

UNDERSTANDING THE INFLUENCE OF STATE POLICY ENVIRONMENT ON
DENTAL SERVICE AVAILABILITY, ACCESS, AND ORAL HEALTH IN
AMERICA'S MEDICALLY UNDERSERVED COMMUNITIES

Hannah L. Maxey

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Eric R. Wright, PhD, Co-Chair

Paul K. Halverson, DrPH, MHA, Co-Chair

Doctoral Committee

John N. Williams, DMD, MBA

July 2, 2014

Ziyue Liu, PhD

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DEDICATION

First, I dedicate this dissertation to my husband, Christopher Maxey, and my children, Alexis and Sebastian. This body of work would not have been possible without their unwavering support and countless sacrifices. Second, I dedicate this dissertation to my parents, Robert and Frances Schallhorn. Their examples of commitment to community and compassion for others largely shaped the person I am today and are reflected in my research. Third, I dedicate this dissertation to all of the American men, women, and children who struggle with poor oral health, especially those living in Indianapolis, Indiana. It is because of you that I found my calling as a public health leader, researcher, and advocate. I will continue to tirelessly work to understand and remove policy barriers to improve dental care access for you. Finally, while some credit their achievements to “standing upon the shoulders of giants”, this dissertation is a testament to the value of standing among a community of family, friends, neighbors, and colleagues. My family and I would not have made it through this process without you.

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Above all I acknowledge God and his provisions which enabled this dissertation. I have found truth in Romans 5:3-5 that “suffering produces perseverance; perseverance, character; and character, hope.” Faith has sustained me, and it is by faith that I have great hope for the future of health policy in the United States.

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Oral health is crucial to overall health and a focus of the U.S. Health Center program, which provides preventive dental services in medically underserved communities. Dental hygiene is an oral health profession whose practice is focused on dental disease prevention and oral health promotion. Variations in the practice and regulation of dental hygiene has been demonstrated to influence access to dental care at a state level; restrictive policies are associated with lower rates of access to care. Understanding whether and to what extent policy variations affect availability and access to dental care and the oral health of medically underserved communities served by grantees of the U.S. Health Center program is the focus of this study.

This longitudinal study examines dental service utilization at 1,135 health center grantees that received community health center funding from 2004 to 2011. The Dental Hygiene Professional Practice Index (DHPPI) was used as an indicator of the state policy environment. The influence of grantee and state level characteristics were also considered. Mixed effects models were used to account for correlations introduced by the multiple hierarchical structure of the data.

Key findings of this study demonstrate that state policy environment is a predictor of the availability and access to dental care and the oral health status of medically underserved communities receiving care as a grantee of the U.S. Health Center program. Grantees located in states with highly restrictive policy environments were 73% less

likely to deliver dental services and, those that did, provided care to 7% fewer patients than those grantees located in states with the most supportive policy environments. Population's served by grantees from the most restrictive states received less preventive care and had greater restorative and emergency dental care needs.

State policy environment is a predictor of availability and access to dental care and the oral health status of medically underserved communities. This study has important implications for policy at the federal, state, and local levels. Findings demonstrate the need for policy and advocacy efforts at all levels, especially within the states with restrictive policy environments.

Eric R. Wright, PhD, Co-Chair

Paul K. Halverson, DrPH, MHA, Co-Chair

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CHAPTER 1. Laying the Foundation: Oral Health, Policy and Access

Oral health is an important component of overall health and well-being. Yet, preventable dental diseases contributing to poor oral health, are among the most common diseases affecting American health. The consequences of poor oral health are felt across the lifetime. It leads to poor academic performance among children and threatens employability among adults.

The burdens of poor oral health are not distributed evenly across the population. Oral health disparities most profoundly impact low-income Americans from racial and ethnic minority groups, which suffer the highest rates of dental disease. Among other factors, a lack of access to preventive oral health care services perpetuate oral health disparities in underserved communities.

Access to oral health care services is multidimensional, influenced by individual demographics, behavioral, socioeconomic, and oral health system factors. Most policies to enhance access to oral health care services focus on reducing barriers associated with socioeconomic status or inadequacies in the oral health system. Medicaid programs seek to remove cost or lack of insurance as a barrier to care, while other programs focus on addressing inadequacies in the oral health care system, such as workforce distribution.

The oral health workforce is largely comprised of two professions: dentistry and dental hygiene. Dentists are trained at the doctoral level and licensed to perform comprehensive dental treatment, including surgical, restorative, and preventive services. Dental hygienists are trained at the undergraduate level, either Associate or Baccalaureate, and licensed to provide preventive and non-surgical dental therapies.

The practice of these professions is regulated at the state level. Whereas the practice of dentistry is in general consistently regulated, large variations exist in the regulation of dental hygienists at the state level. Variations are most commonly present in the permitted clinical tasks, level of supervision, governance structures, and reimbursement policies. In 2001, these variations were documented and quantified in the Dental Hygiene Professional Practice Index (DHPPI), which has been used as an indicator of the degree of professional autonomy held by the dental hygiene profession within a state. DHPPI values have been found to correlate with access to dental care at the state level; reported access to care within the population increases with increasing levels of professional autonomy.

Distribution of the oral health workforce plays a critical role in access and is the subject of federal policy initiatives such as the United States Health Center Program. The U.S. Health Center Program has provided support for the delivery of primary health care in underserved communities since the 1960s. Health Center Grantees have been required to ensure access to preventive dental service for their patients since 2003. While many grantees deliver oral health services onsite, some outsource their dental services through contractual agreements with dentists in their community. Grantees that outsource these services cite the high costs of dental clinic operation and a lack of oral health professionals willing to work at health centers as barriers to onsite delivery of dental care.

Maximizing the utility of resources is important to the successful operation of health centers. In terms of providing for the oral health care needs of patients, dentists and dental hygienists are the most valuable resource at Health Centers. Maximizing the utility of health care providers is achieved allowing these individuals to practice to the

full extent of their professional training; however, in the case of dental hygiene, practice policies in some states actually prohibit the profession from practicing to the full extent of their training. While safety and quality concerns are cited, they are not founded in literature.

The first chapter of this dissertation presents background information on oral health and the role of community health centers and the dental hygiene workforce in access to care. All community health center grantees of the Federal U.S. Health Center program are subject to the same funding criteria; however, health workforce policy environments vary from state to state. The intersection of federal and state policy and their combined effect on utilization and access create an ideal environment for the study of state workforce policy.

Oral Health

Health is fundamental to human existence. It has been defined by the World Health Organization as “a state of complete physical, mental and social well-being and not merely the absence of disease” (Preamble to the Constitution of the World Health Organization as adopted by the International Health Conference, New York, 19-22 June, 1946; signed on 22 July 1946 by the representatives of 61 States [Official Records of the World Health Organization, no. 2, p. 100] and entered into force on 7 April 1948.). By definition, human health is not measured by the functioning of organs or systems within the body, but as the sum of all aspects. This concept is demonstrated in the contributions of oral health to overall health.

Oral health is integral to overall health and quality of life (Locker, 1997; Sheiham, 2005). The human mouth is the portal of entry for life sustaining air, water, and

food. It also serves as a primary mechanism for human communication, contributing to psychological, social, and emotional health throughout all stages of life.

In early childhood, healthy primary teeth enable mastication of solid foods and are rudimentary to speech development. Throughout adolescence and adulthood, teeth continue to serve a critical role in the consumption of many nutritious foods, such as vegetables and meats. In addition, healthy teeth and surrounding structures, gingivae (gums), are equally important for communication and social health (Reisine, 1988; Sheiham & Steele, 2001). Unfortunately, many Americans suffer with poor oral health resulting from preventable dental diseases. These preventable diseases, including dental caries (cavities) and periodontal (gum) disease, are among the most common affecting American health.

Dental Diseases

Dental Caries

Dental caries, frequently described as a condition where “holes” are present in the teeth, is actually a disease process which presents in later stages as holes or cavities in the teeth. The process of dental caries begins with the formation of dental plaque, a biofilm produced through the colonization of oral bacteria, on the teeth. Certain oral bacteria, such as mutans streptococci, are cariogenic, meaning they ferment consumed sugar and carbohydrates to form acid. Over a period of time, acidic biofilm build-up causes the tooth enamel to dissolve, ultimately producing the characteristic “holes” or cavities associated with dental caries (Mandel, 1979). If a large portion of tooth structure is cavitated, the internal structures of the teeth, including the pulp chamber containing the nerve, can become affected and may lead to infection causing pain and inflammation, commonly known as an abscess. Also, with significant damage to its structure, a tooth is

no longer able to maintain the forces of mastication. Portions of the teeth affected by dental caries may break. People of all ages may be affected by dental caries.

Teeth are susceptible to dental caries from the moment that they first erupt in the mouth. Primary teeth, commonly called baby teeth, are vulnerable to dental caries due to their thin enamel structure. Early Childhood Caries (ECC) is a condition in which young children develop significant disease, especially on their anterior (front) teeth. Small children who frequently consume sugars and carbohydrates through bottle are especially vulnerable to ECC (Seow, 1998).

Periodontal Diseases

Periodontal disease is the primary cause of tooth loss among adults (Ong, 1998). It is chronic inflammatory condition resulting from the accumulation of bacterial plaque (dental plaque) on the teeth (Socransky, 1970). Initially, bacterial plaque that is not removed from the teeth during routine dental hygiene stimulates an inflammatory response in the gingivae (gums). This initial stage, known as gingivitis or inflammation of the gingiva, is the most common type of infection in the body.

Gingivitis occurs in the subgingival sulcus, the pocket between the tooth and gum, and is a reversible condition. Gingivitis generally resolves with adequate mechanical removal of dental plaque. If gingivitis is not resolved the inflammation progresses to periodontitis, inflammation of the periodontal ligaments which attach teeth to tooth socket and the alveolar bone (Saglie, Newman, Carranza Jr, & Pattison, 1982). Without intervention, periodontitis compromises these supporting structures of the teeth and the teeth eventually loosen and are lost (Ong, 1998). Periodontal disease is not reversible but

it may go into periods of remission where there is no active destruction of the periodontium.

Tooth loss is the most common but not the only adverse health outcome associated with periodontal disease. Periodontal disease has been linked to adverse cardiovascular events (Beck et al., 1996; Hujoel et al., 2000; Janket et al., 2003), preterm delivery, and low-birth weight infants (Dasanayake, 1998; Offenbacher et al., 1996).

Consequences of Poor Oral Health

The consequences of dental disease and poor oral health are felt across the lifespan. Children with poor oral health are three times as likely to miss school as children with good oral health (Jackson et al., 2011). In addition to excessive absences, children with poor oral health do not perform as well academically as their peers with good oral health (Blumenshine et al., 2008). Poor academic performance has been associated with dental disease even in the absence of pain (Jackson et al., 2011). This suggests the presence of dental disease in any form, from incipient (early) to emergent, may affect a child's ability to achieve academically (Blumenshine et al., 2008; Jackson et al., 2011). It can be reasoned that children with poor oral health are likely to be less academically prepared for higher education than their peers with good oral health, and in addition, are more likely to become adults with poor oral health.

In adulthood, poor oral health is associated with a number of negative consequences, not the least of which is unemployment. Research has demonstrated a positive relationship between oral health and employability (Hyde et al., 2006); as oral health improves, employment improves. Low-income adults, such as those that are unemployed, experience many barriers to oral health and are more likely to raise children

with poor oral health, perpetuating the cycle of poor oral health among low-income populations.

Prevention and Treatment

Dental science demonstrates that, in general, dental caries and periodontal diseases are preventable conditions. While individual behavior has the largest influence on risk for these dental diseases, environmental and oral health system factors also play a role in prevention of dental diseases.

Individual behavior plays a large role in the prevention of dental diseases. At the most basic level, risk for dental caries is associated with consumption of sugars and formation of dental plaque. Healthy behaviors may be thought of as a means of primary prevention of dental disease. A diet which limits sugar intake combined with the performance of routine oral hygiene to remove dental plaque and apply fluoridated dentifrice significantly reduces individual risk for dental caries (Anekar, 2011).

Fluoridation of municipal water is an example of population-level primary prevention of dental disease. Fluoride is an inorganic compound that strengthens the enamel of teeth and is shown to effectively prevent dental caries. It can be delivered either topically or systemically. Fluoridation of drinking water, a system-level health policy, is a population level intervention to prevent dental caries. The Centers for Disease Control and Prevention (CDC) include fluoridation of drinking water among the 10 greatest public health achievements of the 21st Century (CDC, 2013).

Professional dental treatments to prevent the development of dental caries are also recognized as important primary prevention measures. Primary prevention dental

treatments include the application of topical fluoride and dental sealants (Rozier, 2001). Topical fluorides, administered by oral health professionals, contain higher concentrations of fluoride than are found in municipal water systems or fluoride dentifrice. These have an immediate effect on the tooth structure, whereas systemic fluorides aid in strengthening developing teeth. Dental sealants are resin coatings that are placed on the occlusal or chewing surface of the posterior teeth to effectively seal grooves that trap bacterial plaque and more likely to develop dental caries.

Other oral health care services may be considered secondary and tertiary prevention. Routine oral examination by an oral health professional is a secondary prevention measure, whereas dental restorations and non-surgical periodontal therapies are examples of tertiary prevention. Routine oral examinations are performed for the purpose of identifying dental disease in an early stage to prevent progression. Once disease is present, treatments such as dental restorations and non-surgical periodontal therapies are used to reduce impact and restore health.

Dental restorations involve the removal of tooth structure affected by dental caries and restored with a biocompatible material. For incipient to moderate dental caries, dental restorations are an effective means of restoring oral health once disease has occurred. More advanced dental caries, such as those invading the nerve chamber, may require removal (extraction of the tooth) in order to restore health. Non-surgical periodontal therapies include scaling and root-planning procedures in which calcified deposits causing inflammation are removed from the teeth to restore health to the gingivae (gums). While most dental disease are preventable, the burden of poor oral health in America is staggering.

Oral Health in America

The landmark report, *Oral Health in America* published in 2000 by the U.S. Surgeon General, cast light on the ‘silent epidemic’ of poor oral health in America. It was the first report on oral health produced by a federal agency in the United States. It increased public awareness of oral health and disparities in oral health, and generated a new sense of urgency around the issue of oral health within the national agenda. Unfortunately, thirteen years following the publication of this historic report, the United States continues to grapple with significant oral health disparities.

Epidemiology

There are a number of national surveys that collect information on the prevalence of dental diseases in the United States, including the National Health and Nutrition Examination Survey (NHANES) and the Behavioral Risk Factor Surveillance System (BRFSS). NHANES and BRFSS routinely collect data which are used to monitor national trends in oral health.

NHANES, a major program of the National Center of Health Statistics (NCHS), gathers health data on a nationally representative sample of the U.S. population. NHANES includes a comprehensive clinical examination and interview on subjects to gather data on demographic, socioeconomic, dietary, and other key health data. An oral examination is included in NHANES making it the most comprehensive source of clinical oral health data on the U.S. population.

The NHANES oral examination collects information on tooth count, dental caries, dental sealants, dental incisors trauma, and periodontal disease status. Structured clinical

examinations are performed by dentists that are routinely calibrated to enhance reliability. NHANES has been collecting information on oral health in America since the 1960s.

In addition to NHANES, the BRFSS collects data on dental service use and oral health. The BRFSS is an on-going telephone survey administered by CDC and is a mechanism to gather state level prevalence data on personal behaviors that contribute to health. BRFSS surveys began in 1981 but did not collect data from a nationally representative sample until 1993.

Trends in American Oral Health

Trends in American oral health status before and after the U.S. Surgeon General's report can be seen when comparing NHANES III 1988-1994, NHANES 1999-2004, and NHANES 2005-2008. Data on the percent of untreated dental caries by age group, race, and income level are available for each of these survey periods in the Health Data Interactive maintained by the CDC¹.

Research shows that higher income, or higher socioeconomic status, and oral health status during childhood are among the strongest predictors of better oral health throughout one's lifetime (Thomson et al., 2004). Thus, data from NHANES on untreated caries among children 6-19 years are presented here to describe trends in American oral health.

Trends in NHANES data collected over the last two decades demonstrate that, overall, American oral health is improving. Figure 1 presents the percent of untreated tooth decay among children 6-19 years of age. Note the percentage of children between 6-19 years of age with untreated dental caries decreased from 23.6% to 16.2% between

¹ CDC data are available at: <http://www.cdc.gov/nchs/hdi.htm>

NHANES 1988-1994 and NHANES 2005-2008; however, the majority of this decrease was realized following the Surgeon General's report in 2000. There was only a 0.7% decrease between NHANES 1988-1994 and NHANES 1999-2004. In fact, the overall percent of American children 'near poor' with untreated dental caries actually increased between the first two data collection periods, due to a 8.8% increase in the percent of non-Hispanic white children with untreated caries during this time period. In addition, non-poor Mexican-American children also had an increase of 2.3% during this same time period.

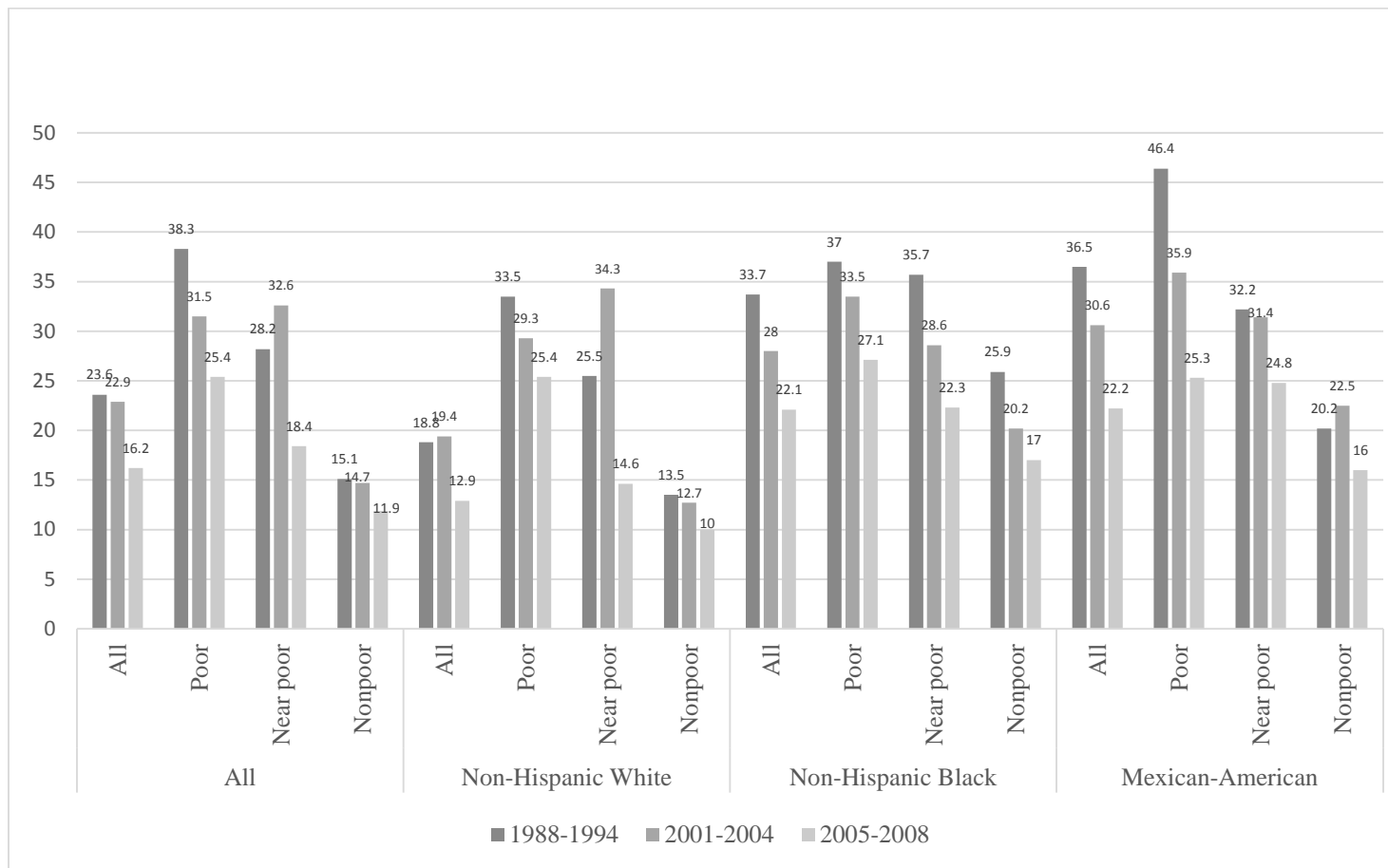


Figure 1. Percent of Untreated Tooth Decay among Children 6-19 Years by Race and Income in the U.S.: 1998-2008

Increases in the percent of untreated caries are not present in any race or income group between 2001-2004 and 2005-2008. The greatest improvements are realized for poor Mexican-American children among whom the percent with untreated dental caries decreased from 35.9% to 25.3%. While significant improvements have been made in children's oral health over than last two decades, over 25% of poor children continue to suffer with untreated dental caries. The burden continues to be the highest in poor, non-Hispanic Black children (27.1%).

Oral Health Disparities

From the NHANES data on untreated dental caries among children, it is clear that dental diseases are not distributed evenly across the U.S. population. The burden of poor oral health disproportionately affects Americans from racial and ethnic minority groups (Dye et al., 2012; Dye et al., 2007; Edelstein & Chinn, 2009). The most recent NHANES data show that 22.2% of Mexican children and 22.1% of Black or African American children suffer with untreated dental caries. This is significantly higher than the 12.9% among white children. These disparities also present among American adults age 20-74. The CDC reports in *Health, United States 2012* that 33.2% of Mexican adults and 32.4% of Black or African American adults, whereas only 17.8% of white adults, experience untreated disease.

Socioeconomic status is an important predictor of oral health status (Dye & Thornton-Evans, 2010). Lower socioeconomic status is associated with numerous barriers to oral health, including access to preventive oral health care services. People of lower socioeconomic status are less likely to have private dental insurance or the ability to pay out of pocket expenses for preventive oral health services. They are more likely

to have government-sponsored health insurance associated with lower reimbursements which are not accepted by oral health providers. The communities in which they reside, low-income communities, are more likely to experience shortages of dental providers and dental providers that accept Medicaid (Doty & Weech-Maldonado, 2003; Okunseri et al., 2008). In addition, people of lower socioeconomic status tend to have lower levels of literacy, which has also been identified as playing a role in oral health status (Byck, 2000; Gillcrist & Brumley, 2001; Miller et al., 2010).

Geographic location also contributes to oral health disparities. Many people from racial and ethnic minority groups reside in low-income urban geographies with shortages of dental providers. In addition, people residing in rural communities also struggle with shortages of oral health providers. People residing in rural communities are less likely to reporting having a dental visit within the past year than people living in urban communities (Vargas, Dye, & Hayes, 2003).

The biological processes and progression of dental disease are relatively straight forward: bacterial plaque, if left on the teeth and gingivae for extended periods of time, causes dental caries and periodontal diseases. The social factors which contribute to oral health disparities are not as straight forward. They are made up of a highly complex web of socioeconomic and environmental factors (Adler & Rehkopf, 2008; Gilbert et al., 2002). Interactions exist between many of these factors. Poverty, race, and geography, for example, are frequently intertwined. People from racial and ethnic minorities groups are more likely to have a lower socioeconomic status and reside in low-income communities with scarce oral health care resources as opposed to their non-Hispanic white counter parts.

Many of the social factors which contribute to oral health disparities, such as race and income, are considered immutable or unalterable through health policy. Oral health system factors such as availability of dental providers and ability to pay for services, which influence access to oral health care services are considered more easily changeable or mutable. As such, these factors are frequently the subject of health policy interventions to address oral health disparities.

Access to Oral Health Care

Access to preventive oral healthcare services is directly related with oral health status (Edelstein & Chinn, 2009; Wing et al., 2005). People with access to preventive dental care generally enjoy better oral health than those experiencing barriers. Unfortunately, inequities in access contribute to oral health disparities for many Americans. Barriers to access most frequently cited include cost and availability of oral health care services (Edelstein & Chinn, 2009). A number of health policies are aimed at reducing cost and improving the availability of oral health care for the purpose of improving oral health and reducing oral disparities.

Policies to Enhance Oral Health Access

Oral health policies can be thought of as focusing on characteristics of the population or the oral health care system (Aday & Andersen, 1974). State Medicaid programs focus on reducing cost of care and insurance status as barriers to oral health care services for low-income populations. Medicaid policies directly influence a targeted population. Federal programs such as the U.S. Health Center program and the National Health Service Corps, administered by Health Resources Services Administration, are

examples of a policy initiatives focused on enhancing the size and capacity of the oral health care system to improve access.

Medicaid Programs

State Medicaid programs are an example of policy aimed at reducing cost as a barrier to oral health care access. The largest of these is the State Children's Health Insurance Plan (SCHIP) which was implemented as a part of the *Balance Budget Act of 1997*. SCHIP policies seek to overcome cost as a barrier to oral health care access through policies to expand health insurance coverage among disadvantaged children. Unfortunately, disadvantaged children from racial and ethnic minority groups continue to experience increasing rates of dental diseases in spite of the implementation of SCHIP (Edelstein & Chinn, 2009). While the overall number of dental visits among American children increased under SCHIP, children from racial and ethnic minority groups continue to be less likely to access preventive dental care than non-minority children (Edelstein & Chinn, 2009; Lewis et al., 2007). Low participation in state Medicaid programs by dentists and the inequitable distribution of dental offices in underserved communities perpetuates the disparities in access (Morris et al., 2004; Okunseri et al., 2008). Overcoming the cost barrier is not enough to ensure access, suggesting that interventions existing in silos within the larger health system limit the ability to measurably impact oral health disparities. A recent study examining trends (reimbursements, providers, and enrollments) in State Medicaid cite the need to "systemically track the status of state policies" to evaluate their impact on oral health disparities (Mandal et al., 2014).

The U.S. Health Center Program

The U.S. Health Center program focuses on addressing the shortage of oral health services in underserved communities. Established in 1964 under Section 330 of the Public Health Service Act (42 USCS § 254b) of the Social Security program, this program allocates grant funding to community health centers for the planning, development, and operation of health centers in geographic areas (also known as catchment areas) which have previously been designated as Medically Underserved Areas/Populations (MUA/P) by the federal government.

