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Mapping Nevada's Dental Workforce

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MAPPING NEVADA'S DENTAL WORKFORCE

by

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ABSTRACT

Access to care is a concern at the forefront of public health. Due to socioeconomic and geopolitical pressures, the distribution of healthcare providers across a population often does not coincide with the demand for healthcare in a specific geographic area. Rural areas typically do not have enough providers and urban areas typically have too many. This stark reality underscores an inherent inefficiency in the allocation of healthcare resources and is a discrepancy that must be addressed by state-sponsored institutions and programs. From a public health perspective, the problem of insufficient or lack of access to care is the greater of the two problems. Rural residents that require care face additional challenges that the urban counterpart does not readily encounter. They include the sheer lack of qualified providers that can address their specific concerns, lack of interdisciplinary care that is required for more complex medical and dental conditions, and higher costs associated with receiving this care, which may come from high transportation costs, long waiting time and long commutes. These barriers place unneeded pressures on the care seeker and can ultimately lead to aggravation of the medical or dental condition itself and poorer patient outcomes.

Geographic information system (GIS) mapping of the state's general dentists and clinical specialists revealed an uneven per capita distribution of dental providers between the 17 counties in the state of Nevada as well as between the 55 zip codes of the Las Vegas Valley. The study found that 0.6% of Nevadan residents in the state lived beyond a 30-mile radius of a dental office and 1.7% of Nevada residents in the state lived beyond a 30-mile radius of a Medicaid-accepting dental office, with virtually all such residents living in a rural county. Moreover, the study found that zip codes with a larger ratio of Medicaid-accepting dental offices in the Las Vegas Valley

were associated with a greater percentage of children, minorities, and Hispanics in the population, as well as a lower median household income.

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CHAPTER 1

INTRODUCTION

Background

At the turn of the new century, the US Department of Health and Human Services (HHS) published the first *Surgeon General's Report on Oral Health*, to raise the profile of health disparities that impact the oral health of Americans (United States Department of Health and Human Services, 2000). In the report, it recognized historic achievements in promoting oral health and preventing disease that oral health professionals have made in the last century. However, it also identified an insidious lag in continual public health efforts, and indeed, a growing divide between certain patient demographics in attaining adequate oral health. *Healthy People 2020* included twelve leading health indicators for the nation, one of which was oral health. One of the targets was to increase the proportion of the population who used the oral health care system in the past year by 10% by 2020 from a baseline of 44.5% to 49% (National Center for Health Statistics, 2016). In the mid-course evaluation of progress in 2016, access to oral health services was one of only two of the leading health indicators that exhibited a decline from baseline. In 2010, 44.5% of Americans were able to access dental services compared to 43.4% in 2016 (National Center for Health Statistics, 2016).

The Centers for Disease Control and Prevention (CDC) observed that between 2013-2016, 16.9% of children and young adults aged 5-19 and 31.6% of adults aged 20-44 had untreated dental caries (National Center for Health Statistics, 2019). Both age groups saw the prevalence rate increase from the prior observation period (2005-2008) to 16.6% and 25.1%, respectively (National Center for Health Statistics, 2019). Rates of untreated caries for adults greater than 44 years old were

around 25% and exhibited the same uptrend between those two time periods (National Center for Health Statistics, 2019). Males consistently had a greater prevalence of untreated dental caries than females across all age groups in both observation periods (National Center for Health Statistics, 2019). African Americans and Hispanics also showed greater prevalence compared with their White and Asian counterparts (National Center for Health Statistics, 2019, p. 2). Furthermore, income levels were shown to correlate negatively with the prevalence of untreated caries across all age groups, with those living at or below the poverty level having as much as a four-fold increase in the prevalence of disease than those living at 400% or more of the poverty level (National Center for Health Statistics, 2019). These data from the CDC shows that there is at least an age, sex, racial and socioeconomic component to the incidence of untreated dental caries and their accessibility to dental care.

Oral Health of People Living in Nevada

A close look at the oral health of Nevadans reveals similar patterns of inequity as those seen across the country. A study of third-graders in Nevada in 2008 revealed that 28% had untreated decay and 65% has had caries experience, versus the national average of 26% and 50%, respectively, for that age group (Whitehill Jr., 2012). In this cohort, Hispanic and African Americans also had a greater prevalence of untreated caries than their White counterparts (Nevada Department of Health and Human Services, 2009; Whitehill Jr., 2012). Also in the same year, the prevalence of adults who had their teeth cleaned in the last 12 months was 64% in Nevada and 71% nationally (Whitehill Jr., 2012). According to one American Dental Association (ADA) survey, 49% of low-income adults and 40% of middle-income adults residing in Nevada consider themselves to have fair or poor oral health (Health Policy Institute, 2015b). This is somewhat greater than the national average of 47% and 33% for low- and middle-income adults, respectively (Health Policy Institute,

2015b). A lower percentage of Nevadans compared to the national average also report that they value their oral health, feel that they need to visit the dentist twice a year, agree that regular dental visits keep them healthy and the appearance of their mouth and teeth does not affect their ability to interview for a job (Health Policy Institute, 2015b). Indeed, only 60% of adults and 75% of children less than 18 years old in Nevada reported having visited a dentist or dental clinic in the past year (Centers for Disease Control and Prevention, n.d.). Among Nevadans, financial difficulty (57%) was most often cited as a reason for not visiting the dentist more frequently, followed by being afraid of the dentist (20%), trouble finding a dentist (15%), and inconvenient location or time (11%) (Health Policy Institute, 2015b; Yarbrough et al., 2014). These barriers against patients seeking preventive care inevitably have future consequences. In Nevada, about 13,000 emergency department dental visits were attributed to dental conditions with adults 21-64 years old accounting for the vast majority (85%) of non-traumatic, dental-related visits (Capurro, 2020; Health Policy Institute, 2019; Zhou et al., 2018).

Public Financing of Dental Care

The prohibitive cost of dental care and lack of dental coverage is the major reason patients delay seeking care (United States Government Accountability Office, 2013). Perhaps surprisingly then, these distressing trends followed the passage of the *Patient Protection and Affordable Care Act (ACA)* in 2010, which included provisions to expand coverage, affordability, and awareness in oral health for children (Patient Protection and Affordable Care Act, Public Law No. 111-148, 2010). The ACA does not secure dental coverage for adults in the US and public insurance coverage remains limited for adults in most states. As a stark reflection of the enduring estrangement of oral health from overall health, and the segregation of the dental and medical professions, oral health screening is not included as part of the 22 preventive screenings that are covered by Medicare

(United States Department of Health and Human Services Oral Health Coordinating Committee et al., 2016). Dental procedures covered by Medicare are only those related to a medical procedure or stands as severe comorbidity to a medical condition if left untreated (Freed et al., 2019; United States Department of Health and Human Services Oral Health Coordinating Committee et al., 2016). In 2016, nearly two out of three Medicare beneficiaries did not have dental coverage and almost half of them did not visit a dentist (Freed et al., 2019).

Furthermore, in 22 states, Medicaid for eligible low-income individuals only covers emergency dental procedures—a self-defeating situation for the state that leads to expensive and unnecessary emergency room visits (Pew Center on the States, n.d.). One study attributed a rise of 3-6% in the use of dental services in 2016 in states that underwent an expansion in dental benefits in adults under the ACA (Nasseh & Vujicic, 2017a). It is unknown what proportion of this percentage is associated with emergency care versus preventive and maintenance dental procedures. Nevada was one of seven states that did not have adult dental coverage in Medicaid but expanded access after the passing of the ACA (Nasseh & Vujicic, 2017b).

As of 2020 in Nevada, individuals under the age of 21 years who receive Medicaid are eligible to receive comprehensive dental care. This includes a full range of dental services necessary for the prevention of disease and maintenance of oral health (Nevada Department of Health and Human Services, Division of Health Care Financing and Policy, 2020). Additional periodontal and restorative services are also available to Medicaid-eligible pregnant women (Nevada Department of Health and Human Services, Division of Health Care Financing and Policy, 2020). Orthodontic treatments are covered only when it is deemed medically necessary and require pre-authorization (Nevada Department of Health and Human Services, Division of Health Care Financing and Policy, 2020). For individuals aged 21 years or older, Medicaid will only cover palliative care,

including emergency extractions; and the furnishing of a complete or partial denture, along with any associated restorative procedures to prepare abutment teeth, if the denture is deemed medically necessary (Nevada Department of Health and Human Services, Division of Health Care Financing and Policy, 2020). The lack of dental coverage and the cost of dental care are some of the many barriers in receiving oral health care. For patients with ample dental coverage or are otherwise capable of paying for services out-of-pocket, they face yet another difficulty.

The Rural Divide

Oral health is inextricably linked to overall health and shares many of the determinants that shape its accessibility. Access to oral health services is a critical component, including the supply of providers in proximity to the potential patient. This is a function of not only how many dentists are in the workforce but also how they are distributed among the patient population. According to the ADA, there were about 200,000 active dentists in the United States in 2018, with a national average of 61 dentists per 100,000 people. Nevada ranked in the middle of all the states with about 55 dentists per 100,000 people (American Dental Association, 2020). However, this number does not tell the whole story as it does not take into consideration the *distribution* of these dentists. The scarcity of oral healthcare providers in many areas of the US is among the perennial challenges facing rural Americans, which constitutes one-sixth of the US population (Berk et al., 1995; Douthit et al., 2015; Mueller et al., 1998). It is in these 50 million Americans that we see oral health disparities compared to their urban counterparts including poorer health outcomes and greater levels of chronic disease (Meit et al., 2014). At least some of this disparity may be due to the difficulty of recruiting healthcare professionals into practicing in rural regions and cultivating the same availability of health services (Douthit et al., 2015). Moreover, the rural-urban chasm is more glaring among racial and ethnic minorities living in rural communities. One study found that

minority populations living in rural communities were less likely to have a primary care provider compared to non-Hispanic Whites (James et al., 2017). In pursuit of improving access to dental care for members of the public living in geographically isolated regions, the Health Resources and Services Administration (HRSA) of the HHS has established health professional shortage areas (HPSAs) to identify these regions that are facing a shortfall in health care professionals. Designated HPSAs guide the distribution of funds from federal scholarships, grants, and loan repayment programs to members of the workforce who commit to practicing in these areas of greatest need.

In Nevada, all 17 counties contain HPSAs, with reasons related primarily to financial limitations reducing access to care in urban areas and long travel times to the nearest provider in rural areas (Department of Health and Human Service, 2018; Human Resources & Services Administration, 2020). Just over 90% of the population in Nevada reside in two population centers: the Reno-Carson City-Fernley corridor in the northwest and the Las Vegas-Henderson corridor at the southern tip of the state (United States Census Bureau, 2020). With 1 in 10 Nevadans living in rural communities, it is important not to neglect their ability to access health care given the relative scarcity of healthcare providers outside urban centers. For the state, the disparity between urban and rural communities has intensified over the last decade. It is estimated that there's about twice the number of per capita dentists in urban versus rural areas, with a 2.9% decrease in the number of dentists over the period between 2008-2018 in the latter areas (Capurro, 2020). From this perspective, and pertaining to oral health care, spatial analysis of the distribution of dentists in Nevada can help identify counties that may have a shortage or are experiencing a decline.

GIS and Dental Public Health

Geographic information systems (GIS) modeling is one technique that has gained usage in the public health domain to understand spatial patterns and relationships between various health determinants (McLafferty, 2003). GIS permits the simultaneous visualization and analysis of multiple layers of geographically-linked data points on a map. Perhaps its most powerful feature is the ability for GIS to generate detailed, information-rich maps in a visually appealing way that is very intuitive and readily accessible to laypersons not well-versed in the intricacies of the underlying system. Base maps are widely available to the public, and a wide selection of geocoded data is available. This feature combined with the vast troves of electronic health records generated each day has become a primary source of big data. From the first application of digital GIS mapping for health care in the early 1990s until today, GIS has played pivotal roles in helping analysts monitor the shifting supply and demand of health care in communities big and small, the quality of health services being provided, the speed and ease of health care delivery, and the forces that shape health disparities across varying demographics (McLafferty, 2003).

