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The Effect of Change in Medi-Cal Dental Coverage on Dental Care Utilization Among Medi-Cal Beneficiaries

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A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy at Virginia Commonwealth University

By

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Table of Contents

List of Tables

List of Figures

Abstract

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By Min He Zhang, M.S.

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One of the most important factors in accessing dental care is having dental insurance. For people with low incomes, Medicaid is the main source of health insurance. Medi-Cal is California's Medicaid program. Adult dental services were mostly eliminated in Medi-Cal in 2009 due to the economic downturn and partially restored in 2014. The objective of this study is to evaluate the effect of change in Medi-Cal dental coverage, specifically the partial restoration of adult dental coverage in 2014, on dental care utilization among Medi-Cal beneficiaries. The partial restoration significantly increased the utilization rates in dental clinics from 2014 to 2017 (22% in 2017 vs. 12% in 2013) for the overall population. However, the magnitude of increase differs in different age groups and ethnic groups. More statistically significant findings show greater utilization rates among beneficiaries of 19-64 than 65-74 and 75+ years old. Also, more significant findings show lower utilization among Black than White, Hispanic or Asian beneficiaries. The partial restoration significantly reduced the dental related ER visits among Medi-Cal beneficiaries from 2015 to 2017. However, the reduction is largely seen in beneficiaries of 19-64 years old in the ethnic groups of White and Black with reductions of 20 and 15 visits per 1,000 enrollees respectively in 2017 comparing to 2013. The dental related ER

visits were lower for Hispanics and Asians, and remained very low among those 65 years old and above. In addition, the partial restoration resulted in increases in participation of dental care providers in the Medi-Cal program.

Chapter One Introduction

Background

Regular visit to dentists and good habits in dental hygiene are important factors to maintain or improve oral health (United States. Congress. Senate. Committee on Health, 2016). Without regular tending to the teeth, dental problems and diseases can cause pain, limitations and disabilities in eating (Locker, 1988). Compared to younger people, older people have a greater prevalence of certain dental problems and diseases such as xerostomia (dry mouth), periodontal disease, tooth loss and oral cancer (Furness, Worthington, Bryan, Birchenough, & McMillan, 2011; Griffin, Jones, Brunson, Griffin, & Bailey, 2012; National Cancer Institute, 2015; National Institute of Dental and Craniofacial Research, 2018a, 2018b). The age-group disparity is mainly due to aging-related physiological changes in the oral cavity, and in the cardiovascular, pulmonary and musculoskeletal systems seen in older people (Abrams & Thompson, 2014). In addition, older people's poly-pharmacy, low oral health literacy and lack of preventive care at younger ages may also contribute to the observed disparities (Douglass & Jiménez, 2014; Douglass & Heckman, 2010; McQuistan, Qasim, Shao, Straub-Morarend, & Macek, 2015).

One of the most important factors in accessing dental care is having dental insurance (Kreider, Manski, Moeller, & Pepper, 2015; Lambert & Tepper, 2010; United States Congress. Senate Committee on Health, 2016). However, many older Americans can't rely on their Medicare insurance to pay for dental services as Medicare Parts A and B don't cover routine dental care such as teeth cleaning, dentures and root canals, etc. (Centers for Medicare & Medicaid Services, 2019a; Willink, Schoen, & Davis, 2016). Currently Medicare Part A and Part B only cover dental care needed by a concomitant medical problem, for example, a tooth extraction may be required prior to a heart surgery (Willink et al., 2016).

For persons with low incomes, Medicaid is the main source of health insurance. While federal law requires Medicaid to provide dental coverage to children, dental coverage for adults is optional, and states have flexibility in which optional Medicaid services they offer. The adult dental coverage in Medicaid varies greatly from state to state. As of Feb. 2016, only 15 states provide comprehensive dental benefits for adults through Medicaid; in the rest of the states, either none, limited or emergency only dental benefits are provided for adult Medicaid beneficiaries (Hinton & Paradise, 2016; United States Congress Senate, Committee on Health, 2016). An additional problem is a lack of dentists serving persons on Medicaid due to low reimbursement rates and excessive administration workloads (Pourat, Andersen, & Marcus, 2015). Consequently, there are a growing number of patients seeking medical treatment in the emergency room (ER) for pain from untreated and delayed dental problems/diseases. Services provided to patients in the ER are costly and reactive, usually with low likelihood of continuity of care (Singhal et al., 2015; Wall & Vujicic, 2015).

Inadequate dental insurance coverage or a lack of dental insurance coverage coupled with a lack of availability of dental care providers create access barriers to utilization of dental care services, especially for older people with low incomes due to factors such as job loss, lower lifetime earnings, or diminishing savings (National Council on Aging, 2019). The lack of access to dental care services puts people at higher risk of developing various health problems and the problems are greater among people of racial and ethnic minorities (Dye, 2015; United States Congress Senate, Committee on Health, 2016).

Objective and Scope of the Study

The objective of this study is to evaluate the effect of change in Medi-Cal dental coverage, specifically the partial restoration of adult dental coverage in 2014, on dental care utilization among

Medi-Cal beneficiaries.

Medi-Cal is California's Medicaid program. In 2018, approximately 13 million (about one-third of California's population) were enrolled in Medi-Cal (California Legislative Analyst's Office, 2018). For this exploratory study, dental coverage refers to adult dental coverage under Medi-Cal, a benefit that has been through many changes over the years. In recent years, the major changes include:

- 2009: elimination of most adult dental services due to the economic downturn
- 2014: partial restoration of adult dental coverage
- 2018: full restoration of adult dental services

Studies evaluating the impact of Medi-Cal's policy change in 2009 show that the elimination of adult dental service resulted in an increase in dental-related ER visits, a reduction in utilization of dental service in the dental clinics among Medi-Cal beneficiaries, and a drop in dental providers participating in Medi-Cal program (Maiuro, 2011; Rampa, Wilson, & Allareddy, 2016; Singhal et al., 2015; Wides, Alam, & Mertz, 2014).

To date, a literature search has yet to find studies evaluating the impact of Medi-Cal's policy changes of partial restoration of adult dental coverage in 2014. Given that full restoration of the adult dental coverage didn't get approved until 2017 and was not enacted until the beginning of 2018, data are yet to become available to evaluate the impact of those changes.

Theoretical Framework

The Ethnicity, Aging and Oral Health Outcome Model developed by Andersen and Davidson (Andersen & Davidson, 1997) is utilized as the theoretical framework for this study. The model was adapted from the Andersen's Behavioral Model for Health Service Utilization

(1995) which is used to explain why individuals differ in the amount of health care they consume. A major goal of the behavioral model is to evaluate measures of access to health care and through the adapted model, inequalities in dental care utilization by age and ethnicity group.

Research Questions

To evaluate the effect of the policy change in Medi-Cal dental coverage on dental care utilization, specifically the partial restoration of adult dental coverage in 2014, among Medi-Cal beneficiaries, the following questions are addressed.

- **Question 1**: Did the partial benefit restoration in 2014 increase the dental care utilization in clinics by Medi-Cal beneficiaries to the level prior to elimination of adult dental coverage in 2009? How does the impact vary by different dental services such as annual dental visit, preventive services, dental exams, restorative services, and treatment of caries?
- **Question 2**: Did the partial benefit restoration in 2014 affect older Medi-Cal beneficiaries' dental care utilization in clinic differently than younger age beneficiaries?
- **Question 3** Did the effect of partial benefit restoration in 2014 vary by ethnic groups?
- **Question 4**: Did the partial benefit restoration in 2014 reduce dental-related ER visit by Medi-Cal beneficiaries? How does the impact vary by age group and ethnic groups?
- **Question 5**: How much has the partial benefit restoration in 2014 increased the participation of dental care providers? Is the impact on general practitioners different from that on specialists (e.g., orthodontist, oral surgeon, periodontist, or prosthodontist)?

Analytical Approach

In this study, dental care utilization was evaluated separately for dental clinic visits and ER visits. All study data were provided by the California Health Care Service. All dental care utilization data were aggregated without any identifiable personal information on Medi-Cal

beneficiaries.

For clinic visits, dental care utilization is defined as utilization rate of different dental care services categorized by Current Dental Terminology (CDT), such as annual dental visit, preventive services, dental exams, dental treatment, restorative services, and treatment of caries. Utilization rate was calculated as number of users for dental care service divided by number of Medi-Cal beneficiaries. Yearly data from 2007 to 2017 by age group, ethnicity group and county were used for the study.

For ER visits, dental care utilization is defined as number of dental related emergency visits per 1,000 enrollees per year. Yearly data from 2013 to 2017 by age group and ethnicity group were used for the study.

In addition, data of dental care providers who participated in the Med-Cal program from 2012 to 2017 were used to evaluate the impact of policy change on providers' participation in the program.

For dental care utilization in clinics and ER, and participation of dental care providers, descriptive statistics were tabulated and graphic presentations were generated for visual inspection of the data. For dental care utilization in clinics, a repeated measures (longitudinal) analysis of variance model was fitted. The repeated measure analysis of variance model is appropriate as utilization rate was measured repeatedly over time for each county by age and ethnicity group. The fixed effects include age, ethnicity and year which are the variables of primary interest, as well as geographic region which serves as a covariate. Analysis of variance was utilized to compare dental related ER visits among calendar years adjusting for age and ethnicity.

For participation of dental care providers in the Medi-Cal program, descriptive statistics and graphic presentations were generated by type of providers (rendering provider, billing provider and Safety Net Clinics (SNCs). In addition, a repeated measures (longitudinal) analysis of variance model was utilized to evaluate the differences in number of Safety Net Clinics (SNCs) among different regions and year, as the data set includes number of SNCs in each county from 2012 and 2017.

For each statistical model, analysis was done to check whether the model assumptions were met. For each statistical comparison (e.g., among age groups and ethnicity groups), estimated difference and its 95% confidence interval and P-value were produced. For this exploratory study, a P-value less than 0.05 (2-sided) is considered statistically significant. Given the exploratory nature of the study and that P-values were not adjusted for multiple comparisons, caution needs to be taken in interpreting the results from each hypothesis testing as discussed in the Results and Discussion sections.

Summary

This introductory chapter provides brief descriptions on the background and theoretical framework of this study. The objective and scope of the study are also stated. In addition, research questions and analytical approaches are introduced.

Chapter Two provides more background on factors affecting oral health, the effects of poor oral health, access to dental care for older Americans specifically adult dental coverage in Medicare and Medicaid, and participation of dental care providers in Medicaid. In addition, recent policy changes in the dental programs under Medi-Cal and studies assessing the impact of these policy changes are reviewed. Chapter Two also presents the Aging and Oral Health Outcome Model developed by Andersen and Davidson (1997) and the rationale for using this

model as the theoretical framework for this study. Research questions and their associated hypotheses are listed at the end of the Chapter Two and the planned statistical analyses are described in Chapter Three. The results from the statistical analyses are presented in Chapter Four and discussed in Chapter Five.

Chapter Two Literature Review

Overview

The literature review of this research includes the sources related to major factors affecting oral health, the effects of poor oral health, and access to dental care for older Americans, especially vulnerable older people. Sources related to factors associated with participation of dental care providers in Medicaid dental program are also presented. In addition, recent policy changes in the dental programs under Medi-Cal (Medicaid in California) and studies assessing the impact of these policy changes are reviewed. The Aging and Oral Health Outcome Model developed by Andersen and Davidson in 1997 is utilized as the theoretical framework for this study. The model was developed based on Andersen's Behavioral Model for Health Care Use which is also briefly described (Andersen, 1995) .

Importance of Oral Health Care for Older Americans

Major factors affecting oral health for older people. The major factors affecting oral health for older people include but are not limited to aging-related physiological developmental changes in oral cavity and throughout the body, dental diseases/problems, diet, medications and oral health literacy.

The age-related physiological developmental changes to the oral cavity affect physical appearances, molecular compositions and functions of tooth tissues, salivation and oral motor functions (Abrams & Thompson, 2014; American Dental Association, 2018a; Guiglia et al., 2010). The aging-related physiological developmental changes in the cardiovascular, pulmonary and musculoskeletal systems may affect oral health, as indicated by studies showing associations of periodontal disease with chronic conditions such as diabetes, heart disease, and stroke (Abrams & Thompson, 2014; American Dental Association, 2018a; Raphael, 2017). The

common dental diseases/problems among older people are xerostomia, periodontal disease, tooth loss and oral cancer.

Xerostomia. Xerostomia, also known as dry mouth, is caused by inadequate saliva production. The prevalence of xerostomia is higher among older people which is estimated at up to 50% compared to 20% in the general population (Furness et al., 2011).

Periodontal disease. Periodontal disease is commonly known as gum disease and is caused by the bacteria in plaque with irritation to the gums which makes the gums swollen, red and easy to bleed (American Dental Association, 2018c). The prevalence of periodontal disease increases with age. In the U.S., the prevalence of periodontal disease in adults age 20 to 64 years old is 8.52%, while the rate is about double in people age 65 and over at 17.20%. For severe periodontal disease, the rate in adults age 20 to 64 is 5.08%, while the rate is also about double in people age 65 and over at 10.58% (National Institute of Dental and Craniofacial Research, 2018a, 2018b).

Tooth loss. There are 28 teeth in a normal adult's mouth, not including the wisdom teeth which are extracted in the majority of people in the U.S. Among people age 65 and over, the average number of permanent teeth is 18.9; with 27.3% of older persons being edentulous (total tooth loss) (National Institute of Dental and Craniofacial Research, 2018c). The rate of total tooth loss increases with age, up to 31% for age 75 years old and above (Griffin et al., 2012). However the proportion of edentulous older adults has decreased over recent years, from 33% in 1993 to 24.3% of non-institutionalized adults age 65 years and older in 2010 (Yellowitz & Schneiderman, 2014). This decrease in the percentage of older adults who are edentulous results in a greater demand for dental care among this population.

Oral cancer. Oral cavity and pharynx cancer represents about 3% of all new cancer cases in the U.S. (National Cancer Institute, 2015). The prevalence of oral cancer is higher among older people compared to younger people, with the median age of diagnosis being 63 years old and the median age of death being 67 years old (National Cancer Institute, 2015).

The major factors affecting oral health for older people also include diet, medications, and oral health literacy.

Diet. A correlation has been established between diet and oral health. Specifically, there is a positive correlation between a balanced diet and a state of oral health while there is also a positive correlation between an imbalanced diet and a state of oral disease. Insufficient supply of proteins, lipids and carbohydrates are shown to lead to a number of dental problems (Scardina & Messina, 2012). Food insecurity is defined as "*limited or uncertain availability of nutritionally adequate and safe foods, or limited or uncertain ability to acquire acceptable foods in socially acceptable ways*." (Wiener, Sambamoorthi, Shen, Alwhaibi, & Findley, 2018, p. 1). A significant association between low food security and unmet dental need has been identified based on data from National Health and Nutrition Examination Survey (NHANES) 2011-2012. Among adults with low food security, the percentage of unmet dental care need was 70% compared to 41% among all adults with high food security (Wiener, Sambamoorthi, Shen, Alwhaibi, & Findley, 2018).

Medication. There are more than 250 medications that affect smell, taste or salivation which may lead to changes in food and fluid intake for patients, such as consuming fewer calories, or adding more salt or sugar, or drinking more fluids to mask the bitter taste of some medications. The issue is greater among older people with a higher rate of frailty and polypharmacy (R. Douglass & Heckman, 2010).

Oral health literacy. There is a positive relationship between level of oral health literacy and oral health status (Baskaradoss, 2018; J. Y. Lee, Divaris, Baker, Rozier, & Vann, 2012). Most older adult patients have knowledge of basic dental disease prevention and treatments, but many are not familiar with concepts related to dental diseases such as periodontal disease, and oral cancer (McQuistan et al., 2015). In addition, some older adults didn't benefit greatly from preventive dental care at younger age and therefore would continue to need operative dental services (C. W. Douglass & Jiménez, 2014).

Effects of poor oral health. According to Locker's conceptual model of oral health (Locker, 1988), there are 5 consequences of oral disease that are sequentially related. They are: impairment, functional limitation, pain and discomfort, disability, and handicap (physical, psychological or social disadvantage, e.g., social isolation) as depicted in Figure 1. For example, tooth loss is a loss of a body part, thus it is a physical impairment. In addition, there are other consequences of tooth loss, such as the functional limitation of eating or speaking and experience of physical discomfort or even pain. Either functional limitation or discomfort and pain could lead to physical disability or psychological and/or social disability. Physical, psychological or social disadvantage could result from either one of these consequences or a combination of multiple consequences of impairment, functional limitation, discomfort and pain, and disability.

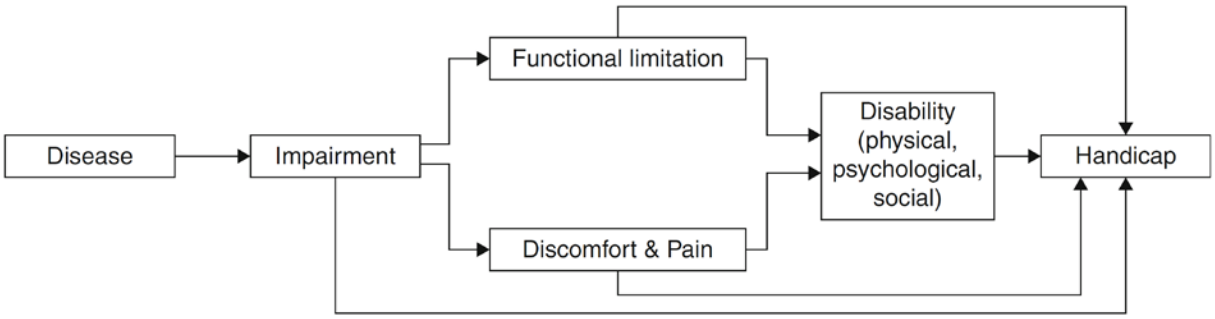


Figure 1. **Locker's (1988) conceptual model of oral health.**

Results from various studies among the older population in the U.S. and other countries have provided evidence supporting Locker's conceptual model of oral health. For example, for older people, the effects of poor oral health include but are not limited to the following (Griffin et al., 2012; Jaffe, 2016):

- Impairment of chewing efficiency which limits food choices and reduces the enjoyment of eating
- Affects to physical appearance which may limit social interactions and reduce self-esteem
- Reduction of quality of life due to pain from untreated oral disease
- Increased risk of adverse health outcomes. For example, an untreated dental cavity can result in bacterial infection which can travel to the bloodstream and pose fatal risks to older people with a compromised immune system. Other adverse health outcomes may include but are not limited to higher incidence of respiratory infections, ischemic stroke, myocardial infarctions, and risks of type-2 diabetes.

In addition, tooth loss has been shown to be an independent risk factor for loneliness among older people (Rouxel et al., 2017), and the transition from having one's own teeth to

having dentures has been correlated with oral functional and psychosocial well-being of older patients (John et al., 2004). Consistent correlations have been shown between oral health quality of life and well-being and depression in old age (Hassel et al., 2011), and between oral health and somatization (a disorder of expressing psychological distress as physical symptoms), the occurrence of which increases with age (Hassel et al., 2007).

Dental Care Access for Older Americans

The Institute of Medicine defines access to health care as "the timely use of personal health services to achieve the best possible health outcomes" (Office of Disease Prevention and Health Promotion, 2018, p. 1). The 3 distinct steps required for access to care are: (a) obtaining entry into the health care system usually through insurance coverage; (b) accessing a location providing health care services; and (c) finding a health care provider with whom the patient can have a personal relationship based on communication and trust (Office of Disease Prevention and Health Promotion, 2018). Timely and appropriate access to health care, including dental care, is important for preservation of function, reduction of premature morbidity and mortality, and improvement of overall quality of life (Dolan, 2010). The major barriers to health services include: high cost (U.S. Department of Health & Human Services, 2016), inadequate or lack of insurance coverage (Henry J. Kaiser Family Foundation, 2019), lack of accessibility and availability of health care services (Kullgren, McLaughlin, Mitra, & Armstrong, 2012), and lack of care of cultural competence (Office of Disease Prevention and Health Promotion, 2018). Barriers to access to care may result in unmet health needs, delays in appropriate treatment, inability to obtain preventive services, financial burdens and preventable hospitalizations (Office of Disease Prevention and Health Promotion, 2018).

For dental care, Guay (2005) depicted an “Access Triangle” (p. 1) (Figure 2) based on the supply-demand relationship in classic economics to illustrate the elements needed for any access program to be successful: “1) an adequate dental workforce able and willing to provide dental care; 2) an adequate effective demand for dental care by the targeted population; and 3) an equitable economic environment for both providers and patients that allows them to participate in the program” (Guay, 2005, p. 1).

Figure 2. **The access triangle (Guay, 2005).**

Older Americans in general have a better oral health status compared to those in previous decades due to increasing awareness of the connections between oral health and systemic health, greater utilization of dental services, improvement in oral hygiene practices and dental technologies (Dolan, 2010). However, there are significant disparities in accessing dental care among older Americans. Older people who have one or more of the following characteristics are likely to have less access to needed dental care: low income (Lee, Kim, Albert, & Nelson, 2014; Manski, Hyde, Chen, & Moeller, 2016; Manski et al., 2012), without dental insurance (Manski et al., 2016), edentulous (Manski et al., 2016), not believing in the need for dental care (Dolan,

2010), with difficulties in transportation (Bethel, Kim, Seitz, & Swann, 2014), difficulties in communication with dental professionals, belong to ethnic or minority groups (Northridge et al., 2017), or having functional or cognitive impairments (Yellowitz & Schneiderman, 2014).

Dental insurance. Regular visit to dentists and good habits in dental hygiene are important factors in maintaining or improving oral health (United States. Congress. Senate. Committee on Health, 2016). The frequency of dental visits should be tailored by dental professionals based on the status of the patient's current oral health and health history (Giannobile et al., 2013). As described above, without regular tending to the teeth, dental problems/diseases can cause impairment, pain, limitations, and disabilities (Locker, 1988).

It has been shown that one of the most important factors in the decision to seek dental care is having dental insurance (Kreider et al., 2015; Lambert & Tepper, 2010; United States. Congress Senate, Committee on Health, 2016). For older Americans, insurance options for health care coverage include Medicare, Medicaid, and private insurance. Dental coverage under Medicare is very limited. Dental care through Medicaid is an optional program benefit that some states cover either through direct coverage or through a Health Maintenance Organization (HMO). Coverage from private insurance companies is expensive and poses a heavy financial burden on many older people whose incomes are limited. About 70% of older Americans don't have dental insurance (Al-Sulaiman & Jones, 2016; Manski et al., 2011), which is much higher than the rate for children and nonelderly adults at 12% and 33% respectively (Vujicic, Buchmueller, & Klein, 2016). Dental coverage provided by Medicare and Medicaid are described below.

Medicare. Medicare was established in 1965 through the passage of the Social Security Act Amendment, which provided Americans aged 65 and older a basic program of hospital

insurance and supplementary medical insurance to aid in paying doctor bills and other health care bills. However, routine dental care, hearing aids and eyeglasses were excluded from Medicare coverage (U.S. National Archives & Records Administration, 2019). Many older Americans can't rely on their Medicare insurance to pay for dental services as Medicare Parts A and B don't cover routine dental care such as teeth cleaning, dentures and root canals, etc. (Centers for Medicare & Medicaid Services, 2019a; Willink et al., 2016). Currently Medicare Part A and Part B only covers dental care needed by a concomitant medical problem; for example, a tooth extraction may be required prior to a heart surgery (Willink et al., 2016).

Since 1965, as each generation reaches age 65, it distinguishes itself from the previous one in demographic and social circumstances. Compared to the 1960s, the population of Americans aged 65 and older has grown from about 12 million (9% of the total population) to about 49 million (15% of the total population) (US Census Bureau, 2017), and it is more diversified in race and ethnicity. The life expectancy at age 65 has increased from 15 years to 19 years (US Census Bureau, 2014). Currently more than 59 million older and disabled Americans (>18% of the nation's population) rely on Medicare for health coverage (Centers for Medicare & Medicaid Services, 2018) and the majority of them don't have dental insurance. Data from the 2012 Medicare Current Beneficiary Survey (MCBS) show that only 11.8% of all beneficiaries in the survey reported having commercial dental insurance and the rate differs sharply by income level as indicated in Table 1 (Willink et al., 2016). For beneficiaries with income levels below the federal poverty level (FPL), only 2.3% of them reported having commercial dental insurance, while for those with income levels of 400% or more of the FPL, the rate was 25.1%.

Table 1

Dental Insurance and Visit, by Beneficiary Income and Insurance Status, 2012

	Medicare Beneficiaries		
	Numbers	**Had a dental visit in past 12 months**	**With dental insurance**
All beneficiaries	56,100,001	46.1%	11.8%
Annual Income (percent of 2016 Federal Poverty Level)			
Less than 100%	8,976,000	26.3%	2.3%
100-149%	9,177,960	28.3%	3.7%
150-199%	6,933,960	36.2%	5.4%
200-399%	18,406,410	51.3%	14.3%
400% or more	12,459,810	72.8%	25.1%

Note: (Willink et al., 2016)

There have been few changes in dental coverage in Medicare since its establishment in 1965. Except for limited coverage under Part C in some Medicare Advantage Plans, routine dental care is still not covered under Medicare Part A and Part B. When changes in demographics and social circumstances outpace the changes in social structure, i.e., when social structures fall short of adapting to new age cohorts with different characteristics from the previous ones, they often fail to meet the needs of the current aging population and therefore result in structural lag (Riley, Kahn, & Foner, 1994). The structural lag is demonstrated in the current policy on dental care coverage in Medicare. Medicare is facing a long-term financing shortfall under currently scheduled benefits and financing according to the 2018 annual report by Social Security Trustees (Social Security Administration, 2018). The report from the Social Security Administration (SSA) lists three major reasons for the rising cost of Medicare: (a) population aging: more baby boomers (those born between 1946 and 1964) are retiring and enrolling in Medicare; (b) slower growth of the labor force and gross domestic product (GDP) due to the lower birth rate since the baby boom; and (c) increasing medical cost. It would take an act of Congress to include more needed dental services in Medicare. Given the current political environment with older people considered as the primary beneficiaries of the rising

national debt and spending on public programs, it is unlikely that Congress will add routine dental care to Medicare in the near future, thus the structural lag is expected to continue.

Medicaid. Medicaid provides health and long-term care to over 72 million Americans who are low-income adults, children, disabled or pregnant women (Centers for Medicare & Medicaid Services, 2019b). The enrollees in Medicaid are America's poorest and most vulnerable people. Medicaid is administrated by the individual states and is jointly funded by federal and state governments. It acts as a high risk pool for the private insurance market. About 7.2 million low-income older people are enrolled in Medicare and Medicaid as 'dual eligible' (Centers for Medicare & Medicaid Services, 2019c). While federal law requires Medicaid to provide dental coverage to children, dental coverage for adults is optional. Currently 46 states and the District of Columbia provide some dental benefits for adult beneficiaries in Medicaid, however the coverage varies greatly from state to state. As of February 2016, comprehensive dental benefits for adults are provided in 15 states (AK, CA, CT, OH, IA, MA, NC, ND, NJ, NM, NY, OR, RI, WA & WI); limited dental benefits for adults are provided in 19 states (AR, CO, D.C., IL, IN, KS, KY, LA, MI, MN, MO, MT, NE, PA, SC, SD, VA, VT & WY); and none or emergency-only dental benefits are provided in the remaining states (Figure 3) (Hinton & Paradise, 2016; United States. Congress. Senate. Committee on Health, 2016).

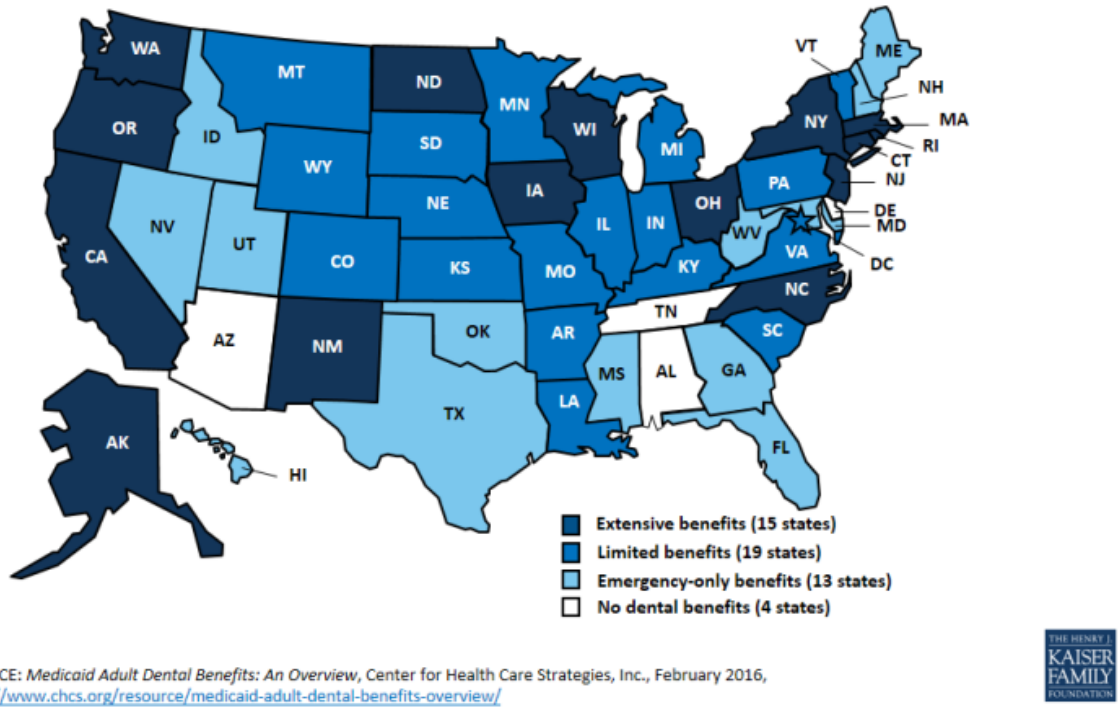


Figure 3. **Medicaid coverage adult dental benefits, February 2016.**
Reprinted from Hinton and Paradise (2016).

Studies using nationally representative survey data from the Behavioral Risk Factor Surveillance System (BRFSS) found that Medicaid dental coverage has an effect on increasing dental visits for Medicaid beneficiaries. Furthermore, Medicaid beneficiaries in states that provided dental care beyond emergency visits were more likely to have a dental visit in the past year than those in states providing emergency-only care (Oh, 2014; Singhal, Damiano, & Sabik, 2017). However, even in states with Medicaid dental benefits for adults, the out of pocket cost can be very high and as adult dental benefits are optional, they are subject to being reduced or cut especially during economic downturns when states are under budget pressures (Hinton & Paradise, 2016). In addition, there has been a long-standing problem of a shortage of dentists in the Medicaid program (Pourat et al., 2015). The estimated dentist participation rate in the Medicaid program varies depending on the source of the data, with median ranges from 45.0% to

76.6%, although the 45.0% figure is generally considered more reliable based on research by American Dental Association (ADA) (Warder & Edelstein, 2017). The estimated average rates of dentists treating at least one Medicaid enrollee are comparable across different sources and are between 40 to 45% (Figure 4).

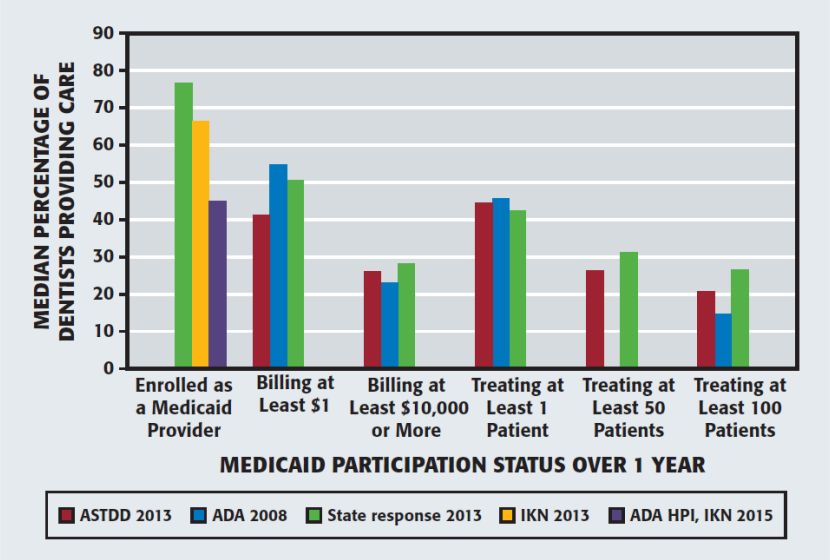


Figure. Median percentage of primary care dentists participating in Medicaid by data source and participation metric. ADA: American Dental Association. ASTDD: Association of State and Territorial Dental Directors. HPI: Health Policy Institute. IKN: InsureKidsNow.org. State response: Information secured from a state Medicaid or dental public health authority.

Figure 4. **Median percentage of dentist participation in Medicaid. Reprinted from Warder and Edelstein (2017).**

The major factors for the low participation rate are low reimbursement rate and excessive administration workloads (Pourat et al., 2015). Medicaid constitutes one of the largest portions of state budgets and the proportion has been rising for a number of years. In 2016, on average, Medicaid accounted for 28.7% of the total state budget and 15.9% of the total state funded budget, which was more than doubled comparing to rates in 1990 of 12.5% and 9.5% respectively as shown in Figure 5 (Medicaid and CHIP Payment and Access Commission, 2018).

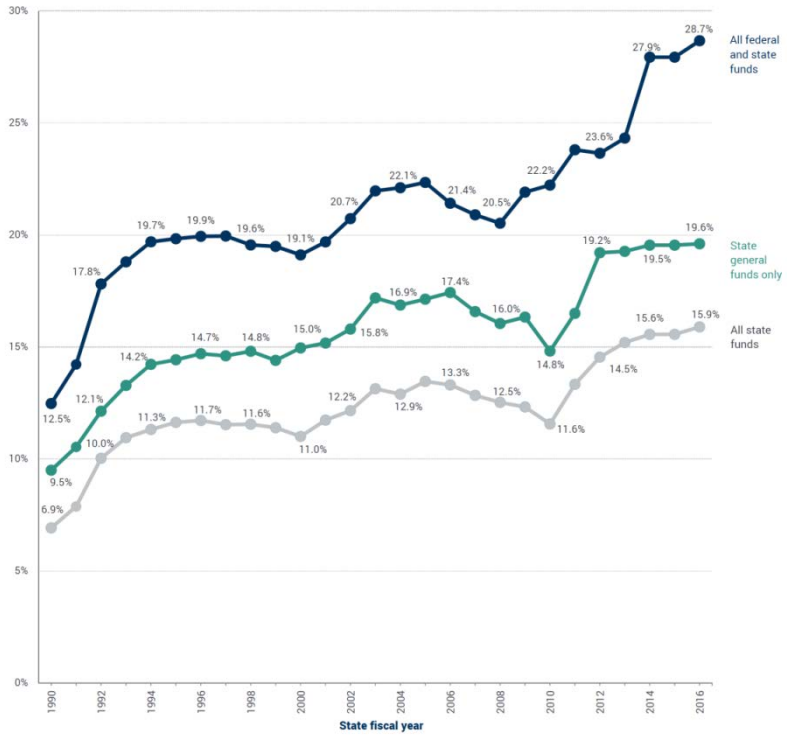


Figure 5. **Medicaid's share of state budgets including and excluding federal funds 1990-2016**. **Reprinted from Medicaid and CHIP Payment and Access Commission (2018).**

During economic downturns, enrollment in Medicaid usually increases as people lose jobs and their health benefits, which results in Medicaid expenses increasing substantially and states struggling to keep up with the higher costs of Medicaid with declining tax revenues (Galewitz, 2010). To control the Medicaid cost, states typically cut payment rates to doctors and/or reduce benefits which negatively impact the supply of providers and patient access (Galewitz, 2015). A Medicaid fee index measures states' payment fees relative to the national average with a survey in 2017 showing 18 states with a Medicaid index for fee-for-service fee below the national average. The excessive administrative burden also drives providers out of Medicaid. One study found that the average medical practice spends 98 eight-hour days on checking boxes and filling out text fields for quality reporting required by Medicaid (Casalino et al., 2016).

The supplier shortage is likely to be greater for older people. In the U.S., geriatrics has not been formally recognized by the American Dental Association (ADA) as an area of specialty and few dental schools offer further studies for a certificate in geriatric dentistry (American Dental Association, 2018b). As continuing education courses in geriatrics are only provided by 23% of dental schools, many dentists don't believe they have been adequately trained to treat older patients (Levy, Goldblatt, & Reisine, 2013). Also, health care providers may be less willing to accept Medicaid patients into their practices, as Medicaid patients are more likely to miss scheduled appointments compared to patients with private insurance due to issues such as lack of transportation and mis-communications (Chaiyachati et al., 2018; Kaplan-Lewis & Percac-Lima, 2013; Nguyen, Dejesus, & Wieland, 2011).

Effects of lack of access. Data from the 2012 Medicare Current Beneficiary Survey (MCBS) show a positive correlation between having dental insurance and dental visits. For beneficiaries below 150% of the FPL, <30% of them had a dental visit within the past year, while for those with an income level ≥200% of the FPL the rate was above 50% (Willink et al., 2016). Half of Medicare beneficiaries live on annual incomes less than $23,000 (Willink et al., 2016), and among them more than a third had untreated tooth decay (United States. Congress. Senate. Committee on Health, 2016). Dental problems of minorities are greater. Data from the National Health and Examination Survey in 2011 and 2012 show that for people age 65 and older, the rate of untreated dental caries was 2.6 times higher among non-Hispanic blacks than that among non-Hispanic whites, and the rate of edentulism was 1.7 times higher among non-Hispanic blacks than that among non-Hispanic whites (Dye, 2015). A cross sectional study utilizing data from the Health Interview Survey of adults, shows a marginally statistically significant but clinically relevant association between dental care utilization and self-reported

diagnosis of oral cavity cancer among over 30,000 non-institutionalized residents, i.e., those who didn't use dental care were more likely to be diagnosed with oral cavity cancer (Holmes Jr et al., 2009).

There is a growing number of patients seeking medical treatment in the ER for pain from untreated and delayed dental problems/diseases. In most cases, patients only receive prescription medications for pain or antibiotics for infections for non-traumatic dental conditions (Singhal et al., 2015; Wall & Vujicic, 2015). The services provided to patients in the ER are costly and reactive, usually with a low likelihood of continuity of care (Bethel et al., 2014). Non-traumatic dental conditions constitute most of the dental ER visits and it is estimated that up to 79% of dental ER visits could be better served in a dental office with the availability of complete treatment and continuity of care (Wall & Vujicic, 2015) . For adults age 65 and older, there has been a significant increase in dental-related ER visits from 1 million during 1999/2000 to 2.3 million during 2009/2010 (Bethel et al., 2014).

California Medi-Cal Dental Program

Eligibility and coverage. Medi-Cal, California's Medicaid program, was expanded under the Affordable Care Act (ACA) in 2013. Individuals or families are deemed eligible for Medi-Cal if their income is below 138% of federal poverty level (California Department of Health Care Services, 2019). In 2018, approximately 13 million Californians were enrolled in Medi-Cal, or about one-third of California's population (California Legislative Analyst's Office, 2018). Among them, 52.6% are adults 64 years and younger, and 8.9% are 65 years and older (California Department of Health Care Services, 2018c). Among the Medi-Cal beneficiaries, 81% are enrolled in Medi-Cal managed care, receiving benefits from contracted Medi-Cal managed care organizations. Nineteen percent are enrolled in Medi-Cal fee-for-service in which

the health care providers submit claims to be reimbursed by Medi-Cal (California Department of Health Care Services, 2015, 2018b). However, for the Medi-Cal dental program, the majority of the beneficiaries are covered through fee-for-service arrangements with the exception of Los Angeles County and Sacramento County. In Los Angeles County, managed care is optional and in Sacramento County it is mandatory (California Department of Health Care Services, 2018d). Currently, the following dental services are covered under the Medi-Cal dental program (California Department of Health Care Services, 2018d) for adults:

- Diagnostic and preventive dental hygiene
- Emergency services for pain control
- Tooth extractions
- Fillings
- Root canal treatments
- Crowns
- Scaling and root planing
- Periodontal maintenance
- Complete and partial dentures

History of legislation and policy changes regarding dental care under Medi-Cal.

Over the years, benefits of the Medi-Cal dental program have changed, sometimes substantially, due to legislation and policy changes. The major changes are as follows and are summarized in Table 2:

- Assembly Bill (AB) 131 (Chapter 30, approved in July 2005, effective January 1, 2006): This bill limited reimbursement to providers of dental services to an annual cap of $1,800 for beneficiaries 21 years of age or older, with certain exceptions. Unless repealed or

extended by statute, the cap would have ended on January 1, 2009 (California Assembly Bill 131, 2005).

- AB 1735 (chapter 719, approved in October 2005, effective January 1, 2006): Due to a significant state budget deficit, payments to Medi-Cal providers including dentists were reduced by 5% until January 1, 2007, with certain exceptions (California Assembly Bill 1735, 2005).
- ABX3 5 (Chapter 3, approved in July 2008, effective till August 2008): Payment to Medi-Cal providers including dentists were reduced by 10 percent. In August 2008, the federal district court issued an injunction to halt the payment reduction (California Assembly Bill X3 5, 2009; California Department of Health Care Services, 2008).
- AB1183 (approved in September 2008, effective on March 1, 2009): This bill made the existing $1,800 annual cap on adult dental services permanent, with certain exemptions (California Assembly Bill 1183, 2008).
- ABX3 5 (Chapter 20, approved in March 2009, effective on July 1, 2009): Most adult dental services were eliminated, with certain exemptions such as emergency services, pregnancy-related services and services provided to Medi-Cal beneficiaries receiving long-term care in a nursing facility (a skilled nursing facility or intermediate care facility) (California Assembly Bill X3 5, 2009).
- AB82 (Chapter 23, approved in June 2013, effective on May 1, 2014): Partially restored adult dental services eliminated in 2009, including basic preventive, diagnostic, restorative, anterior tooth endodontic treatment, complete dentures and complete denture reline/repair services (California Assembly Bill 82, 2013).

- Starting May 1, 2014, Department of Health Care Services (DHCS) implemented a new policy that may allow the payment for non-exempt, medically necessary dental services to exceed the annual cap of $1,800 (California Department of Health Care Services, 2018a).
- AB120 (Chapter 22, approved in June 2017, effective on July 1, 2017): California voters approved Proposition 56 to increase the excise tax rate on cigarettes and tobacco products in November 2016. AB120 appropriated up to $140 million funds from Proposition 56 for dental services under Medi-Cal. The $140 million were appropriated as a 40% reimbursement supplement on restorative, endodontic, prosthodontics, surgical and adjunctive services (California Assembly Bill 120, 2017).
- Senate Bill (SB) 97 (Chapter 52, approved in July 2017, effective on January 1, 2018): This bill fully restored adult dental services that were not restored in May 2014, such as laboratory processed crowns, posterior root canal therapy, periodontal services, and partial dentures, including denture adjustments, repairs, and relines (California Senate Bill 97, 2017).
- The State budget 2018-2019 includes $210 million from Proposition 56 funds for dental programs under Medi-Cal which is an increase of $70 million from the previous year's budget (State of California, 2018).

Table 2

List of Bills with Major Changes in Adult Dental Coverage Under Medi-Cal (2005-2018)

Bill #	Effective Year	Policy Change
AB131 (Chapter 30)	2006	Limited reimbursement to providers to an annual cap of $1,800
AB1735 (Chapter 719)	2006	Reduced payment to providers by 5%
ABX 3 5 (Chapter 3)	2008	Reduced payment to providers by 10%
AB1183	2009	Created the annual cap of $1,800 on reimbursement permanent
ABX 3 5 (Chapter 20)	2009	Eliminated most of the adult dental services
AB82 (Chapter 23)	2014	Partially restored the adult dental services eliminated in 2009
AB120 (Chapter 22)	2017	Appropriated up to 140 million from cigarettes and tobacco taxes to supplement reimbursement for selected dental services
SB97 (Chapter 52)	2018	Fully restored the adult dental services eliminated in 2009

Effects of recent legislations and policy changes. Given the large number of people covered under Medi-Cal, it's important to understand the impact of changes in the Medi-Cal dental program on Medi-Cal beneficiaries' access to dental services. Of special note are the major changes in eliminating most of the adult dental services in 2009, partial restoration of adult dental service in 2014, and full restoration of adult dental service in 2018. Four studies published since 2008 assess the impact of the policy change in 2009.

- Singhal et al (Singhal et al., 2015) examined the impact of the policy change in 2009 in eliminating most adult dental coverage on hospital emergency department (ED) visits for dental problems by Medi-Cal enrollees age 21 or older. Data from 2006 to 2011 from the State Emergency Department Database (SEDD) were used. The study found that the policy change resulted in a significant increase in ER visits for dental problems from an average of 42.4 ED visits per 100,000 Medi-Cal enrollees prior to the policy change to 56.1 visits after the policy change. Also the policy change disproportionately affected young adults (age 21-35), urban residents and people from racial/ethnic minority groups.

- Rampa et al (Rampa et al., 2016) examined the trends of dental-related ED visits in California from 2005 to 2011 using data from SEDD. The study showed that dental-related ED visits increased substantially from 2005 to 2011; the proportion of patients who were covered by Medi-Cal increased from 30.9% in 2005 to 35.1% in 2011, and for patients 65 years and older, the proportion increased from 3.2% in 2005 to 3.8% in 2011. The study also found that most of the dental problems were for dental caries and pulp/periapical lesions.
- Maiuro (Maiuro, 2011) studied the impact of the 2009 policy changes focusing on the areas of dental expenditures, dental utilization for both adults and children, and dental providers by comparing data from 2008-2009 and 2009-2010 provided by California Department of Health Care Services. After the implementation of the benefit cuts in 2009, the dental expenditure decreased by $246 million which exceeded the projected amount of $190 million; and the adult dental utilization went down by a greater proportion for people who were in the blind and disabled categories. Additionally, there was a drop in dental providers with the sharpest decreases in Sacramento (-26%), San Diego (-29%) and San Francisco (-31%).
- Wides et al (Wides et al., 2014) conducted a qualitative study from November 2011 to April 2012, assessing the impacts of the policy changes in 2009 through fourteen telephone or in-person interviews on dental safety-net providers in California including public health departments, community health centers, dental schools, Native American health clinics and private practitioners. It is reported that after the new policy was enacted, there was a decrease in utilization of dental services in the dental clinics by adult patients who were covered by Medi-Cal due to treatment cost.

Furthermore, they suffered from delayed dental care and primarily sought dental services in the ER. The policy change also had a negative impact on dental providers, especially dentists in private practice who had to cut hours, staff and pay due to the drastic decrease in the number of patients.

These studies confirm the reports on reduction in utilization of dental service in the dental clinics and negative impact on the dental providers from the policy change in 2009. To date, the literature search has yet to find studies evaluating the impact of policy changes in the Medi-Cal dental program since 2014.

Providers. There has long been a shortage of dentists in Medi-Cal, and the issue is not necessarily related to the supply of dentists. In California, there has been a steady growth in the number of dentists over the years (Table 3). California is among the most saturated states for dentists in the U.S., ranked #4 in number of dentists per 100,000 civilian population in 2015 with 77.1 dentists. The national average was 60.9 dentists per 100,000 civilian population (Centers for Disease Control and Prevention, 2016; Pourat & Choi, 2014). Yet, for the Medi-Cal dental program, there have been marked shortages of dentists in most counties. In 2017 there were no providers in five counties, and in 14 counties, there are only providers who no longer accept new patients (California Assembly Bill 15, 2017). The shortage of dentists in the Medi-Cal dental program is mainly due to the low participation rate (Pourat et al., 2015). As shown in Table 3 below, in California, the number of dentists increased 14.4% from 26,388 in 2006 to 30,180 in 2015, and the number of dentists per 100,000 civilian population increased 5.2% from 73.26 in 2006 to 77.10 in 2015, but the number of dental providers participating in the Medi-Cal dental program dropped 16% from 9,527 in 2008 to 8001 in 2015, while the number of Medi-Cal beneficiaries increased over 70% from less than 7 million in 2006 to over 12 million in 2014

(California Department of Health Care Services, 2015). The participation rate is lower in California compared to the national average; in 2013, only 29% of California dentists participated in the state's Medi-Cal dental program while the national average was 42% (Little Hoover Commission, 2016). In 2015, about 8,000 out of over 30,000 dentists participated in the Medi-Cal (Table 3), and the participation rate decreased to about 26.5%.

Table 3

Active Dentists in California, Selected Years 2001–2015

	Number of Dentists				**Number of Dentists per 100,000 Civilian Population**			
	2006	2013	2014	2015	2006	2013	2014	2015
California	26,388	29.425	29,530	30,180	73.26	76.60	76.12	77.10
United States	172, 603	191,347	192,313	195,722	57.32	57.85	60.30	60.89

Note: Data adapted from (Centers for Disease Control and Prevention, 2016)

Similarly to nationwide, the major factors for the low participation rate in Medi-Cal are low reimbursement rates and excessive administration workloads (California Assembly Bill 15, 2017; Little Hoover Commission, 2016). The Medicaid fee index shows that the level of physician fees for Medi-Cal was 76% of the national average Medicaid fees (Henry J Kaiser Family Foundation, 2018). California has been among the most expensive states to live in as measured by the cost of living index over the past few decades (The Council for Community and Economic Research, 2018), which effectively makes the reimbursement rate even lower. The reimbursement rates from the Medi-Cal dental program were only about one-third to one-half of the national average for the most common procedures (California Assembly Bill 15, 2017). The excessive administrative burden also drives practices out of the Medi-Cal dental program. A survey of the participating dentists reported common complaints that the State's administrative requirements were much more complex and time-consuming than those of commercial insurance plans and their clinical judgments are often subject to second guessing by the state program

evaluators, resulting in delays of payment (Little Hoover Commission, 2016).

Theoretical Framework

The primary objective of this study is to evaluate the impact of changes in Medi-Cal adult dental coverage on dental care utilization among Medi-Cal beneficiaries. The theoretical framework of the study is the Ethnicity, Aging and Oral Health Outcome Model developed by Andersen and Davidson (Andersen & Davidson, 1997). The model was adapted from Andersen's Behavioral Model for Health Service Utilization (Andersen, 1995) and can be used to predict dental health service utilization with a particular emphasis on ethnicity and age.

Andersen behavioral model for health care use. The initial Andersen behavioral model for health service utilization was developed in 1968 (Andersen, 1968). The model was used to explain why families differ in the amount of health care they consume. In the initial behavioral model for health service utilization Andersen developed, it was assumed that for health care use to take place: "(1) a family must be predisposed to receive medical care; (2) there are enabling conditions that allow the family to attain health services; and (3) the family must perceive a need to these services." (Andersen, 1968, p. ix). Therefore, there are three components in the model: predisposing characteristics, enabling resources, and need.

Since its introduction in the late 1960s, the Andersen behavioral model for health care utilization has gone through several revisions and expansions with later versions using the individual instead of family as the unit of analysis (Figure 6).

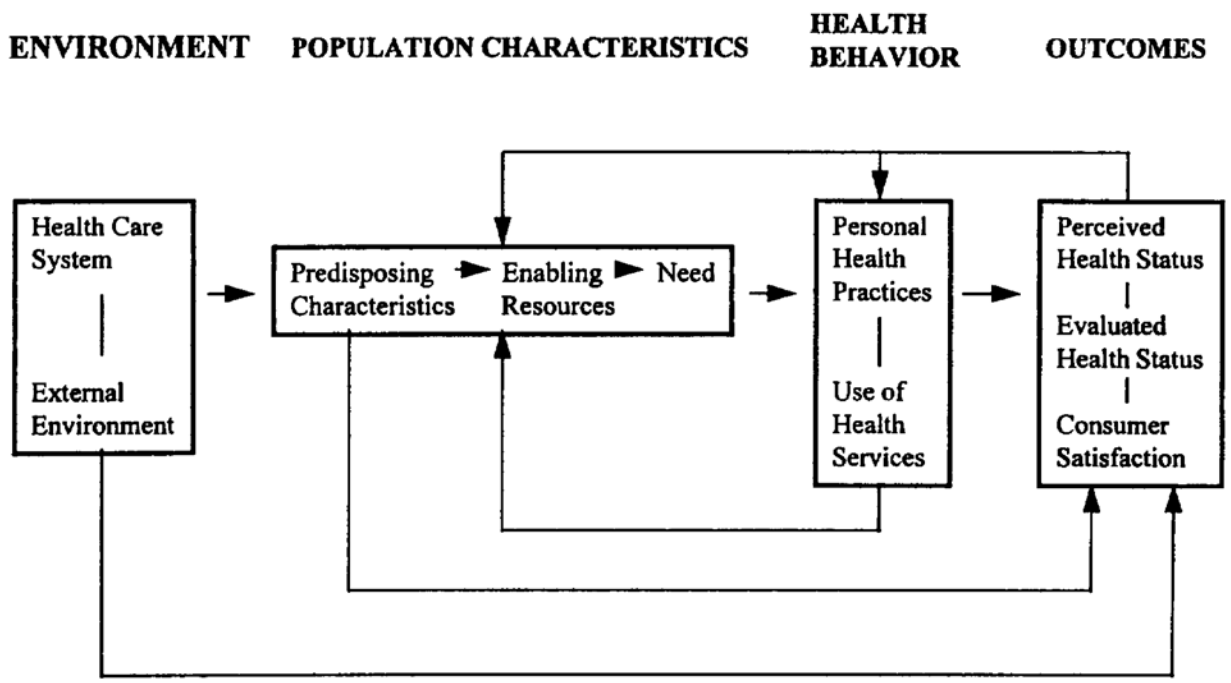


Figure 6. **Emerging Andersen behavioral model for health service use. Reprinted from (Andersen, 1995)**

In the revised model, the population characteristics component retains the three subcomponents of Predisposing, Enabling and Need as in the original model (Andersen, 1995).

Predisposing. Predisposing conditions are individual characteristics that may not be directly responsible for health service utilization, but individuals having those characteristics are more likely to utilize health services. It has the following three subcomponents: 1) Demographic characteristics such as age, gender, and marital status, 2). Social structure, such as education, occupation, ethnicity, social network and social interaction, 3). Health beliefs, such as individual's attitude, value and knowledge about health and health services. The demographic variables are not mutable; in other words as they cannot be changed as a means of influencing health care utilization. The social structure variables are either non-mutable (e.g., ethnicity) or have low mutability, as education, occupation or social network cannot be altered with short term policy to influence an individual's utilization of health services. Health beliefs are considered to

be of medium mutability as interventions such as health education may lead to behavioral changes.

Enabling. Enabling is defined as a condition that allows an individual to act upon a value or satisfy a need regarding health service use. It has the following subcomponents: 1). Financing, such as individual's income and wealth, and effective price of health care as determined by health insurance and co-sharing requirements, and 2). Organization, such as accessibility to health care (e.g., private doctor, community clinic, and emergency room) and transportation, and travel time to health care facility and waiting time to receive services. Andersen considers some enabling variables of high mutability and cites results from the RAND Health Insurance Experiment (HIE) to support high mutability of health insurance (Andersen, 1995). Results from the RAND HIE have shown that higher cost sharing would lead to reduction in healthcare expenditures. The study also indicates that greater cost sharing is associated with reductions in use of clinically important services as well. In addition, results show the change in health care utilization have either minimal or no effects on health status among people with employment-based insurance, but the reduction in health care utilization was harmful on average among people who were both poor and sick (Newhouse, 2004). For dental care, as previously discussed, one of the most important factors in the decision to seek dental care is having dental insurance (Kreider et al., 2015; Lambert & Tepper, 2010; United States Congress Senate, Committee on Health, 2016).

Need. Need is the individual's need for health care services and has the following subcomponents: 1) individual's perceived health status and need for medical care, and 2). individual's health care status and need of medical care obtained through objective evaluation by professional health care providers. Both perceived and evaluated needs can be mutable as they

may be influenced by interventions such as health education for individuals and clinical guidelines on managed care systems for health care providers.

Besides population characteristics, the other dimensions in the model include environment, health behavior and outcome.

Environment. Environment includes characteristics of the healthcare delivery system, the external environment and community-level enabling factors. Examples include public and private organization health policies, per capita community income and wealth, rate of health insurance coverage, relative price of medical care, and provider related variables such as amount and distribution of health services facilities and personnel, ratios of physicians and hospital beds to population and office hours and location of health service outreach and health educational programs (Andersen & Davidson, 2007; Phillips, Morrison, Andersen, & Aday, 1998).

Health behavior. Health behavior includes personal health practices such as diet, exercise, self-care, tobacco use or adherence to care; and use of health services such as type, site, purpose and time interval use of ambulatory care, inpatient care, alternative healthcare or long-term care (Gelberg, Andersen, & Leake, 2000)

Outcome. Outcome of health status allows for evaluation of consequences from changes to the health care utilization induced by various factors in the model, and it includes perceived health status by individuals, evaluated health status by health professionals, and consumer satisfaction with care such as general satisfaction, satisfaction with technical quality, interpersonal aspects, coordination, final aspects and time spent with clinician (Gelberg et al., 2000).

Andersen states that a major goal of the behavioral model is to provide measures of access to health care (Andersen, 1995). Equitable access can occur when most of the variance in

health care utilization can be accounted for with demographic and need variables, and when social structure (e.g., ethnicity), health beliefs and enabling resources (e.g., income, insurance) account for most of the variance in health utilization, inequitable access occurs .

Revised model designed for dental care research. In the initial and revised behavioral models, age is one of the variables in the demographic component of the predisposing factor and ethnicity is one of the variables in the social component of the predisposing factor. As age and ethnicity are indicators of the family or individual's demographic and social position in society, they may predict the family or individual's need for and utilization of health care services. Since age and ethnicity are included in the predisposing factor, they do not independently influence the dependent variable. However, in the Ethnicity, Aging and Oral Health Outcome Model developed by Andersen and Davidson in 1997, age and ethnicity become exogenous variables which can influence the predisposing, enabling and need factors as depicted in Figure 7 (Andersen & Davidson, 1997). Using this model, one can examine the inequalities in dental care utilization by age and ethnicity group.

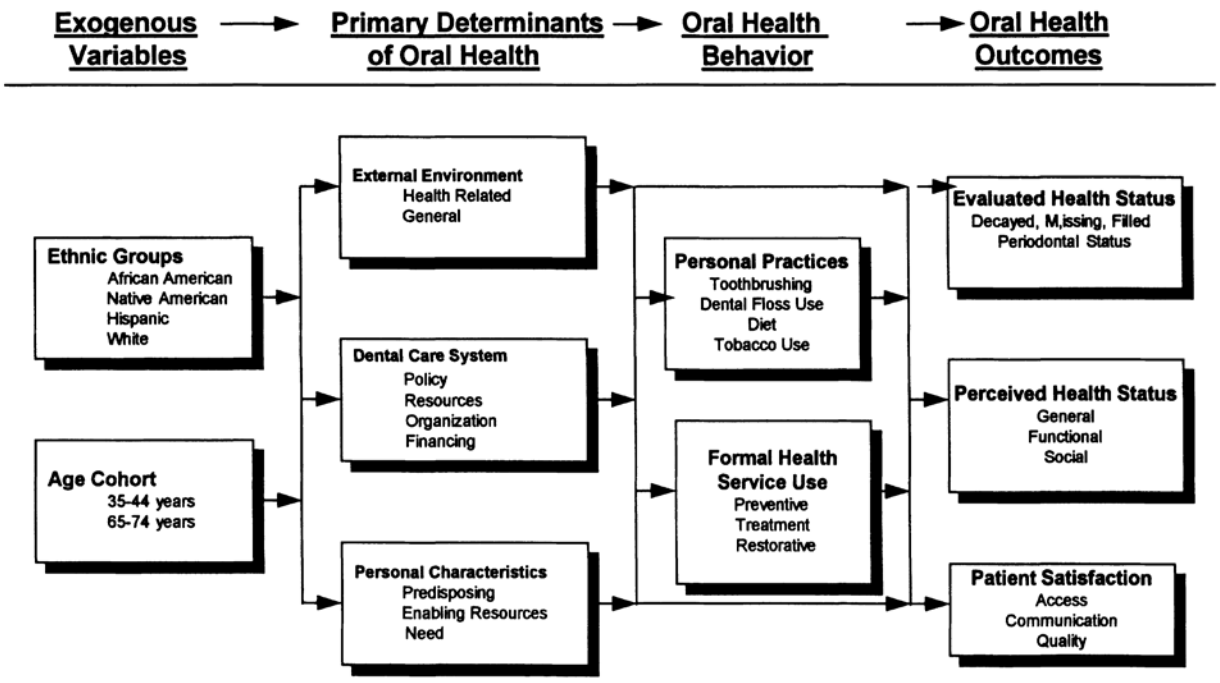


Figure 7. **Ethnicity, aging, and oral health: A conceptual framework. Reprinted from (Andersen & Davidson, 1997)**

This conceptual framework was developed for the Second International Collaborative Study of Dental Manpower Systems in Relation to Oral Health Status (ICS-II) launched in the mid-1980s. The study surveyed people from four international research sites and three locations in the U.S.: Baltimore, Maryland; selected regions served by the Indian Health Service, and San Antonio, Texas. The selection of the research locations was based on different ethnic populations, dental care delivery systems, and water fluoridation. There were three age groups included in the study: 12-13, 35-44 and 65-74 years old. The rationale of adjusting the Behavior Model using ethnic and age groups as exogenous variables is to enable the systematic assessment of differences in the multitude of factors affecting oral health behavior and health status (Andersen & Davidson, 1997).