MUA/P (<http://www.hrsa.gov/shortage/mua/index.html>) designations are identified using the criteria for Designation of a Medically Underserved Area/Population established by the Federal Office of Shortage Designation at Health Resources Services Administration and published in the federal register on October 15, 1976. These criteria originated from the Index of Medical Underservice (IMU), created by the Health Services Research Group at the Center for Health Systems Research and Analysis, University of Wisconsin. The criteria are operationalized using four variables: 1) the per capita rate of primary care physicians to 1,000 population; 2) percent of population below poverty level; 3) infant mortality rate; and, 4) percentage of the population 65 and over (Adams, 1975). The weighted sum of these four variables is calculated and a final value, or score, is assigned (Adams, 1975). Higher scores indicate a greater degree of shortage and higher priority for funding. Designations are used to identify and allocate health center funding to communities with the greatest need.

Health centers located within designated shortage areas and meeting all of the criteria submit competitive application to the U.S. Health Center program. Health center grants are competitive based on the level of need within the defined catchment area.

Thus, health center grantees represent those areas of greatest need, based on the criteria used to determine medically underserved areas. Health centers that receive federal grants are known as Health Center Grantees, or more commonly known as Federally Qualified Health Centers (FQHC's).

Many health centers which do not qualify for or are not a part of the U.S. Health Center program, deliver health care to underserved populations. Among others, these include state-funded community health centers, FHQC look-alike health centers, and health center operated by faith-based and charitable organizations. These health centers are an important part of America's health care safety-net. Unfortunately, there is currently not a uniform method of accounting for the health care delivered by such health centers at the state or national level.

While the U.S. Health Center Program has been in existence since 1964, oral health services were not included as a required service until 2003. Under current funding agreements, health center grantees are required to deliver "primary health services," which are defined in the statute to include "preventive dental services." (42 U.S.C. §254b (a) (1) and §254b (b)(1)(A)(i)(III) (hh)). "Preventive dental services" are further defined by regulation (42 C.F.R. §51c.102 (h) (6)) to include "services provided by a licensed dentist or other qualified personnel, including: (i) "oral hygiene instruction; (ii) oral prophylaxis, as necessary; and (iii) topical application of fluorides, and the prescription of fluorides for systemic use when not available in the community water supply". Health Center Grantees play a crucial role in access to oral health care services for underserved communities. They provide safe care and, in general, operate as effectively as a private practice (Bailitet al., 2013; Beazoglou et al., 2010).

A recent survey suggests that roughly half of all patients seen at U.S. Health Centers report having had a dental visit within the last year, but only 20% report that the care was delivered at their health center (Jones et al., 2013). Cost and availability were cited as the most common factors associated with individuals that did not access oral health care services at the health center where they receive primary medical services (Jones et al., 2013).

State and Federal initiatives, such as Medicaid and the U.S. Health Center program, are crucial to ensuring access to oral health care services and reducing oral health disparities. However, the success of these programs is dependent, to a large extent, upon the availability of oral healthcare providers to deliver care. The oral health workforce, arguably the most critical component of America's oral healthcare system, is positioned at the intersection of dental science, individual oral health, and access to care.

The Oral Health Workforce

Professional dental services are delivered by the oral health workforce. In the United States, this workforce is primarily composed of two professions: dentists and dental hygienists. Other workforce models, such as the dental therapist employed widely in other countries, are slowly being tested and implemented in some states but are not recognized across this country.

Dentists are doctoral level professionals providing comprehensive dental treatment, including diagnostic, preventive, restorative, and surgical procedure for the teeth, gums, and tissue structures of the mouth (Shi & Singh, 2009). Dental hygienists are trained at an associates or baccalaureate degree-level and provide preventive and non-surgical periodontal treatments for teeth and gums (Wilkins & McCullough, 1983).

The practice of these professions is regulated at the state level through professional licensing and state boards. Licensing requirements for each profession include specialized educational and training, as well as written and clinical examinations. In addition, state licensure policies define the parameters of clinical practice within a given state. These parameters are not uniform across the states.

Although some variation exists, the professional practice of dentistry is generally consistent from state to state. Larger variations exist in the professional practice of dental hygienists at the state level that influence their ability to provide care (Mertz & O'Neil, 2002). These variations are most commonly present in the permitted clinical tasks, level of supervision, governance structures, and reimbursement policies. These variations are documented and quantified in the Dental Hygiene Professional Practice Index (DHPPI).

The DHPPI summarizes the legal practice environment of dental hygienists in the 50 states and the District of Columbia as of 2001 (HRSA, 2004; Wing et al., 2005). Health Resources Services Administration (HRSA) of the Department of Health and Human Services (DHHS) commissioned the Center for Health Workforce Studies (CHWS) at the School of Public Health at the University at Albany to study the professional practice environment of dental hygienists and develop the DHPPI in 2001.

The DHPPI summarizes four aspects of legal practice environment of dental hygienists: legal and regulatory environment; supervision in various practice settings; scope of clinical practice or tasks permitted; and, reimbursement environment. Legal requirements (as of December 31, 2001) for the provision of dental hygiene services across the states are used to generate values for each of the four aspects. The total index value reflects the sum of values for the four aspects. Together, the total DHPPI is

believed to estimate the extent dental hygiene represent an autonomous health profession. That is, high scores indicate high levels of professional autonomy for dental hygienists practicing within a state, whereas lower scores indicate lower levels of professional autonomy². DHPPI values have been correlated with access to dental care at the state level, and access to care within the population has been found to be higher in areas with higher levels of professional autonomy.

Although dental hygienists can serve as replacements for dentists in the provision of certain dental services, the practice policies of many states require professional oversight by a licensed dentist. Such practice regulations restrict employment opportunities and settings for dental hygiene (Kleiner & Park, 2010) and have been demonstrated to negatively influence access to preventive oral health services (Wing et al., 2005).

State practice regulation may threaten the effectiveness of policy initiatives aimed at improving access to care. For example, underserved communities frequently experience shortages of oral health professionals. Underserved communities located in states with restrictive practice policies which experience difficulty recruiting dentists are also, by virtue of professional supervision requirements, unable to recruit dental hygienists to provide preventive dental care (Mertz & O'Neil, 2002). In contrast, underserved communities located in states with policies promoting professional autonomy in general or public health settings may be able to recruit a dental hygienist to

² Complete methodology used for the DHPPI are found in the final report, *The Professional Practice Environment of Dental Hygienists in the Fifty States and the District of Columbia, 2001*, published in April of 2004. This report is available to the public through HRSA at: <http://bhpr.hrsa.gov/healthworkforce1/reports/dentalhygiene50statesdc.pdf> .

deliver preventive dental care regardless of the availability of a licensed dentist (Kushman et al., 1996; Mertz & O'Neil, 2002; Perry et al., 1997).

Concerns over quality of care and safety are cited as rationale for restrictive state practices for the dental hygiene profession, but these concerns are largely unsupported (Battrell et al., 2008; Freed et al., 1997). Studies on the independent practice of dental hygienists report high levels of patient satisfaction and quality of care (Battrell et al., 2008; Freed et al., 1997; Kushman et al., 1996).

In addition to quality, costs of care is impacted by professional regulation. Studies of oral health profession regulation found that stricter regulation did not improve outcomes but led to higher dental care costs and higher salaries among licensed dentists (Kleiner & Kudrle, 1997, 2000).

The safety and quality of dental hygiene care is also suggested in the practices of malpractice insurance providers. One study, examining the relationship between malpractice insurance premiums for health professionals and health professional regulation, found insurance premiums did not vary with varying state regulations (Kleiner, 2006). Insurance providers have a vested interest in minimizing financial losses associated with malpractice. Thus, any perceived or calculated increase in the risk for malpractice would be quantified and passed on to consumers through premium increases. The lack of variation in malpractice insurance premiums by state suggests that insurance providers believe quality and safety do not vary with stringency of professional regulation (Kleiner, 2006).

Summary

Oral health is critical to overall health and well-being, yet, millions of Americans suffer with preventable oral diseases. The consequences of poor oral health are felt across the lifetime and are perpetuated from one generation to the next. While the burden of poor oral health exists in all populations, it is inequitably distributed among people from racial and ethnic minority groups and those of lower socioeconomic status.

A lack of access to preventive oral health care services is among the factors contributing to oral health disparities. Cost and availability of oral health care providers are the barriers to access frequently experienced. A number of oral health policies are aimed at removing these barriers to access as a means of improving oral health and reducing oral health disparities. The U.S. Health Center Program is one such policy. The U.S. Health Center Program provides funding to support the development and operation of health centers in medically underserved communities to enhance the delivery of primary health care services, including preventive oral health services. It is a critical part of America's oral health safety-net.

The oral health workforce delivers dental services to Americans, and is integral to health center operations. This workforce is largely comprised of dentists, who provide comprehensive dental services, and dental hygienists, who generally provide preventive dental services. State practice policies determine the clinical tasks and supervision requirements for dental hygiene. These vary widely from state to state, and have been associated with access to care at the population level.

This dissertation seeks to determine whether, and to what extent, state policies regarding dental hygienists influence the delivery of dental services and access to care in

underserved communities served by grantees of the U.S. Health Center program in order to inform policy at the federal, state, and community level. Theory, methods, results, and detailed discussion of findings and implications of this dissertation are presented in subsequent chapters. The goal of this dissertation is to generate information which can be translated into policy action, ultimately improving oral health among underserved American populations.

CHAPTER 2. Framing the Study: Theory, Framework, and Literature

This chapter presents a theoretical framework for studying the influence of state level health workforce policies on access to dental care in underserved communities. Concepts of health policy are explored and described within the context of the key policies this study examines. An existing framework is adapted to study the influence of state health workforce policy on dental care access. Previous research in this area is explored.

Health Policy

Health policies are designed to enhance health or aide in the pursuit of health by influencing factors associated with the determinants of health (Longest, 2009). These policies typically focus on a health issue for a specified population. Medicaid, for example, is a health policy focused on improving health for low-income, uninsured individuals by reducing cost as a barrier to health care access. Poverty and lack of insurance are two of the social factors which play a role in health. This relationship is presented graphically (Medicaid example in red) in Figure 2.



Figure 2. The Pathways by which Health Policy Influences Health

It is important to understand the determinants of health do not exist in a vacuum. They are intertwined and interdependent. For example, people living in poverty are more likely to reside in medically underserved communities where health care services are scarce. Simply addressing cost as a barrier to health care access for people residing in such communities is not likely to be sufficient to ensure the access to health care services necessary to improve health. In addition, removing cost as a barrier to health care access does not guarantee an individual will seek health care services. Individual behavior, an important factor in health and access, is a challenging factor to influence.

Population health is directly related to primary health care access (Starfield et al., 2005). Thus, many health policies seek to enhance access. These policies may target the same or different health determinants but share the same end goal: health improvement. Health policies cannot exist in a vacuum. The complex nature of health and the interconnectedness of its determinants can only be addressed through the coordination of multiple health policies acting in concert with one another.

Whether multiple health policies influencing different aspects of access to care interact with one another is not well known. Determining whether and how these policies influence one another and/or their desired outcome requires a comprehensive understanding of the policies, including: design and implementation; key points of intersection or influence; and, shared measures or outcomes.

Understanding the Influence of Health Policy

Health policies have been defined as public policies which enhance health or aide in the pursuit of health by influencing factors associated with the determinants of health

(Longest, 2009). These policies are enacted by federal, state and local governments in the form of laws, rules and regulations, and operational or judicial decisions.

Health policies can be separated into two broad categories: allocative and regulatory. Allocative policies, such as the U.S. Health Center program, generally involve the redistribution of resources for the betterment of society. Whereas, regulatory policies seek to address specific issues by influencing individual or organizational actions, behaviors, and decisions (Longest, 2009).

Allocative Policy: U.S. Health Center Program

The U.S. Health Center Program, described in Chapter 1, is an example of an allocative policy which influences access to health care. Funding for this program is derived from federal, and state in some jurisdictions, tax dollars through a series of operational decisions depicted in Figure 3 below. The flow of funding for this program begins with the Department of Health and Human Services (DHHS), funded annually in the federal budget. DHHS allocates funding to the major health-related agencies in the United States including, among others, the National Institutes of Health, Centers for Disease Control and Prevention, Agency for Healthcare Research and Quality, and Health Resource Services Administration (HRSA). HRSA, an agency focused on ensuring access to health care for vulnerable and underserved populations, oversees the budget for 16 bureaus/offices, including the Bureau of Primary Care which administers the U.S. Health Center Program.

The U.S. Health Center program allocates funding to Federally Qualified Health Centers, hereafter referred to as Health Center Grantees, to support the delivery of health care services in communities medically underserved. Health Center Grantees use this

funding to deliver health care services to people residing in these communities. Thus, the U.S. Health Center program is an example of federal-level allocative policy, redistributing resources to improve access to care with the end goal of improving health outcomes in medically underserved communities.

While much of their funding comes from the U.S. Health Center program, health center grantees are also reliant upon reimbursements from State Medicaid programs. The specific influence of Medicaid on health center grantees is discussed at length later in this chapter.

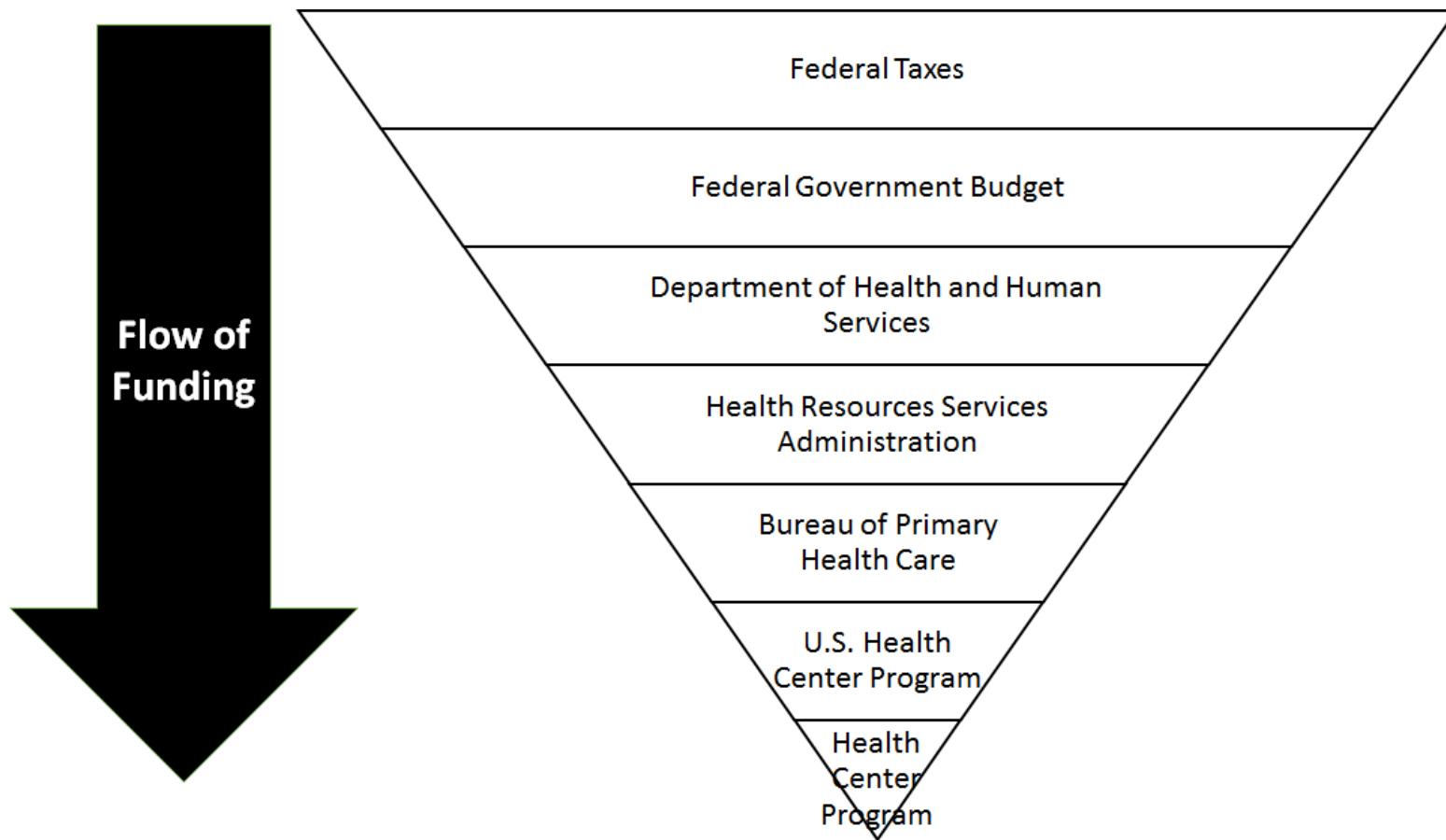


Figure 3. The Process by which Tax Dollars are allocated for U.S. Health Center Program

Regulatory Policy: Health Professions

There can be no access to health care without health care professionals. They form the foundation of the health system, delivering health services to patients. The conditions under which these health care professionals are trained and practice is regulated through a number of policies, including educational, licensing, and reimbursement requirements enacted by the government and professional associations. Each of these policies play a role in health care access; however, state level policies such as licensing and regulations regarding reimbursement, which function to control workforce supply, enforce practice regulations, and determine payments, create the context of interest in this study.

Health Professional Licensing

Licensing of health professionals is an example of regulatory policy directly influencing health care access. These policies were enacted at the state level beginning in 1760 when physicians in New York and New Jersey were first required to pass licensure examinations. In 1889, the U.S. Supreme Court ruled that it was a within a state's right to regulate health care professionals through licensing to ensure the welfare of the people³ and protect them from impaired or incompetent professionals (Weissert, 1996). Since that time, licensing has been upheld as a mechanism for administering and enforcing standards among the health professionals within a state⁴.

Licensing has an important role in the supply of health professionals within the health system. As a market-entry-restriction, licensing acts as the gateway through which

³ *Dent v. West Virginia*, 129 U.S. 114, 122 (1889).

⁴ *Goldfarb v. Virginia State Bar*, 421 U.S. 773, 792 (1975); *see, also, Ferguson v. Skrupa*, 372 U.S. 726, 731 (1963).

qualified health professionals must enter into clinical practice. Most health care professionals are required by state “Professional Practice Acts” to hold and maintain a professional license in order to practice. In this way, licensing regulates the supply, or number, of practicing health professions within a given state.

While laws governing the health professions are enacted through state legislative action, the authority to implement these laws is typically delegated to state licensing boards which represent the health professions. Most health professions are self-regulated by boards comprised mostly of peer professionals, but this varies by profession and state as in the case of dental hygiene, physician assisting, and a number of others. Some, but not all, states are part of multi-state or regional boards or accept licensure through reciprocity (Wakefield, 2010). This limits interstate mobility of health professionals, further controlling supply at the state level.

Education

It is important to note licensing is separate from the academic standards. These standards are regulated at the national level through associations and accreditation. Prior to being eligible for licensure, individuals must complete the required didactic and clinical training and pass national board examinations. Only once these steps are successfully completed may a health professional seek licensure within a state to practice. While educational standards and policies are a mechanism for regulating health professionals, they do not necessarily align with clinical practice of professionals at the community level due to variations in professional practice regulations associated with state licensure and local community needs.

Licensing regulates the actions and behaviors of practicing health professionals by enforcing “Professional Practice Acts” which delineate the clinical tasks permitted and level of professional autonomy. These are not consistent from state to state for a number of health professions. As discussed in Chapter 1, wide variations practice policies exist for the profession of dental hygiene.

Reimbursement

Reimbursement for the provision of health care is essential for health professionals and health service delivery. Oral health providers are reimbursed for the services they provide through dental insurance plans, private and government sponsored, and payments made directly by the patients. Basic dental services are not included in many medical insurance plans. Many individuals, with and without medical insurance, pay out-of-pocket for their dental care.

The cost of dental care is a significant barrier for low-income populations. Fortunately, State Medicaid programs, described in Chapter 1, provide dental insurance benefits for low-income populations as a means of reducing cost as a barrier to care. Thus, Medicaid is an important source of reimbursement for oral health providers who deliver care to underserved population.

Reimbursement policies for government sponsored insurance programs, such as Medicaid, are mandated by law and regulation. These policies indirectly regulate professional practice by determining a profession’s eligibility to bill for certain health services. Practice policy and reimbursement policy do not always align. A certain clinical task may be within a health professional’s scope of clinical practice, but reimbursement policies may not allow for that professional to bill for the services

rendered. Such is the case with the dental hygienist. In most states, reimbursements for the preventive services delivered by a dental hygienist are directed to a supervising dentist and not the dental hygienist.

With some exceptions⁵, oral health services are almost exclusively billed by dentists. This means dentists receive reimbursement for preventive procedures provided by the dental hygienists they employ. Because reimbursement is generally dependent upon an agreement with a dentist, dental hygienists are limited to providing services at locations and for patients of their employing dentist.

Access to care is directly related to reimbursement policy because, in general, health care professionals are unable to sustainably provide services for which they cannot be reimbursed. In the case of State Medicaid programs, reimbursement policies directly affect access for underserved populations dependent upon the availability of health care professionals willing to accept government sponsored insurance. Unfortunately, reimbursement policies in most states do not support the provision of preventive oral health services by dental hygienists as a viable option to address shortages of Medicaid accepting dentists.

Rationale for the Interaction between Policies

Actual access to health care occurs at the individual level; however, environmental factors at the community, state, and health system levels create the context in which access occurs. The contextual relationship between access and environment is depicted using a simple Venn diagram in Figure 4. Note that each level of environment

⁵ As of August 29, 2011, 40 states have provisions allowing physicians to bill Medicaid for fluoride varnish (information found at: <http://www.pewstates.org/research/analysis/reimbursing-physicians-for-fluoride-varnish-85899377335>). As of December 2012, 15 states have provisions for direct Medicaid reimbursement to dental hygienists (<http://www.adha.org/reimbursement>).

is embedded within the context of all higher levels. State policies exist within the context of the larger health system, whereas community level health care delivery structures operate within the context of state policy and that of the broader health care system.

Health policies are designed to influence some aspect/component of the health system or address barriers within certain populations. A policy can be designed and enacted at any level. Many policies are enacted at the federal level but implemented or administered at the community level. Because each community exists within the context of their state, variations in state level policies are likely to impact implementation of federal policy in some way.

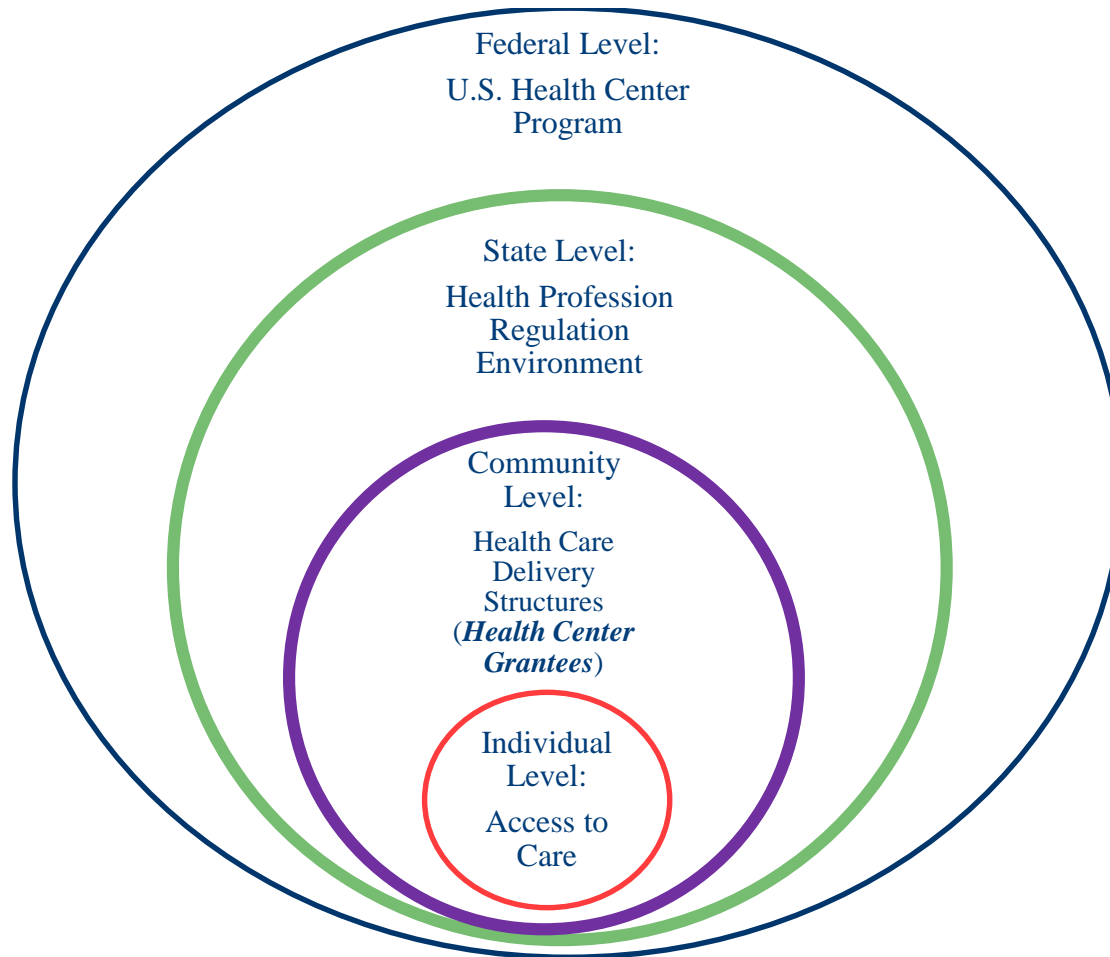


Figure 4. Layering of the Environmental Context for Access and Policy

Concept Application

The U.S. Health Center program is an example of federal level policy being implemented at the community level by health center grantees. Health center grantees structure their health service delivery resources within the context of state policies. Health professionals, as the physical providers of health care services, are a key resource to all health center grantees. Policies regulating health professional practice are enacted and implemented at the state level. As such, it can be assumed variations in these regulations are likely to influence the health care delivery structures of health center grantees, thereby influencing oral health service utilization, and, ultimately, effecting access to care in the medically underserved communities.