The use of GIS in dental public health was widespread even before GIS methods were computerized (Broomhead et al., 2018). Some applications included mapping out the prevalence of tooth decay across socioeconomic boundaries within a city, identifying local clusters of disease endemic to an area, measuring the effects of public health interventions within a community over time, gauging the transportation time of patients to the nearest clinic, defining boundaries of service coverage areas, and calculating dental utilization (Antunes et al., 2001; Antunes et al., 2002; Hirsch et al., 2012; Jäger et al., 2016; Susan C. McKernan et al., 2016a; Yuen et al., 2018). Researchers repeatedly turned to the use of GIS to map the dental workforce to identify areas of dental service shortfalls. This is of special concern in certain rural and frontier communities. One

study published by the ADA found in 2000, that upwards of 15% of the population living in some of the most rural regions of the US did not have private practice dentists (Wall & Brown, 2007). Many US researchers have tried to identify these regions, and their efforts have led to numerous studies using GIS to map the distribution of dentists in states such as Ohio (Horner & Mascarenhas, 2007; Susi & Mascarenhas, 2002), Mississippi (Krause et al., 2005), Kentucky (Saman et al., 2010a), Indiana (Kurcz, 2013), Missouri (Nasseh et al., 2017a), Wisconsin (Nasseh et al., 2017a), North Carolina (Vujicic, 2017) and Georgia (Cao et al., 2017a). In 2015, the Health Policy Institute of the ADA embarked on a cumulative effort to map the dental offices present in each of the 50 states, including those that accepted Medicaid (Health Policy Institute, 2015a). Canadian researchers have made similar attempts in the provinces of Saskatchewan (Shah et al., 2019), Ontario (Ahmad & Quiñonez, 2014; Ghoneim, n.d.; Meyer, 2014), and Quebec (Emami et al., n.d.). As well, spatial analysis of the dental workforce has also been performed for many other countries including New Zealand (E Kruger, 2013; Estie Kruger et al., 2012), Australia (Jean, 2020; E Kruger et al., n.d.; Shiikha et al., 2015), Japan (Hanibuchi et al., 2011), Thailand (Thanakanjanaphakdee et al., 2019), Nepal (Shrestha et al., 2017), Sri Lanka (Wijewardena, 2018), Saudi Arabia (Murad, 2008) and parts of the United Kingdom (Boulos & Phillipps, 2004).

Resources published online by the ADA Health Policy Institute provide a glimpse of dentist distribution in the state, but none have stratified dentists based on specialty or focused on mapping and quantifying the number of dentists in specific zip codes in urban and rural regions in Nevada. Understanding the distribution of the dental workforce serves many purposes. Even for the public, a directory of dentists or dental offices would help would-be patients identify the location of their closest dentist. For dentists, especially new or recent graduates, a map of the existing offices will inform their decision on where to establish a new office. More importantly, from the perspective

of public health, insights about the distribution of dentists in urban and rural communities can inform policymakers on how best to allocate funds to target populations who are underutilizing their share of the state's public health dollars, such as establishing community health centers in rural communities that lack access to the full spectrum of dental services, increasing investment into teledentistry infrastructure to bridge the access-to-care gap for frontier communities, or look into modifying licensure guidelines to allow for dental hygienists to practice within a larger scope or introduce midlevel dental providers in some areas.

This study seeks to utilize an established mapping paradigm to aggregate multiple data sources to visualize the distribution of dental care providers versus the population and other demographic factors. We hypothesize that the distribution of general practice dentists and clinical dental specialists does not distribute evenly per capita between counties in Nevada and between zip code areas in the Las Vegas Valley. We also hypothesize that certain demographics determinants are associated with the location of nearby dentists and dental offices.

CHAPTER 2

METHODS

List of Licensed Dentists

The primary dataset contained a list of licensed dentists in the state in 2018, obtained from the database of the Nevada State Board of Dental Examiners (NSBDE). This original list consisted of 1,986 dentists. Since the NSBDE does not require dentists to list their practice location on their registration, dentists listing an out-of-state address were deemed a non-resident and excluded from this study, reducing the count to 1,674. To more simply quantify the clinical capacity of the dental workforce in Nevada that will be available to serve the public in the mid- to long-term, dentists listed as geographically-restricted (3), live patient supervisor (1), or in possession of a limited dental license (51) were excluded from the final list, as were those listed as an oral and maxillofacial pathologist (1) or dental public health specialist (1). Oral and maxillofacial radiologists are not differentiated in this list. Dental anesthesiology is not part of the list as it was only officially recognized as a dental specialty in 2019. Initial data was stored and organized in an Excel spreadsheet (Microsoft Excel for Office 365, Version 2002). The list of dentists was further separated into general practitioners and clinical specialties, including oral and maxillofacial surgeons, orthodontists, periodontists, prosthodontists, pediatric dentists, and endodontists. Within each list, it was verified that no duplications existed. Recording the number of dentists associated with each of the unique zip codes, a frequency table was generated identifying the number of dentists in each category associated with each zip code. To match zip codes into their appropriate counties, the 4th quarter 2018 crosswalk files were obtained from the United States Department of Housing and Urban Development, Office of Policy Development and Research.

These files contain tables that match each zip code into county GEOID codes so that county-level frequency tables were generated. In instances where a zip code in the list of dentists was not represented in the crosswalk files, the closest geographic zip code that is represented was used to replace it. In the opposite instance where one zip code is represented by more than one county GEOID code, the zip code was identified on OpenStreetMap and the associated county as identified by OpenStreetMap was used.

List of Dental Facilities

A list of dental offices was also obtained from the NSBDE. In the state, all facilities for which dental procedures will be conducted must be registered with the Board. This data was collected because it is one of the more reliable proxies available for measuring the potential availability of dental services in an area. Only offices located in Nevada were included and each office address was counted once regardless of how many additional times the address was listed. A frequency table for the number of dental offices in each zip code and county was created from this list.

List of Medicaid Providers

Medicaid data was obtained from the Nevada Department of Health and Human Services. This database contains a list of all 1057 providers registered with Medicaid as of April 2019, including their service address and in most instances their dental specialty. However, since specialty information was not available for 166 providers, it was decided that specialty data be eliminated from the analysis. Providers classified as out-of-state were removed, leaving 977 in-state providers. Interested only in the number of offices that accepted Medicaid through their providers, duplicated addresses were discarded with 359 unique office locations remaining. Another

frequency table for the number of Medicaid-accepting dental offices in each zip code and county was created from this list.

Dental clinics located within tribal health centers administered by the Indian Health Services (IHS) or correctional institutions were not included in the list of dental offices in the state or included in the Medicaid dataset.

GIS Mapping

To construct the GIS map with census block, zip code, and county-level boundaries, TIGER/Line Shapefiles were obtained from the United States Census Bureau for the year 2018 with street centerline data for Clark County obtained from the county database. Also, from the Census Bureau, demographic information about the population living in each county and zip code was obtained through the 2018 American Community Survey estimates. To construct the distance maps and ensure the most geographically accurate representation of the population, census block-level population data from the United States Census Bureau was used. The latest population numbers available at this level were for 2010. Circular buffer areas representing a 30-mile radius were encircled around each geolocated dental office. These areas were merged and intersected with the underlying census block layer to gauge the percentage of overlap. Where census blocks were partially covered by the buffer area, the population in the census block was multiplied by the percentage of overlap to determine how much of the local population would fall within the radius. The 30-mi "as the crow flies" distance was chosen as this is an often-cited maximum travel distance used to measure network adequacy in the health insurance industry. In the state of Nevada, its 2020 network adequacy standards suggest that 30 miles is the maximum distance in rural counties between in-network patients and an eligible primary care provide (Nevada Division

of Insurance, n.d.). The geodatabase used to render the maps were assembled in ArcGIS 10.7 (ESRI). Data manipulation and computations were performed using Excel (Microsoft Office 365) and SPSS Statistics 26 (IBM).

CHAPTER 3

RESULTS

In 2018, there were an estimated 1,617 fully licensed general and clinical specialty practice dentists registered in Nevada, yielding a ratio of 56 dentists per 100,000 people. This is comparable but slightly below the national average of 61 dentists per 100,000 population as reported by the ADA Health Policy Institute (Health Policy Institute, 2020). Of the 1,617 dentists, there are 1271 general practitioners, 119 orthodontists, 84 pediatric dentists, 49 oral and maxillofacial surgeons, 49 endodontists, 28 periodontists, and 17 prosthodontists. An analysis of the distribution of dentists and the distribution of Nevadans across the state reveals that the dentist-to-population ratio varies significantly depending on which county or zip code is examined.

County-level Findings

Approximately 90.5% of Nevadans live in clusters located in the two urban counties of Clark and Washoe County and within the consolidated municipality of Carson City. This leaves less than 10% living in the remaining 14 rural counties. Urban areas in Nevada have greater racial/ethnic diversity, with twice the percentages of non-English speaking and minority people. The average household income in the urban areas is approximately 6% lower than rural household income. The two urban counties and Carson City are home to 93.9% of the state's general dentists. There are three counties, Esmeralda, Pershing, and Storey that do not have any general dentists registered within their borders, which means the 11,654 people, 2,369 of whom are children, living in those three counties do not have ready access to dental care.

Among dental specialists, the two urban counties and Carson City are home to 96.5% of the dental specialists registered in the state. Only Clark and Washoe counties have all the clinical specialties represented, which means the 329,738 people living outside Clark and Washoe counties do not have access to the full complement of specialists if that was necessary. Twelve dental specialists, including four pediatric dentists, three orthodontists, and oral and maxillofacial surgeons, and two endodontists practice in a rural county. There are no periodontists in the rural counties and no prosthodontists outside Clark and Washoe counties.

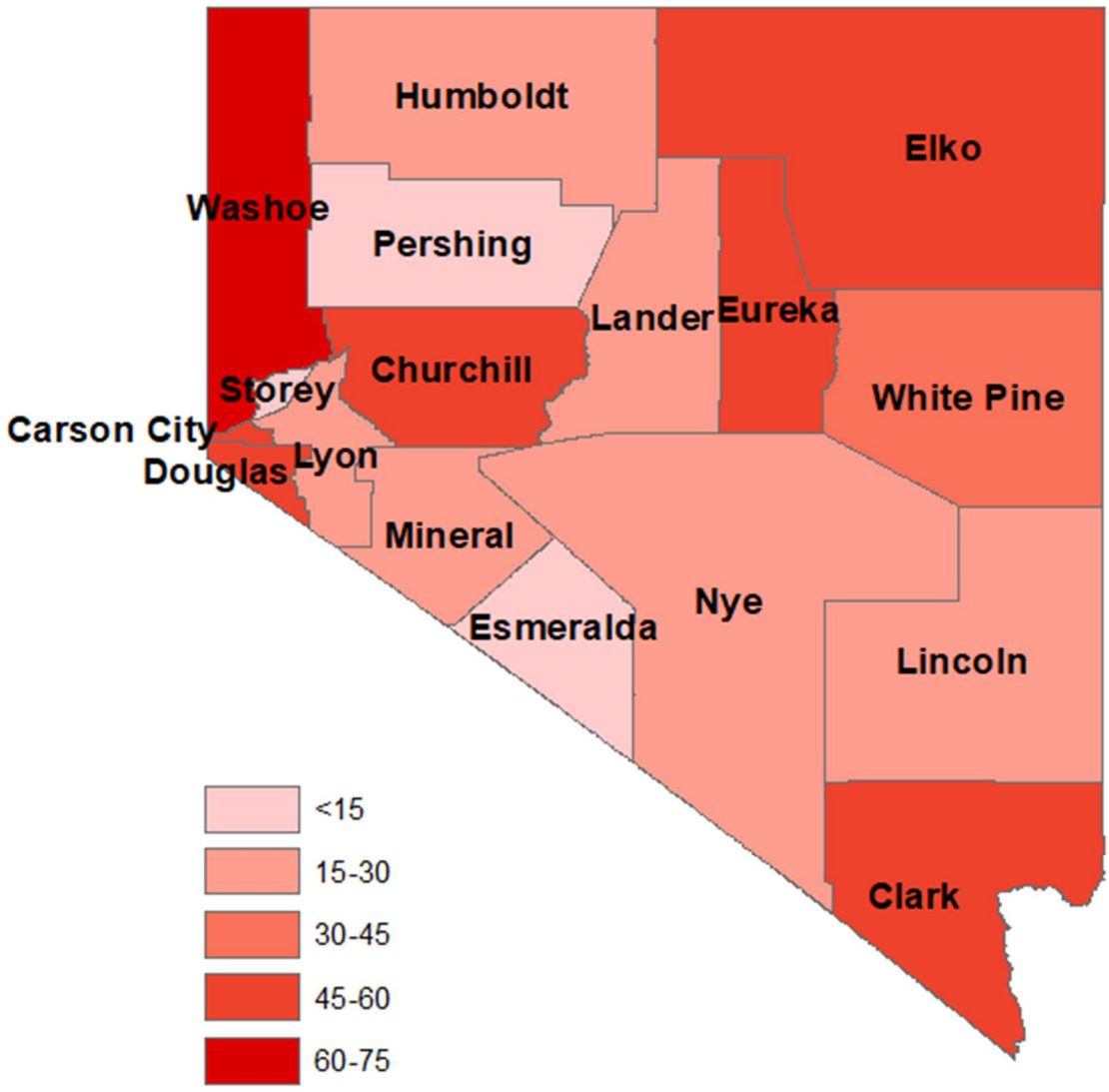

Figure 1 - Density of dentists in each county in Nevada. This is a heatmap showing the relative density of dentists in each county expressed as the number of dentists (general and specialist) per 100,000 people.