Andersen and Davidson cited references reporting underutilization of dental care services among people in the ethnic minority groups compared to Whites in the U.S. and the differences

were associated with factors such as education, knowledge of preventive care and enabling resources. Those findings have remained true since then. Bei et al. (2013) studied racial and ethnic variations in preventive dental care utilization among Americans aged 50 and above based on self-reported data from the Behavioral Risk Factor Surveillance System between 1999 and 2008 (Bei, Jersey, Huabin, & Robert, 2013). Study results show differences between White and minority groups in dental care use over time. For Hispanics, Asian and American Indians/Alaskan Natives, those differences can be explained by social demographic and health characteristics. However, Black respondents were less likely to have had dental cleaning visits compared to White respondents after controlling for demographic characteristics, medical conditions, employment and number of permanent teeth. Reda et al. (2018) conducted a systematic review and meta-analysis on inequality of utilization of dental services based on 117 studies published in the databases of MEDLINE, Embase, Cochrane Central from 2005 and 2017 (Reda, Reda, Thomson, & Schwendicke, 2018). Dental services were characterized by regular or recent examination or preventive dental visits. Results show people from ethnic minorities had significantly lower utilization than those from the ethnic majority in countries of High Human Development Index (HDI, a composite index of life expectancy, education and income per capita), but not those of low HDI. Longitudinal analysis also indicates the magnitude of inequality observed in countries with high HDI was stable overtime.

As for adding the age group of older people, Andersen and Davidson attributed the reason to population aging with 10% of the population age 65 and above at the time the model was developed. This percentage has increased to 14.9% in 2015 (U.S. Census Bureau, 2018). Andersen and Davidson (1997) cited references on aging process and cohort effects upon oral health behaviors and outcomes.

Wall et al studied trends in dental care utilization using data from the National Health Interview Survey between 1997 to 2010 by age and poverty level (Wall, Vujicic, & Nasseh, 2012). Results show that there was a steady increase in dental care utilization among children, which appears to be related to an increase in public coverage for children, and a decrease in dental care utilization among non-elderly adults which appears to be related to a decline in private insurance coverage for this age group. Similar results are shown in the study by Vujicic & Nasseh (2014) using data from Medical Expenditure Panel Survey. Kailembo et al. (2018) examined age group differences in dental visits using data from the National Health and Nutrition Examination Survey between 2011 and 2014. They found that the independent variables of income and wealth (which measure accumulated assets) were fit into two separate models. In the income model, respondents aged 20-44 were 16% more likely to not have a dentist visit than those aged 65 and over. However, age was not statistically significant in the wealth model.

With ethnic group and age cohort as major exogenous variables, they could each independently affect the three primary determinants of oral health: external environment, dental care system and personal characteristics as depicted in Figure 7. The external environment factors influence the community oral health and they include water fluoridation, policies related to tobacco use, free or highly subsidized treatment programs, and health education promoting oral health and nutrition. The delivery system characteristics affect accessibility, availability, acceptability and convenience of dental care services and include policies, resources organization and financial arrangement (Andersen & Davidson, 1997).

The framework posits that the determinants of oral health could influence health behavior such as personal practices (e.g., tooth brushing and dental floss use) and formal health service

use for preventive, treatment or restorative oral care. In this framework, oral health behaviors of oral hygiene practices and/or dental service utilization serve as intermediate dependent variables which can in turn influence oral health outcomes such as evaluated or perceived health status and patient satisfaction. Andersen and Davidson (1997) recommended the theoretical framework to be applied by policy analysts and health services managers for describing, predicting and explaining population-based health behaviors and health outcomes.

Utilization of ethnicity, aging and oral health outcome model in this study. Andersen and Davidson (1997) developed the Ethnicity, Aging and Oral Health Outcome Model for the ICS-II study. Results from the ICS-II study demonstrated improvement in oral health among older adults in the U.S. using the indicators such as tooth loss, periodontal status and perceived oral health. The study also showed the magnitude of improvement was less among ethnic minorities and poorer countries (Atchison & Andersen, 2000). Since then the model has been widely used in oral health studies in the areas of dental care utilization and oral health outcomes. For example, Cooper, Manski, and Pepper (2012) applied the model and used data from the 2003 Medical Expenditure Panel Survey to examine the effect of dental insurance coverage on the probability of having a dental care visit. Baker (2009) utilized data from a UK adult dental health survey to test the model and to examine the direct and mediated pathways between social, attitudinal and behavioral factors and perceived oral health outcomes. Ribeiro, de Oliveira, and Alberto (2013) utilized the model to analyze the use of dental services and associated factors among older patients treated at family health units in southern Brazil.

The primary objective of this study is to evaluate the impact of changes in Medi-Cal adult dental coverage on dental care utilization among Medi-Cal beneficiaries. Differences in dental care utilization were examined among ethnic groups and age groups. The study also explores the

participation of dental service providers in the Medi-Cal program. Their participation can be considered as an intermediate dependent variable, i.e., the policy change can impact the number of dental service providers participating in the Medi-Cal dental program, which in turn can influence the utilization of dental care services by the Medi-Cal beneficiaries. Both the policy and dental service providers are major sub-components of dental care systems. The components of the Ethnicity, Aging and Oral Health Outcome Model explored in the study are circled in Figure 8. The variables included in each component are described in Table 4 in Chapter Three (Methodology). As data for the component of personal characteristics (e.g., gender, income, English proficiency) are not available, this component was not explored in the study.

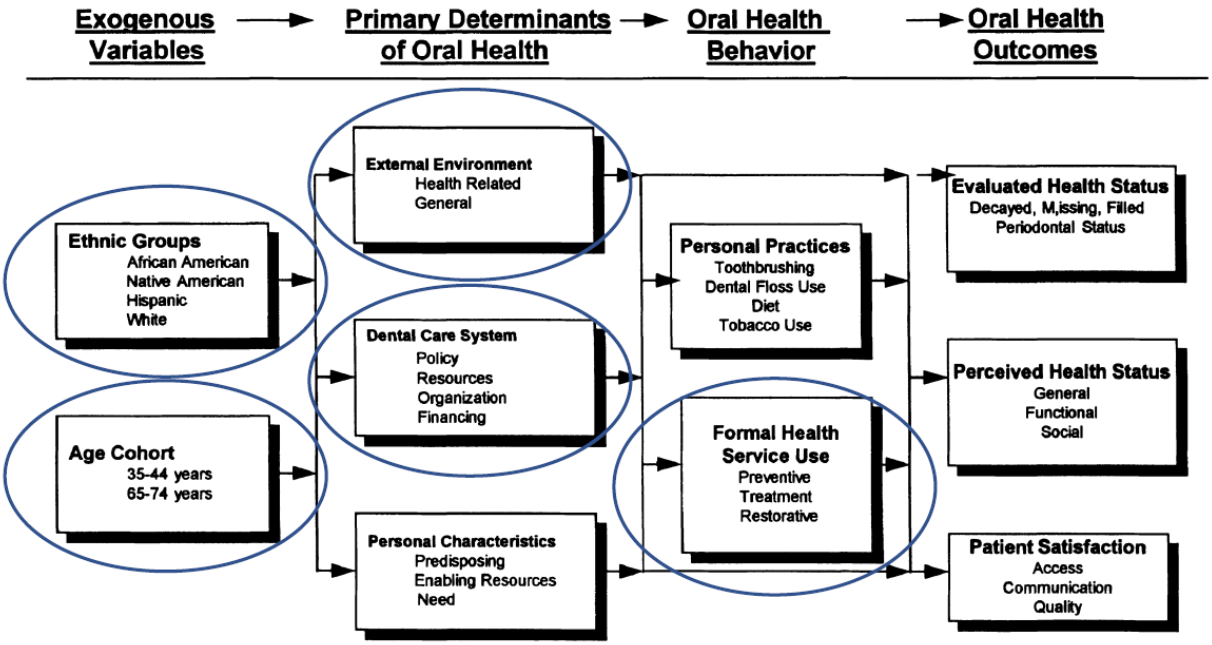


Figure 8. **Ethnicity, aging, and oral health: A conceptual framework. components of the model explored in the study.**
Reprinted from (Andersen & Davidson, 1997)

Summary

In summary, aging-related physiological developmental changes, dental disease/problems, diet, medications, and oral health literacy affect the oral health of older people

and increase their dental care needs for preventive, restorative, cosmetic, periodontal and other dental services. Studies have shown that poor oral health is correlated with physical, psychological and social disability or disadvantage among older people. There are significant disparities in accessing dental care among older Americans. For vulnerable older people who are poor and can't afford private dental insurance, their dental needs may be provided by Medicaid. However, the dental coverage provided by Medicaid varies greatly from state to state, and changes under budget constraints. In addition, there has been a significant shortage of providers due to low reimbursement rates and excessive administration workloads.

Similarly to nationwide, over the years the benefits of the Medi-Cal dental program have gone through major changes. Most of the adult dental services were eliminated in 2009. The eliminated adult dental services were partially restored in 2014 and then fully restored in 2018. Given that about one-third of California's population (13 million) are covered by Medi-Cal, it is important to evaluate the impact of policy changes on access to dental care among Medi-Cal beneficiaries. However, a literature search has not identified studies evaluating the impact of policy changes in the Medi-Cal dental program since 2014. The objective of this study is to evaluate the effect of change in Medi-Cal dental coverage, specifically the partial restoration of adult dental coverage in 2014, on dental care utilization among Medi-Cal beneficiaries. The following questions are addressed.

- Question 1: Did the partial benefit restoration in 2014 increase the dental care utilization in clinics by Medi-Cal beneficiaries to the level prior to elimination of adult dental coverage in 2009? How does the impact vary by different dental services such as annual dental visit, preventive services, dental exams, dental treatment, restorative services, and treatment of caries?

Hypotheses:

1. The partial benefit restoration in 2014 increased the dental utilization in clinics by Medi-Cal beneficiaries in each year from 2015 to 2017. The hypothesis is based on the assumption that as more beneficiaries became aware of the partial restoration of adult dental coverage under Medi-Cal, the dental utilization in clinics would increase.
2. The dental utilization in clinics did not, as of 2017, reach the level of dental service utilization prior to the elimination of adult dental coverage in 2009. The hypothesis is based on the fact that some of the benefits didn't get restored until 2018 and they include services such as laboratory processed crowns, posterior root canal therapy, periodontal services, and partial dentures, including denture adjustments, repairs, and relines (California Senate Bill 97, 2017).
3. The amount of increase differed for different type of dental services due to various levels of complexity and cost of different dental services.

- Question 2: Did the partial benefit restoration in 2014 affect older Medi-Cal beneficiaries' dental care utilization in clinic differently than younger age beneficiaries?

Hypothesis:

4. There is a greater increase in dental care utilization in clinics among older Medi-Cal beneficiaries than among younger age beneficiaries. The hypothesis is based on the fact that compared to younger people, older people have a greater prevalence of certain dental problems and diseases such as xerostomia (dry mouth), periodontal disease, tooth loss and oral cancer (Furness et al., 2011; Griffin et al., 2012; National Cancer Institute, 2015; National Institute of Dental and Craniofacial Research, 2018a, 2018b).

- Question 3: Did the effect of partial benefit restoration in 2014 vary by ethnic groups?

  Hypothesis:

  5. There is a greater increase in dental care utilization in clinic among White beneficiaries compared to those from ethnic minority groups. The hypothesis is based on the reported underutilization of dental care services among people in the ethnic minority groups compared to Whites in the U.S. as described previously.

- Question 4: Did the partial benefit restoration in 2014 reduce dental-related ER visits by Medi-Cal beneficiaries? How does the impact vary by age group and ethnic groups?

  Hypotheses:

  6. The partial benefit restoration in 2014 reduced dental-related ER visits by Medi-Cal beneficiaries each year from 2015 to 2017.
  7. The partial benefit restoration in 2014 reduced dental-related ER visits by older Medi-Cal beneficiaries more than younger age beneficiaries.
  8. The partial benefit restoration in 2014 reduced dental-related ER visits by White Medi-Cal beneficiaries more than by beneficiaries of ethnic minority groups.

  The hypotheses are based on the assumptions that increased utilization of dental services in the clinics would reduce the dental-related ER visits, and there were greater percentages of older beneficiaries seek dental care in clinics than the ones in the younger age group, and the same for White beneficiaries than those from ethnic minorities.

- Question 5: How much has the partial benefit restoration in 2014 increased the participation of dental care providers? Is the impact on general practitioners different from that on specialists?

Hypothesis:

9. The participation of specialist dental care providers in the Medi-Cal program increased each year after restoration of benefits but at a reduced rate from that of general dental care providers in Medi-Cal. The rationale for the hypothesis is that the reimbursement rates from the Medi-Cal dental program were only about one-third to one-half of the national average for the most common procedures (California Assembly Bill 15, 2017) and it is assumed the low reimbursement rates in Medi-Cal dental program was a greater deterrence to dental specialists than general practitioners as the cost of patient care is generally greater for the former than the latter (American Dental Association, 2016).

All the questions listed above are important to be studied for public health. Given that full restoration of the adult dental benefits didn't get approved until 2017 and enacted until beginning of 2018, data are yet to become available to evaluate the impact of those changes. Results from this study not only assessed the impact of the policy change in 2014, but also can provide important baseline data for future impact studies on the policy changes enacted since the beginning of 2018. Details of the statistical analysis plan are described in the next chapter.

Chapter Three Methodology

In this study, descriptive statistics, graphic presentations and hypothesis testing were utilized to explore data on dental care utilization in clinics and ER by Medi-Cal beneficiaries, and participation of dental care providers in the Medi-Cal program. For hypothesis testing, P-value <0.05 (2-sided) is considered as statistically significant. Caution shall be taken in interpreting the results from each hypothesis testing as P-values were not adjusted for multiple comparisons.

Study Population and Study Data

The study populations include Medi-Cal beneficiaries and participating dental care providers in the Medi-Cal program. The study data are provided by the California Department of Health Care Service and include dental care utilization in clinics from 2007 to 2017 and dental related ER visits from 2012 to 2017 by Medi-Cal beneficiaries, and participating dental care providers in the Medi-Cal program from 2013 to 2017. The study data sets and their corresponding hypotheses are listed below.

- **Data Set 1**: Dental Utilization Measures and Sealant data by County, Ethnicity, & Age, Calendar Year: 2007-2017

  Hypotheses:

  1. The partial benefit restoration in 2014 increased the dental utilization in clinics by Medi-Cal beneficiaries in each year from 2015 to 2017.
  2. The dental utilization in clinics did not, as of 2017, reach the level of dental service utilization prior to the elimination of adult dental coverage in 2009.
  3. The amount of increase differed for different type of dental services due to various level of complexity and cost of different dental services.

4. There is a greater increase in dental care utilization in clinic among older Medi-Cal beneficiaries than among younger age beneficiaries.
5. There is a greater increase in dental care utilization in clinic among White beneficiaries than those from ethnic minority groups.

- **Data Set 2**: Dental-related Emergency Room Utilization Data: 2013-2017

  Hypotheses:

6. The partial benefit restoration in 2014 reduced dental-related ER visit by Medi-Cal beneficiaries each year from 2015 to 2017.
7. The partial benefit restoration in 2014 reduced dental-related ER visits by older Medi-Cal beneficiaries more than younger age beneficiaries.
8. The partial benefit restoration in 2014 reduced dental-related ER visits by white Medi-Cal beneficiaries more than by beneficiaries of ethnic minority groups.

- **Data Set 3**: Profile of Enrolled Medi-Cal Dental Fee-for-Service (FFS) Providers and Safety Net Clinics (SNCS): Yearly 2012 through 2017

9. The participation of specialist dental care providers in the Medi-Cal program increased each year after restoration of benefits but at a reduced rate from that of general dental care providers in Medi-Cal.

All data included in the study are of public record. The following data are readily accessible by the public through the website of the California Department of Health Care Service (https://data.chhs.ca.gov): data set 1: 2013-2017; data set 2: 2013 to 215; and data set 3: 2017. The rest of the study data are compiled by the agency at the request of the author at a cost of about $4,500. All dental care utilization data are aggregated without any identifiable personal information on Medi-Cal beneficiaries. Table 4 lists analysis variables included in

the study and their corresponding descriptions.

Table 4

Descriptions of Study Population and Study Data

Data Set Name	Population	Variable	Description
1.Dental Utilization Measures and Sealant data by County, Ethnicity, & Age, Calendar Year: 2007-2017	Medi-Cal beneficiaries who continuously enrolled in either Dental Managed Care or the Dental Fee-for-Service delivery system for at least 3 months during each calendar year from 2007 to 2017	Age group	Age 19-20, 21-34, 35-44, 45-64, 65-74, 75+ years old
		Ethnicity group	White, Black, Hispanic, Asian, Other
		Calendar year	2007, 2008, 2009, 2010, 2011, 2012, 2013, 2013, 2014, 2015, 2016, 2017
		Dental visit type	Based on Current Dental Terminology (CDT): annual dental visit, preventive services, dental exams, dental treatment, restorative services, or treatment of caries
		County	Counties in California
		Number of users	Number of enrollees who had at least one visit during the calendar year
		Number of eligible enrollees	Number of full-Scope beneficiaries with at least 3 months of continuous eligibility in the same plan during the calendar year
2. Dental-related Emergency Room Utilization Data: 2013-2017	Number of certified full scope eligible enrollees during each year from 2013 to 2017	Age group	Age 19-20, 21-44, 45-49, 50-64, 65+ years old
		Ethnicity group	White, Black, Hispanic, Asian, Other
		Calendar year	2013, 2014, 2015, 2016, 2017
		Number of visits	Number of visits for beneficiary with diagnosis codes
		Number of eligible enrollees	Number of certified full scope eligible enrollees
3. Profile of Enrolled Medi-Cal Dental Fee-for-Service (FFS) Providers and Safety Net Clinics (SNCS): Yearly 2012 through 2017	Dental providers participated in Medi-Cal dental program from 2012 to 2017	Provider number	Multiple offices of a billing provider share the same provider number. If a billing provider has more than 99 offices, it is assigned with one or more additional provider number.
		NPI number	National Provider Identifier is a unique identification number issued to health care providers by the Centers for Medicare and Medicaid Services (CMS).
		County	Counties in California
		Enrollment status effective date	Effective date of provider enrollment
		Specialty	General practitioner or dental specialties (endodontist, orthodontist, hygienist, oral pathologist, oral surgeon, periodontist, or prosthodontist)
		Out of state description	Indicate whether the provider is in state or out of state counties in CA

The types of dental service included in dental utilization data set are not mutually exclusive. The CDT codes for each type of dental visit are listed below in Table 5

(https://data.chhs.ca.gov). Each type of dental visit from 2) to 6) is a subset of annual dental visit; restorative service is a subset of dental treatment; and there are overlaps between restorative services and the visits for caries or fluoride treatment.

Table 5

List of Type of Dental Service and CDT Codes

Type of Dental Service	CDT Codes
1) Annual dental visit	D0100 - D9999 or Safety Net Clinics 03 Encounters
2) Preventive services	D1000-D1999
3) Dental exams	D0120, D0145, and D0150
4) Restorative services	D2000-D2999
5) Dental treatment	D2000-D9999
6) Caries or fluoride treatment	D2000-D2999 or D1203-D1208, D1310, D1330, D1351

Statistical Analysis Methods

Utilization of dental care services by adult Medi-Cal beneficiaries

Clinic visits-descriptive data analysis. For each type of dental visit, utilization rate is tabulated by calendar year, ethnicity group and age group. Utilization rate is calculated as number of users divided by number of eligible enrollees and then is multiplied by 100%. Data for adult enrollees under age 65 were combined.

Clinic visits- graphic presentation. Figures were created depicting utilization rate over time for each type of dental visit by age group and ethnicity group for visual inspection of impact of policy change and effect of age and ethnicity.

Clinic visits- hypothesis testing. A repeated measures (longitudinal) analysis of variance model was fitted with time taken as a categorical covariate to evaluate the impact of policy

change on utilization rate (dependent variable, continuous). The repeated measure analysis of variance model is appropriate as utilization rate is measured repeatedly over time for each county by age and ethnicity group. Due to major policy changes in 2009 and 2014 for adult dental coverage, the assumption of linearity needed for treating time as a continuous variable is unlikely to hold true. Therefore time was taken as categorical covariate in the model as the measurement corresponding to before or after the policy change, where there is likely a strong conceptual identity for each assessment. The fixed effects include age, ethnicity and year which are the variables of primary interest, as well as geographic region which serves as a covariate. Geographic region may have an impact on dental utilization; for example, beneficiaries residing in the Bay Area and Southern region in general have better access to public transportation and dental care providers than those who reside in the Northern region, Mountain Valley or Central Valley. The 58 counties in California were grouped under five regions as follows in Table 6 (California Child Welfare Services/Case Management System, 2010).

Table 6

List of Geographic Regions in California and the Counties within Each Region

Geographic Region	**County**
Bay Area	Alameda, Contra Costa, Marin, Monterey, Napa, San Benito, San Francisco, San Mateo, Santa Clara, Santa Cruz, Solano, Sonoma
Central Valley	Fresno, Kern, Kings, Madera, Mariposa, Merced, San Joaquin, San Luis Obispo, Stanislaus, Tulare
Mountain Valley	Alpine, Amador, Calaveras, El Dorado, Inyo, Mono, Nevada, Placer, Sacramento, Sierra, Sutter, Tuolumne, Yolo, Yuba
Northern	Butte, Colusa, Del Norte, Glenn, Humboldt, Lake, Lassen, Mendocino, Modoc, Plumas, Shasta, Siskiyou, Tehama, Trinity
Southern	Imperial, Los Angeles, Orange, Riverside, San Bernardino, San Diego, Santa Barbara, Ventura

The analysis was performed using Mixed procedure (Proc Mixed) in SAS version 9.4 (SAS Institute, Cary, NC, USA) (Littell, 2006). The matrix notion of the statistical model can be represented as

$$\mathbf{y_i = X_i\beta + \varepsilon_i}$$

Where

- Where i is the index for the 'Subject', and observations of 'Subject' are independent of one another.
- β are the 'fixed effects' parameters, i.e., year, age, ethnicity, geographic region and interaction effects.
- $\varepsilon \sim N(0, R)$
- R is block diagonal where the diagonal elements are the covariance matrix of the 'Subject' (e.g., county) across years.
- In the Mixed procedure (Proc Mixed), the repeated component of the model specifies the structure of R which is the covariance structure of ε.

In the analysis model, an unstructured variance/covariance matrix was assumed. All parameter estimates were obtained using restricted maximum likelihood estimation. If there is a statistically significant interaction effect ($p<0.05$, 2-sided), then the analysis was to be conducted separately for each of the subgroups. For example, if there is a statistically significant interaction effect of age group by ethnicity group, then models testing the differences of age group would be fitted separately for each ethnicity group and models testing the differences of ethnicity group would be fitted separately for each age group. For each fitted model, a set of

conditional studentized residual plots were produced for model checking and checks were done to identify outliers and influential observations.

Dental related emergency visits. For this analysis, the dependent variable is number of dental related emergency visits per 1,000 enrollees which were calculated and tabulated for each year and by age group and ethnicity group within each year from 2013 to 2017. The results of the dependent variable over time are plotted for visual inspection of dental related emergency visits over time and the effects of age (<65 vs. 65+) and ethnicity. Analysis of variance was utilized to compare the results of the dependent variable among calendar years adjusting for age and ethnicity. Model checking was done for interaction effects, normality assumption of the residuals and identification of outliers and influential observations. For each fitted model, the least square means of the difference from each comparison, its corresponding 95% confidence interval and P-value were calculated.

Participation of Dental Service Providers in the Medi-Cal Dental Program.

Number of participants of dental service providers was calculated and tabulated by geographic region and dental specialty for each year from 2012 to 2017. The number of participants over time was plotted for visual inspection of the effect of the policy change in 2014 and differences among dental specialties. In addition, repeated data analysis was conducted to evaluate the differences in number of SNCs among different regions and years, as the data set includes number of SNCs in each county from 2012 and 2017. Model checking was done for interaction effects, normality assumption of the residuals and identification of outliers and influential observations. For each fitted model, the least square mean difference from each comparison, its corresponding 95% confidence interval and P-value were calculated.

Summary

In summary, this chapter describes the study population, study data and the planned statistical analyses for the study. The study population includes Medi-Cal beneficiaries and participating dental care providers in the Medi-Cal program. The study data include dental care utilization in clinics from 2007 to 2017 and dental related ER visits from 2012 to 2017 by Medi-Cal beneficiaries, and participating dental care providers in the Medi-Cal program from 2013 to 2017. The planned statistical analyses include descriptive statistics, graphic presentations and hypothesis testing. To test the hypotheses related to policy change on utilization rate in dental clinics, a repeated measures (longitudinal) analysis of variance model was fitted with fixed effects of age, ethnicity and year which are the variables of primary interest, as well as geographic region which serves as a covariate. Analysis of variance was utilized to compare dental related ER visits among calendar years adjusting for age and ethnicity. In addition, a repeated measures (longitudinal) analysis of variance model was used to evaluate the impact of policy change on participation of SNCs in the Medi-Cal program.

Results of the statistical analyses are presented in Chapter Four and discussed in Chapter Five. The discussion includes whether the research findings support the hypotheses and their implications. For example, if the study results show that the utilization rate as of 2017 didn't reach the level during the years prior to dental coverage elimination in 2009 and the increase in participation of dental specialists had been at marked lower rates as of general dentists, those findings may indicate deficiencies in the partial dental coverage restoration in incentivizing dental specialists to participate in the Medi-Cal dental program and providing adequate service to Medi-Cal beneficiaries. For each hypothesis not supported by the research finding, its

interpretation and implication are also discussed. In addition. limitations of the study and recommendations to Medi-Cal dental program are discussed.

Chapter Four Results

Chapter Overview

Results from descriptive analysis and statistical modelling for each of the questions and their associated hypotheses are described in this Chapter. Question 1 to 3 address dental care utilization in clinics by Medi-Cal beneficiaries, with Question 1 focusing on the impact of Medi-Cal policy change on the overall population and Question 2 and 3 on the evaluation of age effect and ethnicity effect, respectively. Question 4 addresses dental related ER visits by adult Medi-Cal beneficiaries. Question 5 addresses dental providers' participation in the Medi-Cal program. Data sets described in Chapter Three were used for the statistical analyses for each of the research questions and their associated hypotheses. As described in Chapter Three, a portion of the data were obtained from the website of the California Department of Health Care Service and the rest were compiled by the agency at the request of the author. Prior to merge, data from the two different sources were prepared to make sure consistency in the name and format for each variable of interest.

Question 1: Utilization of Dental Care Services in Clinics by Adult Medi-Cal Beneficiaries

Question 1 addresses dental care utilization in clinics by adult Medi-Cal beneficiaries with a focus on the impact of Medi-Cal policy change on the overall population. Dental care utilization in clinics by overall population are first summarized descriptively by type of dental care services and calendar year, and hypothesis testing is then conducted using repeated measure analysis.

Question 1 and its three associated hypotheses are listed below.

Question 1: Did the partial benefit restoration in 2014 increase the dental care utilization in clinics by Medi-Cal beneficiaries to the level prior to elimination of adult dental coverage in 2009? How does the impact vary by different dental services such as annual dental visit, preventive services, dental exams, restorative services, and treatment of caries?

Hypothesis 1: The partial benefit restoration in 2014 increased the dental utilization in clinics by Medi-Cal beneficiaries in each year from 2015 to 2017.

Hypothesis 2: The dental utilization in clinics did not, as of 2017, reach the level of dental service utilization prior to the elimination of adult dental coverage in 2009.

Hypothesis 3: The amount of increase differed for different type of dental services due to various levels of complexity and cost of different dental services.

Results from descriptive analysis and repeated measure analysis evaluating the above hypotheses are presented below.

Results from descriptive analysis. Numbers of Medi-Cal beneficiaries who continuously enrolled in either Dental Managed Care or the Dental Fee-for-Service delivery system for at least 3 months during each calendar year from 2007 to 2017 are presented in Table 7. Table 7 also presents the number of beneficiaries that utilized at least one of the dental services and utilization rates by type of dental services and calendar year from 2007 to 2017. Utilization rates over time by type of dental services are depicted in Figure 9.

Results for evaluation of Hypothesis 1. The elimination of most of the adult dental services took effect in July 2009. For each type of dental services, the utilization rate in 2009 was lower than that of 2008. From 2010 to 2013, the utilization rates were substantially lower than those of 2007 and 2008 for each type of dental services. For example, the utilization rate of annual dental visit was reduced from 31.7% in 2008 to 11.8% in 2013; the utilization rate of preventive dental services was reduced from 16.3% to 3% and the utilization rate of restorative dental treatment was reduced from 11.0% to 1.5% (Table 7).

The partial restoration of adult dental services took effect in May 2014. For each type of dental services, the utilization rate in 2014 was higher than that of 2013. For annual dental visits, the utilization rate was 11.8% in 2013 and increased to 20.2%, 22.1%, 21.0% and 21.8% in 2014, 2015, 2016 and 2017 respectively. For the other types of dental services, the utilization rates increased each year from 2014 to 2017 (Table 7).

It is also noted that from 2007 to 2017, except for 2012 and 2013, the number of adult Medi-Cal beneficiaries increased each year and the largest increase occurred in 2014 as the result of Medicaid expansion. In 2014, the number of adult beneficiaries with at least 3 months of continuous enrollment increased from about 3.3 million in 2013 to about 5.7 million, and in 2017 the number increased to about 7.6 million.

Table 7

Total Number of Beneficiaries, Number of Beneficiaries Utilized Dental Services, and Utilization Rate by Type of Dental Services from 2007 to 2017

		Dental Services Number of Beneficiaries with at least One Service (Utilization Rate)					
Year	**N[a]**	**Annual Dental Visits**	**Dental Exams**	**Dental Treatment**	**Preventive Dental Services**	**Restorative Dental Treatment**	**Treatment for Caries**
2007	2,901,623	868,584 (29.9%)	169,847 (5.9%)	490,504 (16.9%)	450,081 (15.5%)	257,758 (8.9%)	257,716 (8.9%)
2008	2,984,703	947,357 (31.7%)	456,511 (15.3%)	625,041 (20.9%)	485,347 (16.3%)	329,397 (11.0%)	346,343 (11.6%)
2009	3,136,576	887,770 (28.3%)	438,978 (14.0%)	635,463 (20.3%)	403,671 (12.9%)	311,389 (9.9%)	330,815 (10.5%)
2010	3,257,986	372,062 (11.4%)	118,814 (3.6%)	284,348 (8.7%)	90,171 (2.8%)	53,190 (1.6%)	67,447 (2.1%)
2011	3,396,832	417,087 (12.3%)	122,522 (3.6%)	297,566 (8.8%)	98,735 (2.9%)	53,465 (1.6%)	71,733 (2.1%)
2012	3,380,040	406,183 (12.0%)	126,297 (3.7%)	296,035 (8.8%)	108,536 (3.2%)	53,100 (1.6%)	86,349 (2.6%)
2013	3,337,128	394,984 (11.8%)	118,900 (3.6%)	269,396 (8.1%)	100,076 (3.0%)	51,413 (1.5%)	87,787 (2.6%)
2014	5,740,867	1157629 (20.2%)	740,842 (12.9%)	619,268 (10.8%)	508,701 (8.9%)	311,140 (5.4%)	446,779 (7.8%)
2015	6,879,119	1519625 (22.1%)	917,858 (13.3%)	808,574 (11.8%)	645,558 (9.4%)	417,020 (6.1%)	621,716 (9.0%)
2016	7,648,757	1603816 (21.0%)	1151549 (15.1%)	963,329 (12.6%)	921,866 (12.1%)	524,723 (6.9%)	785,768 (10.3%)
2017	7,582,583	1654114 (21.8%)	1292346 (17.0%)	984,683 (13.0%)	984,765 (13.0%)	542,505 (7.2%)	833,473 (11.0%)

[a]Numbers of Medi-Cal beneficiaries who continuously enrolled in either Dental Managed Care or the Dental Fee-for-Service delivery system for at least 3 months during each calendar year.
Note here the years where policy changes were occurred.

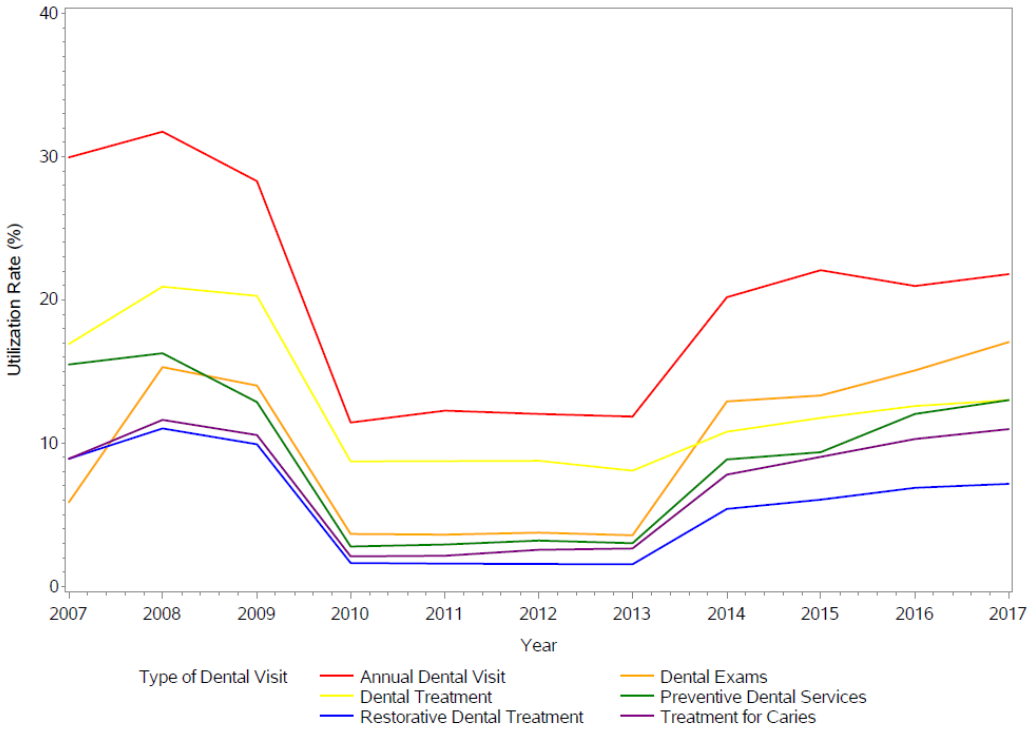


Figure 9. **Line plot of utilization rate of each type of dental services from 2007 to 2017.**

Results for evaluation of Hypothesis 2. As of 2017, except for dental exams, none of the other dental services had reached the level in 2008 (the year prior to elimination of most adult dental services) (Table 7). For example, for annual dental visits, the utilization rate in 2017 was 21.8%, about 69% of the level in 2008 and for preventive dental services the utilization rate in 2017 was 13%, about 3% less than that of 2008. However, for treatment of caries, the utilization rate in 2017 was just slightly lower than that of 2008 (11.0% vs. 11.6%). Figure 10 displays scatter plots of utilization rates of each county in 2008 vs. that of 2017. In 2017, for annual dental visits, the utilization rates were lower than those of 2008 for most of the counties; for dental exams, the utilization rates were higher than those of 2008 for majority of the counties.

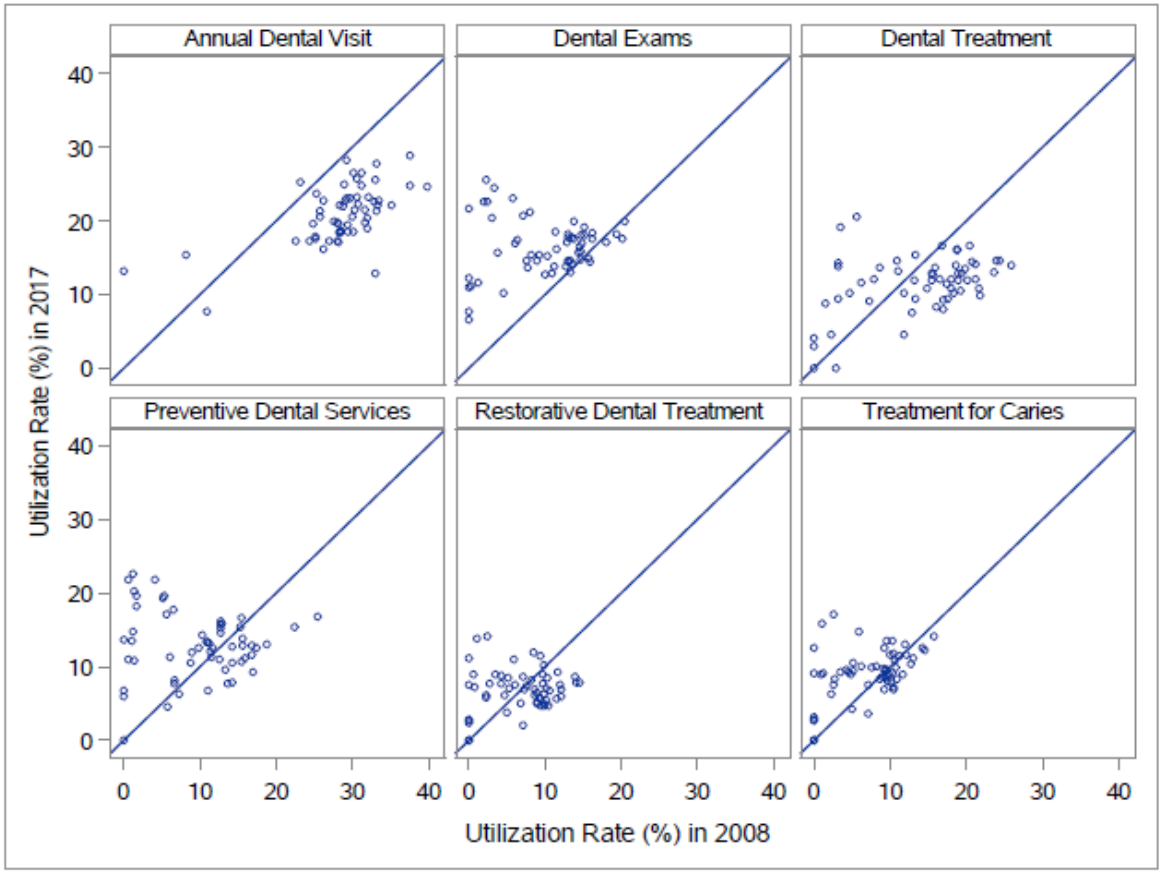


Figure 10. **Scatterplot of utilization rate in 2008 vs. 2017 in each county by types of dental services.**

Results for evaluation of Hypothesis 3. Comparing different types of dental services, utilization rates of dental exams increased 13.4% from 3.6% in 2013 to 17.0% in 2017, and this amount of increase was higher than that for annual dental visit and preventive dental services (10% for both). However, in terms of fold change, the highest fold increases were for restorative dental treatment and treatment for caries with the rates in 2017 of 4.8 and 4.2-fold respectively as that of 2008 (Table 7).

Results from repeated measure analysis.

Results for evaluation of Hypothesis 1. Results from repeated measure analysis show that compared to 2013, the utilization rate was higher in each year from 2014 to 2017 for each type of dental service and all the differences are statistically significant as all the 95% confidence intervals exclude 0 (Table 8).

Results for evaluation of Hypothesis 2. As of 2017, the utilization rates for dental exams, preventative dental services, and treatment for caries demonstrated a statistically significant increase than those in 2008. The utilization rates for annual dental visits and dental treatment showed a statistically significant decrease than those of 2008. There was no statistically significant difference in restorative dental treatment comparing to that of 2008 (Table 8).

Table 8

Least Square (LS) Mean Differences in Utilization Rates (95% CI) Between Comparing Years and by Type of Dental Services

		Dental Services LS Mean Difference of Utilization Rate (95% CI)					
Year	**vs. Year**	**Annual Dental Visits**	**Dental Exams**	**Dental Treatment**	**Preventive Dental Services**	**Restorative Dental Treatment**	**Treatment for Caries**
2014	2013	7.8 (7.05, 8.47)	5.5 (4.53, 6.39)	1.4 (1.07, 1.78)	3.0 (2.37, 3.67)	2.0 (1.62, 2.47)	2.8 (2.26, 3.39)
2015	2013	10.0 (9.11, 10.85)	6.3 (5.36, 7.18)	2.2 (1.77, 2.65)	3.6 (2.89, 4.24)	2.6 (2.15, 3.09)	3.8 (3.11, 4.43)
2016	2013	9.1 (8.31, 9.92)	13.0 (12.00, 14.09)	6.4 (5.42, 7.42)	10.8 (9.66, 12.04)	6.0 (5.25, 6.70)	7.6 (6.82, 8.43)
2017	2013	9.6 (8.88, 10.42)	14.6 (13.61, 15.66)	6.5 (5.50, 7.42)	11.4 (10.17, 12.69)	6.2 (5.42, 6.93)	7.9 (7.09, 8.78)
2017	2008	-7.6 (-8.91, -6.27)	6.3 (4.62, 8.06)	-2.4 (-4.16, -0.70)	3.3 (1.23, 5.41)	-0.0 (-1.28, 1.24)	2.0 (0.85, 3.10)

Diagnostic analyses. Results from diagnostic analyses are summarized below. Except for annual dental visit, there is no indication of substantial deviations from the normality assumption for each of the other types of dental services based on studendized residual plots (Figure 11). Cook's distances showing the influence of each observation on the estimated fitted effect by type of dental services are displayed in Figure 12. On Figure 12, the counties with relatively large Cook's distance values (influential observations) are labelled and the results from those counties in selective years are listed in Table 9. Examples of analyses include:

- Annual dental visits:

- in Trinity County (#53) in the Northern region, in 2008, the utilization rate was 33.1% and in 2013, the rate was only 4.5%; after the partial restoration of adult dental service, the rate increased to 10.4% in 2014 and the rate in 2017 was only 12.8% still about 20% lower than that of 2008.

- Preventive dental services:
  - in Colusa County (#6) in the Northern region, in 2008, the utilization rate was only 1.2% and the rate was 0% in 2013. In 2017, after 3 years of the partial restoration of adult dental service, the rate increased to 22.6%.
  - in Sierra County (#46) in the Mountain Valley region, the utilization rate was 0% in 2008 and remained as 0% after the partial restoration of adult dental service in both 2014 and 2017.

The results from the diagnostic analyses indicate there are regional effects on the dental utilization rates and those effects are further evaluated in the section below.

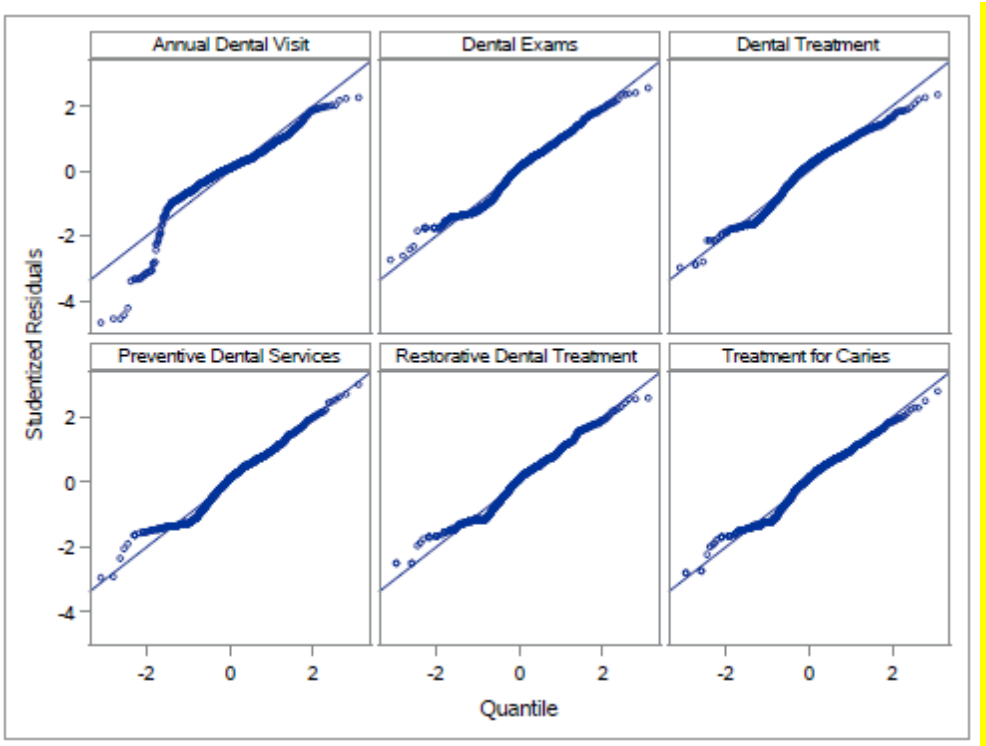


Figure 11. **Studendized residual plots by type of dental services from repeated measure analysis.**

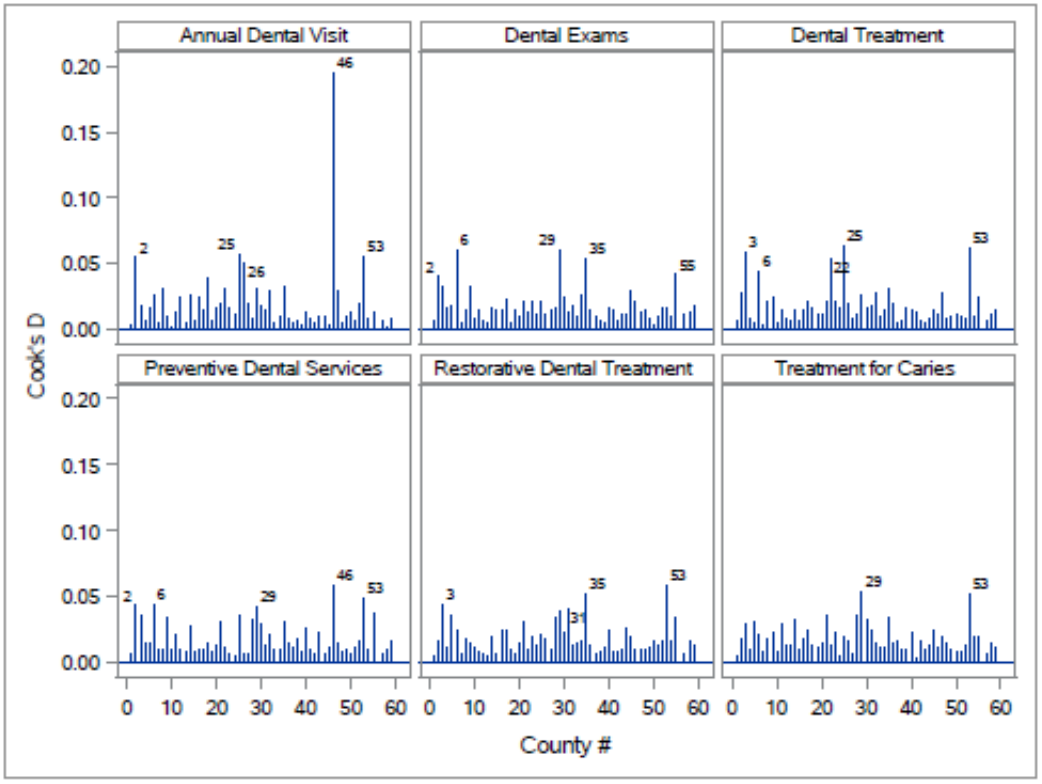


Figure 12. **Needle plots of Cook's distance by type of dental services from repeated measure analysis for each county.**

Table 9

Utilization Rates of Counties with Cook's Distance >=0.04 by Type of Dental Services During Selected Years

		Utilization Rate			
Type of Dental Services	**County #/County/Region**	**2008**	**2013**	**2014**	**2017**
Annual Dental Visits	02 /Alpine/Mountain valley	0/39 (0.0%)	0/81 (0.0%)	16/199 (8.0%)	27/205 (13.2%)
	25 /Modoc/Northern	279/1,206 (23.1%)	128/1,048 (12.2%)	449/1,625 (27.6%)	490/1,939 (25.3%)
	26 /Mono/Mountain valley	29/353 (8.2%)	0/454 (0.0%)	153/1,324 (11.6%)	289/1,878 (15.4%)
	46 /Sierra/Mountain valley	32/292 (11.0%)	0/289 (0.0%)	0/475 (0.0%)	43/561 (7.7%)
	53 /Trinity/Northern	575/1,739 (33.1%)	74/1,629 (4.5%)	284/2,741 (10.4%)	432/3,370 (12.8%)
Dental Exams	02 /Alpine/Mountain valley	0/39 (0.0%)	0/81 (0.0%)	0/199 (0.0%)	25/205 (12.2%)
	06 /Colusa/Northern	43/1,847 (2.3%)	0/1,846 (0.0%)	83/2,874 (2.9%)	1,068/4,188 (25.5%)
	29 /Nevada/Mountain valley	406/5,685 (7.1%)	41/6,439 (0.6%)	351/12,426 (2.8%)	3,375/16,278 (20.7%)
	35 /San Benito/Bay area	486/3,717 (13.1%)	66/4,299 (1.5%)	287/5,671 (5.1%)	1,155/6,506 (17.8%)
	55 /Tuolumne/Mountain valley	366/4,573 (8.0%)	82/4,807 (1.7%)	220/6,165 (3.6%)	1,352/6,406 (21.1%)
Dental Treatment	03 /Amador/Mountain valley	335/2,163 (15.5%)	142/2,482 (5.7%)	314/4,299 (7.3%)	681/5,303 (12.8%)
	06 /Colusa/Northern	58/1,847 (3.1%)	30/1,846 (1.6%)	60/2,874 (2.1%)	581/4,188 (13.9%)
	22 /Mariposa/Central valley	94/1,526 (6.2%)	55/1,648 (3.3%)	60/2,745 (2.2%)	371/3,208 (11.6%)
	25 /Modoc/Northern	27/1,206 (2.2%)	0/1,048 (0.0%)	44/1,625 (2.7%)	88/1,939 (4.5%)
	53 /Trinity/Northern	224/1,739 (12.9%)	24/1,629 (1.5%)	70/2,741 (2.6%)	253/3,370 (7.5%)
Preventive Dental Services	02 /Alpine/Mountain valley	0/39 (0.0%)	0/81 (0.0%)	0/199 (0.0%)	14/205 (6.8%)
	06 /Colusa/Northern	22/1,847 (1.2%)	0/1,846 (0.0%)	48/2,874 (1.7%)	946/4,188 (22.6%)
	29 /Nevada/Mountain valley	369/5,685 (6.5%)	57/6,439 (0.9%)	190/12,426 (1.5%)	2,876/16,278 (17.7%)
	46 /Sierra/Mountain valley	0/292 (0.0%)	0/289 (0.0%)	0/475 (0.0%)	0/561 (0.0%)
	53 /Trinity/Northern	101/1,739 (5.8%)	0/1,629 (0.0%)	41/2,741 (1.5%)	152/3,370 (4.5%)
Restorative Dental Treatment	03 /Amador/Mountain valley	156/2,163 (7.2%)	0/2,482 (0.0%)	101/4,299 (2.3%)	365/5,303 (6.9%)
	31 /Placer/Mountain valley	1,415/14,226 (9.9%)	151/15,866 (1.0%)	845/30,631 (2.8%)	1,917/39,379 (4.9%)
	35 /San Benito/Bay area	282/3,717 (7.6%)	22/4,299 (0.5%)	35/5,671 (0.6%)	477/6,506 (7.3%)
	53 /Trinity/Northern	88/1,739 (5.1%)	0/1,629 (0.0%)	17/2,741 (0.6%)	126/3,370 (3.7%)
Treatment for Caries	29 /Nevada/Mountain valley	291/5,685 (5.1%)	44/6,439 (0.7%)	189/12,426 (1.5%)	1,527/16,278 (9.4%)
	53 /Trinity/Northern	88/1,739 (5.1%)	0/1,629 (0.0%)	46/2,741 (1.7%)	142/3,370 (4.2%)

Summary. The partial restoration of adult dental services in 2014 achieved positive

impact on dental care utilization in clinics by Medi-Cal beneficiaries. The utilization rate at each year from 2014 to 2017 was statistically significantly higher than that in 2013. For most of the dental services, the utilization rates continued to increase each year from 2014 to 2017. However, the amount of increase differed for different type of dental services. Dental exams had the greatest rate increase of 13.4% from 3.6% in 2013 to 17.0% in 2017 while restorative dental treatment had the highest fold increases of 4.8. As of 2017, utilization for annual dental visits and dental treatment didn't reach the level of those in 2008 (the year prior to the elimination of most of the Medi-Cal adult dental services). In addition, results from the diagnostic analyses indicate there are regional effects on the dental utilization rates.

Questions 2 and 3: Age Effect and Ethnicity Effect on Utilization of Dental Care Services in Clinics by Adult Medi-Cal Beneficiaries

Question 2 and 3 address the age effect and ethnicity effect respectively on utilization of dental care services in clinics by adult Medi-Cal beneficiaries. Dental care utilization in clinics are first summarized by age, ethnicity and calendar year for each type of dental service. Hypothesis testing is then conducted using repeated measure analysis. Since statistically significant interaction effects of age by ethnicity, age by geographic region and ethnicity by geographic region were identified through model checking, the age effect was evaluated within each ethnic group and the ethnicity effect was evaluated within each age group for each geographic region and each type of dental service. Therefore, results from evaluation of Question 2 and 3 are presented in one section to show how age effect may vary by ethnic group and ethnicity effect may vary by age group in different geographic regions for each type of dental service.

Question 2 and 3 and their associated hypotheses are listed below.

Question 2: Did the partial benefit restoration in 2014 affect older Medi-Cal beneficiaries' dental care utilization in clinic differently than younger age beneficiaries?	***Hypothesis 4:*** There is a greater increase in dental care utilization in clinics among older Medi-Cal beneficiaries than among younger age beneficiaries.
Question 3: Did the effect of partial benefit restoration in 2014 vary by ethnic groups?	***Hypothesis 5:*** There is a greater increase in dental care utilization in clinic among White beneficiaries compared to those from ethnic minority groups.

Results from descriptive analysis and repeated measure analysis evaluating the above hypotheses are presented below.

Results from descriptive analysis. Table 10 presents the number of Medi-Cal beneficiaries by age group and ethnic group in 2008, 2013 and 2017. Within each ethnic group, the majority of the beneficiaries are in the age group of 19 to 64 years old. Within each age group, the majority of the beneficiaries report their ethnic groups as Hispanic or White. Comparing 2017 to 2008, the number of beneficiaries increased substantially for each ethnic group among those 19 to 64 years old. The number of beneficiaries increased for each ethnic group except for Other among those 65 to 74 years old; and the number of beneficiaries increased among Hispanics and Asians, but decreased among White, Black and Other in the 75 years and older group.

Table 10

Number of Medi-Cal Beneficiaries[a] by Age Group and Ethnic Group During 2008, 2013 and 2017

		Ethnicity					
Year	**Age Group**	**White**	**Black**	**Hispanic**	**Asian**	**Other**	**Total**
2008	Age 19-64	682,898	312,573	833,495	131,393	172,011	2,132,370
	Age 65-74	116,835	29,683	128,968	40,401	90,482	406,369
	Age 75+	155,443	27,231	115,358	57,817	90,115	445,964
	Total	955,176	369,487	1,077,821	229,611	352,608	2,984,703
2013	Age 19-64	722,170	349,727	1,061,765	139,595	228,254	2,501,511
	Age 65-74	111,160	30,214	140,393	44,904	77,210	403,881
	Age 75+	114,374	21,864	136,606	73,313	85,579	431,736
	Total	947,704	401,805	1,338,764	257,812	391,043	3,337,128
2017	Age 19-64	1,778,255	665,829	2,775,458	512,625	799,798	6,531,965
	Age 65-74	151,211	43,051	203,752	76,726	88,945	563,685
	Age 75+	114,505	23,254	168,696	94,029	86,449	486,933
	Total	2,043,971	732,134	3,147,906	683,380	975,192	7,582,583

[a]Numbers of Medi-Cal beneficiaries who continuously enrolled in either Dental Managed Care or the Dental Fee-for-Service delivery system for at least 3 months during each calendar year

Results for evaluation of Hypothesis 4 and 5. One of the main interests in the study is to evaluate the effect of ethnicity. The comparisons among the ethnic groups of White, Black, Hispanic and Asian are presented in the body of the report below. Due to space limitation, the results from Other ethnic group are only depicted in Appendix A, as it was not very meaningful to compare each ethnic group with 'Other' for it includes various minority (or mixture of) ethnic groups.

Figure 13 displays utilization rates by age group (19-64, 65-74 & 75 + years old), ethnic group (White, Black, Hispanic & Asian), and type of dental services from 2007 to 2017.

Utilization rates by age group, ethnic group, type of dental services during year 2008, 2013 and 2017 are tabulated in Table 11.

Table 11 demonstrates that the majority of beneficiaries in all ethnic groups were in the age range of 19-64 years old. Comparing the number of beneficiaries between the 2 subgroups for older adults, for White, the number of beneficiaries was greater in the 75 years old and above group in 2008, similar between the 2 groups in 2013 and greater in the 65-74 years old in 2017. For the ethnic groups of Hispanic and Black, the number was greater in the 65-74 years old group for each of the 3 years; and for the ethnic group of Asian, the number was greater in the 75 years old and above group for each of the 3 years.

In each ethnic group within each age group, the utilization rates decreased post the elimination of most of the adult dental services in 2009 and increased after the partial restoration of adult dental services in 2014 (Table 11 and Figure 13). Prior to the elimination of most of the adult dental services in 2009, the utilization rate was higher in the age group of 19-64 years old compared to the older age groups for each ethnic group for most of the dental services. Post the partial restoration of adult dental services in 2014, the utilization rates were lower for older age groups especially those 75 years old and above among Hispanic and Black participants for a majority of the dental services. However, utilization rates were similar among age groups for the majority of dental services for the ethnic groups of White and Asian. In general, Black participants had the lowest utilization rates among the 4 ethnic groups.

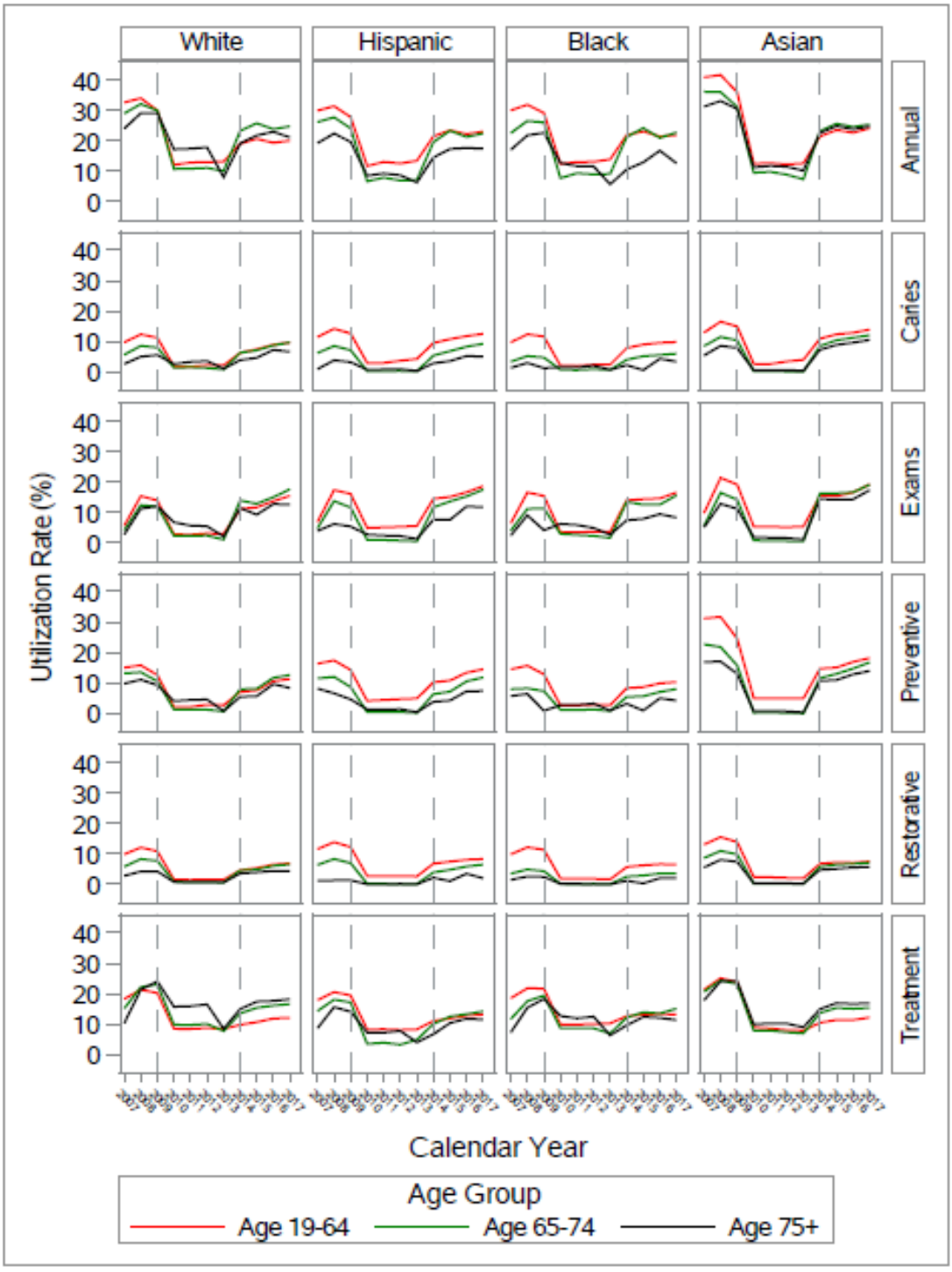


Figure 13. Utilization rate by age group, major ethnic group and type of dental services from 2007 to 2017.