This assumption is supported by previous research examining the relationship between state policy environment for the practice of dental hygiene and state-level access to oral health care services (Wanchek, 2010; Wing et al., 2005). Past research suggests that, at a state level, policies supporting more autonomous practice of dental hygienists are associated with higher levels of access to dental care within the population. While this supports the theory dental hygiene practice policies influence access to care at state level, it is unknown whether this effect exists at the community level.

Summary

Health policies are subject to the context in which they are implemented. The concepts and assumptions presented here support the notion state regulations of dental hygiene is likely to influence the delivery of dental services by grantees of the U.S. Health Center program. The next section presents an existing framework and describes how it is adapted to study the effect of state health professional regulation on dental

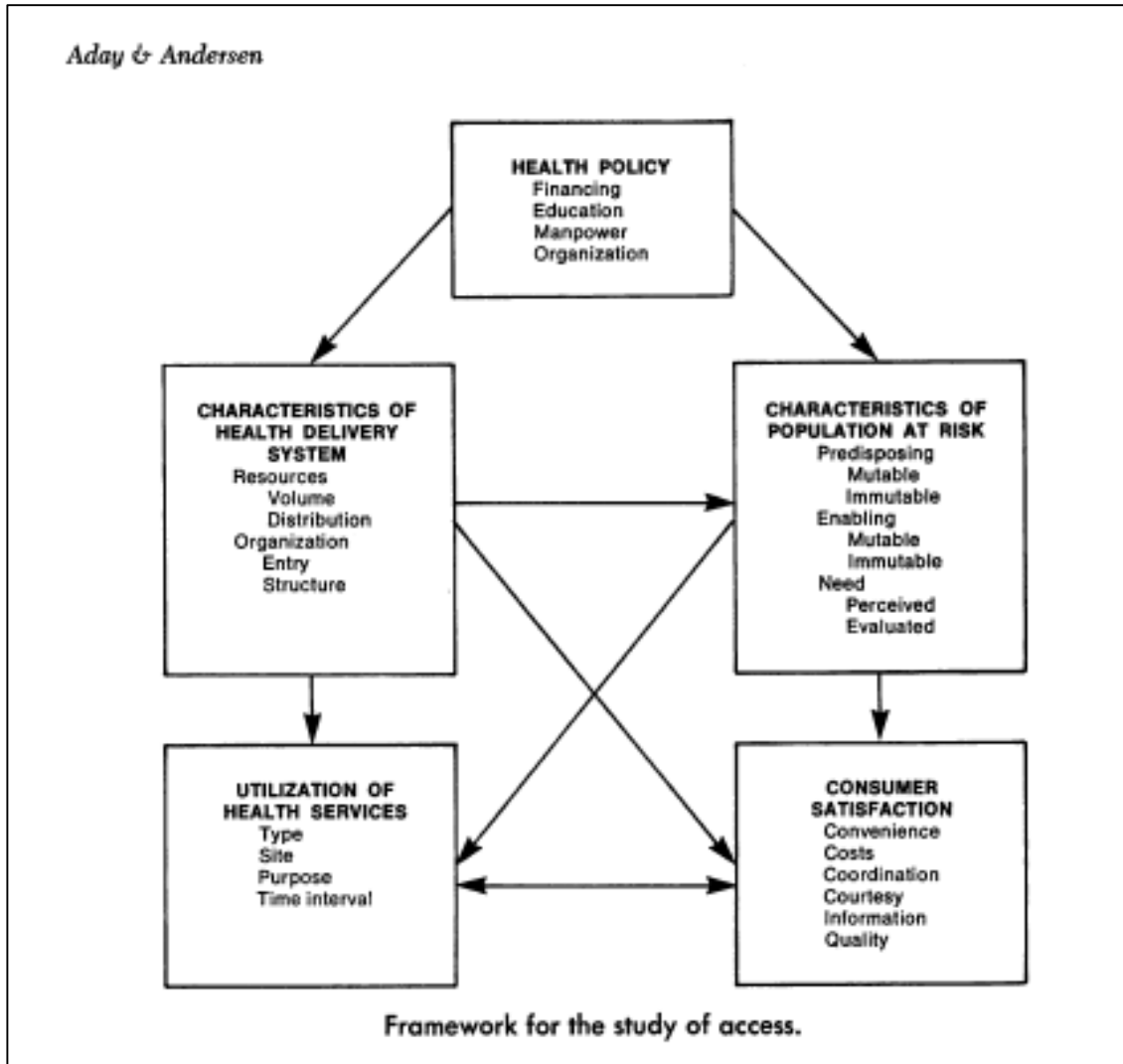
health service delivery and access to care at grantees of the U.S. Health Center program. *A Framework for the Study of Access to Medical Care*, developed by Aday and Andersen (1974), describes the pathways by which health policy influence access to health care. This framework has been expanded to account for state policy environment, which is presented as a key contributor to the context in which health care delivery and access occurs.

A Framework for the Study of Access to Care

Access to health care services is among the key determinants of health. Individuals with greater access to health care generally enjoy better health than those without. As such, a large number of policies focus on influencing access to health care services. The concept of access to care was first operationalized for health policy evaluation in seminal work by Aday and Andersen published in *Health Service Research* in 1974.

Established Framework

In their article, *A Framework for the Study of Access to Medical Care*, Aday and Andersen present a framework which conceptualizes health policy as designed to affect certain aspects of the health care delivery system or the population to bring about changes in access to health care, quantified through utilization of health care services (Aday & Andersen, 1974). This aligns with the more simplified concept depicted in Figure 2 found at the beginning of this chapter, in which health policy is described as influencing factors associated with key health determinants that in turn impact health outcomes. Aday and Andersen's framework is presented in Figure 5.



Note: Request for permission to reprint was submitted to Lu Ann Aday on June 11, 2014.

Figure 5. Framework for the Study of Access to Medical Care by Aday and Andersen

In their framework, Aday and Andersen (1974) conceptualize health policies as being divided into two domains: those influencing characteristics of health delivery system and those changeable (mutable) characteristics of the population. They further characterize the health delivery system as having two elements: 1) resources, which include health professionals, health service infrastructure, and medical equipment and materials; and, 2) organization, or the structure of resources and processes within the system. Population characteristics are divided into three factors: 1) predisposing factors which are fixed or unchangeable, such as demographic characteristics such as age, race, and gender; 2) enabling factors, such as social and environmental characteristics such as income, insurance status, and community resources; and, 3) need for health care, either perceived by the individual or evaluated by the health system.

The major assumption of health policy is that it will influence quantity or quality of access to care. Thus, the impact of health policies are quantified in this framework through health service utilization and/or consumer satisfaction.

The Aday and Andersen framework is universally accepted and widely employed in studies of access to care. As of December 2013, this framework has been cited in 141 articles found in Medline, the largest cataloging of health-related publications. In fact, Aday and Andersen's (1974) framework has been cited recently in a number of studies on access to care. A recent study of socio-economic inequalities in non-use of dental care in European countries applied Aday and Andersen framework in a country level analysis to determine the extent to which individual and system level factors play a role in dental care access (Tchicaya & Lorentz, 2014). Another recent study applied the framework to analyze the effect of health reform on access to medical care along the continuum of care

within Brazil and Columbia (Garcia-Subirats et al., 2014). Both studies use data on health utilization to examine the effect of health policies (i.e., reform and insurance program) on access to care.

Their framework has also been applied to the study of health workforce policies. One such recently applied key aspects of Aday and Andersen's framework to study evaluation methods for determining the effectiveness of financial incentive programs for health care providers on access to care in Belgium (Dewulf et al., 2013). This study found the method of measuring workforce capacity has a significant impact on the evaluation results, highlighting the need for standardized measurements for health workforce capacity in health services research (Dewulf et al., 2013).

These studies represent the most recent application of Aday and Andersen's framework, which is applied to this study on the effect of state health workforce regulation and dental care access at grantees of the U.S. Health Center Program.

Application of the Existing Framework to the Study of Access to Oral Health Care

The influence of state-level health workforce policy on access to oral health care services is conceptualized using Aday and Andersen's framework. The U.S. Health Center program is an allocative policy that seeks to influence volume and distribution of oral health services within health delivery system. By increasing volume and distribution of oral health services within underserved communities, the health center program increases dental service resources, which in turn enables individuals to access care.

It is important to remember, although all health center grantees are subject to the same federal guidelines as set forth by their funding agreement with the U.S. Health Center program, grantees are required to organize or structure oral health service delivery

within the context of their state policy environment. The U.S. Health Center program is enacted at a level above or outside the immediate state context. This study seeks to determine whether and to what extent state policy context has an effect on community-level implementation of the federal U.S. Health Center program, an allocative program funded with federal tax dollars. Figure 6 shows how the Aday and Andersen framework is adapted to study this relationship.

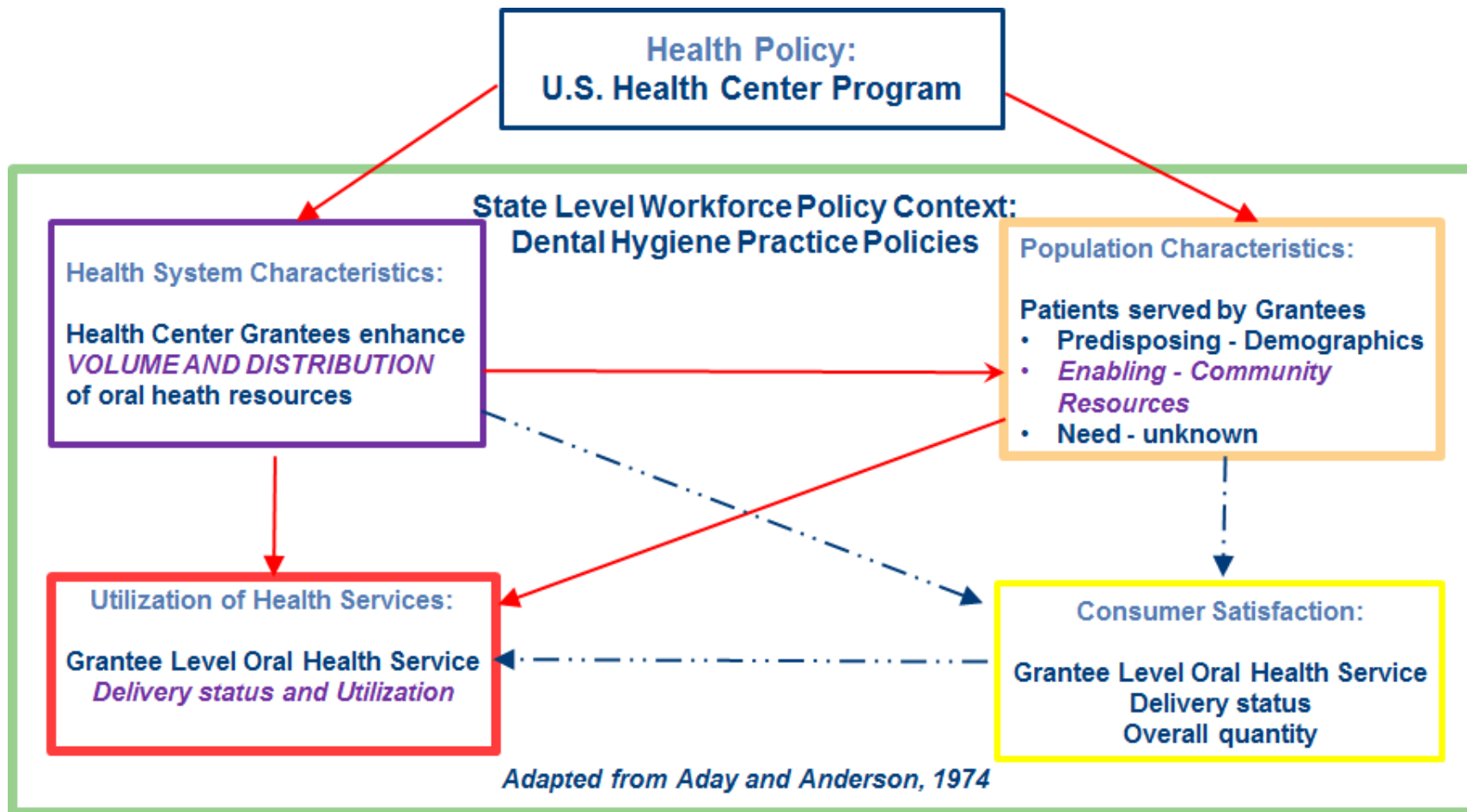


Figure 6. Adapted Framework for the Study of Access to Oral Health Care

The Adapted Framework

In this study, the U.S. Health Center program is the health policy of interest. Arrows in this diagram demonstrate the pathways by which this policy ultimately influences dental service utilization at health center grantees. State policy environment, shown here in green, is the primary effect of interest in this study. In addition, a number of other factors, organizational and population, are also known to effect health service utilization and are examined in this study.

The arrows extending from the U.S. Health Center program demonstrate the pathways of policy influence. The arrow (Figure 6) extending from Health Policy to Characteristics of the Health System, indicates the focus of this program: to influence characteristics of the health care delivery system by allocating funding to health center grantees to increase the volume and distribution of oral health care resources in underserved communities. The arrow extending from Health Policy to Characteristics of the Population, signifies that the U.S. Health Center program increases community dental health resources which enables individuals' greater access to care. These first arrows pass through an intermediary box representing State Policy Context, where the hypothesized effect occurs. The Dental Hygiene Professional Practice Index (DHPPI), described in Chapter 1, quantifies the policy environment of a state, and includes information on four key aspects of dental hygiene practice: supervision requirement, scope of clinical tasks, governance structure, and reimbursements. DHPPI values for each state and the District of Columbia are used as a measure of state policy context within this study.

It is important to note that other state-level policies are recognized to play a role in access to dental care and are likely to have an effect on dental service delivery by health center grantees (Mandal et al., 2014). State Medicaid programs, discussed in Chapter 1 and earlier in this chapter, are an example of one such policy. As previously described, Medicaid functions to remove cost as a barrier to dental healthcare through the provision of dental insurance for low-income populations thereby improving access to care. In addition, Medicaid policies impact grantees of the U.S. Health Center program.

Health center grantees are reimbursed for services provided to Medicaid recipients through a Prospective Payment System (PPS), required by federal law since 2001⁶. Grantees are reimbursed on an encounter basis and not fee-for-service. Each grantee has a unique payment rate, which is calculated based on the average from their reasonable costs per visit rates and adjusted by the Medicare Economic Index (MEI) for primary care and changes in scope of service. Medicaid reimbursements are an important revenue source for grantees. The high cost dental service delivery is cited as a major barrier to implementation by grantees (Beazoglou et al., 2010). Thus, it is likely that grantees rely, to some extent, on Medicaid reimbursements to financially sustain dental services program.

Unfortunately, specific information on Medicaid reimbursement rates to health centers are proprietary and are not available for this study. This inability to account for variations in Medicaid policy is an important limitation; however, the proportion of Medicaid patients served by a grantee is included in this study, and, to some extent, is believed to adjust for the administrative response of grantees to Medicaid policy. In

⁶ Public Law 106-554, Title VII- Medicaid, § 702

addition, statistical methods (Mixed Effects Models) which adjust for correlations between health center grantees located in the same state are employed to control for some state level variations in Medicaid policy.

The primary theory in this study is that state policy moderates the effect of federal policy, in this case the U.S. Health Center Program, on oral health service delivery and access to care in underserved communities. In essence, state policy stands in-between federal money and access to care. The extent to which state policy effects federal monies from reaching underserved communities and enhancing access to care is a significant question posed in this study.

The effect of policy on oral health service delivery structures and access to care is operationalized with data on dental service utilization from health center grantees. Conceptually, this effect is demonstrated by the arrows extending from characteristics of the health system and characteristics of the population to utilization of health services. In addition to the volume and distribution of health services, certain organizational characteristics may influence the likelihood of dental service delivery. Geographic location is an important indicator of oral health service access disparity. Low-income urban and rural communities often experience shortages of dental health services due to inequitable distribution of oral health care providers. The urban-rural location of a health center grantee is included as an important organizational characteristic which may influence, to some extent, the likelihood of dental service delivery.

Chapter 1 outlined the relationship between access to oral health care services and certain socio-economic and demographic characteristics. Individuals from racial and ethnic minority groups disproportionately suffer oral health disparities. In addition,

lower-socioeconomic status is associated with lower levels of access to oral health care services and greater burden of dental diseases. Race and ethnicity and socio-economic status are controlled for in study analyses.

Health insurance status and type are also important predictor of health care utilization and health status. As presented in Chapter 1, individuals with health insurance are more likely to access health care services than those without health insurance. Also, type of health insurance has been associated with health status. Individuals on government sponsored health insurance programs for indigent populations, such as state Medicaid programs, are more likely to experience barriers to accessing health care than those with private health insurance benefits.

These predisposing characteristics of the population are not influenced by policy, but are likely to have some effect on dental service utilization in this study. As such they are included as important factors (covariates) in this study. This relationship is depicted by the arrows extending from characteristics of the population and health service utilization.

Consumer satisfaction associated with dental services provided by health center grantees is important and a likely contributor to oral health utilization. This topic was recently examined in a study of dental patients at Health Center Grantees which was published in the *American Journal of Public Health* in 2013. High levels of satisfaction among health center patients accessing dental services were reported. The study also found many underserved patients at health center continued to experience barriers in accessing dental services and unmet oral health needs (Jones et al., 2013). This recent study supports the fact that consumer satisfaction is associated with utilization, but also

demonstrates access to care continues to be an issue in underserved communities served by health center grantees.

This study focuses on the influence of policy on access and assumes consumer satisfaction does not influence utilization data. This assumption represents a limitation of the study. Although high levels of satisfaction among dental service consumers of health center grantees have been cited recently, consumer satisfaction is likely to influence an individual's choice to access dental care. Organizational data on health center grantees are included in this study. These data do not account for individual perspective. Consumer satisfaction will likely be incorporated into future research. The relationships between characteristics of the health system, population, consumer satisfaction, and health service utilization are denoted using arrows with hash lines.

Literature

Previous Studies

The relationship between the professional practice environment of dental hygienists and access to oral health service has been considered previously in two state-level studies. These studies examine the effect of state policy environment on oral health service access using DHPPI values and state-level oral health service utilization data. Findings from these studies suggest policy environment has a direct effect on access at the state level, but it is not clear whether these findings can be applied at a community level or within certain populations. These studies represent the only identified work in this area. Understanding the designs, methods, strengths, and weaknesses of past studies is critical to this dissertation and future work in the field. A comprehensive review of

previous studies, discussion of lessons learned, and relevance for the current study and future research is presented in this section.

First Study

The first study to use DHPPI as a state level policy indicator, *A Dental Hygiene Professional Practice Index (DHPPI) and Access to Oral Health Status and Service Use in the United States*, was authored by the researchers that developed the DHPPI and published in the *Journal of Dental Hygiene* in the spring of 2005. This study tested two hypotheses: 1) dental hygiene salaries were directly related to state level DHPPI value; and, 2) dental service use within a state is correlated with state DHPPI value.

The first hypothesis was tested using dental hygiene salary data from 2000 as reported by the Centers for Disease Control and Prevention (CDC). The study found that mean dental hygiene salary was statistically significantly ($p < 0.01$) correlated with higher DHPPI values. Specifically, increases in a value of 1 point in the DHPPI was correlated with an increase in salary (coefficient of 0.57).

The second hypothesis examined the relationship between DHPPI value and access to oral health within a state. To test this hypothesis the authors used data on dental visits, aggregated to the state level, collected in the 2001 Behavioral Risk Factor Surveillance System (BRFSS) by the CDC. Background information on BRFSS was presented in Chapter 1. The following BRFSS measures were used: percent of people reporting not visiting the dentist with in the last year; and, percent of people having had no teeth removed due to tooth decay or gum disease.

The measures of access used in the 2005 study differ from those included in the current study in a number of ways. First, the 2005 study examined aggregated data on self-

reported nonuse of dental services. Operationalized as the proportion of nonusers of dental care within a state, this measure served as a proxy for the proportion of people without access to dental care in a state. The current study examines dental service utilization data aggregated to the organizational, or health center grantee, level. The proportion of grantee patients accessing dental services within a year is used as a proxy measure for the proportion of patients with access to care. These opposite perspectives seek to answer the same question: does policy influence access?

Statistically significant relationships were identified between DHPPI values and access to care. The percent of people without a dental visit in the last year was inversely correlated with DHPPI value. For every increase in 1 point in the DHPPI, there was a -0.29 decrease in the percentage of people without dental access ($p < 0.05$). The percentage of people having no teeth removed due to dental disease in a state was directly correlated with DHPPI value. For every increase in 1 point in the DHPPI there was a 0.49 increase in the likelihood of people having teeth removed ($p < 0.01$).

The 2005 study also examined whether the DHPPI value and the number of dentists and dental hygienists per capita within a state were correlated. DHPPI was not significantly correlated with the number of dental hygienists or the number of dentists per capita within a state. These results suggest that policy environment may not be dependent upon the number of dentists or dental hygienists within a state.

Nonparametric methods, such as Spearman's Rank Order Correlations were used to test hypotheses in the 2005 study. These methods were selected due to the non-normal distribution of study data.

There are important limitations to this study. First, this study examines self-reported data collected by the BRFSS. While the BRFSS is an established tool in health services research, it is fraught with a number of widely recognized limitations (Nelson et al., 2003; Remington et al., 1988). BRFSS data are subject to recall bias. In addition, concerns regarding representation from certain communities, especially people living in rural and low-income urban areas, threaten the generalizability of BRFSS data. Because of the longitudinal nature of the survey, BRFSS is a good indicator of changes in behaviors over time, but it may not accurately reflect behavior at any one cross-section of time.

Second, statistical results reported for the 2005 study do not account for other factors, such as demographic and socioeconomic, known contributors to oral health care access. Also, cross-sectional data from the 50 states and the District of Columbia, are analyzed in the study. The size of the population is relatively small, and findings from the 2005 study can only be applied to the state level. No conclusions regarding the influence of policy on access at an individual or community level can be drawn.

By examining longitudinal data from a specific and sizable population, health center grantees, the current study seeks to build upon findings from the 2005 study to make inferences about the influence of policy on access in medically underserved communities. This current study examines organizational data (administrative and aggregate patient characteristics and dental service utilization) reported on an annual basis by health center grantees. In addition, the current study controls for the effect of social and health system factors using hierarchical multivariable regression techniques. While these data are not representative of all underserved communities in the United

States, they are representative of the population of communities served by the U.S. Health Center program. The longitudinal design, size of the population, and extent of the factors examined are strengths of the current study.

Second Study

A more recent study, *Dental Hygiene Regulation and Access to Oral Healthcare: Assessing the Variation across the US States*, by Tanya Wanchek, a health economist at University of Virginia, was published in the *British Journal of Industrial Relations* in December of 2010. This study examined the influence of various components of regulatory policy for the dental hygiene profession on access to dental services. Three hypotheses were tested: 1) liberal license requirements increase dental hygiene employment; 2) liberal practice restrictions increase wage; and, 3) wage and employment jointly influence access. Components of regulation were modeled separately to understand their specific impact on the dental hygiene labor market and access to dental care.

The first two hypotheses examined the influence of state regulation on the dental hygiene labor market, as measured by employment and wage. Although the current dissertation study does not focus on the dental hygiene labor market, the findings of this study are relevant. The dental hygiene workforce delivers preventive dental care. Policies influencing supply of dental hygienists within a state are certainly critical to access.

In order to examine the effect of state regulation on the dental hygiene labor market, the author uses state-level data on the number of dental hygienists, dentists, and dental assistants, and wage which were obtained from the Bureau of Labor Statistics

(BLS), Department of Labor's Occupational Employment Statistics Survey in 2006. DHPPI values and state-level data on market entry restrictions for dental hygienists, such as the number of training programs and credentialing requirements, are used as indicators of the regulatory environment of a state. Dental hygiene wage and employment were modeled as a function of dental hygiene employment per 100,000 population, DHPPI value, entry restrictions, and mean wage of dentists and dental hygienists, which captures price of substitutes or complements. State level cost of living, consumer price index adjusted income, and year are controlled for in analyses.

Findings demonstrate that state regulation does influence the dental hygiene labor market. Results from the regression models for dental hygiene employment suggest that state level market entry restrictions play a significant role in the supply of dental hygienists within a state. These findings are not surprising as entry restrictions directly regulate the number of dental hygienists employed within a state.

Results from the regression models for dental hygiene wage demonstrate that professional practice environment, quantified through the DHPPI, is a significant predictor of wage (0.002, <0.01). This finding suggests every 1 point increase in the DHPPI value (out of 100) is correlated with a 0.2 percent increase in wage, which the author estimates is the equivalent of \$120 wage increase for every 1 point increase, calculated using the national average wage for dental hygiene of \$60,000. This means dental hygiene salaries are higher in states that support more autonomous practice, even after adjusting for differences in cost of living.

Also interesting is the statistically significant, inverse relationship between dental hygiene wage and percent of men reporting dental visits (-0.360, $<p=0.01$), which was

not present with females. This indicates the percent of men with a dental visit decreases as dental hygiene wage increases, but wage increases do not significantly affect the percent of women with a dental visit. These findings suggest men may be more sensitive to price increases for dental services associated with higher dental hygiene wage.

The third hypothesis examines the effect of dental hygiene wage and employment on access to oral health care services. In this study, access to care is conceptualized as a function of the availability of health care providers and prices. State level data on the number of dental hygienists, dentists, and dental assistants are used as proxy for availability, and state level data on wage are used as proxy for price. Access to care is measured with state level BRFSS data from 2002, 2004 and 2006. The percent of state population visiting a dental office or clinic within the last year is pooled for all years included. This pooled measure serves as the primary outcome measure. Access is modeled as a function of state level wage, previously demonstrated to be associated with the DHPPI, and dental hygiene workforce capacity.

Not surprisingly, oral health workforce supply is significantly associated with access. The number dental hygienists per population within a state is statistically significantly associated with access to dental care for men (0.205, $p < 0.01$) and women (0.221, $p < 0.01$). For both sexes, visits increase as the number of hygienists increase. These findings are consistent with other studies finding dental hygienists increase the number of preventive dental visits among dental patients (Perry et al., 1997) and, working in practice environments promoting professional autonomy, are a viable means of increasing access to dental care (Freed et al., 1997). However, as discussed in Chapter 1, most states require some level of professional supervision of dental hygienists by a

licensed dentist. In these states a dental hygienist is not a potential, unique, point of care, but rather an extender of services provided by a dentist. For this reason, the current study includes the number of dentists per capita, rather than the number of dental hygienists per capita as a consistent measure for state level oral health workforce capacity.