As shown in Figure 1, a county-level breakdown of Nevadan general and specialists dentists taken together shows the density of the dental workforce per 100,000 people. Only Washoe and Eureka counties exceed the state's average dentist-to-population ratio, with 75 and 58 dentists per 100,000 people, respectively. On average, there are 61 dentists per 100,000 people in the urban counties and Carson City, and less than half as many in rural counties, at 26 dentists per 100,000 people. Not only are the ratios different between urban and rural areas, but the range of difference is larger in rural counties, with a standard deviation of 10 in urban areas and 18 in rural ones, with half the difference attributed to the three counties that do not have any dentists.

Examining the same ratio for dental specialists in urban areas, the availability of pediatric dentists rank the highest, except in Clark County where there are nearly twice as many orthodontists than pediatric dentists. Following pediatric dentists are orthodontists, endodontists, periodontists, oral and maxillofacial surgeons, and finally, prosthodontists.

Looking at the distribution of children in the state versus the distribution of pediatric dentists, with only four pediatric dentists in the rural counties where 71,528 children under the age of 18 reside, urban counties have a greater number and density of pediatric dentists, with 872,487 children but 80 pediatric dentists. A comparison across Clark and Washoe counties and Carson City shows 7 pediatric dentists per 100,000 children in Clark County, which is home to the most children in any county and is the county with the greatest proportion of children, where more than 1 in 3 residents are below the age of 18. Washoe County and Carson City have 18 and 28 pediatric dentists per 100,000 children, respectively.

Considering dental offices and facilities in the state, Nevada is home to 998 registered locations, with 910 in urban counties including Carson City, and 88 in rural counties. There are two counties

without any registered dental offices: Esmeralda and Storey. Urban counties and Carson City have 44 dental offices per 100,000 people and rural counties have a ratio of 19.

Zip Code-level Findings

The Las Vegas Valley is home to over 2 million people. Comprising over two-thirds of the state's population and 95% of Clark County's population, the Las Vegas Metropolitan Statistical Area is the state's largest urban agglomeration. Within this highly urbanized area, there are 55 zip codes, with an average population of approximately 37,000 residents per zip code. There are 1,126 dentists in the area, with 892 who are general practitioners and 234 who are clinical dental specialists. This amounts to an average of 16.5 general dentists, 1.6 orthodontists, 0.9 pediatric dentists, 0.6 endodontists and oral and maxillofacial surgeons, 0.4 periodontists, and 0.3 prosthodontists per zip code. All but two zip codes have at least one general dentist. Out of the 55 zip codes, 22, 27, 36, 37, 40, and 46 zip codes do *not* have at least one orthodontist, pediatric dentist, endodontists, oral and maxillofacial surgeon, periodontist, and prosthodontists, respectively.

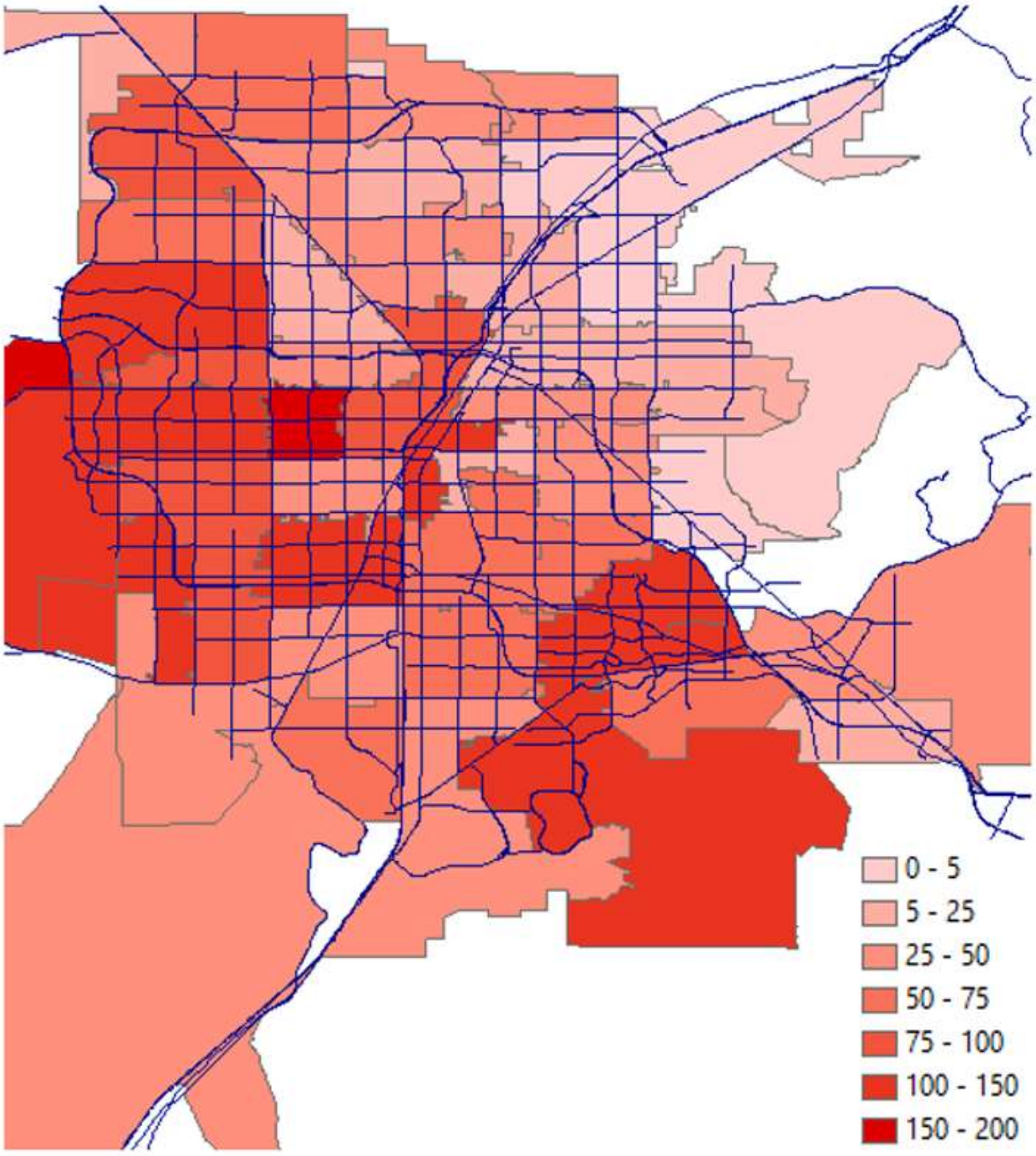

Figure 2 - Density of dentists in each zip code in the Las Vegas Valley. This is a heatmap showing the relative density of dentists in each zip code expressed as the number of dentists (general and specialist) per 100,000 people in the Las Vegas Valley.

The map in Figure 2 shows the number of dentists per 100,000 people in each zip code. The distribution of dentists is heterogeneous across the Las Vegas Valley with some of the highest numbers of dentists located towards more affluent areas of the Valley to the west (i.e. Summerlin, Spring Valley) and southeast of Las Vegas (i.e. Henderson) and the lowest number of dentists in the less affluent neighborhoods of North and East Las Vegas.

Looking only at the number of dental offices located in each zip code generates a very similar map like the one in Figure 2. The average number of dental offices per zip code is 12.5; however, the range can be large, ranging from no offices in a zip code to as high as the *equivalent* of 147 offices per 100,000 people in an area that includes 27 offices and only 18,375 people. The data also shows that there is an average of 20.6 dentists per zip code and the dentist-to-office ratio is about 1.6:1.

A Look at Medicaid

A large population of Nevada relies on the state's dental Medicaid coverage to access dental services. For patients who receive public insurance (Medicaid), the distribution of Medicaid dentists is a more paramount concern than the distribution of *all* dentists. From a county-level, the map in Figure 3 shows the number of Medicaid-accepting dental offices per 100,000 people. From the 359 Medicaid-accepting dental offices in the state, all but 24 are in Clark County, Washoe County, or Carson City. Five rural counties that do not have any Medicaid-accepting dental offices are Esmeralda, Eureka, Humboldt, Pershing, and Storey County. The average dental office-to-population ratio in the remaining rural counties is high due to the low populations in these counties.

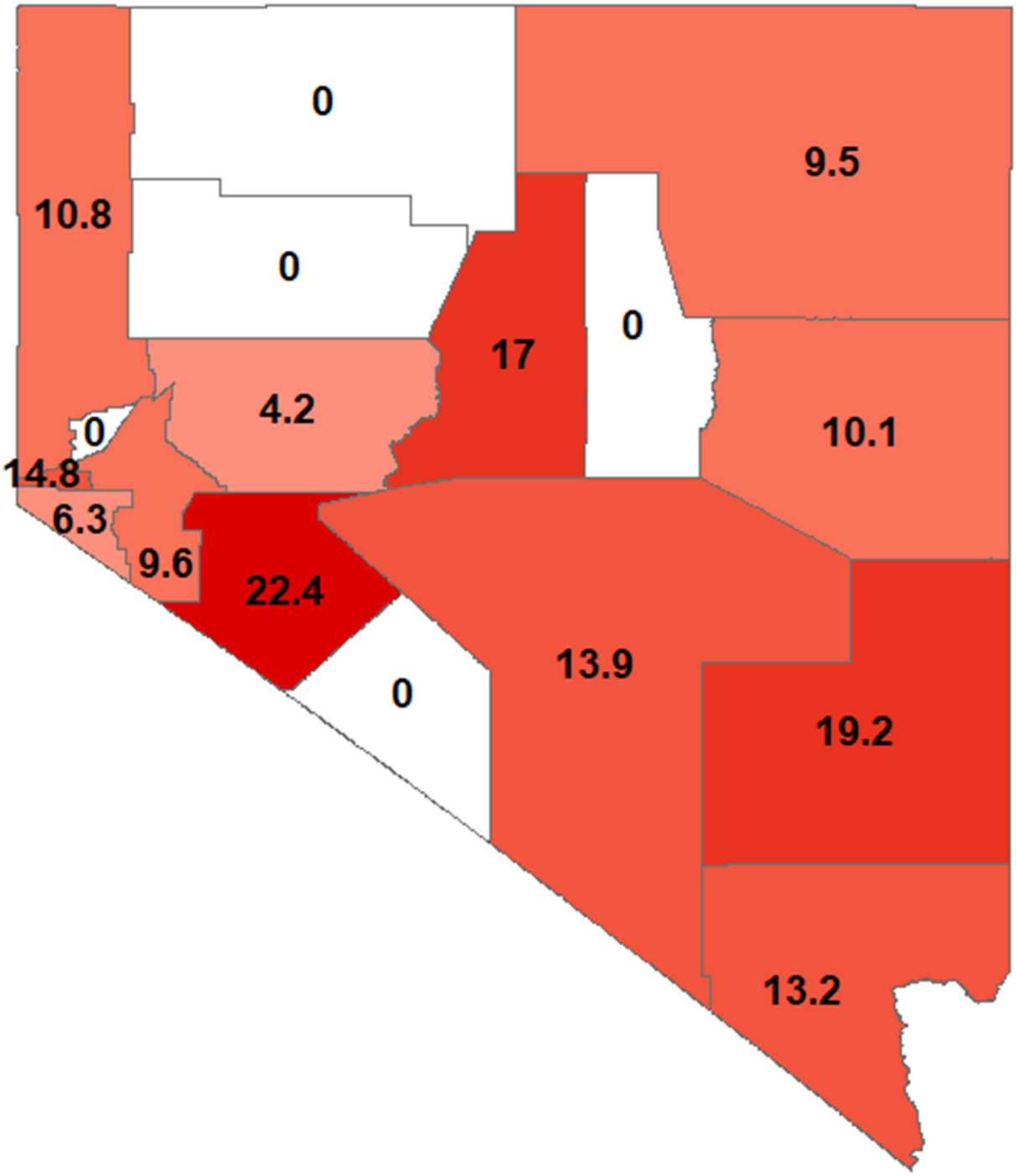

Figure 3 - Density of Medicaid-accepting dental offices in each county in Nevada. This is a heatmap showing the relative density of Medicaid-accepting dental offices in each county expressed as the number of offices per 100,000 people.