Table 11

Utilization Rates by Ethnic Group, Age Group, Type of Dental Services During 2008, 2013 and 2017

Ethnic group=White

N/ Type of Dental Service	2008			2013			2017		
	Age 19-64	**Age 65-74**	**Age 75+**	**Age 19-64**	**Age 65-74**	**Age 75+**	**Age 19-64**	**Age 65-74**	**Age 75+**
N	682,898	116,835	155,443	722,170	111,160	114,374	1,778,255	151,211	114,505
Annual Dental	231,250	37,348	45,030	94,385	11,130	9,163	354,914	37,278	24,105
Visit	(33.9%)	(32.0%)	(29.0%)	(13.1%)	(10.0%)	(8.01%)	(20.0%)	(24.7%)	(21.1%)
Dental Exams	104,855	14,433	17,457	21,545	1,221	2,416	274,313	26,551	14,385
	(15.4%)	(12.4%)	(11.2%)	(2.98%)	(1.10%)	(2.11%)	(15.4%)	(17.6%)	(12.6%)
Dental Treatment	145,894	25,928	33,279	61,137	8,711	9,765	216,320	25,207	20,893
	(21.4%)	(22.2%)	(21.4%)	(8.47%)	(7.84%)	(8.54%)	(12.2%)	(16.7%)	(18.2%)
Preventive Dental	108,041	15,823	17,274	19,752	772	919	201,817	19,097	9,614
Services	(15.8%)	(13.5%)	(11.1%)	(2.74%)	(0.69%)	(0.80%)	(11.3%)	(12.6%)	(8.40%)
Restorative Dental	82,153	9,638	6,504	10,685	629	701	121,311	9,871	5,034
Treatment	(12.0%)	(8.25%)	(4.18%)	(1.48%)	(0.57%)	(0.61%)	(6.82%)	(6.53%)	(4.40%)
Treatment for	84,912	10,102	7,948	16,333	1,032	1,351	172,983	14,763	7,699
Caries	(12.4%)	(8.65%)	(5.11%)	(2.26%)	(0.93%)	(1.18%)	(9.73%)	(9.76%)	(6.72%)

Ethnic group=Black

N/ Type of Dental Service	2008			2013			2017		
	Age 19-64	**Age 65-74**	**Age 75+**	**Age 19-64**	**Age 65-74**	**Age 75+**	**Age 19-64**	**Age 65-74**	**Age 75+**
N	312,573	29,683	27,231	349,727	30,214	21,864	665,829	43,051	23,254
Annual Dental	99,210	7,842	5,912	48,357	2,739	1,241	145,010	9,746	2,928
Visit	(31.7%)	(26.4%)	(21.7%)	(13.8%)	(9.07%)	(5.68%)	(21.8%)	(22.6%)	(12.6%)
Dental Exams	51,679	3,306	2,467	12,744	497	591	109,805	6,710	1,930
	(16.5%)	(11.1%)	(9.06%)	(3.64%)	(1.64%)	(2.70%)	(16.5%)	(15.6%)	(8.30%)
Dental Treatment	68,200	5,214	4,202	36,105	2,117	1,403	87,953	6,523	2,658
	(21.8%)	(17.6%)	(15.4%)	(10.3%)	(7.01%)	(6.42%)	(13.2%)	(15.2%)	(11.4%)
Preventive Dental	49,036	2,452	1,762	9,672	255	216	68,878	3,460	995
Services	(15.7%)	(8.26%)	(6.47%)	(2.77%)	(0.84%)	(0.99%)	(10.3%)	(8.04%)	(4.28%)
Restorative Dental	37,844	1,436	690	5,575	0	0	43,317	1,482	456
Treatment	(12.1%)	(4.84%)	(2.53%)	(1.59%)	(0.00%)	(0.00%)	(6.51%)	(3.44%)	(1.96%)
Treatment for	38,930	1,576	837	8,665	233	179	65,967	2,624	816
Caries	(12.5%)	(5.31%)	(3.07%)	(2.48%)	(0.77%)	(0.82%)	(9.91%)	(6.10%)	(3.51%)

Ethnic group=Hispanic

N/ Type of Dental Service	2008			2013			2017		
	Age 19-64	Age 65-74	Age 75+	Age 19-64	Age 65-74	Age 75+	Age 19-64	Age 65-74	Age 75+
N	833,495	128,968	115,358	1,061,765	140,393	136,606	2,775,458	203,752	168,696
Annual Dental	260,666	35,623	25,723	142,248	9,939	8,583	636,749	45,514	29,235
Visit	(31.3%)	(27.6%)	(22.3%)	(13.4%)	(7.08%)	(6.28%)	(22.9%)	(22.3%)	(17.3%)
Dental Exams	144,323	17,694	7,182	59,060	756	1,783	515,673	35,573	19,754
	(17.3%)	(13.7%)	(6.23%)	(5.56%)	(0.54%)	(1.31%)	(18.6%)	(17.5%)	(11.7%)
Dental Treatment	171,386	23,334	18,051	88,633	6,944	5,576	366,147	28,985	19,476
	(20.6%)	(18.1%)	(15.6%)	(8.35%)	(4.95%)	(4.08%)	(13.2%)	(14.2%)	(11.5%)
Preventive Dental	145,168	15,525	7,658	52,669	312	664	402,584	24,103	12,477
Services	(17.4%)	(12.0%)	(6.64%)	(4.96%)	(0.22%)	(0.49%)	(14.5%)	(11.8%)	(7.40%)
Restorative Dental	114,873	10,678	1,458	27,350	134	0	229,297	13,130	3,307
Treatment	(13.8%)	(8.28%)	(1.26%)	(2.58%)	(0.10%)	(0.00%)	(8.26%)	(6.44%)	(1.96%)
Treatment for	118,859	11,117	4,528	46,500	401	612	349,210	19,028	8,649
Caries	(14.3%)	(8.62%)	(3.93%)	(4.38%)	(0.29%)	(0.45%)	(12.6%)	(9.34%)	(5.13%)

Ethnic group=Asian

N/ Type of Dental Service	2008			2013			2017		
	Age 19-64	Age 65-74	Age 75+	Age 19-64	Age 65-74	Age 75+	Age 19-64	Age 65-74	Age 75+
N	131,393	40,401	57,817	139,595	44,904	73,313	512,625	76,726	94,029
Annual Dental	54,511	14,490	19,047	17,512	3,291	7,446	123,229	19,398	23,162
Visit	(41.5%)	(35.9%)	(32.9%)	(12.5%)	(7.33%)	(10.2%)	(24.0%)	(25.3%)	(24.6%)
Dental Exams	28,013	6,655	7,414	7,519	247	847	98,151	14,651	16,259
	(21.3%)	(16.5%)	(12.8%)	(5.39%)	(0.55%)	(1.16%)	(19.1%)	(19.1%)	(17.3%)
Dental Treatment	33,006	9,847	13,950	11,173	3,163	6,625	62,775	11,825	15,933
	(25.1%)	(24.4%)	(24.1%)	(8.00%)	(7.04%)	(9.04%)	(12.2%)	(15.4%)	(16.9%)
Preventive Dental	41,610	8,805	9,878	6,937	36	266	93,149	12,871	13,126
Services	(31.7%)	(21.8%)	(17.1%)	(4.97%)	(0.08%)	(0.36%)	(18.2%)	(16.8%)	(14.0%)
Restorative Dental	20,302	4,406	4,625	2,740	60	165	38,244	5,423	5,304
Treatment	(15.5%)	(10.9%)	(8.00%)	(1.96%)	(0.13%)	(0.23%)	(7.46%)	(7.07%)	(5.64%)
Treatment for	21,814	4,681	5,011	5,719	70	357	71,691	9,305	9,966
Caries	(16.6%)	(11.6%)	(8.67%)	(4.10%)	(0.16%)	(0.49%)	(14.0%)	(12.1%)	(10.6%)

Further analysis indicates there are regional effects on the utilization rate for each type of dental service (Appendix B). Figure 14 displays utilization rates for annual dental visits by age group, and ethnic group from 2007 to 2017 for each geographic region. Post the partial restoration of adult dental services in 2014:

- For the ethnicity of White, in the Bay Area and Southern region, the utilization rates for annual dental visit were higher in the two older age groups than the age group of 19-64 years older; however, in the other regions, the utilization rate was the lowest in the age group of 75 years old and above.
- For the ethnic groups of Hispanic and Black, the utilization rate was the lowest in the age group of 75 years old and above in most of the years in each region.
- For the ethnicity of Asian, in the Bay Area, Mountain Valley and Southern region, the utilization rates were similar among the age groups, however in the Central Valley and Northern region, the utilization rate was the lowest in the age group of 75 years old and above for most years.

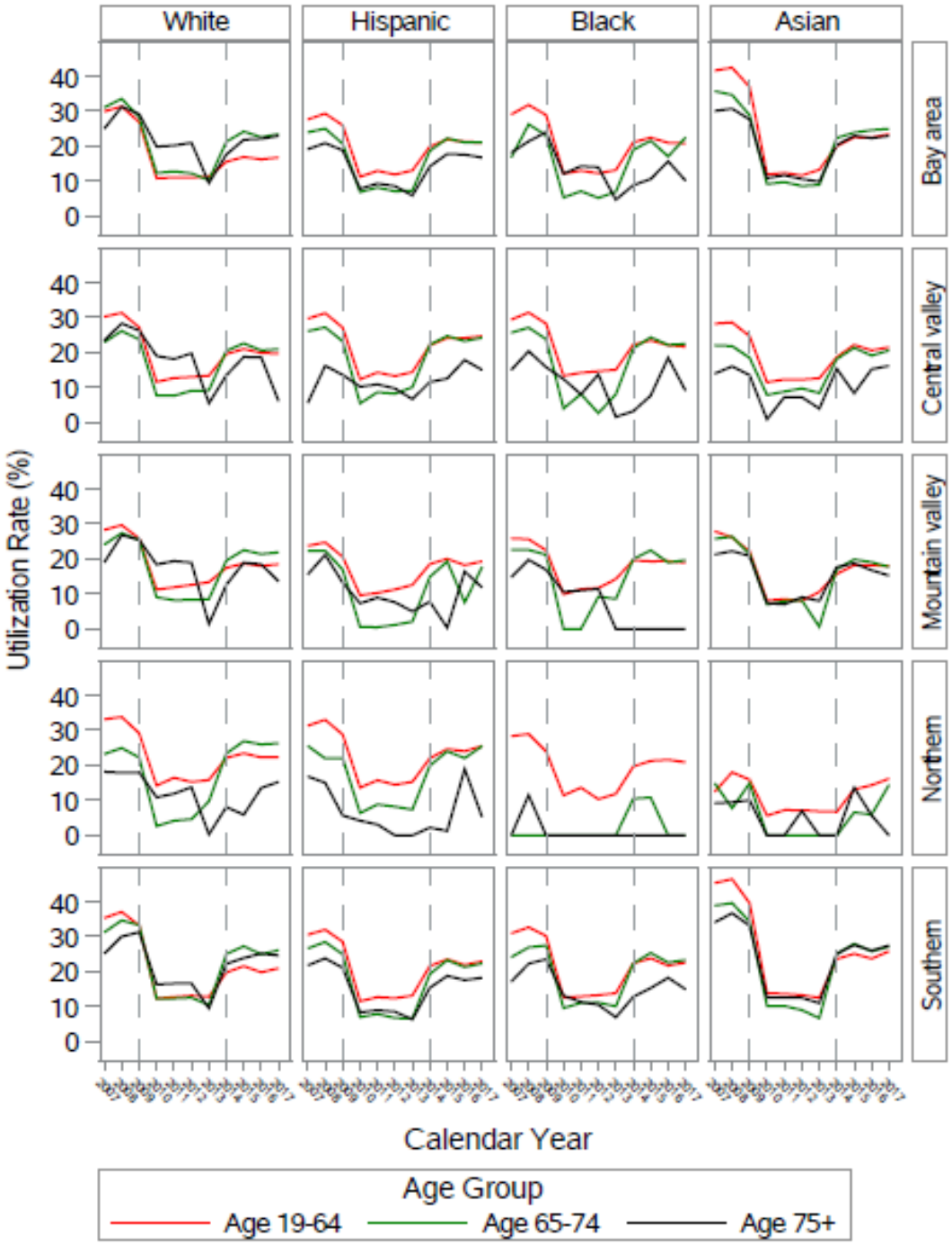


Figure 14. Utilization rates for annual dental visits by age group and ethnic group from 2007 to 2017 in each geographic region.

Results from repeated measure analysis. Results from mixed model analysis including interaction terms show that there are statistically significant interaction effects of ethnic group by age group, ethnic group by geographic region and age group by geographic region for most type of the dental services (Appendix C). Due to the presence of significant interaction effects, repeated measure analyses were performed separately for each region by type of dental services, and ethnicity effects were evaluated for each age group and age effects were evaluated for each ethnic group focusing on year 2008 (prior to elimination of most of the adult dental services) and 2017 (3 years post partial restoration of adult dental services).

Annual dental visits-age effect (hypothesis 4). Figure 15 displays point estimate of the difference in utilization rates for annual dental visits among age groups and its 95% confidence interval by ethnic group and geographic region in 2008 and 2017. The comparisons with statistically significant differences are presented in Table 12.

In 2008, all the comparisons with statistically significant findings show greater utilization rates in the younger age group than the older age group (age 19-64 vs. 65-74, age 19-64 vs. 75+, or age 65-74 vs. 75+ years old), and the ethnicity of Hispanic has the greatest number of statistically significant findings of this age effect among the ethnic groups. In 2017, except for one comparison, all the other comparisions with statistically significant findings show greater utilization rates in the younger age group than the older age group; although the ethnicity of Hispanic still has the greatest number of statistically significant findings of this age effect, the number of significant findings in the ethnicity of Black is more than that of 2008. In both 2008 and 2017, the ethnicity of Asian has the least number of significant findings of differences in utilization rate among age groups.

Table 12

Comparisons with Statistically Significant Differences in Utilization Rate for Annual dental visit among Age Groups by Ethnic Group and Geographic Region in 2008 and 2017

			2008 LS Mean Difference				2017 LS Mean Difference			
Geographic Region	**Age Group**	**vs. Age Group**	**White**	**Black**	**Hispanic**	**Asian**	**White**	**Black**	**Hispanic**	**Asian**
Bay area	Age 19-64	Age 65-74					-6.5			
	Age 19-64	Age 75+		15.1	9.4			15.1	5.9	
	Age 65-74	Age 75+						13.5	5.4	
Central valley	Age 19-64	Age 65-74	5.6							
	Age 19-64	Age 75+	6.0		15.5	13.1	10.3	10.0	12.0	10.9
	Age 65-74	Age 75+			15.1		12.2	9.9	13.0	
Mountain valley	Age 19-64	Age 65-74			15.9				10.1	
	Age 19-64	Age 75+			16.1		10.7	12.7	13.9	
	Age 65-74	Age 75+					12.5			
Northern	Age 19-64	Age 65-74	9.6		14.1			13.2		
	Age 19-64	Age 75+	15.6		17.6		11.1	14.2	21.1	10.1
	Age 65-74	Age 75+	6.0				13.5		15.8	
Southern	Age 19-64	Age 65-74		13.7	3.3					
	Age 19-64	Age 75+	9.2	21.1	7.4	15.1		20.1	4.0	
	Age 65-74	Age 75+			4.0		7.9	15.8	4.6	

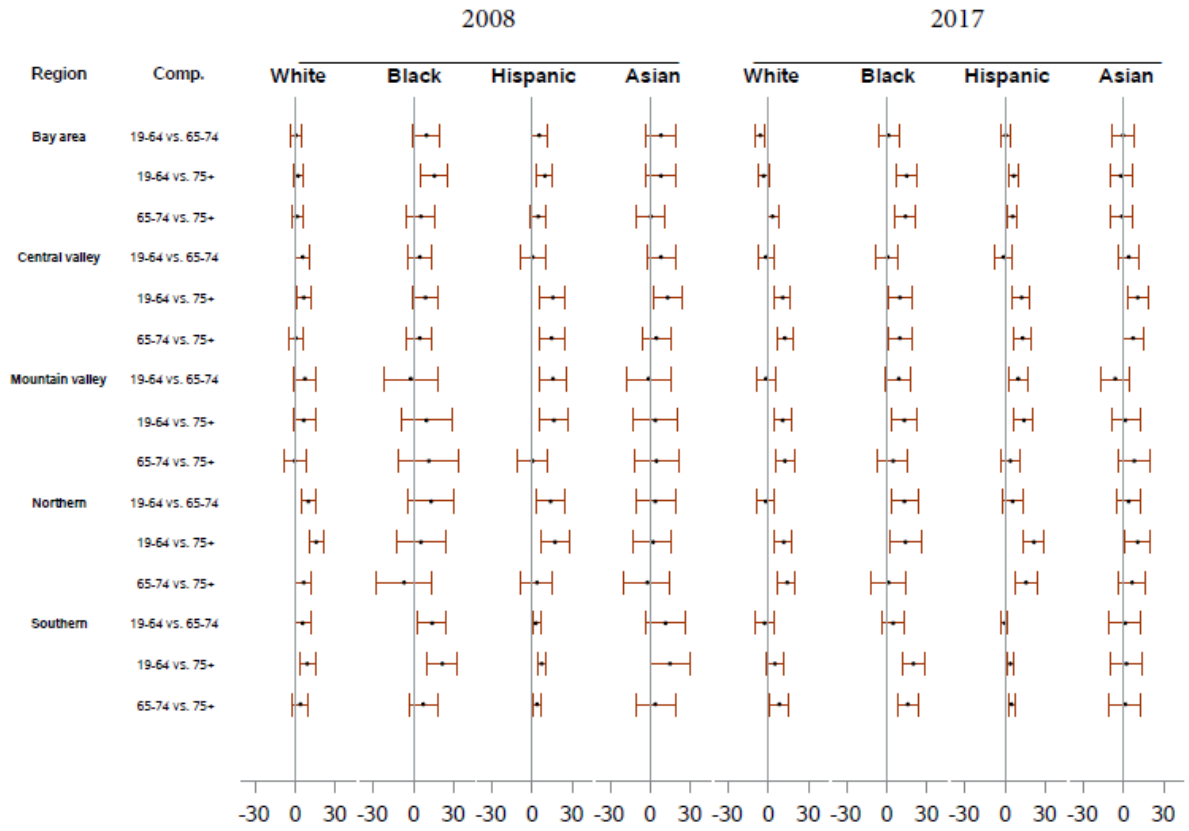


Figure 15. Forest plots of least square mean difference (95% CI) of utilization rates for annual dental visit among age groups by ethnic group and geographic region in 2008 and 2017.

After the partial restoration of the adult dental services in 2014, the utilization rates in 2014, 2015, 2016 and 2017 were greater than that of 2013. However, the magnitude of increase differs in different age groups, ethnic groups and geographic regions. Table 13 presents least square mean differences (95% CI) among age groups for utilization rates difference between 2017 and 2013 by ethnic group and geographic region. For example, in the Bay area, among the ethnicity of White, the increase in utilization rates from 2017 to 2013 in the age group of 19-64 years old was 8.7% lower than that of the age group of 65-74 years old; however in the Northern region, among the ethnicity of Black for the same age group comparison the increase in utilization rates from 2017 to 2013 in the age group of 19-64 years old was 8% greater than that of age group of 65-74 years old. There are more statistically significant findings of age group differences in the ethnic groups of White, Black and Hispanic

than the ethnicity of Asian. Among White beneficiaries, the increase in utilization rates were statistically greater in the age group of 65-74 years old than the age group of 19-64 years old in most of the geographic regions. Among Asian beneficiaries, in general, the increase in utilization rates were similar among age groups.

Table 13

Least Square Mean Differences Among Age Groups for Utilization Rates Difference between 2017 and 2013 by Ethnic Group and Geographic Region for Annual Dental Visit

			Least Square Mean Differences (95% CI) of Differences in Utilization Rates between 2017 and 2013			
Geographic Region	**Age Group**	**vs. Age Group**	**White**	**Black**	**Hispanic**	**Asian**
Bay area	Age 19-64	Age 65-74	-8.7 (-12.04, -5.36)*	-6.5 (-13.19,0.22)	-5.2 (-8.03, -2.40)*	-0.3 (-7.75,7.24)
	Age 19-64	Age 75+	-7.4 (-10.78, -4.09)*	5.5 (-1.25,12.17)	-1.1 (-3.94,1.69)	-0.7 (-8.18,6.82)
	Age 65-74	Age 75+	1.3 (-2.08,4.61)	11.9 (5.24, 18.65)*	4.1 (1.28, 6.91)*	-0.4 (-7.92,7.08)
Central valley	Age 19-64	Age 65-74	-7.4 (-15.00,0.23)	-10.0 (-18.41, -1.52)*	-5.0 (-10.46, 0.43)	0.7 (-7.29,8.78)
	Age 19-64	Age 75+	1.2 (-6.39,8.85)	-5.3 (-14.03,3.39)	4.6 (-0.88,10.01)	5.0 (-3.04,13.03)
	Age 65-74	Age 75+	8.6 (0.99,16.23)*	4.6 (-4.06,13.35)	9.6 (4.00,15.17)*	4.2 (-3.78,12.28)
Mountain valley	Age 19-64	Age 65-74	-8.1 (-13.81, -2.34)*	5.6 (0.01, 11.27)*	3.8 (-3.24,10.78)	-7.4 (-17.67,2.95)
	Age 19-64	Age 75+	1.7 (-4.05,7.42)	8.0 (2.37, 13.63)*	6.7 (-0.68,14.02)	3.8 (-6.53,14.09)
	Age 65-74	Age 75+	9.8 (3.92,15.60)*	2.4 (-4.02,8.74)	2.9 (-4.46,10.25)	11.1 (0.44, 21.84)*
Northern	Age 19-64	Age 65-74	-10.6 (-17.43, -3.83)*	8.0 (0.45, 15.63)*	-4.9 (-12.48,2.66)	-1.7 (-11.91,8.51)
	Age 19-64	Age 75+	-4.1 (-10.87,2.74)	8.0 (-1.12,17.20)	9.3 (1.57, 17.13)*	9.1 (-1.11,19.31)
	Age 65-74	Age 75+	6.6 (-0.24,13.36)	0.0 (-10.27,10.27)	14.3 (6.04, 22.46)*	10.8 (-0.99,22.59)
Southern	Age 19-64	Age 65-74	-8.1 (-14.06, -2.09)*	-3.8 (-10.09,2.41)	-6.9 (-9.54, -4.19)*	-1.0 (-9.66,7.73)
	Age 19-64	Age 75+	-1.7 (-7.66,4.32)	7.9 (1.61, 14.11)*	-3.4 (-6.05, -0.69)*	1.5 (-7.23,10.16)
	Age 65-74	Age 75+	6.4 (0.42,12.39)*	11.7 (5.45, 17.95)*	3.5 (0.82, 6.17)*	2.4 (-6.26,11.13)

* $p < 0.05$, 2-sided.

Annual dental visits-ethnicity effect (hypothesis 5). Figure 16 displays point estimate of the difference in utilization rates for annual dental visits among ethnic groups and its 95%

confidence interval by age group and geographic region in 2008 and 2017. The comparisons with statistically significant differences are presented in Table 14.

The effect by ethnicity differs by age group and geographic region. In both 2008 and 2017 there were more statistically significant findings for ethnicity effect in the older age groups (65-74, and 75+ years old) than in the younger age group (19-64 years old). Among the comparisons with statistically significant differences there are more findings showing the ethnicity of Black has lower utilization rates than other ethnic groups (Table 14 and Figure 16).

Table 14

Comparisons with Statistically Significant Differences in Utilization Rate for Annual dental visit among Ethnic Groups by Age Group and Geographic Region in 2008 and 2017

			2008 LS Mean Difference			2017 LS Mean Difference		
Geographic Region	**Ethnic Group**	**vs. Ethnic Group**	**Age 19-64**	**Age 65-74**	**Age 75+**	**Age 19-64**	**Age 65-74**	**Age 75+**
Bay area	Asian	Black			11.3			16.1
	Asian	Hispanic						
	Asian	White						
	Black	Hispanic						-12.2
	Black	White		-10.7	-14.7			-16.2
	Hispanic	White			-10.0	5.3		
Central valley	Asian	Black	-9.0	-13.0	-13.5			
	Asian	Hispanic		-14.3			-7.1	
	Asian	White	-10.6	-13.3	-17.7			
	Black	Hispanic						
	Black	White						
	Hispanic	White			-13.7	3.4		
Mountain valley	Asian	Black					13.3	
	Asian	Hispanic				-7.8		
	Asian	White	-13.3			-7.7		
	Black	Hispanic						
	Black	White	-14.7		-17.8		-16.1	
	Hispanic	White		-11.3	-11.8		-11.7	
Northern	Asian	Black						
	Asian	Hispanic	-20.8			-13.9	-12.6	
	Asian	White	-27.5	-22.2	-13.6	-13.3	-19.6	-12.3
	Black	Hispanic	-13.3			-10.8	-18.8	
	Black	White	-19.9	-23.8		-10.2	-25.8	-12.7
	Hispanic	White		-11.4				-9.3
Southern	Asian	Black			11.7			16.6
	Asian	Hispanic	8.5					
	Asian	White						
	Black	Hispanic			-10.9			-16.1
	Black	White			-12.8			-13.0
	Hispanic	White						

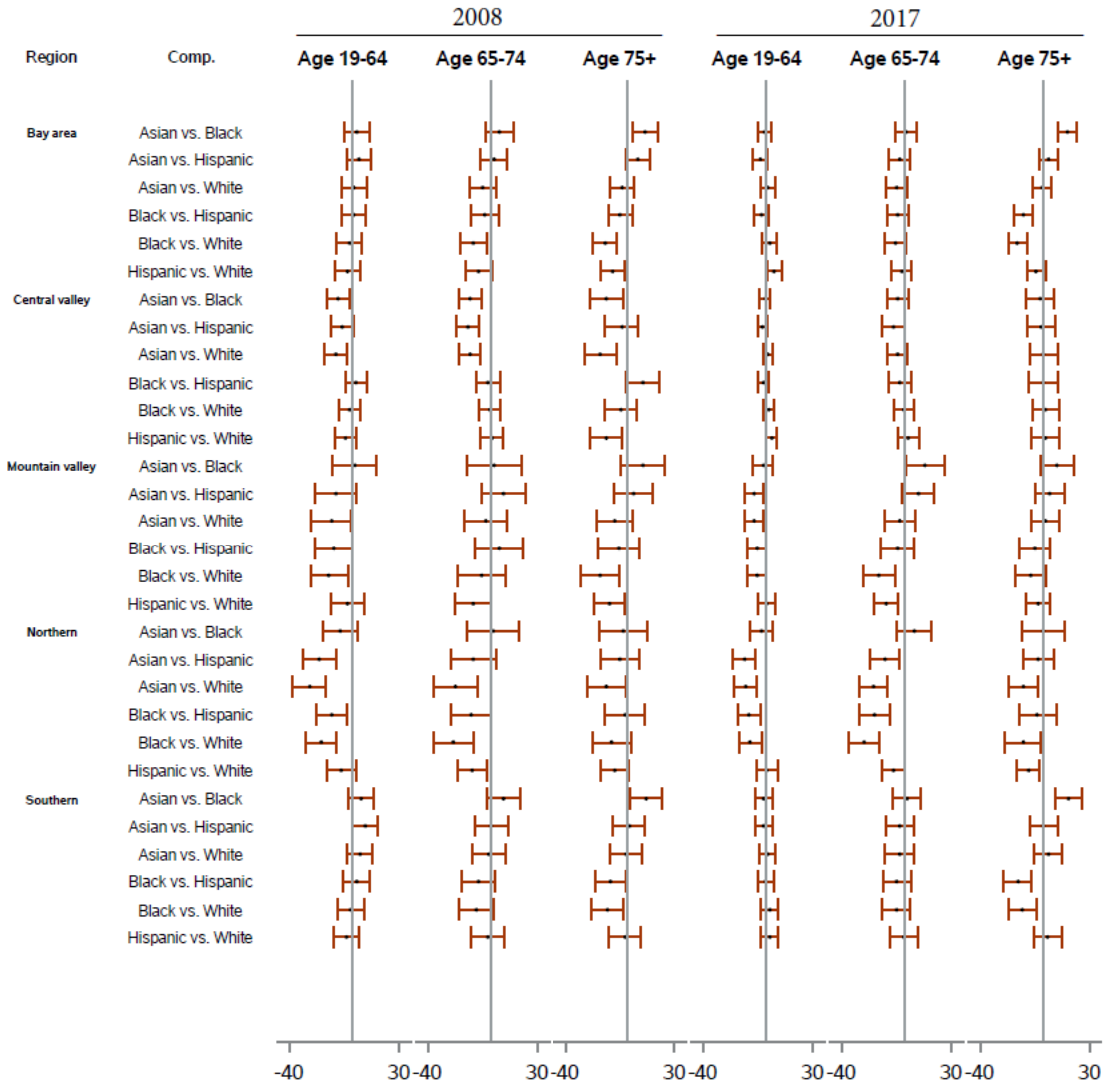


Figure 16. Forest plots of least square mean difference (95% CI) of utilization rates for annual dental visits among ethnic groups by age group and geographic region in 2008 and 2017.

Table 15 presents least square mean differences (95% CI) among ethnic groups for utilization rates difference between 2017 and 2013 by age group and geographic region. There are more statistically significant findings showing the ethnicity of Asian has higher percentage of increase in utilization rate from 2017 to 2013 than other ethnic groups and the ethnicity of Black has lower percentage of increase in utilization rate than other ethnic groups.

Table 15

Least Square Mean Differences Among Ethnic Groups for Utilization Rates Difference between 2017 and 2013 by Age Group and Geographic Region for Annual Dental Visit

			Least Square Mean Differences (95% CI) of Differences in Utilization Rates between 2017 and 2013		
Geographic Region	**Ethnic Group**	**vs. Ethnic Group**	**Age 19-64**	**Age 65-74**	**Age 75+**
Bay area	Asian	Black	4.7 (1.93,7.52)*	-1.5 (-8.18,5.18)	10.9 (5.81,15.92)*
	Asian	Hispanic	3.9 (1.13,6.60)*	-1.1 (-7.63,5.45)	3.4 (-1.52,8.37)
	Asian	White	7.2 (4.48,9.95)*	-1.2 (-7.77,5.31)	0.5 (-4.49,5.41)
	Black	Hispanic	-0.9 (-3.60,1.88)	0.4 (-6.13,6.95)	-7.4 (-12.39,-2.50)*
	Black	White	2.5 (-0.25,5.22)	0.3 (-6.27,6.81)	-10.4 (-15.35,-5.46)*
	Hispanic	White	3.3 (0.67,6.02)*	-0.1 (-6.54,6.26)	-3.0 (-7.80,1.87)
Central valley	Asian	Black	6.3 (1.91,10.74)*	-4.4 (-11.96,3.20)	-4.0 (-13.16,5.19)
	Asian	Hispanic	2.8 (-1.47,7.13)	-2.9 (-10.51,4.65)	2.4 (-6.50,11.31)
	Asian	White	6.9 (2.62,11.22)*	-1.2 (-8.60,6.18)	3.2 (-5.53,11.83)
	Black	Hispanic	-3.5 (-7.80,0.81)	1.5 (-6.13,9.03)	6.4 (-2.79,15.57)
	Black	White	0.6 (-3.71,4.89)	3.2 (-4.22,10.56)	7.1 (-1.82,16.10)
	Hispanic	White	4.1 (-0.10,8.28)	1.7 (-5.67,9.11)	0.7 (-7.93,9.43)
Mountain valley	Asian	Black	1.4 (-4.10,6.83)	14.4 (3.85,24.88)*	5.6 (-4.76,15.93)
	Asian	Hispanic	-1.2 (-6.33,3.98)	10.0 (1.28,18.64)*	1.7 (-7.11,10.54)
	Asian	White	1.7 (-3.34,6.70)	1.0 (-7.61,9.53)	-0.4 (-8.84,8.02)
	Black	Hispanic	-2.5 (-7.32,2.24)	-4.4 (-13.65,4.83)	-3.9 (-13.23,5.49)
	Black	White	0.3 (-4.32,4.95)	-13.4 (-22.54,-4.26)*	-6.0 (-14.99,2.99)
	Hispanic	White	2.9 (-1.41,7.12)	-9.0 (-15.94,-2.04)*	-2.1 (-9.31,5.06)
Northern	Asian	Black	1.1 (-6.24,8.36)	10.8 (-2.05,23.64)	-0.0 (-14.85,14.85)
	Asian	Hispanic	-3.8 (-10.76,3.17)	-7.0 (-18.18,4.18)	-3.5 (-15.05,7.95)
	Asian	White	1.2 (-5.74,8.19)	-7.7 (-18.56,3.15)	-11.9 (-22.96,-0.92)*
	Black	Hispanic	-4.9 (-11.18,1.48)	-17.8 (-28.13,-7.47)*	-3.5 (-16.34,9.25)
	Black	White	0.2 (-6.17,6.49)	-18.5 (-28.48,-8.53)*	-11.9 (-24.31,0.43)
	Hispanic	White	5.0 (-0.92,10.95)	-0.7 (-8.42,7.01)	-8.4 (-16.44,-0.35)*
Southern	Asian	Black	3.8 (0.43,7.20)*	0.9 (-6.50,8.39)	10.2 (4.02,16.39)*
	Asian	Hispanic	3.3 (-0.07,6.69)	-2.6 (-10.03,4.86)	-1.5 (-7.71,4.66)
	Asian	White	4.9 (1.52,8.28)*	-2.2 (-9.65,5.24)	1.8 (-4.42,7.95)
	Black	Hispanic	-0.5 (-3.88,2.88)	-3.5 (-10.97,3.92)	-11.7 (-17.91,-5.55)*
	Black	White	1.1 (-2.29,4.47)	-3.1 (-10.59,4.30)	-8.4 (-14.62,-2.26)*
	Hispanic	White	1.6 (-1.79,4.97)	0.4 (-7.06,7.82)	3.3 (-2.89,9.47)

* $p < 0.05$, 2-sided.

Dental exams-age effect (hypothesis 4). Figure 17 displays point estimate of the

difference in utilization rates for dental exams among age groups and its 95% confidence interval by ethnic group and geographic region in 2008 and 2017. The comparisons with statistically significant differences are presented in Table 16.

In 2008, all the comparisons with statistically significant findings show greater utilization rates in the younger age group than the older age group and the ethnicity of Hispanic has the greatest number of statistically significant findings followed by the ethnic groups of White and Black. There is only one significant finding in the ethnicity of Asian which is in the Bay area. In 2017, except for one, all the other comparisons with statistically significant findings show greater utilization rates in the younger age group than the older age group; and the ethnicity of Hispanic has the greatest number of statistically significant findings of this age effect, followed by the ethnic groups of White and Black. There are only two significant findings of this age effect in the ethnic group of Asian and both are in the Central Valley.

Table 16

Comparisons With Statistically Significant Differences in Utilization Rate for Dental Exams among Age Groups by Ethnic Group and Geographic Region in 2008 and 2017

			2008 LS Mean Difference				2017 LS Mean Difference			
Geographic Region	**Age Group**	**vs. Age Group**	**White**	**Black**	**Hispanic**	**Asian**	**White**	**Black**	**Hispanic**	**Asian**
Bay area	Age 19-64	Age 65-74	3.1	9.2	3.6		-4.2			
	Age 19-64	Age 75+	2.8	8.5	5.2	7.3		9.2	9.4	
	Age 65-74	Age 75+					2.2	7.0	8.8	
Central valley	Age 19-64	Age 65-74	4.6	9.9						
	Age 19-64	Age 75+		10.4	3.6		7.1	11.2	12.1	11.0
	Age 65-74	Age 75+					7.6	8.8	12.2	7.8
Mountain valley	Age 19-64	Age 65-74							7.2	
	Age 19-64	Age 75+						7.9	10.9	
	Age 65-74	Age 75+								
Northern	Age 19-64	Age 65-74	2.8		3.3			9.3		
	Age 19-64	Age 75+	3.9		3.2		8.4		13.0	
	Age 65-74	Age 75+					9.7		9.9	
Southern	Age 19-64	Age 65-74	4.8	9.6	4.2					
	Age 19-64	Age 75+	6.9	14.0	8.1		11.0	13.4	8.6	
	Age 65-74	Age 75+			3.9		12.4		8.5	

Figure 17. Forest plots of least square mean difference (95% CI) of utilization rates for dental exams among age groups by ethnic group and geographic region in 2008 and 2017.

Table 17 presents least square mean differences (95% CI) among age groups for utilization rates difference between 2017 and 2013 by ethnic group and geographic region. Similar to the findings for annual dental visits, the magnitude and direction of the differences among age groups vary for different ethnic groups in different geographic regions. There are more statistically significant findings in White, Black and Hispanic than that of Asian, i.e., in general, the utilization rates for Asian were similar among age groups.

Table 17

Least Square Mean Differences among Age Groups for Utilization Rates Difference between 2017 and 2013 by Ethnic Group and Geographic Region for Dental Exams

			Least Square Mean Differences (95% CI) of Differences in Utilization Rates between 2017 and 2013			
Geographic Region	**Age Group**	**vs. Age Group**	**White**	**Black**	**Hispanic**	**Asian**
Bay area	Age 19-64	Age 65-74	-5.6 (-7.95,-3.17)*	2.5 (-3.77,8.69)	-2.9 (-7.28,1.40)	-2.7 (-8.23,2.87)
	Age 19-64	Age 75+	-2.7 (-5.12,-0.35)*	9.8 (3.60,16.07)*	6.2 (1.88,10.55)*	-1.6 (-7.13,3.97)
	Age 65-74	Age 75+	2.8 (0.43,5.21)*	7.4 (1.14,13.60)*	9.2 (4.82,13.49)*	1.1 (-4.45,6.65)
Central valley	Age 19-64	Age 65-74	-2.6 (-6.83,1.61)	0.2 (-6.98,7.45)	-3.4 (-7.90,1.06)	1.6 (-4.77,8.01)
	Age 19-64	Age 75+	6.1 (1.91,10.35)*	8.4 (0.97,15.85)*	9.5 (5.02,13.98)*	9.4 (3.03,15.81)*
	Age 65-74	Age 75+	8.7 (4.52,12.96)*	8.2 (0.73,15.61)*	12.9 (8.33,17.52)*	7.8 (1.41,14.19)*
Mountain valley	Age 19-64	Age 65-74	-2.3 (-8.26,3.76)	5.2 (-2.16,12.63)	6.6 (0.98,12.30)*	-4.2 (-13.03,4.64)
	Age 19-64	Age 75+	4.7 (-1.26,10.76)	8.8 (1.43,16.22)*	10.0 (4.11,15.97)*	3.8 (-5.00,12.66)
	Age 65-74	Age 75+	7.0 (0.88,13.12)*	3.6 (-4.80,11.97)	3.4 (-2.53,9.33)	8.0 (-1.15,17.19)
Northern	Age 19-64	Age 65-74	-1.6 (-7.74,4.44)	10.0 (1.53,18.52)*	-0.1 (-7.19,6.96)	-2.5 (-11.25,6.27)
	Age 19-64	Age 75+	8.1 (2.01,14.19)*	10.0 (-0.23,20.28)	11.4 (4.18,18.72)*	6.7 (-2.06,15.46)
	Age 65-74	Age 75+	9.8 (3.66,15.84)*	0.0 (-11.50,11.50)	11.6 (3.89,19.24)*	9.2 (-0.93,19.31)
Southern	Age 19-64	Age 65-74	-3.9 (-8.89,1.18)	3.9 (-3.38,11.14)	-4.9 (-9.23,-0.66)*	-1.3 (-9.15,6.62)
	Age 19-64	Age 75+	9.7 (4.69,14.75)*	12.0 (4.74,19.25)*	4.3 (-0.02,8.55)	-1.7 (-9.58,6.19)
	Age 65-74	Age 75+	13.6 (8.55,18.61)*	8.1 (0.86,15.37)*	9.2 (4.93,13.49)*	-0.4 (-8.32,7.45)

* $p < 0.05$, 2-sided.

Dental exams-ethnicity effect (hypothesis 5). Figure 18 displays point estimate of the difference in utilization rates for dental exams among ethnic groups and its 95% confidence interval by age group and geographic region in 2008 and 2017. The comparisons with statistically significant differences are presented in Table 18.

In 2008, there are more statistically significant findings for ethnicity effect in the older age groups (65-74, and 75+ years old) than in the younger age group (19-64 years old). In

2017 there is an increase in the number of statistically significant findings for ethnicity effect in the age group of 19-64 years old. In both 2008 and 2017, among the comparisons with statistically significant differences, there are more findings showing the ethnicity of Black has lower utilization rates than other ethnic groups (Table 18 and Figure 18).

Table 18

Comparisons with Statistically Significant Differences in Utilization Rate for Dental Exams among Ethnicty Groups by Age Group and Geographic Region in 2008 and 2017

			2008 LS Mean Difference			2017 LS Mean Difference		
Geographic Region	**Ethnic Group**	**vs. Ethnic Group**	**Age 19-64**	**Age 65-74**	**Age 75+**	**Age 19-64**	**Age 65-74**	**Age 75+**
Bay area	Asian	Black		6.9				9.9
	Asian	Hispanic						6.8
	Asian	White						
	Black	Hispanic		-7.0	-4.8			
	Black	White		-7.4	-7.0		-5.5	-10.2
	Hispanic	White				4.2		-7.2
Central valley	Asian	Black						
	Asian	Hispanic		-5.8	-5.8			
	Asian	White			-6.8			
	Black	Hispanic		-5.7	-5.2			
	Black	White			-6.2			
	Hispanic	White				3.2		
Mountain valley	Asian	Black					12.0	
	Asian	Hispanic				-6.4		
	Asian	White				-6.7		
	Black	Hispanic				-7.0		
	Black	White			-7.3	-7.4	-12.1	-9.3
	Hispanic	White					-7.4	
Northern	Asian	Black						
	Asian	Hispanic				-11.5	-9.9	
	Asian	White				-11.1	-14.0	-9.5
	Black	Hispanic				-9.0	-15.1	
	Black	White		-2.2		-8.6	-19.3	-9.5
	Hispanic	White		-2.1				
Southern	Asian	Black			5.9			12.7
	Asian	Hispanic						
	Asian	White						11.5
	Black	Hispanic					-7.3	
	Black	White			-6.5			
	Hispanic	White						

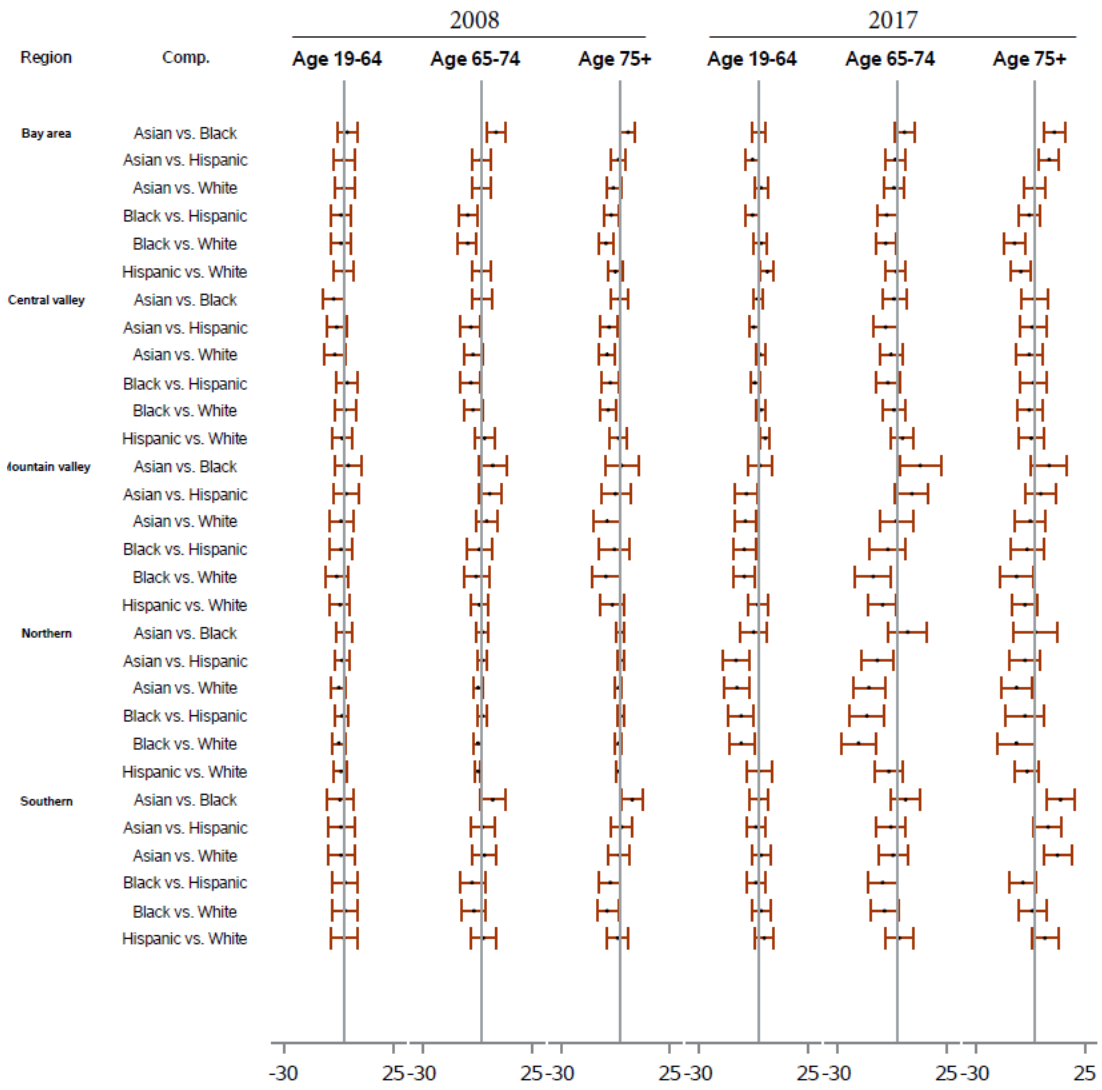


Figure 18. Forest plots of least square mean difference (95% CI) of utilization rates for dental exams among ethnicty groups by age group and geographic region in 2008 and 2017.

Table 19 presents least square mean differences (95% CI) among ethnic groups for utilization rates difference between 2017 and 2013 by age group and geographic region. Overall, there are more statistically significant findings showing the ethnicity of Black has lower percentage of increase in utilization rate than other ethnic groups.

Table 19

Least Square Mean Differences among Ethnic Groups for Utilization Rates Difference between 2017 and 2013 by Age Group and Geographic Region for Dental Exams

			Least Square Mean Differences (95% CI) of Differences in Utilization Rates between 2017 and 2013		
Geographic Region	**Ethnic Group**	**vs. Ethnic Group**	**Age 19-64**	**Age 65-74**	**Age 75+**
Bay area	Asian	Black	-0.9 (-3.65,1.84)	4.2 (-0.95,9.41)	10.5 (5.23,15.78)*
	Asian	Hispanic	-0.8 (-3.50,1.88)	-1.1 (-6.14,4.00)	7.0 (1.82,12.14)*
	Asian	White	1.6 (-1.04,4.34)	-1.2 (-6.30,3.84)	0.5 (-4.67,5.66)
	Black	Hispanic	0.1 (-2.59,2.78)	-5.3 (-10.37,-0.24)*	-3.5 (-8.69,1.64)
	Black	White	2.6 (-0.13,5.24)	-5.5 (-10.53,-0.39)*	-10.0 (-15.17,-4.85)*
	Hispanic	White	2.5 (-0.17,5.09)	-0.2 (-5.11,4.80)	-6.5 (-11.54,-1.44)*
Central valley	Asian	Black	0.5 (-2.07,3.05)	-0.9 (-6.86,5.09)	-0.5 (-7.48,6.45)
	Asian	Hispanic	-0.4 (-2.94,2.04)	-5.5 (-11.47,0.48)	-0.4 (-7.13,6.39)
	Asian	White	1.7 (-0.78,4.21)	-2.5 (-8.34,3.31)	-1.6 (-8.16,5.01)
	Black	Hispanic	-0.9 (-3.44,1.55)	-4.6 (-10.58,1.37)	0.1 (-6.82,7.11)
	Black	White	1.2 (-1.27,3.72)	-1.6 (-7.45,4.20)	-1.1 (-7.86,5.74)
	Hispanic	White	2.2 (-0.26,4.59)	3.0 (-2.84,8.80)	-1.2 (-7.79,5.38)
Mountain valley	Asian	Black	2.3 (-3.76,8.44)	11.8 (1.47,22.06)*	7.3 (-1.88,16.55)
	Asian	Hispanic	-3.8 (-9.54,1.97)	7.1 (-1.45,15.55)	2.4 (-5.43,10.29)
	Asian	White	-3.2 (-8.84,2.36)	-1.3 (-9.69,7.09)	-2.3 (-9.84,5.19)
	Black	Hispanic	-6.1 (-11.46,-0.78)*	-4.7 (-13.76,4.33)	-4.9 (-13.24,3.43)
	Black	White	-5.6 (-10.75,-0.41)*	-13.1 (-22.01,-4.12)*	-9.7 (-17.67,-1.65)*
	Hispanic	White	0.5 (-4.22,5.30)	-8.3 (-15.15,-1.54)*	-4.8 (-11.15,1.65)
Northern	Asian	Black	-3.3 (-10.83,4.18)	9.2 (-2.39,20.77)	0.0 (-12.31,12.31)
	Asian	Hispanic	-11.1 (-18.23,-3.91)*	-8.7 (-18.77,1.38)	-6.3 (-15.86,3.22)
	Asian	White	-10.8 (-17.97,-3.65)*	-10.0 (-19.75,-0.19)*	-9.4 (-18.55,-0.27)*
	Black	Hispanic	-7.7 (-14.25,-1.24)*	-17.9 (-27.19,-8.57)*	-6.3 (-16.93,4.29)
	Black	White	-7.5 (-13.99,-0.98)*	-19.2 (-28.15,-10.17)*	-9.4 (-19.66,0.85)
	Hispanic	White	0.3 (-5.85,6.36)	-1.3 (-8.23,5.68)	-3.1 (-9.76,3.59)
Southern	Asian	Black	-0.8 (-4.51,2.95)	4.4 (-2.71,11.44)	12.9 (6.14,19.69)*
	Asian	Hispanic	0.6 (-3.13,4.33)	-3.1 (-10.16,3.99)	6.6 (-0.21,13.33)
	Asian	White	1.2 (-2.50,4.96)	-1.4 (-8.44,5.72)	12.7 (5.88,19.43)*
	Black	Hispanic	1.4 (-2.35,5.11)	-7.4 (-14.52,-0.37)*	-6.4 (-13.12,0.42)
	Black	White	2.0 (-1.72,5.74)	-5.7 (-12.80,1.35)	-0.3 (-7.03,6.51)
	Hispanic	White	0.6 (-3.10,4.36)	1.7 (-5.35,8.80)	6.1 (-0.68,12.86)

* $p < 0.05$, 2-sided.

Dental treatment-age effect (hypothesis 4). Figure 19 displays point estimate of the difference in utilization rates for dental treatment among age groups and its 95% confidence

interval by ethnic group and geographic region in 2008 and 2017. The comparisons with statistically significant differences are presented in Table 20.

In 2008, all the comparisons with statistically significant findings show greater utilization rates in the younger age group than the older age group and the ethnicity of Black has the greatest number of statistically significant findings among the ethnic groups. In 2017, except for two, all the other comparisons with statistically significant findings show greater utilization rates in the younger age group than the older age group; and the ethnic groups of White, Black and Hispanic have similar numbers of significant findings. There are no significant findings of age group difference in utilization rates in the ethnicity of Asian.

Table 20

Comparisons with Statistically Significant Differences in Utilization Rate for Dental Treatment among Age Groups by Ethnic Group and Geographic Region in 2008 and 2017

Geographic Region	Age Group	vs. Age Group	2008 LS Mean Difference				2017 LS Mean Difference			
			White	Black	Hispanic	Asian	White	Black	Hispanic	Asian
Bay area	Age 19-64	Age 65-74		8.7			-4.9			
	Age 19-64	Age 75+		9.4	3.4		-4.4	6.5	3.4	
	Age 65-74	Age 75+							4.4	
Central valley	Age 19-64	Age 65-74								
	Age 19-64	Age 75+		13.7		9.1		10.4		
	Age 65-74	Age 75+						8.8		
Mountain valley	Age 19-64	Age 65-74								
	Age 19-64	Age 75+							5.6	
	Age 65-74	Age 75+					5.6			
Northern	Age 19-64	Age 65-74	3.8		4.8			7.0		
	Age 19-64	Age 75+	5.6		3.7		5.1		7.4	
	Age 65-74	Age 75+					6.2			
Southern	Age 19-64	Age 65-74		10.8						
	Age 19-64	Age 75+		15.5	5.0			8.0		
	Age 65-74	Age 75+							2.4	

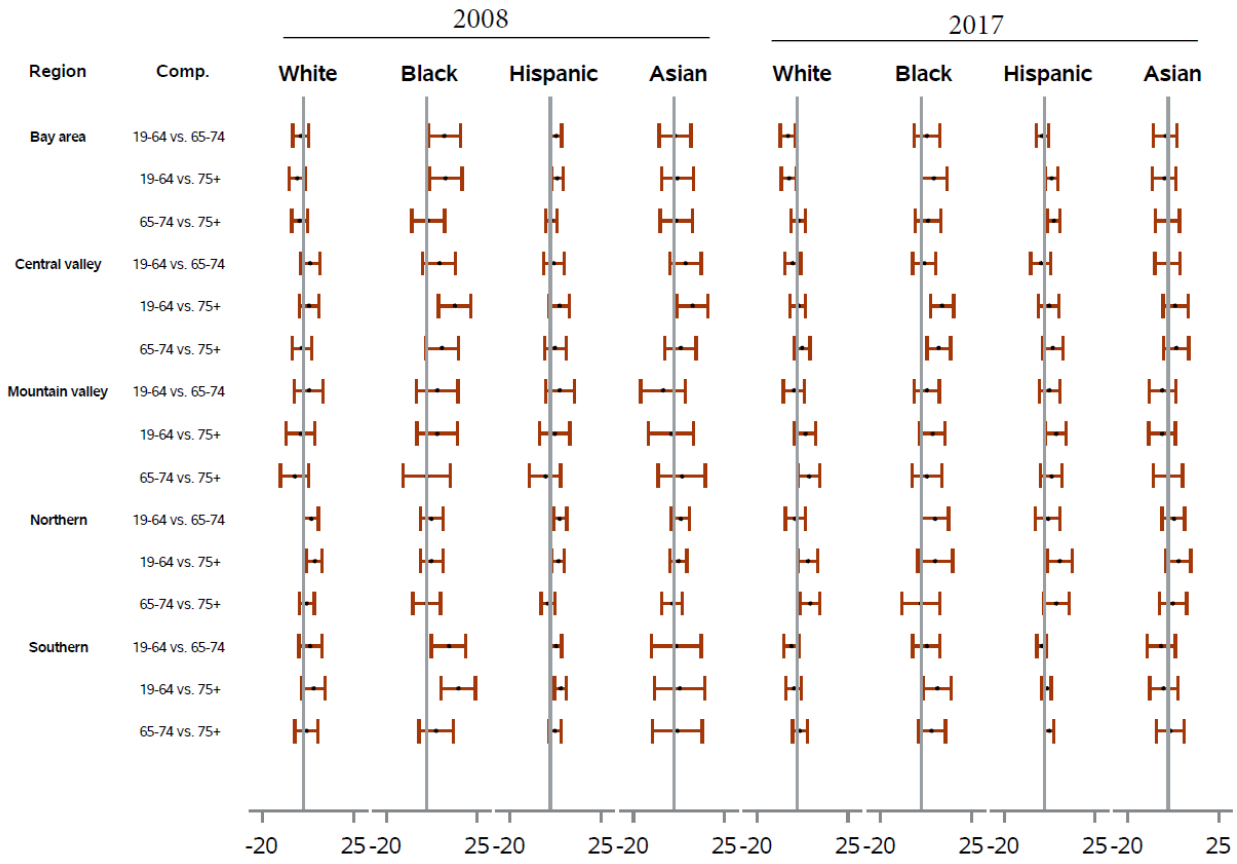


Figure 19. Forest plots of least square mean difference (95% CI) of utilization rates for dental treatment among age groups by ethnic group and geographic region in 2008 and 2017.

Table 21 presents least square mean differences (95% CI) among age groups for utilization rates difference between 2017 and 2013 by ethnic group and geographic region. Similar to the findings for annual dental visits, the magnitude and direction of the differences among age groups vary for different ethnic groups in different geographic regions. The number of statistically significant findings is the highest in the ethnicity of White, followed by the ethnicity of Hispanic, there are two significant findings in the ethnicity of Black and no significant findings of age group differences in utilization rates in the ethnicity of Asian.

Table 21

Least Square Mean Differences among Age Groups for Utilization Rates Difference between 2017 and 2013 by Ethnic Group and Geographic Region for Dental Treatment

			Least Square Mean Differences (95% CI) of Differences in Utilization Rates between 2017 and 2013			
Geographic Region	**Age Group**	**vs. Age Group**	**White**	**Black**	**Hispanic**	**Asian**
Bay area	Age 19-64	Age 65-74	-5.6 (-8.26,-2.97)*	-1.1 (-5.78,3.51)	-4.4 (-7.82,-1.00)*	0.2 (-5.22,5.64)
	Age 19-64	Age 75+	-5.1 (-7.71,-2.42)*	2.4 (-2.24,7.06)	0.7 (-2.67,4.16)	1.6 (-3.79,7.07)
	Age 65-74	Age 75+	0.5 (-2.10,3.20)	3.5 (-1.10,8.19)	5.2 (1.74,8.57)*	1.4 (-4.00,6.86)
Central valley	Age 19-64	Age 65-74	-5.1 (-9.07,-1.23)*	-4.3 (-9.56,0.90)	-3.4 (-7.62,0.91)	-0.9 (-6.43,4.55)
	Age 19-64	Age 75+	-3.1 (-7.03,0.81)	2.3 (-3.10,7.68)	-2.7 (-6.94,1.60)	1.7 (-3.75,7.23)
	Age 65-74	Age 75+	2.0 (-1.89,5.96)	6.6 (1.23,12.01)*	0.7 (-3.69,5.07)	2.7 (-2.81,8.17)
Mountain valley	Age 19-64	Age 65-74	-5.5 (-9.96,-0.98)*	1.7 (-2.86,6.34)	-0.0 (-4.81,4.79)	-1.5 (-7.77,4.74)
	Age 19-64	Age 75+	1.2 (-3.32,5.67)	3.0 (-1.56,7.64)	2.9 (-2.14,7.93)	-1.4 (-7.64,4.86)
	Age 65-74	Age 75+	6.6 (2.07,11.22)*	1.3 (-3.92,6.51)	2.9 (-2.13,7.94)	0.1 (-6.36,6.61)
Northern	Age 19-64	Age 65-74	-2.8 (-7.32,1.76)	7.2 (-0.03,14.46)	-1.3 (-7.35,4.67)	-0.2 (-7.01,6.62)
	Age 19-64	Age 75+	2.8 (-1.77,7.30)	7.2 (-1.52,15.96)	5.7 (-0.52,11.84)	4.0 (-2.84,10.78)
	Age 65-74	Age 75+	5.5 (1.01,10.08)*	0.0 (-9.80,9.80)	7.0 (0.48,13.52)*	4.2 (-3.70,12.03)
Southern	Age 19-64	Age 65-74	-5.6 (-8.31,-2.97)*	-3.1 (-9.05,2.94)	-4.9 (-8.25,-1.53)*	-2.4 (-6.45,1.55)
	Age 19-64	Age 75+	-4.5 (-7.16,-1.82)*	3.8 (-2.18,9.81)	-3.4 (-6.74,-0.02)*	-0.7 (-4.74,3.27)
	Age 65-74	Age 75+	1.2 (-1.52,3.82)	6.9 (0.87,12.87)*	1.5 (-1.85,4.87)	1.7 (-2.29,5.71)

* $p < 0.05$, 2-sided.

Dental treatment-ethnicity effect (hypothesis 5). Figure 20 displays point estimate of the difference in utilization rates for dental treatment among ethnic groups and its 95% confidence interval by age group and geographic region in 2008 and 2017. The comparisons with statistically significant differences are presented in Table 22.

In both 2008 and 2017, there are more statistically significant findings for ethnicity effect in the older age groups (65-74, and 75+ years old) than in the younger age group (19-64

years old). In 2017, compared to 2008, there is an increase in number of statistically significant findings for ethnicity effect in the age group of 19-64 years old. In both 2008 and 2017 among the comparisons with statistically significant differences there are more findings showing the ethnicity of Black with lower utilization rates than other ethnic groups (Table 22 and Figure 20).