This study provides excellent insight into the relationship between state regulation and the dental hygiene labor market. It demonstrates state regulation has a significant effect on workforce supply and wage. However, the relationship between state regulation and access to care is not directly examined. Instead, access is modeled as a function of wage and supply, demonstrated by the author to be correlated to regulatory environment. Wage and supply only account for a portion of a state health workforce policy environment. For example, these measures do not directly account for variations captured by the DHPPI, including reimbursement policy, level of professional supervision, scope of clinical tasks, and the structures of professional oversight within a state. In addition, similar to the 2005 study, this study analyzes data aggregated to the state level. Thus, findings cannot be applied to specific populations or communities. The current study expands upon findings of the 2010 study by directly examining the relationship between state policy environment and access to care in a defined community.

Summary

Previous research has examined the relationship between dental hygiene regulation and access to dental care. These state level studies use the DHPPI as an indicator of the state policy environment and BRFSS data to measure access to care. The 2005 study examined the direct relationship between DHPPI value and access, identifying statistically significant correlations, but did not control for other factors that

contributed to oral health care access. The 2010 study, which focused primarily on the relationship between state regulation and the dental hygiene labor market, did not directly examine the relationship between DHPPI and access. Rather, it examined the influence of DHPPI on the labor market, and then the influence of labor market on access.

Both studies offer insight into the influence of state policy on access. Their findings suggest the policy environment is, to some extent, associated with access to dental care at a state level. However, as previously suggested, their findings cannot be applied to certain populations, communities, or individuals. Many population characteristics that contribute to oral health service access, such as demographics, insurance status, etc., were not examined by these studies. The current study contributes depth to the existing body of knowledge by examining the influence of state policy environment on organizations which receive federal support to meet the oral health needs of specific populations.

Presentation of Study Hypotheses

Findings of previous studies support the general proposition the state policy environment influences the dental service delivery and access to care at grantees of the U.S. Health Center program. Based on previous work, a direct relationship between state policy environment and dental service delivery and access to care is expected. The following specific hypotheses are tested:

H1: Grantees located in states with restrictive policy environments are less likely to deliver dental services.

H2: Grantees delivering dental services in restrictive policy environments will have lower rates of access to dental care among their patients.

H3: Grantees delivering dental services in restrictive policy environments will have lower rates of dental patient encounters for preventive care, higher rates of dental patient encounters for restorative care, and higher rates of dental patient encounters for emergency care.

Many health policies influence access to health care resources. The U.S. Health Center program is a federal, allocative policy seeking to improve access to health care as a means of enhancing health outcomes within underserved communities. State level policies, such as licensing and reimbursements, regulate health professionals and have an effect on supply of health care services which directly impact access to care. The relationship between policy and access has been demonstrated at the state level. The current study demonstrates the effect of state policy on dental service delivery, access to care, and oral health in medically underserved communities. Also important, this study demonstrates state policy may affect the implementation and success of programs funded through federal tax dollars.

CHAPTER 3: Study Population, Data and Methods

The general purpose of this study is to determine whether, to what extent, and in what ways state level dental hygiene practice policies and regulation influence the dental service delivery, access to dental care, and oral health in medically underserved communities served by grantees of the U.S. Health Center program. As detailed in the prior chapters, the dental hygiene practice policy and regulatory environment in the U.S. states is varied and multifaceted. For the purposes of this dissertation, the dental hygiene practice policies and regulatory environment is operationalized and measured by the Dental Hygiene Professional Practice Index (DHPPI) Specifically, this study seeks to answer the following research questions: 1) are DHPPI values associated with the oral health service delivery status (whether they provide dental services directly or not) of Health Center grantees; and 2) for Health Center grantees that do delivery oral health services, are DHPPI values associated with a) the proportion of patients accessing dental services and b) the proportion of preventive, restorative, and emergent dental services delivered. This chapter outlines the data and methods which are used to test the hypotheses presented in Chapter 2.

Study Population

Health center grantee is the unit of analysis in this study. A grantee may operate multiple clinical locations, but data reported annually to the UDS are aggregated to the grantee level. Findings of this study represent grantees and may not be representative of specific clinical locations.

Inclusion/Exclusion Criteria

This study includes data from 1,135 unique health center grantees, accounting for 8,526 grantee observations between 2004 and 2012. All U.S. Health Center Grantees reported to have received community health center funding from 2004-2012 and be geographically located in the 50 states and the District of Columbia are included in the study analyses.

Community Health Center Funding

Grantees receiving community health center funding are required to ensure the delivery of defined primary health care services (including preventive dental services) to all residents within their ‘catchment area.’ This requirement did/does not apply to health centers receiving grants specifically for the provision of care to migrant health workers, the homeless, and residents of public housing.

Health Center Grantees solely serving the primary health care needs of special populations may not be comparable to Health Center grantees delivering care to the entire population within a catchment area. Thus, any U.S. Health Center Grantee receiving funding exclusively through Health Care for the Homeless, Migrant Health Centers, or the Public Housing Primary Care Health Centers are excluded from this study.

These inclusion/exclusion criteria are similar to those used in previous studies of U.S. Health Center grantees (Shi et al., 2007; Shi et al., 2010; L. Shi et al., 2012). More detailed information on the grant types used to determine these criteria can be found in Section 330 of the Public Health Service Act (42 USCS § 254b subsections (a) (g) (h) and (i)).

Of the 9,596 total health center grantee observations between 2004 and 2012, 8,777 received community health center funding during the study period. The remaining 819 health center grantee observations received funding to exclusively serve certain populations. These have been excluded from the study.

Geography

In addition to the aforementioned criteria, this study includes only those health center grantees geographically located within the 50 states and the District of Columbia. The U.S. Health Center program supports health centers in all 50 states, the District of Columbia and seven U.S. territories, including American Samoa, Federated States of Micronesia, Guam, Marshall Islands, Puerto Rico, Palau, and the Virgin Islands. While enhancing access to oral health care services in U.S. territories is important, the Dental Hygiene Professional Practice Index does not include index values indicating the practice environment of dental hygienists in U.S. territories. Because index values serve as the primary independent variable in this study, only health center grantees geographically located within the 50 states and the District of Columbia will be included in analyses. Of the 8,777 grantees observations receiving community health center funding from 2004 to 2012, 235 located in U.S. territories are not included in this study. After excluding these grantees, there are 8,542 grantee observations remaining.

Clinically Operational

There are 16 grantee meeting the community health center funding and geographic location inclusion criteria but report having no patients during a funding period. A formal inquiry was placed with the Office of Data Quality (ODQ) in the Bureau of Primary Health Care at HRSA on February 18, 2014 to identify potential

reasons these grantee reported no patients⁷. After investigation by the ODQ, a formal response was received on March 26, 2014 detailing these 16 grantees were newly funded and in the process of developing infrastructure and establishing operations. These grantees were not operational and therefore reported no patients. These 16 grantees observations (their first funding year only) are excluded because they are not clinically operational.

After exclusions, there remained 8,526 grantee observations or 1,135 unique grantees receiving community health center funding, clinically operational, and geographically located in the 50 states and the District of Columbia from 2004-2012. Table 3.1, below, summarizes the number of grantees excluded by criteria for each year of the study.

⁷ Formal inquiry detailing the issue and including a table with identifiable information on the 16 grantees (UDS number, funding year, state, etc.) was submitted electronically to the Office of Data Quality at OQDDATAREquest@hrsa.gov on February 18, 2014. Follow-up communication occurred with Alek Sripipatana, Chief of the Data Branch at HRSA on February 20 and 24. The inquiry was subsequently assigned to Michelle Chung, data analyst, to research and respond. A formal response was received from Ms. Chung on March 26, 2014.

Table 3.1:

Summary of Study Population: Total U.S. Health Center Grantees, Exclusion Counts by Type, and Total Included

Year	Total Grantees	Total Excluded			Total Grantees Included in Study
		Did not receive Community Health Center funding	Not Geographically Located in the 50 States or District of Columbia	Not Clinically Operational	
2004	914	97	26	1	790
2005	952	101	26	1	824
2006	1002	100	27	1	874
2007	1067	99	26	9	932
2008	1080	80	26		974
2009	1131	90	26	1	1014
2010	1124	83	26		1015
2011	1128	85	26		1016
2012	1198	84	26	3	1087
Total	9596	819	235	16	8526

Grantee Distribution by Year and State

The distribution of included health center grantees by state and year is important in this study. All grantees clustered within a state are subject to the same state policy context, including health professional practice and state Medicaid policies, among others. The proportion of total grantees funded from 2004 to 2012 varied widely by state, and is presented in Figure 7 below. A complete listing of grantees funded by state for each year of the study is available upon request but is not included here due to size. Nevada and Wyoming account for the fewest grantees (0.2% each) whereas California accounts for the largest number of grantees (9.9%). California has significantly more grantees than any other state. The second highest is Texas which accounted for 5.6% of grantees included in the study.

State level clustering of grantees is important in this study. Grantees located within the same state are likely to share some of the same characteristics. For example, they are more likely to serve populations with similar demographic characteristics, and they are subject to the same state policies, such as Medicaid and health professional regulation. In order to control for correlation between grantees located within a state, appropriate adjustments are made in statistical analyses. These are discussed in greater length in the discussion on statistical analyses.

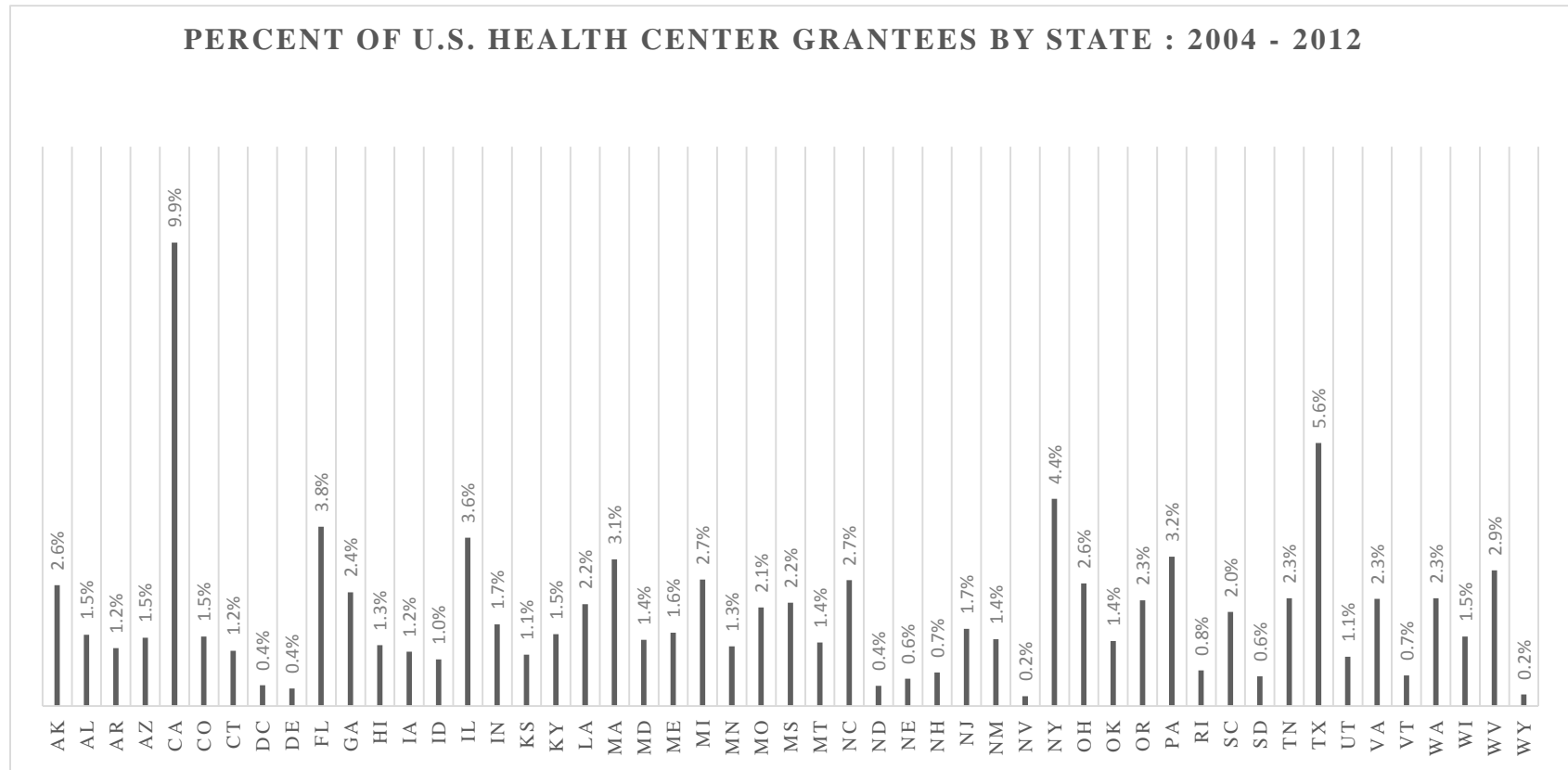


Figure 7. Percent of Total U.S. Health Center Grantees funded by State: 2004-2012

Study Data

This study analyzes secondary data on 1,135 U.S. Health Center grantees reported to the Uniform Data System following funding periods for 2004-2012. These data were obtained through a Freedom of Information Act (FOIA) request submitted to the Department of Health and Human Services in April of 2013. The request, FOIA case number HRSA 13F074, was approved on July 31, 2013, and data were obtained on August 15, 2013. A copy of the FOIA letter which accompanied the compact disc containing requested UDS can be found in the appendices. The letter states the release of non-proprietary data is approved for all health center grantees, in addition to proprietary data for health center grantees consenting to public release. Proprietary data include business and financial information which are not necessary for the analyses in this study, but may be of interest in future research. The following section describes UDS data which will be used in this study.

Uniform Data System (UDS)

As described in section 1, HC grantees are required to submit information on an annual basis to DHHS through the Uniform Data System (UDS). In addition to administrative data, the UDS collects information on aggregate patient characteristics (demographic and socio-economic), utilization of certain health services, and a number of health care quality measures, all of which are reported at the grantee level.

All patient, utilization, and quality measures reported to the UDS are aggregated at the grantee level. Grantees may oversee the administration of health care services at more than one clinical site within a defined service area. While aggregation of UDS data

at the grantee level is an important limitation, data are representative of services provided within a single service area.

In order to enhance the validity and comparability of UDS, the U. S. Health Center program develops and maintains a UDS reporting manual for each year. These manuals explicitly describe the methods of reporting for each measure used in this study. Report manuals for each year of UDS data included in this study were obtained by contacting the UDS help desk which provides support for UDS content questions by telephone at 1-866-837-4357. These manuals were used extensively in the preparation of data for this study.

Data Quality

Data quality is a concern with secondary data sources. In examining UDS data for inconsistency and potential coding errors, there are 4 HC grantees from 5 grantee years reporting dental visits but not reporting dental patients. These were the only years these health center grantees received funding. Their UDS number is not present in any other years. These are presented below in Table 3.2 by year and UDS number. These are the only instances of inconsistency in key outcome data for all years in the UDS data. These errors occurred during the first two years of required reporting for dental services, and are likely associated errors in reporting from the grantee.

Table 3.2:

Inconsistencies in reporting of dental visits and dental patients in UDS data by Year and UDS number

UDS Number	Grant year	State	Community Health Center Funding	Dental Visits	Dental Patients
43340	2004	GA	1	3827	0
10840	2004	MA	1	14025	0
90730	2004	PW	1	9461	0
90730	2005	PW	1	7656	0
511330	2006	OH	0	1885	0

Fortunately, three of the grantee observations are excluded from study analyses because they did not meet the inclusion criteria (community health center funding and geographical location in the 50 states and District of Columbia). The remaining 2 grantee observations from 2004 are assumed to be errors in reporting and are excluded from appropriate study analyses.

Study Measures

The following section describes the measures in this study and the methods used to prepare the variables for analysis. They are presented by type of measure in the following order: outcome measures; primary independent measures; covariates health center grantee characteristics

Outcome Measures

As described in Chapter 2, utilization of health services is commonly accepted as a measure of health service access (Aday & Andersen, 1974). The UDS data contains oral health utilization data for all health center grantees included in this study. Oral

health utilization data for dental services reported to the UDS are specified with International Classification of Disease, Ninth Revision, Clinical Modification (ICD9 CM) codes. The following dental services were defined consistently with the same ICD9 CM codes for all years which will be included in this study: 1) emergency services (D9110); 2) oral examinations (D0120, D0140, D0145, D0150, D0160, D0170, and D0180); 3) prophylaxis for adult or child (D1110 or D1120); 4) sealants (D1351); 5) fluoride treatment for adult or child (D1203, D1204, D1206); 6) restorative services (D21xx – D29xx); 7) oral surgery (D7111, D7140, D7210, D7220, D7230, D7240, D7241, D7250, D7260, D7261, D7270, D7272, and D7280); and, 8) rehabilitative services including endodontics, periodontics, prosthodontics, orthodontics (D3xxx, D4xxx, D5xxx, D6xxx, D8xxx). All dental services associated with the aforementioned ICD9 CM codes were reported by unique patient and unique visits to the UDS in Table 6A, line 27 through 34 for each year of data used in this study.

It is important to note the criteria for reporting dental services is different from the reporting of primary care measures. Primary care service measures are reported for services by primary diagnosis code for each unique patient and unique visit and do not include multiple services for one calendar day. For a visit or patient encounter with multiple diagnosis codes only the first (primary) is reported in the UDS. In the case of dental services, all services rendered are reported as separate patient encounters. For example, if an oral examination (D0120, D0140, D0145, D0150, D0160, D0170, and D0180) and prophylaxis (D1110 or D1120) occur during the same appointment, both services are counted separately for a total of two patient encounters. However, a unique service is only counted once per patient appointment. For example, multiple dental

restorations or dental sealants may be provided during the same appointment. These services would only account for one patient encounter. Thus, dental service utilization data represent the frequency of patient encounters for certain services and not the specific volume of services provided. Complete reporting for these measures increases the internal validity of dental services data within the UDS, and facilitates comparisons between the grantees.

Defining Patients and Visits

Utilization of dental services are reported in terms of the number of unique visits and the number of unique patients. Unique visits are defined in the UDS manual as “documented face-to-face contacts between a patient and a provider who exercises independent professional judgment in the provision of services to a patient.” This includes services provided by a dentist and, where applicable, a dental hygienist who practices independently.

To qualify as a visit, dental services rendered have to be documented in a chart in the possession of the health center grantee. Oral health services provided at a private dental office under contractual agreement with a community dentist not owned and operated by the health center grantee are not counted as dental visits within the UDS. A unique patient may be have multiple dental visits within a given dental service category during one year if that service was delivered at different appointments (for example: two oral examinations in one year).

Dental patients are defined as a patient that had at least one encounter during the reporting period for the selected dental services as defined above. Unique patients are only counted one time in a calendar year for any given service regardless of the number

of times they accessed the service. For example, a dental patient who present for two dental examinations within a given reporting year is only counted as one patient encounter in the UDS.

Currently, there is no way to account for the number of dental visits or patient encounters occurring in private dental offices under contractual agreement. This represents an important limitation to UDS data. This study seeks to examine the effect of policy on the direct dental service delivery status of grantees. Grantees reporting no dental visits /patients are considered as not directly delivering dental services.

Variable Definitions

There are five outcomes of interest in this study, including: 1) dental services status; 2) proportion of health center patients accessing dental services; and, proportion of dental patient encounters that were 3) preventive, 4) restorative, or 5) emergent. Each of these variables is calculated for each health center grantee for each reporting year. Grantees receiving funding for each or multiple years in this study will have a value for each year of UDS data. The specific methods used to code each of these variables are summarized:

1. Dental service status is a binary variable indicating whether a grantee reported delivering dental services during the reporting period. A value of 0 indicates no dental services were delivered directly by the grantee, whereas a value of 1 indicates dental services were directly delivered during the reporting period. This outcome variable will be used to test the first hypothesis that a relationship exists between DHPPI value and the dental services delivery status of health center grantees.

2. Proportion of health center patients accessing dental services is a continuous variable with a value between 0 and 1 reflecting the proportion of patients at the health center that accessed dental services at the health center during the calendar year. Whereas a unique patients may be counted as having multiple dental visits for a specified dental service within a given year, unique dental patients are only counted once per specific dental service encounter. In addition, unique dental patients may be counted as having an encounter once in each category of dental service within a reporting year. Thus, totaling the number of unique patients in each dental service category would result in counting a unique patient multiple times. Oral examinations are generally performed at each patient encounter prior to any other treatment, preventive, restorative, etc. As such, the number of unique patients accessing an oral examination (patient encounters for dental examination) is used as proxy for the number of patients accessing dental services. The proportion of unique patients with an oral examination for a given grantee during a reporting period was generated to enable comparisons between grantees. This measure adjusts for varying patient population sizes and allows for comparative analyses of access to dental services independent of total patient volume. This is important because of large variations in total patient counts between grantees. This outcome will be used to test the second hypothesis that a relationship exists between DHPPI value and proportion of health center patients accessing dental services.

The method of calculation for this is shown below:

Dental patient oral examinations / total health center patients = Proportion of patients accessing dental services

While total unique patients served by a grantee is provided in the UDS, it is important to note the total number of unique visits is considered proprietary information. This information is withheld from UDS data requests for all health center grantees not consenting to release proprietary data reported to the UDS. Because the majority health center grantee do not consent to release proprietary data, the proportion of all grantee visits for dental services is not included as an outcome in this study.

3. Proportion of total dental patient encounters attributable to examination, preventive, restorative and surgical, specialty, and emergent dental services are continuous measures with a values between 0 and 1 whose sum adds to one for each grantee within a given reporting year. These measures reflect the proportion of dental patient encounters for certain types of services. This outcome will be used to test the third hypothesis that state policy environment contributes to the frequency of certain types of dental services delivered by grantees.
 - a. Oral examinations (D0120, D0140, D0145, D0150, D0160, D0170, and D0180) are diagnostic procedures required prior to the determination of treatment.
 - b. Preventive dental services, prophylaxis for adult or child (D1110 or D1120), dental sealants (D1351), and fluoride treatment for adult or child (D1203, D1204, D1206), are procedures that promote and/or maintain dental health. Oral examinations and preventive dental services are

required under grantee funding agreement with the U.S. Health Center program.

- c. Restorative dental services are performed for the purpose of treating dental disease and restoring dental health (D21xx – D29xx).
- d. Surgical dental services generally involve the removal of hard or soft tissue and are more invasive than restorative dental services (D7111, D7140, D7210, D7220, D7230, D7240, D7241, D7250, D7260, D7261, D7270, D7272, and D7280).
- e. Specialty dental services (called rehabilitative services in the UDS manual) include advanced dental procedures such as endodontic, periodontic, prosthodontic, orthodontic treatments (D3xxx, D4xxx, D5xxx , D6xxx, D8xxx).
- f. Emergent dental services (D9110) are delivered when a patient presents with a dental problem requiring immediate attention, such as dental abscess which can be a life threatening condition.

The method of definition and measurement for outcome measured used for each research question is presented below in Table 3.3.

Table 3.3

Outcome Variable Definition by Research Question

Variable	Definition	Value
Research Question 1		
Dental Service Delivery Status	Indicates whether health center delivered dental services during reporting period	0= no dental services 1=dental services
Research Question 2		
Level of Dental Care Access	The proportion of health center patient that had an oral examination during the reporting period	value between 0 and 1
Research Question 3		
Dental Examinations	The proportion of dental patient encounter attributable to oral examinations (D0120, D0140, D0145, D0150, D0160, D0170, and D0180)	value between 0 and 1
Preventive Care	The proportion of dental patient encounter attributable to preventive services prophylaxis for adult or child (D1110 or D1120), sealants (D1351), fluoride treatment for adult or child (D1203, D1204, and D1206)	
Restorative Care	The proportion of dental patient encounter attributable to restorative services (D21xx – D29xx)	value between 0 and 1
Surgical Care	The proportion of dental patient encounter attributable to oral surgery (D7111, D7140, D7210, D7220, D7230, D7240, D7241, D7250, D7260, D7261, D7270, D7272, and D7280)	value between 0 and 1
Specialty Care	The proportion of dental patient encounter attributable to specialty (rehabilitative) services including endodontics, periodontics, prosthodontics, orthodontics(D3xxx, D4xxx, D5xxx , D6xxx, D8xxx)	value between 0 and 1
Emergency Care	The proportion of dental patient encounter attributable to emergency dental services (D9110)	value between 0 and 1

Note. ICD 9 DM codes included in each dental service category reflect those included in the UDS Manual used by grantees to prepare their annual reports

Primary Independent Measure

Dental Hygiene Professional Practice Index

The Dental Hygiene Professional Practice Index (DHPPI), presented in Chapter 1, contains values representing the professional practice of dental hygienists in the 50 states and the District of Columbia as of 2001. It was developed by the Center for Health Workforce Studies at the State of New York at Albany (SUNY) for Health Resources Services Administration (HRSA).

As described in Chapter 1, the DHPPI summarizes and quantifies the four aspects of legal practice environment of dental hygienists: legal and regulatory environment; supervision in various practice settings; tasks permitted under various levels of supervision; and, reimbursement environment. Legal requirements (as of December 31, 2001) for the provision of dental hygiene services across the states are sought to generate values for each of the four aspects. The total index value reflects the sum of values for the four aspects. The influence of each aspect is not distributed equally, as maximum values are assigned for each aspect based on predefined level of importance. Higher values in a category are associated with more supportive environment. The breakdown of these values is as follows: 10 points for legal and regulatory environment; 47 points for supervision; 28 points for tasks permitted; and, 15 points reimbursement environment. DHPPI values are also grouped into 5 policy categories: restrictive, 0-29; limiting, 30-39; satisfactory 40-49; favorable, 50-79; and, excellent, 80-100. Complete methodology for the DHPPI was published in the final report, *The Professional Practice Environment of Dental Hygienists in the Fifty States and the District of Columbia, 2001*, in April of 2004

and is available to the public through HRSA at:

<http://bhpr.hrsa.gov/healthworkforce1/reports/dentalhygiene50statesdc.pdf>.

