rejection of the null hypothesis strengthens the notion that increasing the number of pediatric dentists in underserved communities can help children better access preventive dental care.

3.2 Study design

3.2.1 Design overview

This study is a cross-sectional, secondary data analysis of Medicaid claims data requested from the Washington State Department of Social and Health Services (DSHS). The analysis also uses county-level data from various public sources collected by the Health Resource and Services Administration and the U.S. Census Bureau, and Washington State Academy of Pediatric Dentists.

3.2.2 Conceptual Framework

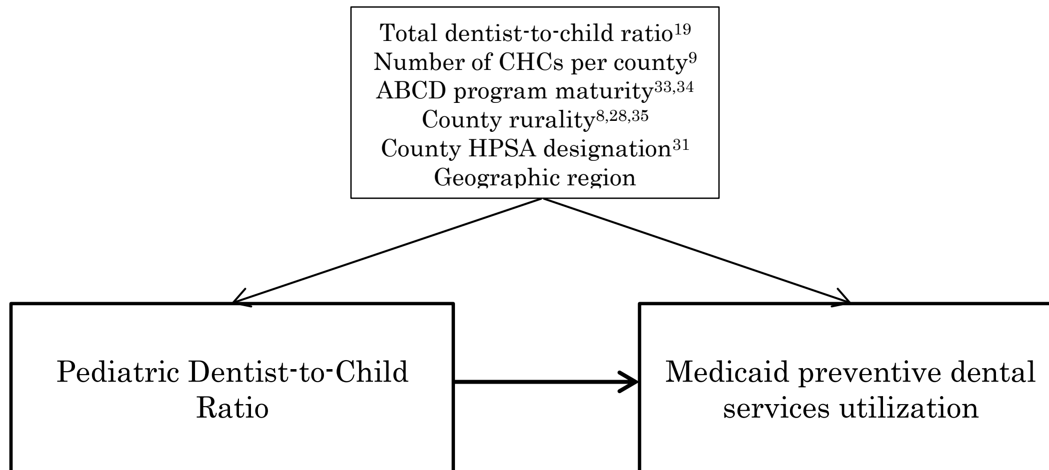

Figure 1. *Conceptual model of the relationship between pediatric dentist-to-child ratio and preventive services in a Medicaid population*

The study hypothesis is illustrated by the following conceptual framework (Figure 1). Several factors relating to both the use of preventive dental services among children with Medicaid and pediatric dental provider density were identified through literature review. These factors were also included in the framework as potential confounders in observing the true effect of the pediatric dentist-to-child ratio on preventive services use. This framework serves as a model for both data collection and analysis.

3.2.3 Study Population

The study population includes all individuals ages 0-17 years (hereto forward referred as "children") continuously enrolled in the Medicaid program in 2012, as recorded by the Washington State Department of Social and Health Services (DSHS). Continuous

enrollment is defined as at least 11 months of enrollment out of the calendar year. Continuous enrollment does not include children born in 2012 whose length of enrollment was less than 11 months.

3.3 Data

3.3.1 Washington State Medicaid Data

A dataset including all children enrolled in the Medicaid program, associated dental claims and dental provider details for the year 2012 was obtained from the Washington State DSHS Research & Data Analysis Division's Integrated Client Database (ICDB). DSHS follows strict confidentiality standards, ensuring that information from ICDB protect personal client information. The Washington State institutional review board (IRB) reviewed and approved this study protocol prior to start of the study. (FWA00000326)

The ICDB dataset included three separate data files corresponding to child demographic data, provider data, and claims data. Each child and dental provider was assigned a unique identifier. The child demographic and claims files were then merged into a single database, using the child unique identifier as the linking variable.

Table 1 summarizes the list of variables collected from Washington State DSHS to be used for analysis in the study.

Table 1. Medicaid Variables

Demographic Data:	Provider Data:
Child Number	Provider Number
Number of Months Enrolled in Medicaid	Provider Type
Date of Birth	Specialty Type
Gender	Start Date in Medicaid
Race	End Date in Medicaid
City	Is Dental Provider a Primary Care
County	DDS
Medicaid Eligibility Category	Dentist Type
	Dentist Birth Date
Claims Data:	Dentist Name
Child Number	Address
Current Dental Terminology (CDT) Code	City
Provider Number	Zip Code
Date of Service	County

3.3.2 Area Health Resource File/US Census Bureau

Specific county-level variables were obtained from the 2012-13 Area Health Resource File, distributed by the U.S. Department of Health and Human Services Health Resource and Services Administration. This database is a collection of county-level health data assembled annually from more than 50 sources. Not all variables in the 2012-13 AHRF are reported by age. In some cases, these data were collected from the U.S. Census Bureau. The following variables, identified in the literature review as potential confounders, were extracted from the 2012-13 AHRF and the U.S. Census Bureau online database for each of the 39 counties in Washington State (Table 2).

Table 2. County-level variables

Variable	Source
Total Population, 2010	2012-13 AHRF
Total number of children (<18 years), 2010	2010 U.S. Census
Percent children	2012-13 AHRF
Total number of active dentists, 2010	2012-13 AHRF
Total number of pediatric dentists, 2010	2012-13 AHRF
Number of Federally Qualified Health Care Centers, 2011	2012-13 AHRF
Age of ABCD program	WSAPD
East vs. west region	State elevation map

3.3.3 AAPD Provider Directory/WSAPD Database

Historical information on pediatric dentists practicing in Washington State from 2012 was obtained from the Washington State Academy of Pediatric Dentistry (WSAPD). The WSAPD membership database is generated each year. Providers in this database include dentists who are members of the WSAPD, dentists living in the state who are members of the American Academy of Pediatric Dentists (AAPD) but who are not current members of WSAPD, Washington State pediatric dentistry residents, and retired pediatric dentists living in Washington State.

For the purposes of this study, residents, retired dentists, providers living outside the state of Washington, and all providers who are not pediatric dentists were excluded.

Next, steps were taken to verify the pediatric dentist specialty status and practice location for each year of the database. First, specialty status was verified by pediatric dentist status as reported in the AAPD national membership directory. Non-AAPD member dentists living in Washington State were verified by searching practice websites, the Washington State Department of Health provider registry and National Provider Identification (NPI) registry. The AAPD Membership Directory and practice websites were used to verify practice location in similar fashion.

3.4 Variable Definitions

3.4.1 Independent Variable

The main predictor of the study was county-level pediatric dentist density, defined as the number of pediatric dentists per 10,000 Medicaid-enrolled children in a county.