Table 22

Comparisons with Statistically Significant Differences in Utilization Rate for Dental Treatment among Ethnic Groups by Age Group and Geographic Region in 2008 and 2017

Geographic Region	Ethnic Group	vs. Ethnic Group	2008 LS Mean Difference			2017 LS Mean Difference		
			Age 19-64	Age 65-74	Age 75+	Age 19-64	Age 65-74	Age 75+
Bay area	Asian	Black						6.3
	Asian	Hispanic				-3.5		
	Asian	White			-7.1			
	Black	Hispanic					-5.4	
	Black	White		-10.4	-12.8		-6.7	-9.8
	Hispanic	White			-8.1			-5.3
Central valley	Asian	Black						
	Asian	Hispanic		-7.9	-8.7			
	Asian	White		-7.7	-11.5			-6.2
	Black	Hispanic			-7.4			-9.2
	Black	White			-10.2			-10.2
	Hispanic	White						
Mountain valley	Asian	Black						8.1
	Asian	Hispanic						
	Asian	White						
	Black	Hispanic						
	Black	White			-11.1		-8.4	
	Hispanic	White						
Northern	Asian	Black						
	Asian	Hispanic				-7.7	-8.7	
	Asian	White	-6.0	-4.7		-8.1	-11.7	-7.9
	Black	Hispanic				-5.5	-11.1	
	Black	White	-5.7	-4.4		-6.0	-14.1	
	Hispanic	White		-4.6				
Southern	Asian	Black			11.2			8.2
	Asian	Hispanic						
	Asian	White						
	Black	Hispanic			-8.5			-7.3
	Black	White			-11.5			-9.4
	Hispanic	White						

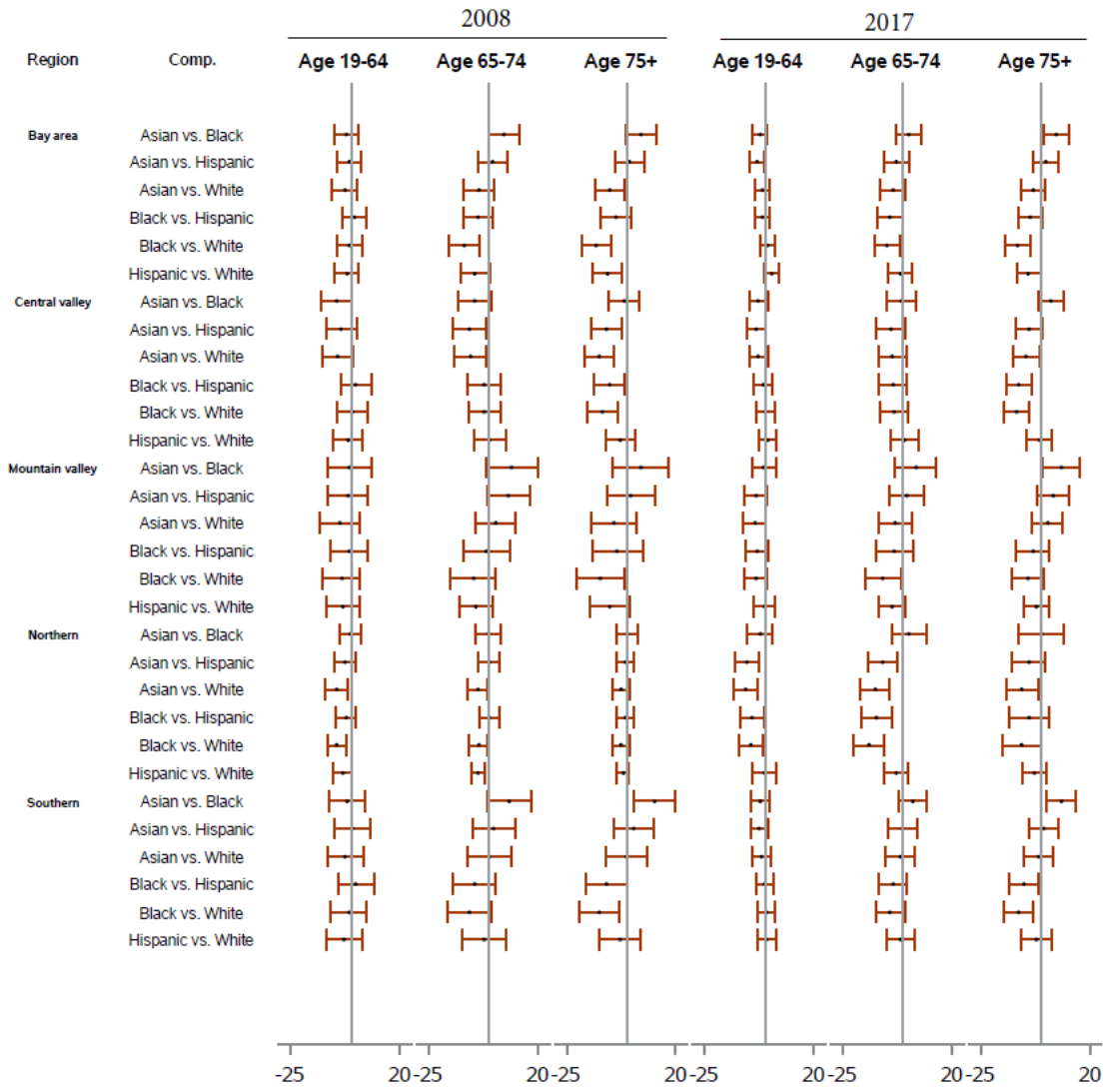


Figure 20. Forest plots of least square mean difference (95% CI) of utilization rates for dental treatment among ethnic groups by age group and geographic region in 2008 and 2017.

Table 23 presents least square mean differences (95% CI) among ethnic groups for utilization rates difference between 2017 and 2013 by age group and geographic region. There are more statistically significant findings showing the ethnicity of Black has lower percentage of increase in utilization rate than other ethnic groups.

Table 23

Least Square Mean Differences among Ethnicty Groups for Utilization Rates Difference between 2017 and 2013 by Age Group and Geographic Region for Dental Treatment

			Least Square Mean Differences (95% CI) of Differences in Utilization Rates between 2017 and 2013		
Geographic Region	**Ethnic Group**	**vs. Ethnic Group**	**Age 19-64**	**Age 65-74**	**Age 75+**
Bay area	Asian	Black	2.5 (-0.11,5.15)	1.2 (-3.48,5.82)	3.3 (-0.75,7.33)
	Asian	Hispanic	1.1 (-1.48,3.67)	-3.5 (-8.08,1.03)	0.2 (-3.76,4.15)
	Asian	White	4.0 (1.40,6.55)*	-1.9 (-6.41,2.70)	-2.7 (-6.69,1.22)
	Black	Hispanic	-1.4 (-4.00,1.15)	-4.7 (-9.25,-0.15)*	-3.1 (-7.05,0.86)
	Black	White	1.4 (-1.13,4.02)	-3.0 (-7.59,1.52)	-6.0 (-9.98,-2.07)*
	Hispanic	White	2.9 (0.35,5.39)*	1.7 (-2.79,6.12)	-2.9 (-6.80,0.93)
Central valley	Asian	Black	1.8 (-2.22,5.82)	-1.6 (-6.90,3.72)	2.4 (-2.09,6.79)
	Asian	Hispanic	-1.5 (-5.45,2.38)	-4.0 (-9.26,1.35)	-5.9 (-10.25,-1.64)*
	Asian	White	0.7 (-3.27,4.57)	-3.6 (-8.73,1.61)	-4.2 (-8.40,-0.00)*
	Black	Hispanic	-3.3 (-7.26,0.58)	-2.4 (-7.67,2.94)	-8.3 (-12.74,-3.86)*
	Black	White	-1.2 (-5.07,2.76)	-2.0 (-7.14,3.20)	-6.6 (-10.89,-2.22)*
	Hispanic	White	2.2 (-1.63,6.00)	0.4 (-4.77,5.57)	1.7 (-2.45,5.94)
Mountain valley	Asian	Black	1.2 (-3.38,5.79)	4.5 (-3.20,12.13)	5.6 (-0.90,12.17)
	Asian	Hispanic	-1.8 (-6.11,2.54)	-0.3 (-6.62,6.04)	2.5 (-3.08,8.07)
	Asian	White	0.1 (-4.10,4.32)	-3.8 (-10.09,2.41)	2.7 (-2.65,8.00)
	Black	Hispanic	-3.0 (-7.01,1.02)	-4.8 (-11.49,1.99)	-3.1 (-9.06,2.76)
	Black	White	-1.1 (-4.98,2.79)	-8.3 (-14.97,-1.65)*	-3.0 (-8.64,2.72)
	Hispanic	White	1.9 (-1.68,5.48)	-3.6 (-8.63,1.51)	0.2 (-4.36,4.72)
Northern	Asian	Black	-3.2 (-8.75,2.26)	4.2 (-4.14,12.47)	0.0 (-10.31,10.31)
	Asian	Hispanic	-7.4 (-12.60,-2.11)*	-8.5 (-15.73,-1.27)*	-5.7 (-13.65,2.32)
	Asian	White	-6.4 (-11.64,-1.15)*	-9.0 (-16.00,-1.96)*	-7.6 (-15.26,0.05)
	Black	Hispanic	-4.1 (-8.88,0.66)	-12.7 (-19.35,-5.99)*	-5.7 (-14.55,3.22)
	Black	White	-3.2 (-7.92,1.62)	-13.1 (-19.60,-6.70)*	-7.6 (-16.19,0.99)
	Hispanic	White	1.0 (-3.52,5.43)	-0.5 (-5.47,4.51)	-1.9 (-7.53,3.65)
Southern	Asian	Black	1.4 (-0.94,3.67)	0.8 (-4.18,5.70)	5.9 (1.76,10.08)*
	Asian	Hispanic	0.0 (-2.27,2.34)	-2.4 (-7.34,2.54)	-2.6 (-6.76,1.55)
	Asian	White	1.4 (-0.88,3.73)	-1.8 (-6.71,3.17)	-2.3 (-6.48,1.83)
	Black	Hispanic	-1.3 (-3.64,0.97)	-3.2 (-8.10,1.78)	-8.5 (-12.68,-4.37)*
	Black	White	0.1 (-2.25,2.36)	-2.5 (-7.47,2.41)	-8.2 (-12.40,-4.09)*
	Hispanic	White	1.4 (-0.91,3.70)	0.6 (-4.30,5.57)	0.3 (-3.88,4.44)

* $p < 0.05$, 2-sided.

Preventive dental services-age effect (hypothesis 4). Figure 21 displays point estimate of the difference in utilization rates for preventive dental services among age groups and its

95% confidence interval by ethnic group and geographic region in 2008 and 2017. The comparisons with statistically significant differences are presented in Table 24.

In both 2008 and 2017, all the comparisons with statistically significant findings show greater utilization rates in the younger age group than the older age group and the ethnic group of Hispanic has the grestest number of statistically significant findings of this age effect and the ethnicity of Asian has the least number of statistically significant findings of age group differences in utilization rates among the ethnic groups.

Table 24

Comparisons with Statistically Significant Differences in Utilization Rate for Preventive Dental Services among Age Groups by Ethnic Group and Geographic Region in 2008 and 2017

			2008 LS Mean Difference				2017 LS Mean Difference			
Geographic Region	**Age Group**	**vs. Age Group**	**White**	**Black**	**Hispanic**	**Asian**	**White**	**Black**	**Hispanic**	**Asian**
Bay area	Age 19-64	Age 65-74		10.2	5.2					
	Age 19-64	Age 75+		9.3	10.7	9.0		5.3	7.7	
	Age 65-74	Age 75+			5.6				5.4	5.7
Central valley	Age 19-64	Age 65-74	5.0	9.1	5.2	6.3		7.9		6.0
	Age 19-64	Age 75+		9.8	10.4	9.0	9.6	9.8	8.3	9.0
	Age 65-74	Age 75+			5.2		10.0		7.6	
Mountain valley	Age 19-64	Age 65-74	5.2	4.4					9.4	
	Age 19-64	Age 75+	5.6			9.5			11.0	
	Age 65-74	Age 75+					7.5			
Northern	Age 19-64	Age 65-74	2.2		2.4			7.0	9.8	4.2
	Age 19-64	Age 75+	3.1		2.4		11.1		15.5	4.2
	Age 65-74	Age 75+					11.3			
Southern	Age 19-64	Age 65-74	5.3	9.4	5.9					
	Age 19-64	Age 75+	7.4	14.0	11.8		5.7	11.8	7.5	
	Age 65-74	Age 75+			6.0		6.2	7.4	6.3	

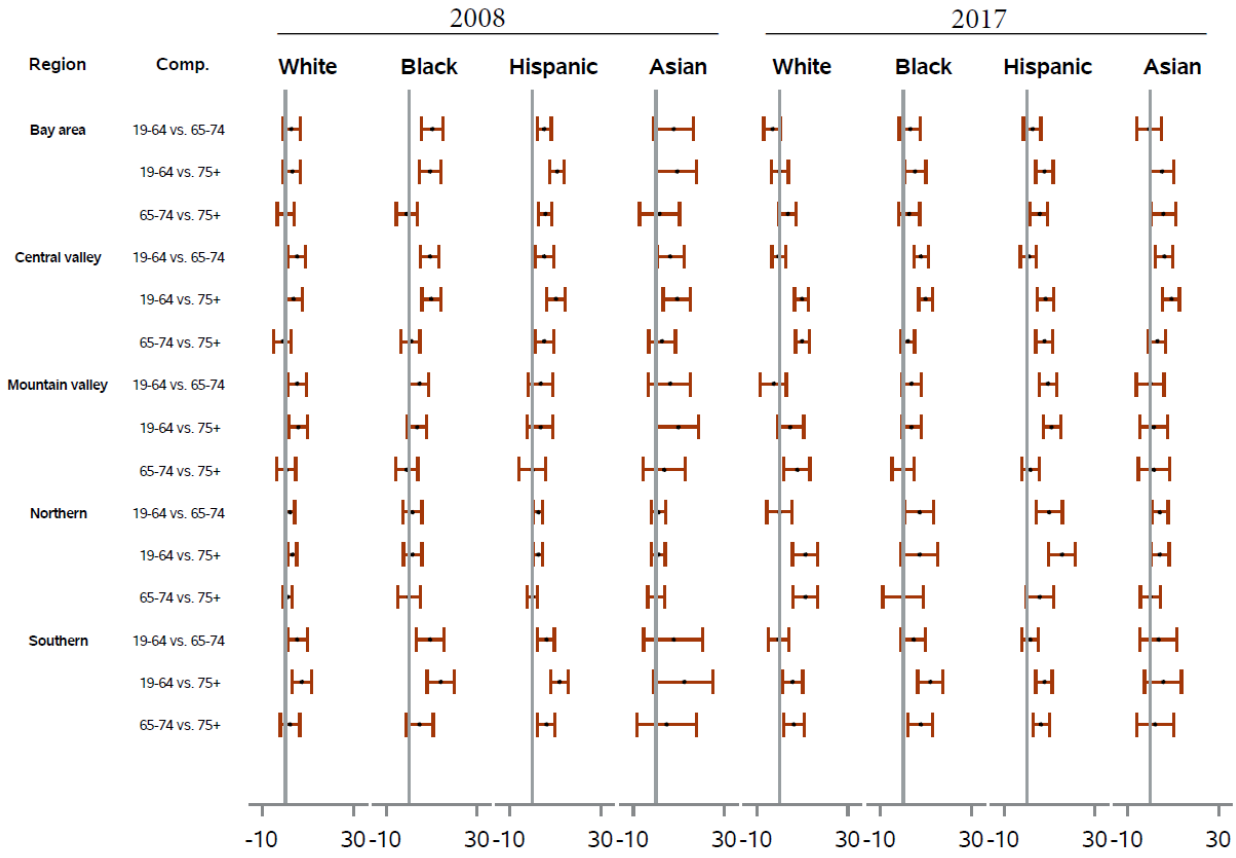


Figure 21. Forest plots of least square mean difference (95% CI) of utilization rates for preventive dental services among age groups by ethnic group and geographic region in 2008 and 2017.

Table 25 presents least square mean differences (95% CI) among age groups for utilization rates difference between 2017 and 2013 by ethnic group and geographic region. Except for one, all the other comparisons with statistically significant findings show the increases in utilization rate from 2017 to 2013 are greater in the younger age group than the older age group. The numbers of statistically significant findings of the age effect are higher in the ethnic groups of White and Hispanic than those of the ethnic groups of Black and Asian, i.e., in majority of the observations, the increases in utilization rates were similar among age groups for Black and Asian beneficiaries.

Table 25

Least Square Mean Differences among Age Groups for Utilization Rates Difference between 2017 and 2013 by Ethnic Group and Geographic Region for Preventive Dental Services

			Least Square Mean Differences (95% CI) of Differences in Utilization Rates between 2017 and 2013			
Geographic Region	**Age Group**	**vs. Age Group**	**White**	**Black**	**Hispanic**	**Asian**
Bay area	Age 19-64	Age 65-74	-4.9 (-8.58,-1.20)*	2.4 (-2.08,6.90)	-0.9 (-4.88,3.05)	-1.7 (-6.66,3.19)
	Age 19-64	Age 75+	-1.1 (-4.81,2.57)	4.8 (0.35,9.33)*	4.6 (0.67,8.60)*	4.1 (-0.86,8.98)
	Age 65-74	Age 75+	3.8 (0.09,7.46)*	2.4 (-2.06,6.92)	5.5 (1.58,9.51)*	5.8 (0.88,10.72)*
Central valley	Age 19-64	Age 65-74	-1.9 (-5.31,1.55)	6.0 (2.72,9.24)*	-2.4 (-5.84,1.14)	4.6 (0.85,8.39)*
	Age 19-64	Age 75+	7.8 (4.34,11.20)*	7.8 (4.42,11.14)*	5.4 (1.87,8.85)*	7.6 (3.80,11.34)*
	Age 65-74	Age 75+	9.7 (6.22,13.08)*	1.8 (-1.56,5.16)	7.7 (4.13,11.30)*	3.0 (-0.82,6.72)
Mountain valley	Age 19-64	Age 65-74	-5.1 (-10.81,0.53)	3.8 (-0.49,8.09)	8.8 (5.08,12.57)*	1.2 (-4.89,7.28)
	Age 19-64	Age 75+	3.3 (-2.38,8.97)	4.1 (-0.19,8.39)	10.3 (6.41,14.26)*	2.7 (-3.36,8.81)
	Age 65-74	Age 75+	8.4 (2.66,14.21)*	0.3 (-4.56,5.17)	1.5 (-2.42,5.44)	1.5 (-4.78,7.84)
Northern	Age 19-64	Age 65-74	-0.4 (-5.93,5.16)	7.6 (0.64,14.56)*	8.2 (1.94,14.54)*	5.3 (0.72,9.90)*
	Age 19-64	Age 75+	10.9 (5.40,16.49)*	7.6 (-0.81,16.00)	15.0 (8.48,21.42)*	5.3 (0.72,9.90)*
	Age 65-74	Age 75+	11.3 (5.78,16.88)*	0.0 (-9.42,9.42)	6.7 (-0.11,13.54)	-0.0 (-5.30,5.30)
Southern	Age 19-64	Age 65-74	-3.3 (-7.79,1.29)	2.6 (-2.92,8.04)	-3.4 (-7.14,0.31)	0.2 (-7.47,7.82)
	Age 19-64	Age 75+	3.2 (-1.37,7.71)	10.0 (4.53,15.49)*	3.1 (-0.66,6.79)	2.4 (-5.24,10.04)
	Age 65-74	Age 75+	6.4 (1.88,10.96)*	7.4 (1.96,12.93)*	6.5 (2.76,10.20)*	2.2 (-5.41,9.87)

* $p < 0.05$, 2-sided.

Preventive dental services-ethnicity effect (hypothesis 5). Figure 22 displays point estimate of the difference in utilization rates for preventive dental services among ethnic groups and its 95% confidence interval by age group and geographic region in 2008 and 2017. The comparisons with statistically significant differences are presented in Table 26.

In 2008, all statistically significant findings for ethnicity effect are in the older age groups (65-74, and 75+ years old); in 2017, there is an increase in number of statistically

significant findings for ethnicity effect in the age group of 19-64 years old. In both 2008 and 2017, among the comparisons with statistically significant difference, there are more findings showing the ethnicity of Black has lower utilization rates than other ethnic groups (Table 26 and Figure 22).

Table 26

Comparisons with Statistically Significant Differences in Utilization Rate for Preventive Dental Services among Ethnic Groups by Age Group and Geographic Region in 2008 and 2017

Geographic Region	Ethnic Group	vs. Ethnic Group	2008 LS Mean Difference			2017 LS Mean Difference		
			Age 19-64	Age 65-74	Age 75+	Age 19-64	Age 65-74	Age 75+
Bay area	Asian	Black		8.7	6.3	5.2	8.6	5.4
	Asian	Hispanic			5.8			
	Asian	White						
	Black	Hispanic		-6.9		-6.3	-6.7	
	Black	White		-9.6	-8.6		-7.6	-6.8
	Hispanic	White			-8.1	4.7		
Central valley	Asian	Black						
	Asian	Hispanic		-4.5		-4.0	-9.3	-4.6
	Asian	White			-7.3		-6.6	
	Black	Hispanic		-4.5		-3.8	-11.1	-5.3
	Black	White			-5.4		-8.4	
	Hispanic	White			-5.4	3.8		5.1
Mountain valley	Asian	Black						
	Asian	Hispanic				-6.3		
	Asian	White					-6.9	
	Black	Hispanic				-8.8		
	Black	White				-6.7	-13.1	-5.6
	Hispanic	White					-10.1	-4.2
Northern	Asian	Black						
	Asian	Hispanic				-12.2	-6.5	
	Asian	White				-11.2	-15.5	
	Black	Hispanic				-9.4		
	Black	White				-8.4	-15.5	
	Hispanic	White		-1.6	-0.8		-9.0	
Southern	Asian	Black		10.0	10.1			10.4
	Asian	Hispanic			6.6			
	Asian	White						
	Black	Hispanic						-7.2
	Black	White			-8.3			-6.0
	Hispanic	White						

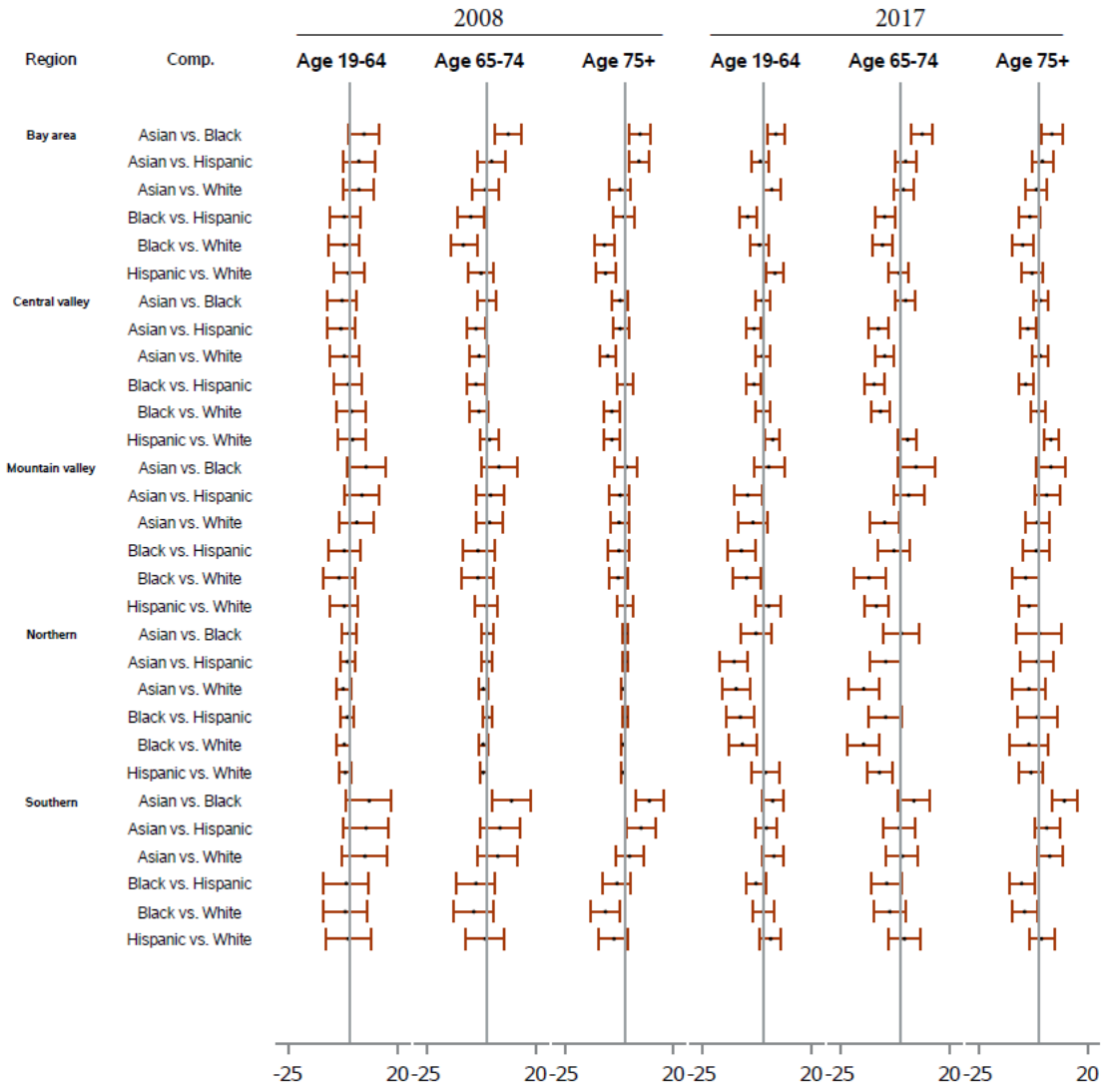


Figure 22. Forest plots of least square mean difference (95% CI) of utilization rates for preventive dental services among ethnic groups by age group and geographic region in 2008 and 2017.

Table 27 presents least square mean differences (95% CI) among ethnic groups for utilization rates difference between 2017 and 2013 by age group and geographic region. There are more statistically significant findings showing the ethnicity of Black has lower percentage of increase in utilization rate than other ethnic groups.

Table 27

Least Square Mean Differences among Ethnic Groups for Utilization Rates Difference between 2017 and 2013 by Age Group and Geographic Region for Preventive Dental Services

			Least Square Mean Differences (95% CI) of Differences in Utilization Rates between 2017 and 2013		
Geographic Region	**Ethnic Group**	**vs. Ethnic Group**	**Age 19-64**	**Age 65-74**	**Age 75+**
Bay area	Asian	Black	4.7 (1.32,8.14)*	8.9 (4.55,13.21)*	5.5 (1.09,9.94)*
	Asian	Hispanic	1.1 (-2.27,4.40)	1.9 (-2.35,6.12)	1.6 (-2.70,5.97)
	Asian	White	4.3 (0.99,7.66)*	1.2 (-3.07,5.41)	-0.9 (-5.19,3.48)
	Black	Hispanic	-3.7 (-7.01,-0.33)*	-7.0 (-11.23,-2.76)*	-3.9 (-8.21,0.45)
	Black	White	-0.4 (-3.74,2.93)	-7.7 (-11.95,-3.47)*	-6.4 (-10.70,-2.03)*
	Hispanic	White	3.3 (-0.00,6.53)	-0.7 (-4.86,3.43)	-2.5 (-6.73,1.75)
Central valley	Asian	Black	0.4 (-2.78,3.54)	1.7 (-2.34,5.82)	0.6 (-2.81,3.98)
	Asian	Hispanic	-2.3 (-5.39,0.76)	-9.3 (-13.37,-5.21)*	-4.5 (-7.82,-1.23)*
	Asian	White	0.5 (-2.55,3.60)	-6.0 (-9.96,-2.00)*	0.7 (-2.49,3.93)
	Black	Hispanic	-2.7 (-5.77,0.38)	-11.0 (-15.10,-6.94)*	-5.1 (-8.51,-1.72)*
	Black	White	0.1 (-2.93,3.22)	-7.7 (-11.69,-3.74)*	0.1 (-3.18,3.45)
	Hispanic	White	2.8 (-0.16,5.83)	3.3 (-0.67,7.28)	5.2 (2.04,8.46)*
Mountain valley	Asian	Black	3.6 (-3.45,10.67)	6.2 (-1.32,13.75)	5.0 (-1.18,11.14)
	Asian	Hispanic	-4.4 (-11.10,2.21)	3.2 (-3.04,9.40)	3.2 (-2.09,8.41)
	Asian	White	-1.5 (-7.95,5.01)	-7.8 (-13.95,-1.67)*	-0.9 (-5.92,4.12)
	Black	Hispanic	-8.1 (-14.23,-1.88)*	-3.0 (-9.65,3.60)	-1.8 (-7.39,3.75)
	Black	White	-5.1 (-11.06,0.90)	-14.0 (-20.57,-7.47)*	-5.9 (-11.24,-0.53)*
	Hispanic	White	3.0 (-2.53,8.48)	-11.0 (-15.97,-6.01)*	-4.1 (-8.34,0.22)
Northern	Asian	Black	-2.3 (-9.25,4.67)	-0.0 (-9.72,9.72)	-0.0 (-10.42,10.42)
	Asian	Hispanic	-10.7 (-17.31,-4.03)*	-7.7 (-16.20,0.72)	-1.0 (-9.10,7.05)
	Asian	White	-9.8 (-16.42,-3.14)*	-15.5 (-23.69,-7.26)*	-4.1 (-11.93,3.64)
	Black	Hispanic	-8.4 (-14.42,-2.35)*	-7.7 (-15.55,0.07)	-1.0 (-9.98,7.93)
	Black	White	-7.5 (-13.53,-1.46)*	-15.5 (-23.02,-7.93)*	-4.1 (-12.84,4.55)
	Hispanic	White	0.9 (-4.77,6.55)	-7.7 (-13.57,-1.90)*	-3.1 (-8.72,2.48)
Southern	Asian	Black	3.0 (-0.81,6.80)	5.4 (-1.20,11.97)	10.6 (5.47,15.74)*
	Asian	Hispanic	2.8 (-0.96,6.65)	-0.7 (-7.32,5.84)	3.5 (-1.63,8.64)
	Asian	White	4.1 (0.34,7.95)*	0.7 (-5.86,7.30)	4.9 (-0.22,10.05)
	Black	Hispanic	-0.2 (-3.96,3.65)	-6.1 (-12.71,0.45)	-7.1 (-12.23,-1.96)*
	Black	White	1.2 (-2.65,4.96)	-4.7 (-11.24,1.92)	-5.7 (-10.82,-0.55)*
	Hispanic	White	1.3 (-2.50,5.11)	1.5 (-5.11,8.05)	1.4 (-3.73,6.55)

* $p < 0.05$, 2-sided.

Restorative dental treatment-age effect (hypothesis 4). Figure 23 displays point estimate of the difference in utilization rates for restorative dental treatment among age groups

and its 95% confidence interval by ethnic group and geographic region in 2008 and 2017. The comparisons with statistically significant differences are presented in Table 28.

In both 2008 and 2017, all the comparisons with statistically significant findings show greater utilization rates in the younger age group than the older age group and the ethnic groups of White and Hispanic have greater number of statistically significant findings of this age effect than those of the ethnic groups of Black and Asian, i.e., among White and Hispanic beneficiaries, in majority of the observations, the utilization rates were higher in the younger age group than the older age group; while for Black and Asian beneficiaries, in majority of the observations, the utilization rates were similar among age groups.

Table 28

Comparisons with Statistically Significant Differences in Utilization Rate for Restorative Dental Treatment among Age Groups by Ethnic Group and Geographic Region in 2008 and 2017

			2008 LS Mean Difference				2017 LS Mean Difference			
Geographic Region	**Age Group**	**vs. Age Group**	**White**	**Black**	**Hispanic**	**Asian**	**White**	**Black**	**Hispanic**	**Asian**
Bay area	Age 19-64	Age 65-74	3.7	8.5	5.5	4.9				
	Age 19-64	Age 75+	7.9	9.4	8.2	6.1		4.4	4.9	
	Age 65-74	Age 75+	4.3		2.7		2.7		3.8	
Central valley	Age 19-64	Age 65-74	5.6	7.5	4.9	5.1		4.0		
	Age 19-64	Age 75+	8.7	9.0	8.5	6.2	3.5	5.2	5.3	5.4
	Age 65-74	Age 75+	3.1		3.7		2.4		3.8	
Mountain valley	Age 19-64	Age 65-74	3.7						3.8	
	Age 19-64	Age 75+	6.0		3.9	4.7	5.5		5.4	
	Age 65-74	Age 75+					5.0			
Northern	Age 19-64	Age 65-74	2.8		2.5					
	Age 19-64	Age 75+	3.5		2.5		5.6		8.4	
	Age 65-74	Age 75+					4.0		5.2	
Southern	Age 19-64	Age 65-74	6.1	9.2	5.7			4.3		
	Age 19-64	Age 75+	9.5	10.6	11.9		3.5	5.3	4.7	
	Age 65-74	Age 75+	3.4		6.2		2.5		3.6	

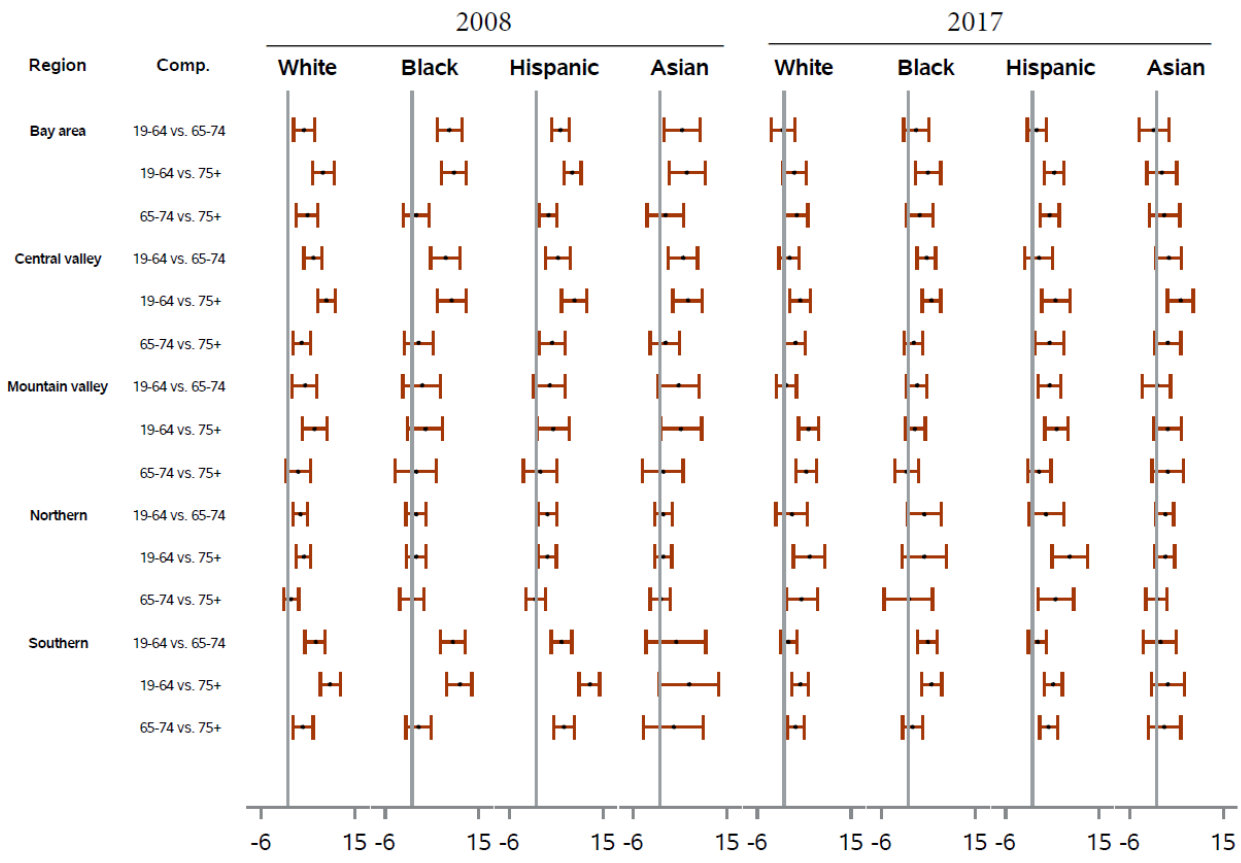


Figure 23. Forest plots of least square mean difference (95% CI) of utilization rates for restorative dental treatment among age groups by ethnic group and geographic region in 2008 and 2017.

Table 29 presents least square mean differences (95% CI) among age groups for utilization rates difference between 2017 and 2013 by ethnic group and geographic region. All statistically significant findings show the increases in utilization rates from 2017 to 2013 are greater in the younger age group than the older age group. The numbers of statistically significant findings are greater in the ethnic groups of White and Hispanic than those of the ethnic groups of Black and Asian.

Table 29

Least Square Mean Differences among Age Groups for Utilization Rates Difference between 2017 and 2013 by Ethnic Group and Geographic Region for Restorative Dental Treatment

			Least Square Mean Differences (95% CI) of Differences in Utilization Rates between 2017 and 2013			
Geographic Region	**Age Group**	**vs. Age Group**	**White**	**Black**	**Hispanic**	**Asian**
Bay area	Age 19-64	Age 65-74	-0.9 (-3.54,1.69)	1.7 (-1.17,4.49)	-0.5 (-2.84,1.86)	-0.7 (-4.05,2.66)
	Age 19-64	Age 75+	1.7 (-0.88,4.34)	4.2 (1.42,7.07)*	3.4 (1.00,5.71)*	1.2 (-2.20,4.50)
	Age 65-74	Age 75+	2.7 (0.04,5.26)*	2.6 (-0.24,5.41)	3.8 (1.49,6.20)*	1.8 (-1.51,5.20)
Central valley	Age 19-64	Age 65-74	-0.2 (-2.50,2.16)	2.9 (0.82,5.06)*	-0.3 (-3.33,2.73)	1.9 (-0.97,4.74)
	Age 19-64	Age 75+	2.3 (-0.08,4.58)	4.0 (1.86,6.24)*	3.5 (0.47,6.52)*	4.5 (1.65,7.35)*
	Age 65-74	Age 75+	2.4 (0.09,4.75)*	1.1 (-1.08,3.29)	3.8 (0.69,6.90)*	2.6 (-0.24,5.47)
Mountain valley	Age 19-64	Age 65-74	-0.5 (-2.69,1.63)	2.0 (-0.28,4.21)	3.6 (1.09,6.03)*	1.1 (-2.17,4.28)
	Age 19-64	Age 75+	4.8 (2.68,7.00)*	1.6 (-0.64,3.85)	5.1 (2.48,7.66)*	3.5 (0.31,6.77)*
	Age 65-74	Age 75+	5.4 (3.16,7.57)*	-0.4 (-2.91,2.19)	1.5 (-1.07,4.11)	2.5 (-0.86,5.83)
Northern	Age 19-64	Age 65-74	1.5 (-2.04,5.02)	NE[a]	1.8 (-2.28,5.95)	2.4 (-0.13,4.85)
	Age 19-64	Age 75+	5.4 (1.91,8.97)*	NE[a]	8.0 (3.79,12.25)*	2.4 (-0.13,4.85)
	Age 65-74	Age 75+	4.0 (0.42,7.48)*	NE[a]	6.2 (1.72,10.65)*	-0.0 (-2.88,2.88)
Southern	Age 19-64	Age 65-74	-0.3 (-2.05,1.35)	3.3 (1.34,5.26)*	-1.4 (-3.38,0.66)	-0.4 (-3.79,3.04)
	Age 19-64	Age 75+	2.1 (0.45,3.84)*	4.2 (2.28,6.20)*	2.2 (0.20,4.23)*	1.5 (-1.94,4.89)
	Age 65-74	Age 75+	2.5 (0.80,4.19)*	0.9 (-1.02,2.90)	3.6 (1.56,5.59)*	1.8 (-1.57,5.26)

[a]NE: not estimable as the utilization rate was all 0% for each year for the age group of 65-74 years old and 75 years and above.
* $p < 0.05$, 2-sided.

Restorative dental treatment-ethnicity effect (hypothesis 5). Figure 24 displays point estimate of the difference in utilization rates for restorative dental treatment among ethnic groups and its 95% confidence interval by age group and geographic region in 2008 and 2017. The comparisons with statistically significant differences are presented in Table 30.

In 2008, there are more statistically significant findings for ethnicity effect in the older age groups (65-74, and 75 + years old) than in the younger age group of 19-64 years old,

indicating greater racial disparity among older age groups than the young age group. In 2017, there is an increase in number of statistically significant findings for ethnicity effect in the age group of 19-64 years old. In both 2008 and 2017, among the comparisons with statistically significant difference, there are more findings showing the ethnicity of Black has lower utilization rates than other ethnic groups (Table 30 and Figure 24).

Table 30

Comparisons with Statistically Significant Differences in Utilization Rate for Restorative Dental Treatment among Ethnic Groups by Age Group and Geographic Region in 2008 and 2017

Geographic Region	Ethnic Group	vs. Ethnic Group	2008 LS Mean Difference			2017 LS Mean Difference		
			Age 19-64	Age 65-74	Age 75+	Age 19-64	Age 65-74	Age 75+
Bay area	Asian	Black						2.5
	Asian	Hispanic				-3.8		
	Asian	White		-3.2				
	Black	Hispanic		-4.2	-2.4	-3.1	-3.9	-2.7
	Black	White		-5.6	-2.2			-2.7
	Hispanic	White				2.5		
Central valley	Asian	Black						
	Asian	Hispanic	-4.9	-5.2	-2.6		-3.6	-2.5
	Asian	White	-4.2	-3.7	-1.7			-2.6
	Black	Hispanic		-3.9	-1.7		-5.1	-2.4
	Black	White		-2.4			-3.8	-2.6
	Hispanic	White						
Mountain valley	Asian	Black						
	Asian	Hispanic				-2.9		
	Asian	White				-2.7		
	Black	Hispanic				-3.9		
	Black	White				-3.8	-5.2	
	Hispanic	White					-3.1	
Northern	Asian	Black						
	Asian	Hispanic				-7.3	-6.1	
	Asian	White				-7.1	-7.4	
	Black	Hispanic				-5.6	-6.1	
	Black	White	-2.6			-5.4	-7.4	
	Hispanic	White		-0.8				
Southern	Asian	Black		6.1	4.6		4.3	3.4
	Asian	Hispanic			4.1			
	Asian	White						
	Black	Hispanic		-5.2			-5.7	-3.0
	Black	White		-4.5			-4.3	-2.7
	Hispanic	White						

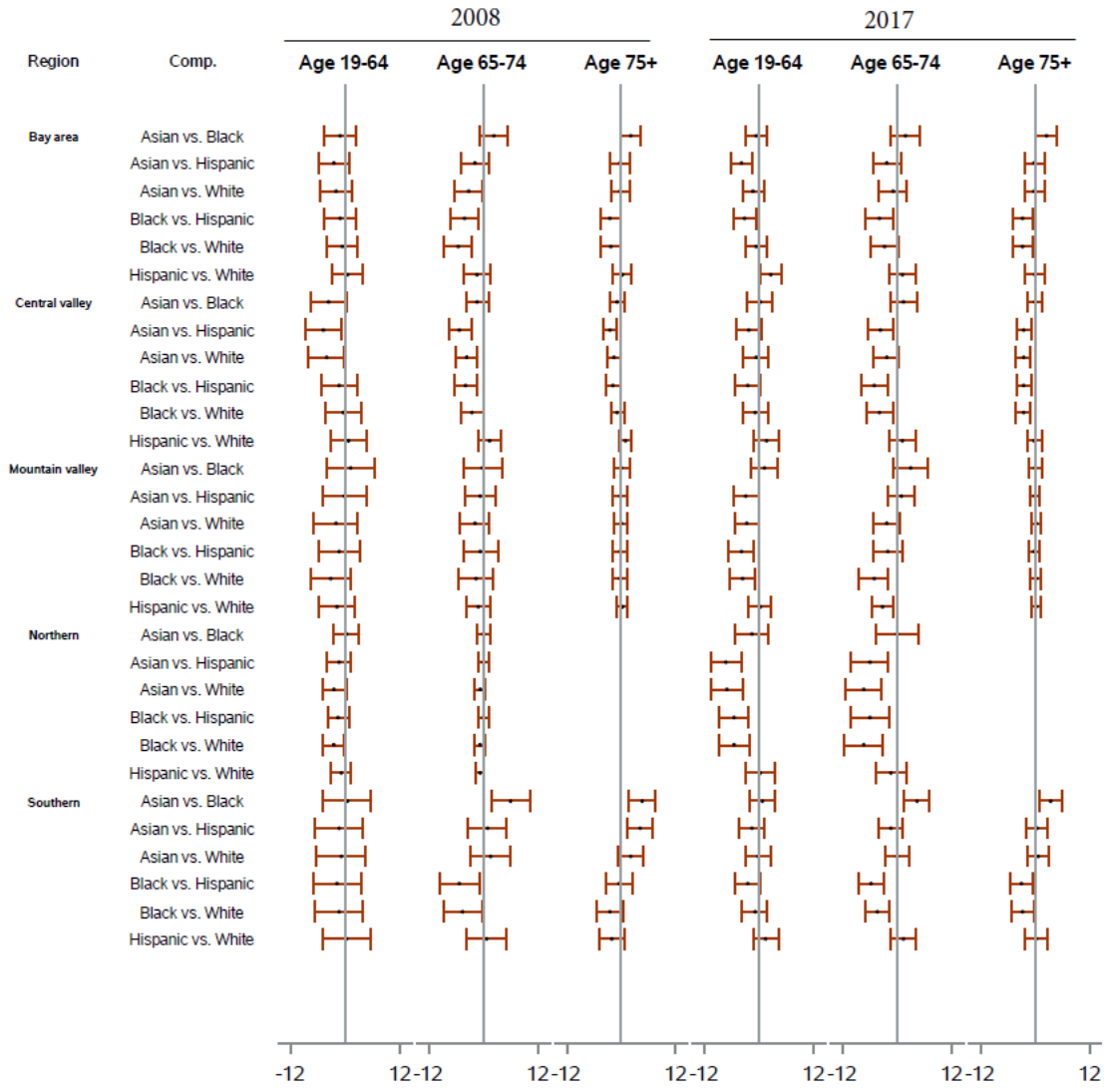


Figure 24. Forest plots of least square mean difference (95% CI) of utilization rates for restorative dental treatment among ethnic groups by age group and geographic region in 2008 and 2017.

Table 31 presents least square mean differences (95% CI) among ethnic groups for utilization rates difference between 2017 and 2013 by age group and geographic region. There are more statistically significant findings showing the ethnicity of Black has lower percentage of increase in utilization rate than other ethnic groups.

Table 31

Least Square Mean Differences among Ethnic Groups for Utilization Rates Difference between 2017 and 2013 by Age Group and Geographic Region for Restorative Dental Treatment

			Least Square Mean Differences (95% CI) of Differences in Utilization Rates between 2017 and 2013		
Geographic Region	**Ethnic Group**	**vs. Ethnic Group**	**Age 19-64**	**Age 65-74**	**Age 75+**
Bay area	Asian	Black	-0.6 (-3.08,1.84)	1.7 (-1.41,4.89)	2.5 (0.25,4.71)*
	Asian	Hispanic	-2.4 (-4.80,0.02)	-2.2 (-5.27,0.90)	-0.2 (-2.37,1.99)
	Asian	White	-0.6 (-3.03,1.79)	-0.8 (-3.93,2.23)	-0.0 (-2.23,2.14)
	Black	Hispanic	-1.8 (-4.18,0.64)	-3.9 (-7.01,-0.84)*	-2.7 (-4.85,-0.48)*
	Black	White	-0.0 (-2.41,2.41)	-2.6 (-5.67,0.50)	-2.5 (-4.70,-0.34)*
	Hispanic	White	1.8 (-0.59,4.13)	1.3 (-1.68,4.35)	0.1 (-1.99,2.28)
Central valley	Asian	Black	0.4 (-2.35,3.11)	1.4 (-1.48,4.36)	-0.1 (-1.77,1.63)
	Asian	Hispanic	-1.5 (-4.11,1.21)	-3.6 (-6.56,-0.72)*	-2.5 (-4.11,-0.81)*
	Asian	White	-0.4 (-3.02,2.31)	-2.4 (-5.25,0.44)	-2.6 (-4.21,-0.99)*
	Black	Hispanic	-1.8 (-4.50,0.83)	-5.1 (-8.00,-2.16)*	-2.4 (-4.09,-0.69)*
	Black	White	-0.7 (-3.40,1.93)	-3.8 (-6.69,-1.00)*	-2.5 (-4.19,-0.87)*
	Hispanic	White	1.1 (-1.49,3.69)	1.2 (-1.61,4.08)	-0.1 (-1.75,1.47)
Mountain valley	Asian	Black	2.0 (-1.11,5.15)	2.9 (-0.74,6.60)	0.1 (-1.32,1.50)
	Asian	Hispanic	-1.6 (-4.58,1.33)	0.9 (-2.16,3.91)	-0.1 (-1.29,1.11)
	Asian	White	-1.1 (-3.93,1.82)	-2.6 (-5.63,0.35)	0.2 (-0.91,1.39)
	Black	Hispanic	-3.7 (-6.39,-0.91)*	-2.1 (-5.28,1.17)	-0.2 (-1.46,1.09)
	Black	White	-3.1 (-5.74,-0.43)*	-5.6 (-8.76,-2.39)*	0.1 (-1.07,1.37)
	Hispanic	White	0.6 (-1.88,3.01)	-3.5 (-5.95,-1.09)*	0.3 (-0.65,1.31)
Northern	Asian	Black	-1.5 (-5.54,2.44)	NE[a]	0.0 (-5.66,5.66)
	Asian	Hispanic	-6.6 (-10.45,-2.84)*	NE[a]	-1.0 (-5.37,3.40)
	Asian	White	-6.5 (-10.29,-2.68)*	NE[a]*	-3.4 (-7.60,0.80)
	Black	Hispanic	-5.1 (-8.56,-1.64)*	NE[a]	-1.0 (-5.86,3.89)
	Black	White	-4.9 (-8.39,-1.47)*	NE[a]	-3.4 (-8.11,1.31)
	Hispanic	White	0.2 (-3.08,3.41)	NE[a]	-2.4 (-5.48,0.65)
Southern	Asian	Black	0.5 (-1.76,2.86)	4.2 (1.58,6.86)*	3.3 (1.00,5.63)*
	Asian	Hispanic	-0.4 (-2.75,1.87)	-1.4 (-4.06,1.21)	0.3 (-2.02,2.62)
	Asian	White	0.2 (-2.08,2.54)	0.3 (-2.38,2.89)	0.9 (-1.41,3.22)
	Black	Hispanic	-1.0 (-3.30,1.32)	-5.6 (-8.28,-3.01)*	-3.0 (-5.33,-0.70)*
	Black	White	-0.3 (-2.63,1.99)	-4.0 (-6.60,-1.33)*	-2.4 (-4.73,-0.09)*
	Hispanic	White	0.7 (-1.64,2.98)	1.7 (-0.95,4.32)	0.6 (-1.71,2.92)

[a]NE: not estimable as the utilization rate was all 0% for each year for the age group of 65-74 years old and 75 years and above.
* $p < 0.05$, 2-sided.

Treatment for caries-age effect (hypothesis 4). Figure 25 displays point estimate of

the difference in utilization rates among age groups and its 95% confidence interval by ethnic group and geographic region in 2008 and 2017. The comparisons with statistically significant differences are presented in Table 32.

In both 2008 and 2017, all the comparisons with statistically significant findings show greater utilization rates in the younger age group than the older age group. In 2008, the ethnicity of White has the greatest number of statistically significant findings of this age effect, and in 2017 the ethnicity of Hispanic has the greatest number of statistically significant findings of this age effect followed by the ethnic groups of Black, White and Asian. For example, among Hispanic beneficiaries, in a majority of the observations, the utilization rates were greater in the younger age group than the older age group, while among Asian beneficiaries, in general, the utilization rates were similar among the age groups.

Table 32

Comparisons with Statistically Significant Differences in Utilization Rate for Treatment for Caries among Age Groups by Ethnic Group and Geographic Region in 2008 and 2017

			2008 LS Mean Difference				2017 LS Mean Difference			
Geographic Region	**Age Group**	**vs. Age Group**	**White**	**Black**	**Hispanic**	**Asian**	**White**	**Black**	**Hispanic**	**Asian**
Bay area	Age 19-64	Age 65-74	3.7	8.2	5.4	5.0				
	Age 19-64	Age 75+	7.4	9.5	7.8	6.2		5.0	9.1	
	Age 65-74	Age 75+	3.7		2.5				7.0	
Central valley	Age 19-64	Age 65-74	5.7	7.9	5.0	5.5		6.6		5.0
	Age 19-64	Age 75+	9.1	9.4	9.2	6.6	7.7	7.7	8.4	7.9
	Age 65-74	Age 75+	3.4		4.3		6.6		5.9	
Mountain valley	Age 19-64	Age 65-74	4.1					3.8	4.7	
	Age 19-64	Age 75+	5.1		3.9		3.8	3.8	5.7	
	Age 65-74	Age 75+					3.6			
Northern	Age 19-64	Age 65-74	3.1		2.7				7.4	
	Age 19-64	Age 75+	3.4		2.6				9.5	
	Age 65-74	Age 75+								
Southern	Age 19-64	Age 65-74	5.9	9.5	5.8			6.8		
	Age 19-64	Age 75+	8.4	11.3	11.0		7.2	8.2	7.5	
	Age 65-74	Age 75+			5.2		6.3		5.1	

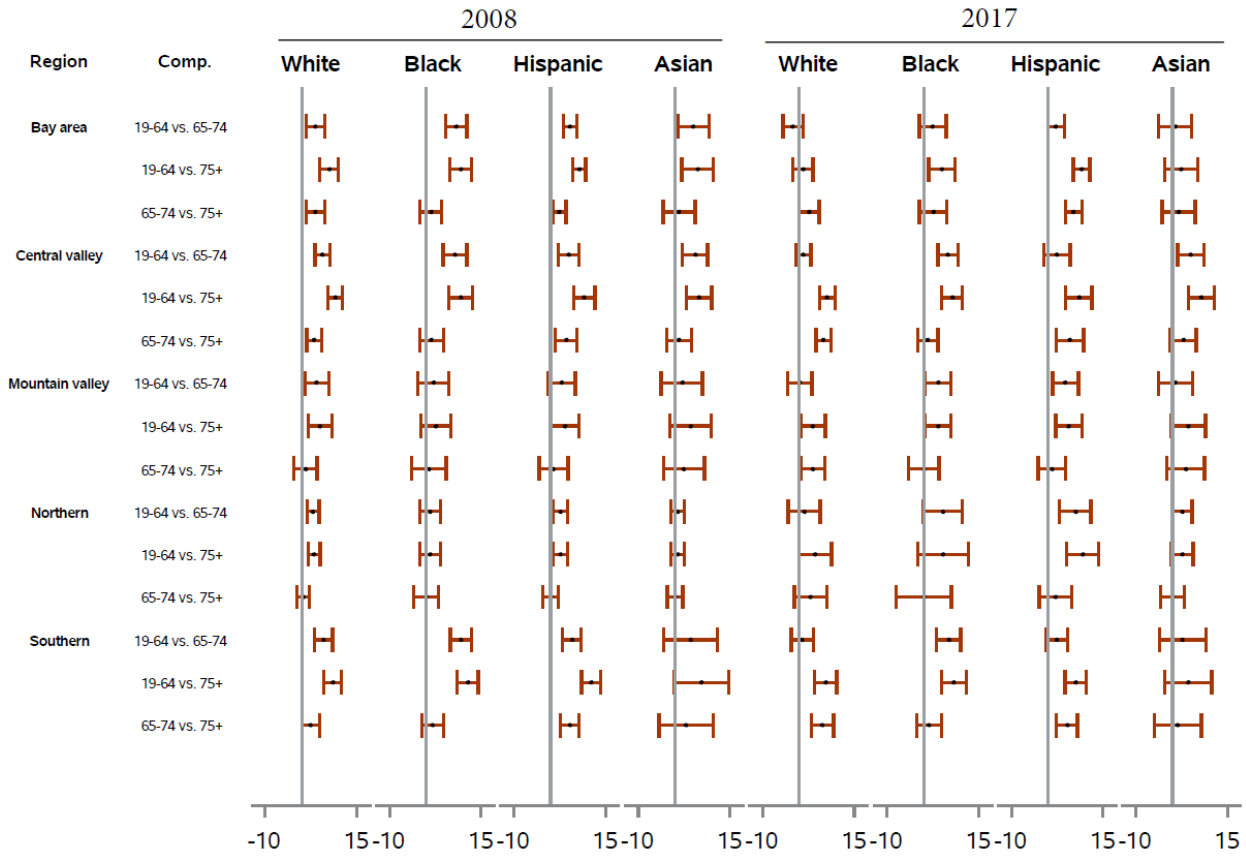


Figure 25. Forest plots of least square mean difference (95% CI) of utilization rates for treatment for caries among age groups by ethnic group and geographic region in 2008 and 2017.

Table 33 presents least square mean differences (95% CI) among age groups for utilization rates difference between 2017 and 2013 by ethnic group and geographic region. Except for one, all the other comparisions with statistically significant findings show the increases in utilization rates from 2017 to 2013 are greater in the younger age group than the older age group. The numbers of statistically significant findings are the highest among the ethnicity of Hispanic, followed by the ethnic groups of White and Black and the number is the least in the ethnicity of Asian. Among Asian beneficiaries, in general, the increases in utilization rates were similar among the age groups.

Table 33

Least Square Mean Differences among Age Groups for Utilization Rates Difference between 2017 and 2013 by Ethnic Group and Geographic Region for Treatment for Caries

			Least Square Mean Differences (95% CI) of Differences in Utilization Rates between 2017 and 2013			
Geographic Region	**Age Group**	**vs. Age Group**	**White**	**Black**	**Hispanic**	**Asian**
Bay area	Age 19-64	Age 65-74	-2.7 (-5.31,-0.10)*	2.2 (-1.39,5.69)	-0.5 (-2.98,1.98)	-0.3 (-4.48,3.96)
	Age 19-64	Age 75+	0.2 (-2.36,2.85)	4.6 (1.03,8.11)*	6.5 (4.06,9.03)*	1.5 (-2.69,5.74)
	Age 65-74	Age 75+	3.0 (0.35,5.56)*	2.4 (-1.12,5.96)	7.0 (4.57,9.53)*	1.8 (-2.43,6.00)
Central valley	Age 19-64	Age 65-74	-0.3 (-2.41,1.82)	5.0 (2.24,7.83)*	-0.3 (-3.80,3.16)	3.9 (0.30,7.46)*
	Age 19-64	Age 75+	6.0 (3.93,8.16)*	6.0 (3.15,8.91)*	5.7 (2.23,9.19)*	6.7 (3.17,10.32)*
	Age 65-74	Age 75+	6.3 (4.23,8.46)*	1.0 (-1.89,3.88)	6.0 (2.47,9.61)*	2.9 (-0.72,6.44)
Mountain valley	Age 19-64	Age 65-74	-1.6 (-4.71,1.51)	4.0 (0.45,7.63)*	4.1 (0.74,7.45)*	2.1 (-2.30,6.56)
	Age 19-64	Age 75+	2.6 (-0.46,5.76)	4.3 (0.72,7.90)*	4.8 (1.32,8.36)*	5.8 (1.35,10.21)*
	Age 65-74	Age 75+	4.2 (1.08,7.41)*	0.3 (-3.81,4.34)	0.7 (-2.77,4.27)	3.7 (-0.95,8.25)
Northern	Age 19-64	Age 65-74	1.1 (-3.27,5.51)	5.7 (-0.20,11.68)	6.4 (1.63,11.08)*	3.2 (-0.25,6.58)
	Age 19-64	Age 75+	4.2 (-0.15,8.62)	5.7 (-1.44,12.92)	8.8 (3.92,13.62)*	3.2 (-0.25,6.58)
	Age 65-74	Age 75+	3.1 (-1.27,7.50)	0.0 (-8.04,8.04)	2.4 (-2.71,7.54)	-0.0 (-3.94,3.94)
Southern	Age 19-64	Age 65-74	-1.2 (-4.16,1.68)	5.1 (2.30,7.96)*	-1.6 (-4.49,1.22)	0.1 (-5.74,5.88)
	Age 19-64	Age 75+	5.2 (2.29,8.13)*	6.6 (3.80,9.46)*	3.6 (0.74,6.45)*	1.7 (-4.11,7.51)
	Age 65-74	Age 75+	6.4 (3.53,9.37)*	1.5 (-1.33,4.33)	5.2 (2.38,8.08)*	1.6 (-4.18,7.44)

* $p < 0.05$, 2-sided.

Treatment for caries-ethnicity effect (hypothesis 5). Figure 26 displays point estimate of the difference in utilization rates among ethnic groups and its 95% confidence interval by age group and geographic region in 2008 and 2017. The comparisons with statistically significant differences are presented in Table 34.

In both 2008 and 2017, there are more statistically significant findings for ethnicity effect in the older age groups (65-74, and 75+ years old) than in the younger age group of 19-

64 years old. In 2017, there is an increase in number of statistically significant findings for ethnicity effect in the age group of 19-64 years old. In both 2008 and 2017, among the comparisons with statistically significant difference, there are more findings showing the ethnicity of Black has lower utilization rates than other ethnic groups (Table 34 and Figure 26).