The total DHPPI values is used in this study as a baseline measure of the broader state policy environment. This study is a first step in elucidating a relationship, and will likely be followed by additional studies on the effect of specific policy aspects (supervision, reimbursement, etc.). The DHPPI is presented below in Figure 8.

DHPPI values (total value, components values, and category) have been linked to health center grantees via two character state abbreviation code. DHPPI total value and category will serve as the primary independent variables in this study.

Table 3-1
Dental Hygiene Professional Index, 2001
Index Components by State

State	DHPI Component					DHPI Rating
	Regs	Sup	Tasks	Reimb	Total	
Maximum Score	10	47	28	15	100	
Colorado	9	47	26	15	97	Excellent
Washington	10	45	26	15	96	
Oregon	10	41	22	15	88	
California	8	37	26	15	86	
New Mexico	10	37	24	15	86	
Connecticut	9	33	18	15	75	Favorable
Missouri	8	29	22	15	74	
Nevada	9	36	20	0	65	
Minnesota	8	36	20	0	64	
Maine	8	30	18	0	56	
Utah	7	21	20	5	53	
New York	9	23	18	0	50	
Arizona	6	21	18	0	45	
Idaho	7	18	20	0	45	
South Carolina	8	21	16	0	45	
Nebraska	7	21	16	0	44	
Wisconsin	7	21	16	0	44	
Pennsylvania	8	18	16	0	42	
South Dakota	6	16	20	0	42	
Louisiana	8	15	18	0	41	
Montana	9	16	16	0	41	
Texas	8	23	10	0	41	
Kansas	7	14	18	0	39	Limiting
New Hampshire	9	16	14	0	39	
Tennessee	7	14	18	0	39	
Vermont	9	16	14	0	39	
Ohio	6	16	16	0	38	
Indiana	8	19	10	0	37	
New Jersey	6	15	16	0	37	
Iowa	8	10	18	0	36	
Illinois	7	11	18	0	36	
Maryland	10	16	10	0	36	
Alaska	9	12	14	0	35	
Michigan	7	18	10	0	35	
Massachusetts	6	16	12	0	34	
Wyoming	4	14	16	0	34	
Florida	6	21	6	0	33	
Rhode Island	7	16	10	0	33	
District of Columbia	6	16	10	0	32	
Delaware	8	16	8	0	32	
Hawaii	5	11	16	0	32	
North Dakota	6	16	10	0	32	
Oklahoma	6	7	18	0	31	
North Carolina	6	9	14	0	29	Restrictive
Arkansas	6	5	16	0	27	
Georgia	8	9	6	0	23	
Alabama	6	12	0	0	18	
Kentucky	6	8	4	0	18	
Virginia	7	8	2	0	17	
Mississippi	6	7	2	0	15	
West Virginia	6	2	2	0	10	

Center for Health Workforce Studies, University at Albany, 6/2003

Figure 8. DHPPI Index⁸

⁸ Source: Figure available to the public by the Bureau of Health Professions at Health Resources Service Administration in the Department of Health and Human Services. Found at: <http://bhpr.hrsa.gov/healthworkforce/supplydemand/dentistry/dentalhygieneenvironment.pdf>

Study Covariates

A number of factors potentially impact the relationship between DHPPI values and outcomes in this study were presented in Chapter 2. These include various characteristics of health center grantees, state level dentist per population, and key changes in the legal practice environment of dental hygienists occurring after December 31, 2001.

Health Center Grantee Characteristics

Administrative Characteristics

The UDS collects a number of measures that help to describe the location and administrative structure of health center grantees. Among these are the address (street, city, state, zip code) of the grantee, the number of unique sites a grantee operates, the number of National Health Service Corps assignees, and whether the HC grantee operates a school-based clinic. Unfortunately, certain administrative data, such as number and type of oral health professionals are not included in the UDS data obtained from HRSA. These data are considered proprietary and protected under Freedom of Information Act Exemption (b) (4) which ‘protects against the disclosure of information that could result in competitive harm.’ These data are only available for a relatively small number of health center grantees each year consenting to release proprietary information.

NHSC assignee and school-based clinic information are not included in the UDS data tables obtained for this study for years 2008 – 2011. In addition, the number of clinical sites is prepopulated in the general grantee information until 2007, after which the number has to be calculated by summing the site locations by HC grantee UDS number from a separate data table.

The size of a health center grantee is also considered in this study using two measures. Health center grantees may operate multiple clinical sites. In this study, the number of clinical sites operated by a grantee is considered a proxy for its capacity to deliver healthcare services. Due to the relatively small number of grantees operating greater than 8 clinical sites and under the assumption grantees operating 8 or more sites are similar, the variable is collapsed to 8 levels where 1-7 represent the specific number of sites and 8 represents 8 or more clinical sites. Pooling data from all study years, just under half (46.21%) of grantees operate 1 to 3 clinical sites, 29.87% operate 4 to 7 clinical sites, and 23.92% operate 8 or more clinical sites. In addition, the number of total unique patients served by a health center grantee is also examined in this study. As previously described, this measure is used to generate a continuous outcome measures and a number of covariates in this study.

Geography (either urban or rural) served by a grantee is collected in the annual UDS report. The level of reporting for geography changed during the years included in the study. From 2004 to 2010 geography was reported at the clinical site level for each grantee. Beginning in 2011 geography was reported at the grantee level. In addition to changes in level of reporting, the value (either urban or rural) is self-reported by the grantee in the UDS report and not based on a defined index value. Self-reporting of geography is a limitation to the reliability of this measure; however, it is assumed a grantee will be aware and accurately report the geography they serve.

The final measure of geography in this study is coded as a binary variable in which 0 indicates a grantee serves primarily rural communities and 1 indicates a grantee serves primarily urban communities. For grantee observations from 2004-2010, this

value is calculated by summing the binary urban/rural indicator value reported for clinical sites and dividing it by the total number of sites. Values greater than 0.5 are assigned a 1 and assumed to serve a primarily urban geography, and values less than 0.5 are assigned a 0 and assumed to serve a primarily rural geography. Geographic measure for grantee observations from 2011 and 2012 are used as reported in the UDS.

Aggregate Patient Characteristics

The UDS collects aggregated information on the race and ethnicity of health center patients. The method of reporting for these data has changed over the years included in this study. For years 2004, 2005 and 2006 race and ethnicity were not collected as separate measures in the required UDS report format. During these years, patients identified as Hispanic were identified through a variable defined as “Hispanic (all races).” In 2007 and 2008, ethnicity and race were collected as separate measures. Patient ethnicity was reported as Hispanic or Non-Hispanic, and race was reported as a separate measure. In 2009 -2011, the UDS the collected patient race by ethnicity. For example, patients of the white race were reported as either being Hispanic or Non-Hispanic in ethnicity.

The proportion of minority patients served by HC grantees is included as a covariate in this study. This variable is calculated by taking the sum of White non-Hispanic (WNH) and unknown non-Hispanic (UNH) patients, dividing that value by the total number of patients served by the grantee, and subtracting the product from one. This is also provided as an equation sentence below.

$$\textit{Proportion minority} = 1 - ((\textit{WNH} + \textit{UNH}) / \textit{total patient count})$$

The specific method used to define the collection of this variable changed within certain years of the UDS reporting. Specifically, in 2007 and 2008, aggregate patient counts by ethnicity and race were reported separately disallowing for the identification of the count of individuals that were non-Hispanic white and unknown. The lack of continuity in measurement of race is a recognized limitation to the race variable (proportion minority patients) used within these analyses.

In order to assess whether changes in the method of reporting for race and ethnicity affect the reliability of this measure, the average proportion of minority patients for each year of the study is calculated. The calculated averages for each year are then compared to assess the impact of changes in reporting. Table 3.4 presents the calculated average of minority patients for each year. The average proportion of minority patients served by the health center program grantees was significantly lower in 2007 and 2008. All other years the proportion ranged from 0.51 to 0.54, but during 2007 and 2008 the proportion minority dropped to 0.32 and 0.30. Based on fluctuations in the average proportion of minority patients by year, changes in the measurement of race and ethnicity make data from 2007 and 2008 unreliable. This fluctuation is presented graphically in Figure 9 below.

Table 3.4

Average Proportion of Minority Patients Served by HC Grantees by Year

Year	HC Grantees	Percent
2004	914	0.54
2005	952	0.53
2006	1002	0.53
2007	1067	0.32
2008	1080	0.30
2009	1131	0.51
2010	1124	0.51
2011	1129	0.52

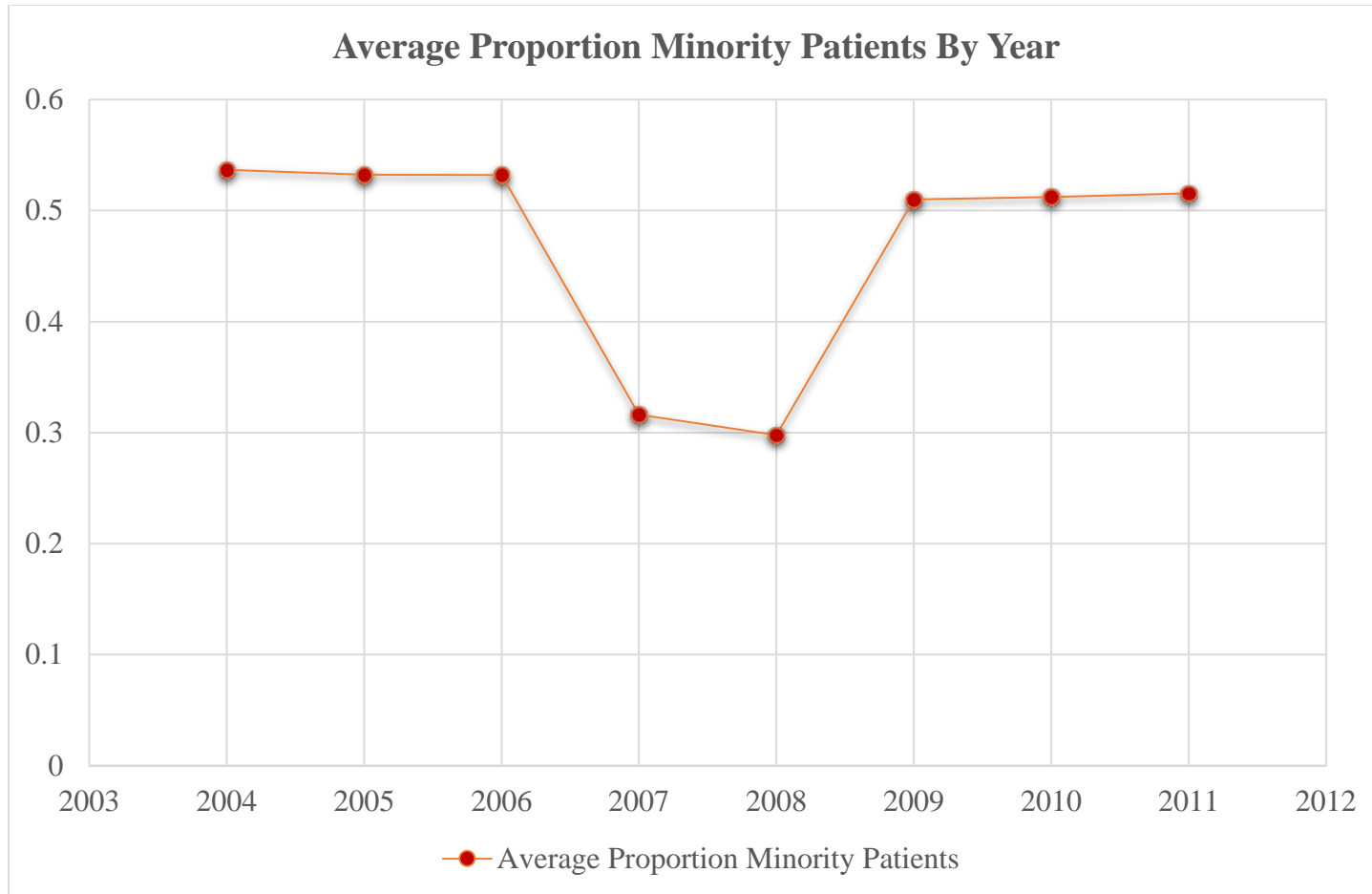


Figure 9. Average Proportion of Minority Patients Served at HC Grantees by Year

The proportion of minority patients seen by a unique health center grantee fluctuated very little in each of the years with the exception of 2007 and 2008. The average proportion of minority patients from 2004-2006 and 2009-2011 is calculated for each health center grantee. Data reported for 2007 and 2008 are not included. This constant value is the measure used for proportion minority patients served by the health center grantee for each year in the study data. A total of 13 grantee observations received funding only in 2007 and 2008, the years in which method of reporting changed. Because there is no reliable information to calculate the average proportion of minority patients, this variable is excluded for these 13 grantee observations. Select information on these grantee observations can be found in Table 3.5 below. Eight of the grantees (years) or 61% are associated with delivery of dental services, five grantee (years) or 39% did not delivery dental services. Eleven of the grantees (years) are located in states with DHPPI values less than 42. Only two are located in states with DHPPI values of 50 or greater.

Table 3.5

Grantees without Reliable Minority Information

State	UDS Number	Year	Dental Service Status	Proportion Dental Visits	DHPPI
MA	10120	2008	1	0.09	34
NH	10130	2008	1	0.05	39
MA	11720	2008	0	0.00	34
NY	21700	2008	0	0.00	50
FL	42400	2008	1	0.19	33
MI	50390	2008	1	0.21	35
IL	51900	2008	1	0.10	36
TX	627840	2007	1	0.20	41
TX	627840	2008	1	0.20	41
IA	70530	2008	1	0.03	36
ND	818890	2007	0	0.00	32
ND	818890	2008	0	0.00	32
CA	99370	2008	0	0.00	86

Aggregate counts of patients at different poverty levels (100% or below, 101-150%, 151-200%) are collected in the UDS during annual reporting by HC grantees. The method of reporting for this variable remain consistent within all years included in this study. The proportion of patients at or below 200% poverty is generated by calculating the sum of patients over 200% poverty and those of unknown poverty level, dividing this value by the total patient count, and subtracting the product from one. This is also provided below in equation format.

$$\textit{Proportion at or below 200\% poverty} = 1 - ((\textit{patient above 200\% poverty} + \textit{unknown}) / \textit{total patients})$$

The UDS gathers information on insurance status and type, including the count of uninsured and Medicaid patients. The proportion of uninsured patients and the proportion of Medicaid patients are included as potential covariates in this study. The proportion of uninsured patients is generated by dividing the count of uninsured patients by the total number of patients, and the proportion of Medicaid patients is similarly calculated by dividing the count of Medicaid patients by the total patients.

The UDS also collects information on Medicare and managed care utilization, neither of which are included in these analyses. Medicare is only available to Americans over the age of 65 years or those who are disabled, and it does not provide insurance coverage for preventive or basic oral health care services. Also, the total count of Medicaid patients used to generate the proportion of Medicaid patients include Medicaid recipients enrolled in managed care plans.

State Level Oral Health System Characteristic

Dentist to Population

The dentists to population rate is frequently used as an indicator of access to oral health care services. The Area Resource File (ARF) is a commonly used source of data on the number of dentists and dental hygienists at the state level. The ARF is an open sourced database maintained by HRSA containing administrative information on the health care system. Data on the number of dentists per state contained in the ARF originated from the American Dental Association. These data are not updated on an annual basis. The total count of professionally active dentists has been updated in 1998, 2007, 2009, and 2010.

State level information on dentist per 10,000 population ratio is reported by the Centers for Disease Control and Prevention (CDC) in their annual publications on *Health, United States*. These data include information on professionally active dentists that are also obtained from the American Dental Association survey of dentists. Data are available for 2003, 2006, 2007, 2008, and 2009. The most recent data published in *Health, United States, 2012*, are found below in Figure 10.

Health workforce experts from the Center for Health Workforce Studies at the State University of New York in Albany were consulted to determine the preferred source of data for this study. The CDC data (reported in *Health, United States*) was recommended as a more reliable source of data for this study due to technical issue with the ARF in personal communication with Tracey Continelli on December 8, 2013.

From CDC reported data on dentist per 10,000 population presented in *Health, United States, 2012* it is evident there is very little change in the number of dentists at the

state level from year to year. Because there is very little variation from year to year, dentist to 10,000 ratio from CDC reported in 2007, the midpoint of this study, will be used as a constant value representing the state-level dental workforce capacity.

Table 103. Active dentists, by state: United States, selected years 1993–2009

[Data are based on reporting by dentists]

State	1993	2000	2007	2008	2009	1993	2000	2007	2008	2009
	Number of dentists					Number of dentists per 10,000 civilian population				
United States	155,087	166,383	181,725	181,774	186,084	6.1	6.1	6.0	6.0	6.0
Alabama	1,779	1,912	2,032	2,032	2,069	4.3	4.3	4.4	4.4	4.4
Alaska	421	467	519	505	534	7.5	7.5	7.6	7.4	7.4
Arizona	2,032	2,322	3,225	3,302	3,447	5.3	4.5	5.1	5.1	5.1
Arkansas	1,001	1,080	1,162	1,125	1,162	4.2	4.0	4.1	3.9	3.9
California	20,909	22,963	27,654	27,922	28,776	6.8	6.8	7.6	7.6	7.6
Colorado	2,503	2,818	3,181	3,212	3,328	7.3	6.6	6.5	6.5	6.5
Connecticut	2,587	2,636	2,710	2,610	2,702	7.9	7.7	7.7	7.5	7.5
Delaware	331	357	403	403	406	4.8	4.6	4.7	4.6	4.6
District of Columbia	810	728	614	634	646	13.9	12.7	10.4	10.7	10.7
Florida	7,110	8,170	9,640	9,741	9,877	5.3	5.1	5.3	5.3	5.3
Georgia	3,251	3,611	4,295	4,260	4,430	4.9	4.4	4.5	4.4	4.4
Hawaii	976	992	1,043	1,039	1,048	8.8	8.2	8.1	8.1	8.1
Idaho	573	678	863	890	932	5.4	5.2	5.8	5.8	5.8
Illinois	7,978	8,205	8,268	8,192	8,345	6.9	6.6	6.4	6.3	6.3
Indiana	2,716	2,867	3,035	3,009	3,078	4.8	4.7	4.8	4.7	4.7
Iowa	1,545	1,564	1,610	1,600	1,625	5.5	5.3	5.4	5.3	5.3
Kansas	1,316	1,329	1,437	1,413	1,446	5.3	4.9	5.2	5.0	5.0
Kentucky	2,129	2,258	2,356	2,388	2,437	5.7	5.6	5.6	5.6	5.6
Louisiana	2,029	2,086	2,118	2,066	2,133	4.8	4.7	4.9	4.7	4.7
Maine	592	601	662	657	662	4.8	4.7	5.0	5.0	5.0
Maryland	3,753	3,986	4,212	4,138	4,211	7.7	7.5	7.5	7.3	7.3
Massachusetts	4,652	5,137	5,314	5,442	5,502	7.8	8.1	8.2	8.4	8.4
Michigan	5,884	5,913	6,126	6,060	6,068	6.2	5.9	6.1	6.1	6.1
Minnesota	2,913	2,960	3,196	3,174	3,201	6.5	6.0	6.1	6.1	6.1
Mississippi	1,040	1,115	1,190	1,190	1,190	4.0	3.9	4.1	3.9	3.9
Missouri	2,773	2,680	2,813	2,803	2,865	5.4	4.8	4.8	4.7	4.7
Montana	476	485	549	548	582	5.8	5.4	5.7	5.7	5.7
Nebraska	1,054	1,087	1,111	1,105	1,112	6.6	6.4	6.3	6.2	6.2
Nevada	570	763	1,285	1,330	1,367	4.3	3.8	5.0	5.1	5.1
New Hampshire	642	707	830	817	837	5.8	5.7	6.3	6.2	6.2
New Jersey	6,144	6,607	7,042	6,925	7,062	7.9	7.9	8.1	8.0	8.0
New Mexico	719	809	907	916	935	4.6	4.4	4.6	4.6	4.6
New York	14,395	15,159	15,184	14,980	15,131	8.0	8.0	7.9	7.7	7.7
North Carolina	2,968	3,394	4,108	4,183	4,315	4.4	4.2	4.5	4.5	4.5
North Dakota	315	300	326	329	339	5.0	4.7	5.1	5.1	5.1
Ohio	5,981	6,108	6,063	6,029	6,093	5.4	5.4	5.3	5.2	5.2
Oklahoma	1,584	1,683	1,804	1,805	1,846	5.0	4.9	5.0	5.0	5.0
Oregon	2,034	2,273	2,551	2,574	2,651	6.8	6.6	6.8	6.8	6.8
Pennsylvania	7,915	8,031	7,747	7,756	7,798	6.6	6.5	6.2	6.2	6.2
Rhode Island	581	589	569	573	578	5.8	5.6	5.4	5.5	5.5
South Carolina	1,601	1,803	2,026	2,065	2,116	4.5	4.5	4.6	4.6	4.6
South Dakota	347	359	397	406	418	4.9	4.8	5.0	5.0	5.0
Tennessee	2,748	2,993	3,076	3,015	3,093	5.5	5.3	5.0	4.9	4.9
Texas	8,860	9,873	10,981	10,936	11,567	5.1	4.7	4.6	4.5	4.5
Utah	1,162	1,398	1,713	1,743	1,809	6.4	6.3	6.5	6.4	6.4
Vermont	323	353	361	360	355	5.7	5.8	5.8	5.8	5.8
Virginia	3,686	4,036	4,563	4,640	4,796	5.9	5.7	5.9	6.0	6.0
Washington	3,271	3,860	4,528	4,579	4,737	6.4	6.5	7.0	7.0	7.0
West Virginia	816	828	847	844	861	4.5	4.6	4.7	4.7	4.7
Wisconsin	3,054	3,119	3,186	3,208	3,246	6.1	5.8	5.7	5.7	5.7
Wyoming	235	267	269	266	282	5.1	5.4	5.1	5.0	5.0

NOTES: The data include professionally active dentists only. Professionally active dentist occupation categories include active practitioners (full- or part-time); dental school faculty or staff; armed forces dentists; government-employed dentists at the federal, state, or local levels; graduate students/interns and residents; and other health or dental organization staff members. U.S. totals include dentists with unknown state of practice not shown separately. Rates were calculated using the number of dentists from the American Dental Association and civilian population data from the American Medical Association to be consistent with Table 100.

SOURCE: American Dental Association, Survey Center, Distribution of Dentists in the United States: Historical Report, 1993–2001, Table 1; p. 6 (number of dentists); Distribution of Dentists in the United States by Region and State, 2003, Table 1; p. 6–7 (number of dentists); Distribution of Dentists in the United States by Region and State, 2006, Table 1; p. 6–7 (number of dentists); Distribution of Dentists in the United States by Region and State, 2007, Table 1; p. 6–7 (number of dentists); Distribution of Dentists in the United States by Region and State, 2008, Table 1; p. 6–7 (number of dentists) United States by Region and State, 2009, Table 1; p. 6–7 (number of dentists) (Copyright 2003, 2005, 2008, 2009, 2010, 2011, 2012 American Dental Association. Reprinted with permission. All rights reserved.) Any form of reproduction is strictly prohibited without prior written permission of the American Dental Association; American Medical Association (AMA). Physician characteristics and distribution in the U.S., 2011 and previous editions (number of civilian population) (Copyright 1994, 1997, 2002, 2005, 2008, 2009, 2010, 2011, 2012: Used with the permission of the AMA). See Appendix 1, American Dental Association (ADA).

Figure 10. Reported Dentists per State as found in *Health, United States, 2012*⁹⁹ Source: Health, United States, 2012

Key Legislative Changes Following DHPPI Development

The DHPPI was developed based on legislative data collected in 2001. Thus, the DHPPI reflects a cross-section of the professional practice environment of dental hygienists at the state level. A number of states experienced changes in legislation for dental hygiene supervision, reimbursement, and scope of clinical practice following the development of the DHPPI. These changes are likely to alter the DHPPI; however, it is unlikely legislative changes have an immediate impact on oral health service delivery within a HC grantee due to the nature of the legislative processes in most states.

The American Dental Hygiene Association (ADHA) has collected information annually on state level legislative changes since 2002, specifically the data track bills that have been signed into law by state Governors. This includes information on reimbursement policies, supervision requirements, and scope of clinical practice. This information was obtained from ADHA's legislative liaison, Daniel Zurawski, on September 16, 2013 for the purpose of this study.

Changes in the legislative environment of a state following the development of the DHPPI may affect the delivery of oral health care services in HC grantees over the study period. In order to control for changes, ADHA legislative data are used to generate legislative change variable. Changes are identified by year for each state. A total of nine legislative change variables are created: 8 variables representing state-level changes for each year of the study and 1 variable representing any legislative changes within a state during the 8 year period. States with legislative changes are coded as 1 and states without change are coded as zero.

Ideally, the DHPPI or another indicator of the political practice environment should be updated on an annual basis. Unfortunately, the DHPPI index has not been routinely updated as it requires a significant amount of resources (time and manpower) which have not been readily available. This study examines DHPPI values as a baseline measurement of state policy environment, controlling for key changes in the policy environment. Updating the DHPPI is outside of the scope of this study; however, the development of an index which could be updated annual may be warranted, if the legislative change variables included this study as covariates have a significant impact.

The following summarize states with key policy (statute or regulatory) changes following the development of the Dental Hygiene Professional Practice Index (DHPPI). This index was developed based on the state level policy environment in 2001. Domains of interest in this study include supervision requirement, scope of clinical practice, and Medicaid reimbursement. These were selected because they 1) are included in the DHPPI (Wing et al., 2005) and 2) have been identified to have direct influence on the dental hygiene labor market and access to oral health care within a state (Wancheck, 2010; Wing et al., 2005).

Supervision requirements are defined as the level of professional oversight required for the clinical practice of dental hygiene. Generally, oversight by a licensed dentist is the most common supervision requirement. There is a large range in the level oversight required. For example, in Colorado there are currently no supervision requirements for delivery of basic dental hygiene procedures (with the exception of the administration of local anesthesia). Whereas in Mississippi, direct oversight by a licensed dentist is required for all clinical dental hygiene services. The DHPPI measured

level of supervision within a state using discrete values. Changes in the level of supervision are important; however, this study seeks to identify change in supervision requirement as a two level variable (yes/no). All legislative changes reviewed for this study included provisions that increased professional autonomy for dental hygienists within a state. Thus, policy changes would be associated with an increase in the value of the respective aspects (supervision, tasks, etc.) addressed and the total DHPPI value. This two level variable will be used as a covariate in statistical analyses to control for policy changes in cross-sectional and longitudinal analyses.