3.4.2 Outcome variable

The outcome of interest was the county-level proportion of Medicaid-enrolled children in a county receiving any preventive dental services utilization at the county level. The definition of a preventive dental service is based on the previous dental utilization studies such as that of Chi et al[32], and uses Current Dental Terminology (CDT) codes, as reported in the DSHS Claims File (Table 3). At the county level, the proportion of children receiving any preventive dental service will be calculated from the individual-level outcome measure described above.

Table 3. Preventive Dental Services Definition

CDT 2011-2012 Code	Service Description
D0120	periodic oral evaluation – established patient
D0150	comprehensive oral evaluation – new or established patient
D1110	prophylaxis – adult
D1120	prophylaxis – child
D1206	topical fluoride varnish; therapeutic application for moderate to high caries risk patients
D1208	topical application of fluoride
D1351	sealant – per tooth

3.4.3 Potential confounders:

Following literature review, four variables were identified as potential confounders in observing the relationship between pediatric dentist density and preventive dental care use. These included total dentist-to-child ratio; county rurality as defined by its Rural Urban Continuum Code; number of community health centers in a county; and the county HPSA status. Further analysis of the unique characteristics of Washington State identified two additional potential confounders: the age of Washington's Access to Baby and Child Dentistry (ABCD) program in the county, and county regionality, defined as whether the majority of the county population resides east or west of the Cascades mountain range.

3.5 Statistical analysis

Descriptive statistics (means, standard deviations, counts, and percentages) were calculated for all variables of interest, including age, race, and gender of children

continuously enrolled in Medicaid in 2012. Unadjusted linear regression was used to assess the association between the primary predictor variable (pediatric dentist density), the outcome variable (preventive dental care use), and each of the theoretic confounders to determine if they were statistical confounders. All identified statistical confounders were tested for multicollinearity by measuring variance inflation factor values. Unadjusted and adjusted linear regression models were performed to test the association between the primary predictor variable (pediatric dentist density) and the outcome variable (preventive dental care use). All data were analyzed with Stata 13 for Windows (StataCorp LP, College Station, Texas).

Chapter 4 : Results

4.1 Study population

There were a total of 899,089 children who received services funded through the Washington State Medicaid program in 2012. Of those individuals, 981 lived outside of Washington State. An additional 103,991 children were did not meet the age selection criteria of age less than 18 years by the last day of 2012. From the remaining 794,117 children, 189,231 were enrolled in Medicaid for fewer than 11 months out of the year. The resulting 604,885 children made up the study population of individuals between ages 0 to 17 years who were enrolled in Medicaid for at least 11 months out of the year 2012 (Figure 2).

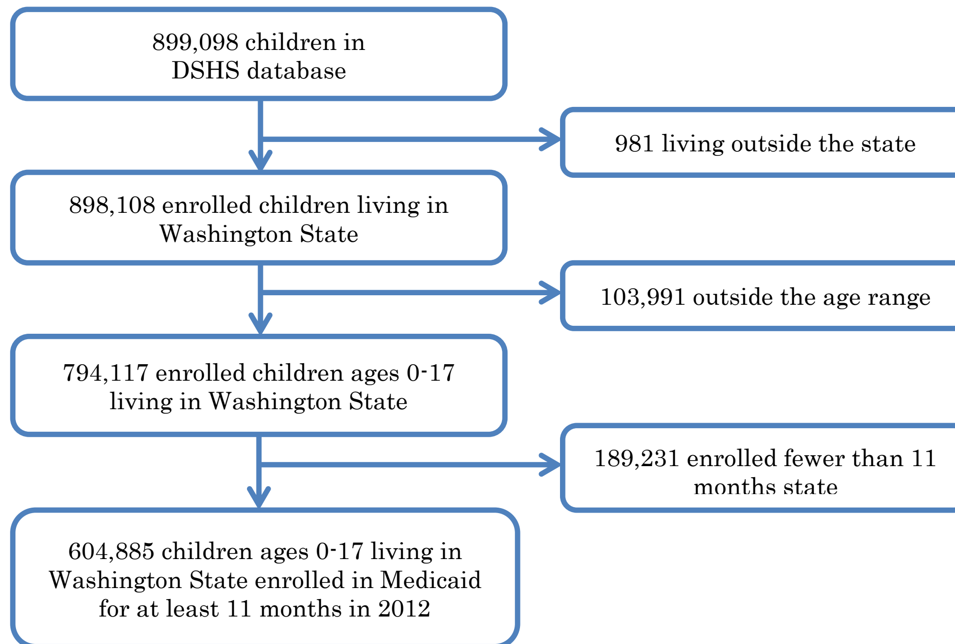

Figure 2. Flowchart of inclusion process for determining the study population

4.2 Descriptive Statistics

Demographic information for the study population by county and for the entire state is summarized in Table 4, Table 5, and Table 6. Of the 604,885 Medicaid-enrolled children in Washington State, nearly half (49.2%) lived in King, Pierce, Snohomish or Yakima Counties. Sixty-six percent of the population lived in western Washington counties, with 34% living in eastern Washington. Average age of the study population was 8.8 years, with a median of 8.5 years. Distribution of age was positively skewed, with the highest enrollment among 5-year-olds (Figure 3). Most of the study population was White (41.6%), with the next largest component consisting of "Other Race", at 25.5%.