Table 34

Comparisons with Statistically Significant Differences in Utilization Rate for Treatment for Caries among Age Groups by Ethnic Group and Geographic Region in 2008 and 2017

Geographic Region	Ethnic Group	vs. Ethnic Group	2008 LS Mean Difference			2017 LS Mean Difference		
			Age 19-64	Age 65-74	Age 75+	Age 19-64	Age 65-74	Age 75+
Bay area	Asian	Black						4.4
	Asian	Hispanic				-2.8		4.0
	Asian	White		-3.5				
	Black	Hispanic		-4.3	-3.2	-4.6	-4.9	
	Black	White		-5.5	-3.1		-5.4	-5.3
	Hispanic	White				3.3		-4.9
Central valley	Asian	Black						
	Asian	Hispanic	-4.9	-5.4	-2.2		-5.0	
	Asian	White		-3.8	-1.5			
	Black	Hispanic		-4.1			-7.4	-2.5
	Black	White		-2.6			-5.7	
	Hispanic	White						
Mountain valley	Asian	Black						
	Asian	Hispanic						
	Asian	White						
	Black	Hispanic				-4.3		
	Black	White					-7.0	-3.4
	Hispanic	White					-3.6	
Northern	Asian	Black						
	Asian	Hispanic				-8.6		
	Asian	White				-8.0	-9.2	-6.2
	Black	Hispanic				-5.9		
	Black	White	-2.5			-5.3	-9.2	-6.2
	Hispanic	White					-5.5	-4.5
Southern	Asian	Black		6.4	5.3		7.1	7.0
	Asian	Hispanic			3.2			
	Asian	White						5.5
	Black	Hispanic		-5.4			-7.5	
	Black	White		-5.0	-4.3		-6.3	
	Hispanic	White						

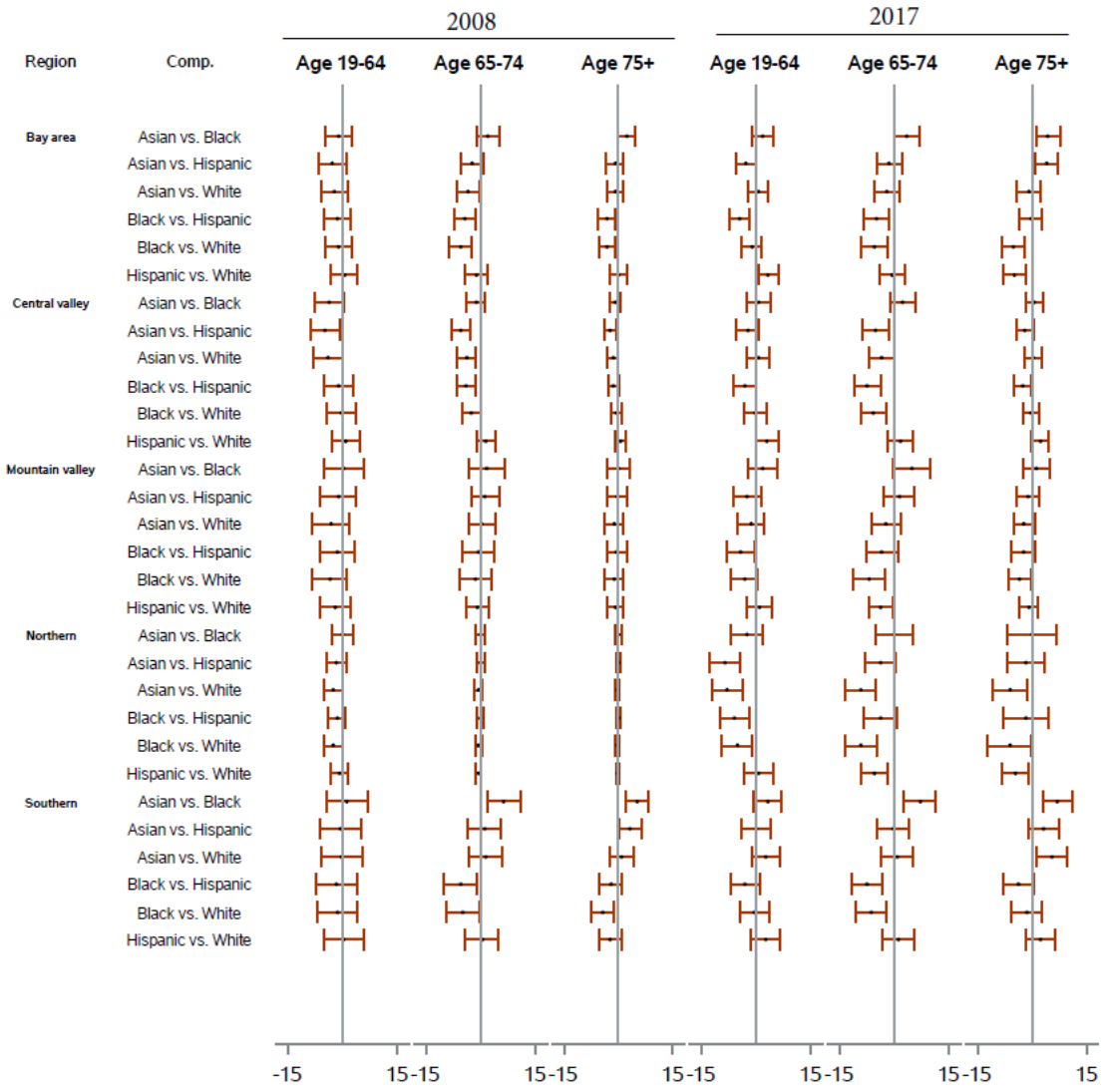


Figure 26. Forest plots of least square mean difference (95% CI) of utilization rates for treatment for caries among ethnic groups by age group and geographic region in 2008 and 2017.

Table 35 presents least square mean differences (95% CI) among ethnic groups for utilization rates difference between 2017 and 2013 by age group and geographic region. There are more statistically significant findings showing the ethnicity of Black has lower percentage of increase in utilization rate than other ethnic groups.

Table 35

Least Square Mean Differences among Ethnic Groups for Utilization Rates Difference between 2017 and 2013 by Age Group and Geographic Region for Treatment for Caries

			Least Square Mean Differences (95% CI) of Differences in Utilization Rates between 2017 and 2013		
Geographic Region	**Ethnic Group**	**vs. Ethnic Group**	**Age 19-64**	**Age 65-74**	**Age 75+**
Bay area	Asian	Black	1.3 (-1.16,3.86)	3.8 (0.20,7.33)*	4.4 (1.27,7.53)*
	Asian	Hispanic	-1.1 (-3.52,1.39)	-1.3 (-4.80,2.18)	4.0 (0.89,7.02)*
	Asian	White	0.9 (-1.58,3.33)	-1.6 (-5.06,1.92)	-0.4 (-3.46,2.67)
	Black	Hispanic	-2.4 (-4.87,0.04)	-5.1 (-8.56,-1.58)*	-0.4 (-3.50,2.63)
	Black	White	-0.5 (-2.93,1.98)	-5.3 (-8.82,-1.84)*	-4.8 (-7.86,-1.73)*
	Hispanic	White	1.9 (-0.46,4.34)	-0.3 (-3.68,3.15)	-4.4 (-7.35,-1.36)*
Central valley	Asian	Black	1.2 (-1.79,4.11)	2.3 (-1.24,5.87)	0.4 (-2.07,2.97)
	Asian	Hispanic	-0.8 (-3.63,2.12)	-5.0 (-8.52,-1.41)*	-1.8 (-4.23,0.66)
	Asian	White	1.2 (-1.63,4.12)	-2.9 (-6.41,0.53)	0.5 (-1.84,2.93)
	Black	Hispanic	-1.9 (-4.79,0.95)	-7.3 (-10.84,-3.72)*	-2.2 (-4.76,0.28)
	Black	White	0.1 (-2.79,2.95)	-5.3 (-8.72,-1.78)*	0.1 (-2.36,2.56)
	Hispanic	White	2.0 (-0.80,4.80)	2.0 (-1.44,5.49)	2.3 (-0.05,4.72)
Mountain valley	Asian	Black	2.9 (-1.12,6.85)	4.8 (-0.18,9.73)	1.4 (-2.28,5.07)
	Asian	Hispanic	-0.6 (-4.33,3.19)	1.4 (-2.70,5.48)	-1.5 (-4.65,1.62)
	Asian	White	1.0 (-2.69,4.64)	-2.8 (-6.80,1.28)	-2.2 (-5.16,0.83)
	Black	Hispanic	-3.4 (-6.92,0.05)	-3.4 (-7.75,0.97)	-2.9 (-6.23,0.42)
	Black	White	-1.9 (-5.27,1.49)	-7.5 (-11.84,-3.22)*	-3.6 (-6.75,-0.36)*
	Hispanic	White	1.5 (-1.57,4.65)	-4.1 (-7.42,-0.87)*	-0.7 (-3.20,1.90)
Northern	Asian	Black	-2.6 (-7.54,2.38)	0.0 (-6.62,6.62)	-0.0 (-7.78,7.78)
	Asian	Hispanic	-7.6 (-12.37,-2.91)*	-4.4 (-10.21,1.32)	-2.0 (-8.06,3.99)
	Asian	White	-7.1 (-11.87,-2.41)*	-9.2 (-14.78,-3.59)*	-6.1 (-11.84,-0.29)*
	Black	Hispanic	-5.1 (-9.37,-0.77)*	-4.4 (-9.77,0.88)	-2.0 (-8.74,4.67)
	Black	White	-4.6 (-8.87,-0.26)*	-9.2 (-14.33,-4.04)*	-6.1 (-12.55,0.42)
	Hispanic	White	0.5 (-3.53,4.54)	-4.7 (-8.71,-0.76)*	-4.0 (-8.25,0.19)
Southern	Asian	Black	2.2 (-0.75,5.20)	7.3 (3.06,11.51)*	7.2 (3.14,11.17)*
	Asian	Hispanic	1.5 (-1.46,4.49)	-0.2 (-4.42,4.03)	3.4 (-0.61,7.42)
	Asian	White	2.5 (-0.48,5.47)	1.2 (-3.04,5.41)	6.0 (1.99,10.02)*
	Black	Hispanic	-0.7 (-3.68,2.26)	-7.5 (-11.70,-3.25)*	-3.7 (-7.76,0.27)
	Black	White	0.3 (-2.71,3.24)	-6.1 (-10.32,-1.87)*	-1.1 (-5.16,2.87)
	Hispanic	White	1.0 (-2.00,3.95)	1.4 (-2.85,5.60)	2.6 (-1.42,6.61)

* $p < 0.05$, 2-sided.

Results from diagnostic analyses. Appendix D displays Studendized residual plots from mixed model analysis evaluating age effect within each ethnic group and geographic

region by type of dental service, and the needle plots of Cook's distances showing the influence of each observation on the estimated fitted effect are displayed in Appendix E. Appendix F displays Studendized residual plots from mixed model analysis evaluating ethnicity effect within each age group and geographic region by type of dental service, and the needle plots of Cook's distances showing the influence of each observation on the estimated fitted effect are displayed in Appendix G.

Results from the diagnostic analyses show that the normality assumption is held for most of the subgroup analysis and the observed outliers indicate the existence of geographic regional effect in the utilization rates for various types of dental services.

Summary: The majority of Medi-Cal beneficiaries in each ethnic group were in the age range of 19-64 years old. Within each age group, the majority of the beneficiaries reported their ethnicity as Hispanic or White. In each ethnic group within each age group, the rates of dental care utilization in clinics decreased post the elimination of most of the adult dental services in 2009 and increased after the partial restoration of adult dental services in 2014. However, the magnitude of increase differs in different age groups, ethnic groups and geographic regions. As of 2017, most of the age group comparisions with statistically significant findings show greater utilization rates in the younger age group than the older age group (age 19-64 vs. 65-74, age 19-64 vs. 75+, or age 65-74 vs. 75+ years old). Across all geographic regions, for most type of dental services, the ethnicity of Hispanic has the greatest number of statistically significant findings of this age effect; and for each type of dental services, the age effect is the least observed in Asians. As for the ethnicity effect, among the comparisons with statistically significant findings, there are more findings showing the ethnicity of Black has lower utilization

rates than other ethnic groups and this ethnicity effect are more observed in the older age groups (65-74, and 75+ years old) than in the younger age group of 19-64 years old.

Question 4: Dental-related ER visits

Question 4 addresses dental related ER visits by adult Medi-Cal beneficiaries. ER visit rates are first summarized descriptively by ethnic group and age group from 2013 to 2017, and hypothesis testing is then conducted using ANOVA. Question 4 and its three associated hypotheses are listed below.

Question 4: Did the partial benefit restoration in 2014 reduce dental-related ER visits by Medi-Cal beneficiaries? How does the impact vary by age group and ethnic groups?

Hypothesis 6: The partial benefit restoration in 2014 reduced dental-related ER visits by Medi-Cal beneficiaries each year from 2015 to 2017.

Hypothesis 7: The partial benefit restoration in 2014 reduced dental-related ER visits by older Medi-Cal beneficiaries more than younger age beneficiaries.

Hypothesis 8: The partial benefit restoration in 2014 reduced dental-related ER visits by White Medi-Cal beneficiaries more than by beneficiaries of ethnic minority groups.

Results from descriptive analysis and ANOVA evaluating the above hypotheses are presented below.

Results from descriptive analysis. ER visit rate is calculated as number of dental related emergency visits per 1,000 enrollees and tabulated by ethnic group and age group from 2013 to 2017 in Table 36. Figure 27 displays the ER visit rate by ethnic group and age group from 2013 to 2017. Figure 28 displays ER visit rate change from 2013 by ethnic group and age group from 2014 to 2017.

Results for evaluation of Hypothesis 6. Overall, the ER visit rate reduced each year since the partial restoration of adult dental service in 2014 (Total panel in Figure 27). However, the results are different for the younger and older age groups. In 2013, for Medi-Cal enrollees age 19 to 64 years old, the ER visit rate was 19.6 visits per 1,000 enrollees across all ethnic groups and differed among ethnic groups with 29.8, 26.0, 14.7, 3.0 and 14.2 visits per 1,000 enrollees for the ethnic groups of White, Black, Hispanic, Asian and Other respectively. For Medi-Cal enrollees age 65 years and above, the ER visit rate was much lower at 0.8 visit per 1,000 enrollees across all ethnic groups and similar among ethnic groups at 0.7, 1.1, 0.9, 0.6 and 0.7 visit per 1,000 enrollees for the ethnic groups of White, Black, Hispanic, Asian and Other respectively (Table 36).

Results for evaluation of Hypothesis 7. Since the partial restoration of adult dental services in 2014, for the age group of 19 to 64 years old, the ER visit rate decreased each year from 19.6 visits per 1,000 enrollees in 2013 to 16.1, 10.0, 8.8 and 6.2 visits per 1,000 enrollees in 2014, 2015, 2016 and 2017 respectively; for the age group of 65 years old and above, the rates remained low each year similar to that of 2013 at about 1 visit or below per 1,000 enrollees (Table 36, Figure 27).

Results for evaluation of Hypothesis 8. Across age groups, the ER visit rate decreased each year since the partial restoration of adult dental services in 2014 and the reductions were greater in the ethnic groups of White and Black than those in the ethnic groups of Hispanics and Asian (Figure 27). However, the results are different for the younger and older age group. For the age group of 19 to 64 years old, the ER visit rate decreased each year for each ethnic group and the greatest reduction occurred in the ethnic group of White. As of 2017, the number of the reduction in ER visit comparing to 2013 was 20.0, 15.3, 10.5, 1.8 and 9.1 visits per 1,000 enrollees for the ethnic group of White, Black, Hispanics, Asian and Other respectively (Table 36, Figure 28). For the age group of 65 years old and above, the ER visit rates were low for each ethnic group; as of 2017, the ER visit rates were 1.1, 1.9,

0.9 and 0.6 visit per 1,000 enrollees for the ethnic groups of White, Black, Hispanic and Asian respectively.

Table 36

Number of ER Visit, Number of Med-Cal Enrollees and ER Visits Per 1,000 Enrollees by Ethnic Group, Age Group from 2013 to 2017

	White		Black		Hispanic	
Year	**Age 19-64**	**Age 65+**	**Age 19-64**	**Age 65+**	**Age 19-64**	**Age 65+**
2013	22,799/765,628 (29.8)	196/264,422 (0.7)	8,759/336,661 (26.0)	64/57,267 (1.1)	15,714/1,071,973 (14.7)	265/289,933 (0.9)
2014	38,848/1,556,009 (25.0)	255/271,078 (0.9)	13,251/574,336 (23.1)	69/59,910 (1.2)	23,479/1,975,514 (11.9)	329/307,769 (1.1)
2015	25,781/1,792,368 (14.4)	197/284,653 (0.7)	9,423/618,722 (15.2)	49/63,999 (0.8)	17,903/2,346,508 (7.6)	248/333,532 (0.7)
2016	26,737/1,897,446 (14.1)	362/293,709 (1.2)	10,385/686,816 (15.1)	116/69,274 (1.7)	16,444/2,812,574 (5.8)	386/368,670 (1.0)
2017	17,775/1,818,320 (9.8)	329/295,890 (1.1)	7,204/671,339 (10.7)	136/71,263 (1.9)	12,005/2,859,000 (4.2)	361/383,017 (0.9)
	Asian		**Other**		**Total**	
Year	**Age 19-64**	**Age 65+**	**Age 19-64**	**Age 65+**	**Age 19-64**	**Age 65+**
2013	562/187,761 (3.0)	97/165,493 (0.6)	3,506/246,090 (14.2)	83/126,331 (0.7)	55,061/2,808,449 (19.6)	804/1,047,903 (0.8)
2014	1,247/504,341 (2.5)	129/179,279 (0.7)	7,440/585,771 (12.7)	71/129,184 (0.5)	90,461/5,612,657 (16.1)	961/1,104,920 (0.9)
2015	1,049/596,407 (1.8)	94/193,864 (0.5)	6,348/728,145 (8.7)	75/137,053 (0.5)	65,565/6,573,089 (10.0)	731/1,182,250 (0.6)
2016	765/531,336 (1.4)	112/163,585 (0.7)	5,888/835,583 (7.0)	146/184,958 (0.8)	64,537/7,305,057 (8.8)	1,266/1,260,703 (1.0)
2017	604/521,597 (1.2)	109/173,125 (0.6)	4,271/827,675 (5.2)	136/183,838 (0.7)	44,828/7,228,172 (6.2)	1,236/1,293,443 (1.0)

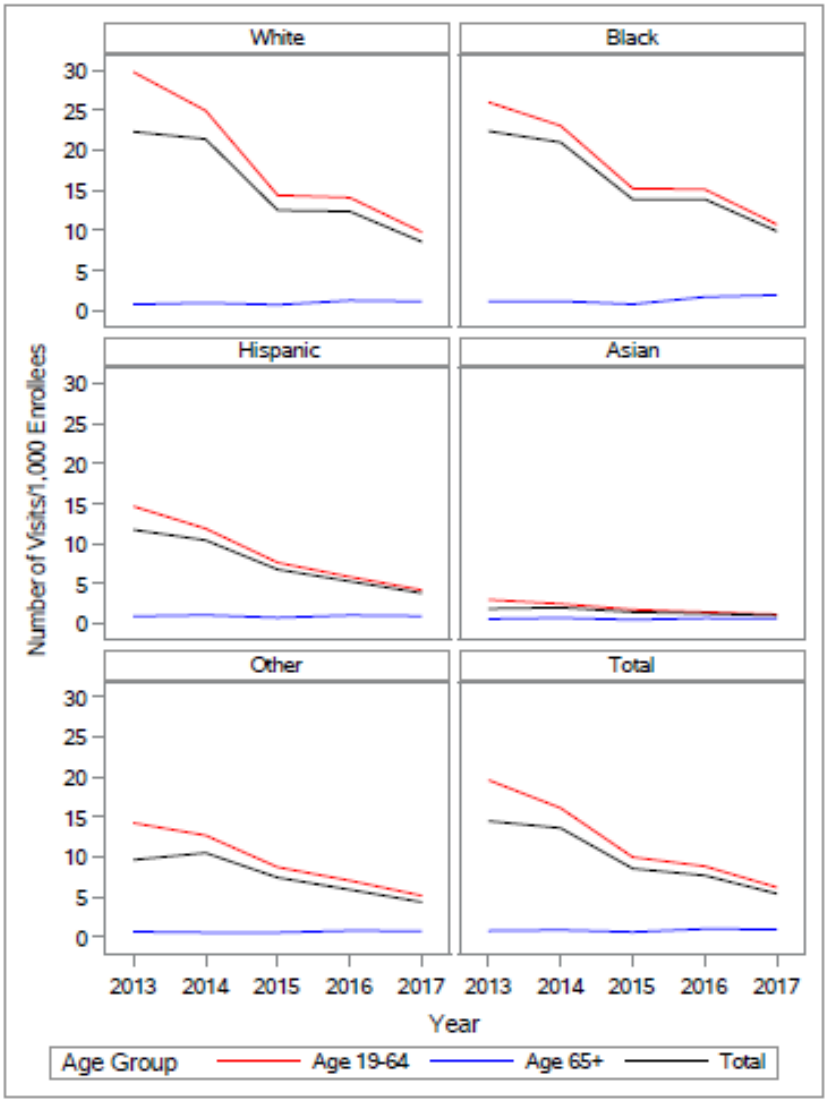


Figure 27. ER visit rate by ethnic group, age group from 2013 to 2017.

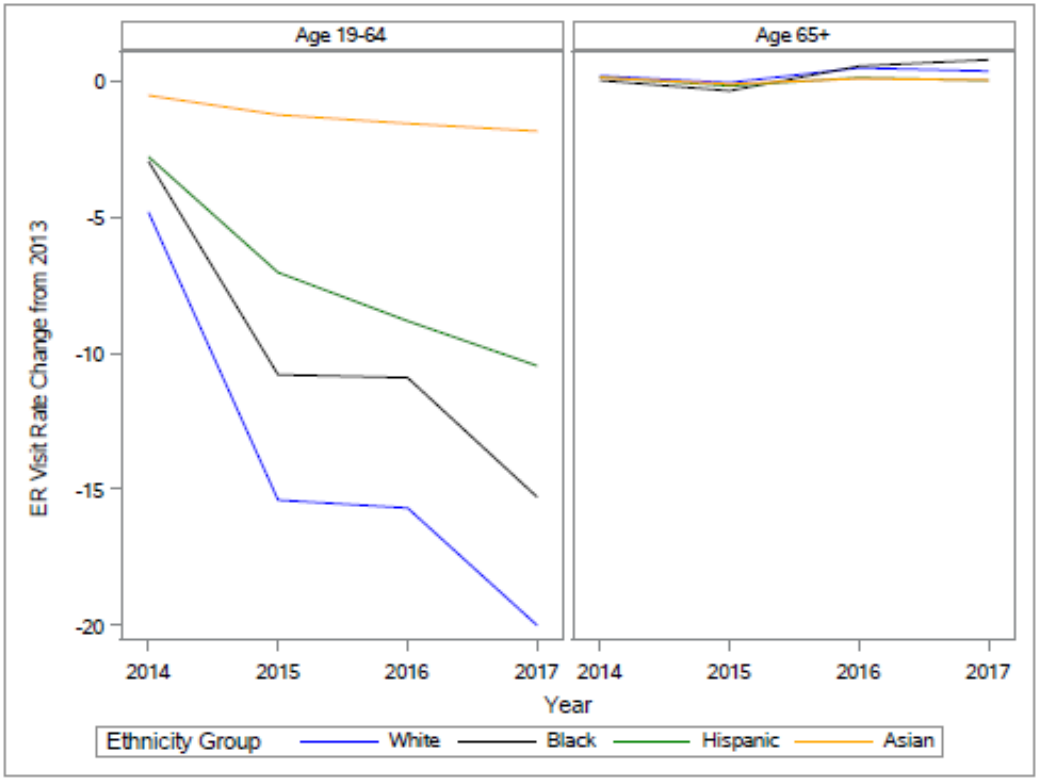


Figure 28. ER visit rate change from 2013 by ethnic group and age group from 2014 to 2017.

Results from ANOVA analysis. ANOVA was conducted among age group of 19 to 64 years old to evaluate the effect of ethnicity (hypothesis 8). Comparisons to ER visit rates in 2013 were made for each year from 2014 to 2017 to evaluate the impact of the partial restoration of adult dental services. ANOVA was not conducted among age group of 65 years old and above as there was little difference in ER visit rate among the ethnic groups over the years. Results from ANOVA are tabulated in Table 37 and Table 38.

Across the years, the ethnicity of Asian has statistically significantly lower ER visit rates comparing to other ethnic groups, the ethnicity of Black has statistically significantly higher ER visit rates than the ethnic groups of Asian, Hispanic and Other, and the ethnicity of Hispanic has statistically significantly lower ER visit rate than the ethnicities of White and Black (Table 37). Across all ethnic groups, comparing to 2013, the reduction in ER visit rate in 2014 was not

statistically significant, however the reductions in ER visit rate in 2015, 2016 and 2017 were all statistically significant (Table 38).

Table 37

Results from ANOVA: Comparison among Ethnic Group for ER Visit Rate for Age Group 19-64 Years Old

Ethnic Group	vs. Ethnic Group	LSMean Difference (95% CI)	P-value
ASIAN	BLACK	-16.1 (-19.94, -12.20)	<0.0001
ASIAN	HISPANIC	-6.9 (-10.75, -3.01)	0.0017
ASIAN	OTHER	-7.6 (-11.48, -3.74)	0.0007
ASIAN	WHITE	-16.6 (-20.51, -12.76)	<0.0001
BLACK	HISPANIC	9.2 (5.32, 13.06)	0.0001
BLACK	OTHER	8.5 (4.59, 12.33)	0.0003
BLACK	WHITE	-0.6 (-4.44, 3.31)	0.7612
HISPANIC	OTHER	-0.7 (-4.60, 3.14)	0.6945
HISPANIC	WHITE	-9.8 (-13.63, -5.88)	<0.0001
OTHER	WHITE	-9.0 (-12.90, -5.15)	0.0001

Table 38

Results from ANOVA: Comparison to Year 2013 for ER Visit Rate for Age Group 19-64 Years Old

Year	vs. Year	LSMean Difference (95% CI)	P-value
2014	2013	-2.5 (-6.39, 1.35)	0.1869
2015	2013	-8.0 (-11.87, -4.12)	0.0005
2016	2013	-8.8 (-12.70, -4.96)	0.0002
2017	2013	-11.3 (-15.21, -7.46)	<0.0001

The studendized residual plot doesn't indicate deviations from the normality assumption with the ANOVA model (Figure 29).

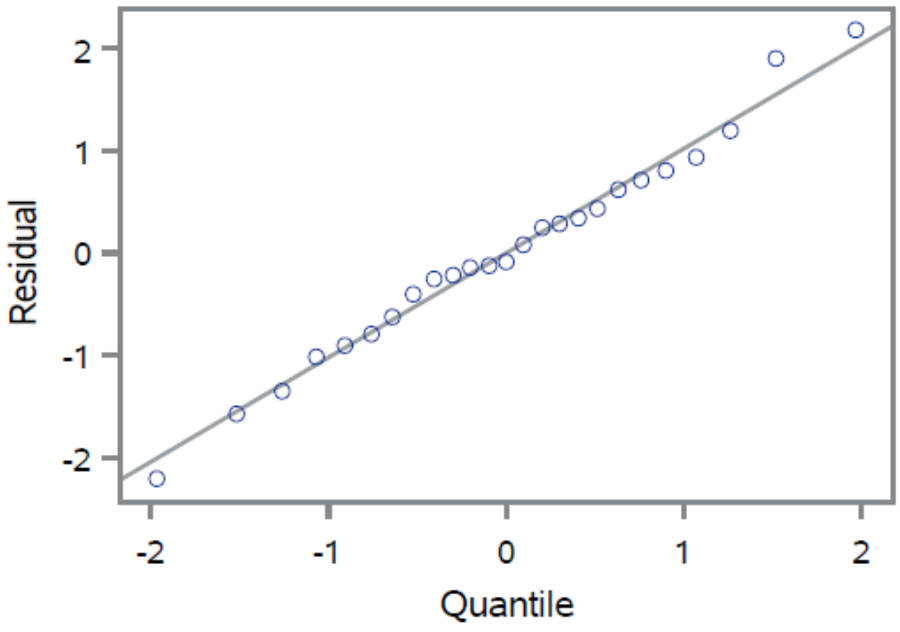


Figure 29. Studendized residual plot from ANOVA for ER visit rate among age group of 19-64 years old.

Summary. Overall, the ER visit rate reduced each year since the partial restoration of adult dental service in 2014, and across age groups, the reductions were greater in the ethnic groups White and Black than those in the ethnic groups of Hispanics and Asian. However, results from the age group of 19 to 64 years old are different from those of 65 years old and above. For the younger age group, decrease in ER visits began to show in 2014, the first year the partial restoration of adult dental services took effect. Since 2014, the ER visit rate continued to decrease each year from 19.6 visits per 1,000 enrollees in 2013 to 16.1, 10.0, 8.8 and 6.2 visits per 1,000 enrollees in 2014, 2015, 2016 and 2017 respectively in the younger age group. For the age group of 65 years old and above, in 2013 the year before partial restoration of adult dental services, the ER visit rate was much lower than the younger age group (0.8 visit per 1,000 enrollees in the older age

group vs. 19.6 visits in the younger age group). Since 2014, the ER visit rates in the older age group remained low each year at a level similar to that of 2013 at about 1 visit or below per 1,000 enrollees.

Question 5: Participation of dental care providers

Question 5 addresses dental providers' participation in the Medi-Cal program. Participation of rendering providers, billing providers and SNCs are first summarized descriptively. Data from rendering providers are presented by specialty and calendar year, and data from billing providers and SNCs are presented by geographic region and calendar year. As the data set includes number of SNCs in each county from 2012 and 2017, repeated measure analysis can be conducted to evaluate the differences in number of SNCs among different regions and years.

Question 5 and its associated hypothesis are listed below.

Question 5: How much has the partial benefit restoration in 2014 increased the participation of dental care providers? Is the impact on general practitioners different from that on specialists?	***Hypothesis 9:*** The participation of specialist dental care providers in the Medi-Cal program increased each year after restoration of benefits but at a reduced rate from that of general dental care providers in Medi-Cal.

Results from descriptive analysis. There are 3 types of providers included in the data set: rendering provider, billing provider and safety net clinic (SNC). The California Department of Health Care Service doesn't have specialty data for billing providers and geographic information for rendering providers as they may provide services at multiple locations (California Health & Human Services Agency, 2018). As mentioned in Chapter Two, for the Medi-Cal dental program, the majority of the beneficiaries are covered through fee-for-service arrangements with the exception of Los Angeles County and Sacramento County. In Los Angeles County, managed care is optional and in Sacramento County it is mandatory (California Department of Health Care Services, 2018d). In data provided by

California Department of Health Care Service, only fee-for-service providers are included.

***Rendering provider*.** Table 39 presents number of fee-for-service rendering dental providers from 2012 to 2016 by specialty type. The percent changes from 2012 for each year from 2013 to 2016 are also presented in Table 39.

There were noticeable increases in the number of providers for general practitioners and the specialists of endodontist, hygienist-RDHAP, and orthodontist in 2014 and the trend continued in 2015 and 2016. General practitioners constitute the majority of the providers and had the greatest increase in the number of providers compared to specialists. As of 2016, there were 14,175 fee-for-service general practitioners participating in the Medi-Cal program which represents an increase of 614 (4.5%) from 2013. However, the percent increases were greater for the specialists of endodontist, hygienist – RDHAP, orthodontist and periodontist than that of general practitioner with the percent increase ranging from 5.2% for orthodontist to 27.2% for Endodontist (Table 39 & Figure 30).

Data for 2012 to 2016 include rendering providers who had a claim during the entire calendar year. As providers may enroll or disenroll during the year, the number of providers at a given point of time was lower as shown for Year 2017 which is the number of rendering providers in November 2017 (Table 40).

Table 39

Number of Fee-for-Service Rendering Dental Providers from 2012 to 2017 by Specialty Type

General Practitioner/Specialty	Number of Providers /% Change from 2013				
	2012	**2013**	**2014**	**2015**	**2016**
General practitioner	13,414 (N/A)	13,561 (N/A)	13,790 (1.69%)	14,270 (5.23%)	14,175 (4.53%)
Endodontist	54 (N/A)	55 (N/A)	62 (12.73%)	68 (23.64%)	70 (27.27%)
Hygienist – RDHAP[a]	215 (N/A)	243 (N/A)	253 (4.12%)	266 (9.47%)	271 (11.52%)
Oral pathologist	3 (N/A)	3 (N/A)	3 (0.00%)	3 (0.00%)	2 (-33.3%)
Oral surgeon	425 (N/A)	425 (N/A)	432 (1.65%)	436 (2.59%)	427 (0.47%)
Orthodontist	827 (N/A)	843 (N/A)	864 (2.49%)	890 (5.58%)	887 (5.22%)
Periodontist	91 (N/A)	92 (N/A)	94 (2.17%)	96 (4.35%)	104 (13.04%)
Prosthodontist	69 (N/A)	69 (N/A)	70 (1.45%)	73 (5.80%)	67 (-2.90%)

[a]Registered Dental Hygienist in Alternative Practice (RDHAP): licensed registered dental hygienist who holds a specific license to practice in settings outside of the traditional dental office (California Dental Hygienists Association, 2019).

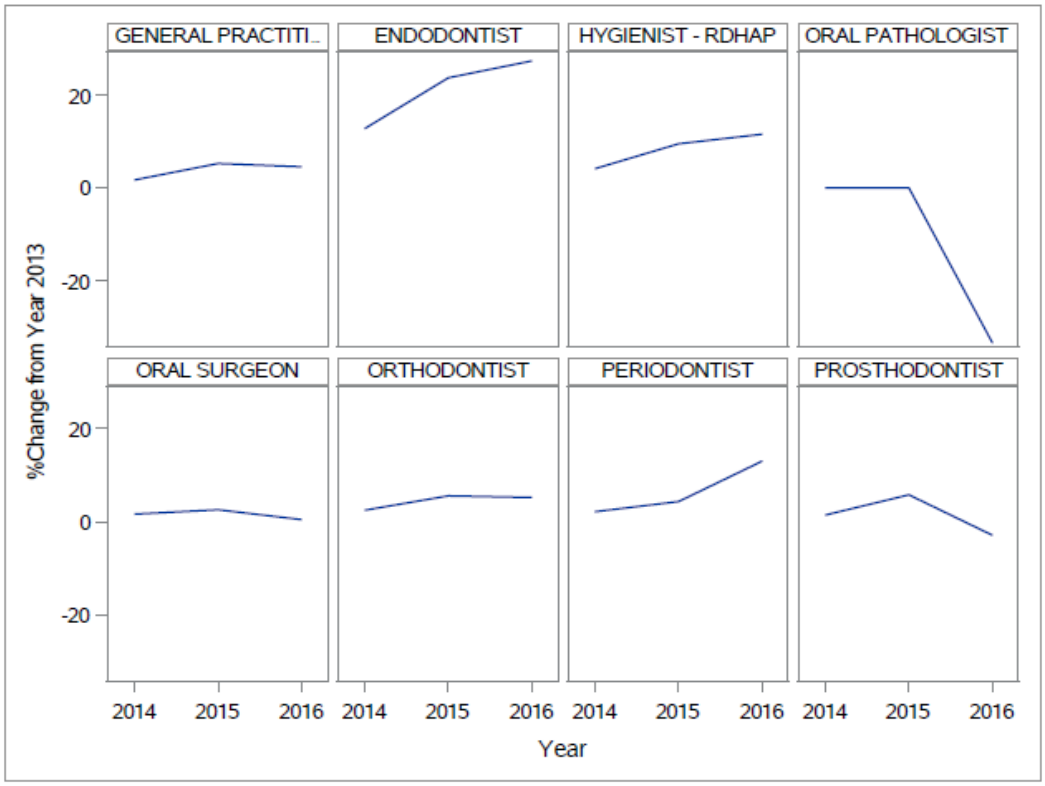


Figure 30. Percent change from 2013 for number of dental providers in 2014 to 2016 by dental specialty.

Table 40

Number of Fee-for-Service Rendering Dental Providers in November 2017

General Practitioner/Specialty	Number of Providers in November 2017
General practitioner	8,297
Hygienist – RDHAP[a]	193
Oral pathologist	3
Oral surgeon	198
Orthodontist	570
Periodontist	45
Prosthodontist	27

[a]Registered Dental Hygienist in Alternative Practice (RDHAP): licensed registered dental hygienist who holds a specific license to practice in settings outside of the traditional dental office (California Dental Hygienists Association, 2019).

Billing provider. Unlike a rendering provider who is a health care professional providing services to patients, a billing provider could either be a doctor or a company which can provide contract and claim services to multiple doctor's offices. Data from Table 41 show that in general, there are decreases in the number of billing providers in each region over the years. The decreases in the number of billing providers together with increases in rendering providers may indicate a trend of business consolidation among billing providers. It is also worth noting that the Southern region has the greatest number of billing providers among all the regions in California. In the year of 2016, among 6,163 billing providers in the state, 4,604 (75%) of them were located in the Southern region (Table 41).

Table 41

Number of Billing Officers from 2012 to 2017 and %Change from 2013 from 2013 to 2016

	Number of Billing Offices /% Change from 2013					
Geographic Region	**2012**	**2013**	**2014**	**2015**	**2016**	**2017[a]**
Bay Area	988 (N/A)	964 (N/A)	943 (-2.18%)	928 (-3.73%)	779 (-19.2%)	919
Central Valley	574 (N/A)	562 (N/A)	581 (3.38%)	580 (3.20%)	530 (-5.69%)	488
Mountain Valley	254 (N/A)	263 (N/A)	253 (-3.80%)	247 (-6.08%)	201 (-23.6%)	151
Northern	90 (N/A)	86 (N/A)	78 (-9.30%)	74 (-14.0%)	49 (-43.0%)	72
Southern	4,833 (N/A)	4,830 (N/A)	4,936 (2.19%)	5,010 (3.73%)	4,604 (-4.68%)	4,061

[a]Data were collected at one time point in November 2017

***Safety Net Clinics*.** There are noticeable differences in the change of number of SNCs over the years in different regions of California. In 2012, the region of the Bay area had the largest number SNCs and the region of Mountain valley had the least number of SNCs (Table 42). In 2017, the Southern region had the largest number of SNCs with 258 locations, which was a 63.3% increase from 158 of them in 2013. As of 2017, for each geographic region, the numbers of SNCs were all greater than those of 2013 (Table 42). The number of SNCs overtime by geographic region is depicted in Figure 31.

Table 42

Number of Safety Net Clinics (SNCs) from 2012 to 2017 and % Change of SNCs from 2013 by Geographic Region

Geographic Region (number of counties)	Number of Safety Net Clinics/% Change from 2013					
	2012	2013	2014	2015	2016	2017[a]
Bay Area (12 counties)	133 (N/A)	99 (N/A)	108 (9.09%)	120 (21.21%)	120 (21.21%)	131 (32.32%)
Central Valley (10 counties)	77 (N/A)	69 (N/A)	77 (11.59%)	76 (10.14%)	79 (14.49%)	100 (44.93%)
Mountain Valley (14 counties)	24 (N/A)	27 (N/A)	38 (40.74%)	33 (22.22%)	34 (25.93%)	41 (51.85%)
Northern (14 counties)	55 (N/A)	66 (N/A)	60 (-9.09%)	56 (-15.2%)	63 (-4.55%)	72 (9.09%)
Southern (8 counties)	98 (N/A)	158 (N/A)	164 (3.80%)	177 (12.03%)	212 (34.18%)	258 (63.29%)

[a]Data were reported as of May 2017

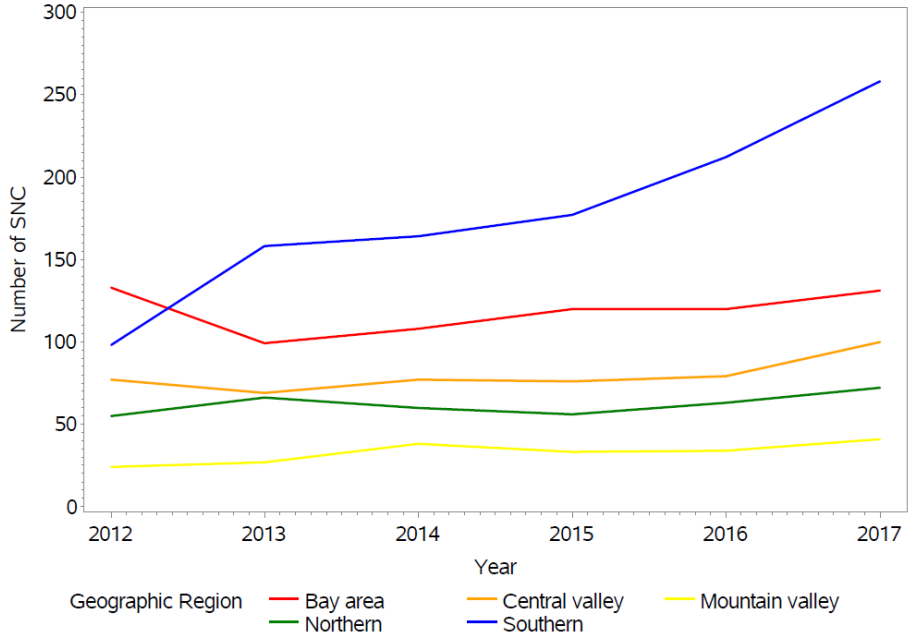


Figure 31. Number of SNCs by geographic region from 2012 to 2017.

Results from repeated measure analysis. As the data set includes number of SNCs in each county from 2012 and 2017, repeated data analysis was conducted to evaluate the

differences in number of SNCs among different regions and years. The initial model has number of SNCs as the dependent variable and independent variables of region, year and the interaction effect of region and year. There was a statistically significant interaction effect of region and year with *p*-value of 0.0025. As a result of detection of significant interaction effect, the repeated measure analysis was then run separately for each geographic region and the results are presented in Table 43. A statistically significant increase in the number of SNCs providing dental care comparing to 2013 was shown in the Bay area, Central valley and the Southern region in 2017 (Table 43).

Table 43

Results from Repeated Measure Analysis on Evaluating Difference of Number of SNCs among Different Years by Geographic Region

Comparing Years	**Least Square Mean Difference in Number of SNCs per County (Standard Error) P-value**				
	Bay Area	**Central Valley**	**Mountain Valley**	**Northern**	**Southern**
2014 vs. 2013	0.8 (0.48) 0.1455	0.8 (0.99) 0.4383	0.8 (0.37) 0.0512	-0.4 (0.36) 0.2536	0.7 (1.03) 0.4904
2015 vs. 2013	1.8 (0.84) 0.0627	0.7 (0.84) 0.4283	0.4 (0.44) 0.3491	-0.7 (0.62) 0.2664	2.4 (1.41) 0.1368
2016 vs. 2013	1.8 (0.74) 0.0375	1.0 (0.80) 0.2443	0.5 (0.44) 0.2780	-0.2 (0.33) 0.5328	6.7 (2.67) 0.0394
2017 vs. 2013	2.7 (1.00) 0.0222	3.1 (0.87) 0.0063	1.0 (0.63) 0.1359	0.4 (0.34) 0.2337	12.5 (4.43) 0.0257

Results from diagnostic analysis show there are outliers and influential observations in each region (Figure 32 and Figure 33). Appendix H lists number of SNCs in each county from 2012 to 2017.

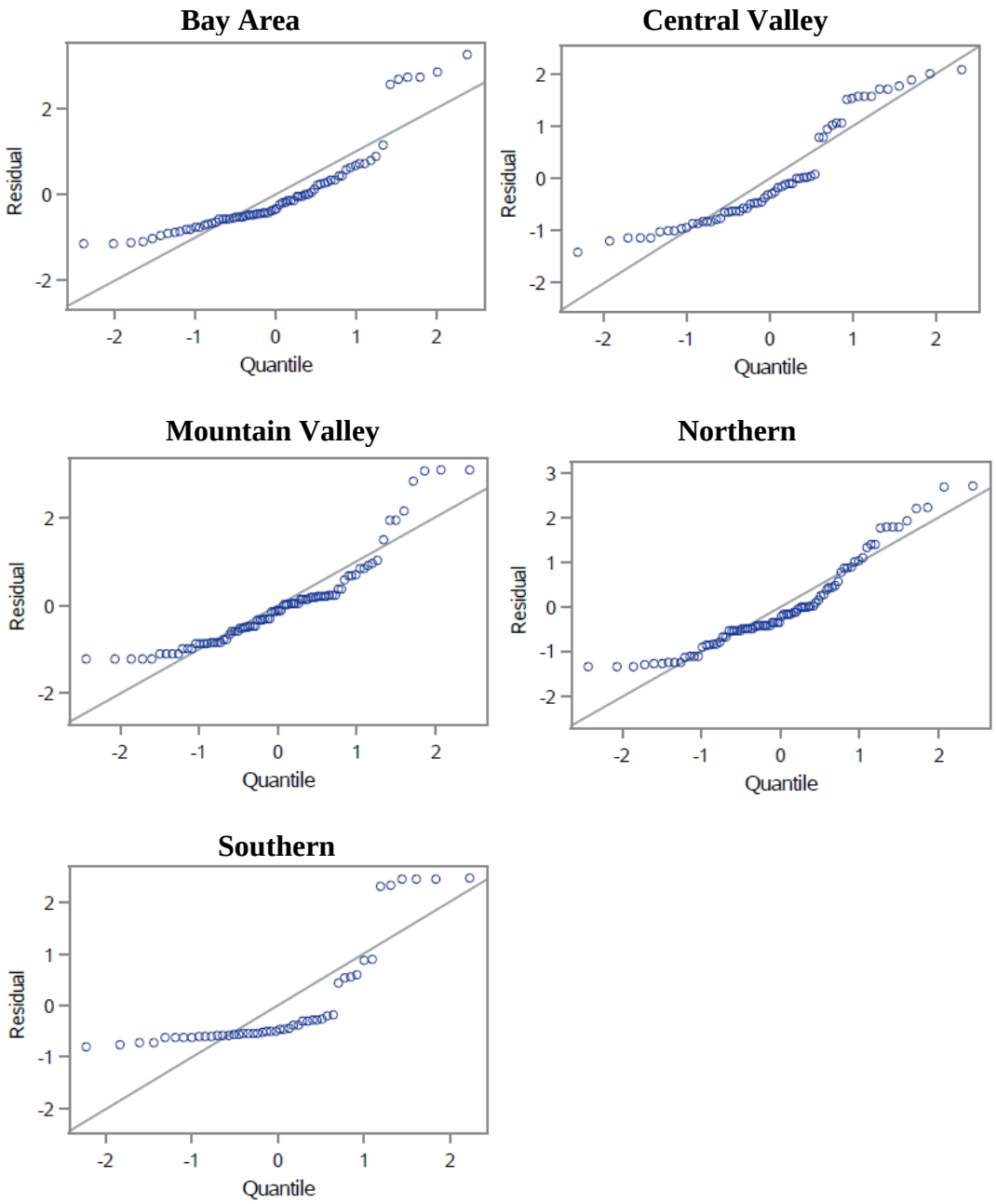


Figure 32. Studendized residual plots by geographic region from repeated measure analysis for SNC.

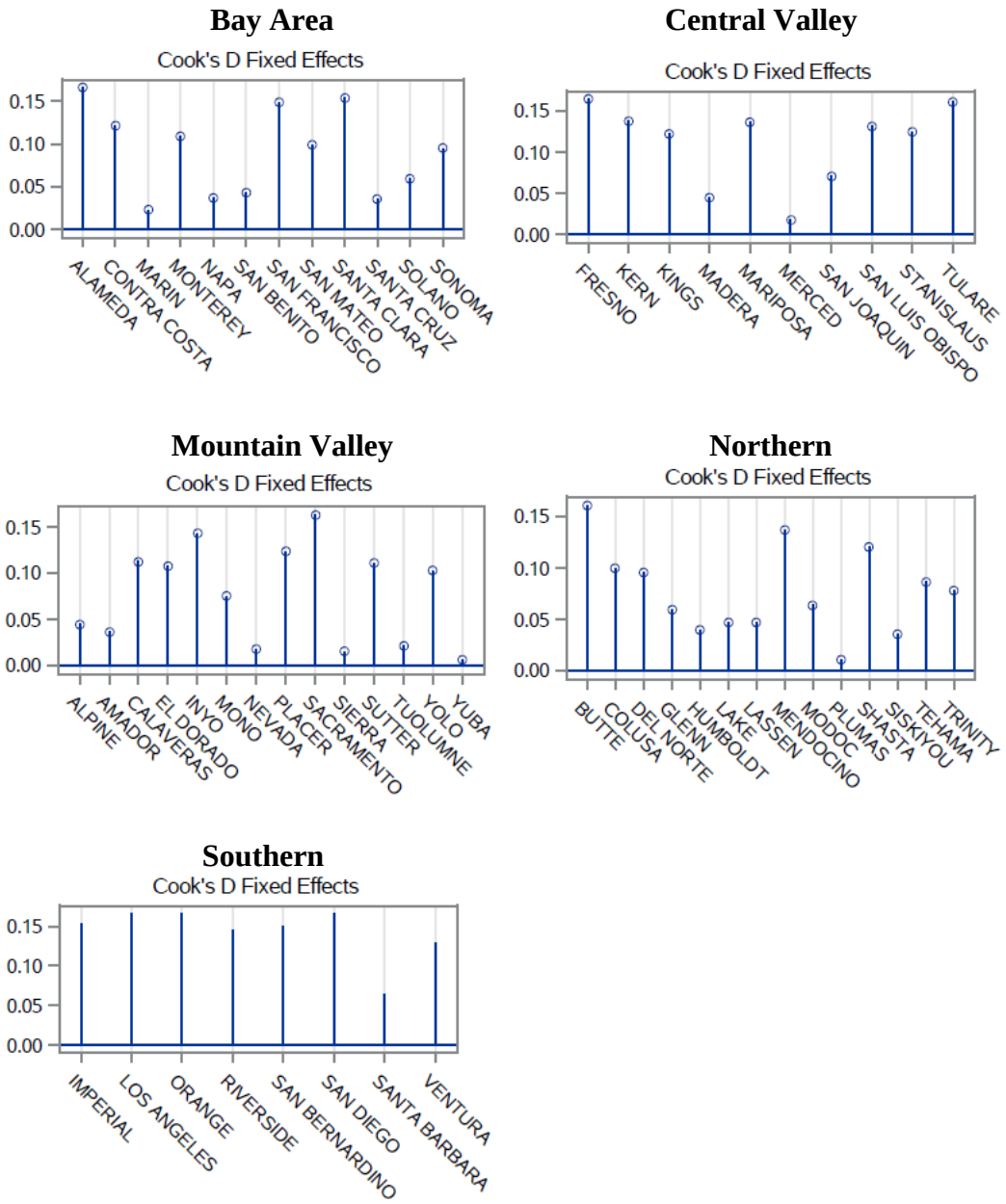


Figure 33. Needle plots of Cook's Distance by geographic region from repeated measure analysis for SNC.

The number of SNCs per 10,000 Medi-Cal enrollees was also calculated by region and presented in Table 44. With Medicaid expansion in 2014, there have been substantial increases in the number of Medi-Cal beneficiaries in each region. Even though there have been increases in the number of SNCs in majority of the regions, it has not kept up with the increases in the

number of Medi-Cal beneficiaries. In 2016, in 4 out of the 5 regions, the number of SNCs per 10,000 enrollees was lower than that of 2012. In 2016, in the Southern region, the number of 0.5 SNC per 10,000 enrollees was the lowest among all regions despite the fact that the Southern region has the greatest number of SNCs.

Table 44

Number of SNC, Number of Medi-Cal Enrollees and Number of SNC per 10,000 Enrollees from 2012 to 2017

Geographic Region	Number of Safety Net Clinics/Number of Medi-Cal Enrollees[a] (Number of SNC per 10,000 enrollees)					
	2012	2013	2014	2015	2016	2017[b]
Bay area	133/602,092 (2.2)	99/571,547 (1.7)	108/1,005,906 (1.1)	120/1,201,610 (1.0)	120/1,273,522 (0.9)	131/1,260,025 (1.0)
Central valley	77/546,983 (1.4)	69/530,194 (1.3)	77/825,049 (0.9)	76/992,115 (0.8)	79/1,076049 (0.7)	100/1,092,506 (0.9)
Mountain valley	24/217,465 (1.1)	27/249,608 (1.1)	38/412,650 (0.9)	33/493,008 (0.7)	34/568,380 (0.6)	41/567,463 (0.7)
Northern	55/128,365 (4.3)	66/120,409 (5.5)	60/190,579 (3.1)	56/223,345 (2.5)	63/236,859 (2.7)	72/238,832 (3.0)
Southern	98/1,885,135 (0.5)	158/1,865,370 (0.8)	164/3,306,683 (0.5)	177/3,969,041 (0.4)	212/4,493,947 (0.5)	258/4,423,757 (0.6)

[a]Numbers of Medi-Cal beneficiaries who continuously enrolled in either Dental Managed Care or the Dental Fee-for-Service delivery system for at least 3 months during each calendar year.
[b]Data were reported as of May 2017

Summary. For rendering providers, there were noticeable increases in the number of providers for general practitioners and the specialists of endodontist, hygienist-RDHAP, and orthodontist in 2014 and the trend continued in 2015 and 2016. The percent increases were greater for the specialists of endodontist, hygienist – RDHAP, orthodontist, and periodontist than that of general practitioner. For billing providers, in general, there were decreases in the number of billing providers in each region over the years after the partial restoration of Medi-Cal adult dental services. The decreases in number of billing providers together with increases in rendering providers may indicate a trend of business consolidation among billing providers. For

SNCs, as of 2017, in each geographic region, the numbers of SNCs were all greater than those of 2013, however, the increase of SNCs has not kept up with the increase of Medi-Cal beneficiaries.

Chapter Five Discussion and Conclusions

Introduction

The objective of this study is to evaluate the effect of change in Medi-Cal dental coverage, specifically the partial restoration of adult dental coverage in 2014, on dental care utilization in clinics and ER among Medi-Cal beneficiaries. The study also examines the impact of the partial restoration of adult dental coverage on the participation of dental care providers in the Medi-Cal program. Study data include dental care utilization in clinics from 2007 to 2017, and dental related ER visits from 2012 to 2017 by Medi-Cal beneficiaries, and participating dental care providers in the Medi-Cal program from 2013 to 2017. Results from evaluating each question and testing each hypothesis are summarized and discussed below. Also, the limitations of the study, overall implications and conclusions are presented.

Discussion

Utilization of dental care services in clinics by adult Medi-Cal beneficiaries. The first research question addresses dental care utilization in clinics by adult Medi-Cal beneficiaries with a focus on the impact of Medi-Cal policy change on the overall population. Results and implications of the three specific hypotheses related to this research question are addressed below.

It was hypothesized (Hypothesis 1) that the partial benefit restoration in 2014 would increase the dental care utilization in clinics by Medi-Cal beneficiaries in each year from 2015 to 2017. The hypothesis was based on the assumption that as more beneficiaries became aware of the partial restoration of adult dental coverage under Medi-Cal, the dental utilization in clinics would increase.

Results demonstrate that as the partial restoration of adult dental services took effect in

May 2014, the effect on the increase in the dental utilization began to show in that year. Compared to 2013, the utilization rate was significantly higher in each year from 2014 to 2017 for each type of dental services. For dental services other than annual dental visits, the utilization rates continued to increase each year from 2014 to 2017. For annual dental visits, the utilization rate was 11.8% in 2013 and increased to 20.2%, 22.1%, 21.0% and 21.8% in 2014, 2015, 2016 and 2017 respectively. One reason the utilization rates for annual dental visits in 2016 and 2017 were at the similar level as of 2015 may be due to how it was measured. According to the CDT codes described in Chapter Three, annual dental visit counts the number of beneficiaries who used at least once of dental care service during a calendar year. For a beneficiary who used one or multiple dental services during a calendar year, he/she would only be counted once for the annual dental visits. For example, if a beneficiary used only preventive service in 2015, but used preventive service and restorative service in 2016, the beneficiary would be only counted once in the annual dental visits for both 2015 and 2016. In summary, hypothesis 1 was partially supported.

It was further hypothesized (Hypothesis 2) that the dental utilization in clinics did not, as of 2017, reach the level of dental service utilization prior to the elimination of adult dental coverage in 2009. This hypothesis was based on the fact that many benefits (such as laboratory processed crowns, posterior root canal therapy, periodontal services, and partial dentures, including denture adjustments, repairs, and relines (California Senate Bill 97, 2017) didn't get restored until 2018. As of 2017, the utilization rates for annual dental visits and dental treatment were statistically significantly lower than those of 2008. However, the utilization rates for dental exams, preventative dental services and treatment for caries in 2017 were statistically higher than those in 2008, and there was no statistically significant difference in restorative dental

treatment compared to that of 2008. The rationale for this observation may due to the fact that the partially restored adult dental services in 2014 included basic preventive, diagnostic, restorative, anterior tooth endodontic treatment, complete dentures and complete denture reline/repair services (California Assembly Bill 82, 2013), as described in the Chapter Two. In summary, hypothesis 2 was partially supported.

It was also hypothesized (Hypothesis 3) that the amount of increase differed for different type of dental services due to various levels of complexity and cost of different dental services. Consistent with the hypothesis, comparing among different types of dental services, utilization rates of dental exams increased 13.4% from 3.6% in 2013 to 17.0% in 2017, and this amount of increase was higher than the increase of 10% for preventive dental services. However, in terms of fold change, the highest fold increases were for restorative dental treatment and treatment for caries with the rates in 2017 of 4.8 and 4.2-fold respectively as that of 2013. The utilization rates were 1.5% and 2.6% for restorative dental treatment and treatment for caries, respectively in 2008; and those rates were 7.2% and 11.0% respectively in 2017. The magnitude of increase in restorative dental treatment and treatment for caries indicates there was a greater need for those services which were not met during the years when most of the adult dental services were eliminated in Medi-Cal. In summary, hypothesis 3 was supported.

Age effect on utilization of dental care services in clinics. The second research question addresses the age effect on utilization of dental care services in clinics by adult Medi-Cal beneficiaries. Results and implications of the specific hypothesis related to this research question are addressed below.

It was hypothesized (Hypothesis 4) that there is a greater increase in dental care utilization in clinics among older Medi-Cal beneficiaries than among younger age beneficiaries. The hypothesis

was based on the fact that compared to younger people, older people have a greater prevalence of certain dental problems and diseases such as xerostomia (dry mouth), periodontal disease, tooth loss and oral cancer (Furness et al., 2011; Griffin et al., 2012; National Cancer Institute, 2015; National Institute of Dental and Craniofacial Research, 2018a, 2018b).

Results demonstrated that after the partial restoration of adult dental services in 2014, the utilization rates in 2014, 2015, 2016 and 2017 were greater than that of 2013. As of 2017, most of the age group comparisons with statistically significant findings show greater utilization rates in the younger age group than the older age group (age 19-64 vs. 65-74, age 19-64 vs. 75+, or age 65-74 vs. 75+ years old). Across all geographic regions, for most type of dental services, the ethnicity of Hispanic has the greatest number of statistically significant findings of this age effect; and for each type of dental services, the age effect is the least observed in Asians.

Regarding to the magnitude of increase, the age effect differs in different ethnic groups and geographic regions. With the exception of Asian beneficiaries, there was no consistent findings in age effect among different ethnic groups in different geographic regions. For example. for an ethnic group, results could show greater increase in the younger age group in one geographic region, but greater increase in the older age group in another region. For Asian beneficiaries in general, the increases in utilization rates were similar for different types of dental services in most of the geographic regions.

Although the literature demonstrated that older people have a greater prevalence of dental problems and diseases resulting in greater need for dental care, results from this research demonstrate that among Medi-Cal beneficiaries, most of the age group comparisons with statistically significant findings show greater utilization rates in the younger age group than the

older age group. It is interesting to note that this age effect is more prevalent among Hispanic beneficiaries. The finding implies the greater need in dental care services among older beneficiaries are not being met by the Medi-Cal dental program, especially for Hispanic beneficiaries, which as of 2017, consists of 42% of all Medi-Cal beneficiaries. In order to understand the reasons of the disparities in dental care utilizations among different age groups and then implement effective policies to reduce those disparities, studies need to be conducted with additional data such as Medi-Cal beneficiaries' dental health, oral health literacy and accessibility to dental care providers in each age group, ethnic group and geographic region. In summary, hypothesis 4 was not supported.

Ethnicity effect on utilization of dental care services in clinics. The third research question addresses the ethnicity effect on utilization of dental care services in clinics by adult Medi-Cal beneficiaries. Results and implications of the specific hypothesis related to this research question are addressed below.

It was hypothesized (Hypothesis 5) that there is a greater increase in dental care utilization in clinic among White beneficiaries compared to those from ethnic minority groups. The hypothesis was based on the reported underutilization of dental care services among people in the ethnic minority groups compared to Whites in the U.S. as described previously.

Results demonstrated that the effect of ethnicity differs by age group and geographic region. Among the comparisons with statistically significant findings, the ethnicity of Black has lower utilization rates than other ethnic groups, and this effect is observed more among the older age groups (65-74, and 75+ years old) than in the younger age group of 19-64 years old. Also, there are more statistically significant findings showing that the ethnicity of Black has a lower percentage of increase in utilization rate from 2017 to 2013 than other ethnic groups. In

addition, compared to 2008, except for annual dental visits, there is an increase in the age group of 19-64 years old in the number of statistically significant findings for ethnicity effect especially lower utilization rates among Black beneficiaries than other ethnic groups.

The findings from this study indicate among Medi-Cal beneficiaries whose income below 138% of federal poverty level (California Department of Health Care Services, 2019), there is still a racial disparity in the utilization of dental care services, especially for Black beneficiaries. Results from the study by Bei et al (2013) (see Chapter Three) showing Black respondents to the study were less likely to have had dental cleaning visits compared to White respondents after controlling for demographic characteristics, medical conditions, employment and number of permanent teeth. (Bei et al., 2013). Results from this study not only support the findings from Bei et al. (2013), but also show that in addition to preventive services, Black beneficiaries had lower utilization rates than other ethnic groups for dental exams and treatment. Study results provide additional support for Bei et al. (2013) demonstrating systemic differences in factors between Black and other ethnic groups in regard to utilization of dental services. Bei et al. (2013) identified that the quality of dental care and priority of use of preventative health services may be a contributing factor in inequity in utilization of dental services. Further studies need to be conducted to understand the reasons for the lower utilization rates among Black beneficiaries with a specific emphasis on the implementation of effective policies to reduce or eliminate this disparity. In summary, hypothesis 5 was partially supported.

Dental-related ER visits. The fourth research question addresses dental related ER visits by adult Medi-Cal beneficiaries. Results and implications of the three specific hypotheses related to this research question are addressed below.

Hypothesis 6 stated that the partial benefit restoration in 2014 reduced dental-related ER

visits by Medi-Cal beneficiaries each year from 2015 to 2017. The hypothesis was based on the assumption that increased utilization of dental services in the clinics would reduce the dental-related ER visits. Overall, the ER visit rate reduced each year since the partial restoration of adult dental service in 2014 and the hypothesis was supported.

Hypothesis 7 stated that the partial benefit restoration in 2014 reduced dental-related ER visits by older Medi-Cal beneficiaries more than younger age beneficiaries. The hypothesis was based on the assumption that there were greater percentages of older beneficiaries seeking dental care in clinics than ones in the younger age group. Results from the age group of 19 to 64 years old showed differences in prevalence of ER utilization from those of 65 years old and above. For the younger age group, as the partial restoration of adult dental services took effect in May 2014, the effect on the decrease in ER visits began to show that year. Since 2014, the ER visit rate decreased each year from 19.6 visits per 1,000 enrollees in 2013 to 16.1, 10.0, 8.8 and 6.2 visits per 1,000 enrollees in 2014, 2015, 2016 and 2017 respectively in the younger age group. However, for the age group of 65 years old and above, in 2013 the year before partial restoration of adult dental services, the ER visit rate was much lower than the younger age group with 0.8 visit per 1,000 enrollees in the older age group vs. 19.6 visits in the younger age group. Since 2014, the ER visit rates in the older age group remained low each year at a level similar to that of 2013 at about 1 visit or below per 1,000 enrollees.