When comparing the number of Medicaid-accepting dental offices between the three urban counties/cities, Clark County has the largest absolute number of Medicaid-accepting offices (279), 13.2 offices per 100,000 people. The same ratio in Washoe County is 10.8 dentists per 100,000 population and 14.8 in Carson City.

The Las Vegas Valley area alone hosts 269 out of the county's 279 Medicaid-accepting dental offices. Examining the Las Vegas Valley from a zip code level, as shown in the map below in Figure 4, it is once again evident that the Medicaid-accepting dental office-to-population ratio is not homogeneous throughout the area's zip codes. There is a lower per capita number of Medicaid-accepting dental offices in the peripherals of the valley's boundaries, with some zip codes notably having none. From the 688 dental offices in the area, 39.1% accept Medicaid.

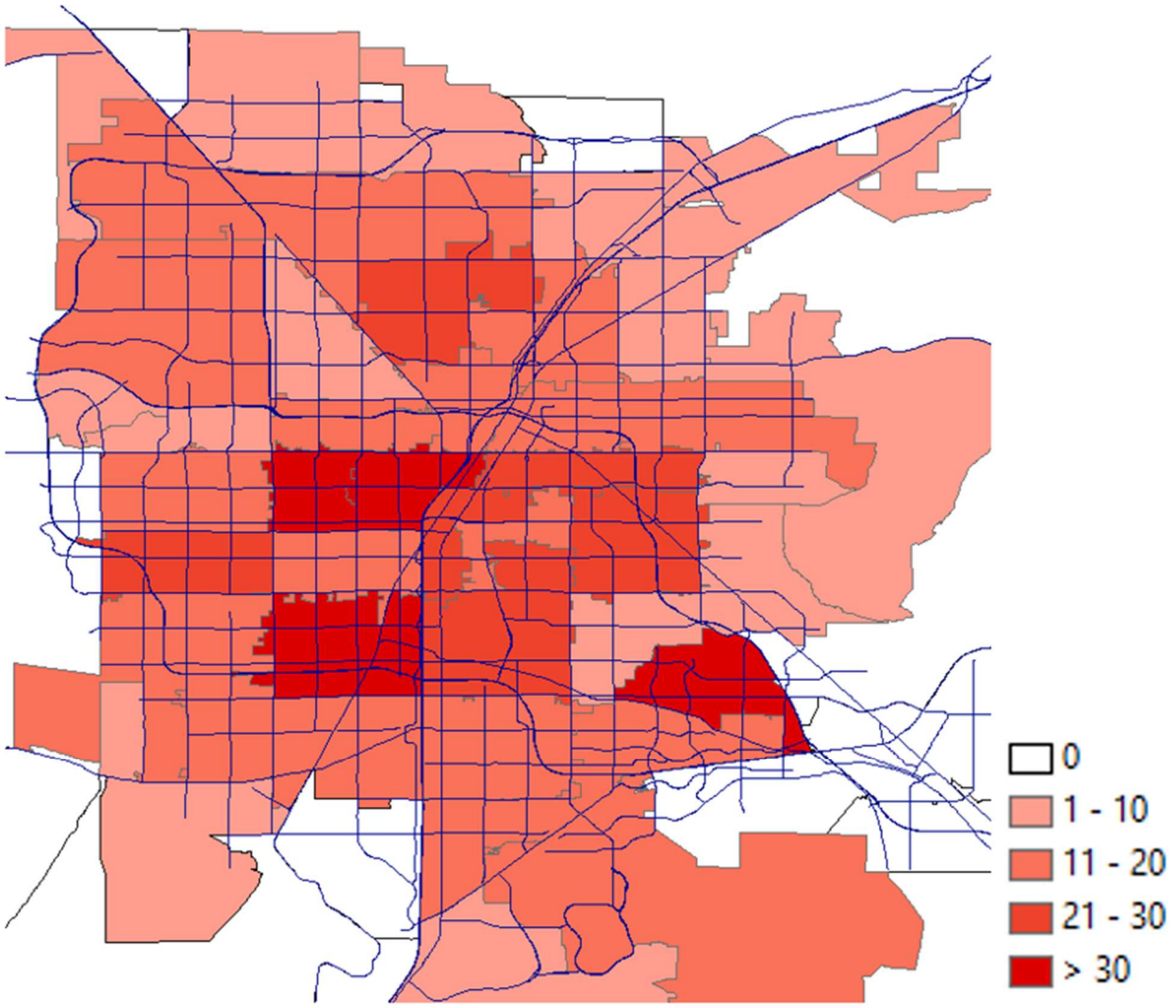

Figure 4 - Density of Medicaid-accepting dental offices in each zip code in the Las Vegas Valley. This is a heatmap showing the relative density of Medicaid-accepting dental offices in each zip code as the number of dental offices per 100,000 people in the Las Vegas Valley.

Distance to Dental Offices

Finally, in examing the distribution of the population versus the distribution of the dental offices in the state, two distance maps were created to show how they overlap. Catchment areas represented by circles with a radius of 30 miles were drawn around each dental office in the state (Figure 5a) and then specifically those that accepted Medicaid (Figure 5b). It was found that 0.6% or 15,580 people out of the total state population lived beyond 30 miles of a dental office, with three times as many, 1.7% or 45,679 people, who live beyond 30 miles of a Medicaid-accepting office. In either type of dental offices, virtually anyone that lived in the urban counties of Clark and Washoe or Carson City lived within 30 miles of one. From the county-level, it is clear that even in the remainder of the rural counties, that most of the people that fell outside the 30-mile catchment areas were not necessarily those counties that had the fewest dental offices per capita. Indeed, the four counties with less than 30 dentists per 100,000 people and the four lowest per capita number of dentists in the state have only a combined 601 people living outside a 30-mile radius of a dental office. So far as the five out of the 14 rural counties without any Medicaid-accepting dental offices are concerned, they contribute a combined 56% of 45,679 people living beyond 30 miles of a Medicaid-accepting office.

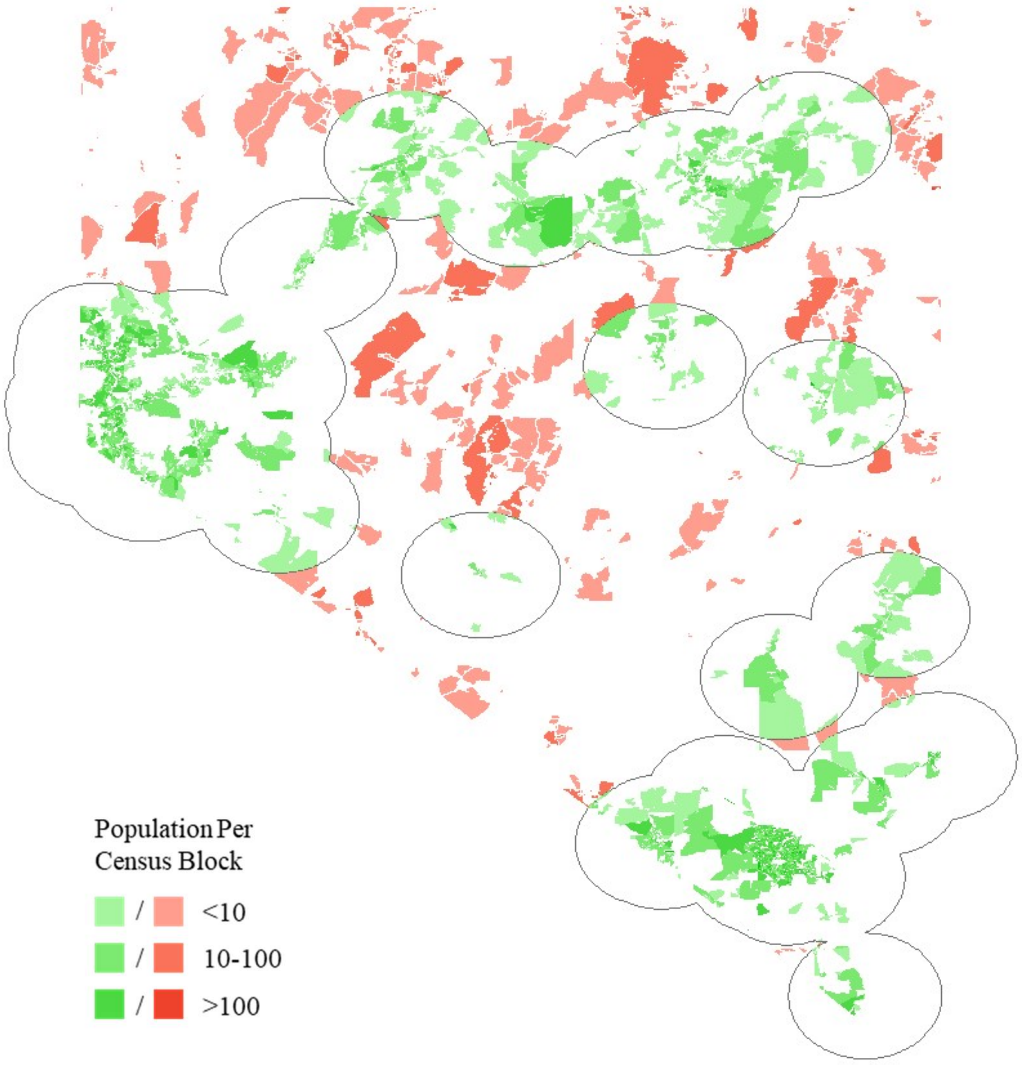

Figure 5a - All dental offices in Nevada with a 30-mi radius catchment area. This map shows the location of all dental offices in Nevada with a 30-mi radius circle surrounding each one. Census blocks in green show populations with access to a dental office within a 30-mi radius. Census blocks in red show populations without access to a dental office within a 30-mi radius.