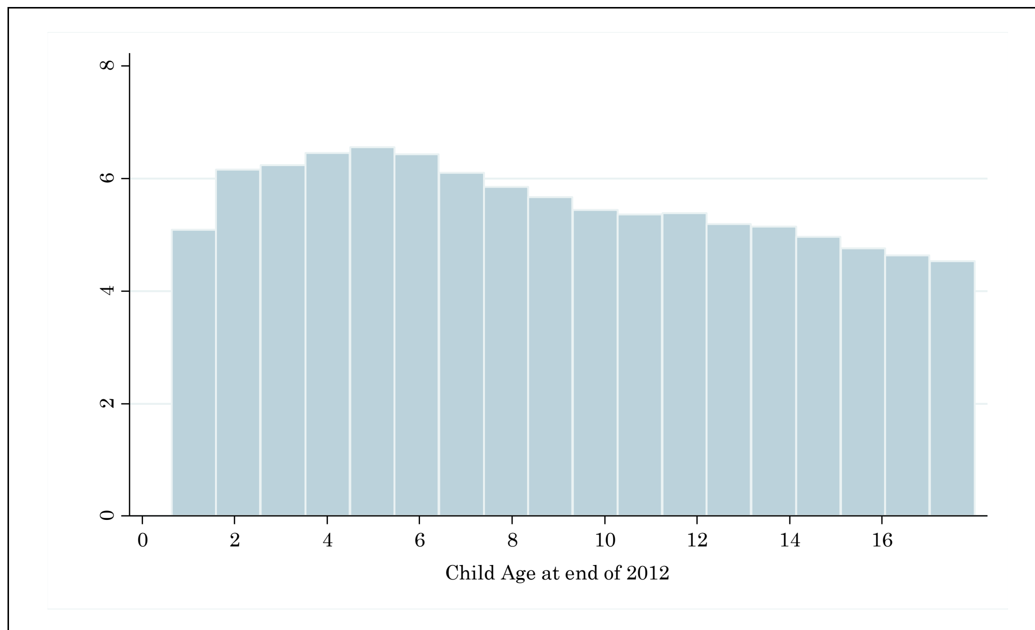

Figure 3. Distribution of age among Medicaid-enrolled children in Washington State, 2012

4.3 Preventive dental care use

Utilization of preventive dental care services among the 604,885 Medicaid-enrolled children in the study population varied widely across counties in Washington State in 2012, ranging from a low of 31.9% in Clallam County to a high of 80.8% in Chelan County. Average county preventive dental care utilization was 59.4%. Statewide preventive dental care use among the study population was 62.2% (Table 7).

4.3.1 Geospatial patterns of utilization

Preventive dental care use was notably lower among coastal counties of Western Washington. All four of the state's counties bordering the Pacific coast – Clallam, Jefferson, Pacific and Grays Harbor – were among the five Washington State counties with the lowest preventive dental care utilization.

Dividing the state along the Cascades mountain range reveals a significant difference in preventive dental care utilization based on geographic region. Preventive dental services use among Medicaid-enrolled children in the Washington's 21 eastern counties is 70.6%, compared to 57.9% in among those living in western Washington counties. The top 12 counties with the highest percent preventive dental services use among the study population were all in eastern Washington (Table 7).

Table 4. Age of Children enrolled in Medicaid for at least 11 months in 2012, by County

County	Total enrolled 11+ months in 2012	Age (%)			
		<3 years	3-5 years	6-11 years	12-17 years
Adams	5,172	801 (15.5)	1,119 (21.6)	1,847 (35.7)	1,405 (27.2)
Asotin	2,001	270 (13.5)	358 (17.9)	731 (36.5)	642 (32.1)
Benton	20,419	2,920 (14.3)	4,202 (20.6)	7,323 (35.9)	5,974 (29.3)
Chelan	10,431	1,417 (13.6)	2,147 (20.6)	3,672 (35.2)	3,195 (30.6)
Clallam	6,022	842 (14.0)	1,174 (19.5)	2,072 (34.4)	1,934 (32.1)
Clark	41,245	5,421 (13.1)	7,971 (19.3)	14,809 (35.9)	13,044 (31.6)
Columbia	392	46 (11.7)	60 (15.3)	139 (35.5)	147 (37.5)
Cowlitz	11,672	1,609 (13.8)	2,282 (19.6)	4,197 (36.0)	3,584 (30.7)
Douglas	5,092	705 (13.8)	1,040 (20.4)	1,754 (34.4)	1,593 (31.3)
Ferry	763	91 (11.9)	153 (20.1)	267 (35.0)	252 (33.0)
Franklin	16,918	2,355 (13.9)	3,539 (20.9)	6,215 (36.7)	4,809 (28.4)
Garfield	186	22 (11.8)	31 (16.7)	61 (32.8)	72 (38.7)
Grant	16,795	2,408 (14.3)	3,398 (20.2)	6,005 (35.8)	4,984 (29.7)
Grays Harbor	8,103	1,097 (13.5)	1,589 (19.6)	2,859 (35.3)	2,558 (31.6)
Island	3,712	504 (13.6)	692 (18.6)	1,322 (35.6)	1,194 (32.2)
Jefferson	1,807	223 (12.3)	330 (18.3)	612 (33.9)	642 (35.5)
King	123,753	17,885 (14.5)	25,341 (20.5)	43,167 (34.9)	37,360 (30.2)
Kitsap	15,101	2,104 (13.9)	3,013 (20.0)	5,381 (35.6)	4,603 (30.5)
Kittitas	2,912	425 (14.6)	616 (21.2)	1,046 (35.9)	825 (28.3)
Klickitat	2,042	230 (11.3)	335 (16.4)	762 (37.3)	715 (35.0)
Lewis	9,118	1,260 (13.8)	1,745 (19.1)	3,194 (35.0)	2,919 (32.0)
Lincoln	899	106 (11.8)	159 (17.7)	302 (33.6)	332 (36.9)
Mason	5,914	857 (14.5)	1,142 (19.3)	2,100 (35.5)	1,815 (30.7)
Okanogan	6,293	898 (14.3)	1,267 (20.1)	2,238 (35.6)	1,890 (30.0)
Pacific	1,867	269 (14.4)	357 (19.1)	643 (34.4)	598 (32.0)
Pend Oreille	1,348	142 (10.5)	245 (18.2)	464 (34.4)	497 (36.9)
Pierce	71,142	10,000 (14.1)	14,361 (20.2)	25,325 (35.6)	21,456 (30.2)
San Juan	782	104 (13.3)	154 (19.7)	273 (34.9)	251 (32.1)
Skagit	13,310	1,778 (13.4)	2,674 (20.1)	4,812 (36.2)	4,046 (30.4)
Skamania	877	105 (12.0)	157 (17.9)	301 (34.3)	314 (35.8)
Snohomish	52,444	7,372 (14.1)	10,825 (20.6)	18,596 (35.5)	15,651 (29.8)
Spokane	48,548	6,871 (14.2)	9,928 (20.4)	17,236 (35.5)	14,513 (29.9)
Stevens	4,827	555 (11.5)	870 (18.0)	1,720 (35.6)	1,682 (34.8)
Thurston	17,854	2,491 (14.0)	3,566 (20.0)	6,247 (35.0)	5,550 (31.1)
Wahkiakum	311	41 (13.2)	54 (17.4)	101 (32.5)	115 (37.0)
Walla Walla	6,228	815 (13.1)	1,179 (18.9)	2,332 (37.4)	1,902 (30.5)
Whatcom	15,924	2,281 (14.3)	3,102 (19.5)	5,534 (34.8)	5,007 (31.4)
Whitman	2,021	343 (17.0)	456 (22.6)	681 (33.7)	541 (26.8)
Yakima	50,640	6,841 (13.5)	10,280 (20.3)	18,229 (36.0)	15,290 (30.2)
State Total	604,885	84,504 (14.0)	121,911 (20.2)	214,569 (35.5)	183,901 (30.4)