Results from this study provide support for the findings found by Singhal et al's (2015) examining the impact of the 2009 policy change on eliminating most adult dental coverage on hospital emergency department (ED) visits for dental problems by Medi-Cal enrollees age 21 or older. Their study found that the policy change resulted in a significant increase in ER visits for dental problems, especially for White, Black and Latino younger adults (21-35 years old).

Results from this study also indicate that the ER dental visits by older Medi-Cal beneficiaries are not responsive to the policy change in Medi-Cal dental coverage. In California, young children and people age 65 years and above have higher ER visit rates than other age groups and people with Medi-Cal have higher ER visit rates than uninsured and people with private insurance (McConville, Danielson, & Hsia, 2019). A literature search didn't reveal any published data on ER visit by diagnosis and age group. Given the low dental ER visits among the older age group, it is expected that the percentage of ER visits due to dental problems would be low in this age group. As discussed earlier, for utilization of dental services in clinics, most of the age group comparisons with statistically significant findings show greater utilization rates in the younger age group than the older age group. The reason for the lower utilization rates of dental ER visits and dental clinic visits among older Medi-Cal beneficiaries needs to be further studied by incorporating additional data such as beneficiaries' dental health, oral health literacy and accessibility to dental care providers. In summary, hypothesis 7 was not supported.

It was hypothesized (Hypothesis 8) that the partial benefit restoration in 2014 reduced dental-related ER visits by White Medi-Cal beneficiaries more than by beneficiaries of ethnic minority groups. This hypothesis was based on the assumption that there were greater percentages of White beneficiaries seeking dental care in clinics than beneficiaries from other ethnic groups.

Results found that across age groups, the ER visit rate decreased each year since the partial restoration of adult dental services in 2014 and the reductions were greater in the ethnic groups of White and Black than those in the ethnic groups of Hispanics and Asian. However, results differed between the younger and older age groups. For the age group of 19 to 64 years old, the ER visit rate decreased each year for each ethnic group and the greatest reduction occurred in the ethnic group of

White. As of 2017, the number of the reduction in ER visits compared to 2013 is 20.0, 15.3, 10.5, 1.8 and 9.1 visits per 1,000 enrollees for the ethnic group of White, Black, Hispanics, Asian and Other respectively.

For the age group of 65 years old and above, the ER visit rates are low for each ethnic group; as of 2017, the ER visit rates are 1.1, 1.9, 0.9 and 0.6 visit per 1,000 enrollees for the ethnic groups of White, Black, Hispanic and Asian respectively.

Results from this study demonstrate the ER visit rates were lower in the ethnic groups of Hispanics and Asian. The lower rates may be due to limited English proficiency (LEP) and lack of transportation. In California, Hispanic and Asian Americans have high rates of LEP with self-reported LEP rates of 37%, 27%, 39% and 38% for adult Hispanics, Chinese, Korean and Vietnamese, respectively, compared to <1% for White survey responders (Sentell & Braun, 2012). Individuals with LEP are less likely to seek medical care in places where care providers don't speak their native language or interpretation services are not available. Studies show people with LEP are more likely to forgo needed medical care (Shi, Lebrun, & Tsai, 2009). With regard to transportation, readily available transportation is necessary for patients to get access to the ER. A greater proportion of Asian immigrants from a majority of Asian countries didn't know how to drive when they immigrated to the US compared to their counterparts who grew up in the U.S. or immigrated from major European countries (Misra, 2015). According to Pew Research conducted in 44 countries in 2014, car ownership was 88% per household in the US and ranged from 64-89% in major European countries; however, in Asian countries, the car ownership was generally low (e.g., 2%, 6%, 6% and 17% in Vietnam, Indonesia, India and China, respectively) with the exceptions of South Korea, Japan and Malaysia where the car

ownership was above 80% per household (Misra, 2015). In summary, hypothesis 8 was partially supported.

Participation of dental care providers. The fifth research question addresses dental providers' participation in the Medi-Cal program. Results and implications of the specific hypothesis related to this research question are addressed below.

It was hypothesized (Hypothesis 9) that the participation of specialist dental care providers in the Medi-Cal program increased each year after restoration of benefits but at a reduced rate from that of general dental care providers in Medi-Cal. The rationale for the hypothesis was that the reimbursement rates from the Medi-Cal dental program were only about one-third to one-half of the national average for the most common procedures (California Assembly Bill 15, 2017) and it was assumed the low reimbursement rates in Medi-Cal dental program was a greater deterrence to dental specialists than general practitioners as the cost of patient care is generally greater for the former than the latter (American Dental Association, 2016).

For rendering providers, there were noticeable increases in the number of providers for general practitioners and the specialists of endodontist, hygienist-RDHAP, and orthodontist in 2014 and the trend continued in 2015 and 2016. General practitioners constitute the majority of the providers and had the greatest increase in the number of providers comparing to the specialists. As of 2016, there were 14,175 fee-for-service general practitioners participated in the Medi-Cal program which was an increase of 614 (4.5%) from 2013. However, the percent increases were greater for each of the specialists of endodontist, hygienist – RDHAP, orthodontist, and periodontist than that of general practitioner with the percent increase ranging from 5.2% (from 43 to 887) for orthodontist to 27.2% (from 55 to 77) for Endodontist.

Additionally, there were decreases in the number of billing providers in each region over the years after the partial restoration of dental services. The decreases in the number of billing providers together with increases in rendering providers may indicate a trend of business consolidation among billing providers.

For SNC, as of 2017, in each geographic region, the numbers of SNCs were all greater than those of 2013, and statistically significant increase from 2013 was observed in the Bay area, Central valley and the Southern region. However, the increase of SNCs has not kept up with the increases of Medi-Cal beneficiaries. In 2016, in 4 out of the 5 regions, the number of SNCs per 10,000 enrollees was lower than that of 2012. In summary, hypothesis 9 was partially supported.

Limitations

This study has several limitations. First, only data for dental care utilizations reported to the Medi-Cal are included. Beneficiaries could seek dental services from health care providers who didn't participate in the Medi-Cal program, or there could be participating health care providers who didn't file the service claim to Medi-Cal due to administrative error or other reasons. However, given only individuals and families of low income are eligible for Medi-Cal benefits and they likely couldn't afford to seek dental care outside Medi-Cal program, the amount of those unreported dental care utilization is expected to be low.

Second, there may be other variables associated with dental care utilization that are not included in the present study. The Ethnicity, Aging and Oral Health Outcome Model developed by Andersen and Davidson (Andersen & Davidson, 1997) is utilized as the theoretical framework for this study. According to the model, the variables that may affect the utilization of dental care services include the variables of ethnicity and age and the primary determinants of oral health which include external environment, dental care system and personal characteristics.

The variables included in this study are the variables of ethnicity and age, and dental care providers and Medi-Cal policy which are factors under the primary determinants of oral health. The variables in the personal characteristics are not available for this study, for examples, gender, marital status, social network and health belief in the predisposing factor, income, English proficiency and transportation in the enabling factor, and need factor either perceived by the patients or obtained through objective evaluation by health care professionals. In addition, the available data on dental care providers only allow for evaluation of impact on participation by the Medi-Cal policy, but not adequate for assessment of correlation between participating dentists and utilization of dental care service. However, given the observation of a sharp increase in dental care utilization in clinics and a large decrease in dental related ER visits in 2014, it can be concluded with high confidence that those changes are predominantly due to the partial restoration of adult dental services in Medi-Cal.

Thirdly, data of ethnicity is self-reported on the beneficiaries' Medi-Cal application form. It is possible that there are some mis-classification by the applicants, especially for people with mixed ethnicity. Although there is no gold standard of measurement of ethnicity, it is most agreed that self-reported is superior to assessment from other sources (Aspinall, 2011; Mays, Ponce, Washington, & Cochran, 2003).

Conclusions

In conclusion, the partial restoration of Medi-Cal adult dental services provided much needed access to dental care for Medi-Cal beneficiaries and resulted in significant increase in utilization rates in dental clinics in each dental service evaluated in the study for the overall population. However, the magnitude of increase differs in different age groups, ethnic groups and geographic regions. Most of the age group comparisons with statistically significant

findings show greater utilization rates in the younger age group than the older age group and this age effect is more observed in the ethnic group of Hispanics. Also, among the comparisons with statistically significant findings of ethnicity effect, there are more findings showing Black beneficiaries have lower utilization rates than other ethnic groups and this ethnicity effect is more observed in the older age group. Those findings indicate among Medi-Cal beneficiaries whose income below 138% of federal poverty level (California Department of Health Care Services, 2019), there are still age and racial disparities in the utilization of dental services in clinics. To understand the reasons for those disparities, studies need to be conducted with additional data such as Medi-Cal beneficiaries' dental health, oral health literacy and accessibility to dental care providers. With the data of beneficiaries' dental health, studies can also be done to further evaluate the impact on oral health status with the improvement of access.

The partial restoration of Medi-Cal adult dental services also significantly reduced the dental related ER visits among Medi-Cal beneficiaries. However, the reduction is largely seen among the beneficiaries in the younger age group in the ethnic groups of White and Black. The dental related ER visits were lower in the ethnic groups of Hispanics and Asian, and very low in the older age group for each ethnic group. Those findings indicate greater problems in access to urgent dental care for Hispanics and Asian beneficiaries, and also for older beneficiaries. Programs such as providing access to transportation to ER and greater availability of translation services may help to reduce the access problem. A previous study has shown the elimination of most adult dental services in Medi-Cal resulted in significant increase in dental related ER visits. Results from this study and the previous study demonstrates that dental related ER visits are significantly associated with coverage of adult dental services in clinics. The services provided to patients in the ER are costly and reactive, usually with a low likelihood of continuity of care.

The purpose of elimination of most adult dental services in 2009 was to cut government spending. However, in addition to negative impact on beneficiaries' oral health, this change of policy also resulted in increase in the cost from dental related ER visits. A cost-effective study will be very helpful for policy makers when contemplating making changes to the Medi-Cal dental coverage during future economic downturns.

Regarding the impact of partial restoration of adult dental services on the participation of dental care providers, results from this study demonstrate that the policy change resulted in increases in participation of dental care providers in the Medi-Cal program. In the future, when necessary data become available, a study should be done to evaluate the association of participation of dental care providers and utilization of dental care services by beneficiaries. A better understanding of this association can help policy makers to improve the Medi-Cal program and provide greater access of dental care to Medi-Cal beneficiaries.

With economic recovery in recent years and increases in tax revenues, there are additional changes to the Medi-Cal dental program since the partial restoration in 2014. Those changes were aimed to increase dental coverage and access to dental care for Medi-Cal beneficiaries. The 2 major ones are AB120 to increase reimbursement to participating dental care providers and SB97 to fully restore the adult dental benefits. Data are yet to become available to evaluate the impact of those changes as AB120 was enacted in June 2017 and SB97 was enacted in January 2018. Results from this study not only assess the impact of the policy change in 2014, but also provide important baseline data for future impact studies on the policy changes enacted since 2017. With each major policy change, it is important to conduct impact studies to quantify its effects and identify the deficiencies. The results from the impact studies

will help to propose and promote better Medi-Cal dental program to provide adequate dental coverage to beneficiaries in all age groups and ethnic groups in the Medi-Cal program.

References

Abrams, A. P., & Thompson, L. A. (2014). Physiology of aging of older adults: systemic and oral health considerations: systemic and oral health considerations. *Dental Clinics of North America, 58*(4), 729-738. doi:10.1016/j.cden.2014.06.002

Alexandre Emidio Ribeiro, S., Caroline de Oliveira, L., & Carlos Alberto, F. (2013). Use of dental services and associated factors among elderly in southern Brazil. *Revista Brasileira de Epidemiologia, 16*(4), 1005-1016. doi:10.1590/S1415-790X2013000400020

Al-Sulaiman, A., & Jones, J. (2016). Geriatric oral health care delivery in the United States of America. *Current Oral Health Reports, 3*(3), 164-170. doi:10.1007/s40496-016-0093-z

American Dental Association. (2016). The per-patient cost of dental care, 2013: A look under the hood. Retrieved from http://www.ada.org/~/media/ADA/Science%20and%20Research/HPI/Files/HPIBrief_0316_4.pdf

American Dental Association. (2018a). Aging and dental health. Retrieved from https://www.ada.org/en/member-center/oral-health-topics/aging-and-dental-health

American Dental Association. (2018b). Dental specialties. Retrieved from https://www.ada.org/en/ncrdscb/dental-specialties

American Dental Association. (2018c). Tooth. Retrieved from https://www.mouthhealthy.org/en/az-topics/t/tooth

Andersen, R. M. (1968). *Families' use of health services: A behavioral model of predisposing, enabling, and need components* (Doctoral dissertation). Retrieved from ProQuest Dissertations Publishing

Andersen, R. M. (1995). Revisiting the behavioral model and access to medical care: Does it matter? *Journal of Health and Social Behavior, 36*(1), 1-10. doi:10.2307/2137284

Andersen, R. M., & Davidson, P. L. (1997). Ethnicity, aging, and oral health outcomes: A conceptual framework. *Advances in Dental Research, 11*(2), 203-209. doi:10.1177/08959374970110020201

Andersen, R. M., & Davidson, P. (2007). Improving access to care in America: Individual and contextual indicators. In R. Andersen, T. Rice, & J. Kominski (Eds.), *Changing the U.S. health care system: Key issues in health services policy and management* (pp. 3-31). San Francisco, CA: Jossey-Bass.

Aspinall, P. J. (2011). The utility and validity for public health of ethnicity categorization in the 1991, 2001 and 2011 British Censuses. *Public Health, 125*(10), 680-687. doi:10.1016/j.puhe.2011.05.001

Atchison, K. A., & Andersen, R. M. (2000). Demonstrating successful aging using the international collaborative study for oral health outcomes. *Journal of Public Health Dentistry, 60*(4), 282-288. doi:10.1111/j.1752-7325.2000.tb03336.x

Baker, S. R. (2009). Applying Andersen's behavioural model to oral health: what are the contextual factors shaping perceived oral health outcomes? *Community Dentistry and Oral Epidemiology, 37*(6), 485-494. doi:10.1111/j.1600-0528.2009.00495.x

Baskaradoss, J. (2018). Relationship between oral health literacy and oral health status. *BMC Oral Health, 18*(1). doi:10.1186/s12903-018-0640-1

Bei, E., Jersey, E., Huabin, E., & Robert, E. (2013). Racial and ethnic variations in preventive dental care utilization among middle-aged and older Americans, 1999-2008. *Frontiers in Public Health, 1*. doi:10.3389/fpubh.2013.00065

Bethel, L. A., Kim, E. E., Seitz, C. M., & Swann, B. J. (2014). Innovations in dental care delivery for the older adult. *Dental Clinics of North America, 58*(4), 845-855. doi:10.1016/j.cden.2014.07.003

California Assembly Bill 131. (2005a). Assembly Bill No. 131 (Chapter 80). Retrieved from http://www.leginfo.ca.gov/pub/05-06/bill/asm/ab_0101-0150/ab_131_bill_20050719_chaptered.pdf

California Assembly Bill 1735. (2005b). Assembly Bill No. 1735 (Chapter 719). Retrieved from http://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=200520060AB1735

California Assembly Bill 1183. (2008). Assembly Bill No. 1183. Retrieved from http://leginfo.ca.gov/pub/07-08/bill/asm/ab_1151-1200/ab_1183_cfa_20080917_123558_asm_floor.html

California Assembly Bill X3 5. (2009). ABX3 5 (Chapter 20). Retrieved from http://www.leginfo.ca.gov/pub/09-10/bill/asm/ab_0001-0050/abx3_5_bill_20090303_chaptered.html

California Assembly Bill 82. (2013). Assembly Bill No. 82 (Chapter 23). Retrieved from http://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140AB82

California Assembly Bill 15. (2017a). AB-15 Denti-Cal program: reimbursement rates. Retrieved from https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB15

California Assembly Bill 120. (2017b). Assembly Bill No. 120 (Chapter 22).

California Child Welfare Services/Case Management System. (2010). *CWS/CMS County Regions*. Retrieved from https://www.hwcws.cahwnet.gov/countyinfo/county_contacts/county_regions.asp.

California Dental Hygienists Association. (2019). RDHAP. Retrieved from http://cdha.org/rdhap

California Department of Health Care Services. (2008). Medi-Cal provider payment reductions. Retrieved from https://files.medi-cal.ca.gov/pubsdoco/newsroom/newsroom_9757.asp

California Department of Health Care Services. (2015). Medi-cal statistical brief. Retrieved from https://www.dhcs.ca.gov/dataandstats/statistics/Documents/New_24_Month_Examination.pdf

California Department of Health Care Services. (2018a). The Department of Health Care Services Medi-Cal dental services rate review. Retrieved from https://www.dhcs.ca.gov/services/Documents/MDSD/2018_Dental_Rate_Review_8-22-18CLN_ADAC.pdf

California Department of Health Care Services. (2018b). Medi-Cal at a glance. Retrieved from https://www.dhcs.ca.gov/dataandstats/statistics/Documents/Medi-Cal_at_a_Glance_Jan2018_ADA.pdf

California Department of Health Care Services. (2018c). Medi-Cal certified eligibles – Recent trends. Retrieved from https://www.dhcs.ca.gov/dataandstats/statistics/Pages/Medi-Cal-Certified-EligiblesRecentTrends.aspx

California Department of Health Care Services. (2018d). Medi-Cal dental program. Retrieved from https://www.dhcs.ca.gov/services/Pages/MediCalDental.aspx

California Department of Health Care Services. (2019). Do you qualify for medi-cal benefits? Retrieved from Do You Qualify for Medi-Cal Benefits?

California Health & Human Services Agency. (2018). Profile of Enrolled Medi-Cal dental fee-for-service (FFS) providers and safety net clinics (SNCs). Retrieved from

https://data.chhs.ca.gov/dataset/profile-of-enrolled-medi-cal-fee-for-service-ffs-providers-as-of-june-1-2017/resource/f110622d-01f6-4028-8103-e27bd256a0de

California Legislative Analyst's Office. (2018). The 2019-20 Budget: California's fiscal outlook. Retrieved from https://lao.ca.gov/Publications/Report/3898

California Senate Bill 97. (2017). Senate Bill No. 97 (Chapter 52). Retrieved from https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB97

Casalino, L. P., Gans, D., Weber, R., Cea, M., Tuchovsky, A., Bishop, T. F., … Evenson, T. B. (2016). U.S. physician practices spend more than $15.4 billion annually to report quality measures. *Health Affairs (Project Hope)*, *35*(3), 401. doi:10.1377/hlthaff.2015.1258

Centers for Disease Control and Prevention. (2016). *Active dentists, by state: United States, selected years 2001–2015*. Retrieved from https://www.cdc.gov/nchs/data/hus/2016/086.pdf

Centers for Medicare & Medicaid Services. (2018). CMS fast facts. Retrieved from https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/CMS-Fast-Facts/index.html

Centers for Medicare & Medicaid Services. (2019a). Dental services. Retrieved from https://www.medicare.gov/coverage/dental-services

Centers for Medicare & Medicaid Services. (2019b). October 2018 Medicaid & CHIP enrollment data highlights. Retrieved from https://www.medicaid.gov/medicaid/program-information/medicaid-and-chip-enrollment-data/report-highlights/index.html

Centers for Medicare & Medicaid Services. (2019c). Seniors & Medicare and Medicaid enrollees. Retrieved from https://www.medicaid.gov/medicaid/eligibility/medicaid-enrollees/index.html

Chaiyachati, K. H., Hubbard, R. A., Yeager, A., Mugo, B., Lopez, S., Asch, E., … Grande, D. (2018). Association of rideshare-based transportation services and missed primary care appointments: A clinical trial. *JAMA Internal Medicine, 178*(3), 383-389. doi:10.1001/jamainternmed.2017.8336

Cooper, F. P., Manski, J. R., & Pepper, V. J. (2012). The effect of dental insurance on dental care use and selection bias. *Medical Care, 50*(9), 757-763. doi:10.1097/MLR.0b013e318255172d

Dolan, T. (2010). Access to dental care for older Americans. *New York State Dental Journal, 76*(5), 34-37.

Douglass, C. W., & Jiménez, M. C. (2014). Our current geriatric population: Demographic and oral health care utilization. *Dental Clinics of North America, 58*(4), 717-728. doi:10.1016/j.cden.2014.06.001

Douglass, R., & Heckman, G. (2010). Drug-related taste disturbance: A contributing factor in geriatric syndromes. *Canadian Family Physician Medecin de famille canadien, 56*(11), 1142.

Dye, B. A. A. (2015). *Dental caries and tooth loss in adults in the United States, 2011-2012*: Hyattsville, MD : U.S. Dept. of Health and Human Services, Centers for Disease Control and Prevention, National Center for Health Statistics.

Furness, S., Worthington, H. V., Bryan, G., Birchenough, S., & McMillan, R. (2011). Interventions for the management of dry mouth: topical therapies. *The Cochrane Database of Systematic Reviews, 12*(12), CD008934. doi:10.1002/14651858.CD008934.pub2

Galewitz, P. (2010). States cutting medicaid benefits as they stagger under economic downturn. Retrieved from https://khn.org/news/medicaid-cutbacks/

Galewitz, P. (2015). 5 challenges facing Medicaid At 50. Retrieved from https://khn.org/news/5-challenges-facing-medicaid-at-50/

Gelberg, L., Andersen, R. M., & Leake, B. D. (2000). The behavioral model for vulnerable populations: Application to medical care use and outcomes for homeless people. *Health Services Research, 34*(6), 1273-1302.

Giannobile, W. V., Braun, T. M., Caplis, A. K., Doucette-Stamm, L., Duff, G. W., & Kornman, K. S. (2013). Patient stratification for preventive care in dentistry. *Journal of Dental Research, 92*(8), 694-701. doi:10.1177/0022034513492336

Griffin, S. O., Jones, J. A., Brunson, D., Griffin, P. M., & Bailey, W. D. (2012). Burden of oral disease among older adults and implications for public health priorities. *American Journal of Public Health, 102*(3), 411. doi:10.2105/AJPH.2011.300362

Guay, A. H. (2005). Improving access to dental care for vulnerable elders. *Journal of Dental Education, 69*(9), 1045.

Guiglia, R., Musciotto, A., Compilato, D., Procaccini, M., Russo, L., Ciavarella, D., … Campisi, G. (2010). Aging and oral health: Effects in hard and soft tissues. *Current Pharmaceutical Design, 16*(6), 619-630. doi:10.2174/138161210790883813

Hassel, A., Danner, D., Schmitt, M., Nitschke, I., Rammelsberg, P., & Wahl, H.-W. (2011). Oral health-related quality of life is linked with subjective well-being and depression in early old age. *Clinical Oral Investigations, 15*(5), 691-697. doi:10.1007/s00784-010-0437-3

Hassel, A., Rolko, C., Leisen, J., Schmitter, M., Rexroth, W., & Leckel, M. (2007). Oral health-related quality of life and somatization in the elderly. *An International Journal of Quality*

of Life Aspects of Treatment, Care and Rehabilitation - Official Journal of the International Society of Quality of Life Research, 16(2), 253-261. doi:10.1007/s11136-006-9122-z

Henry J. Kaiser Family Foundation. (2018). Medicaid physician fee index. Retrieved from https://www.kff.org/medicaid/state-indicator/medicaid-fee-index/?currentTimeframe=0&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D

Henry J. Kaiser Family Foundation. (2019). Key facts about the uninsured population. Retrieved from https://www.kff.org/uninsured/fact-sheet/key-facts-about-the-uninsured-population/

Hinton, E., & Paradise, J. (2016). Access to dental care in Medicaid: Spotlight on nonelderly adults. Retrieved from https://www.kff.org/medicaid/issue-brief/access-to-dental-care-in-medicaid-spotlight-on-nonelderly-adults/

Holmes Jr, L., Desvignes-Kendrick, M., Slomka, J., Mahabir, S., Beeravolu, S., & Emani, S. R. (2009). Is dental care utilization associated with oral cavity cancer in a large sample of community-based United States residents? *Community Dentistry and Oral Epidemiology, 37*(2), 134-142. doi:10.1111/j.1600-0528.2008.00450.x

Jaffe, S. (2016). Seeking dental care for older Americans. *Health Affairs (Project Hope), 35*(12), 2164-2167. doi:10.1377/hlthaff.2016.1393

John, M. T., Koepsell, T. D., Hujoel, P., Miglioretti, D. L., Leresche, L., & Micheelis, W. (2004). Demographic factors, denture status and oral health-related quality of life. *Community Dentistry and Oral Epidemiology, 32*(2), 125-132.

Kaplan-Lewis, E., & Percac-Lima, S. (2013). No-show to primary care appointments: Why patients do not come. *Journal of Primary Care & Community Health, 4*(4), 251-255. doi:10.1177/2150131913498513

Kreider, B., Manski, R. J., Moeller, J., & Pepper, J. (2015). The effect of dental insurance on the use of dental care for older adults: A partial identification analysis. *Health Economics, 24*(7), 840-858. doi:10.1002/hec.3064

Kullgren, J. T., McLaughlin, C. G., Mitra, N., & Armstrong, K. (2012). Nonfinancial Barriers and access to Care for U.S. Adults. *Health Services Research, 47*(1pt2), 462-485. doi:10.1111/j.1475-6773.2011.01308.x

Lambert, N. M., & Tepper, L. M. (2010). Prevention of oral disease for long-term care and homebound elderly. *The New York State Dental Journal, 76*(5), 42-45.

Lee, J. Y., Divaris, K., Baker, A. D., Rozier, R. G., & Vann, W. F. (2012). The relationship of oral health literacy and self-efficacy with oral health status and dental neglect. *American Journal of Public Health, 102*(5), 923-929. doi:10.2105/AJPH.2011.300291

Lee, W., Kim, S.-J., Albert, J. M., & Nelson, S. (2014). Community factors predicting dental care utilization among older adults. *The Journal of the American Dental Association, 145*(2), 150-158. doi:10.14219/jada.2013.22

Levy, N., Goldblatt, R. S., & Reisine, S. (2013). Geriatrics education in U.S. dental schools: where do we stand, and what improvements should be made? *Journal of Dental Education, 77*(10), 1270-1285.

Littell, R. C. C. (2006). *SAS for mixed models* (2nd ed.). Place of publication not identified SAS Institute Inc.

Little Hoover Commission. (2016). Fixing Denti-Cal. Retrieved from https://lhc.ca.gov/report/fixing-denti-cal

Locker, D. (1988). Measuring oral health: A conceptual framework. *Community Dental Health, 5*(1), 3-18.

Maiuro, L. (2011). Eliminating adult dental benefits in Medi-Cal: An analysis of impact. Retrieved from https://www.chcf.org/wp-content/uploads/2017/12/PDF-EliminatingAdultDentalMediCalcx.pdf

Manski, R. J., Hyde, J. S., Chen, H., & Moeller, J. F. (2016). Differences among older adults in the types of dental services used in the United States. *INQUIRY: The Journal of Health Care Organization, Provision, and Financing, 53*(1). doi:10.1177/0046958016652523

Manski, R. J., Moeller, J. F., Chen, H., St. Clair, P. A., Schimmel, J., & Pepper, J. V. (2012). Wealth effect and dental care utilization in the United States. *Journal of Public Health Dentistry, 72*(3), 179-189. doi:10.1111/j.1752-7325.2012.00312.x

Manski, R. J., Moeller, J. F., St Clair, P. A., Schimmel, J., Chen, H., & Pepper, J. V. (2011). The influence of changes in dental care coverage on dental care utilization among retirees and near-retirees in the United States, 2004-2006. *American Journal of Public Health, 101*(10), 1882-1891. doi:10.2105//AJPH.2011.300227

Mays, V. M., Ponce, N. A., Washington, D. L., & Cochran, S. D. (2003). Classification of race and ethnicity: implications for public health. *Annual Review of Public Health, 24*, 83.

McConville, S., Danielson, C., & Hsia, R. (2019). Emergency department use in California. Retrieved from https://www.ppic.org/wp-content/uploads/emergency-department-use-in-california-demographics-trends-and-the-impact-of-the-aca-february-2019.pdf

McQuistan, M., Qasim, A., Shao, C., Straub-Morarend, C., & Macek, M. (2015). Oral health knowledge among elderly patients. *American Dental Association. The Journal of the American Dental Association, 146*(1), 17. doi:10.14219/jada.archive.2006.0262

Medicaid and CHIP Payment and Access Commission. (2018). Medicaid's share of state budgets. Retrieved from https://www.macpac.gov/subtopic/medicaids-share-of-state-budgets/

Misra, T. (2015). Global Car, motorcycle, and bike ownership in 1 infographic. Retrieved from https://www.citylab.com/transportation/2015/04/global-car-motorcycle-and-bike-ownership-in-1-infographic/390777/

National Cancer Institute. (2015). Cancer Stat facts: Oral cavity and pharynx cancer. Retrieved from https://seer.cancer.gov/statfacts/html/oralcav.html

National Council on Aging. (2019). Economic security for seniors facts. Retrieved from https://www.ncoa.org/news/resources-for-reporters/get-the-facts/economic-security-facts/

National Institute of Dental and Craniofacial Research. (2018a). Periodontal disease in adults (Age 20 to 64). Retrieved from https://www.nidcr.nih.gov/research/data-statistics/periodontal-disease/adults

National Institute of Dental and Craniofacial Research. (2018b). Periodontal disease in seniors (Age 65 and Over). Retrieved from https://www.nidcr.nih.gov/DataStatistics/FindDataByTopic/GumDisease/PeriodontaldiseaseSeniors65over.htm.

National Institute of Dental and Craniofacial Research. (2018c). Tooth loss in seniors. Retrieved from https://www.nidcr.nih.gov/research/data-statistics/tooth-loss/seniors

Newhouse, J. P. (2004). Consumer-directed health plans and the RAND health insurance experiment. *Health Affairs (Project Hope), 23*(6), 107-113. doi:10.1377/hlthaff.23.6.107

Nguyen, D. L., Dejesus, R. S., & Wieland, M. L. (2011). Missed appointments in resident continuity clinic: patient characteristics and health care outcomes. *Journal of Graduate Medical Education, 3*(3), 350-355. doi:10.4300/JGME-D-10-00199.1

Northridge, M. E., Estrada, I., Schrimshaw, E. W., Greenblatt, A. P., Metcalf, S. S., & Kunzel, C. (2017). Racial/ethnic minority older adults' perspectives on proposed medicaid reforms' effects on dental care access. *American Journal of Public Health, 107*(S1), S65. doi:10.2105/AJPH.2016.303640

Office of Disease Prevention and Health Promotion. (2018). Access to health services. Retrieved from https://www.healthypeople.gov/2020/topics-objectives/topic/Access-to-Health-Services

Oh, A. (2014). The effect of Medicaid dental coverage on dental care utilization among older Americans. In D. J. Becker, J. Blackburn, A. Davis, J. Locher, & B. Sen (Eds.): ProQuest Dissertations Publishing.

Phillips, K. A., Morrison, K. R., Andersen, R. M., & Aday, L. A. (1998). Understanding the context of healthcare utilization: assessing environmental and provider-related variables in the behavioral model of utilization. *Health Services Research, 33*(3 Pt 1), 571-596.

Pourat, N., Andersen, R. M., & Marcus, M. (2015). Assessing the contribution of the dental care delivery system to oral health care disparities. *Journal of Public Health Dentistry, 75*(1), 1-9. doi:10.1111/jphd.12064

Pourat, N., & Choi, M. K. (2014). Trends in the Supply of Dentists in California. Retrieved from http://healthpolicy.ucla.edu/publications/Documents/PDF/2014/dentistspb-mar2014.pdf

Rampa, S., Wilson, F. A., & Allareddy, V. (2016). Trends in dental-related emergency department visits in the State of California from 2005 to 2011. *Oral Surgery, Oral Medicine, Oral Pathology and Oral Radiology, 122*(4), 426-433. doi:10.1016/j.oooo.2016.05.003

Raphael, C. (2017). Oral health and aging. *American Journal of Public Health, 107*(S1), S44. doi:10.2105/AJPH.2017.303835

Reda, S. F., Reda, S. M., Thomson, W. M., & Schwendicke, F. (2018). Inequality in utilization of dental services: A systematic review and meta-analysis. *American Journal of Public Health, 108*(2), e1-e7. doi:10.2105/AJPH.2017.304180

Riley, M. W., Kahn, R. L., & Foner, A. (1994). *Age and structural lag: Society's failure to provide meaningful opportunities in work, family, and leisure*. New York, NY: Wiley.

Rouxel, P., Heilmann, A., Demakakos, P., Aida, J., Tsakos, G., & Watt, R. G. (2017). Oral health-related quality of life and loneliness among older adults. *European Journal of Ageing, 14*(2), 101-109. doi:10.1007/s10433-016-0392-1

Scardina, G. A., & Messina, P. (2012). Good oral health and diet. *Journal of Biomedicine and Biotechnology, 2012*. doi:10.1155/2012/720692

Sentell, T., & Braun, K. L. (2012). Low health literacy, limited english proficiency, and health status in asians, latinos, and other racial/ethnic groups in California. *Journal of Health Communication, 17*(sup3), 82-99. doi:10.1080/10810730.2012.712621

Shi, L., Lebrun, L. A., & Tsai, J. (2009). The influence of English proficiency on access to care. *Ethnicity & Health, 14*(6), 625-642. doi:10.1080/13557850903248639

Singhal, A., Caplan, D., Jones, M., Momany, E., Kuthy, R., Buresh, C., … Damiano, P. (2015). Eliminating Medicaid adult dental coverage in California led to increased dental

emergency visits and associated costs. *Health Affairs, 34*(5), 749-756,741-714. doi:10.1377/hlthaff.2014.1358

Singhal, A., Damiano, P., & Sabik, L. (2017). Medicaid adult dental benefits increase use of dental care, but impact of expansion on dental services use was mixed. *Health Affairs (Project Hope), 36*(4), 723. doi:10.1377/hlthaff.2016.0877

Social Security Administration. (2018). A summary of the 2018 annual reports. Retrieved from https://www.ssa.gov/OACT/TRSUM/index.html

State of California. (2018). California State Budget 2018-2019. Retrieved from http://www.ebudget.ca.gov/FullBudgetSummary.pdf

The Council for Community and Economic Research. (2018). Cost of living index. Retrieved from http://coli.org/

U.S. Department of Health & Human Services. (2016). 2016 National Healthcare Quality and Disparities Report. Retrieved from https://www.ahrq.gov/research/findings/nhqrdr/nhqdr16/overview.html

U.S. National Archives & Records Administration. (2019). Social Security Act Amendments (1965). Retrieved from https://www.ourdocuments.gov/print_friendly.php?flash=true&page=&doc=99&title=Social+Security+Act+Amendments+%281965%29

United States Congress, Senate Committee on Health, E. L. a. P. S. o. P. H. a. A. (2016). *Dental crisis in America: The need to address cost: Hearing before the Subcommittee on Primary Health and Aging of the Committee on Health, Education, Labor, and Pensions, United States Senate, One Hundred Thirteenth Congress, first session ... September 12, 2013*: Washington, DC: U.S. Government Publishing Office.

U.S. Census Bureau. (2014). An aging nation: the older population in the United States. Retrieved from https://www.census.gov/prod/2014pubs/p25-1140.pdf

U.S. Census Bureau. (2017). Older Americans month: May 2017. Retrieved from https://www.census.gov/content/dam/Census/newsroom/facts-for-features/2017/cb17-ff08.pdf

Vujicic, M., Buchmueller, T., & Klein, R. (2016). Dental care presents the highest level of financial barriers, compared to other types of health care services. *Health Affairs, 35*(12), 2176-2182. doi:10.1377/hlthaff.2016.0800

Wall, T., & Vujicic, M. (2015). Emergency department use of dental conditions continues to increase. Retrieved from http://www.ada.org/~/media/ADA/Science%20and%20Research/HPI/Files/HPIBrief_0415_2.ashx

Wall, T., Vujicic, M., & Nasseh, K. (2012). Recent trends in the utilization of dental care in the United States. *Journal of Dental Education, 76*(8), 1020-1027.

Warder, C. J., & Edelstein, B. L. (2017). Evaluating levels of dentist participation in Medicaid: A complicated endeavor: A complicated endeavor. *The Journal of the American Dental Association, 148*(1), 26-32.e22. doi:10.1016/j.adaj.2016.09.010

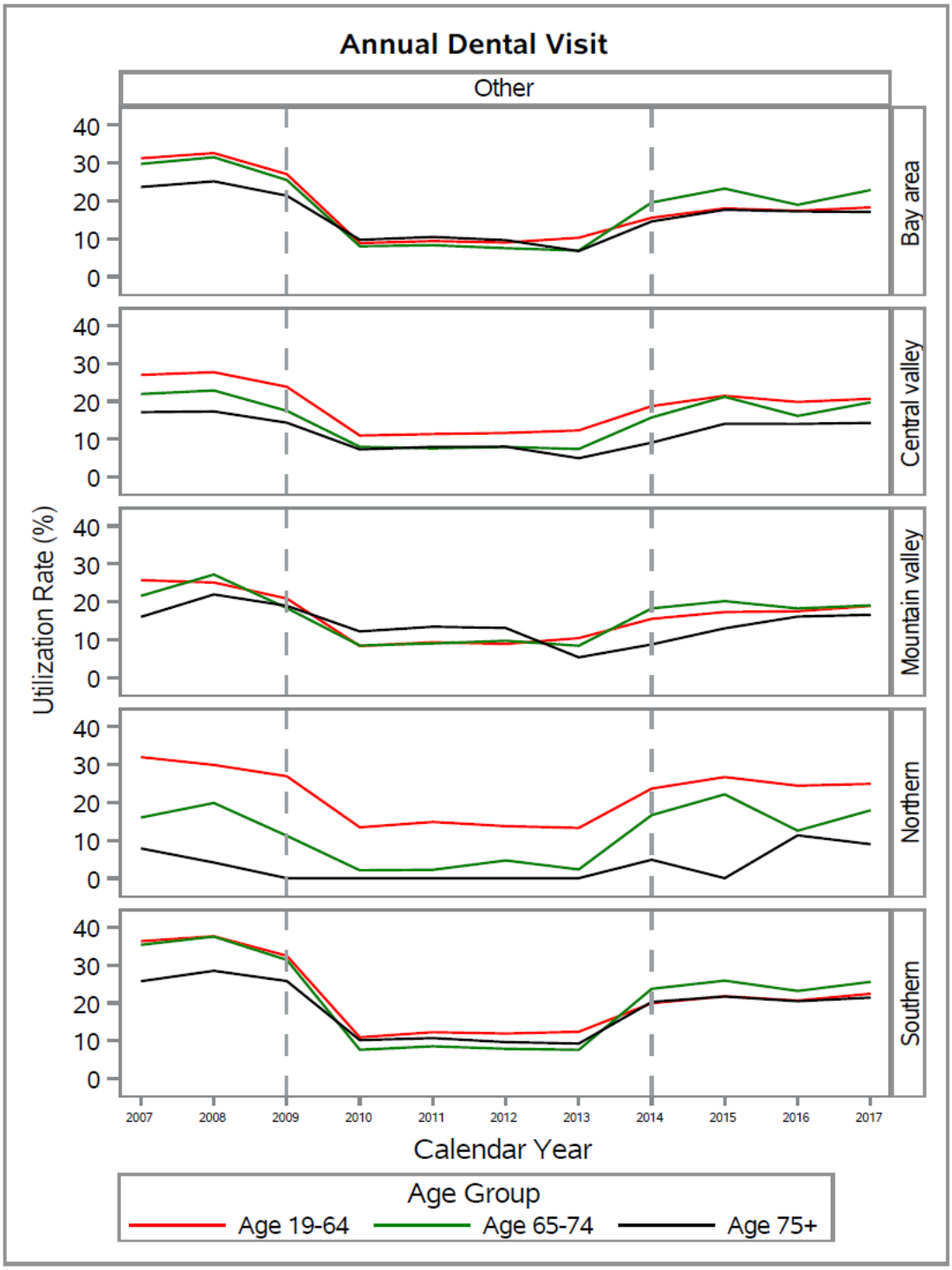
Wides, C., Alam, S., & Mertz, E. (2014). Shaking Up the Dental Safety-net: Elimination of optional adult dental Medicaid benefits in California. *Journal of Health Care for the Poor and Underserved, 25*(1), 151-164. doi:10.1353/hpu.2014.0072

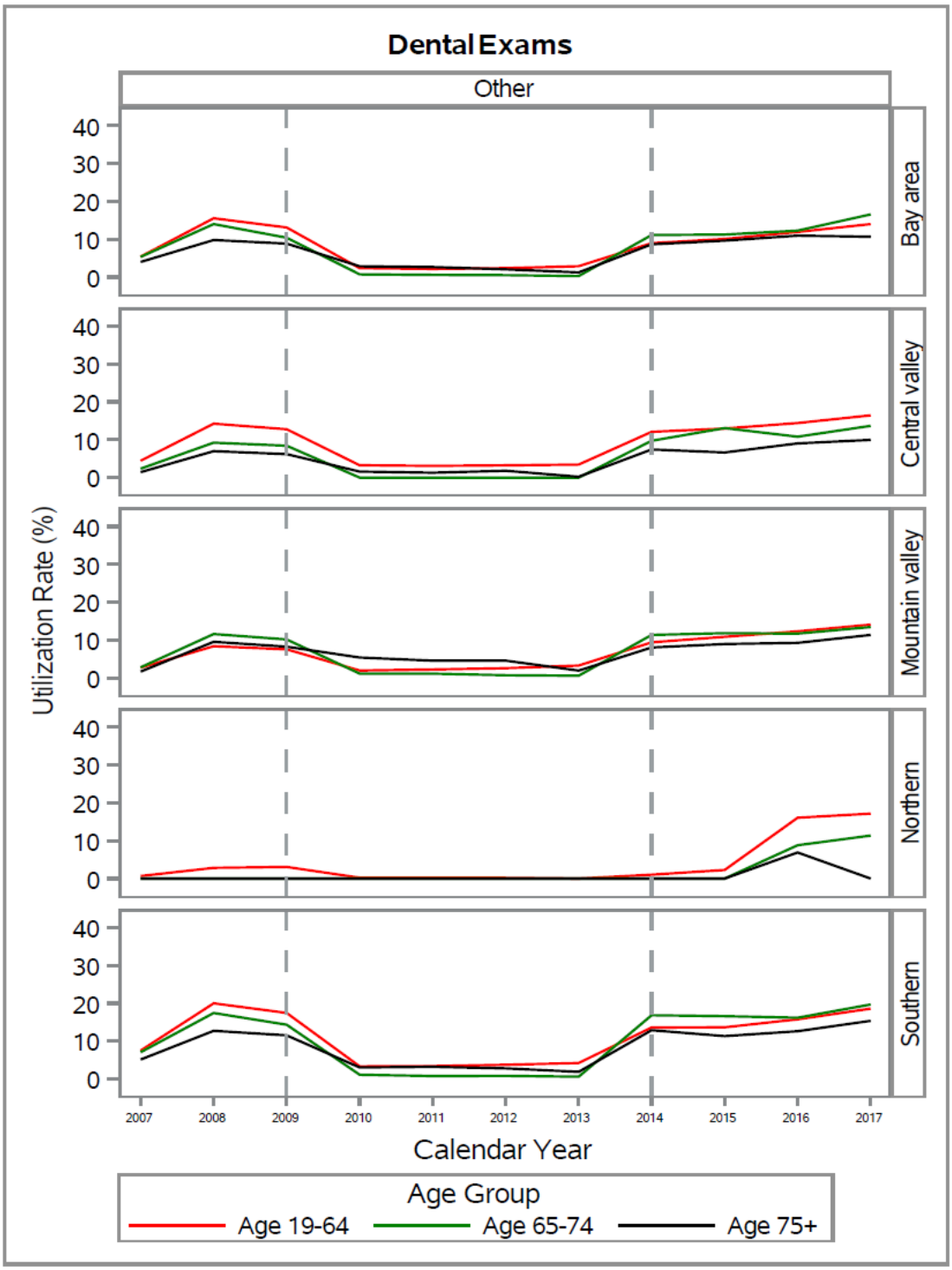
Wiener, R. C., Sambamoorthi, U., Shen, C., Alwhaibi, M., & Findley, P. (2018). Food Security and Unmet Dental Care Needs in Adults in the United States. *Journal of Dental Hygiene: JDH, 92*(3), 14-22.

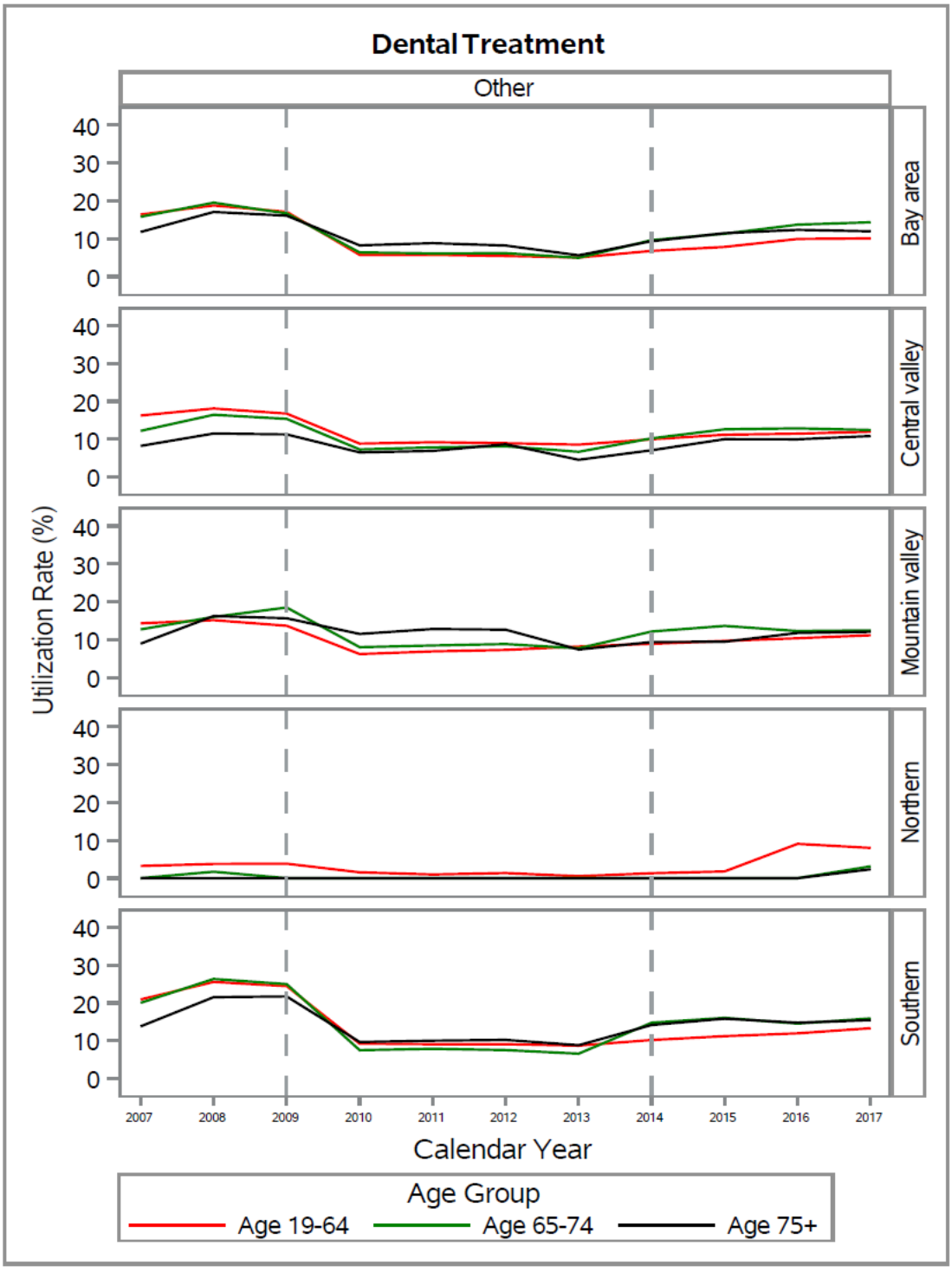
Willink, A., Schoen, C., & Davis, K. (2016). Dental care and medicare beneficiaries: Access gaps, cost burdens, and policy options. *Health Affairs (Project Hope), 35*(12), 2241. doi:10.1377/hlthaff.2016.0829

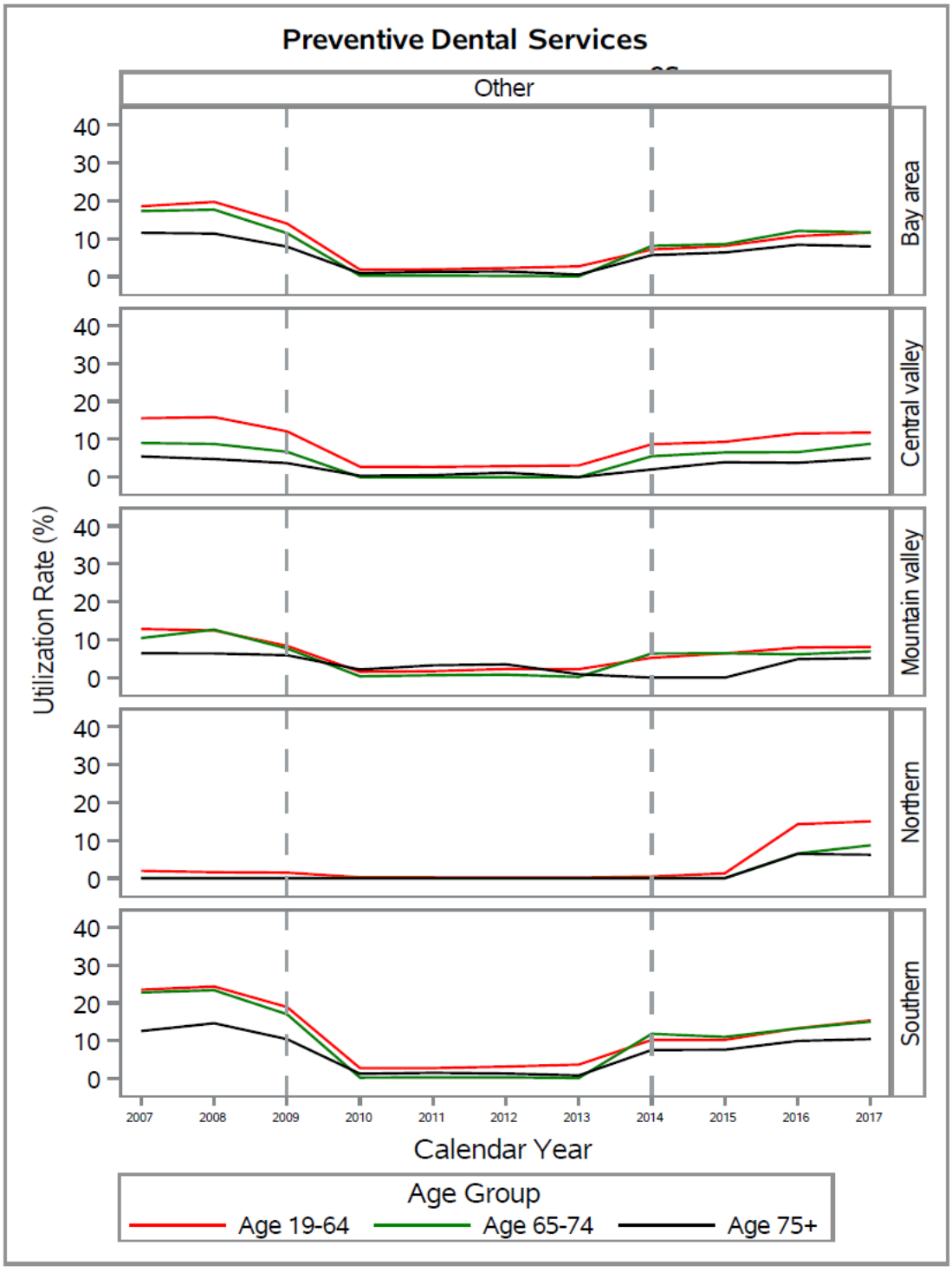
Yellowitz, J. A., & Schneiderman, M. T. (2014). Elder's oral health crisis. *The Journal of Evidence-Based Dental Practice, 14*, 191-200. doi:10.1016/j.jebdp.2014.04.011

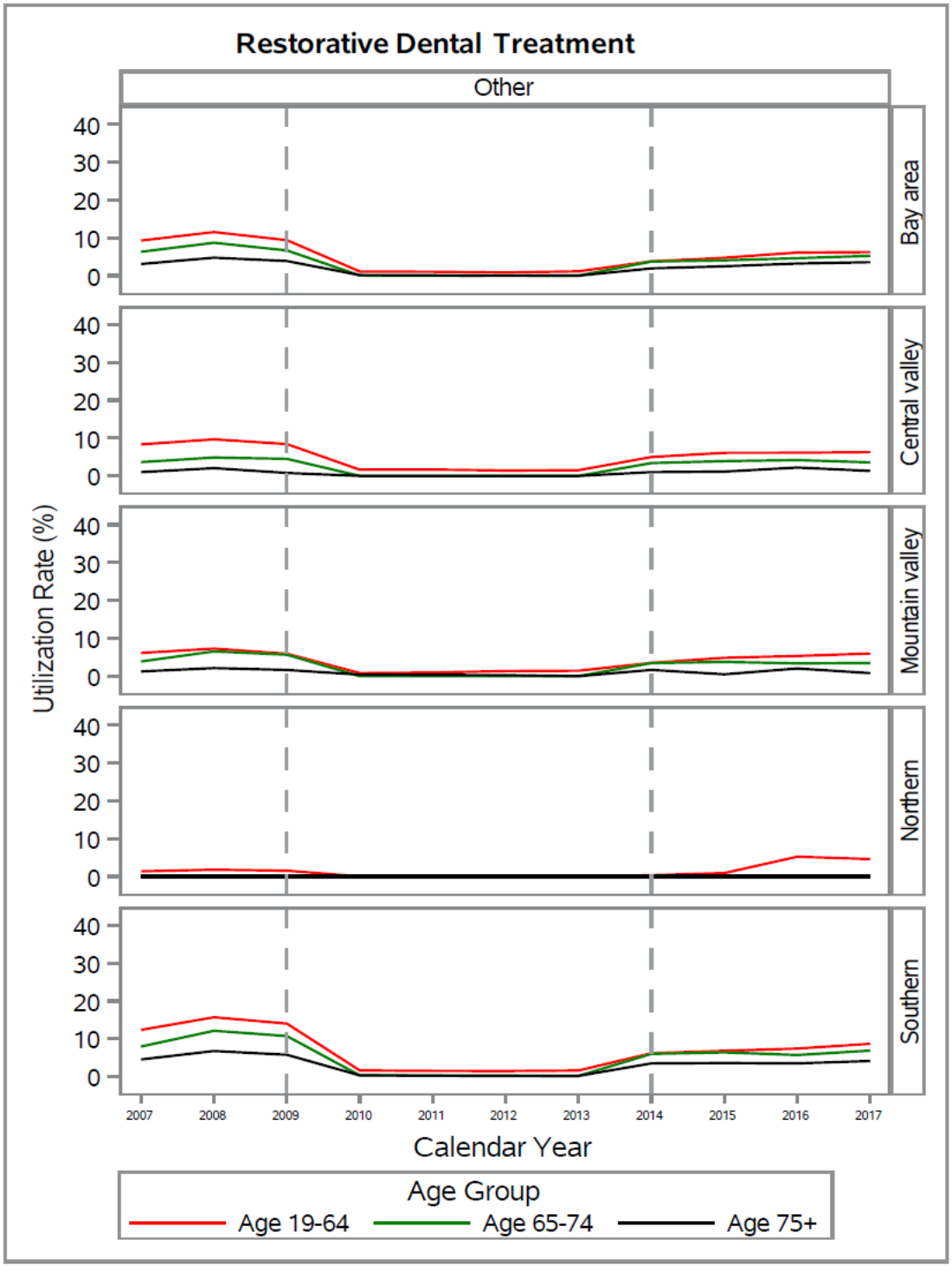
Appendix A. Plots of Utilization Rates for Each Type of Dental Service by Age Group and Geographic Region for the Ethnic Group of Other from 2007 to 2017

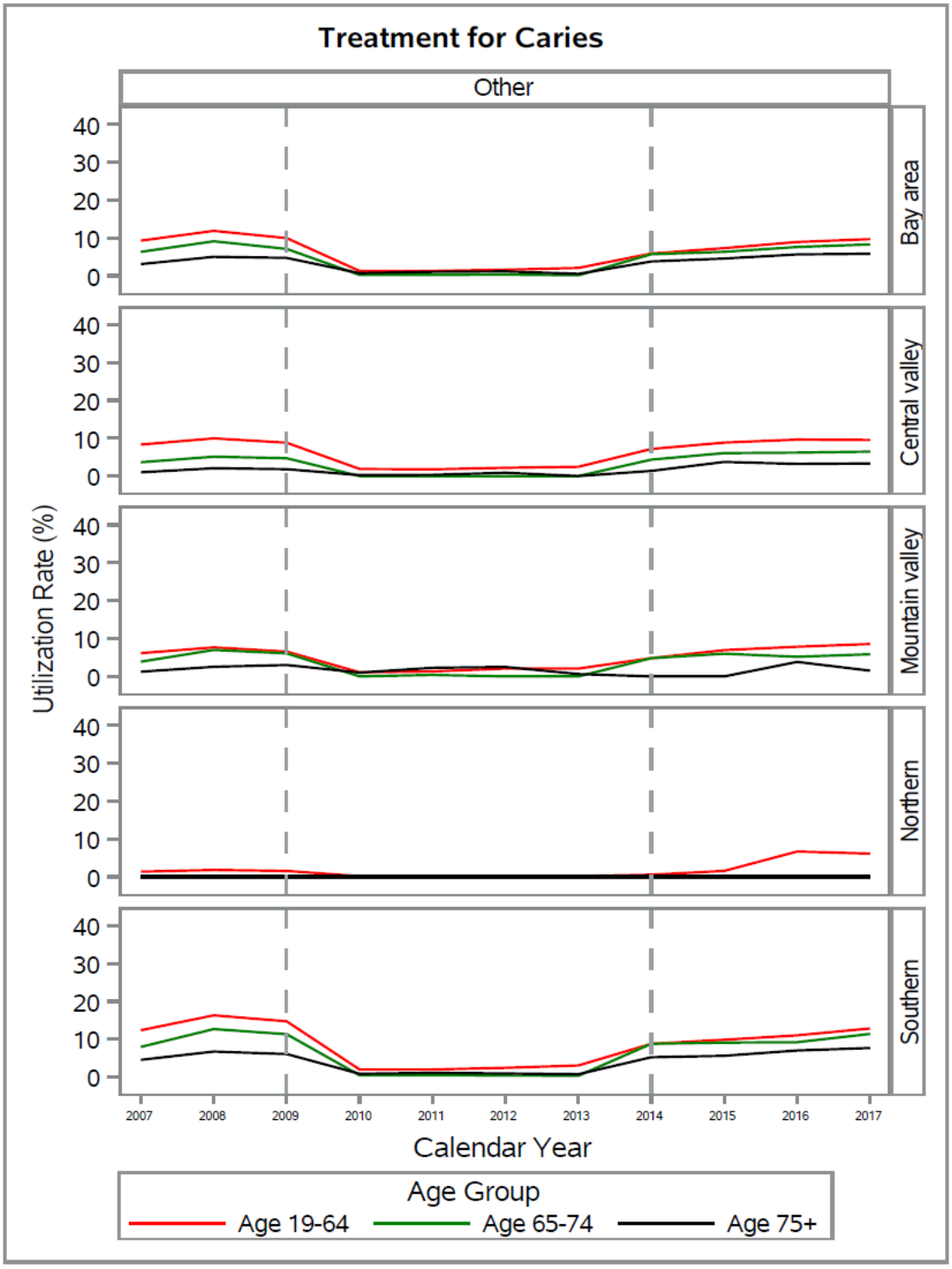



Dental Exams
Other
Bay area
Central valley
Mountain valley
Northern
Southern
Utilization Rate (%)
0
10
20
30
40
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Calendar Year
Age Group
Age 19-64
Age 65-74
Age 75+