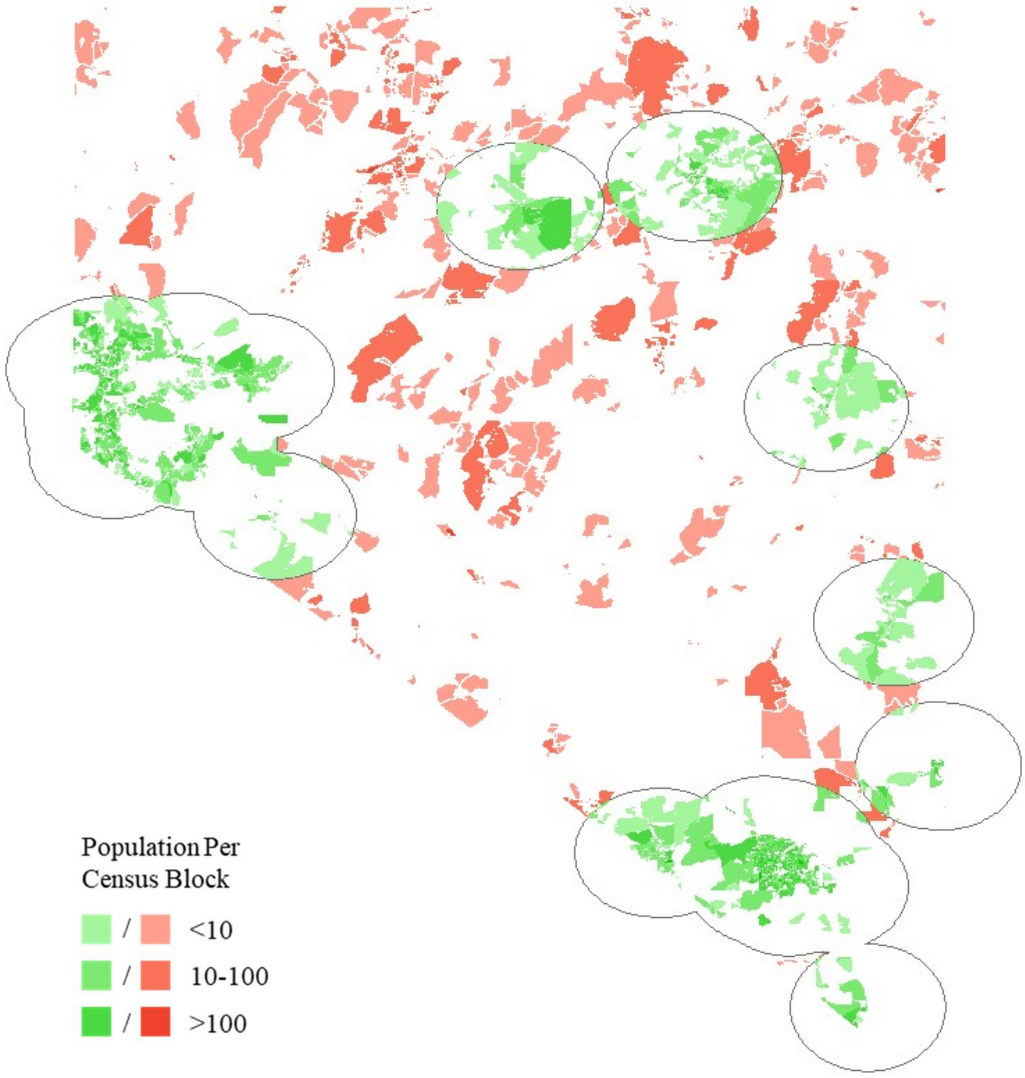

Figure 5b - Medicaid-accepting dental offices in Nevada with a 30-mi radius catchment area. This map shows the location of all Medicaid-accepting dental offices in Nevada with a 30-mi radius circle surrounding each one. Census blocks in green show populations with access to a Medicaid-accepting dental office within a 30-mi radius. Census blocks in red show populations without access to a Medicaid-accepting dental office within a 30-mi radius.

The Relationship of Demographics and the Dental Workforce

We sought to find out whether certain demographic variables such as median household income and percentage of minority influenced the availability of dental care. Based on our data, no appreciable correlation (Pearson's *r,* $-0.4 \leq r \leq 0.4$) was found between the number of general practitioners and the total population in a zip code ($r = 0.284$, $p < 0.05$), nor was there an appreciation correlation found between the number of dental offices and the median household income in each zip code ($r = -0.294$, $p < 0.05$). The number of pediatric dentists per 100,000 people in each zip code was also not strongly correlated with the population of children ($r = -0.339$, $p < 0.05$) or the population of minority residents ($r = -0.346$, $p < 0.05$). On the other hand, there was found to be a positive correlation between the population of the zip code versus the number of Medicaid-accepting dental offices ($r = 0.520$, $p < 0.05$) and the total number of dental offices ($r = 0.487$, $p < 0.05$). The absolute ($r = -0.532$, $p < 0.05$) and per capita ($r = -0.474$, $p < 0.05$) number of Medicaid-accepting dental offices was found to be negatively correlated with the median household income levels. As ancillary findings, we found that the percentage of the population who are children was positively and strongly correlated with the percentage of minorities ($r = 0.727$, $p < 0.05$) and the percentage of Hispanics ($r = 0.852$, $p < 0.05$). Furthermore, the percentage of minorities ($r = -0.585$, $p < 0.05$) and Hispanics ($r = -0.779$, $p < 0.05$) was negatively and moderately correlated with the median household income. Looking at Medicaid-accepting offices, there seems to be a mild to moderate, positive correlation between the percentage of dental offices in each zip code that accept Medicaid versus the percentage of children ($r = 0.473$, $p < 0.05$), minorities ($r = 0.414$, $p < 0.05$), and Hispanics ($r = 0.609$, $p < 0.05$) that reside there. The percentage of Medicaid-accepting offices was found to also correlate negatively with the zip code's median household income ($r = -0.524$, $p < 0.05$).

Looking at how dental personnel and facilities interact with each other may also provide some insights. In general, there tends to be a moderately positive correlation between the number of dentists of one kind (general or specialist) and the number of dentists of another kind, in each zip code. The number of dental offices also positively correlate with the number of general and specialist dentists or Medicaid-accepting dental offices. In some pairings, the correlation may not be appreciable (i.e. $r < 0.4$) or not statistically significant (i.e. $p \geq 0.05$), but the direction of the correlation is a positive one, nonetheless.

CHAPTER 4

DISCUSSION

Preamble

One of the core challenges of dental public health relates to the problem of ensuring the availability of dental services within a population. For highly dense populaces, the economics of dentistry almost ensures that new and existing dentists will set up practices at such locations hoping to expose their practice to the highest number of possible patients. Over time, these dense metropolitan hotspots become saturated with dentists until the increasing competition deters potential competitors from entering the market and driving them to seek out other less crowded neighborhoods. Given a homogenous marketplace, with identical geographies and demographics, dentists would be equally distributed throughout the population. In reality, dentists are distributed very unevenly across intra-city boundaries (i.e. areas defined by zip codes) and between counties. To the original point, the economics of dentistry also means that rural areas that lack large clusters of the population sometimes make it more difficult for the dentist to sustain a profitable practice. However, rural practices attract patients from a wider area due to the paucity of dentists willing to practice in rural areas. Raising prices to counter the lack of patient volume introduces yet another problem for those patients who are now obliged to pay more for dental care, making good oral health less accessible. For public health-minded policymakers who want to direct greater healthcare dollars toward underserved communities and for dentists who want to find out which area in town is not as saturated with dentists, a clear picture of the distribution of dentists relative to the population would be useful. Leveraging publicly available data collected by regulatory agencies and the mapping capabilities of GIS, such a picture is well within reach.

Concerning access to dental care, dentists identified carrying limited dental licenses, geographically-restricted licenses, or live patient supervisor licenses were removed from the final list of 1,617 because they were considered not stable, reliable, and independent members of the dental workforce. It was also only pertinent for this study to map general dentists and *clinical* dental specialists. Non-clinical dental specialists, all of whom are no less important than their clinical counterparts, do not have the reach of their expertise hampered by geography. An oral and maxillofacial pathologist or radiologist can apply their skill remotely and does not require proximity with a patient, and public health dentists focus on the health of the population. From a total of 1,617 dentists in the state, approximately 4 out of 5 of them are general dentists. Orthodontists comprise about 7%, pediatric dentists about 5%, oral and maxillofacial surgeons and endodontists about 3%, periodontists about 2%, and prosthodontists about 1%. This compares similarly to the rest of the US where 4-5% are orthodontists, 3-4% are oral and maxillofacial surgeons, 3-4% are pediatric dentists and 2-3% each is endodontists and periodontists (Health Policy Institute, 2015c, 2017; Kaiser Family Foundation, n.d.).

County-level Analysis

The state of Nevada exhibits a bipolar distribution of its population, with 9 out of 10 Nevadans living in the northwest corner of the state (Washoe County and Carson City) or the southern tip of it in the Las Vegas Valley area. This latter area alone is home to three-fourths of the state population and over 80% of the state's urban population. Therefore, a county-level analysis was supplemented with a zip code-level analysis of the Las Vegas Valley area to learn in greater detail how dentists are distributed within the largest population cluster in Nevada. Across counties, the number of dentists seemingly correlates with the county population. Counties like Clark and Washoe with significantly greater populations have a commensurately greater number of dentists,

while the opposite is true with a lesser number of dentists in sparsely populated counties. However, plotting the dentist-to-population ratio on a heatmap shows a wide variation in the number of dentists per 100,000 people. This presentation shows that the distribution of dentists is not consistent with the county population, and three of the counties representing over 10,000 people do not have dentists altogether. This is not to say that normal supply and demand economic forces are not encouraging the development of new dental offices in these areas, but that perhaps other forces are at play that does not attract dentists to settle in these areas. Residents living in Storey County, which is one of three counties with no dentists registered within its boundaries, may not be facing an effective shortfall in access to dental care due to their proximity to Reno and Carson City. The picture is starker when dental specialists are considered with only 12 registered outside Clark County, Washoe County, and Carson City. Treated as a group, these urban areas have more than double the number of dentists per 100,000 people than in rural areas. These numbers confirm the familiar finding that rural communities have lesser access to dental care than urban communities not only in whether or not a dental provider is available in your vicinity but also with having to confront a smaller breadth of specialty services and therefore fewer treatment alternatives. One study comparing the dental supply of urban and rural America similarly found that the proportion of specialist dentists is lower in non-metropolitan locations than in metropolitan locations where specialists are represented in greater proportions (Doescher & Keppel, 2015). A patient living in a community where no dental providers can adequately perform retreatment of a molar root canal, will likely only receive extraction of the tooth and the placement of a bridge as the sole treatment plan available. More severe cases demanding higher levels of expertise will not receive the needed attention from a dental specialist. Patients in rural communities will have less access to second opinions, will be less able to find a dentist that they prefer, and have reduced

latitude to compare costs. Rural children in need of care from a pediatric dentist face a similar disposition. With only four pediatric dentists serving over 70,000 children scattered through the rural counties, it is more likely that an urban child will have access to a pediatric dentist if needed. The number of dental offices in each county provides an additional metric to gauge the availability of dental care. This analysis will undercount the dental care capacity in areas with multiple dentists and potentially reduce the apparent discrepancy between urban and rural counties. Even so, the number of dental offices in urban counties is more than double that in rural counties. This suggests that not only are there more doctors, but also more dental facilities to provide care in urban areas.

Zip Code-level Analysis

With over 2 million people, Clark County is the state's most populous county. Nearly all of the residents and dentists in Clark County live in the Las Vegas Valley. The county ranks as the state's most racially diverse and is home to the greatest percentage of children under the age of 18. A zip code-level analysis of the metropolitan area reveals similar pockets of underserved areas and certain demographic variables, such as percentage of minorities and Hispanics and mean household income that influence this. Residents living in underserved zip codes within urban areas can travel to adjacent zip codes to seek dental treatment. Even then, for those without a personal vehicle, it would not be uncommon for them to require taking multiple modes of public transit to get to and from the dental office. One can imagine this issue being more acute for Medicaid patients with lesser means of transport having to travel potentially greater distances to reach a dental office that accepts Medicaid. The zip code boundaries that contain each segment of the population are fuzzy and do not necessarily represent tangible barriers preventing access to dental care. Therefore, the value of the zip code-level analysis comes from allowing dentists to understand which areas of town are less saturated with dental offices and for policymakers to

understand the implications of certain demographics in influencing either the availability of dentists or the demand for dental care. A heatmap of the density of dentists in each zip code highlights a large disparity between the zip codes with the most and least dentists per 100,000 people. It is important to take note that zoning laws may have a strong impact on where commercial establishments like dental offices can be located (Maantay, 2001). A zip code with a greater amount of area designated as residential zones and therefore contain more people but fewer dental offices may appear to be an underserved area even though the zip code is surrounded by other zip codes with greater numbers of dentists. This does not appear to be a significant confounding factor since the average population of a zip code in the Las Vegas Valley area is 37,211 people with only four of the 55 zip codes in this area having populations that fall below 10,000. Another interesting finding is that the total population in a zip code was not found to be correlated with the number of general practitioners anyway. A more glaring disparity exists for dental office locations distributed across the Valley. Some zip codes do not have any dental offices per 100,000 people, while some have as many as 20+ offices. The number of dental offices tended to be higher for zip codes with greater number of dentists indicating a predictable propensity for dentists to work in areas with offices available. The number of dental offices was found not to be influenced by the zip code's median household income. This is in contrast to a study in Kentucky that showed a 37% increase in the number of dentists for every $10,000 increase in per capita income (Saman et al., 2010b). However, this study used per capita income instead of household income. The geographic distribution of the population and dental offices themselves throughout the state may also be vastly different from Nevada's. The way the dental offices are distributed may also speak to the local, county, and state differences in zoning laws and/or economic forces like the affordability of land or office space to start a practice.