Table 5. Gender of Children enrolled in Medicaid for at least 11 months in 2012, by County

County	Total enrolled 11+ months in 2012	Sex (%)	
		Female	Male
Adams	5,172	2,537 (49.1)	2,635 (50.9)
Asotin	2,001	980 (49.0)	1,021 (51.0)
Benton	20,419	10,014 (49.0)	10,405 (51.0)
Chelan	10,431	5,071 (48.6)	5,360 (51.4)
Clallam	6,022	2,956 (49.1)	3,066 (50.9)
Clark	41,245	19,983 (48.4)	21,262 (51.6)
Columbia	392	187 (47.7)	205 (52.3)
Cowlitz	11,672	5,787 (49.6)	5,885 (50.4)
Douglas	5,092	2,502 (49.1)	2,590 (50.9)
Ferry	763	379 (49.7)	384 (50.3)
Franklin	16,918	8,267 (48.9)	8,651 (51.1)
Garfield	186	93 (50.0)	93 (50.0)
Grant	16,795	8,314 (49.5)	8,481 (50.5)
Grays Harbor	8,103	4,009 (49.5)	4,094 (50.5)
Island	3,712	1,815 (48.9)	1,897 (51.1)
Jefferson	1,807	886 (49.0)	921 (51.0)
King	123,753	60,439 (48.8)	63,310 (51.2)
Kitsap	15,101	7,349 (48.7)	7,752 (51.3)
Kittitas	2,912	1,433 (49.2)	1,479 (50.8)
Klickitat	2,042	982 (48.1)	1,060 (51.9)
Lewis	9,118	4,434 (48.6)	4,684 (51.4)
Lincoln	899	459 (51.1)	440 (48.9)
Mason	5,914	2,930 (49.5)	2,984 (50.5)
Okanogan	6,293	3,108 (49.4)	3,185 (50.6)
Pacific	1,867	905 (48.5)	962 (51.5)
Pend Oreille	1,348	634 (47.0)	714 (53.0)
Pierce	71,142	34,815 (48.9)	36,326 (51.1)
San Juan	782	391 (50.0)	391 (50.0)
Skagit	13,310	6,637 (49.9)	6,673 (50.1)
Skamania	877	451 (51.4)	426 (48.6)
Snohomish	52,444	25,788 (49.2)	26,655 (50.8)
Spokane	48,548	23,450 (48.3)	25,098 (51.7)
Stevens	4,827	2,358 (48.9)	2,469 (51.1)
Thurston	17,854	8,665 (48.5)	9,188 (51.5)
Wahkiakum	311	152 (48.9)	159 (51.1)
Walla Walla	6,228	3,124 (50.2)	3,103 (49.8)
Whatcom	15,924	7,842 (49.2)	8,082 (50.8)
Whitman	2,021	962 (47.6)	1,059 (52.4)
Yakima	50,640	24,778 (48.9)	25,861 (51.1)
State Total	604,885	295,866 (48.9)	309,010 (51.1)

Table 6. Race of Children enrolled in Medicaid for at least 11 months in 2012, by County

County	Race/Ethnicity (%)						
	White	Black or African American	Asian	Alaska Nat. or Nat. Am.	Nat. Hawaiian or Pac. Isl.	Not Provided	Other
Adams	1,777(34.4)	6(0.1)	12(0.2)	5(0.1)	8(0.2)	342(6.6)	3,022(58.4)
Asotin	1,623(81.1)	22(1.1)	19(0.9)	54(2.7)	8(0.4)	168(8.4)	107(5.3)
Benton	7,231(35.4)	256(1.3)	201(1.0)	85(0.4)	158(0.8)	4,235(20.7)	8,252(40.4)
Chelan	3,049(29.2)	20(0.2)	31(0.3)	57(0.5)	29(0.3)	1,487(14.3)	5,758(55.2)
Clallam	3,743(62.2)	41(0.7)	27(0.4)	816(13.6)	29(0.5)	917(15.2)	449(7.5)
Clark	24,120(58.5)	987(2.4)	650(1.6)	278(0.7)	650(1.6)	9,404(22.8)	5,156(12.5)
Columbia	281(71.7)	4(1.0)	1(0.3)	0(0.0)	2(0.5)	54(13.8)	50(12.8)
Cowlitz	7,488(64.2)	66(0.6)	92(0.8)	259(2.2)	46(0.4)	2,379(20.4)	1,342(11.5)
Douglas	1,589(31.2)	11(0.2)	18(0.4)	42(0.8)	20(0.4)	701(13.8)	2,711(53.2)
Ferry	396(51.9)	4(0.5)	2(0.3)	246(32.2)	1(0.1)	84(11.0)	30(3.9)
Franklin	2,479(14.7)	163(1.0)	103(0.6)	42(0.2)	155(0.9)	3,277(19.4)	10,699(63.2)
Garfield	127(68.3)	2(1.1)	2(1.1)	4(2.2)	1(0.5)	35(18.8)	15(8.1)
Grant	5,592(33.3)	108(0.6)	42(0.3)	123(0.7)	37(0.2)	1,550(9.2)	9,343(55.6)
Grays Harbor	4,722(58.3)	63(0.8)	57(0.7)	653(8.1)	31(0.4)	1,476(18.2)	1,101(13.6)
Island	2,169(58.4)	127(3.4)	23(0.6)	54(1.5)	104(2.8)	911(24.5)	324(8.7)
Jefferson	1,347(74.5)	17(0.9)	13(0.7)	34(1.9)	25(1.4)	280(15.5)	91(5.0)
King	29,575(23.9)	17,084(13.8)	8,607(7.0)	1,593(1.3)	4,563(3.7)	32,649(26.4)	29,681(24.0)
Kitsap	8,721(57.8)	625(4.1)	177(1.2)	686(4.5)	600(4.0)	3,178(21.0)	1,114(7.4)
Kittitas	1,643(56.4)	22(0.8)	26(0.9)	25(0.9)	26(0.9)	551(18.9)	619(21.3)
Klickitat	1,180(57.8)	6(0.3)	13(0.6)	101(4.9)	9(0.4)	302(14.8)	431(21.1)
Lewis	5,577(61.2)	36(0.4)	26(0.3)	105(1.2)	27(0.3)	2,203(24.2)	1,144(12.5)
Lincoln	691(76.9)	3(0.3)	3(0.3)	20(2.2)	3(0.3)	127(14.1)	52(5.8)
Mason	3,265(55.2)	23(0.4)	23(0.4)	304(5.1)	39(0.7)	1,247(21.1)	1,013(17.1)
Okanogan	2,480(39.4)	18(0.3)	11(0.2)	791(12.6)	10(0.2)	754(12.0)	2,229(35.4)
Pacific	1,046(56.0)	6(0.3)	36(1.9)	49(2.6)	3(0.2)	307(16.4)	420(22.5)
Pend Oreille	1,106(82.0)	7(0.5)	2(0.1)	62(4.6)	1(0.1)	132(9.8)	38(2.8)
Pierce	29,669(41.7)	7,344(10.3)	2,398(3.4)	1,953(2.7)	2,440(3.4)	16,614(23.4)	10,723(15.1)
San Juan	462(59.1)	5(0.6)	2(0.3)	18(2.3)	3(0.4)	151(19.3)	141(18.0)
Skagit	5,287(39.7)	95(0.7)	71(0.5)	395(3.0)	77(0.6)	2,456(18.5)	4,929(37.0)
Skamania	579(66.0)	5(0.6)	0(0.0)	16(1.8)	1(0.1)	182(20.8)	94(10.7)
Snohomish	23,070(44.0)	1,706(3.3)	1,731(3.3)	1,222(2.3)	919(1.8)	13,218(25.2)	10,577(20.2)
Spokane	33,971(70.0)	1,301(2.7)	643(1.3)	1,570(3.2)	595(1.2)	7,435(15.3)	3,032(6.2)
Stevens	3,697(76.6)	32(0.7)	7(0.1)	388(8.0)	17(0.4)	560(11.6)	126(2.6)
Thurston	10,631(59.5)	531(3.0)	448(2.5)	466(2.6)	295(1.7)	3,492(19.6)	1,991(11.2)
Wahkiakum	214(68.8)	0(0.0)	0(0.0)	9(2.9)	1(0.3)	66(21.2)	21(6.8)
Walla Walla	2,579(41.4)	51(0.8)	22(0.4)	28(0.4)	60(1.0)	907(14.6)	2,580(41.4)
Whatcom	8,386(52.7)	155(1.0)	366(2.3)	1,315(8.3)	149(0.9)	2,609(16.4)	2,944(18.5)
Whitman	1,441(71.3)	39(1.9)	91(4.5)	30(1.5)	19(0.9)	243(12.0)	158(7.8)
Yakima	8,780(17.3)	243(0.5)	108(0.2)	1,890(3.7)	545(1.1)	7,069(14.0)	32,005(63.2)
State Total	251,783(41.6)	31,234(5.2)	16,104(2.7)	15,788(2.6)	11,706(1.9)	123,752(20.5)	154,512(25.5)