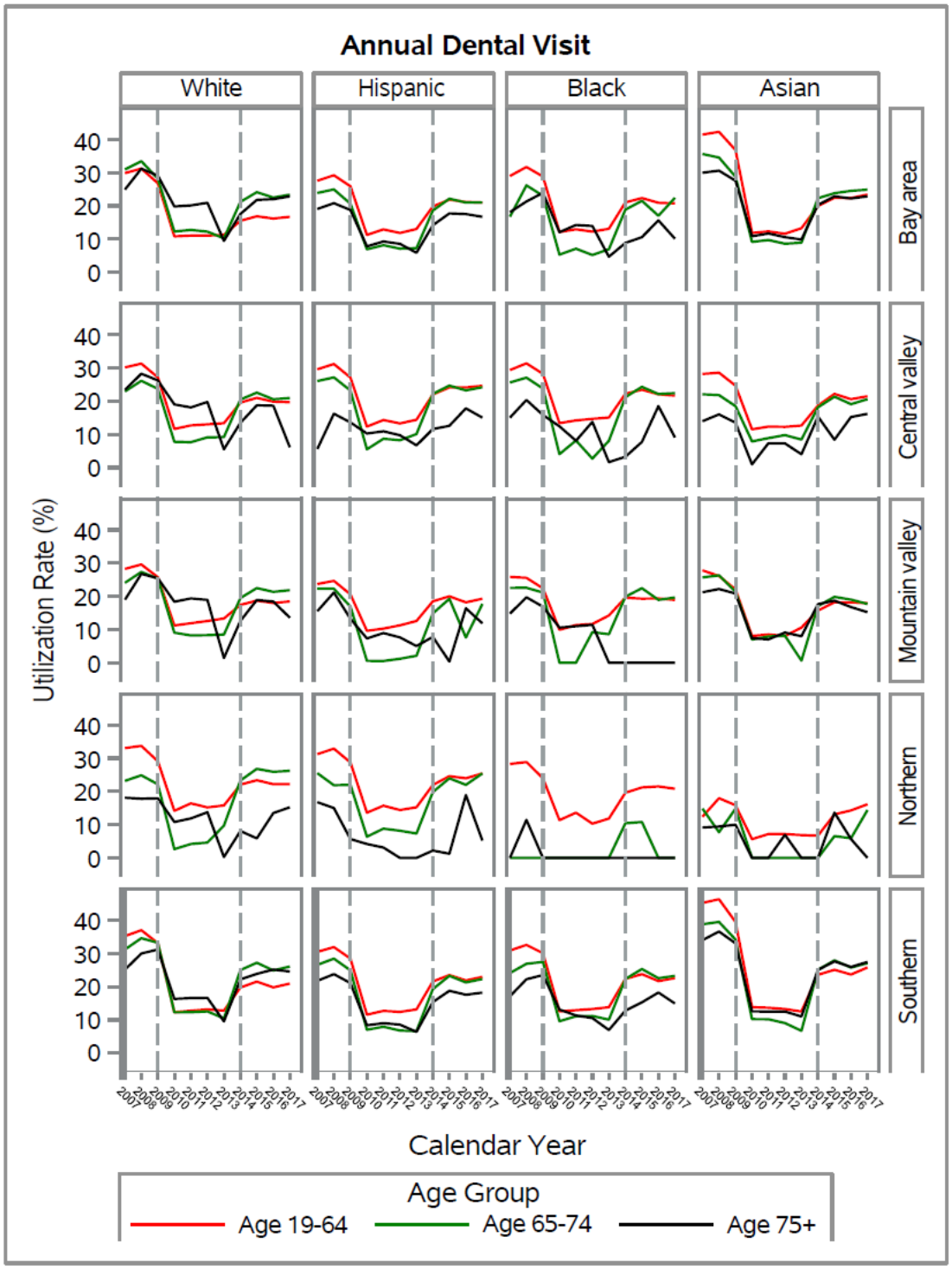

Dental Treatment
Other
Bay area
Central valley
Mountain valley
Northern
Southern
Utilization Rate (%)
0
10
20
30
40
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Calendar Year
Age Group
Age 19-64
Age 65-74
Age 75+

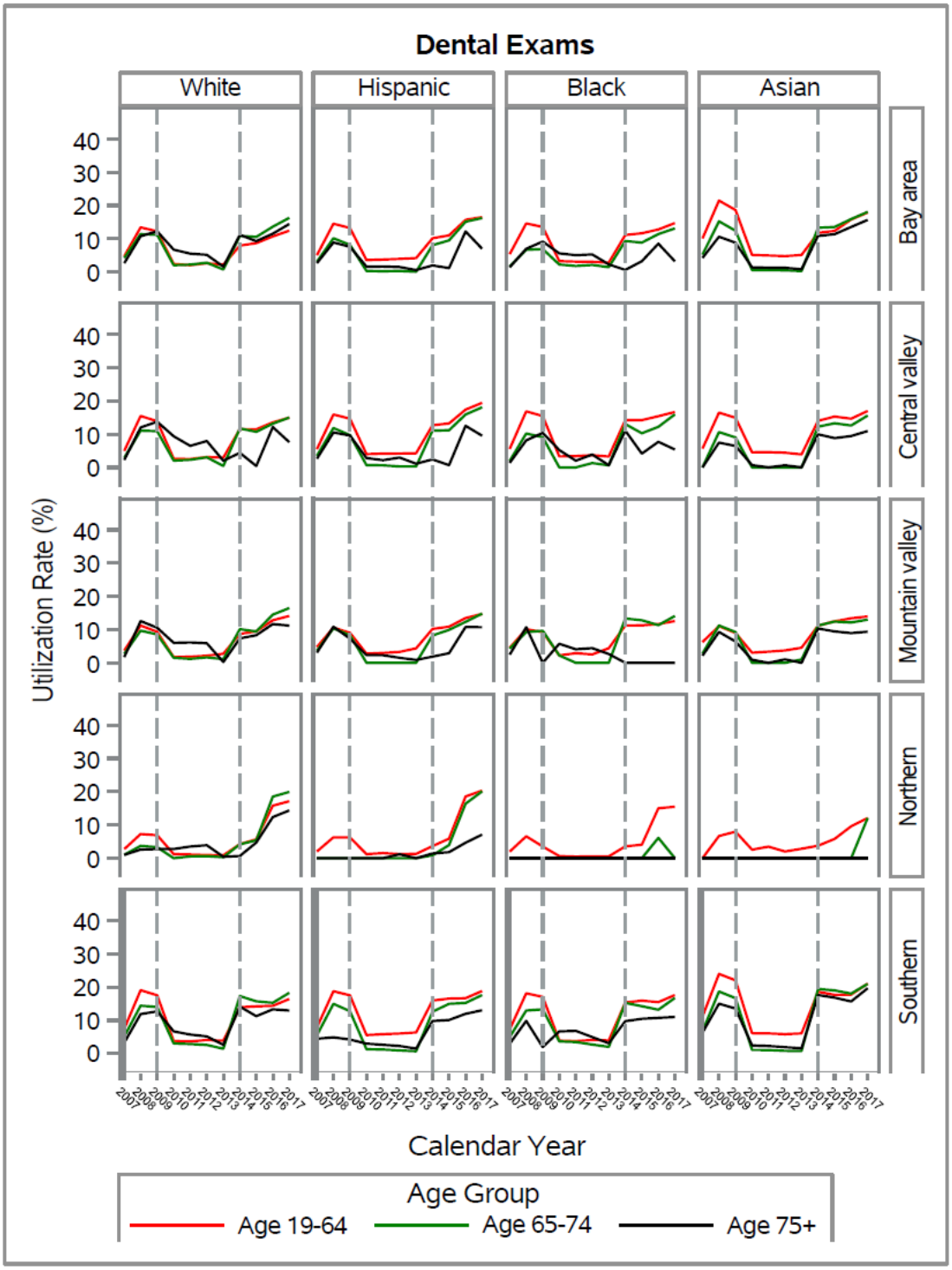

Preventive Dental Services
Other
Bay area
Central valley
Mountain valley
Northern
Southern
Utilization Rate (%)
0
10
20
30
40
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Calendar Year
Age Group
Age 19-64
Age 65-74
Age 75+

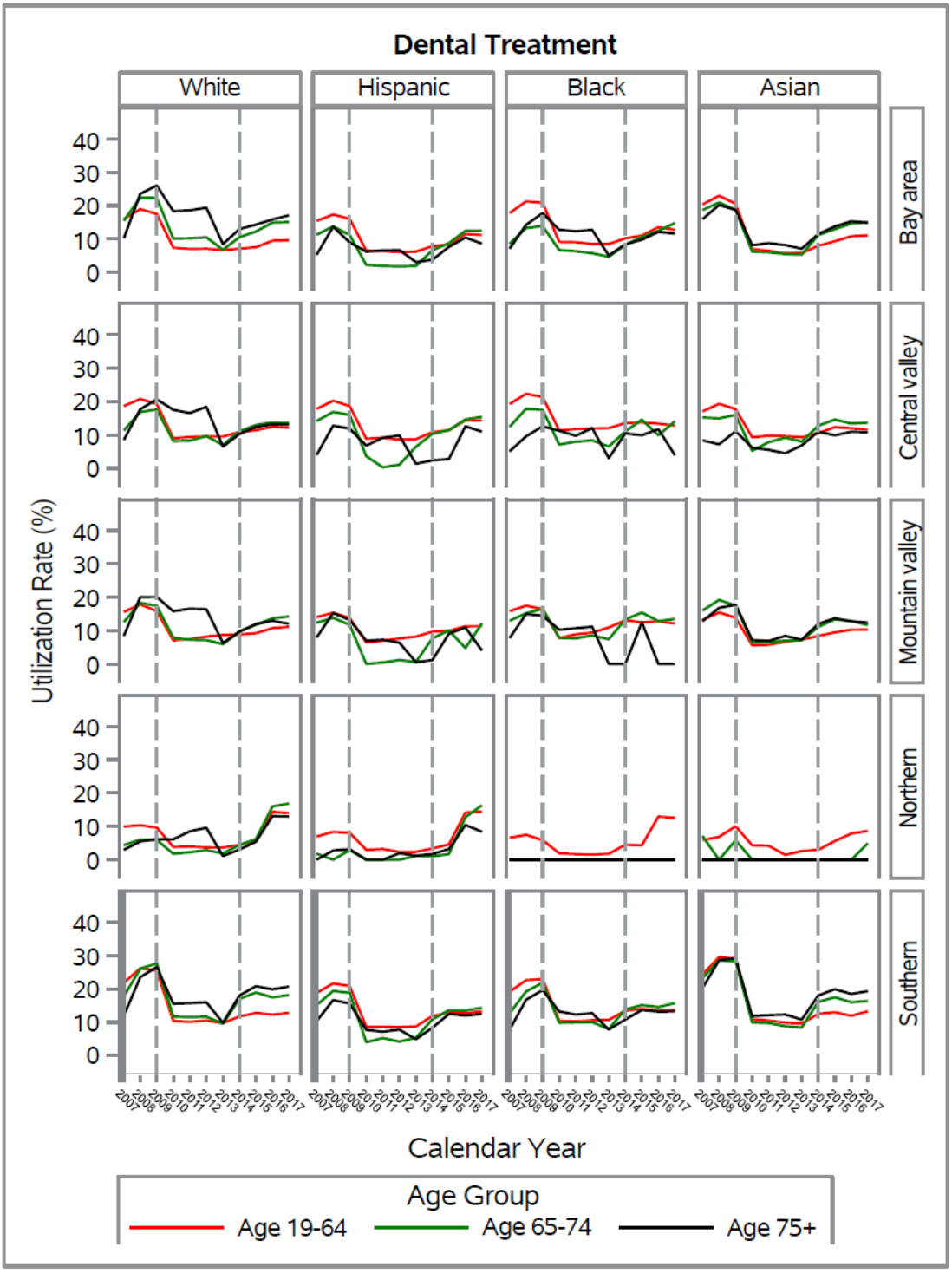

Restorative Dental Treatment
Other
Bay area
Central valley
Mountain valley
Northern
Southern
Utilization Rate (%)
0
10
20
30
40
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Calendar Year
Age Group
Age 19-64
Age 65-74
Age 75+

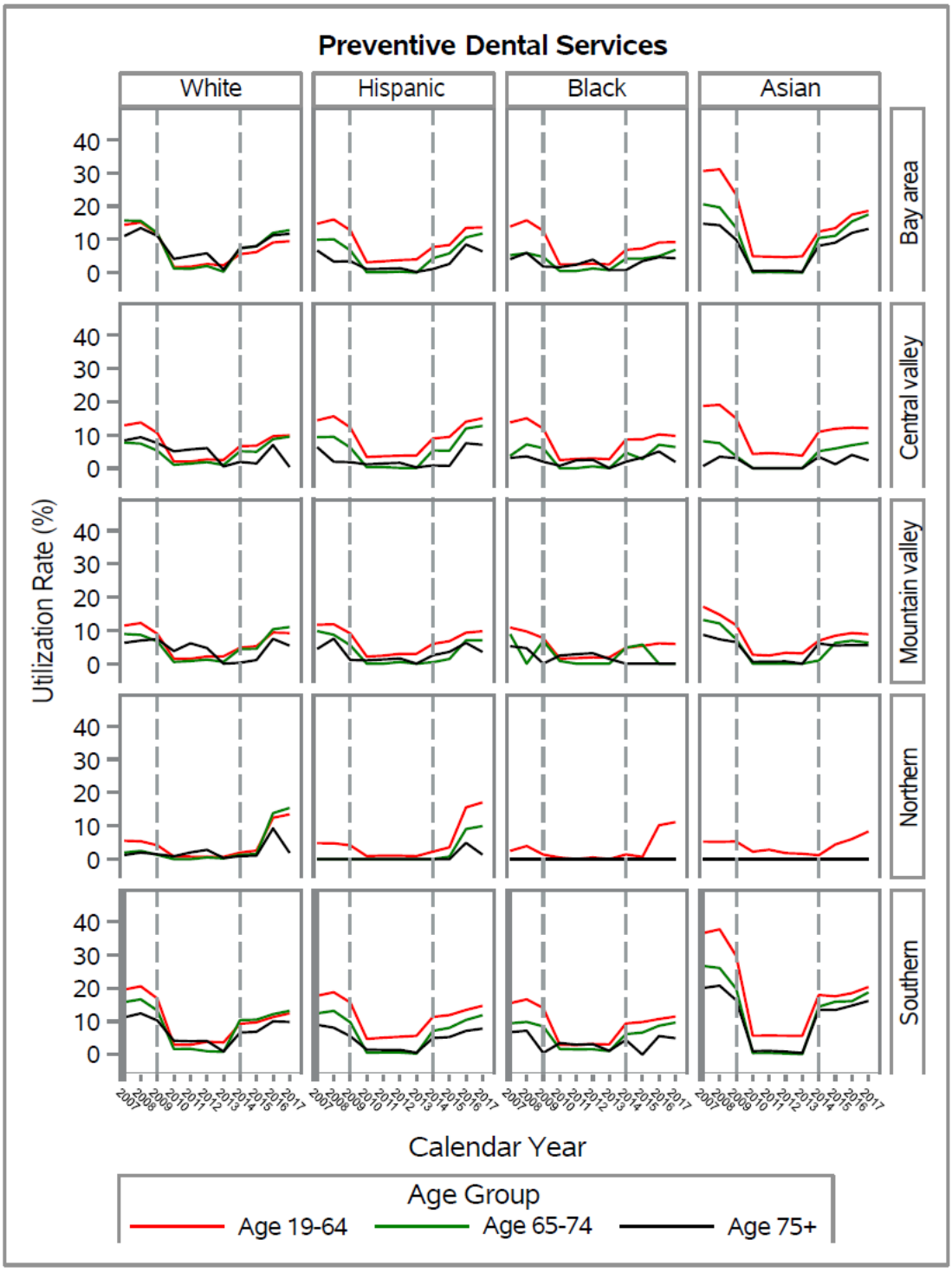

Treatment for Caries
Other
Bay area
Central valley
Mountain valley
Northern
Southern
Utilization Rate (%)
0
10
20
30
40
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Calendar Year
Age Group
Age 19-64
Age 65-74
Age 75+

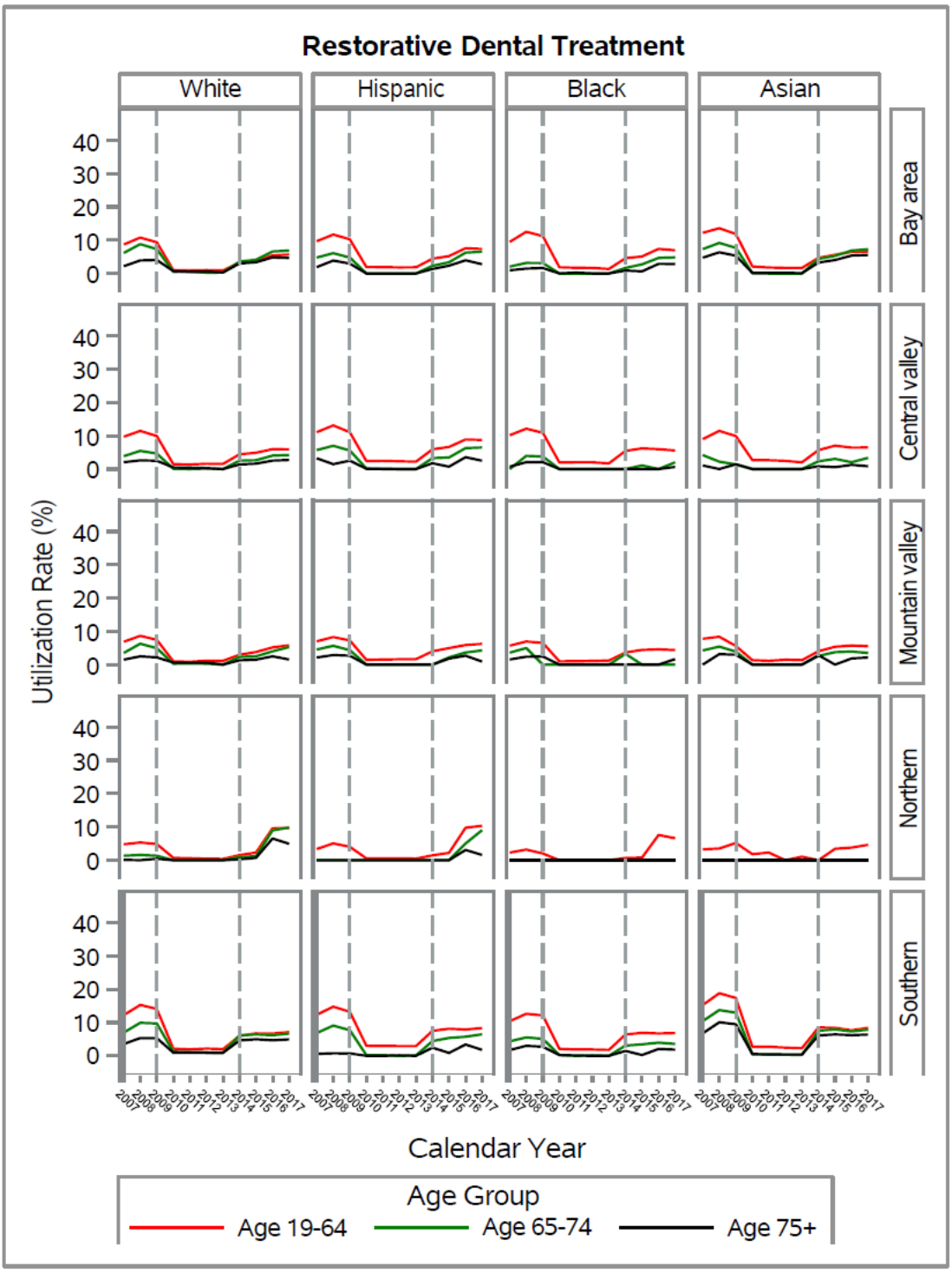
Appendix B. Plots of Utilization Rates for Each Type of Dental Service by Age Group, Major Ethnic Group and Geographic Region from 2007 to 2017

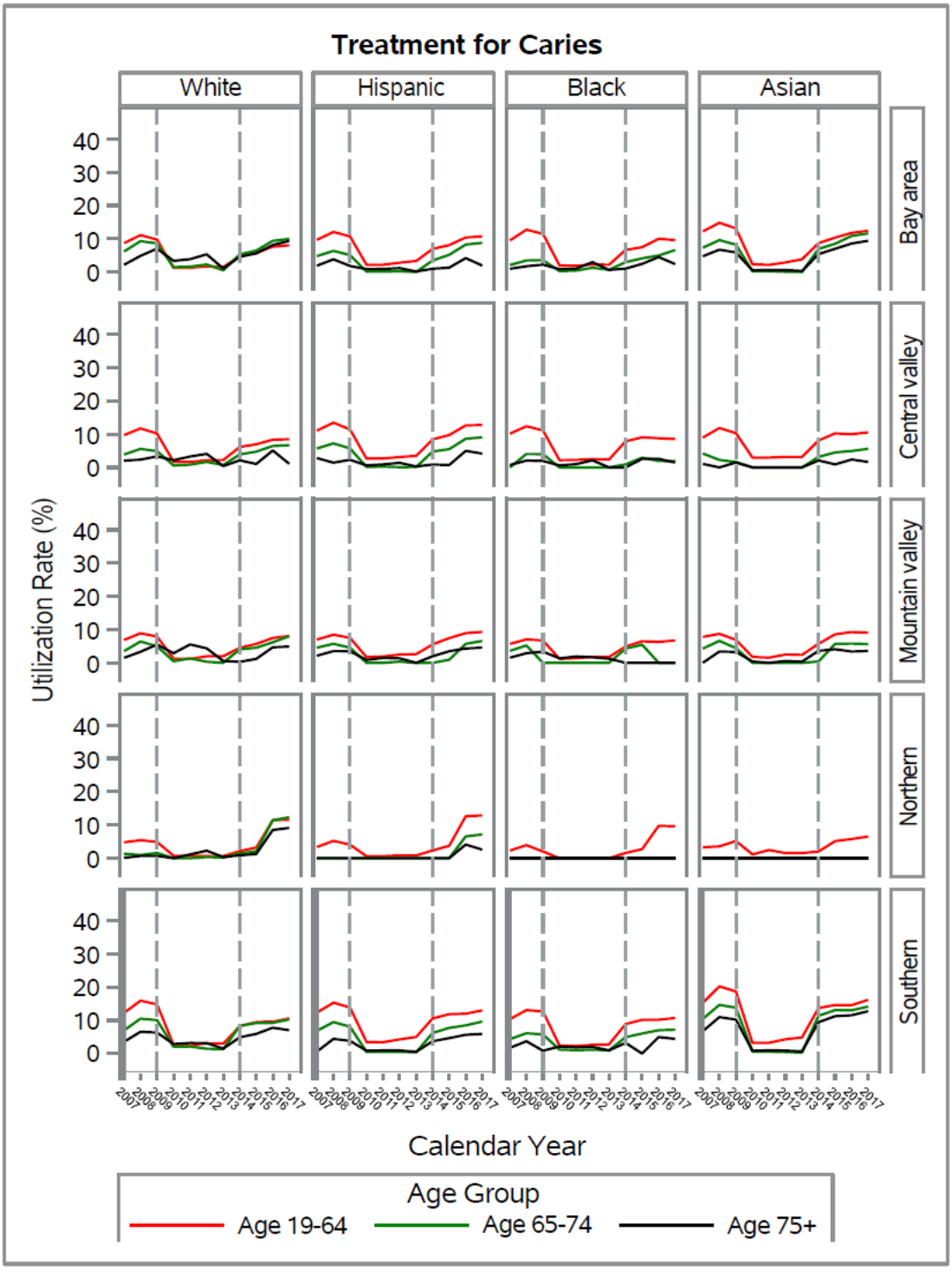



Dental Exams
White
Hispanic
Black
Asian
Bay area
Central valley
Mountain valley
Northern
Southern
Utilization Rate (%)
0
10
20
30
40
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Calendar Year
Age Group
Age 19-64
Age 65-74
Age 75+


Dental Treatment
White
Hispanic
Black
Asian
Bay area
Central valley
Mountain valley
Northern
Southern
Utilization Rate (%)
0
10
20
30
40
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Calendar Year
Age Group
Age 19-64
Age 65-74
Age 75+


Preventive Dental Services
White
Hispanic
Black
Asian
Bay area
Central valley
Mountain valley
Northern
Southern
Utilization Rate (%)
0
10
20
30
40
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Calendar Year
Age Group
Age 19-64
Age 65-74
Age 75+


Restorative Dental Treatment
White
Hispanic
Black
Asian
Bay area
Central valley
Mountain valley
Northern
Southern
Utilization Rate (%)
0
10
20
30
40
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Calendar Year
Age Group
Age 19-64
Age 65-74
Age 75+


Treatment for Caries
White
Hispanic
Black
Asian
Bay area
Central valley
Mountain valley
Northern
Southern
Utilization Rate (%)
0
10
20
30
40
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
Calendar Year
Age Group
Age 19-64
Age 65-74
Age 75+

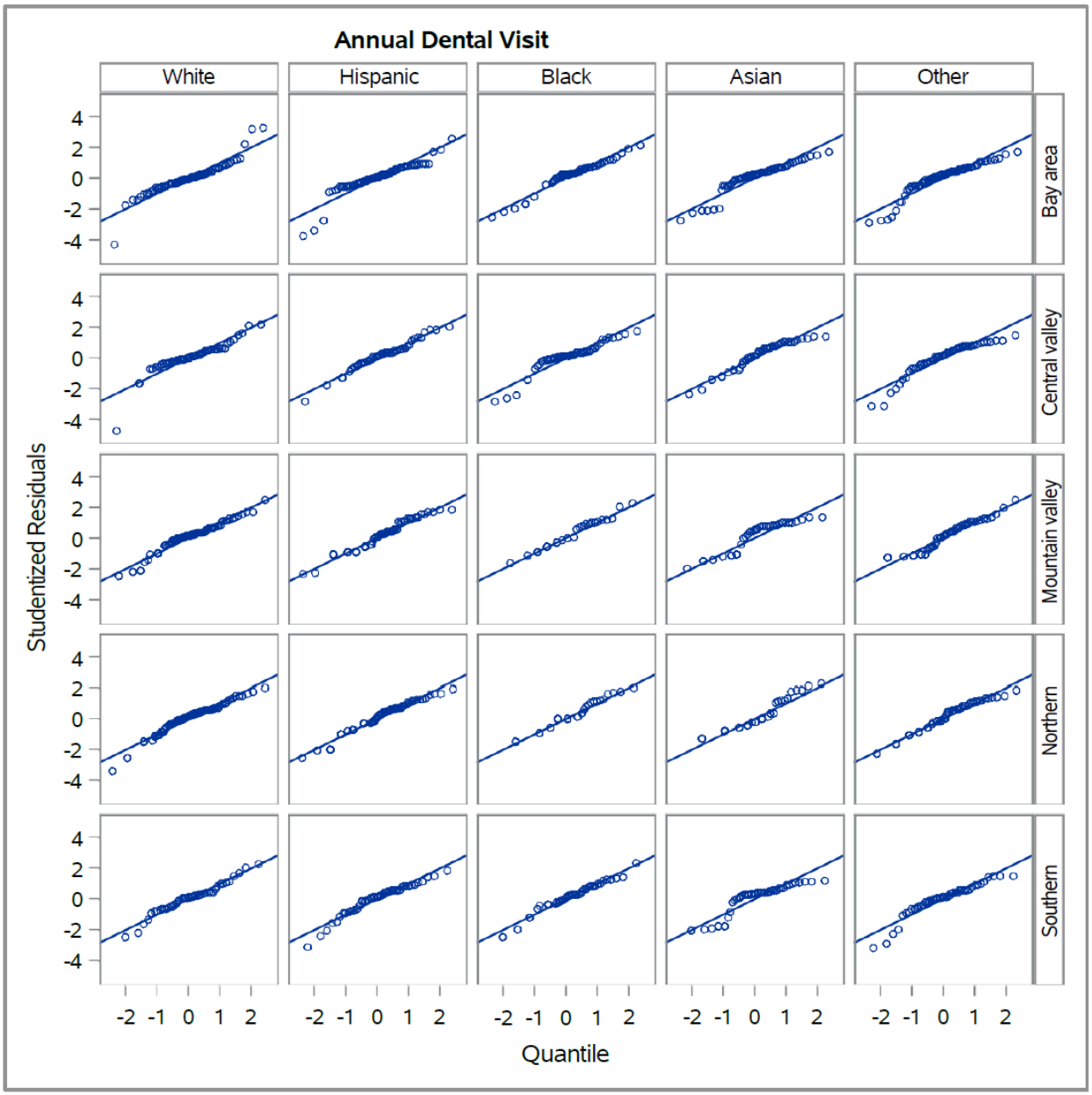
Appendix C. Interaction Effects from Repeated Measure Analysis for Evaluation of Age Effects and Ethnicity Effects on Utilization of Dental Services in Clinics by Adult Medi-Cal Beneficiaries

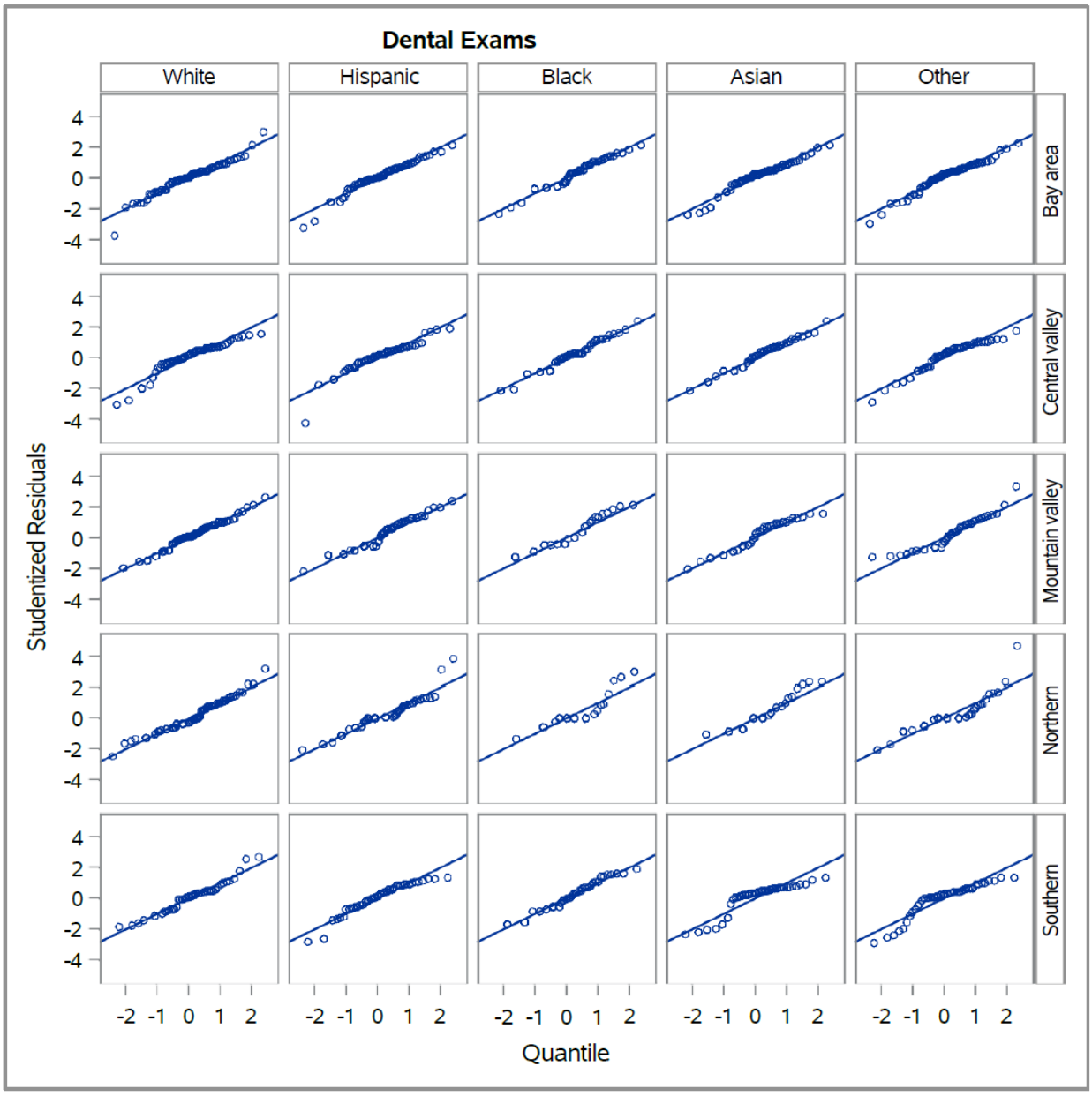
Type of Dental Services	Interaction Effect	Numerator Degrees of Freedom	Denominator Degrees of Freedom	F-Value	P-value
Annual Dental Visit	Ethnicity *Age	8	694	3.78	0.0002
	Ethnicity *Region	16	694	4.72	<.0001
	Age*Region	8	693	3.90	0.0002
Dental Exams	Ethnicity *Age	8	681	2.73	0.0057
	Ethnicity *Region	16	684	2.09	0.0075
	Age*Region	8	680	1.83	0.0689
Dental Treatment	Ethnicity *Age	8	698	4.08	<.0001
	Ethnicity *Region	16	699	1.73	0.0375
	Age*Region	8	698	1.58	0.1264
Preventive Dental Services	Ethnicity *Age	8	692	2.98	0.0028
	Ethnicity *Region	16	694	4.35	<.0001
	Age*Region	8	691	1.39	0.1983
Restorative Dental Treatment	Ethnicity *Age	8	702	3.52	0.0005
	Ethnicity *Region	16	704	2.36	0.0020
	Age*Region	8	701	2.54	0.0099
Treatment for Caries	Ethnicity *Age	8	696	3.27	0.0011
	Ethnicity *Region	16	698	2.66	0.0004
	Age*Region	8	695	5.56	<.0001

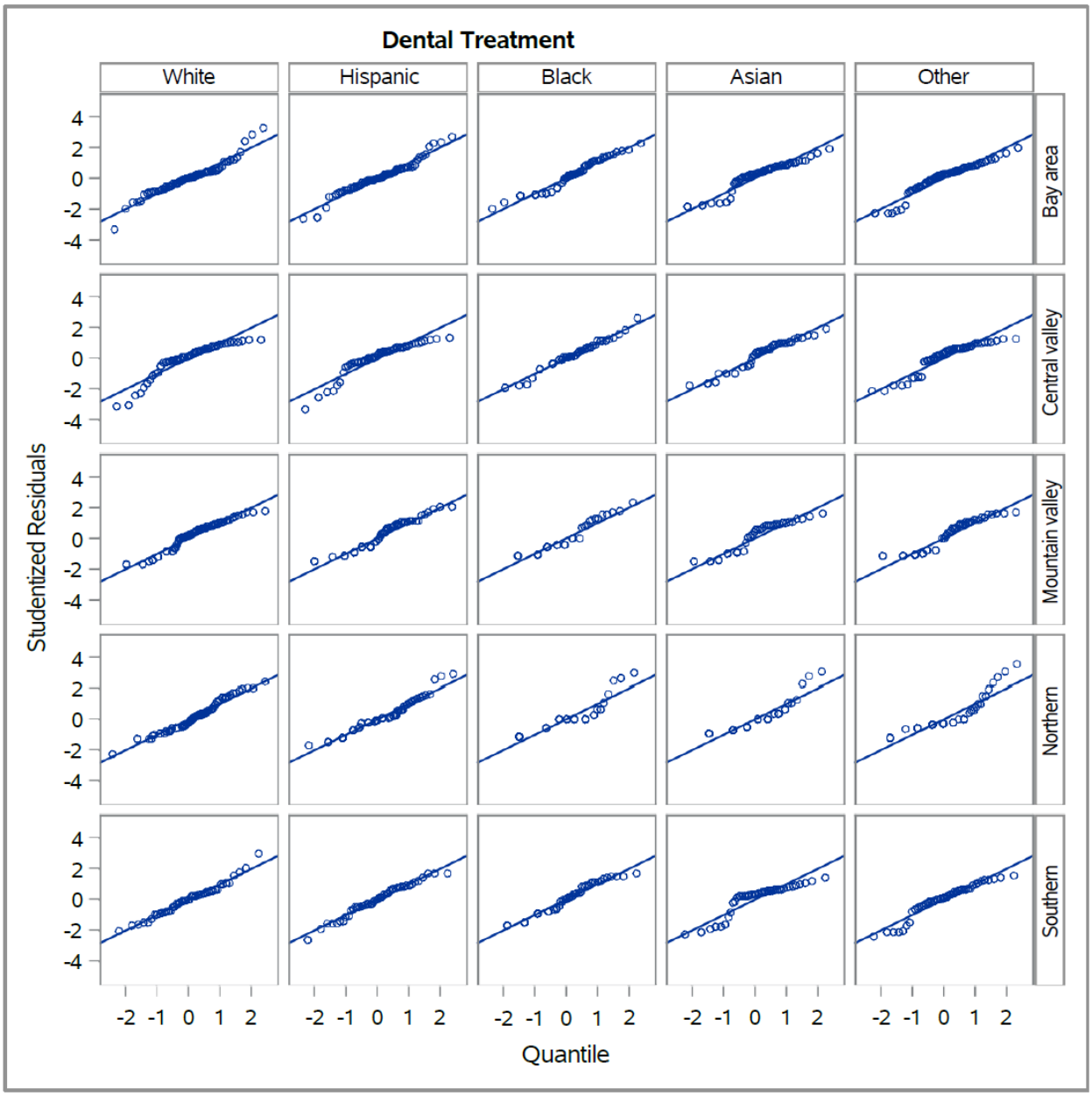
Appendix D. Studendized Residual Plots from Mixed Model Analysis

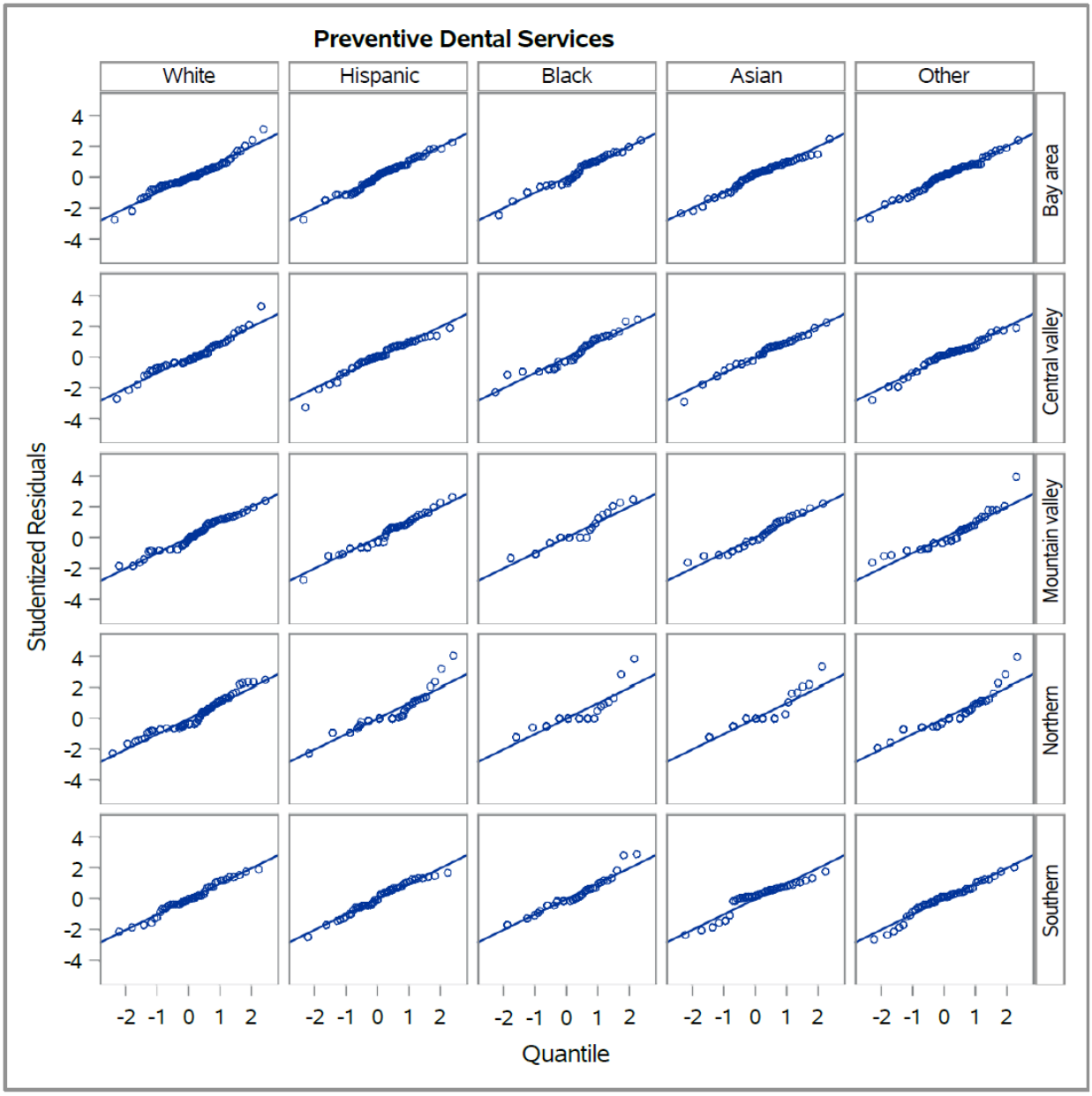
Evaluating Age Effect within Each Ethnicity Group and Geographic Region

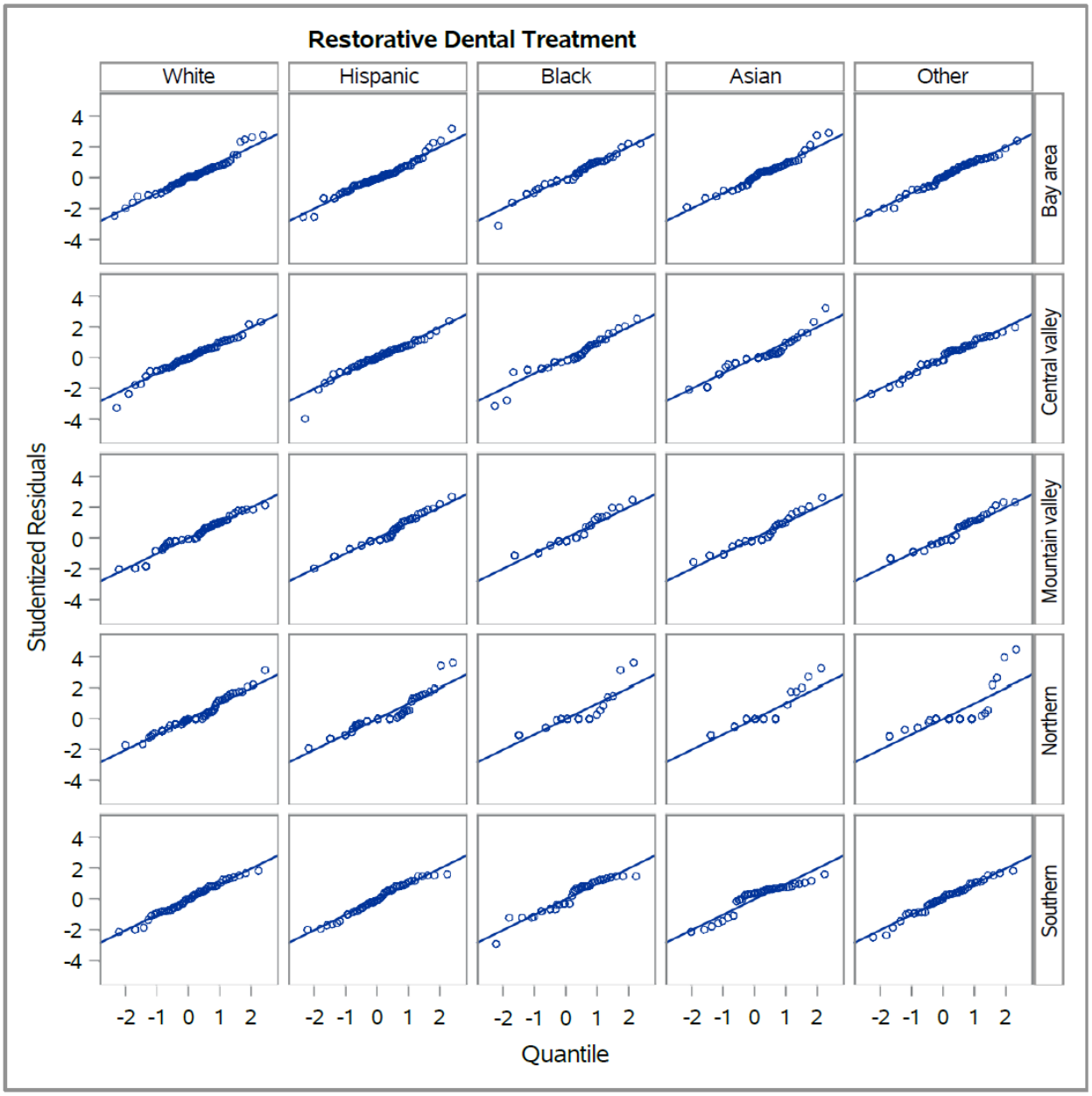
by Type of Dental Services

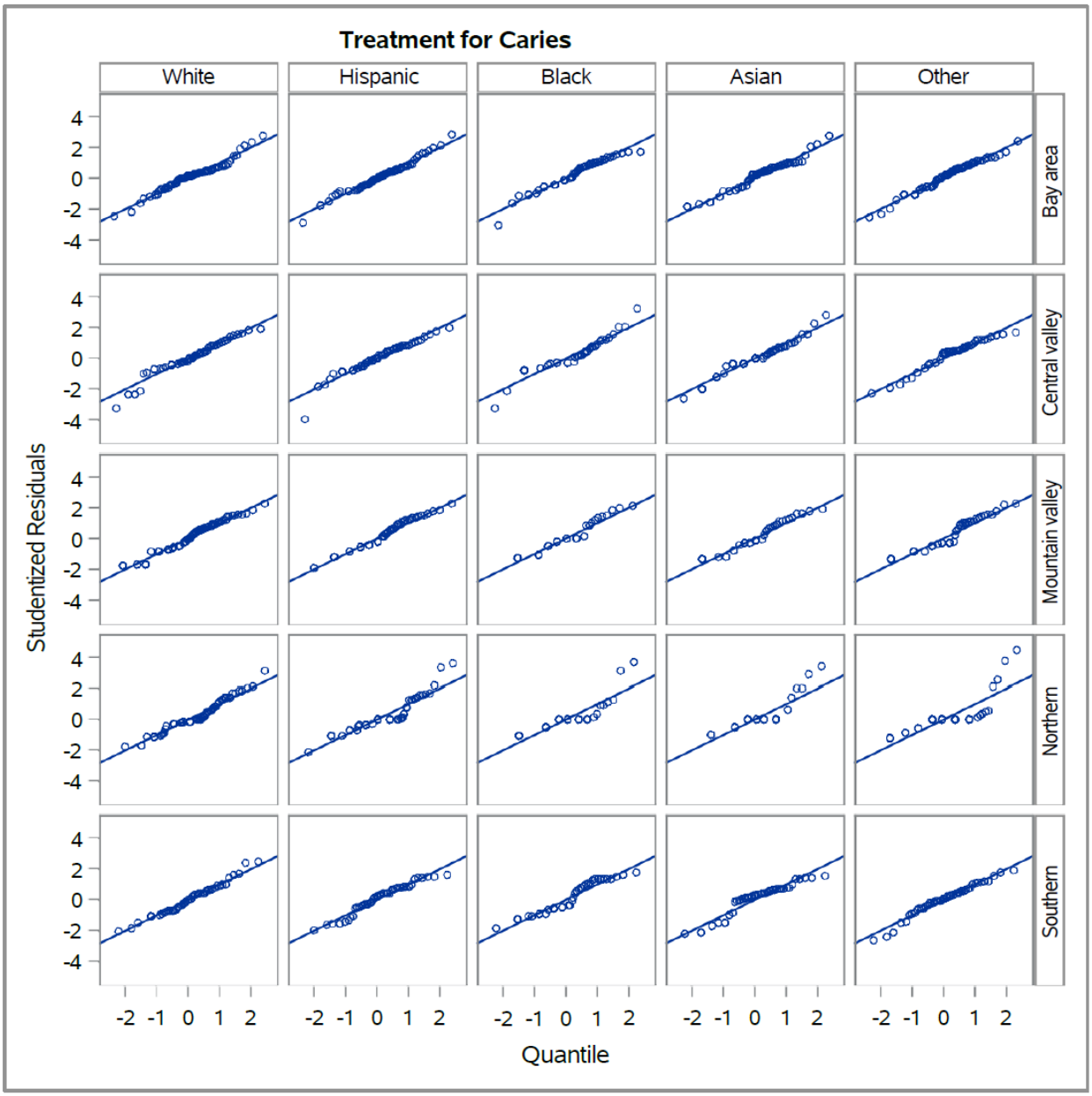



Dental Exams
White
Hispanic
Black
Asian
Other
Bay area
Central valley
Mountain valley
Northern
Southern
Studentized Residuals
Quantile
4
2
0
-2
-4
-2 -1 0 1 2

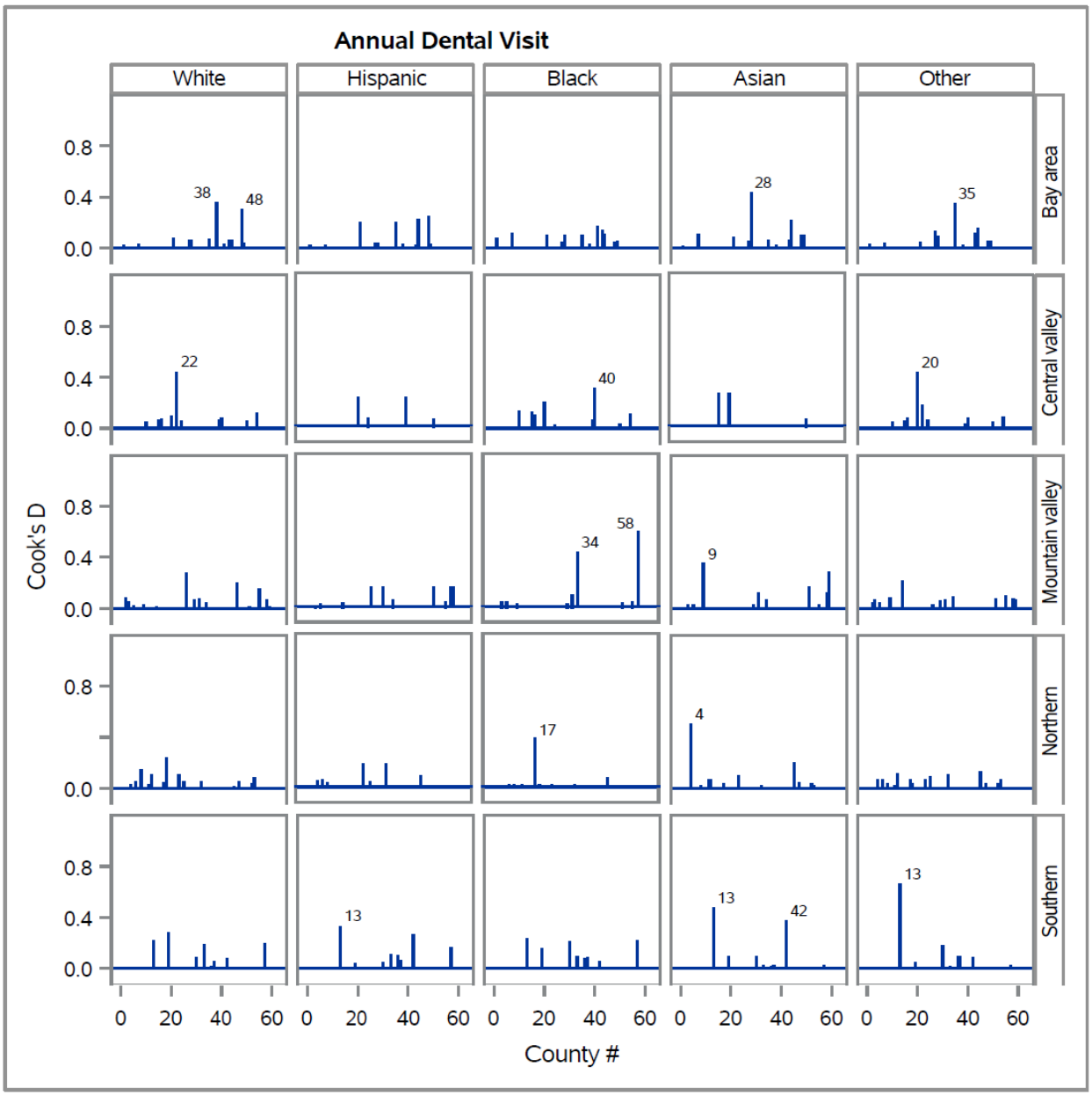

Dental Treatment
White
Hispanic
Black
Asian
Other
Bay area
Central valley
Mountain valley
Northern
Southern
Studentized Residuals
Quantile
4
2
0
-2
-4
-2 -1 0 1 2

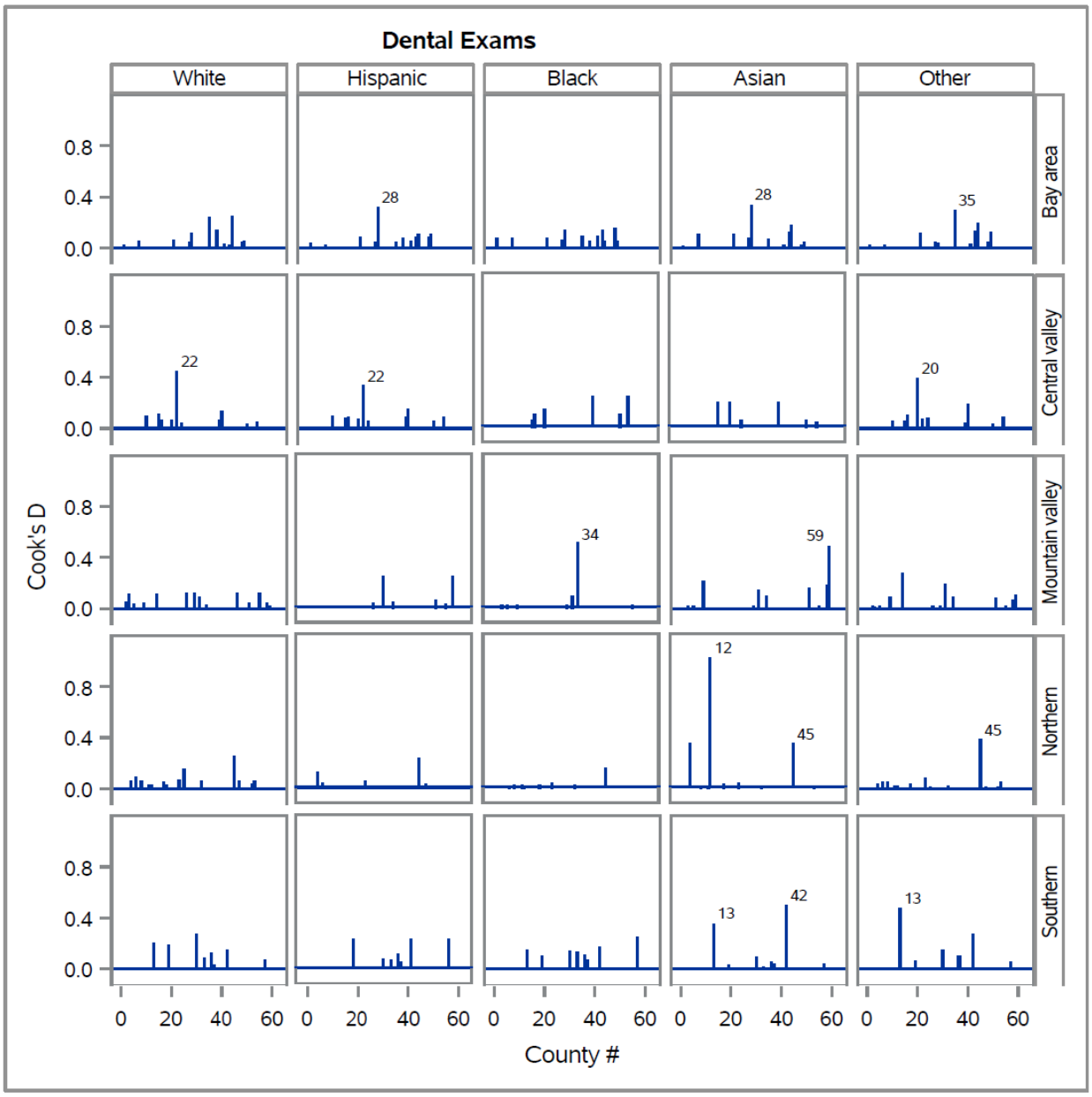

Preventive Dental Services
White
Hispanic
Black
Asian
Other
Bay area
Central valley
Mountain valley
Northern
Southern
Studentized Residuals
Quantile
4
2
0
-2
-4
-2 -1 0 1 2

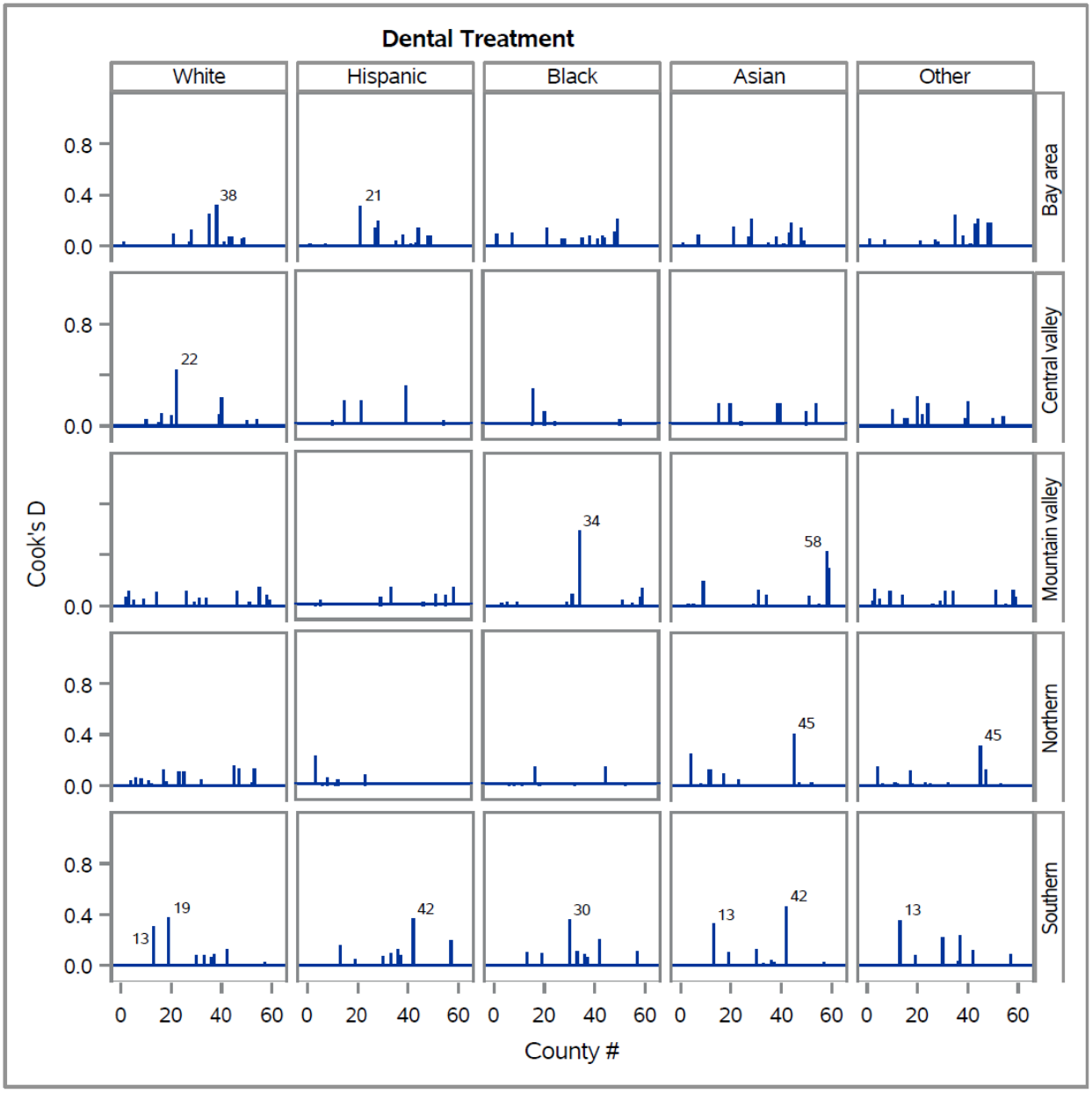

Restorative Dental Treatment
White
Hispanic
Black
Asian
Other
Bay area
Central valley
Mountain valley
Northern
Southern
Studentized Residuals
Quantile
4
2
0
-2
-4
-2 -1 0 1 2

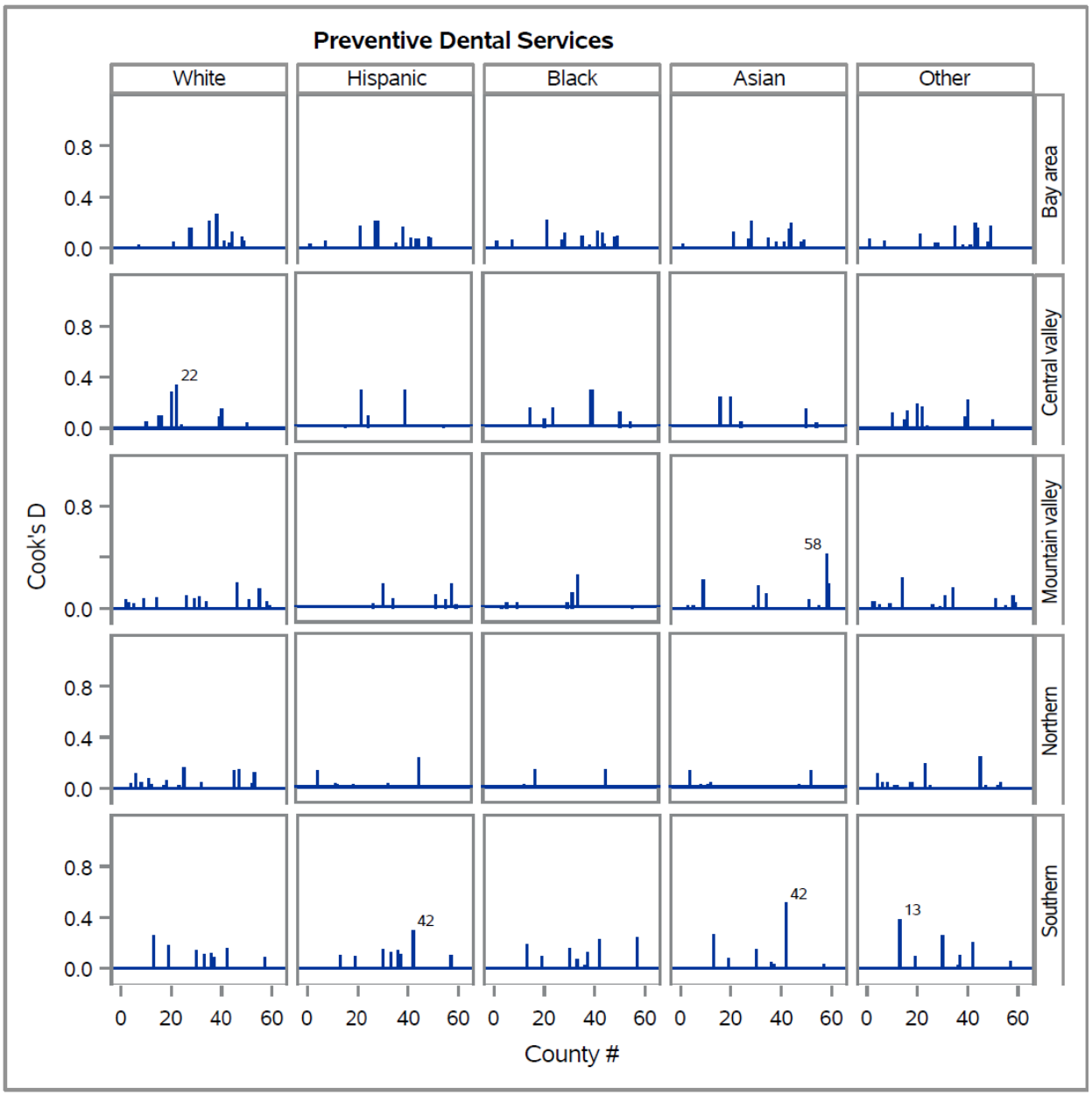

Treatment for Caries
White
Hispanic
Black
Asian
Other
Bay area
Central valley
Mountain valley
Northern
Southern
Studentized Residuals
Quantile
4
2
0
-2
-4
-2 -1 0 1 2