The DHPPI includes professional regulation as a fourth domain. The structure of professional governance, state board, is the primary measure for regulation within a state. This is included in the DHPPI as an important measure of the level of professional autonomy within a state; however, it is unlikely changes in the regulatory structure within a state translate directly to changes in delivery of care by dental hygienists. Rather, these changes are likely to be precursory to changes in the other measures (supervision, scope of clinical practice, and Medicaid reimbursement). As changes to governance structures are not considered to have a direct effect on the clinical practice of dental hygiene, they are not included among those changes that are controlled in analyses of this study.

Table 3.6 lists the states in which policy changes occur by aspect (supervision, clinical tasks, reimbursements, any). A total of 36 states had policy changes between 2002 and 2011. The majority, 27 states, had changes to supervision requirements, and 17 states had changes to clinical tasks. Only three states had changes to reimbursement policy.

Table 3.6
Summary of States with Policy Changes by Type

State Abbreviation	Change			
	Supervision	Clinical Tasks	Reimbursement	Any
AR	1			1
AZ	1			1
CA	1			1
CO		1		1
CT		1		1
DC	1			1
FL	1			1
ID	1			1
IL	1			1
IN	1			1
KS	1			1
KY	1	1		1
LA	1	1		1
MA	1	1	1	1
MD	1	1		1
ME		1		1
MI	1	1		1
MN	1	1		1
MO		1		1
NC	1			1
ND	1	1		1
NE	1			1
NH		1		1
NM			1	1
OH	1	1		1
OK	1			1
OR		1		1
RI	1			1
SC	1			1
SD	1			1
TN		1		1
TX	1			1
VA	1	1		1
WA	1			1
WI			1	1
WV	1	1		1
Total	27	17	3	36

Nine states had changes in more than one of the policy aspects during this time period. Changes included in this study are summarized by year.

2003: November 2002 - July 2003

Among the states with key policy changes in supervision requirements during this time period are Illinois, Kansas, Maryland, Minnesota, Oklahoma, South Carolina, and Virginia. Illinois, Kansas and Minnesota introduced policy specific to public health settings, such as federally qualified health centers. North Dakota and West Virginia had changes in scope of practice policy. New Mexico had changes to reimbursement policy which enabled direct reimbursement to dental hygienists for unsupervised dental hygiene care.

2004: August 2003 – September 2004

Arizona, Idaho, Illinois, and the District of Columbia had changes in supervision requirements during this period. Of these, Arizona's policies were specifically aimed at reducing barriers to dental hygiene practice in public health settings, such as federally qualified health centers. In addition, Michigan and Tennessee had changes within scope of clinical practice policy.

2005: January –November 2005

Michigan was the only state to have changes to supervision requirements during this period. These changes were directly focused on reducing supervision requirements in public health settings, such as federally qualified health centers. Connecticut, Massachusetts, Maine, and Minnesota had changes in scope of practice during this period.

2006: January – June 2006

Arizona, Florida, and Rhode Island had changes to supervision requirements during this time period. Policy changes in Arizona and Florida were specifically focused on public health settings. In Rhode Island, policy changes were directed toward care for the elderly through reducing supervision requirements in nursing homes. New Hampshire, Ohio and Virginia had changes in scope of clinical practice. Wisconsin policy changes enabled direct reimbursement to dental hygienists for specified services only.

2007: July 2006 – June 2007

A number of states had key policy changes during this period. California, Indiana, Kansas, Louisiana, Maryland, Nebraska, North Carolina, North Dakota, Rhode Island, and Washington all had changes to supervision requirements. Among these, Kansas, Louisiana, Nebraska, and North Carolina policy changes specified decreased levels of supervision within public health setting, which included federally qualified health centers. A number of the supervision changes also permitted lower levels of supervision for the provision of care to the elderly in nursing homes and senior centers. In addition, a number of states had policy changes which expanded scope of clinical practice, including Minnesota, Louisiana, Maryland, Oregon, and Virginia. Most notable among these are Oregon and Minnesota which incorporated dental hygiene diagnosis or examination into the scope of clinical practice. Wisconsin had changes in reimbursement policy which enabled direct reimbursement to dental hygienists for the delivery of any dental hygiene service.

2008: September 2007 - July 2008

Arkansas, Indiana, Maine, Maryland, Pennsylvania, Vermont had changes to supervision requirement policies. All of these changes included reducing the level of supervision required within public health settings. Although variability in these changes were large; for example, Indiana required examination by a dentist within 45 days of dental hygiene care, while Vermont and Arkansas supervision only required patient chart review or collaborative agreement with a dentist and not a physical oversight examination. In addition, Arkansas and Tennessee had changes to scope of clinical practice.

2009: July 2008 - June 2009

During this time period Arkansas, Massachusetts, Texas, Virginia, Washington, and West Virginia had changes to supervision requirements. Massachusetts, Texas and West Virginia specified policy changes reducing the amount of supervision required in federally qualified health centers. Colorado, Kentucky, and Maryland had changes to scope of clinical practice during this period. Of note, Massachusetts policy changes also enabled Medicaid reimbursement direct to dental hygienists practicing in underserved areas.

2010: July 2009 - June 2010

Kentucky, Maryland, and Ohio had changes to supervision regulation during this period. Maryland policy changes were focused on long-term care facilities. Louisiana and Missouri had policy changes involving scope of practice.

2011: July 2010 – June 2011

Arkansas, Florida, and South Dakota had supervision requirement changes during this time period. Of note, Florida statute included physicians as providing professional oversight for dental hygienists. New Hampshire, Oregon, Indiana, and Ohio had changes to scope of practice statute or rules during this period. Maine had changes to Medicaid reimbursement (MaineCare) enabling direct reimbursement for dental hygiene services. Definition and measurement of study variables are provided in Table 3.7.

Table 3.7

Independent Study Variables: Definition and Measurement

Variable	Definition	Value
Sites	The number of clinical sites operated by the health center grantee	>0
Geography	The percent urban geographic area served by health center grantee.	0= rural 1= urban
Race	Average proportion of patients from a racial or ethnic minority group for all years of UDS reporting period	>0
Poverty	Percent of patients at or below 200% poverty during reporting period	>0
Uninsured	The percent of uninsured patients served by health center grantee during reporting period	>0
Medicaid	The percent of Medicaid patients served by health center grantee during reporting period	>0
Workforce	State level value indicating the dentists per 10,000 population	>0
Policy change	Key policy changes during the study period and for each year	0= no changes 1= changes
DHPPI Value	Sum of DHPPI index values for 4 aspects of professional practice environment of dental hygienists	>0
DHPPI Rankings	Level 1 = Restrictive, DHPPI range 0-29	1
	Level 2 = Limiting, DHPPI range 31-39	2
	Level 3 = Satisfactory, DHPPI range 40-49	3
	Level 4 = Favorable, DHPPI range 50-79	4
	Level 5 - Excellent, DHPPI range 80-100	5

Data Analysis

Data Management

All data that are used in this study are available to the public or available through the federal government upon request. All health service utilization and patient characteristic data have been aggregated to the health center grantee level by the federal government. Because all analyses and reporting will occur at the health center grantee (organizational) level, there is no threat to the safety and security of individual patient protected health information. The Institutional Review Board at Indiana University was consulted on April 28, 2014 and determined that this study did not involve human subjects and did not require board approval.

The data are prepared and analyzed using Microsoft Excel© and SAS 9.3 (SAS Institute, Cary NC). All statistical tests performed in this study will be two-sided with a significance level of 0.05.

Descriptive Statistics

The following descriptive statistics are reported for each year and state included in the study: mean and standard deviation (SD) for all continuous variables (outcome, independent, and covariate) and proportion/percentage for binary variables (outcome and covariate). Distribution of study variables is examined and tests for normal distribution are performed on all continuous measures.

Inferential Statistics

Mixed models are used in this study for both cross-sectional and longitudinal analyses. Generalized linear mixed effects models are used in analyses for the binary outcome, and linear mixed effects models are used in analyses for continuous outcomes.

These methods were selected because they can account for correlations introduced by the multiple hierarchical structure and they allow subject-specific fittings. Variables representing state policy environment and health center characteristics are examined as fixed effects. In addition, there are two levels of random effects present in study data.

First, there are repeated measures on health center grantees. It is assumed that repeated measures on grantees are correlated. Analyses are therefore adjusted for within grantee correlations. In addition, health center grantees are clustered (nested) within states. Grantees in the same state are subject to the same policy environment. It is assumed that, to some extent, correlations exist between grantees located in the same state. Longitudinal data plot (Figure 11) performed at the state level confirm there are state level correlations. Each line represents the average proportion of grantee patients accessing dental care within a state. Changes in variability between states over the study period are evident in all plots generated. Thus, all analyses are adjusted for within state correlations. Random intercepts at the grantee and state level are used to capture within grantee and within state correlations separately.

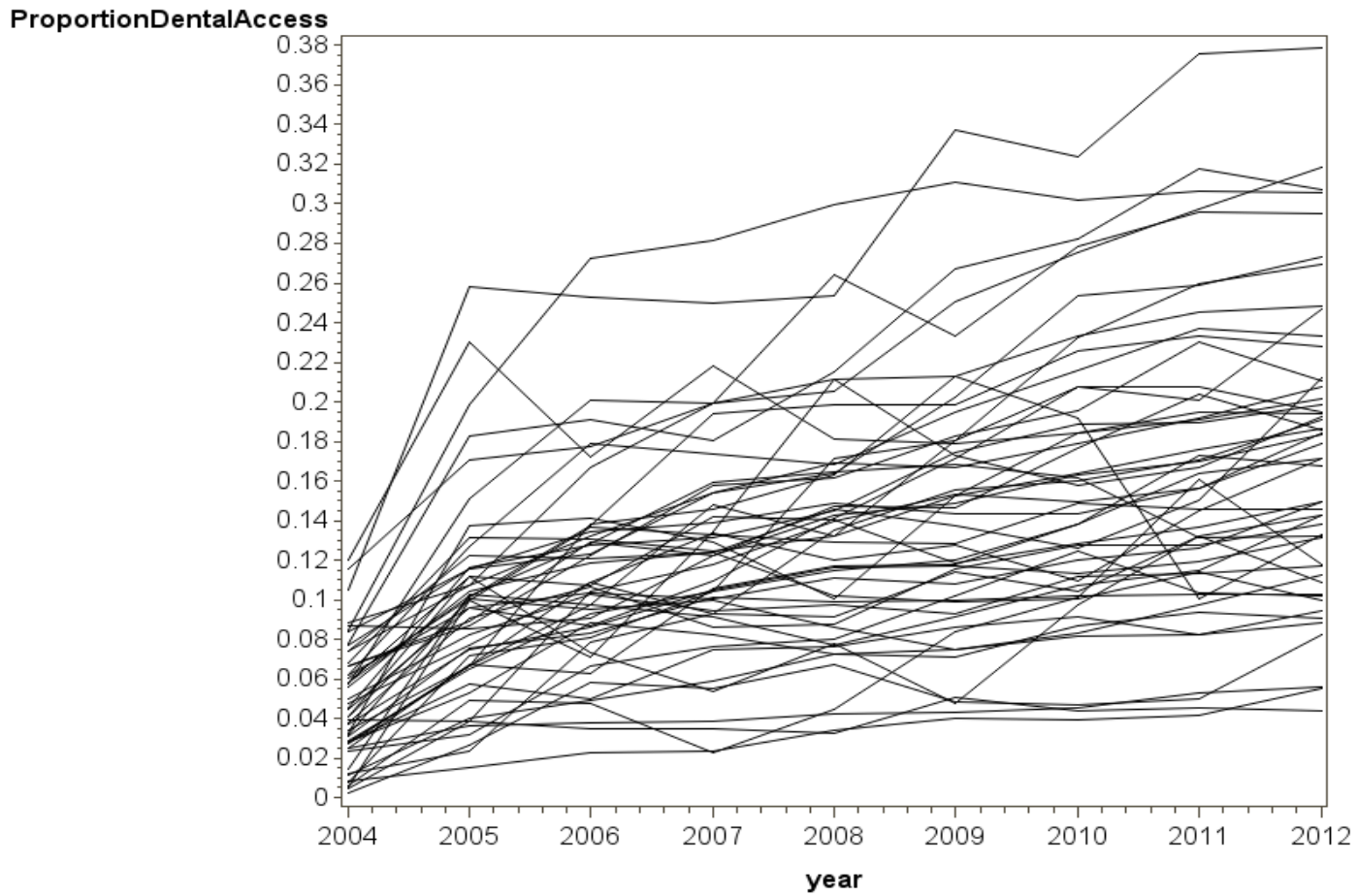


Figure 11. Proportion of Grantee Patients Accessing Dental Services by State

Software Implementation

All statistical analyses are performed using SAS© Version 9.3. The GENMOD procedure is used for cross-sectional analyses with the binary outcome variable. The repeated statement is used to adjust for state level correlations. An exchangeable covariance structure is specified because grantees within the same state respond to the same policy environment. A binomial distribution is specified and the link logit was used to obtain odds ratio estimates.

The GLIMMIX procedure is used for multivariable analyses with the binary outcome. The random statement is used to make adjustments for random intercepts at the grantee and state levels. A binary distribution is specified. Odds ratios and confidence intervals are calculated.

The MIXED procedure is used for cross-sectional and multivariable analyses with the continuous outcome variables. The random statement is used to make adjustments for random intercepts at the state level in cross-sectional analyses. In multivariable analyses, the random statement is used to make adjustments for random intercepts at the grantee level and state level.

Model Fitting

Cross-sectional and longitudinal regression models are fit to each outcome using a series of steps. First, all variables of theoretical importance or those with a hypothesized effect are examined with univariate regression analyses to determine whether they are significant predictors. Second, all variables of theoretical importance or those with a hypothesized effect are included in full multivariable regression model, regardless of whether they are significant predictors. The results of this model are compared to

univariate regression results. Finally, the final regression model is fit by including variables of theoretical and hypothesized effect and those that were significant predictors in either the univariate or the full multivariable regression models. Variables not significant in either univariate or multivariable regression models are excluded from the final model.

Goodness of fit statistics for the full and final models are compared to determine whether the final models provide sufficient goodness of fit. For cross-sectional multivariable regression models with the binary outcome variable where the GENMOD procedure is used, the Quasi-likelihood Information Criteria (QIC) is used to determine which model provides superior fit (Pan, 2001). For longitudinal multivariable regression models with both binary and continuous outcomes, the Akaike's Information Criterion (AIC) is used to determine which model provides superior fit (Posada & Buckley, 2004). Residuals plots are examined to determine whether assumptions are violated or held.

Data Reporting

Data and results are presented in the following three chapters, each of which examine one of the three hypotheses presented at the end of Chapter 2. Odds ratio estimates, 95% confidence intervals, and p-values are reported for regression analyses with the binary outcome. Regression coefficients, standard error terms, and p-values are reported for regression analyses with the continuous outcomes. Significance is set at alpha 0.05 for all tests.

Study Limitations

There are a number of limitations that affect the internal and external validity of study findings.

Internal Validity

This observational study examines secondary data and is subject to associated limitations. Information biases (misclassification of outcome), lack of control over assignment of outcomes, variability in ICD9 coding, and data programming errors, are recognized limitations that threaten internal validity (Grimes & Schulz, 2002). In addition, this study is testing for association between a policy indicator and outcomes not measured at the same point in time. This study assumes a latent period exists between when pertinent policy changes are signed into law, when they are fully implemented, and when they can be evaluated. This is especially the case in health workforce policy where additional changes in administrative processes, education and training, and other pertinent areas may be required in order to fully implement an enacted change in policy. To address threats to internal validity associated temporal differences in outcome and independent measures, state level policy change indicator variables have been generated for each of four DHPPI policy component areas for each year of the study. These will be included as covariates in data analyses.

External Validity

The findings of this study will only apply to health center grantees that received community health center funding during the years included in the study period. Findings may not be generalizable to utilization of dental services within the general population or other underserved communities. In addition, findings will only reflect the influence of

dental hygiene practice policy on dental service utilization provided directly by U.S. Health Centers. Information on the dental services rendered by privately practicing dentists under contract with a health center are not included in these analyses. Findings of this study are not generalizable for other professions, such as dentistry, or for other types of health services.

Summary

The data and methods presented in this chapter are used to test the hypotheses presented in Chapter 2. The results of this study are presented in subsequent chapters, each of which examine one of the three hypotheses. In addition to presenting key results, each chapter provides a brief background on the research question of focus, describes study design and methods specific to the analyses, and discusses key findings.

CHAPTER 4. State Policy as Barrier to Dental Service Delivery in Underserved Communities

Assuring access to preventive dental care is an important aspect of the U.S. Health Center Program. Grantees are required to ensure access to preventive dental services, described in Chapter 1, as a part of their federal funding agreement. Although the majority of health center grantees report delivering dental services directly to their patients, roughly 20% of all grantees report they do not. These grantees generally contract with private oral health professionals to provide the required dental services to their patient population. The high cost associated with dental service delivery and a lack of oral health professionals available and willing to work in community health centers are cited as major barriers to the direct delivery of dental services (Beazoglou et al., 2010).

As presented in Chapter 1, dental hygiene represents an oral health profession focused on dental disease prevention and oral health promotion. While dental hygienists are trained to national standards, professional practice is regulated at the state level through licensing. Wide variations in the policies regulating the professional practice of dental hygienists exist between states. These variations influence the level of professional autonomy for dental hygienists, ultimately controlling where, when, and under what conditions they can provide preventive dental care. As such, state policy environment for the dental hygiene profession may be thought of as a barometer for the support a state provides to its preventive oral health workforce. Whether and to what extent state policy environment influences the dental service delivery status of grantees has previously not been known.

This chapter presents data which demonstrates the influence of state policy environment on the dental service delivery status of grantees receiving funding from the U.S. Health Center program. The adapted framework supporting this study, presented in Chapter 2, posits that the delivery of dental services by these grantees is to some extent a function of state policy environment for the profession of dental hygiene. The *primary hypothesis* is that state policy, as quantified by the Dental Hygiene Professional Practice Index (DHPPI), is positively associated with dental service delivery status. Meaning grantees located in states with higher DHPPI values, more supportive of the preventive oral health workforce, will be more likely to delivery dental services than those located in state with lower DHPPI values.

Methods

This study examines data on 1,135 unique grantees receiving community health center funding from the U.S. Health Center program from 2004-2012. Longitudinally, these grantees represent a total of 8,526 grantee observations from 2004 to 2012. Data for these analyses came from the Uniform Data System (UDS); all community health centers funded by the federal government are required to report administrative and aggregate patient and utilization data on an annual basis. These data were obtained from the Department of Health and Human Services by a Freedom of Information Act (FOIA) request. Detailed methods, including definitions for study variables, may be found in Chapter 3.

Grantee dental service delivery status is the outcome of interest in these analyses. DHPPI policy category is the primary effect of interest. In addition, key characteristics

of grantees (administrative, aggregate patient characteristics) and the state environment (policy changes and dentists per capita) are included in analyses.

Statistical Analyses

Descriptive

As presented in the data analysis plan section in Chapter 3, a series of analyses have been performed in order to test the primary hypothesis. First, the distribution of continuous variables is assessed, and tests for normal distribution performed using the UNIVARIATE procedure. Non-normal distributions are identified in a number of the continuous variables. Descriptive statistics (means and frequencies) are generated by year and dental service delivery status for study variables using Chi-Square tests, and T-tests. Second, cross-sectional and longitudinal univariate regression analyses are performed to determine whether study variables (DHPPI values and covariates) are individual significant predictors of dental services status.

As discussed previously, the PROC GENMOD procedure is used for cross-sectional analyses and the PROC GLIMMIX procedure is used for longitudinal analyses (Fitzmaurice, Laird, & Ware, 2011). It is important to note that DHPPI, key policy changes, and dentists per capita are all state-level measures. Adjustments for state level are not required for cross-sectional univariate regression analyses with these variables. The PROC LOGISTIC procedure is used for univariate regression analyses with these state level measures.

Inferential Statistics

Cross-sectional multi-variable regression analyses are performed using the PROC GENMOD procedure with adjustment for random intercepts at the state level using the repeated statement and an exchangeable covariance structure. The link logit is specified

to produce odds ratio and confidence interval estimates. Policy environment measures (DHPPI and policy changes indicators) are included in all models because of their hypothesize effect. All covariates significantly associated with dental services status during a year are included in final regression model for that year. For example, bivariate regression analyses in 2005 are used to determine variables for inclusion in the final multivariable regression model for 2005.

Longitudinal analyses are performed using the PROC GLIMMIX procedure. The random statement is used to specify adjustments for correlations at the grantee and state level. A binary distribution is specified. Odds ratio, 95% confidence intervals, and p-values are reported for all statistical tests. Significance is set at alpha 0.05 for all tests. Convergence criterion are satisfied in all multivariable regression models with the exception of models where DHPPI is analyzed as a continuous measure and in a number of the regression models generated during the model selection/fitting process. The reasons for this are unknown. However, this issue has been noted by others, and is not believed to impact final regression model result where DHPPI is analyzed as an ordinal measure.

Model Selection

The methods used for model selection are discussed in Chapter 3. Multi-variable regression models are fit first with all study variables (full model) and then excluding variables are not significant predictors of dental service status in univariate or full multivariable regression analyses. As described in Chapter 3, the Quasi-Likelihood Information Criteria (QIC) and Akaike's Information Criterion (AIC) statistics from the final and full regression models are compared to determine goodness of fit. For each

year, the final models had lower QIC or AIC values and provided a better fit. For comparison purposes, results of the full models that are prepared during the model fitting processes for the data presented in this chapter can be found in Appendix B. In addition, QIC and AIC values for full and final models are found in Appendix A.

Results

Descriptive

A summary of descriptive statistics and results of longitudinal univariate regression analyses are presented in Table 4.1. To stream-line the presentation of key findings only longitudinal univariate regression results are presented. Cross-sectional univariate regression results are available from the author upon request. During the nine years included in this study the majority (79.61%) of grantees reported direct dental service delivery, 20.39% reported delivering no dental services. Results from descriptive and univariate regression analyses are summarized below.

Policy Environment

As described in Chapters 1 and 3, the Dental Hygiene Professional Practice Index (DHPPI) quantifies the policy environment in which grantees are located. DHPPI serves as the primary effect of interest in this study. Each grantee is assigned the DHPPI value corresponding to the state in which they are located.

DHPPI is analyzed as both a continuous and ordinal measure. As a continuous measure, DHPPI is not normally distributed. Some states share the same DHPPI total value. The ordinal measure contains 5 levels (see Chapter 3 for complete description) in which 1 indicates most restrictive and 5 indicates the most supportive policy environment. As an ordinal measure, DHPPI (categories) is more evenly distributed in

the data. DHPPI is a significant predictor of dental service status as a continuous and ordinal measure. However, the ordinal measure of state DHPPI provides more meaningful information. Therefore, only results from analyses with the DHPPI ordinal measure are reported.

Trends in dental service delivery status are observed in the descriptive data (Table 4.1). In general, a greater proportion of grantees located in states with higher DHPPI values delivered dental services than those in states with lower DHPPI values. Grantees located in states with the lowest DHPPI values (level 1: North Carolina, Arkansas, Georgia, Alabama, Kentucky, Virginia, Mississippi, West Virginia) are approximately half as likely in univariate regression analyses (OR 0.51; 95% CI 0.32, 0.80) to deliver dental services as grantees located in states with the highest DHPPI values (level 5: Colorado, Washington, Oregon, California, New Mexico). The greatest proportion of grantees delivering dental services is found in states with a favorable practice environment (level 4: Connecticut, Missouri, Nevada, Minnesota, Maine, Utah, and New York). Temporal trends in dental service delivery status by DHPPI category are depicted in Figure 12.

Table 4.1
Summary of Descriptive Characteristics by Dental Services Status and Univariate Regression Results

VARIABLES	Dental Services Status				Univariate Regression Results			
	YES (n=6830)		NO (n=1696)		OR	95% CI		P
DISCRETE	Freq	Percent	Freq	Percent		Lower	Upper	
DHPPI Range								
1 (1-30)	1044	72.6	394	27.4	0.51	0.32	0.8	0.004
2 (31-40)	2273	77.84	647	22.16	0.77	0.47	1.26	0.31
3 (41-49)	1348	80.77	321	19.23	0.8	0.47	1.37	0.42
4 (50-80)	907	89.62	105	10.38	1.14	0.45	2.9	0.79
5 (81-100)	1258	84.6	229	15.4	ref	ref	ref	ref
Urban								
Yes	3282	48.05	956	56.37				
No	3548	51.95	740	43.63	0.84	0.57	1.25	0.39
Policy Changes Occur in State								
Yes	5528	80.94	1472	86.79				
No	1302	19.06	224	13.21	0.66	0.46	0.95	0.03
CONTINUOUS	Mean	SD	Mean	SD	OR	Lower	Upper	P
DHPPI Value								
(Continuous)	1.01	1	1.01	0.12	1.01	1	1.02	0.03
Clinical Sites	4.91	2.59	3.36	2.29	1.57	1.47	1.67	<0.0001
Total Patients	19335	19234	8524	9683	1	1	1	<0.0001
Proportion								
Medicaid Patients	0.29	0.15	0.23	0.2	189.4	79.34	452.3	<0.0001
Proportion in Poverty	0.66	0.25	0.58	0.27	5.12	3.13	8.37	<0.0001
Proportion Minority Patients	0.47	0.32	0.41	0.33	1.29	0.7	2.39	0.41
Proportion Uninsured Patients	0.39	0.18	0.37	0.2	0.59	0.27	1.27	0.18
Dentist per 100,000	5.98	1.33	5.78	1.29	1.11	0.97	1.27	0.14

* Note: Statistics reported for grantee level characteristics (urban geography, patients, clinical sites, proportion of patient on Medicaid or uninsured, proportion minority, and proportion at or below 200% poverty) represent results of analyses that have been adjusted for repeated measures on grantees and clustering at the state level. DHPPI measures (continuous and ordinal), policy change variables, and dentist per 100,000 are state level variables were not adjusted for state level clustering.