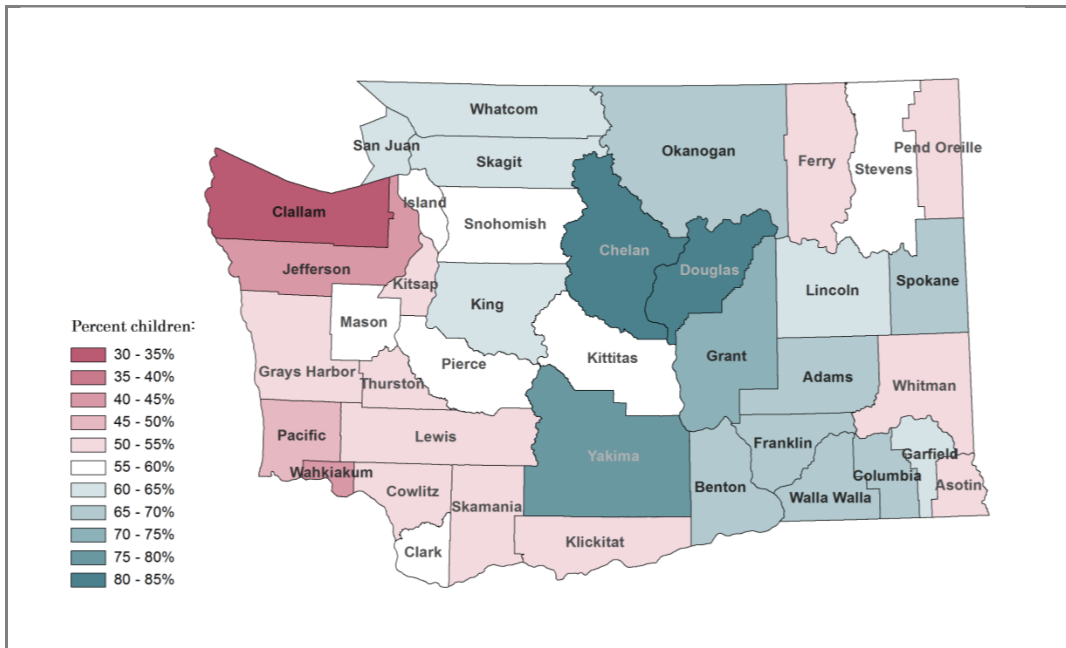

Figure 4. *Preventive Dental Care Utilization by Medicaid- enrolled Children in Washington State by County, 2012*