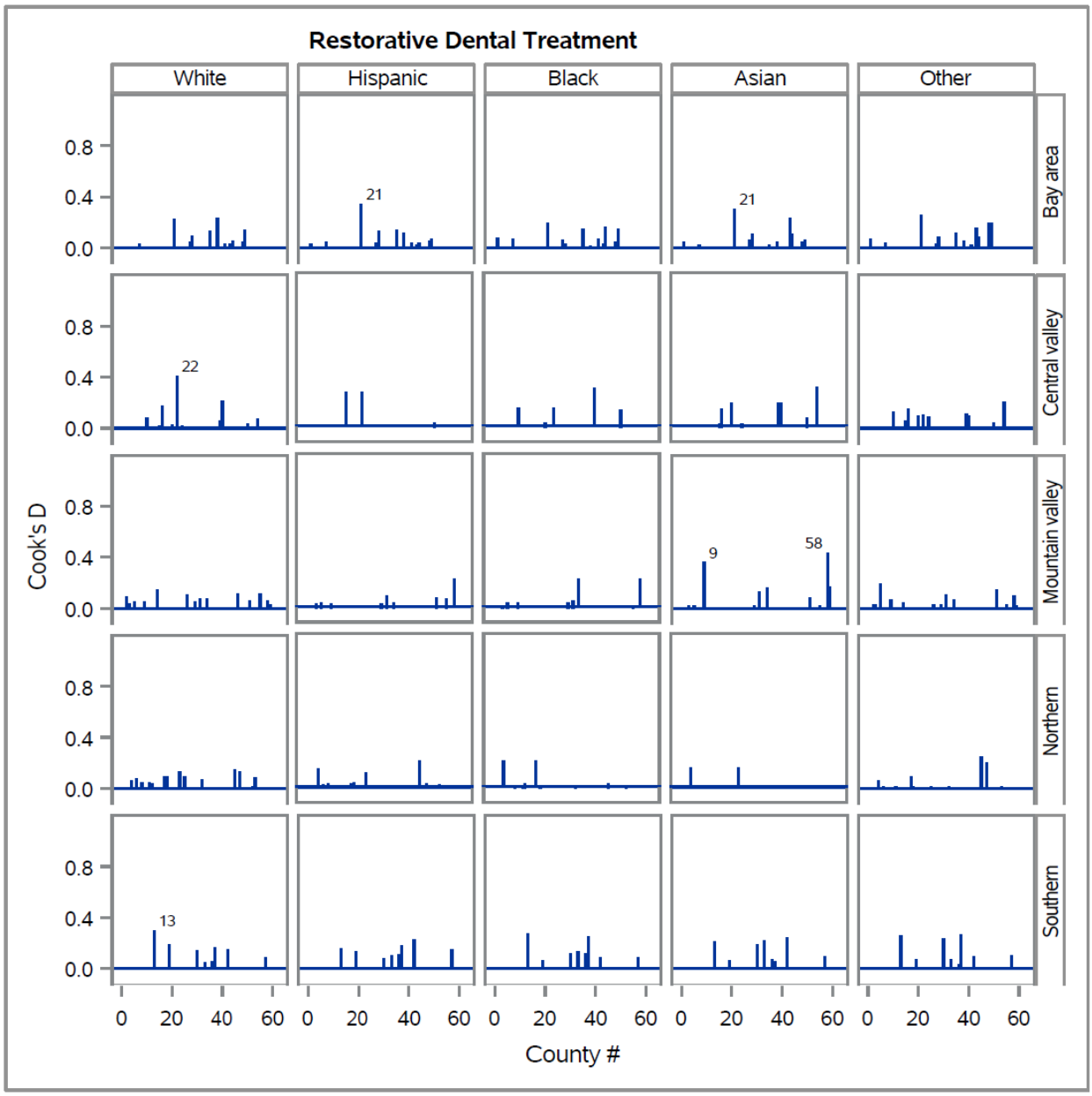
Appendix E. Needle Plots of Cook's Distances from Mixed Model Analysis Evaluating Age Effect within Each Ethnicity Group and Geographic Region by Type of Dental Services

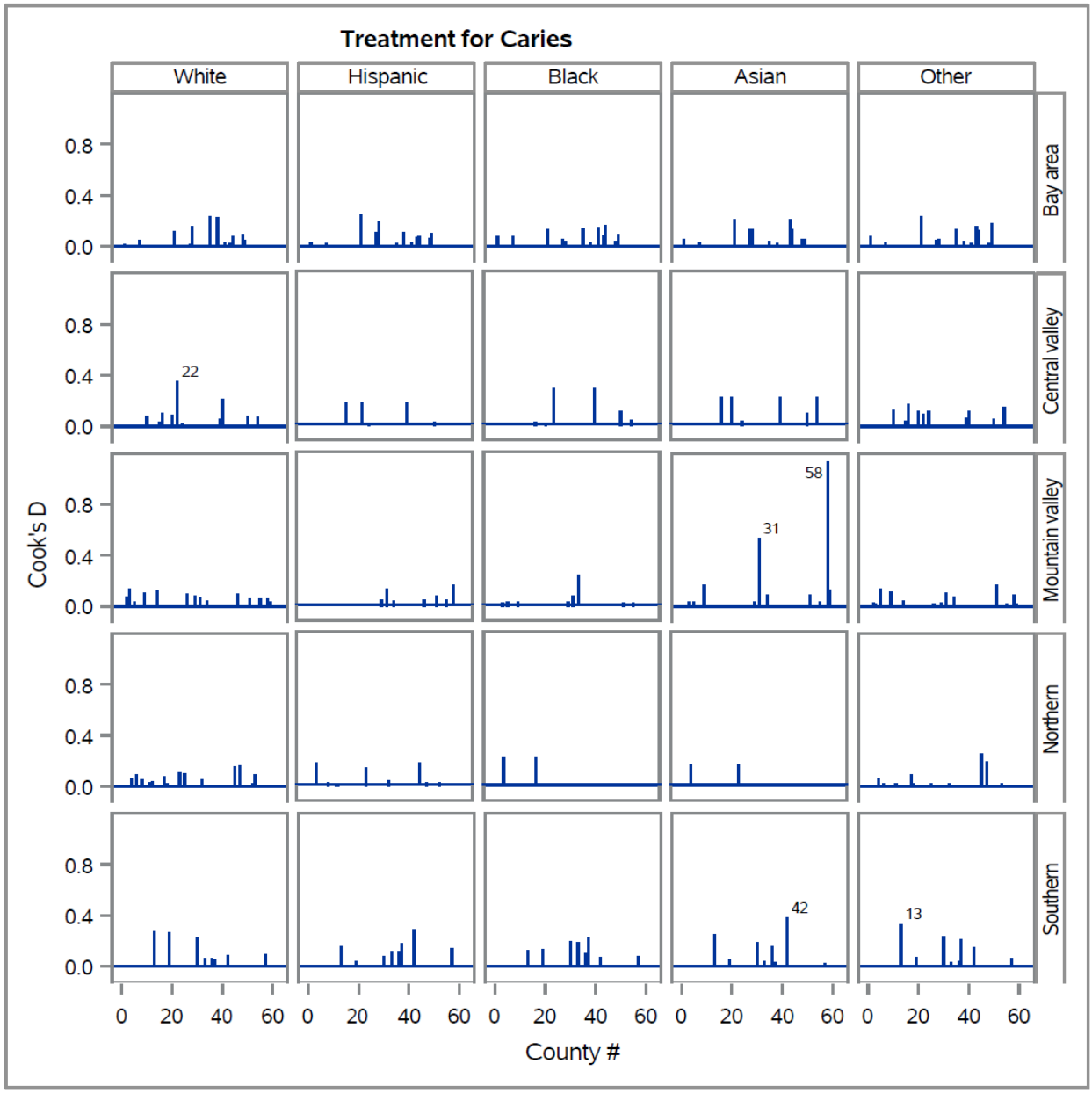



Dental Exams
White
Hispanic
Black
Asian
Other
Bay area
Central valley
Mountain valley
Northern
Southern
Cook's D
0.0
0.4
0.8
0
20
40
60
County #
28
28
35
22
22
20
34
59
12
45
45
13
42
13

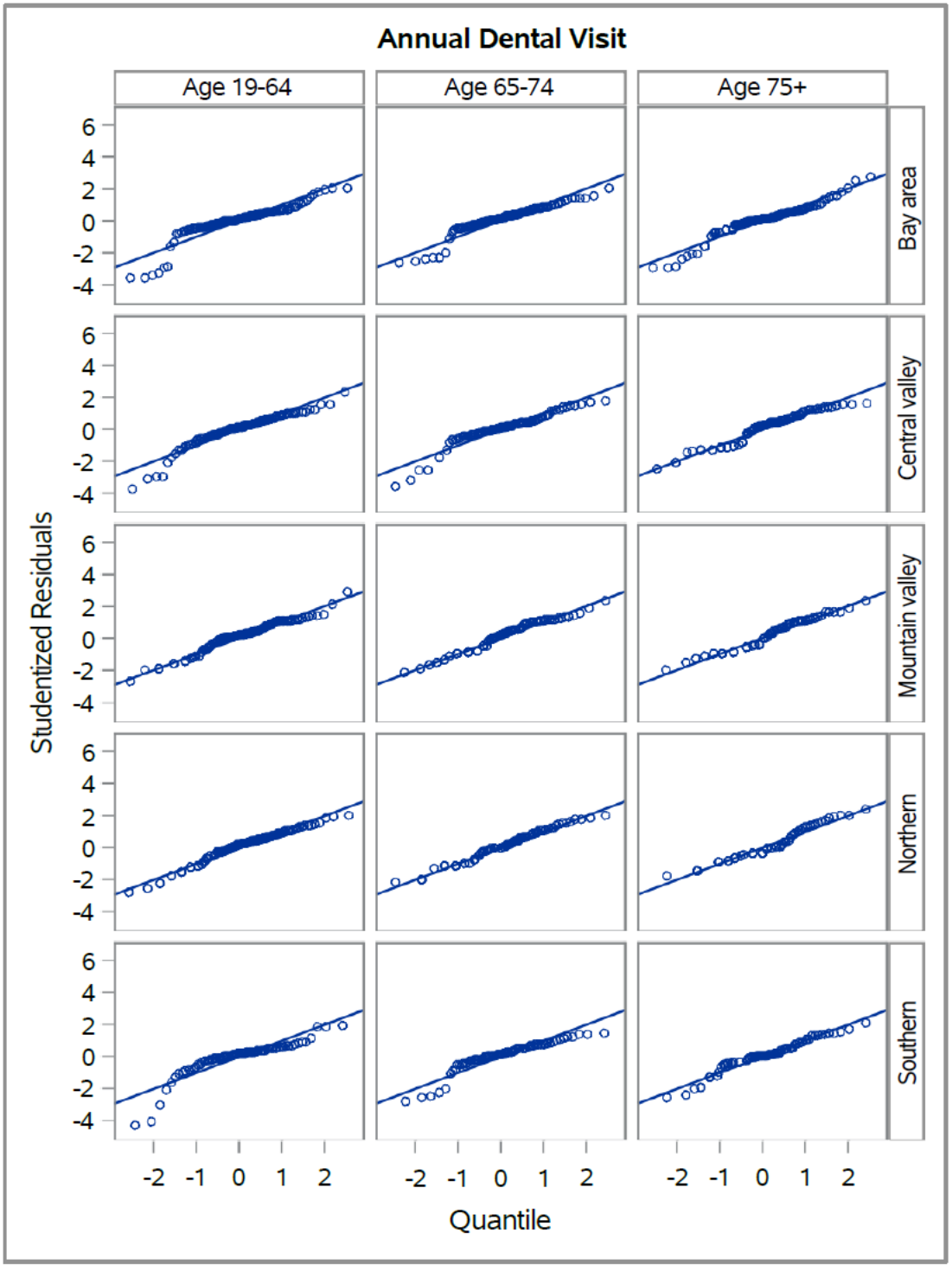

Dental Treatment
White
Hispanic
Black
Asian
Other
Bay area
Central valley
Mountain valley
Northern
Southern
Cook's D
0.0
0.4
0.8
38
21
22
34
58
45
45
13
19
42
30
13
42
13
0
20
40
60
County #

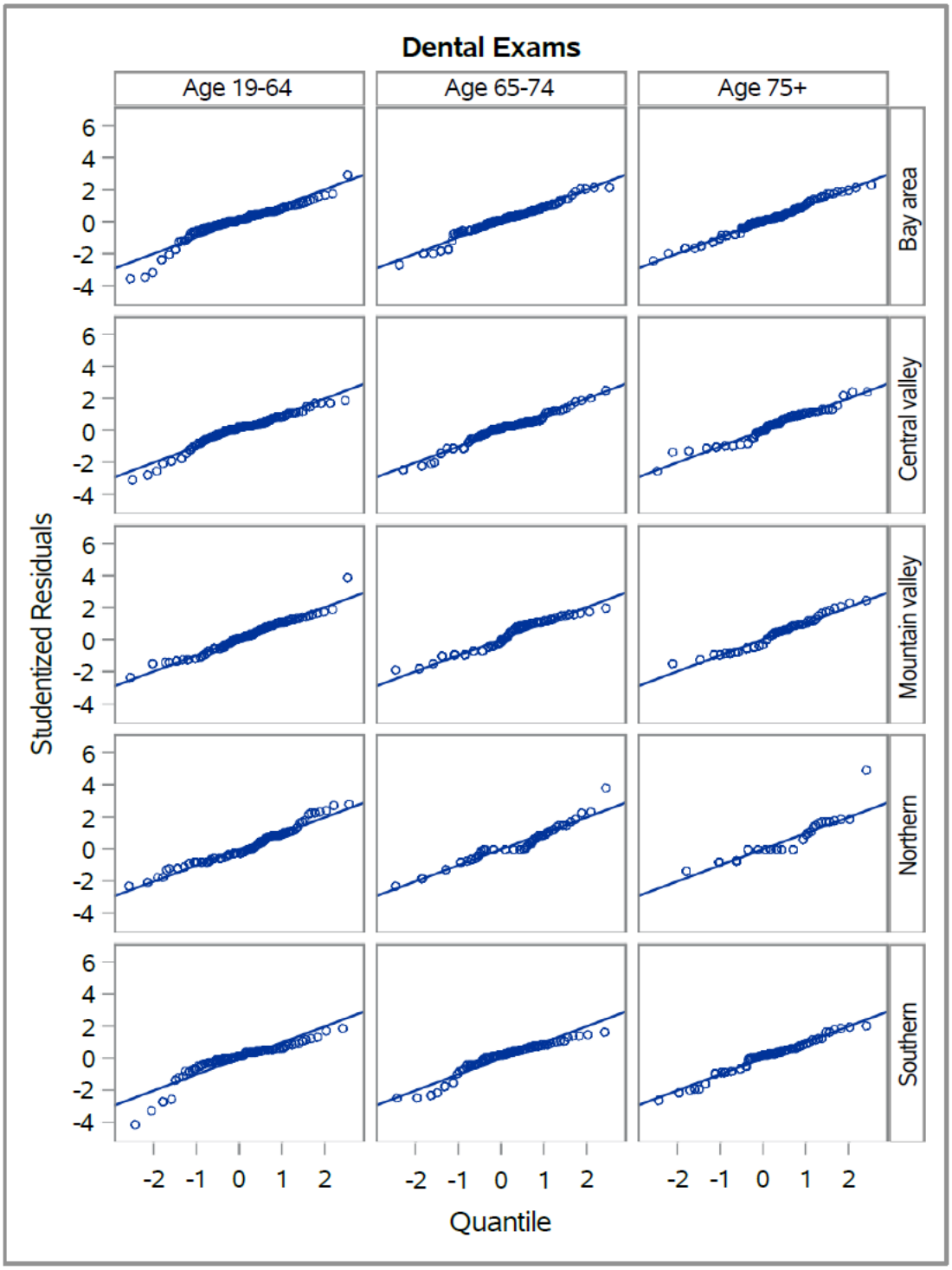

Preventive Dental Services
White
Hispanic
Black
Asian
Other
Bay area
Central valley
Mountain valley
Northern
Southern
Cook's D
0.0
0.4
0.8
22
58
42
42
13
0
20
40
60
County #

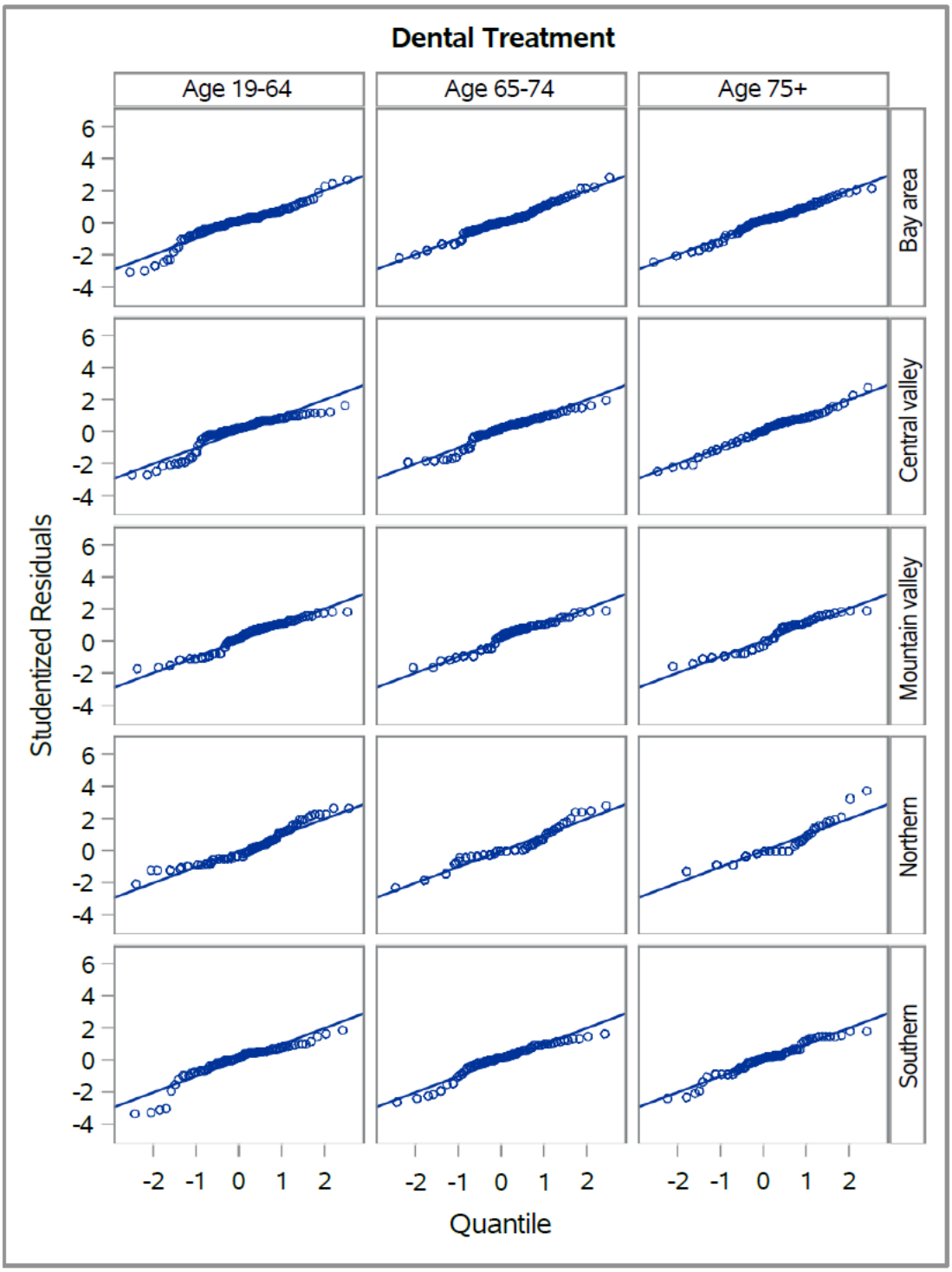

Restorative Dental Treatment
White
Hispanic
Black
Asian
Other
Bay area
Central valley
Mountain valley
Northern
Southern
Cook's D
0.0
0.4
0.8
21
21
22
9
58
13
0
20
40
60
County #

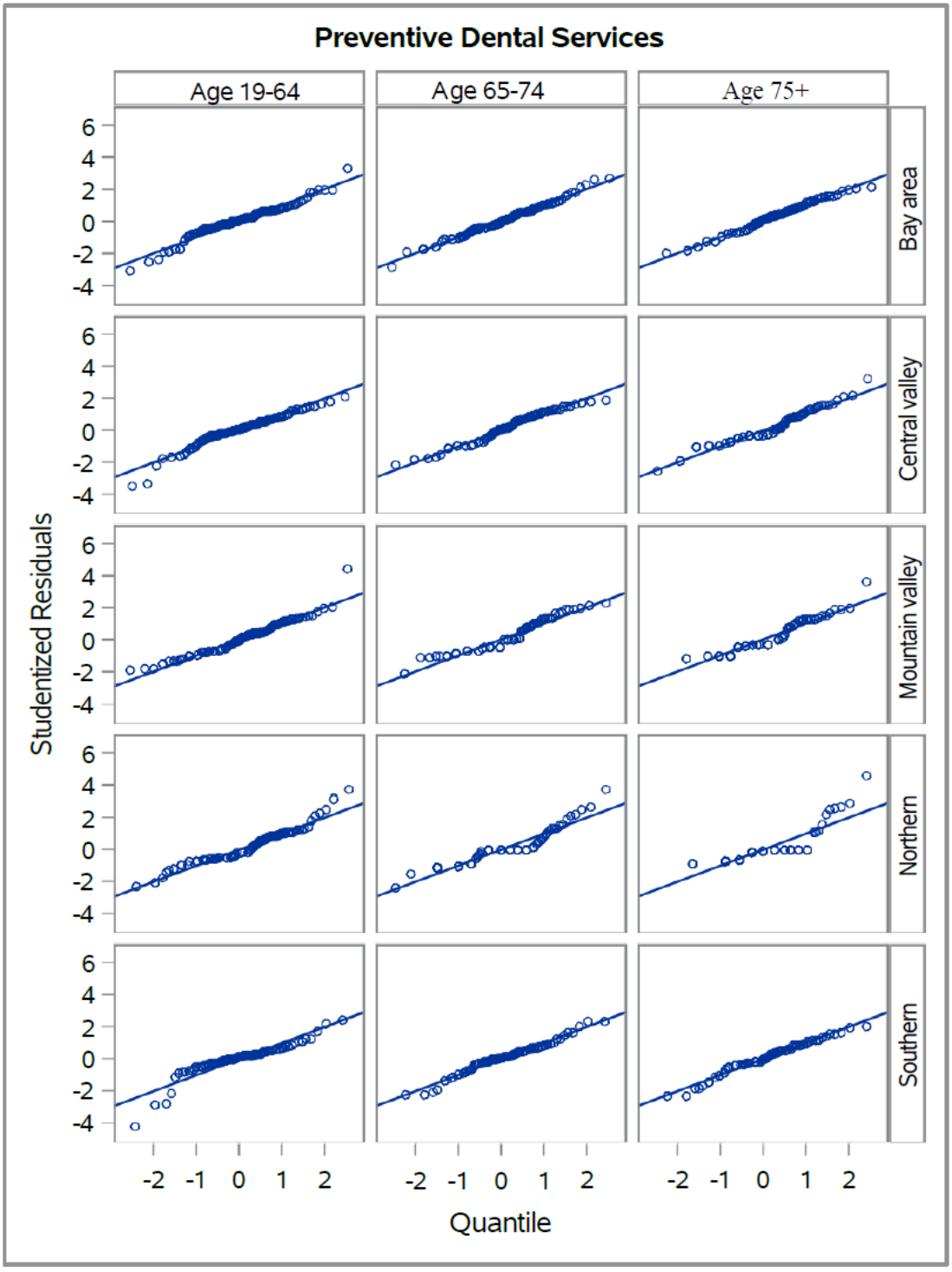

Treatment for Caries
White
Hispanic
Black
Asian
Other
Bay area
Central valley
Mountain valley
Northern
Southern
Cook's D
0.0
0.4
0.8
22
58
31
42
13
0
20
40
60
County #

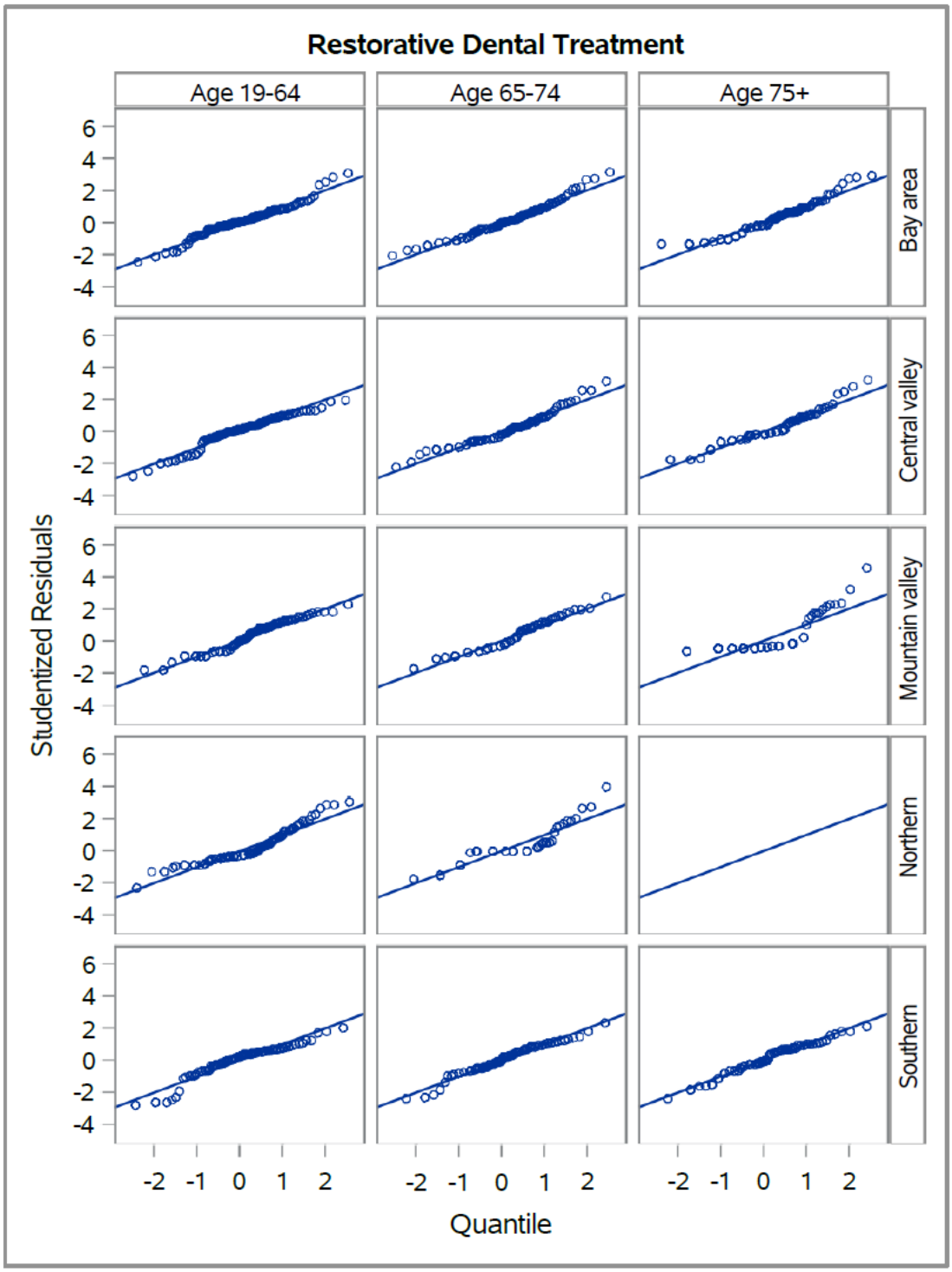
Appendix F. Studendized Residual Plots from Mixed Model Analysis Evaluating Ethnicity Effects within Each Age Group and Geographic Region by Type of Dental Services

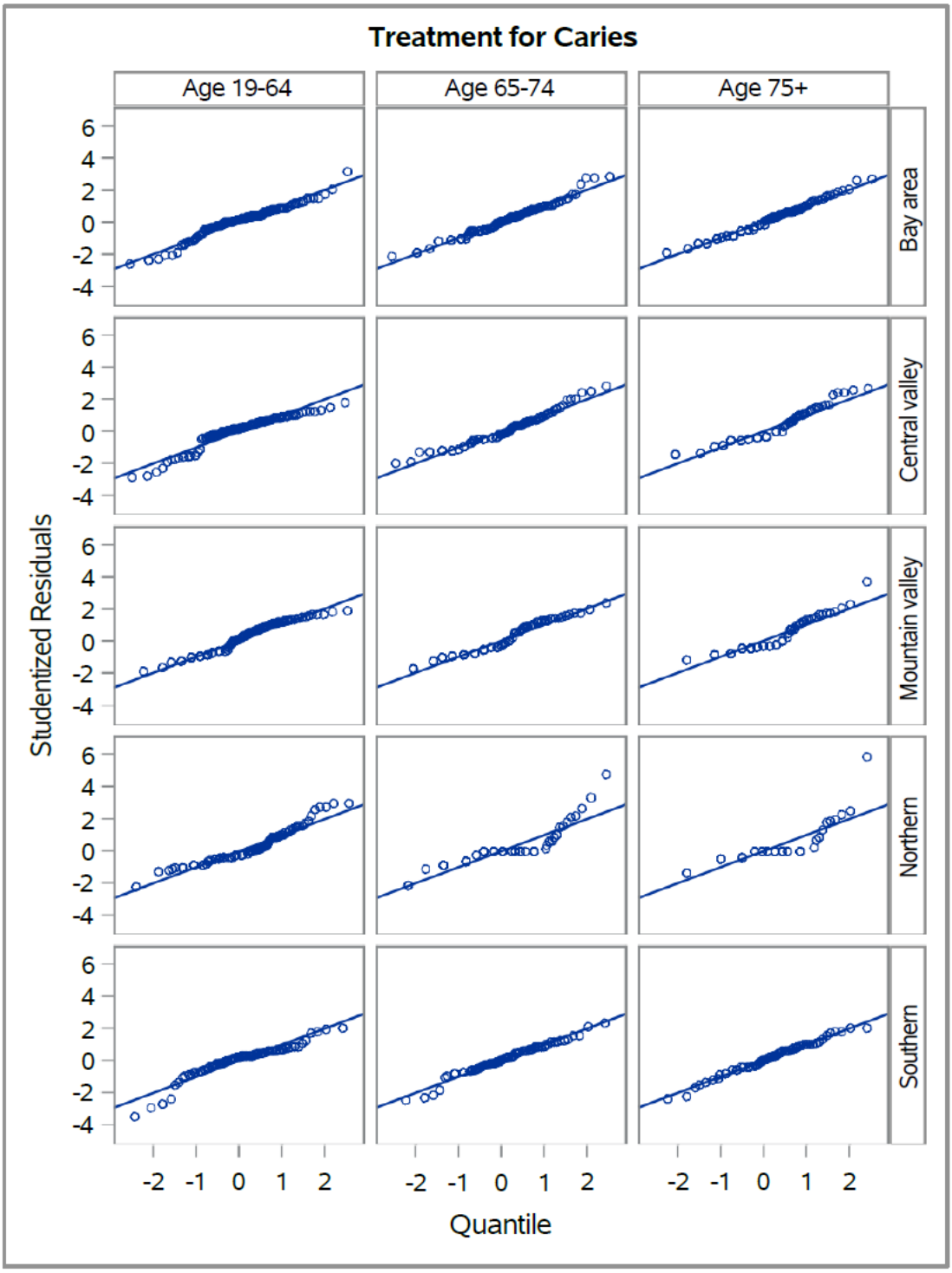



Dental Exams
Age 19-64
Age 65-74
Age 75+
Bay area
Central valley
Mountain valley
Northern
Southern
Studentized Residuals
Quantile
6
4
2
0
-2
-4
-2 -1 0 1 2

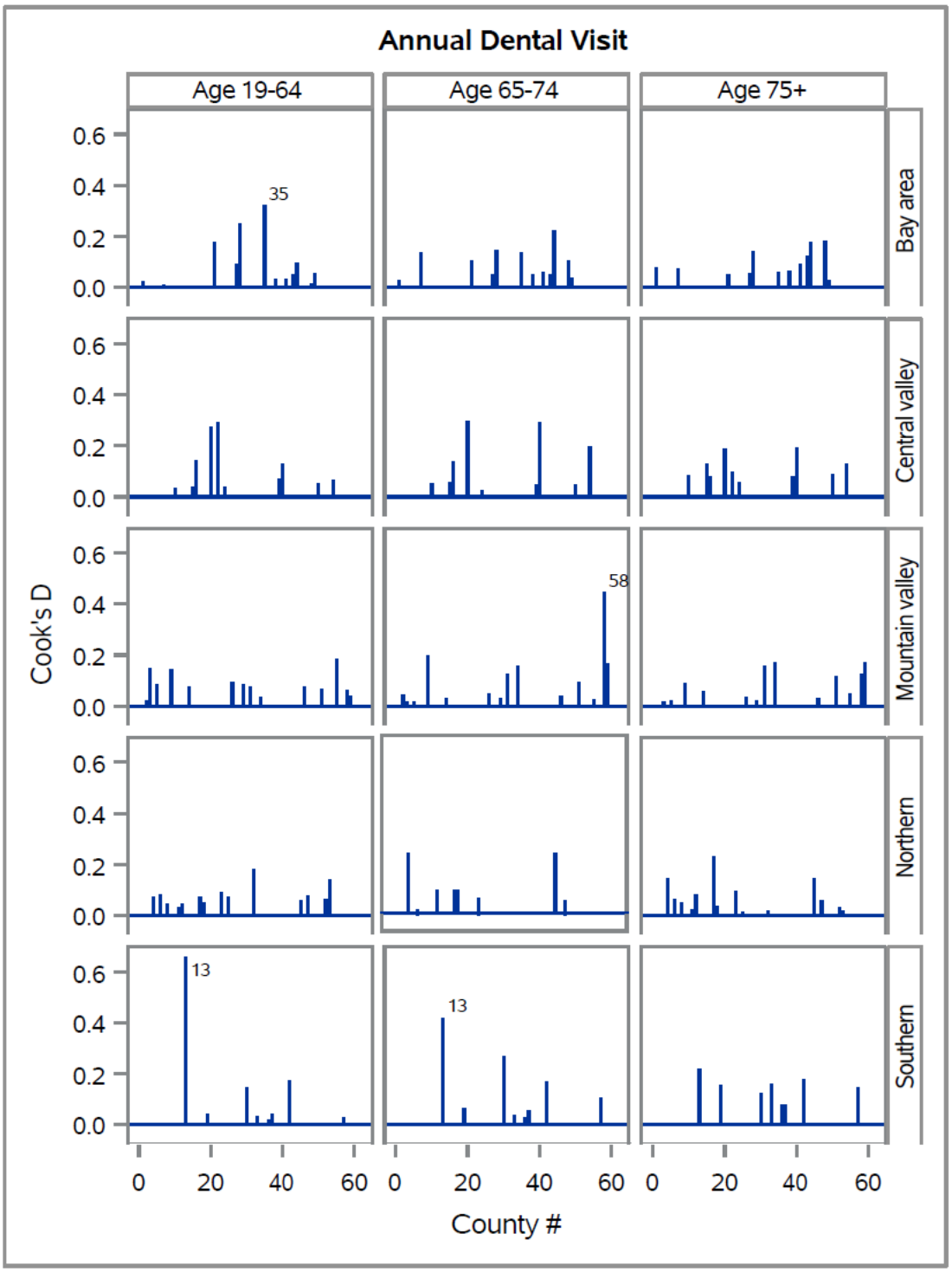

Dental Treatment
Age 19-64
Age 65-74
Age 75+
Bay area
Central valley
Mountain valley
Northern
Southern
Studentized Residuals
Quantile
6
4
2
0
-2
-4
-2 -1 0 1 2

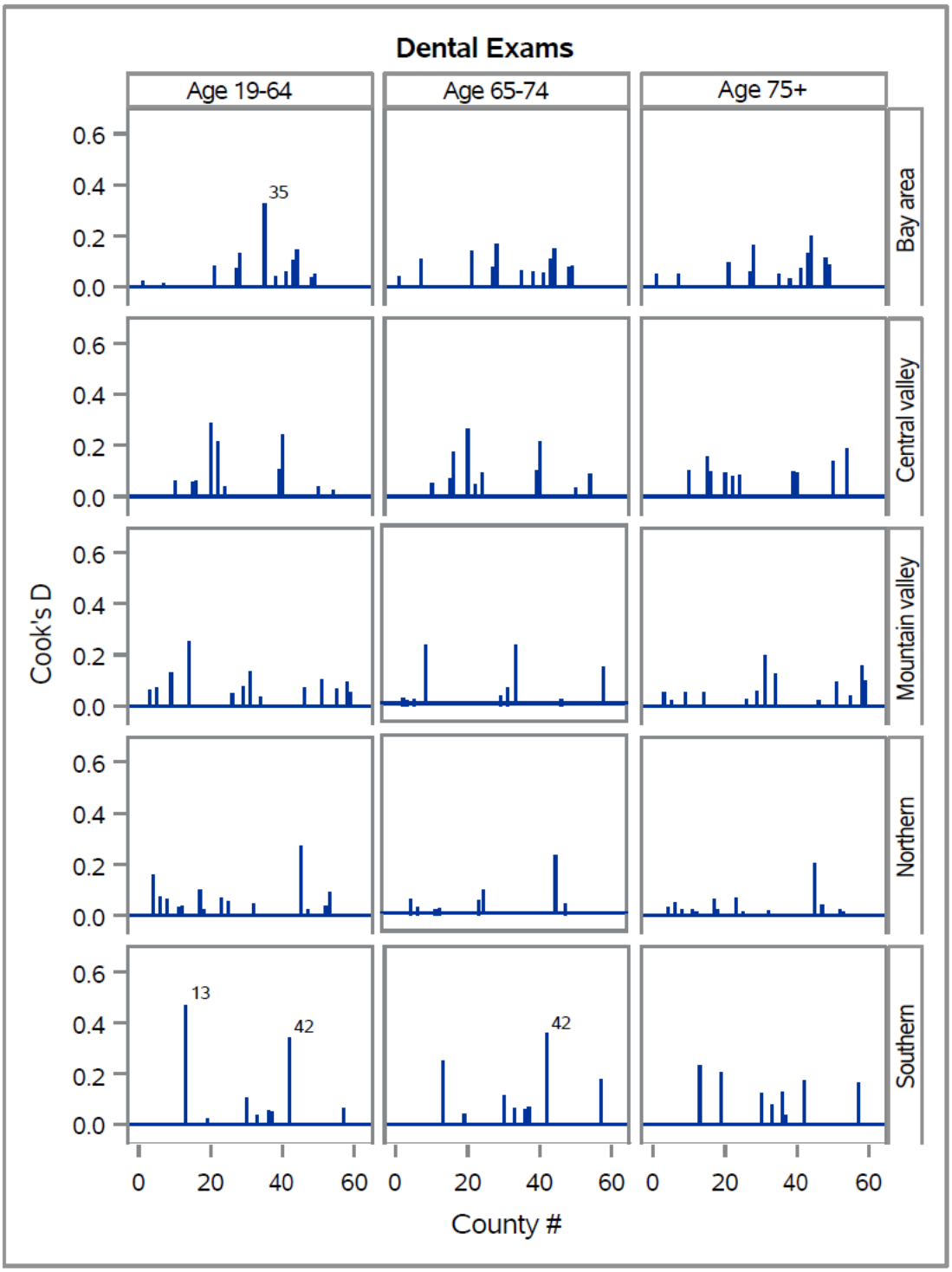

Preventive Dental Services
Age 19-64
Age 65-74
Age 75+
Bay area
Central valley
Mountain valley
Northern
Southern
Studentized Residuals
Quantile
6
4
2
0
-2
-4
-2 -1 0 1 2

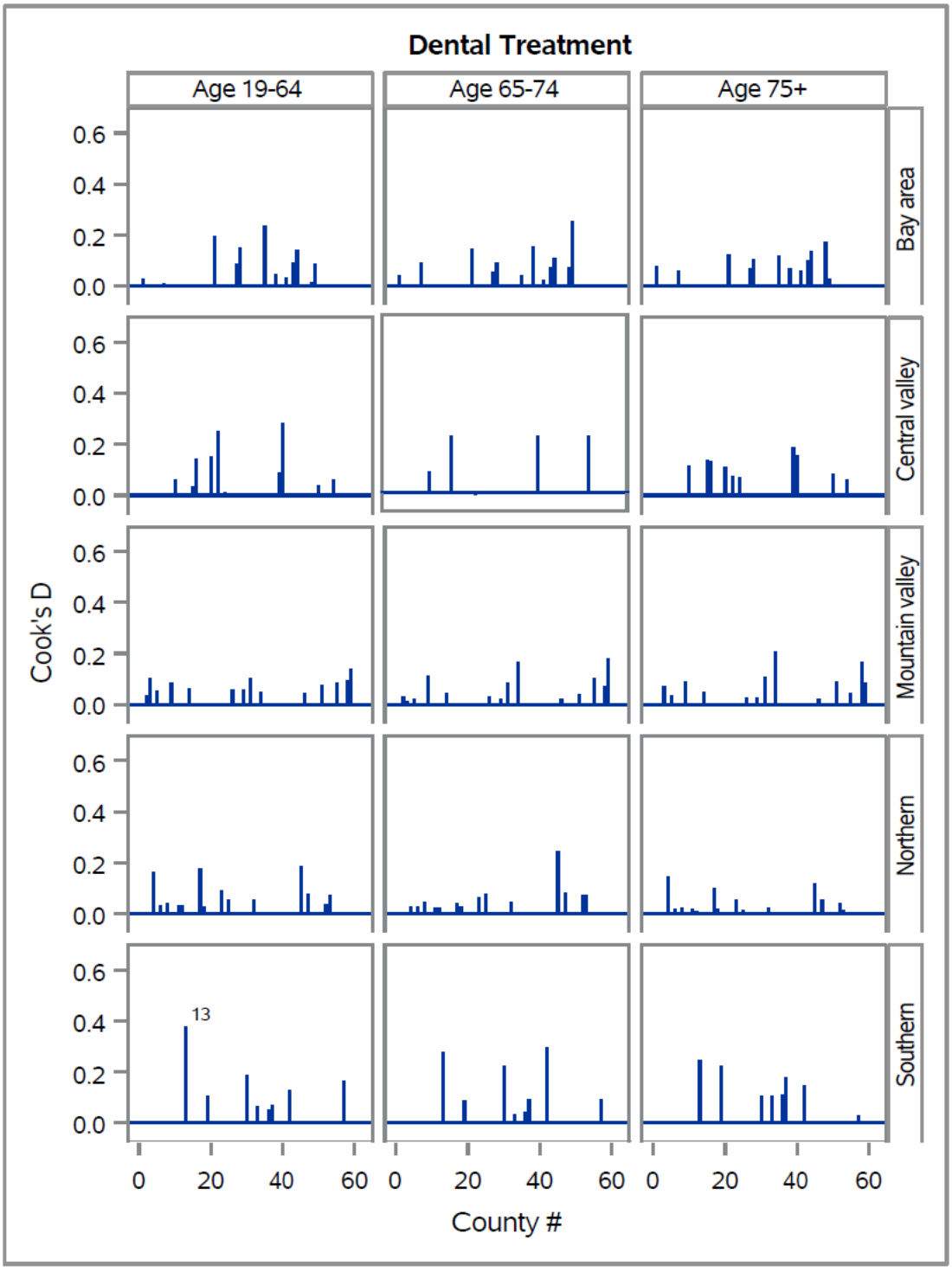

Restorative Dental Treatment
Age 19-64
Age 65-74
Age 75+
Bay area
Central valley
Mountain valley
Northern
Southern
Studentized Residuals
6
4
2
0
-2
-4
-2 -1 0 1 2
Quantile

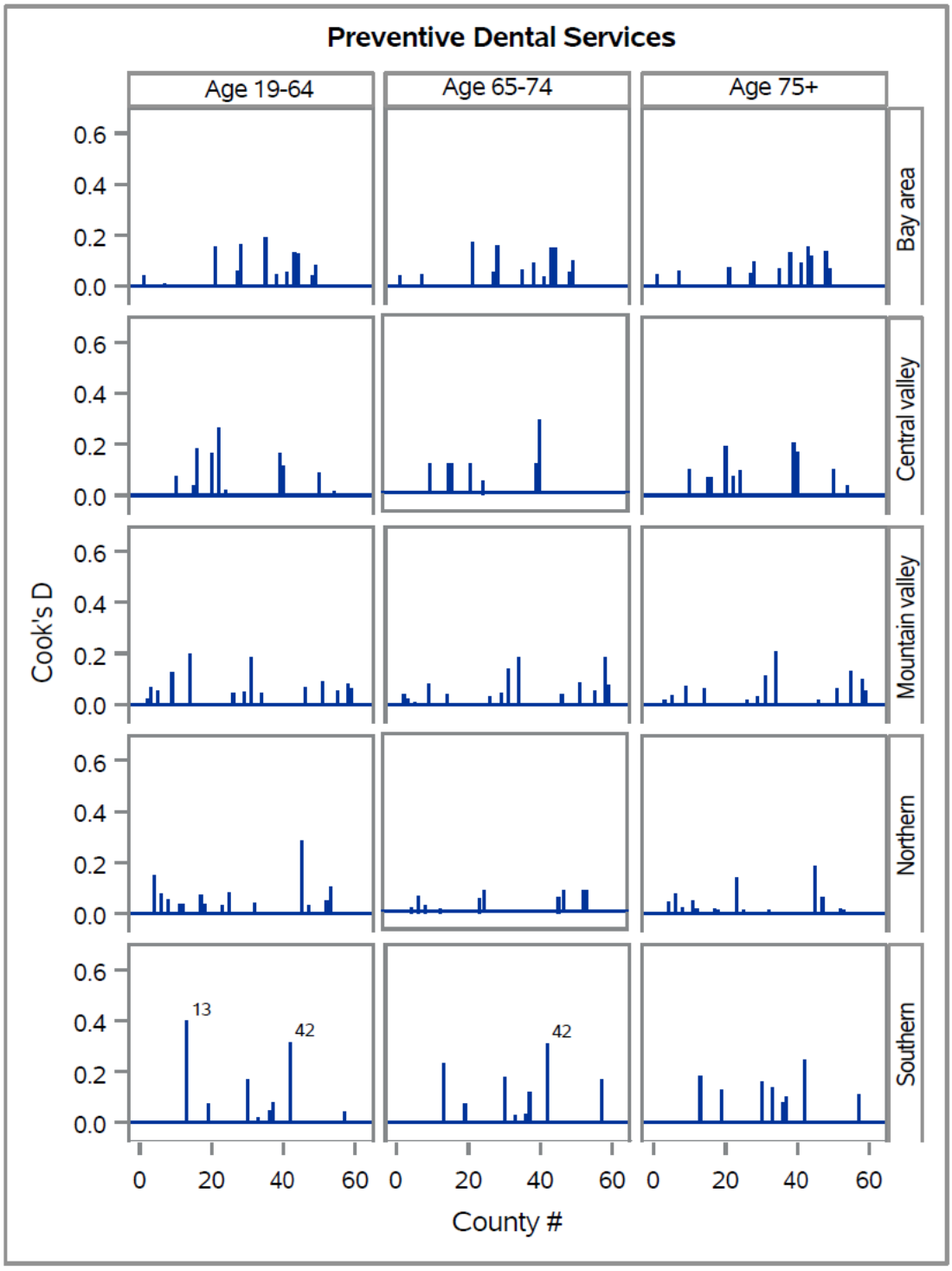

Treatment for Caries
Age 19-64
Age 65-74
Age 75+
Bay area
Central valley
Mountain valley
Northern
Southern
Studentized Residuals
Quantile
6
4
2
0
-2
-4
-2 -1 0 1 2

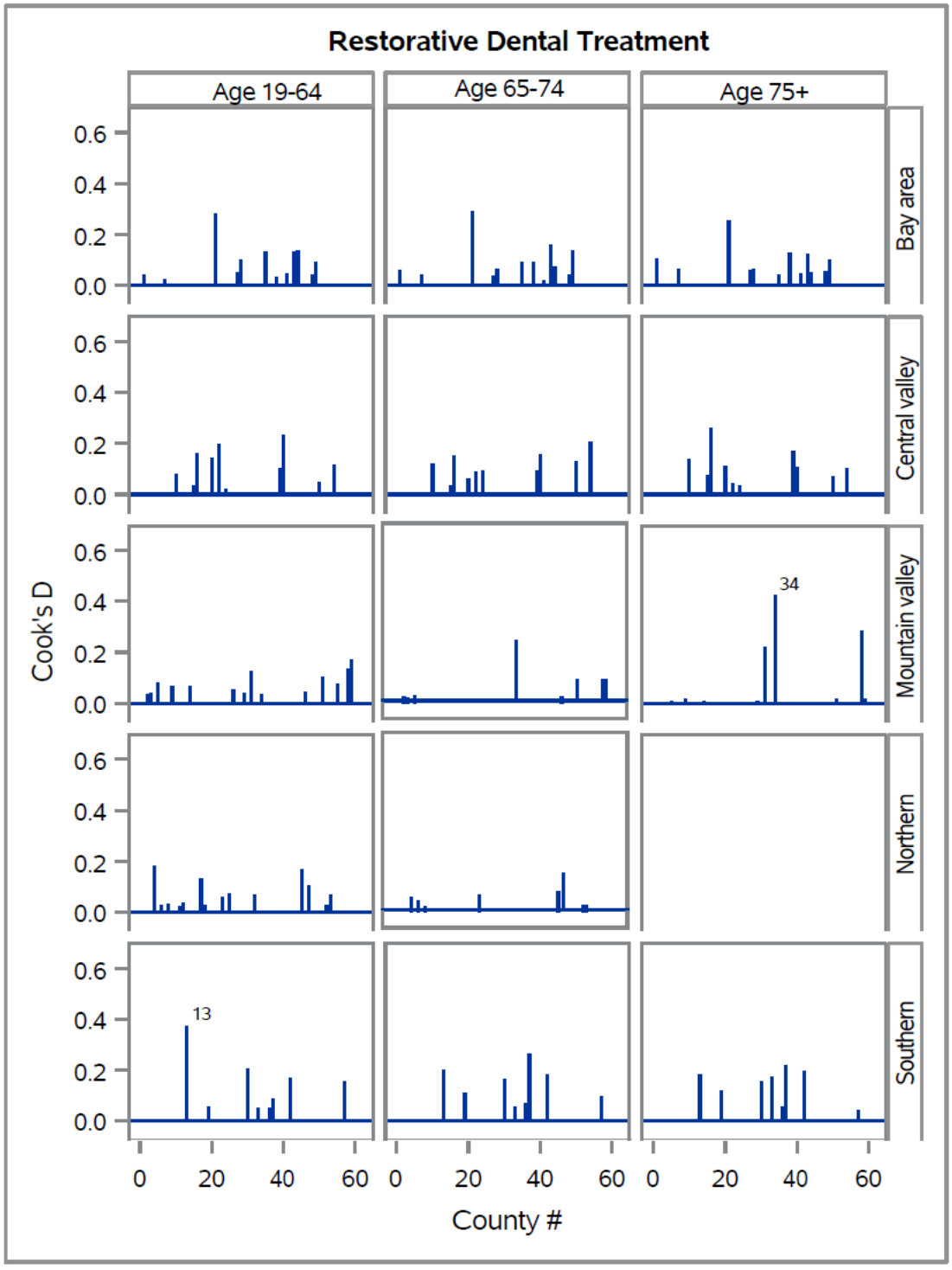
Appendix G. Needle Plots of Cook's Distances from Mixed Model Analysis Evaluating Ethnicity Effect within Age Ethnicity Group and Geographic Region by Type of Dental Services

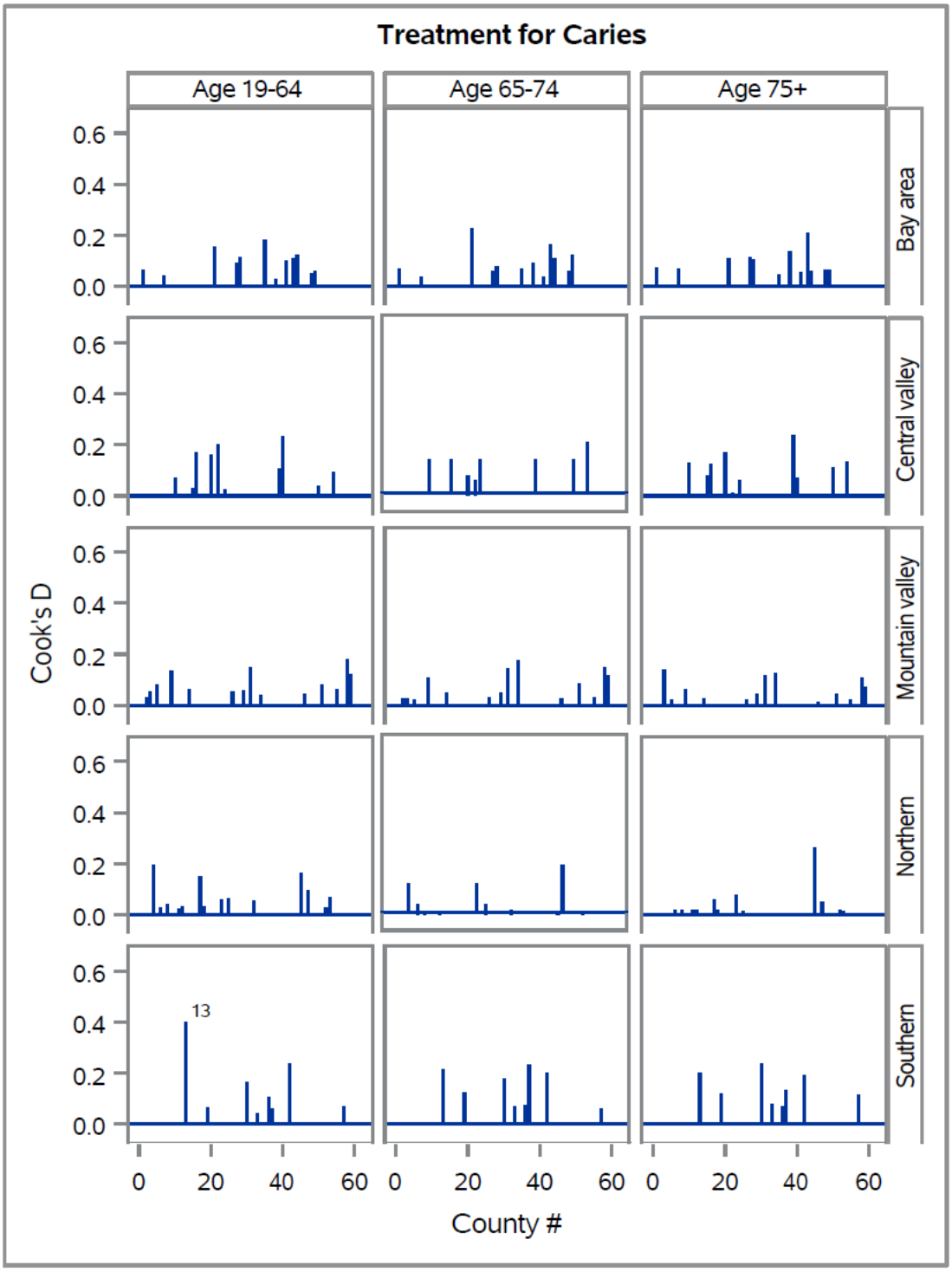



Dental Exams
Age 19-64
Age 65-74
Age 75+
Bay area
Central valley
Mountain valley
Northern
Southern
Cook's D
0.0
0.2
0.4
0.6
35
13
42
42
0
20
40
60
County #


Dental Treatment
Age 19-64
Age 65-74
Age 75+
Bay area
Central valley
Mountain valley
Northern
Southern
Cook's D
0.0
0.2
0.4
0.6
13
0
20
40
60
County #


Preventive Dental Services
Age 19-64
Age 65-74
Age 75+
Bay area
Central valley
Mountain valley
Northern
Southern
Cook's D
0.0
0.2
0.4
0.6
13
42
42
0
20
40
60
County #


Restorative Dental Treatment
Age 19-64
Age 65-74
Age 75+
Bay area
Central valley
Mountain valley
Northern
Southern
Cook's D
0.0
0.2
0.4
0.6
34
13
0
20
40
60
County #


Treatment for Caries
Age 19-64
Age 65-74
Age 75+
Bay area
Central valley
Mountain valley
Northern
Southern
Cook's D
0.0
0.2
0.4
0.6
13
0
20
40
60
County #

Appendix H. Number of SNCs in Each County from 2012 to 2017

Region	County	2012	2013	2014	2015	2016	2017
Bay area	ALAMEDA	80	26	28	35	30	35
Bay area	CONTRA COSTA	12	12	12	11	10	11
Bay area	MARIN	3	4	5	4	4	4
Bay area	MONTEREY	7	8	8	7	9	7
Bay area	NAPA	1	2	3	3	3	3
Bay area	SAN BENITO	0	1	1	1	1	1
Bay area	SAN FRANCISCO	10	10	11	13	15	17
Bay area	SAN MATEO	4	7	4	6	6	7
Bay area	SANTA CLARA	8	13	14	17	19	19
Bay area	SANTA CRUZ	1	3	5	5	6	6
Bay area	SOLANO	1	5	5	6	5	7
Bay area	SONOMA	6	8	12	12	12	14
Central valley	FRESNO	21	15	14	12	14	16
Central valley	KERN	19	16	14	16	17	20
Central valley	KINGS	7	4	5	5	5	8
Central valley	MADERA	2	3	4	4	3	4
Central valley	MARIPOSA	1	1	1	3	2	1
Central valley	MERCED	7	7	7	8	8	10
Central valley	SAN JOAQUIN	2	1	2	1	2	5
Central valley	SAN LUIS OBISPO	6	6	4	4	3	6
Central valley	STANISLAUS	4	5	6	5	7	10
Central valley	TULARE	8	11	20	18	18	20
Mountain valley	AMADOR	1	1	1	1	1	0
Mountain valley	CALAVERAS	0	0	0	0	0	4
Mountain valley	EL DORADO	2	2	4	2	3	3
Mountain valley	INYO	0	1	3	0	0	0
Mountain valley	MONO	2	2	2	3	2	2

Region	County	2012	2013	2014	2015	2016	2017
Mountain valley	NEVADA	3	3	3	3	3	3
Mountain valley	PLACER	1	2	2	2	3	3
Mountain valley	SACRAMENTO	4	5	9	11	11	12
Mountain valley	SIERRA	1	1	1	1	1	1
Mountain valley	SUTTER	0	0	3	0	0	4
Mountain valley	TUOLUMNE	3	3	3	3	3	2
Mountain valley	YOLO	5	5	5	5	5	5
Mountain valley	YUBA	2	2	2	2	2	2
Northern	BUTTE	9	12	9	5	13	14
Northern	COLUSA	2	3	4	4	4	3
Northern	DEL NORTE	3	3	1	1	1	3
Northern	GLENN	2	2	3	2	2	4
Northern	HUMBOLDT	4	5	5	4	4	6
Northern	LAKE	3	3	3	4	4	4
Northern	LASSEN	3	3	3	4	4	4
Northern	MENDOCINO	8	11	8	8	8	8
Northern	MODOC	1	1	1	1	1	1
Northern	PLUMAS	3	3	3	3	3	4
Northern	SHASTA	7	8	8	6	7	8
Northern	SISKIYOU	3	4	4	5	5	5
Northern	TEHAMA	4	6	7	8	6	7
Northern	TRINITY	3	2	1	1	1	1
Out of State	OUT OF STATE	1	1	1	1	1	1
Southern	IMPERIAL	3	4	3	3	4	4
Southern	LOS ANGELES	52	79	74	87	102	120
Southern	ORANGE	6	6	8	10	17	22
Southern	RIVERSIDE	4	12	14	17	20	23
Southern	SAN BERNARDINO	2	6	10	9	9	19
Southern	SAN DIEGO	22	42	41	37	43	48

Region	County	2012	2013	2014	2015	2016	2017
Southern	SANTA BARBARA	5	5	7	6	7	11
Southern	VENTURA	4	4	7	8	10	11