Transportation Barriers

What does the uneven distribution of offices mean in public health terms? It means that a patient's health, which is linked to access to care is intimately tied to access to *transportation*. In this study, we found that a small percentage (around 6% of rural county residents), yet a still sizeable portion of the population are beyond a 30-mi radius of the nearest dental office "as the crow flies". This result builds on top of a report released by the Health Policy Institute of the ADA which found that 3% of the overall state population do not live within 15-minutes of a dental office (Health Policy Institute, n.d.). Taking into consideration residents that live farther from major arterial roads, there will be some, which this study did not try to quantify, who will have a greater travel distance than 30 miles and increasingly greater time expenditure as the distance grows. Another study that used travel time to delineate their catchment area found that 99.2% and 99.9% of the population of Missouri and Wisconsin respectively, could be contained within a 30-minute drive of the closest dental office (Nasseh et al., 2017b). Increased travel time and distance from the dental office raises transportation costs and further impedes a patient's likelihood of seeking and affording dental care. The importance of proximity as a factor to access to care cannot be understated. One study found that each one-mile increase in the distance to the dental office equates to a 2% decline in the odds that a patient will complete a comprehensive exam (Wehby et al., 2017). Especially among low-income populations, greater utilization of health care services is significantly associated with perceived or actual shorter distances to the clinic and reduced drive time (Mattson, 2011; S C McKernan et al., 2018; Nemet & Bailey, 2000). Having more than one dental office to choose from may also be beneficial because patients do not necessarily go to the nearest provider for dental care (Susan C. McKernan et al., 2016b). Compared to children with private dental insurance, Medicaid-enrolled children were found to live farther from their dentist due to the

relative scarcity of dentists who accept Medicaid. Yet, it was still found that children with private dental insurance were more likely to have bypassed the closest dental office to get to their current dentist (Susan C. McKernan et al., 2016b). Transportation and distance to the closest dental office are only one of many factors that play a role in determining the accessibility of dental services in rural areas. A study in Illinois found that regardless of whether Medicaid-enrolled children lived in urban or rural communities, the most important factors associated with dental utilization was not the rurality of their home, but factors like how many of the children have enrolled in Medicaid and the number of Medicaid-accepting dentists per capita (Byck et al., 2002). Another study looking at the effects of the Affordable Care Act Medicaid expansions showed that the expansion only increased the rate of dental visits for low-income patients in states with a high dentist-to-population ratio to begin with, and no utilization improvement was seen in states where this ratio was already low or where dental coverage was limited (Wehby et al., 2019). Taken together, this suggests that improving access to care in rural communities with a low dental workforce will require the concerted effort of greater funding to increase reimbursement rates, dental coverage, and enrolment rates for Medicaid patients; bring in mid-level providers that may be more accepting of the lower reimbursement rates and starting public health initiatives to incentivize more dentists to rural areas.

Medicaid County-level Analysis

It is therefore important that the Medicaid-accepting cohort of dentists be examined separately as there is a sizeable portion of the population that indeed only has access to dental care through Medicaid. For a Medicaid patient, the 998 dental offices shrink down to 359 ones that accept Medicaid. If the patient lives in a rural area, their access to a Medicaid-accepting office can drop significantly depending on where they reside. Out of the 359 dental offices that accept Medicaid

in the state, only 24 are in a rural county and five of them do not have any. Some rural counties boast a very high ratio of Medicaid-accepting offices out of the total number; however, many of these counties still have very low numbers of dental offices and low total populations. If one or two of the current Medicaid-accepting offices decided to stop taking Medicaid, then the entire county's ratio will decrease drastically, and vice versa. Roughly a third of dental offices in the three urban counties/city accept Medicaid, but only about a quarter of dental offices accept Medicaid in rural counties. The reasons for this are unclear. It may be that dentists operating in these more remote parts of the state already do not have an abundance of patients and must charge a higher treatment fee and cannot accept the lower reimbursement rates to stay profitable, or simply that reduced competition has obviated the need to accept patients that reimburse at the lower Medicaid rate. The fact that rural median household income is 6% greater than their urban median household income may also play a part, and if this is true, how does this affect low-income residents living *within* these supposedly wealthier enclaves? It is likely that the access to care disparity between low- and high-income individuals and households is even greater in these rural counties. Indeed, one study that looked at dental utilization in the state of Iowa found that low-income, Hispanic children living in rural populations had some of the lowest rates of utilization, even as their urban counterparts enjoyed significantly higher rates of utilization (Susan C. McKernan et al., 2015). This study found that the population outside of a 30-mi radius of a dental office increased three-fold when only Medicaid-accepting offices were included in the analysis in both urban and rural counties. Furthermore, it is likely certain demographics groups within these urban and rural counties will be at varying distances away from the closest dental office as a Georgia study found. In that study, low-income, Medicaid-eligible children were found to have to

travel an average of 3-5 times farther to an available dentist, depending on their rurality, than their high-income, privately insured counterpart (Cao et al., 2017b).

Medicaid Zip Code-level Analysis

The Las Vegas Valley is home to 269 of the county's 279 Medicaid-accepting dental offices. The Medicaid-accepting dental office-to-population ratio is similarly disparate across the Valley with higher densities of dental offices accepting Medicaid near the more insular parts of the metropolitan area and nearly none at the outskirts. Here, within a city with a very segmented population divided upon socioeconomic class, it was found that zip codes with higher median household incomes tended to have fewer Medicaid-accepting dentists in absolute terms and as a percentage. This is remarkable because it may suggest that dentists are responsive to the needs of their surrounding communities. If a dentist is in a lower-income area with many patients that qualify for Medicaid, they are more likely to accept these patients. This study found several demographic variables that may further weigh into how Medicaid-accepting dental offices are distributed. Median household income in a zip code was found to correlate negatively with the number of children, minorities, and Hispanic population as well. It is perhaps not surprising to find that those zip codes with higher percentages of these demographics also had a higher percentage of Medicaid-accepting offices. What is not clear is what underlying factors correlate these demographic variables together. For example, do zip codes with more children mean that parents are more likely to stay at home to care for the children and thus earn a lower median household income? Are Hispanic and minority populations earning less because they are younger or because they have lower educational attainment? Are most of the Medicaid-accepting offices in these zip codes pediatric dental clinics that tend to congregate around schools and community centers where children reside? These distinctions are difficult to ascertain, but finding this

distinction is important to inform the implementation of more precise public policies to improve dental wellness for the most vulnerable demographics.

CHAPTER 5

LIMITATIONS AND FUTURE STUDIES

Limitations of the Datasets

The list of licensed dental providers from the NSBDE contains a list of individuals registered with the board who can practice dentistry in the state. However, the Board does not require these individuals to list their office address, nor does it require they list all the offices where they practice. This address, which is used to allocate dentists in each county and zip code, may not be where the dentist practices dentistry. Since dentists may work in multiple locations, the availability of dental providers in each county and zip code may be underestimated. This study did not measure the availability of dentists based on such granular measures as the number of dentist hours available to service their county or zip code. Indeed, very limited hours in a rural clinic may overestimate how much dental care is available in the area. A future study that seeks to capture this information may rely on the conducting of a survey for all dentists in the state asking for the number of hours they work per week, which days of the week they work, and the location. Another way to assess productivity would be to access billing information from the state health department and private insurance companies; however, those patients that pay out of pocket will not be represented in that dataset.

Analyzing the location of dental offices also does not speak to any increase in access to care from the use of mobile clinics. The use of mobile dental clinic is not widespread in the state of Nevada, however, these clinics can be very effective modalities used to fill small pockets of the population that may either be living in very remote areas without a nearby dental office or otherwise are

encumbered with insurmountable transportation or other logistical difficulties that preclude them from being able to visit one.

Influence of Terrain on Travel

In analyzing the data, it was found that certain rural counties had a higher-than-average dental office-to-population ratio, but this may be due to the low populations in these counties, and at the level of the county, the residents may very well still live very far from them. On the other hand, residents that live in a county with few dental offices may well live closer to dental offices in a nearby county or even in a nearby state. However, the latter would not be an option for a Nevada Medicaid patient seeking care from an out-of-state Medicaid office—health coverage would not be automatically extended. The 30-mi radius catchment areas were used to partially account for these factors; even so, because rural landscapes may feature a greater range and number of natural barriers than urban ones, and the road networks may not often allow non-circuitous routes to the final destination, the transportation difficulties of residents living within the catchment areas are likely not homogenous and some will have to travel much greater distances than 30 miles. Future studies can factor in an assessment of the terrain and factor in any impediments to travel and also create the catchment area from predicted travel times based on the road network. This may also help identify isolated communities whose problem is not so much that a dental office is not nearby, but that the community is missing a road conjoining them. Also, this study did not account for any tribal health centers that are administered by the Indian Health Services or correctional institutions as private dental offices registered with the state would not be servicing this population. The Census Bureau data likely counted this population within their respective county, zip code, or census block, so some minor degree of overestimation of the population may be present.

Medicaid Utilization

This study treated each Medicaid-accepting office equally, however not all Medicaid providers and offices accept and bill the same number of Medicaid procedures. As is the case with any dental office, one or more providers may be present. Some providers may also be listed as Medicaid providers; however, they are no longer accepting new Medicaid patients. The list that was used did not contain information about the actual billing amount the provider charged to the state. Even if that were provided, the type of procedure would need to be recorded to weigh the effectiveness of a Medicaid provider to service their network of Medicaid patients. For example, a provider may only bill for patient consultations or records without substantial operative dental procedures performed. A future study can examine the range and frequency of Medicaid-qualifying dental procedures and possibly identify procedures that dentists are not doing due to low reimbursement rates, or conversely, procedures that are overly-represented compared to other comparable procedures possibly because it is more viable from an economic sense or it is procedure code that has a higher reimbursement rate and can be used if the dentist renders their diagnosis more liberally. Furthermore, future studies can differentiate between dental offices that accept Medicaid and dental providers themselves that do. This will give a sense of how each specialty is represented and where they are in the state.

Redefining the Dental Workforce

Future studies can also expand the definition of Nevada's dental workforce by including dental hygienists or even dental assistants. In the state of Nevada, dental hygienists can receive a special endorsement which allows them an expanded role, allowing them to practice with greater independence in certain public health or not-for-profit settings. These members of the dental

profession can help augment the reach of the dental workforce, especially out into more rural environments.

This study used county-level and zip code-level analysis to link dentists and dental offices. Since jurisdictions for health administration are often represented at the (multi-)county-level, each county needed to be identified separately. Zip code-level analysis for the Las Vegas Valley was used as opposed to smaller units of the area because zip codes are most familiar to the layperson as compared to any other smaller units of area (e.g. census tracts). The use of zip codes is easily understood by dentists deciding on where to start a practice and by patients seeking a dental practice near their home.

Varying Size of Catchment Areas

This study used a catchment area representing a 30-mile radius from all dental offices and only those that accepted Medicaid. Future studies can alter the size of this circle, and use travel distance or travel time to approximate a catchment area of a different size. The percentage of the population that do not have access to a personal vehicle, cannot afford a hired driver, and do not live in areas with a robust public transportation system will have to rely on other forms of transportation. Future studies can estimate the number of people in this category and outline smaller catchment areas to estimate the proportion of the population who live outside, of that area.

Deeper Dive into Income Levels

This study used median household income for each zip code and county, which precludes a deeper level of analysis using detailed income information. With more than 1 in 10 people in the nation living below the poverty threshold, it is a public health interest to not solely quantify the size of

this population but understand correlating demographics and geographic distribution—and specific to dental public health—how the dental workforce can sometimes be out of reach for these individuals. Future studies can also map the distribution of the population covered under Medicaid or other means-tested forms of public insurance and people who have access to employer-based or direct-purchase private insurance. For example, how many seniors without private health insurance are under 50% of the poverty threshold and where do they tend to live? This segment of the population is particularly vulnerable because Medicare does not provide routine dental coverage to them. Individuals with lower income levels can face impeded access to dental services. Knowing how large this population is and where they are located helps enhance public health policymaking and aids in directing resources more precisely to these populations.

Greater Characterization of the Dental Workforce

To augment studies can also attempt to gather more information about the characteristics of the dental offices. In addition to knowing where they are located, it would be useful to know the languages spoken by the dentists who will be more conversant with the corresponding minority groups. Similarly, knowing the age of the dentist can help predict where an eventual shortage of dentists will be when they retire. How do the dentists' demographic related to those of whom they serve? What kind of insurance plans do they accept and what is the average cost of dental care in an area? Even knowing which dental insurance plans are accepted by dentists in an area can be useful as it will inform patients on which company's plans to purchase, and whether they reside close to their in-network providers.

With access to data from multiple sites, a new study can explore correlations between the locations of dentists with the characteristics of their communities. If a community can encourage and allow

a dental office to thrive, then it is useful to better understand these dynamics. These data will help with city planning and the zoning of land in a way that is mindful of the health of the public. This coalignment of public and private interest can lead to thoughtful decisions being made that benefit public health and private enterprise.