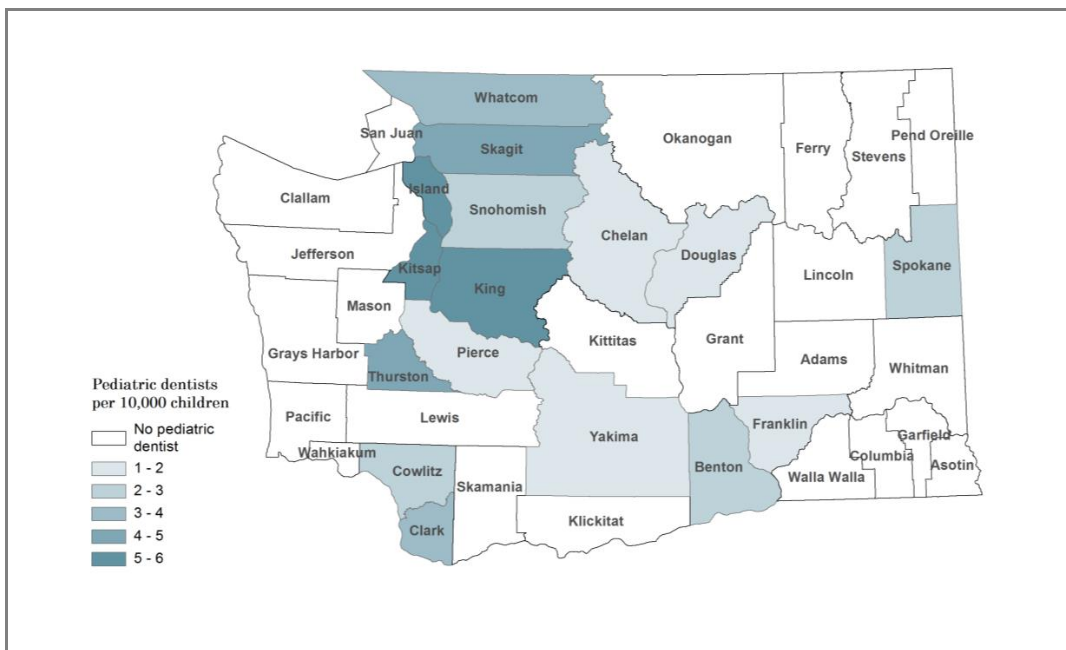

Figure 5. *Pediatric Dentist Density in Washington State by county, 2012*

Table 7. Percent of children in Medicaid who received any preventive dental service in 2012, by County

County	Children enrolled in Medicaid 11+ months	Number receiving any dental service	Percent receiving any preventive dental service	Region
Chelan	10,431	8,432	80.8	East
Douglas	5,092	4,103	80.6	East
Yakima	50,640	38,642	76.3	East
Grant	16,795	12,157	72.4	East
Okanogan	6,293	4,402	70.0	East
Spokane	48,548	33,464	68.9	East
Franklin	16,918	11,617	68.7	East
Walla Walla	6,228	4,223	67.8	East
Adams	5,172	3,488	67.4	East
Benton	20,419	13,714	67.2	East
Columbia	392	258	65.8	East
Lincoln	899	584	65.0	East
San Juan	782	506	64.7	West
Skagit	13,310	8,593	64.6	West
Garfield	186	119	64.0	East
Whatcom	15,924	9,775	61.4	West
King	123,753	74,911	60.5	West
Stevens	4,827	2,877	59.6	East
Island	3,712	2,212	59.6	West
Pierce	71,142	42,050	59.1	West
Kittitas	2,912	1,720	59.1	West
Mason	5,914	3,451	58.4	West
Snohomish	52,444	30,360	57.9	West
Clark	41,245	23,303	56.5	West
Pend Oreille	1,348	741	55.0	East
Lewis	9,118	4,974	54.6	West
Cowlitz	11,672	6,316	54.1	West
Kitsap	15,101	8,105	53.7	West
Whitman	2,021	1,084	53.6	East
Thurston	17,854	9,473	53.1	West
Klickitat	2,042	1,073	52.5	East
Skamania	877	457	52.1	East
Asotin	2,001	1,012	50.6	East
Ferry	763	385	50.5	East
Grays Harbor	8,103	4,073	50.3	West
Pacific	1,867	872	46.7	West
Jefferson	1,807	751	41.6	West
Wahkiakum	311	129	41.5	West
Clallam	6,022	1,920	31.9	West
Total	**604,885**	**376,326**	**62.2**	

4.4 Pediatric Dentist Density

During 2012, there were 604,885 children between ages 0 to 17 years enrolled in Medicaid for at least 11 months. One hundred seventy-nine pediatric dentists were identified, practicing in 16 of the 39 Washington State counties during 2012. Table 8 summarizes the study population and number of pediatric dentists by county.

4.4.1 County- and State-level density

Pediatric dentist density for counties with at least one pediatric dentist ranged from 1.18 to 5.98 pediatric dentists per 10,000 Medicaid-enrolled children (Figure 5). Twenty-three counties had a density of zero pediatric dentists per 10,000 Medicaid-enrolled children. The average pediatric dentist density per county was 1.32 pediatric dentists per 10,000 Medicaid-enrolled children. Pediatric dentist density across the entire state was 2.98 pediatric dentists per 10,000 Medicaid-enrolled children.

4.4.2 Distribution of densities

The highest density of pediatric dentists was found in King County, where 74 pediatric dentists, or 41.3% of the state's pediatric dentists practice, serve 20.5% of the state's Medicaid-enrolled child population. The four counties with the highest density of pediatric dentists (King, Island, Kitsap, Skagit) constitute 50.3% of the state's pediatric dental workforce and 25.8% of the state's Medicaid-enrolled population. There were 86,680 or 14.3% of Medicaid-enrolled children living in counties that were not served by a pediatric dentist. Thirty-eight percent of

Medicaid-enrolled children live in a county that is at or above the total state average pediatric dentist density (Figure 6).

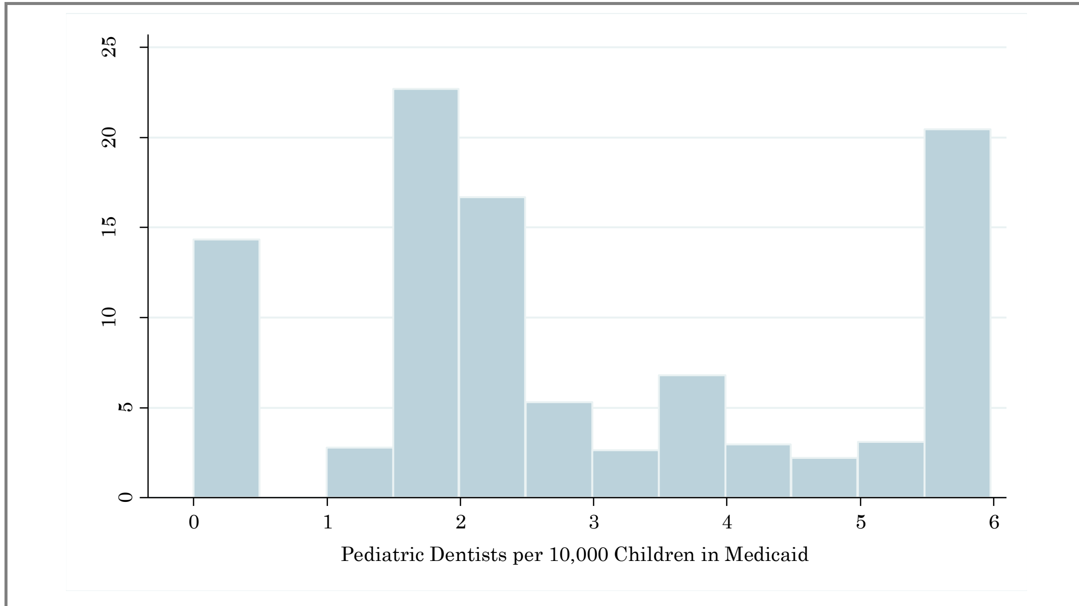

Figure 6. *Distribution of Medicaid-enrolled children in Washington State by county pediatric dentist density, 2012*