The DHPPI was developed based on information from the policy environment of states in 2001. Policy changes occurring in the 50 states and the District of Columbia from 2002 to 2011 are identified and recorded and included in these analyses. Grantees located in states where policy changes occurred are 0.67 times as likely, or a 33% less likely, to deliver dental services as those located in states without a policy change during the nine year period. Interestingly, in cross-sectional univariate regression analyses, policy changes are a predictor of dental services status beginning in 2009 and continuing through 2012. Potential explanations for this observation are considered later in this chapter.

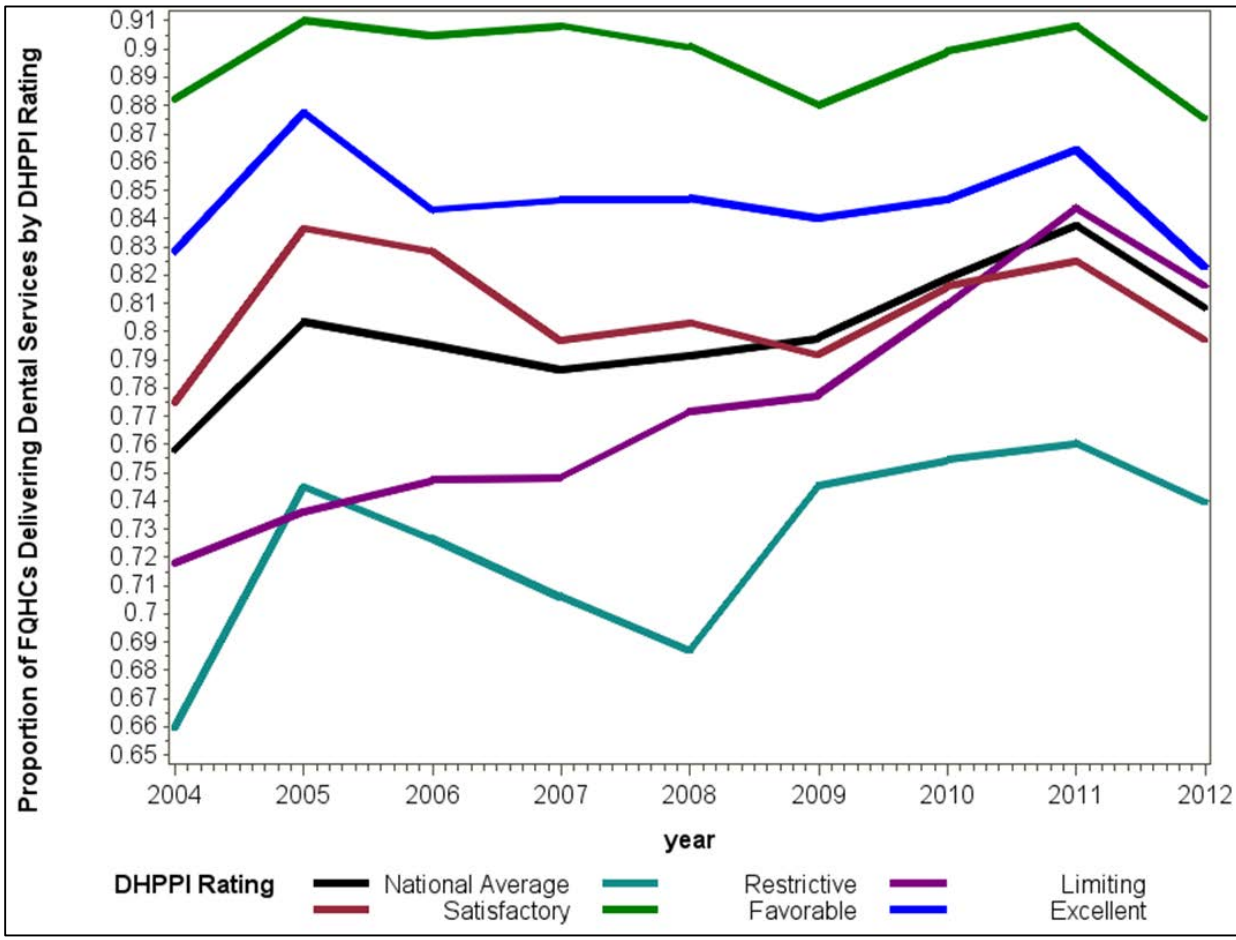


Figure 12. Proportion of FQHCs Delivering Dental Services by DHPPI Rating

Characteristics of Health Center Grantees

Administrative characteristics of the health centers are important in the study of access to dental care. Certain administrative characteristics, such as geographic location and organizational capacity, may influence a grantee's ability to deliver dental services. This study examined the grantees' geographic location, the number of clinical sites a grantee operates, and the total number of unique patients served during a reporting year in order to understand whether these factors play a role in delivery status, and if so, control for them in multivariable analyses.

Grantees are distributed (almost) evenly between urban (49.93%) and rural (50.07%) geographies. Urban location was a significant predictor of dental service delivery status from 2004 to 2008. During these years, grantees located in primarily urban areas were 0.54 to 0.69 times as likely to deliver dental services as those in rural areas. However, beginning in 2009, the proportion of grantees delivering dental services is approximately the same for grantees located in urban and rural settings. Longitudinally, urban or rural geography is not significantly associated with dental service status.

One health center grantee may operate multiple clinical sites. The number of clinical sites is analyzed as a continuous variable, and tests for normal distribution are performed. Modifications to this measure were described in Chapter 3. In this study, the number of clinical sites operated by a grantee is considered a proxy measure for its size and capacity to deliver healthcare services. Univariate regression analyses identified the number of clinical sites as a significant predictor of dental service delivery status.

Likelihood of delivering dental services increased with increasing number of clinical sites (OR 1.57, 95% CI 1.47, 1.67).

Descriptive statistics on the number of total patients is also examined. This measure is not normally distributed, and there are a large number of outlier observations. The number of total patients is strongly significantly correlated to the number of clinical sites (Spearman's Correlations Coefficient, 0.69, $p < 0.0001$). This is not surprising as the number of patients a health care organization delivers care to is directly dependent upon its organizational capacity to deliver those services. In order to avoid issues associated with multicollinearity in regression analyses, the number of clinical sites is examined as a preferable measure of grantee size and organizational capacity to deliver dental services.

Patient Population Characteristics

Chapter 1 presented information on a number of population characteristics, such as demographic and socioeconomic, associated with oral health care access and utilization. In order to examine the effect of these factors on a grantees dental services status, aggregate data on a grantee's patient population are assessed, including: the proportion of patients from racial and ethnic minority groups; the proportion of Medicaid recipients; the proportion of uninsured patients; and, the proportion of patients living at or below 200% poverty.

As discussed in Chapter 2, Medicaid is an important source of reimbursement for grantees. The proportion of grantee patients that are Medicaid recipients is an important factor in the delivery of dental services by grantees. This is because they are reimbursed through a Prospective Payment System on an encounter basis and not fee-for-service. The high cost of dental service delivery is cited as a major barrier to providing dental

services. It is likely that, to some extent, grantees rely on Medicaid reimbursements to financially support and sustain dental services programs.

The proportion of Medicaid patients served by a grantee is a significant predictor of dental service delivery in cross-sectional and longitudinal analyses. Grantees delivering dental services reported greater proportions of Medicaid patients. Increases in the proportion of Medicaid patients are associated with significant increases in the likelihood of delivering dental services. Interestingly but not surprisingly, temporal trends in the proportion of Medicaid patients served by grantees are also observed. This is likely to be associated with changes in the economic environment. Approximately 20% of patients served by grantees delivering dental services were Medicaid recipients from 2004 to 2007. In 2008, the proportion of Medicaid patients increased to 33% and continued to increase annually to 36% in 2012. Similar trends are observed in grantees that do not deliver dental services.

The proportion of uninsured patients served by grantees is significantly associated with an increased likelihood of dental service delivery in 2004 and 2005 only. However, the actual difference is relatively small and is probably not substantively significant. It is important to note the proportion of Medicaid recipients and the proportion of uninsured patients are directly dependent upon one another. Increases in the proportion of Medicaid recipients served by a grantee results in direct decreases in the proportion of uninsured patients served. Because of their interdependence and because of the significance of Medicaid to the delivery of dental service by grantees, the proportion of Medicaid patients is included in the regression model as a preferable measure of health insurance status.

By virtue of their mission, grantees serve communities of lower socioeconomic status. The proportion of patients at or below 200% poverty is an important indicator of socioeconomic status of the patient population. The proportion of patients at or below 200% poverty is a significant predictor of dental service status in all years. Grantees delivering dental services reported a higher proportion of patients in poverty (65-68%) than those that do not (55-61%). Over the nine years included in this study, increases in the proportion of patients at or below 200% poverty are associated with a 5.12 increase in the likelihood of delivering dental services. This suggests grantees serving more economically disadvantaged areas are more likely to deliver dental services.

People from racial and ethnic minority groups disproportionately struggle with health disparities related to inequities in access. Grantees delivering dental services report serving approximately 50% of patients from racial and ethnic minority groups. On average, these grantees serve 5% more minority patients than those that do not deliver dental services. Statistically significant differences are observed in the proportion of patients from racial and ethnic minority groups by dental service delivery status in a number of years (2005, 2006 and 2007). During these years, increases in the proportion of minority patients is associated with an increase (OR 2.0) in the likelihood of delivering dental services.

State Level Oral Health Workforce Capacity

The number of dentists per 10,000 population is commonly used as a measure of oral health workforce capacity. Relatively small differences are observed in this measure by dental service delivery status (difference of 0.2 dentists per 10,000). The number of

dentists per 10,000 population is not a predictor of grantee dental services delivery status in most years or longitudinally.

Multivariable Models

Analytic tests are performed on data from each year included in the study and longitudinally. Each test is performed twice: once with DHPPI as a continuous measure and again with DHPPI as an ordinal variable representing 5 levels of policy environment (1 = most restrictive to 5 = most supportive), as categorized in report published by HRSA. As discussed earlier, because DHPPI is not a true continuous measure across the state and the categorical or ordinal measure generates more meaningful information, only results for the regression models where DHPPI is analyzed an ordinal measure are reported here.

Constructing the Regression Models

The methods used to build the final multivariable regression models were discussed in Chapter 3. State policy environment is the primary effect of interest in this dissertation. As such, DHPPI and policy change measures, indicators of state policy environment, are included in all regression models. Because of their hypothesized effect and theoretical significance, discussed in Chapter 2, and their significance as predictors of dental services status, the following variables are included in all or some of the models: proportion of patients from racial or ethnic minority groups, at or below 200% poverty, Medicaid recipients; urban geography; policy changes; and, number of clinical sites. Dentists per 10,000 population are excluded from multivariable regression analyses.

The number of dentists per 10,000 population are excluded for a number of reasons. There is little to no evidence the number of dentists per capita within a state is a significant predictor of dental services status in cross-sectional bivariate and longitudinal bivariate analyses. This is not surprising as grantees deliver health care services in communities recognized as medically underserved, which are demonstrated to have significant shortages of health professionals, including dentists. Dental workforce shortages exist in these communities independent of the number of dentists per capita within other communities across a state. Therefore, it is theoretically not likely that the number of dentists per capita within a state is a major factor in the dental service deliver status of grantees. Rather, it is likely that the shortage of oral health professionals working or willing to work in medically underserved communities reflects personal preferences or professional needs, similar to factors identified with other health professions, that influence practice setting decisions (Daniels et al., 2007; Xu et al., 1997).

Summary of Analytic Test Results

Cross-sectional

Results of the cross-sectional regression models for 2005, 2008 and 2011 are presented in Table 4.2. These years are selected because they provide a view of trends over time. Results are reported starting in 2005, the second year data on dental service utilization data were reported to the UDS. Ideally, quality and accuracy of reporting for these measure is improved after the first year. After 2005 results are reported for every third year (2008 and 2011). Results from these years are reflective of trends observed at the beginning, middle, and end of the study period.

Cross-sectional multivariable regression results presented in Table 4.2 provide temporal trends in the effect of state policy environment on dental service delivery status over time. Using grantees located in states with the most supportive policy environment (level 5) as a reference group, grantees located in state with the most restrictive policy environment (level 1), and limiting policy environments (level 2) in early years, are statistically significantly less likely to deliver dental services. Grantees located in states with the most restrictive policy environment (level 1) are 0.35 to 0.43 (or 35% to 43%) as likely to deliver dental services as those located in states with the most supportive policy environment during select years.

In 2011, grantees located in states where key policy changes occurred at some point during the nine years are approximately 0.48 times or 48% as likely to deliver dental services as grantees located in states where policy changes did not occur. The number of clinical sites, proportion of patients with Medicaid, and the proportion of patients at or below 200% poverty are significant predictors of dental service delivery status in the regression models for most years. In general, likelihood of delivering dental services increase with increases in the number of clinical sites and the proportion of patients on Medicaid and living in poverty. Not surprisingly, the proportion of patients on Medicaid have the largest effect on dental services delivery status in all years. The odds ratio for the proportion of Medicaid patients decrease from 13.83 in 2005 to 7.14 in 2011. Fluctuations in the odds ratio estimates for proportion Medicaid patients may reflect changes in Medicaid policy or the economic environment. The proportion of minority patients and urban setting are not significant predictors of dental service status in any year.

Table 4.2

Results from Cross-sectional Multivariable Regression Analysis with DHPPI as a Ordinal (5 Level) Measure: Predictors of Grantee Dental Service Delivery Status (2005, 2008 and 2011)

VARIABLES	2005 (n=824)				2008 (n=974)				2011 (n=1016)			
	OR	95% CI		P	OR	95% CI		P	OR	95% CI		P
		Lower	Upper			Lower	Upper			Lower	Upper	
DHPPI Range												
1 (1-30)	0.38	0.14	0.99	0.05	0.35	0.13	0.90	0.03	0.43	0.19	0.94	0.03
2 (31-40)	0.30	0.11	0.77	0.01	0.49	0.20	1.17	0.11	0.72	0.33	1.60	0.42
3 (41-49)	0.59	0.17	2.03	0.40	0.62	0.22	1.72	0.35	0.56	0.22	1.48	0.25
4 (50-80)	1.00	0.34	2.98	1.00	1.11	0.30	4.13	0.88	0.75	0.25	2.23	0.60
5 (81-100)	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Policy Changes												
Occur in State	0.80	0.43	1.48	0.48	0.77	0.41	1.45	0.42	0.49	0.24	0.98	0.04
Urban setting	0.65	0.44	0.97	0.03	0.84	0.59	1.19	0.33	-	-	-	-
Number of Clinical Sites	1.28	1.17	1.39	<.0001	1.25	1.17	1.34	<.0001	1.28	1.18	1.39	<.0001
Proportion Medicaid Patients												
	13.83	0.75	256.21	0.08	14.61	4.01	53.26	<.0001	7.14	2.40	21.20	0.00
Proportion at or Below 200% Poverty												
	2.23	1.15	4.32	0.02	3.38	1.55	7.35	0.00	1.73	0.72	4.19	0.22
Mean Proportion or Minority Patients												
	0.79	0.39	1.60	0.51	0.62	0.29	1.33	0.22	-	-	-	-

Note: Variables were selected for cross-sectional regression analyses based on bivariate analyses. Models were fit using the PROC GENMOD procedure. Adjustments were made for clustering of grantees at the state level.

Longitudinal

Longitudinal regression models are fit with adjustments for repeated measures and state-level clustering. In addition to longitudinal analyses included all years (2004-2012), regression models are fit for pre- (2004-2007) and post- (2008-2012) economic recession to examine whether this influenced trends in dental service delivery.

Longitudinal results were similar to those from cross-sectional analyses. Over the entire study period, grantees located in states with the most restrictive policy environment (level 1) are 0.28 times as likely to deliver dental services as those located in states with the most supportive practice environment (level 5). In addition, the number of clinical sites (OR 1.48, 95% CI 1.38, 1.58), proportion Medicaid patients (OR 20.79, 95% CI 6.51, 66.44), and proportion at or below 200% poverty (OR 4.09, 95% CI 2.35, 7.13) are all significant predictors of dental service delivery status. In addition, the likelihood of dental service delivery also increase over time (OR 1.09, 95% CI 1.04, 1.15). Policy changes within a grantee's state are not significant predictors in the longitudinal models.

The economic recession has minimal effect on the influence of policy as a predictor of grantee dental service delivery status. Pre-recession grantees located in states with the most restrictive policies are 0.31 times as likely to deliver dental service as those in states with the most supportive policy environment. Also, grantees located in states with limiting policy environments (level 2) are 0.35 times as likely as those in the most supportive states (level 5) to deliver services directly in the pre-recession period. However, whereas during the pre-recession years policy is a predictor of dental service

delivery status for grantees in limiting states, this effect is not observed in the years post-recession.

Post-recession grantees in the most restrictive states are 0.33 times as likely to deliver dental services. There is, however, a significant change in the effect size for the proportion Medicaid patients. Pre- economic recession, the proportion Medicaid patients has a larger effect (OR 99.7, 95% CI 13.22, 750.02) on dental service delivery than post-economic recession (OR 16.42, 95% CI 4.32, 62.31).

Table 4.3

Results of Longitudinal Analyses with DHPPI as Ordinal Measure: Predictors of Dental Services Status

VARIABLES	All Years				2004-2007				2008-2012			
	OR	95% CI		P	OR	95% CI		P	OR	95% CI		P
		Lower	Upper			Lower	Upper			Lower	Upper	
DHPPI Range												
1 (1-30)	0.28	0.09	0.93	0.04	0.31	0.10	0.94	0.04	0.33	0.10	1.09	0.07
2 (31-40)	0.43	0.15	1.21	0.11	0.35	0.13	0.93	0.04	0.56	0.19	1.62	0.28
3 (41-49)	0.62	0.19	1.99	0.43	0.65	0.22	1.91	0.43	0.65	0.20	2.07	0.47
4 (50-80)	0.92	0.23	3.62	0.98	1.13	0.31	4.16	0.85	0.95	0.24	3.83	0.94
5 (81-100)	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref	ref
Policy Change	0.62	0.27	1.42	0.26	0.83	0.38	1.81	0.64	0.51	0.22	1.18	0.12
Clinical Sites	1.48	1.38	1.58	<.0001	1.37	1.27	1.49	<.0001	1.43	1.33	1.55	<.0001
Medicaid	20.79	6.51	66.44	<.0001	99.57	13.22	750.02	<.0001	16.42	4.32	62.31	<.0001
200% Poverty	4.09	2.35	7.13	<.0001	2.83	1.40	5.44	0.00	3.64	1.80	7.38	0.00
Time	1.09	1.04	1.15	<.0001	1.21	1.08	1.36	0.00	1.06	0.97	1.15	0.19

Note: Covariates were included based on results of cross-sectional regression analyses. The PROC GLIMMIX procedure was used. Adjustments were made for repeated measures of grantees and clustering of grantees at the state level.

Discussion

The findings of these analyses demonstrate the state policy environment is a significant predictor of the dental service delivery status of health centers receiving funding from the U.S. Health Center program. Grantees located in states where policies support and promote professional autonomy for the dental hygiene profession, a workforce focused on dental disease prevention and oral health promotion, are significantly more likely to deliver dental services than grantees located in states with more restrictive policies. The influence of policy on dental service delivery in medically underserved communities where grantees are located is observed consistently from year to year and cumulatively over nearly a decade.

Interestingly, the greatest proportion of grantees delivering dental services is found in states with favorable policy environments (level 4), not grantees located in states with excellent policy environments (level 5) which promote the highest levels of professional autonomy. These findings, depicted in Figure 12, suggest that favorable policies for the practice of dental hygiene may create an optimal policy environment for grantees to operate a dental service delivery program.

Other factors also play an important role in grantee dental service delivery status. For example, the proportion of Medicaid recipients is a highly significant predictor of grantee dental service delivery status. This, however, is expected as Medicaid is an important source of reimbursements for health centers. Also not surprising, the number of clinical sites is a significant predictor of grantee dental service delivery status. Theoretically, the more capacity a grantee has, the more patients it can serve. The more

patients a grantee serves, the more revenues it generates. The more revenue it generates, the more likely it is to be able to provide dental services directly.

The proportion of patients living at or below 200% poverty is a significant predictor of grantee dental service delivery status. The greater the proportion of patients living in poverty, the more likely grantees are to deliver dental services. This finding aligns with the mission of health center grantees and demonstrates their success at reaching indigent populations with comprehensive services.

Although not statistically significant in the multi-variable analyses, bivariate analyses demonstrates that the proportion of minority patients a grantee serves may be inversely related to grantee dental services delivery status. This suggests grantees serving a greater proportion of minority patients are less likely to directly deliver dental services than those serving smaller proportion of minority patients. It may also suggest that minorities are concentrated and have more difficult times in the more conservative states. This finding may be significant as minority populations struggle with oral health and access to dental care disparities. Additional research is needed in this area to elucidate these findings.

Finally, trends observed in the data demonstrate the influence of policy and the economy over time. Trends in the proportion of Medicaid and uninsured patients suggest grantees may have made administrative changes to adjust for the economic environment. Over the nine year period, grantees have been increasingly serving Medicaid patients while decreases are observed in the proportion of uninsured patients. Increases in the proportion of Medicaid patients may reflect grantees efforts to enhance their revenues under increasingly constraining economic environment, but it also suggests that less

uninsured patients are accessing care at grantees. Where these uninsured populations are accessing care is not known. Additional research is needed to understand these trends.

Perhaps more important, temporal trends in state policy changes are a significant predictor of grantee dental service delivery status. Grantees located in states where key policy changes occurred between 2002 and 2011 are significantly less likely to deliver dental services in later years of the study. The greatest number of total policy changes occurred in states with restrictive (level 1) and limiting (level 2) policy environments, but policy changes did occur in many states with satisfactory (level 3), favorable (level 4), and excellent (level 5) policy environments. This finding likely reflects, to some extent, changes in the economic environment, such as the recession, or major changes in federal policy, such as the American Reinvestment and Recovery Act which allocated \$2.5 billion dollars to improving access to health care in underserved communities. While this findings suggest changes to state policy had a negative influence on the dental service delivery status of grantees, additional research is needed to understand the specific effect.

Summary

The findings of this chapter demonstrate that state policy environment is an important predictor of grantees dental service delivery status. They demonstrate that state policy environments promoting greater levels of autonomy for dental hygiene, a profession focused on dental disease prevention and oral health promotion, directly enhance the availability of dental services in medically underserved communities. The next chapter examines the influence of state policy on the access to dental care among patients of grantees that deliver dental services to the patients directly.

CHAPTER 5. State Policy and Access to Dental Care

Health centers are an important component of the oral health safety-net in America (Jones et al., 2013). As described in the preceding chapters, the U.S. Health Center program supports the delivery of primary care, including dental services in underserved communities. Grantees of this program are required to ensure access to preventive dental care for the communities they serve as a part of their federal funding agreement. Approximately 80% of health center program grantees deliver dental services directly to their patient population. The remaining 20% make other provisions to ensure access to dental care for their patients. Grantees delivering dental services directly to their patient population are required to report utilization for selected dental procedures on an annual basis to the federal government. No dental service utilization data are reported for grantees having alternate provisions for ensuring access to care.

As discussed in previous chapters, dental hygiene is an oral health profession focused on dental disease prevention and oral health promotion. In fact, community-based oral health programming is a focus area of dental hygiene education (ADEA, 2004). Based on the focus of their training and practice, dental hygienists are well-positioned to provide preventive dental services for underserved communities in health centers, such as those operated by grantees of the U.S. Health Center program.

As previously discussed, the professional practice environment of dental hygienists varies widely between the states. Variations occur in key aspects of practice, such as professional supervision requirements, permitted clinical tasks, and reimbursement policies. These policies form parameters for professional practice, including the practice of dental hygiene in health centers and other public health settings.

For example, in Colorado, dental hygienists, practicing with full professional autonomy, are able to deliver preventive dental services for patients at health centers or another established clinical location without supervision¹⁰. This is in contrast to Mississippi where dental hygiene practice requires direct supervision by a licensed dentist, the only exception being made for dental hygienists employed by the state health department for whom there are provisions to perform oral hygiene instruction and dental screenings under general supervision¹¹. A state's policy environment for the dental hygiene profession is indicative of the level of support for preventive oral health workforce within a state.

State policy environment determines the professional practice of dental hygienists: where they practice; what services they can provide; and, how they are employed or reimbursed for the services they provide. The analyses presented in the previous chapter indicate that the state policy environment is a major predictor of/contributor to the dental service delivery status of health center grantees, particularly with regard to the availability of dental services in medically underserved communities. This chapter examines the effect of state policy environment on the proportion of total patients that access dental care service among grantees of the U.S. Health Center program to determine whether policy plays a role in access to care.

¹⁰ Colorado Revised Statutes, Title 12 Professions and Occupations, Article 35 "Dental Practice Law of Colorado," §12-35-103 (4) –Definitions. Accessed April24, 2014. Available at: <http://cdn.colorado.gov/cs/Satellite?blobcol=urldata&blobheadername1=Content-Disposition&blobheadername2=Content-Type&blobheadervalue1=inline%3B+filename%3D%22Colorado+Revised+Statutes+for+Dentists+and+Dental+Hygienists%2C+effective+July+1%2C+2011.pdf%22&blobheadervalue2=application%2Fpdf&blobkey=id&blobtable=MungoBlobs&blobwhere=1251832178076&ssbinary=true>

¹¹ Mississippi Code of 1972, Annotated Title 73, Chapter 9: Dentists, § 73-9-5 –"Dental Hygiene" Defined. Accessed April 24, 2014. Available at: http://www.dentalboard.ms.gov/msbde/msbde.nsf/webpages/Laws_PracticeAct?OpenDocument

Methods

Multiple cross-sectional and longitudinal analyses are performed on data from 956 unique grantees of the U.S. Health Center program that received community health center funding, were geographically located in the 50 states or the District of Columbia, clinically operational between 2004 and 2012, and reported the direct delivery of dental services. These 956 grantees account for 6,830 grantee observations over the nine years included in the study.

The outcome of interest in this chapter is the proportion of unique patients that accessed dental services within a reporting year for a grantee. This was calculated by dividing the total count of unique health center patients by the total number of unique patients that had a dental examination within a reporting year. Dental examinations are required prior to any other type of dental service. Thus, the number of unique patients having a dental examination within a given year provides a “best estimate” of the number of unique patients accessing dental services.