Including the Element of Time

With datasets from multiple time points, it is possible to look at the changes of demographics and how dentists are distributed over time and the population threshold where a community can sustain a dental office. Major societal events such as financial downturns or global pandemics will affect both the demand (i.e. patients) and supply (i.e. dentists) of dental care. Major policy changes in the state, including the expansion of dental coverage through the Affordable Care Act, can influence a greater rate of new office start-ups or more dentists deciding to accept Medicaid. These studies will not only help to take a retrospective look at the result of these changes in the dental landscape but also provide a way to monitor and track the result of current and future public health initiatives.

Identifying Dental Care-Friendly Neighborhoods

Finally, future studies can devise metrics to measure the level of accessibility based on criteria including availability and cost of public transportation, the number of Medicaid-accepting dentists that still accept patients, waiting times for the earliest dental appointment, convenience of those times, ease of referrals between general dentists and specialists, and between dentists and other healthcare providers. These metrics can be indexed and mapped to visualize areas that may have greater access to dental care, which can be called dental care-friendly neighborhoods. These studies can survey the average cost of various dental services in a community and map their relative

affordability to determine the utilization of dental services. Using billing data from the state health department or private insurers, the volume and amount of dental care rendered can also be mapped across the state providing insights into whether there are areas with a sizable population and sufficient dental workforce, but below-average utilization.

CHAPTER 6

CONCLUSION

Many factors influence the accessibility of dental care and this study has illustrated that geography, as it pertains to the distribution of the dental workforce, is one such factor. In an urban area, having more or less dentists practicing in a given area signal to the affordability of the dental care, the breadth of dental services one may have access to, and the ease of traveling to those practices. In a rural setting, the same considerations are present, but with a greater emphasis on the influence of large distances to the nearest practice acting as a barrier to accessing care. To say that geography is destiny may be hyperbolic, but geographic factors do have epidemiological ramifications. This study found that the distribution of dentists, dental offices, including those that accept Medicaid across the state and in the Las Vegas Valley is uneven compared to the county's or zip code's total population. Nevadans living in rural counties are more likely to live farther away from a dental office, and less likely to have access to Medicaid-accepting or specialist providers. Future studies can investigate whether these discrepancies bear themselves out in lower quality of life, worse clinical outcomes, or poorer health. Median household income, a variable that's also tied to the percentage of children, minorities, and Hispanics living in an area, has been shown to inversely correlate with the number of Medicaid-accepting offices. Though the causality of this relationship is unclear, it nonetheless indicates a conducive symbiotic relationship between higher numbers of providers that are willing to accept Medicaid in an area with greater demand for Medicaid services.

Increasing access to oral health care has long been at the forefront of dental public health efforts that aim to contribute to the overall health of the population, by dissolving barriers that prevent patients from receiving the oral health care that they need. Community water fluoridation, for

example, has been lauded by many inside and outside the dental community as one of the greatest public health accomplishments realized in the post-war era. The credit for these successes, however, belongs to our forebearers. Today, with greater technological advances in such areas as teledentistry and big-data and a greater understanding of biological disease processes and their epidemiology, this generation of public health professionals is charged with maintaining this momentum.

APPENDIX A

IPR APPROVAL LETTER

UNLV

UNLV Biomedical IRB - Administrative Review
Notice of Excluded Activity

DATE:	December 6, 2018
TO:	David Capelli
FROM:	UNLV Biomedical IRB
PROTOCOL TITLE:	[1348004-1] Mapping the Distribution of Dentists in Nevada Using GIS
SUBMISSION TYPE:	New Project
ACTION:	EXCLUDED - NOT HUMAN SUBJECTS RESEARCH
REVIEW DATE:	December 6, 2018
REVIEW TYPE:	Administrative Review

Thank you for your submission of New Project materials for this protocol. This memorandum is notification that the protocol referenced above has been reviewed as indicated in Federal regulatory statutes 45CFR46.

The UNLV Biomedical IRB has determined this protocol does not meet the definition of human subjects research under the purview of the IRB according to federal regulations. It is not in need of further review or approval by the IRB.

We will retain a copy of this correspondence with our records.

Any changes to the excluded activity may cause this protocol to require a different level of IRB review. Should any changes need to be made, please submit a Modification Form.

If you have questions, please contact the Office of Research Integrity - Human Subjects at IRB@unlv.edu or call 702-895-2794. Please include your protocol title and IRBNet ID in all correspondence.

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APPENDIX B

TABLES

Number of Dentists by Specialty in Nevada

County	Number of General Practitioners	Number of Orthodontists	Number of Oral and Maxillofacial Surgeons	Number of Periodontists	Number of Prosthodontists	Number of Pediatric Dentists	Number of Endodontists	Number of General and Specialist Dentists
Clark County	921	91	34	21	14	52	32	1165
Washoe County	255	22	12	5	3	24	13	334
Carson City	17	3	0	2	0	4	2	28
Churchill County	11	0	0	0	0	0	0	11
Douglas County	20	1	1	0	0	2	0	24
Elko County	17	1	2	0	0	2	2	24
Esmeralda County	0	0	0	0	0	0	0	0
Eureka County	1	0	0	0	0	0	0	1
Humboldt County	5	0	0	0	0	0	0	5
Lander County	1	0	0	0	0	0	0	1
Lincoln County	1	0	0	0	0	0	0	1
Lyon County	11	1	0	0	0	0	0	12
Mineral County	1	0	0	0	0	0	0	1
Nye County	7	0	0	0	0	0	0	7
Pershing County	0	0	0	0	0	0	0	0
Storey County	0	0	0	0	0	0	0	0
White Pine County	3	0	0	0	0	0	0	3
Total	1271	119	49	28	17	84	49	1617

Number of Dentists by Specialty per 100,000 People in Nevada

County	Number of General Practitioners per 100,000 People	Number of Orthodontists per 100,000 People	Number of Oral and Maxillofacial Surgeons per 100,000 People	Number of Periodontists per 100,000 People	Number of Prosthodontists per 100,000 People	Number of Pediatric Dentists per 100,000K People	Number of Endodontists per 100,000 People	Total Number of General and Specialist Dentists per 100,000 People
Clark County	43.6	4.4	1.6	1	0.7	2.5	1.5	55.1
Washoe County	57.2	4.9	2.7	1.1	0.7	5.4	2.9	75
Carson City	31.4	5.5	0	3.7	0	7.4	3.7	51.6
Churchill County	45.8	0	0	0	0	0	0	45.8
Douglas County	42	2.1	2.1	0	0	4.2	0	50.4
Elko County	32.5	1.9	3.8	0	0	3.8	3.8	45.8
Esmeralda County	0	0	0	0	0	0	0	0
Eureka County	57.9	0	0	0	0	0	0	57.9
Humboldt County	29.3	0	0	0	0	0	0	29.3
Lander County	17	0	0	0	0	0	0	17
Lincoln County	19.2	0	0	0	0	0	0	19.2
Lyon County	21	1.9	0	0	0	0	0	22.9
Mineral County	22.4	0	0	0	0	0	0	22.4
Nye County	16.2	0	0	0	0	0	0	16.2
Pershing County	0	0	0	0	0	0	0	0
Storey County	0	0	0	0	0	0	0	0
White Pine County	30.4	0	0	0	0	0	0	30.4

Number of Dental Offices in Nevada

County	Number of Medicaid-Accepting Dental Offices	Number of Medicaid-Accepting Dental Offices per 100,000 People	Number of Dental Offices	Number of Dental Offices per 100,000 People	Percent of Dental Offices that Accept Medicaid
Clark County	279	13.2	709	33.6	0.39
Washoe County	48	10.8	168	37.7	0.29
Carson City	8	14.8	33	60.9	0.24
Churchill County	1	4.2	7	29.1	0.14
Douglas County	3	6.3	22	46.2	0.14
Elko County	5	9.5	18	34.4	0.28
Esmeralda County	0	0.0	0	0.0	-
Eureka County	0	0.0	1	57.9	0.00
Humboldt County	0	0.0	5	29.3	0.00
Lander County	1	17.0	1	17.0	1.00
Lincoln County	1	19.2	2	38.4	0.50
Lyon County	5	9.6	12	22.9	0.42
Mineral County	1	22.4	2	44.7	0.50
Nye County	6	13.9	13	30.0	0.46
Pershing County	0	0.0	2	30.0	0.00
Storey County	0	0.0	0	0.0	-
White Pine County	1	10.1	3	30.4	0.33
Total	359		998		0.36

Select Demographics in Nevada

County	Total Population	Ratio of Total Population Who are Children	Ratio of Total Population Who are Minorities	Ratio of Total Population Who are Hispanic	Median Household Income
Clark County	2112436	0.34	0.38	0.32	54882
Washoe County	445551	0.29	0.20	0.25	58595
Carson City	54219	0.27	0.19	0.24	49341
Churchill County	24022	0.28	0.15	0.14	46914
Douglas County	47632	0.21	0.12	0.13	61176
Elko County	52377	0.33	0.13	0.24	76178
Esmeralda County	1102	0.27	0.10	0.14	39405
Eureka County	1728	0.24	0.02	0.05	67159
Humboldt County	17088	0.33	0.12	0.27	69324
Lander County	5887	0.34	0.11	0.30	79865
Lincoln County	5203	0.20	0.13	0.07	52971
Lyon County	52303	0.26	0.14	0.18	50920
Mineral County	4471	0.24	0.38	0.12	39375
Nye County	43296	0.21	0.17	0.15	44225
Pershing County	6661	0.23	0.17	0.24	52308
Storey County	3891	0.13	0.07	0.03	63607
White Pine County	9858	0.24	0.14	0.16	60358
Total	2887725				

Population outside 30-mi Radius Catchment Area (2010)

County	Total Population	Population *Within* 30-mi Catchment Area of a Medicaid-Accepting Dental Office	Population *Outside* a 30-mi Catchment Area of a Medicaid-Accepting Dental Office	Population *Within* 30-mi Catchment Area of a Dental Office	Population *Outside* a 30-mi Catchment Area of a Dental Office
Clark County	1950951	1950161	790	1950939	12
Washoe County	421407	420847	560	420860	547
Carson City	55274	55274	0	55274	0
Churchill County	24877	24810	67	24810	67
Douglas County	46997	46997	0	46997	0
Elko County	48818	39439	9379	41372	7446
Esmeralda County	783	0	783	292	491
Eureka County	1987	546	1441	1935	52
Humboldt County	16528	57	16471	15064	1464
Lander County	5775	5241	534	5241	534
Lincoln County	5345	3813	1532	5139	206
Lyon County	51980	51974	6	51980	0
Mineral County	4772	4747	25	4748	24
Nye County	43946	37022	6924	39639	4307
Pershing County	6753	2	6751	6698	55
Storey County	4010	4010	0	4010	0
White Pine County	10030	9614	416	9655	375
Total	2700233	2654554	45679	2684653	15580

Number of Dentists by Specialty in the Las Vegas Valley

Zip Code	Number of General Practitioners	Number of Orthodontists	Number of Oral and Maxillofacial Surgeons	Number of Periodontists	Number of Prosthodontists	Number of Pediatric Dentists	Number of Endodontists	Total Number of General and Specialist Dentists
89002	5	1	0	0	0	0	0	6
89012	18	4	0	0	0	0	0	22
89014	30	6	0	0	0	5	1	42
89015	14	0	0	1	0	1	0	16
89044	7	0	0	0	0	0	0	7
89052	46	9	3	2	0	4	1	65
89074	50	6	2	1	0	1	5	65
89030	4	0	0	0	0	1	1	6
89031	6	0	0	0	0	1	0	7
89032	13	0	0	0	0	0	0	13
89081	1	0	0	0	0	0	0	1
89084	8	1	1	0	0	0	0	10
89085	0	0	0	0	0	0	0	0
89086	1	0	0	0	0	0	1	2
89101	9	0	0	0	0	0	1	10
89102	23	1	3	2	0	0	1	30
89103	15	0	0	0	0	0	0	15
89104	14	1	0	0	0	1	0	16
89106	15	2	1	2	2	2	0	24
89107	13	0	0	0	0	0	0	13
89108	4	1	1	0	0	0	0	6
89109	7	1	1	0	0	1	0	10
89110	11	2	0	1	0	0	0	14
89113	19	2	1	0	0	1	0	23
89115	1	0	0	0	1	0	0	2
89117	67	6	0	3	0	2	2	80
89118	21	1	0	0	0	3	1	26
89119	25	1	2	0	2	0	0	30
89120	15	0	1	0	0	0	0	16
89121	21	1	1	1	0	0	0	24