Table 8. Pediatric dentist density in Washington State by county, 2012

County	Children enrolled in Medicaid 11+ months	Pediatric Dentists	Pediatric Dentists per 10,000 Children in Medicaid
King	123,753	74	5.98
Island	3,712	2	5.39
Kitsap	15,101	8	5.30
Skagit	13,310	6	4.51
Thurston	17,854	8	4.48
Clark	41,245	16	3.88
Whatcom	15,924	5	3.14
Benton	20,419	6	2.94
Cowlitz	11,672	3	2.57
Spokane	48,548	12	2.47
Snohomish	52,444	11	2.10
Pierce	71,142	14	1.97
Douglas	5,092	1	1.96
Chelan	10,431	2	1.92
Yakima	50,640	9	1.78
Franklin	16,918	2	1.18
Adams	5,172	0	0
Asotin	2,001	0	0
Clallam	6,022	0	0
Columbia	392	0	0
Ferry	763	0	0
Garfield	186	0	0
Grant	16,795	0	0
Grays Harbor	8,103	0	0
Jefferson	1,807	0	0
Kittitas	2,912	0	0
Klickitat	2,042	0	0
Lewis	9,118	0	0
Lincoln	899	0	0
Mason	5,914	0	0
Okanogan	6,293	0	0
Pacific	1,867	0	0
Pend Oreille	1,348	0	0
San Juan	782	0	0
Skamania	877	0	0
Stevens	4,827	0	0
Wahkiakum	311	0	0
Walla Walla	6,228	0	0
Whitman	2,021	0	0
TOTAL	604,885	179	2.96*

*Total density is state-wide density, not average county density

4.5 Analysis of confounders

Unadjusted linear regression testing found both ABCD program age and east/west regionality to be statistical cofounders with respect to observing the relationship between the outcome and predictor variables. There was no multicollinearity between these variables.

Total dentist-to-child ratio, number of CHCs per county, and county rurality were significantly related to pediatric dentist density. However, no similar relationship was found between these variables and preventive dental care use among Medicaid-enrolled children. County DHPSA designation was not significantly related to either variable (Table 9).

Table 9. Unadjusted associations between theoretical confounders with pediatric dentist density and preventive dental services use among children in Medicaid in a Washington State county in 2012 (n = 39)

Variable:	Pediatric Dentist Density		Percent Children in Medicaid Receiving Preventive Services	
	β-Coefficient (95% CI)	*P*-value	*β* coefficient (95% CI)	*P*-value
General dentist-to-Child ratio	0.08 (0.02-0.13)	0.014*	-0.09 (-0.45-0.27)	0.613
Number of CHCs	0.19 (0.07-0.31)	0.002*	0.39 (-0.34-1.12)	0.290
DHPSA Designation		0.075		0.117
No part of county a shortage area (reference)	—		—	
Whole county a shortage area	-3.15 (-7.08-0.79)	0.113	-3.18 (-24.64-18.28)	0.766
Part of county a shortage area	-2.50 (-6.26-1.33)	0.196	4.93 (-15.78-25.63)	0.632
Rural-Urban Continuum Codes		< 0.001*		0.201
1 - 3 (reference)	—		—	
4 - 6	-2.36 (-3.38, -1.34)	< 0.001*	-5.07 (-12.40-2.25)	0.168
7 - 9	-2.72 (-4.01, -1.42)	< 0.001*	-7.38 (-16.66-1.90)	0.115
ABCD Program age	0.19 (0.06-0.33)	0.005*	1.02 (0.27-1.77)	0.009*
Regionality		0.001*		0.001*
Western Washington (reference)	—		—	
Eastern Washington	10.29 (4.38-16.21)	0.001*	10.30 (4.38-16.21)	0.001*

*Indicates statistically significant results at $\alpha = 0.05$

4.6 Regression analysis

All 39 counties in Washington State were included in the final regression analysis. A simple linear regression model was created to test the relationship between pediatric dentist density and preventive dental care use by Medicaid-enrolled children in a county. This model revealed that as the ratio of pediatric dentist per 10,000 children in a county increases by 1, on average, the percentage of preventive

dental services per county increase by 0.79%. This is not a significant increase (p=0.449, 95% CI = (-1.30, 2.87)).

Multivariate linear regression was performed, adjusting for regionality and county ABCD program age. After taking into account these confounding variables, as the ratio of pediatric dentist per 10,000 children in a county increases by 1, on average, the percentage of preventive dental services per county increase by 1.67%. This is a significant increase (p=<0.001, 95% CI = (0.02, 3.32)).

Table 10. Multivariate linear regression models predicting preventive dental services use among Medicaid-enrolled children in a Washington State county in 2012 (n=39)

County variable:	Percent Children in Medicaid Receiving Preventive Services	
	β-Coefficient (95% CI)	*P*-value
Unadjusted model:		
Pediatric dentist density	0.90 (-0.93-2.73)	0.326
Adjusted model:		< 0.001*
Pediatric dentist density	1.67 (0.02-3.32)	0.047*
Regionality		< 0.001 *
Western Washington (reference)	—	
Eastern Washington	13.52 (8.03-19.00)	< 0.001*
ABCD Program age	-0.002 (-0.004 , -0.000)	0.016*

*Indicates statistically significant results at α = 0.05

Chapter 5 : Discussion

This study finds a significant association between the density of pediatric dental providers and preventive dental care utilization among Medicaid-enrolled children. This association became significant after adjusting for the unique regionality of Washington State and county ABCD program age. The results of this analysis are consistent with those of Groenewegen and Postma which describe a small but significant increase in the demand for dental services among publically insured patients corresponding to an increase in dentist density[18]. Their study model, which evaluated dentist density and its effects on adult utilization of any dental services, sampled the population by survey. The value of the present study compared to Groenewegen and Postma is that it uses a complete data set, thus eliminating potential recall bias and sampling error.

Unlike the Groenewegen and Postma's study, this analysis looks at pediatric dentist density and child dental care utilization rather than all dentist density and adult dental care utilization. Interestingly, from the analysis of potential confounders, we discovered that there was no significant association between density of all dental provider types and child preventive dental care utilization.

5.1.1 Significance of regionality

The two distinct geographic regions of Washington State very clearly affect both the density of pediatric dentists in a county and how children might access preventive dental care (Figure 7). With respect to provider density, pediatric dentists may chose to practice in either eastern or western Washington based on county characteristics

such as climate, population density, proximity to the ocean, all of which vary vastly between the two regions. Differences in utilization between the two regions might be explained by differences in factors such as mode of transportation, weather patterns, or lifestyle related to area industries. Given the magnitude of the effect of regionality on preventive dental services use, it would be important to understand through future studies the characteristics of these regions that most affect dental care utilization.

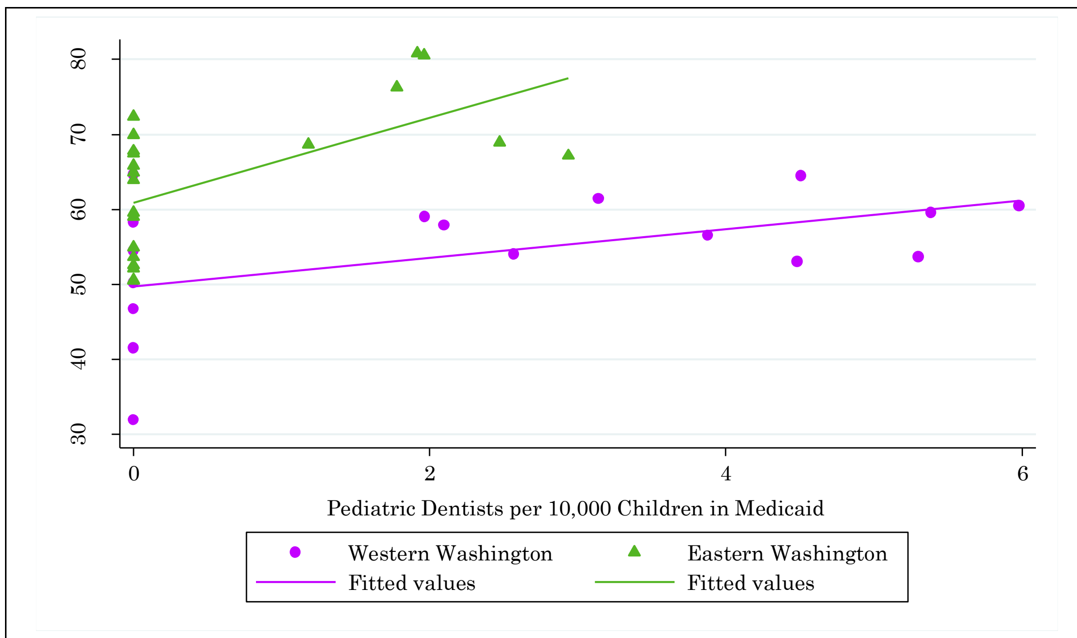

Figure 7. *Dental care utilization and pediatric dentist density, comparing eastern and western Washington State counties, 2012*

5.1.2 Policy implications

These findings give more weight to the discussion regarding how best to address dental workforce issues in underserved areas. The federal standard for defining areas of dental need is the DHPSA. The current methodology for defining DHPSA uses primarily a population-to-provider ratio. Programs such as National Health Services Corps, Title VII training programs, Federally Qualified Health Centers, and federal and state loan repayment programs direct funding and placed dental provider in areas based on DHPSA scores. As demonstrated in the present study, this ratio may not be as relevant to the pediatric population. Taking into account the population-pediatric dentist ratio in defining and allocating resources to areas of need could potentially help realize improvements in dental care utilization among children.

Care should be taken when considering the implications of these findings in other states. Each state has unique patterns of dental care utilization given its own state Medicaid policies, population characteristics, and regional differences that are not easily accounted for in a single generalizable model. The protocol for evaluating the effect that pediatric dentist density has on preventive dental care use in this study may be helpful in developing models that better explain preventive dental care utilization in other states.

5.1.3 Study limitations

There are a number of limiting factors that should be acknowledged in interpreting the results of this study. First, county-level pediatric dentist density is only an approximation of geographic access to pediatric dental care in a county. This

estimate has an inherent level of error. The model also assumes that patients do not travel out of their county of residence for dental care. For example, a child in Pasco, Franklin County lives within 10 miles of all pediatric dentists in Benton County. In this case, the county-level density measure underestimates true geographic access to pediatric dental care among most residents of Franklin County. A more complex geospatial analysis at the individual level might be able to account for these factors and may provide a more accurate result.

Next, the model only takes into consideration primary place of practice for the pediatric dentist, as reported by the Washington State Academy of Pediatric Dentistry and verified through practice website details, and the Washington State Department Public Health and NPI registries. These data sources gave no consistent information about if and how a provider might split time between primary practice location and a secondary practice site such as a satellite office. Basing pediatric dentist density on number of full-time equivalents (FTEs) rather than number of providers would provide a more accurate estimate of the workforce distribution. This would also help account for pediatric dentists who spend less than 1.0 FTE in clinical practice. In the present study, there would be a larger potential for error in counties with a lower child population or a small number of total pediatric dentists, should there be a difference between the number of pediatric dentists in the county and actual FTEs worked by those providers in the county.

This study only addresses preventive dental care utilization among children whose dental care is financed through Medicaid funds. There is no consistent data source that can help compare utilization patterns of Medicaid-enrolled children with those

of children who receive dental service under private commercial insurance, self-pay and charity care.

The number of counties in Washington limits the number of predictors that can be reliably used in a multiple linear regression model. In the present study model, there was one main predictor variable and two statistical confounders identified. While no a priori power analysis was performed in this study, it was within reasonable limits of the rule-of-thumb to use at most 1 predictor for each 10 observations.

Chapter 6 : Conclusion

Based upon this study's results, the following conclusions can be drawn:

- After adjusting for county regionality and ABCD program age, there is a significant relationship observed between the number of pediatric dentists per 10,000 Medicaid-enrolled children in a Washington State county and the proportion of those children who receive any preventive dental care services in a given year.
- On average, after adjusting for county regionality and ABCD program age, each additional pediatric dentist per 10,000 Medicaid-enrolled children in a county accounts for a 1.67% increase in utilization of preventive dental services.
- Policies aimed at improving pediatric oral health disparities should include strategies to increase the number of pediatric dentists who practice in counties with large numbers of Medicaid-enrolled children.

Chapter 7 : References

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