89122	2	0	0	0	0	0	0	2
89123	25	2	0	0	0	1	2	30
89128	31	3	4	1	1	1	2	43
89129	23	2	0	0	0	3	2	30
89130	11	0	0	0	0	1	0	12
89131	21	4	0	0	1	1	0	27
89134	30	3	0	0	0	0	1	34
89135	26	2	0	2	0	1	0	31
89138	17	0	2	1	0	2	1	23
89139	16	2	0	0	0	0	0	18
89141	16	1	0	0	0	2	0	19
89142	4	0	0	1	0	0	0	5
89143	5	0	0	0	0	0	0	5
89144	13	3	0	0	0	6	4	26
89145	15	2	0	0	2	1	0	20
89146	28	3	1	2	0	0	2	36
89147	31	4	2	1	2	2	1	43
89148	47	2	6	0	3	1	0	59
89149	23	6	1	0	0	3	1	34
89156	0	0	0	0	0	0	0	0
89166	3	0	0	0	0	0	0	3
89169	5	0	0	0	0	0	0	5
89178	11	0	0	0	0	0	0	11
89179	2	0	0	0	0	1	0	3
89183	11	1	0	0	0	1	0	13
Total	899	86	33	21	14	50	30	1133

Number of Dentists by Specialty per 100,000 People in the Las Vegas Valley

Zip Code	Number of General Practitioners per 100,000 People	Number of Orthodontists per 100,000 People	Number of Oral and Maxillofacial Surgeons per 100,000 People	Number of Periodontists per 100,000 People	Number of Prosthodontists per 100,000 People	Number of Pediatric Dentists per 100,000 People	Number of Endodontists per 100,000 People	Total Number of General and Specialist Dentists per 100,000 People
89002	14.2	2.8	0.0	0.0	0.0	0.0	0.0	17.1
89012	55.4	12.3	0.0	0.0	0.0	0.0	0.0	67.7
89014	76.0	15.2	0.0	0.0	0.0	12.7	2.5	106.4
89015	33.0	0.0	0.0	2.4	0.0	2.4	0.0	37.8
89044	35.9	0.0	0.0	0.0	0.0	0.0	0.0	35.9
89052	85.9	16.8	5.6	3.7	0.0	7.5	1.9	121.4
89074	101.8	12.2	4.1	2.0	0.0	2.0	10.2	132.4
89030	8.2	0.0	0.0	0.0	0.0	2.0	2.0	12.3
89031	9.0	0.0	0.0	0.0	0.0	1.5	0.0	10.5
89032	29.4	0.0	0.0	0.0	0.0	0.0	0.0	29.4
89081	2.8	0.0	0.0	0.0	0.0	0.0	0.0	2.8
89084	31.6	4.0	4.0	0.0	0.0	0.0	0.0	39.5
89085	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
89086	16.7	0.0	0.0	0.0	0.0	0.0	16.7	33.3
89101	21.8	0.0	0.0	0.0	0.0	0.0	2.4	24.2
89102	59.2	2.6	7.7	5.2	0.0	0.0	2.6	77.3
89103	28.9	0.0	0.0	0.0	0.0	0.0	0.0	28.9
89104	35.5	2.5	0.0	0.0	0.0	2.5	0.0	40.5
89106	56.0	7.5	3.7	7.5	7.5	7.5	0.0	89.5
89107	35.3	0.0	0.0	0.0	0.0	0.0	0.0	35.3
89108	5.4	1.3	1.3	0.0	0.0	0.0	0.0	8.0
89109	90.9	13.0	13.0	0.0	0.0	13.0	0.0	129.8
89110	14.8	2.7	0.0	1.3	0.0	0.0	0.0	18.8
89113	67.5	7.1	3.6	0.0	0.0	3.6	0.0	81.7
89115	1.7	0.0	0.0	0.0	1.7	0.0	0.0	3.3
89117	122.3	11.0	0.0	5.5	0.0	3.7	3.7	146.1
89118	98.1	4.7	0.0	0.0	0.0	14.0	4.7	121.5
89119	47.9	1.9	3.8	0.0	3.8	0.0	0.0	57.5
89120	59.4	0.0	4.0	0.0	0.0	0.0	0.0	63.4
89121	32.6	1.6	1.6	1.6	0.0	0.0	0.0	37.2

89122	3.9	0.0	0.0	0.0	0.0	0.0	0.0	3.9
89123	42.6	3.4	0.0	0.0	0.0	1.7	3.4	51.2
89128	85.1	8.2	11.0	2.7	2.7	2.7	5.5	118.1
89129	40.9	3.6	0.0	0.0	0.0	5.3	3.6	53.4
89130	30.3	0.0	0.0	0.0	0.0	2.8	0.0	33.1
89131	44.9	8.6	0.0	0.0	2.1	2.1	0.0	57.7
89134	123.2	12.3	0.0	0.0	0.0	0.0	4.1	139.6
89135	99.0	7.6	0.0	7.6	0.0	3.8	0.0	118.1
89138	112.5	0.0	13.2	6.6	0.0	13.2	6.6	152.1
89139	41.2	5.1	0.0	0.0	0.0	0.0	0.0	46.3
89141	51.2	3.2	0.0	0.0	0.0	6.4	0.0	60.7
89142	11.1	0.0	0.0	2.8	0.0	0.0	0.0	13.9
89143	37.1	0.0	0.0	0.0	0.0	0.0	0.0	37.1
89144	66.4	15.3	0.0	0.0	0.0	30.7	20.4	132.8
89145	61.1	8.2	0.0	0.0	8.2	4.1	0.0	81.5
89146	152.4	16.3	5.4	10.9	0.0	0.0	10.9	195.9
89147	57.6	7.4	3.7	1.9	3.7	3.7	1.9	79.9
89148	92.6	3.9	11.8	0.0	5.9	2.0	0.0	116.2
89149	60.6	15.8	2.6	0.0	0.0	7.9	2.6	89.6
89156	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
89166	14.9	0.0	0.0	0.0	0.0	0.0	0.0	14.9
89169	23.8	0.0	0.0	0.0	0.0	0.0	0.0	23.8
89178	30.0	0.0	0.0	0.0	0.0	0.0	0.0	30.0
89179	32.4	0.0	0.0	0.0	0.0	16.2	0.0	48.6
89183	28.2	2.6	0.0	0.0	0.0	2.6	0.0	33.4

Number of Dental Offices in the Las Vegas Valley

Zip Code	Number of Medicaid-Accepting Dental Offices	Number of Medicaid-Accepting Dental Offices per 100,000 People	Number of Dental Offices	Number of Dental Offices per 100,000 People	Ratio of Dental Offices that Accept Medicaid
89002	0	0.0	2	5.7	0.00
89012	0	0.0	10	30.8	0.00
89014	14	35.5	22	55.8	0.64
89015	0	0.0	13	30.7	0.00
89044	1	5.1	2	10.2	0.50
89052	10	18.7	32	59.8	0.31
89074	5	10.2	28	57.0	0.18
89030	8	16.3	9	18.4	0.89
89031	7	10.5	11	16.5	0.64
89032	10	22.6	15	34.0	0.67
89081	2	5.6	2	5.6	1.00
89084	1	4.0	5	19.8	0.20
89085	0	0.0	0	0.0	0.00
89086	0	0.0	2	33.3	0.00
89101	8	19.4	13	31.5	0.62
89102	18	46.4	19	48.9	0.95
89103	7	13.5	18	34.7	0.39
89104	9	22.8	15	38.0	0.60
89106	4	14.9	12	44.8	0.33
89107	5	13.6	10	27.1	0.50
89108	6	8.0	7	9.4	0.86
89109	2	26.0	4	51.9	0.50
89110	10	13.4	11	14.8	0.91
89113	3	10.7	14	49.7	0.21
89115	3	5.0	6	9.9	0.50
89117	8	14.6	41	74.9	0.20
89118	7	32.7	18	84.1	0.39
89119	12	23.0	29	55.6	0.41
89120	1	4.0	12	47.6	0.08
89121	14	21.7	28	43.4	0.50

89122	3	5.9	3	5.9	1.00
89123	6	10.2	21	35.8	0.29
89128	6	16.5	31	85.1	0.19
89129	7	12.5	18	32.0	0.39
89130	7	19.3	13	35.9	0.54
89131	3	6.4	12	25.7	0.25
89134	4	16.4	16	65.7	0.25
89135	0	0.0	7	26.7	0.00
89138	0	0.0	1	6.6	0.00
89139	6	15.4	12	30.9	0.50
89141	0	0.0	4	12.8	0.00
89142	1	2.8	3	8.4	0.33
89143	0	0.0	1	7.4	0.00
89144	1	5.1	4	20.4	0.25
89145	2	8.2	9	36.7	0.22
89146	14	76.2	27	146.9	0.52
89147	12	22.3	30	55.7	0.40
89148	5	9.8	30	59.1	0.17
89149	6	15.8	14	36.9	0.43
89156	1	3.5	1	3.5	1.00
89166	1	5.0	1	5.0	1.00
89169	4	19.1	7	33.4	0.57
89178	1	2.7	3	8.2	0.33
89179	0	0.0	0	0.0	0.00
89183	4	10.3	10	25.7	0.40
Total	269		688		0.39

Select Demographics in the Las Vegas Valley

Zip Code	Total Population	Ratio of Total Population Who are Children	Ratio of Total Population Who are Minorities	Ratio of Total Population Who are Hispanic	Median Household Income ($)
89002	35170	0.30	0.15	0.15	78792
89012	32503	0.25	0.22	0.14	72973
89014	39460	0.26	0.30	0.21	54051
89015	42366	0.24	0.19	0.20	52082
89044	19525	0.20	0.22	0.09	78896
89052	53535	0.28	0.26	0.13	79026
89074	49107	0.23	0.23	0.18	68479
89030	48944	0.59	0.48	0.70	32533
89031	66830	0.35	0.42	0.36	63004
89032	44155	0.39	0.52	0.42	56978
89081	35467	0.39	0.51	0.33	61116
89084	25307	0.31	0.41	0.21	71924
89085	4679	0.33	0.27	0.21	106295
89086	6003	0.41	0.52	0.27	57340
89101	41265	0.46	0.60	0.58	24023
89102	38831	0.49	0.50	0.50	33681
89103	51928	0.38	0.50	0.37	39770
89104	39473	0.44	0.47	0.59	34792
89106	26803	0.45	0.65	0.38	31421
89107	36861	0.39	0.38	0.49	41333
89108	74753	0.40	0.41	0.45	44602
89109	7705	0.33	0.37	0.28	46875
89110	74466	0.50	0.41	0.64	44947
89113	28166	0.30	0.44	0.18	65337
89115	60348	0.51	0.45	0.55	35395
89117	54762	0.27	0.36	0.17	54216
89118	21407	0.32	0.47	0.23	51687
89119	52171	0.44	0.48	0.41	32879
89120	25235	0.30	0.36	0.39	51422
89121	64457	0.35	0.43	0.43	39173

89122	51074	0.33	0.51	0.38	46560
89123	58630	0.24	0.31	0.22	62745
89128	36412	0.30	0.39	0.26	55840
89129	56224	0.28	0.32	0.20	67866
89130	36246	0.26	0.30	0.21	65485
89131	46772	0.28	0.25	0.17	85955
89134	24357	0.13	0.17	0.08	64844
89135	26259	0.26	0.25	0.10	84397
89138	15117	0.34	0.26	0.12	110136
89139	38846	0.39	0.54	0.20	73375
89141	31276	0.33	0.42	0.19	85924
89142	35891	0.44	0.60	0.55	48978
89143	13491	0.33	0.26	0.19	81419
89144	19575	0.30	0.29	0.14	84051
89145	24536	0.29	0.29	0.27	56424
89146	18375	0.34	0.42	0.36	46451
89147	53840	0.31	0.44	0.21	52796
89148	50767	0.36	0.44	0.20	67477
89149	37967	0.28	0.28	0.15	68538
89156	28746	0.41	0.39	0.52	47541
89166	20128	0.32	0.32	0.20	80814
89169	20987	0.44	0.40	0.44	30960
89178	36615	0.31	0.43	0.19	79846
89179	6172	0.36	0.42	0.19	85647
89183	38941	0.30	0.40	0.24	64616
Total	2028926				

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