The Dental Hygiene Professional Practice Index (DHPPI), discussed in Chapter 1, is the primary effect of interest. As in the analyses presented in Chapter 4, DHPPI values are analyzed as a five level variable in which level 1 indicates the most restrictive policy environment and level 5 indicates the most supportive policy environment. In addition, key characteristics of grantees, including administrative, aggregate patient characteristics, and state environment, policy changes and dentists per capita, are included in analyses.

Statistical Analyses

Cross-sectional and longitudinal analyses are performed to determine the influence of state policy environment on dental service access. Descriptive statistics and

tests for normal distribution were performed as a part of the analyses presented in Chapter 4. Univariate regression analyses were performed to determine whether study variables were individual significant predictors. Multivariable regression models were fit using the procedures described in Chapter 3. Results from the regression models generated for the model fitting process and goodness of fit statistics are provided in the Appendix C. Whereas, the fit statistics favor the final regression models in the previous chapter, the final regression models in this chapter yield a slightly higher AIC statistic value than the full model (see Appendix A for values). Although urban setting, proportion of patients at or below 200% poverty, and the number of dentists per capita are not significant predictors in univariate regression analyses, their inclusion in the multivariate regression analyses has an impact on the fit statistic. In addition, it is important to note that they impact the significance of primary effect of interest. After careful consideration it was determined that the full models, including insignificant variables, would be reported (results from the models excluding these variables and AIC values are found in the Appendix A).

The MIXED procedure is used for all regression analyses with continuous outcomes (Fitzmaurice et al., 2011; SAS Institute, 2011; Singer, 1998). The RANDOM statement is used to specify appropriate adjustments for correlations at the state level and, in longitudinal analyses, grantee level. Parameter estimate, standard error, and p-value are reported for all statistical tests. All p-values less than 0.05 are considered statistically significant.

Results

Descriptive

A summary of characteristics for grantees that report directly delivering dental services during the study period is presented in Table 5.1. Reported results reflect adjustments for repeated measures on grantees and state-level clustering.

Policy Environment

The mean proportion of grantee patients accessing dental services varied by DHPPI category. Approximately 0.18 or 18% of patients served by grantees located in states with favorable practice environments (level 4) had a dental visit during the study period. Direct dental care access is the highest among this group. Grantees located in states with excellent (level 5), satisfactory (level 3) and limiting (level 2) policy environments report roughly 0.16 or 16% of their patients accessed dental services during the study period. The lowest proportion of access to direct dental services is found in grantees located in restrictive (level 1) states, which report that only 0.12 or 12% of their patients access dental services. Although not reported in Table 5.1, trends in the proportion of patients accessing dental care were observed in cross-sectional data. These trends are depicted in Figure 13. Note that increases in the proportion of grantee patients accessing dental services occurred in all DHPPI levels. Similar to Table 4.1 from Chapter 4, grantees located in states with favorable policy environments (level 4) consistently provided dental services to the greatest proportion of patients. Whereas, grantees located in states with the most restrictive policy environments (level 1) consistently report providing dental services to the smallest proportion of patients.

Using grantees located in the most supportive states (level 5) as a reference group, statistically significant differences are identified among grantees located in states with the most restrictive policies. Grantees located in states with the most restrictive practice environments (level 1) provide dental services to -0.06 or approximately 6% fewer patients than grantees located in the most supportive states (level 5). This indicates that, without controlling for other factors, state policy may contribute to the proportion of patients that access dental care through a health center grantee.

The mean proportion of grantee patients did not vary significantly between states where changes to key policy occurred. The mean among grantees in states with policy changes is 0.16 or 16% versus 0.17 or 17% among grantees in states where no policy changes occurred.

Table 5.1

Characteristics of U.S. Health Center Grantees that Dental Services Status for years 2004-2012 and Results of Univariate Regression Analyses (n=6830)

VARIABLE	Proportion Patients with Dental Care Access				
	Mean	SD	β	SE	P
DHPPI Range					
1 (1-30)	0.12	0.11	-0.06	0.03	0.05
2 (31-40)	0.16	0.13	-0.02	0.02	0.47
3 (41-49)	0.16	0.12	-0.01	0.03	0.74
4 (50-80)	0.18	0.13	0.03	0.03	0.38
5 (81-100)	0.16	0.12	<i>ref</i>		<i>ref</i>
Urban					
Yes	0.16	0.13	0.01	0.01	0.15
No	0.16	0.12			
Clinical Sites	4.54	2.63	0.01	0.00	<.0001
Policy Changes Occur in State					
Yes	0.16	0.12	-0.01	0.02	0.57
No	0.17	0.12			
Proportion Medicaid	0.29	0.15	0.30	0.01	<.0001
Proportion 200% Poverty	0.66	0.25	0.00	0.01	0.64
Proportion Minority Patients	0.47	0.32	-0.05	0.01	0.0001
Proportion Uninsured Patients	0.39	0.18	-0.10	0.01	<.0001
Dentist per 10,000	5.98	1.33	0.01	0.01	0.17

Note: Results reported in this table reflect longitudinal univariate regression analyses. Adjustments were made for state level clustering and repeated measures. Analyses were performed using the MIXED procedure and include adjustment for state level correlations.

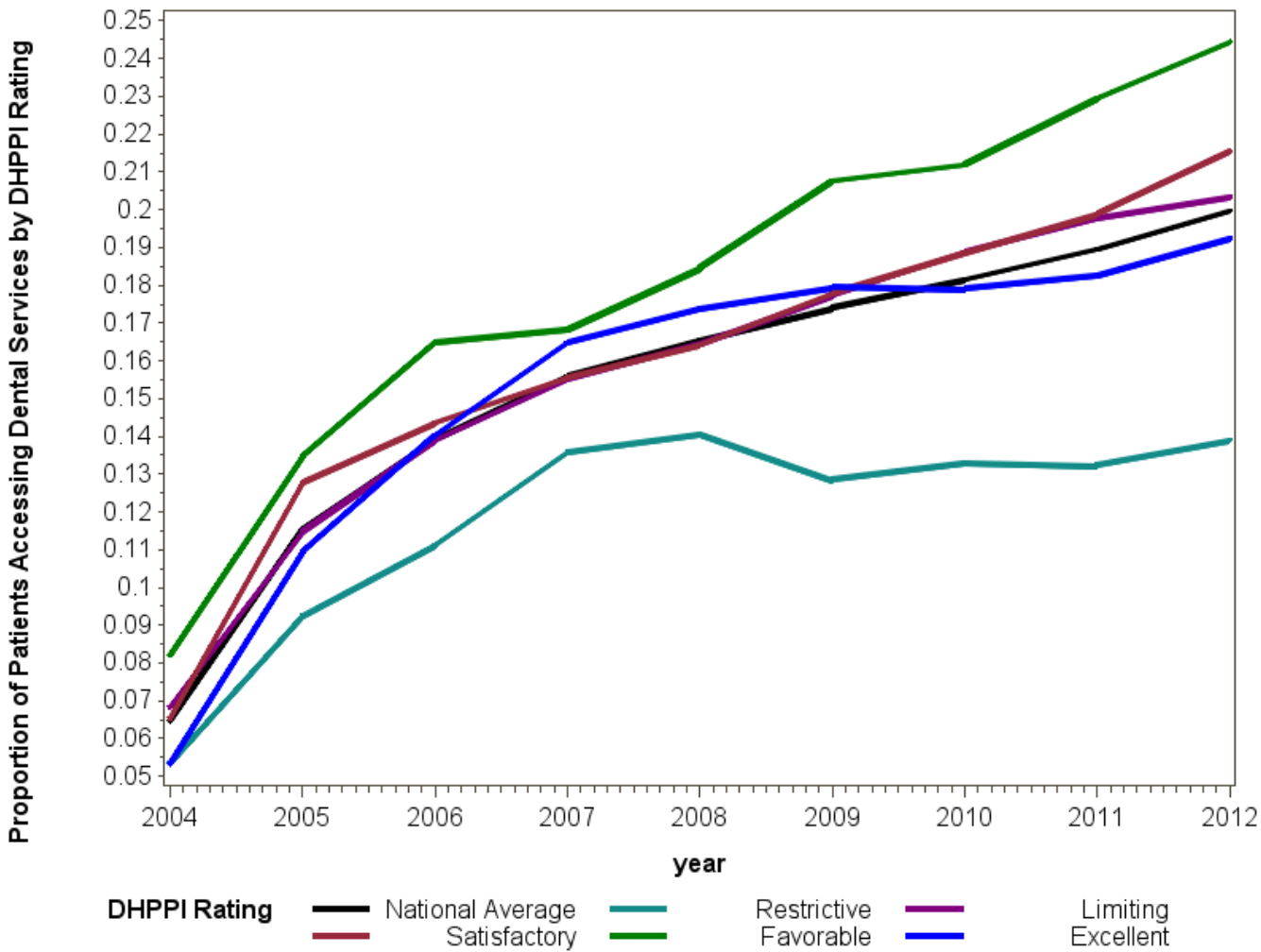


Figure 13. Proportion of FQHC Patients Accessing Dental Services by DHPPI Rating

Grantee Characteristics

With the exception of the categorical measure for geography, basic descriptive information on the characteristics of grantees that deliver dental services were presented and discussed in Chapter 4. Geographic setting is a categorical variable. Thus, the mean proportion of grantee patients accessing dental services is reported for urban and rural settings. The proportion of grantee patients accessing dental services is 0.16 or 16% for urban and rural setting. Reported access does not vary between urban and rural settings.

A number of grantee characteristics are correlated with the proportion of patients accessing dental services. The proportion of Medicaid patients and the number of clinical sites are directly related to the proportion of patients accessing dental services. Increasing the proportion of Medicaid patients by a unit of 1 corresponds to a 0.29 or 29% increase in the proportion of patients accessing dental services. Similarly, increases in the number of clinical sites by 1 is correlated with a 0.01 or 1 percent increase in the proportion of patients accessing dental care.

The proportion of minority patients and the proportion of uninsured patients are inversely correlated to the proportion of patients accessing dental services. As the proportion of minority patients increases, the proportion of patients accessing dental care decreases. Increases in the proportion of minority patients correlated with a -0.05 or 5% decrease in the proportion of patients accessing dental services. This is also the case with the proportion of uninsured patients. Increases in the proportion of uninsured patients are correlated with a -0.10 or 10% decrease in the proportion of patients accessing dental services. The proportion of patients living at or below 200% poverty

and the number of dentists per 10,000 population within a grantees state were not significantly correlated with the proportion of patients accessing dental care.

Multivariable Results

Similar to methods reported in Chapter 4, analytic tests are performed for each year and longitudinally. DHPPI is analyzed as an ordinal variable. DHPPI and policy changes measure are included in all regression models. The methods used for model selection and to test goodness of fit were presented in Chapter 3 and discussed earlier in this chapter.

Table 5.2

Longitudinal Predictors of the Proportion of Grantee Patients Accessing Dental 2004-2012 (n=6830)

VARIABLE	All Years			2004-2007			2008-2012		
	β	SE	P	β	SE	P	β	SE	P
DHPPI Range									
1 (1-30)	-0.05	0.03	0.10	-0.02	0.03	0.54	-0.07	0.04	0.06
2 (31-40)	-0.03	0.03	0.29	-0.01	0.02	0.60	-0.03	0.03	0.25
3 (41-49)	-0.01	0.03	0.84	0.00	0.02	0.92	-0.01	0.03	0.77
4 (50-80)	0.02	0.03	0.63	0.01	0.03	0.68	0.00	0.04	0.90
5 (81-100)	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>
Policy Changes	-0.01	0.02	0.76	0.00	0.02	0.81	-0.01	0.02	0.51
Clinical Sites	0.00	0.00	0.06	0.00	0.00	<.0001	0.00	0.00	0.14
Urban	0.01	0.01	0.17	0.01	0.01	0.48	0.02	0.01	0.05
Medicaid	0.09	0.01	<.0001	0.18	0.03	<.0001	0.16	0.02	<.0001
Poverty	0.00	0.01	0.74	0.00	0.01	1.00	0.01	0.01	0.04
Minority	-0.04	0.01	0.00	-0.04	0.01	0.00	-0.05	0.02	0.00
Dentists per 10,000	0.00	0.01	0.5594	0.01	0.01	0.2037	0.00	0.01	0.8859
Time	0.01	0.00	<.0001	0.03	0.00	<.0001	0.01	0.00	<.0001

Note: Longitudinal regression analyses included adjustments for repeated measures and state clustering. Results from longitudinal bivariate and cross-sectional analyses were used for variable selection. Variables significantly associated or predictive of the proportion of patients accessing dental services were included.

Little variation exists in the results from the multiple cross-sectional analyses. For this reason, and to simplify the presentation of findings, only results from the longitudinal analyses are presented here. Longitudinal regression models are fit with adjustments for correlations resulting from repeated measurements and state level clustering. In addition to the longitudinal analyses including all years (2004-2012), regression models are fit for pre- (2004-2007) and post- (2008-2012) economic recession to examine the effect of important changes in the economic environment.

Results are presented in Table 5.2. Longitudinal results differ from univariate regression results presented in Table 5.1. Whereas, grantees located in states with restrictive policy environments (level 1) provided dental services to proportionately fewer patients than those located in supportive states (level 5), this is not significant in the multivariable regression model. The proportion of Medicaid patients is also directly correlated with access to dental care. Increases in the proportion of Medicaid patients are correlated with 0.09 or 9% increase in the proportion of patients accessing dental services. The proportion of minority patients is inversely correlated to the proportion accessing dental services. Increases in the proportion of Medicaid patients are correlated with -0.04 or a 4% decrease in the proportion of patients accessing dental services. Time, representing year of a particular grantee observation, is also correlated with the proportion of grantee patients accessing dental services. For every increase of one year, the proportion of patients accessing dental services increased by 0.01 or 1%.

Results from the longitudinal analyses pre- and post-economic recession suggest that it may have had some impact on relationship between state policy and dental care access. The estimated effect of state policy environment increased post-recession.

Although not statistically significant, in the pre-recession period (2004-2007), grantees located in states with restrictive policy environments (level 1) provided dental services to -0.02 or 2% fewer patients than those in the most supportive states (level 5). In contrast, post-recession results are tending towards significance. In the post-recession period grantees located in the most restrictive environments provided dental services to -0.07 or 7% fewer patients than those located in the most supportive states.

Temporal trends are also observed in the effect of the economic recession on the coefficient estimates for the proportion of Medicaid and minority patients. The effect of Medicaid decreases in the post-recession period. In the pre-recession period, increases in the proportion of Medicaid patients are correlated with a 0.18 or 18% increase in dental access among grantee patients, whereas in the post-recession period increases in the proportion of Medicaid patients is correlated with a 0.16 or 16% increase. The inverse effect was observed in minority patients. In the pre-recession period increases in the proportion of minority patients were associated with a -0.04 or 4% decrease in the proportion of patients accessing dental services. However, in the post-recession period increases in the proportion of minority patients correspond to a -0.06 or 6% decrease in dental care access.

The effect of time period, or funding year also varies pre- and post-recession. An increase in one year pre-recession corresponds to a 0.03 or 3% increase in dental access, whereas post-recession increase in one year corresponds to a 0.01 or 1 % increase in access.

Discussion

These results provide important insight on the factors influencing dental care access among health center grantee patients. Results suggest state policy environment may contribute to the proportion of grantee patients that access dental care, especially in more recent years. As compared to grantees located in states with the most supportive policy environments, grantees located in states with restrictive policy environments for dental hygienists deliver dental services to proportionately fewer patients. This means the policy environment of a state for dental hygiene, a workforce focused on dental disease prevention and oral health promotion, may have some influence on access to dental care in medically underserved communities receiving federal support. This findings suggests restrictive state policies may have a negative impact on access to dental care in underserved communities. It also may suggest restrictive policies for the dental hygiene profession reflect, to some extent, a lack of support for preventive oral health care services within underserved communities. While patients of health center grantees providing dental services may choose to seek dental care from privately practicing oral health professionals, this has not been studied and is not supported by other the literature on dental care access.

The fact that grantees located in restrictive states provide dental services to proportionately fewer patients in the years post-recession suggest the policy environment has an even greater impact during weak economic periods. A number of factors are likely to contribute to this effect. This finding may be reflective of, to some extent, resource limitation among the grantees' patients and/or administrative responses by the grantees. Post-recession increases in unemployment likely impacted the patients'

abilities to pay for dental services, even fees under a federally-based sliding fee scale offered by health center grantees. In addition, the high cost of dental service delivery has an effect on grantees ability to deliver dental service. Decreases in revenues from patient payments and other sources would likely result in grantees having fewer resources to cost-shift to support the operation of high cost dental programs.

Also significant is the finding of an inverse relationship between the proportion of minority patients and the proportion of patients with access to dental care. The larger the proportion of minority patients served by a grantee the smaller the proportion of patients with dental access. There are a number of social and cultural factors that may contribute to this. For example, varying social or cultural norms among patients from different racial and ethnic minority groups may influence their dental health care seeking behaviors and dental service utilization patterns (Butani et al., 2008; Hilton et al., 2007; Kelly et al., 2005). Additional research is needed to elucidate these findings; however, they have significant implications for health center grantees which are focused on reducing oral health addressing oral health disparities.

Summary

Whereas the previous chapter demonstrated the influence of state policy environment on the availability of dental services in medically underserved communities, this chapter considered how the policy environment influences actual access to dental care. Findings of this chapter suggest state policy may have some impact on access. Policy environments that promote higher levels of professional autonomy for a workforce focused on dental disease prevention and oral health promotion also promote higher levels of access to dental care in their medically underserved communities.

CHAPTER 6. State Policy and the Oral Health in Underserved Communities

As presented in Chapter 1, oral health is a critical component of overall health and a contributor to quality of life. Unfortunately, dental diseases are among the most prevalent conditions affecting Americans. The burden of dental disease and poor oral health in America, especially among poor children from racial and ethnic minority groups, is staggering. Roughly, 27% of non-Hispanic Black American children suffer with untreated dental decay. Untreated dental decay is associated with physical, psychological, and social pain and suffering.

Fortunately, dental decay is a completely preventable condition. Modern dental science provides a comprehensive understanding of the disease mechanisms and the methods for prevention. This science has been translated into individual level dental services and system level policies that promote dental disease prevention. Yet, regardless of these advancements, countless Americans continue to suffer with dental decay.

As presented in previous chapters, dental disease prevention and oral health promotion is the professional focus of the dental hygiene profession. This group of oral health professionals is trained to nationally accepted standards and licensed by states to provide preventive dental services. While the academic preparation required for dental hygiene is standardized nationally, the practice environment varies based on state-level policies that regulate the profession. These variations are quantified in the Dental Hygiene Professional Practice Index (DHPPI). DHPPI values provide a baseline measure of the level of professional autonomy for dental hygienists within a state.

Chapters 4 and 5 examined the effect of state policy environment on dental service delivery and access to dental care for grantees of the U.S. Health Center program.

Findings demonstrated the policy environment is a predictor of dental service delivery status and proportion of grantee patients that access dental services. Grantees located in states with restrictive policies that minimize professional autonomy for the dental hygiene profession are less likely to deliver dental services directly to their patients. Among grantees that do deliver dental care directly, those located in restrictive states provide dental services to proportionately fewer patients than those located in states with policies highly supportive of the dental hygiene profession.

This chapter considers the relationship between state policy environment and proportion of preventive, restorative, and emergent dental patient encounters among health center grantees to determine whether, and to what extent, a state's policy environment influences the oral health care needs of underserved communities. Because the state policy environment is demonstrated to have a significant, direct effect on availability of dental services (Chapter 4) and may also effect access to dental care (Chapter 5), it is expected that state policy environment will also affect the volume of certain dental services. Specifically, this chapter examines the hypotheses that restrictive state policy is associated with a proportionately more restorative and emergent dental patient encounters and proportionately fewer preventive dental patient encounters.

The theory, presented in Chapter 2, which supports the hypotheses that are the focus of this chapter suggests state policy environment creates the context in which dental service delivery and access occur. The specific theory here is that state policy, to some extent, influences the oral health status of the population, which may be quantified through patterns in the utilization of certain types of dental services. Under this theory, policies promoting prevention would be associated with better population oral health,

operationalized as more preventive services and fewer restorative and emergent services associated with dental disease.

Methods

Similar to the analyses presented in Chapter 5, multiple cross-sectional and longitudinal analyses are performed on 956 unique grantees of the U.S. Health Center program that received community health center funding, were geographically located in the 50 states or the District of Columbia, clinically operational between 2004 and 2012, and reported the direct delivery of dental services. These 956 grantees account for 6,830 grantee observations over the nine years included in the study.

The outcomes of interest in these analyses are the proportion of dental patient encounters attributable to preventive, restorative, and emergent dental services. The proportion of preventive dental patient encounters include those reported as prophylaxis (services as defined with ICD9 DM codes - D1110 or D1120), dental sealants (D1351), and fluoride treatment (D1203, D1204, and D1206). These services are within the scope of clinical training and practice for dental hygienists. The proportion of restorative dental patient encounters include reported encounters for restorative dental procedures (D21xx – D29xx). The proportion of emergent dental patient encounters includes encounters reported for emergency dental procedures (D9110). A more detailed description of the methods used to generate these outcome measures is found in Chapter 3.

As previously stated, the DHPPI quantifies the policy environment of a state and serves as the primary effect of interest in these analyses. As is the case in Chapters 4 and 5, DHPPI was analyzed as an ordinal (5 level) measure in which 1 indicates the most restrictive and 5 indicates the most supportive policy environment for the dental hygiene

profession. Additionally, key characteristics of grantees (administrative and aggregate patient characteristics) and state environment (policy changes and dentists per capita) are included in analyses.

Statistical Analyses

The methods for these analyses are similar to those from Chapter 5. Cross-sectional and longitudinal analyses are performed to determine the influence of state policy environment on the proportion of dental patient encounters for each type of service (preventive, restorative, emergent). Descriptive statistics and tests for normal distribution are performed as a part of the analyses presented in Chapter 4. Univariate regression analyses are used to identify whether variables are individual predictors. Mixed effects models are used for multivariable regression analyses to adjust for correlations associated with state level clustering and repeated measurements.

Statistical tests are performed using the PROC MIXED procedure in SAS © Version 9.2 (Fitzmaurice et al., 2011). The RANDOM statement is used to specify adjustments for correlations associated with state level correlations and repeated measurements. Parameter estimates, standard error, and p-values are reported for all statistical tests. All p-values less than 0.05 are considered statistically significant. Multivariable regression models are fit using the methods described in Chapter 3. Model fit statistics for the final (excluding covariate that are not significant predictors in univariate regression analyses) and full (including all covariates) regression models are found in the Appendix A. The full regression models, which provided the best fit based on AIC statistic values, are reported.

Results

Descriptive Characteristics

Descriptive characteristics of grantees by type of service (preventive, restorative, and emergent) are presented in Table 6.1. Statistics presented in Table 6.1 represent results from longitudinal bivariate analyses, which include adjustments for repeated measures on grantees and clustering at the state-level.

Policy Environment

Descriptive data in Table 6.1 demonstrate the mean proportion of preventive, restorative and emergent dental patient encounters varied by DHPPI category. Similar to the trends observed in Chapters 4 and 5, grantees located in states with favorable policy environments reported the best outcomes (i.e., proportionately more preventive and fewer restorative and emergent encounters) and those located in state with the most restrictive policy environments reported the poorest outcomes (i.e., proportionately more restorative and emergent and fewer preventive).

Grantees located in states with the most restrictive policy environment (level 1) report the largest proportion of restorative (0.29 or 29%) and emergent (0.05 or 5%) encounters and the smallest proportion of preventive (0.26 or 26%) encounters. In contrast, grantees located in states with favorable practice environments (level 4) report the largest proportion of preventive (0.37 or 37%) encounters and the smallest proportions of restorative (0.22 or 22%) and emergent (0.03 or 3%) encounters. Grantees located in states with the most supportive (level 5), satisfactory (level 3), and limiting (level 2) practice environments report 0.03 or 3% emergent encounters.

Temporal trends in the proportion of preventive, restorative, and emergent dental encounters demonstrate changes in distribution of services by grantees. These trends are depicted in Figures 14 (preventive), 15 (restorative), and 16 (emergent). Decreases in the proportion of restorative and emergent encounters are observed consistently in grantees regardless of state policy environment. Less variation is observed in the proportion of preventive encounters. Although slight increases are observed in a number of DHPPI categories, the largest increase (from approximately 30% to 35%) in preventive dental encounters is observed in grantees located in states with excellent policy environments (level 5). Grantees located in states with limiting policy environments (level 2) had a lower proportion of preventive dental services during this period (i.e., from approximately 37% to 34%). Grantees located in states with the most restrictive policy environments consistently report providing proportionately more restorative and emergent encounters and proportionately fewer preventive encounters.

The only statistically significant correlations between dental service type and policy environment is found in the proportion of preventive encounters. Using grantees located in the states with the most supportive environments (level 5) as a reference group, grantees located in the most restrictive state (level 1) report -0.09 or 9% fewer preventive dental encounters.

The proportion of encounters by dental service type varied little with whether or not policy changes occurred within a state. In bivariate analyses, policy changes are significantly correlated with the proportion of restorative encounters. The occurrence of a policy change decreased the proportion of restorative encounters by -0.03 or 3%.

Grantee Characteristics

Descriptive characteristics and results of bivariate analyses for grantee level characteristics are also presented by dental service type in Table 6.1. Geographic setting is the only grantee level variable for which the proportion of type of service is reported. The remaining descriptive data is representative of the population of grantees that deliver dental services. A discussion of these characteristics is presented in Chapter 4. The proportion of type of dental service was calculated by urban and rural setting. Little variation are evident in the proportions of dental encounters by geographic setting. A slightly higher proportion of preventive, restorative, and emergent encounters are reported in urban as compared to rural settings. The only significant correlation is observed in the proportion of emergent encounters. Grantees located in urban settings proportionately provide 0.03 or 3% more emergent dental encounters than grantees located in rural settings.

Bivariate analyses identified significant associations between the number of clinical sites, the proportion of Medicaid and uninsured patients, and the proportion of patients living at or below 200% poverty with all types of dental services. The number of clinical sites and the proportion of patients in poverty are directly correlated to the proportion of preventive, restorative and emergent services. As the number of clinical sites increases or the proportion of patients living in poverty increases, the proportion of preventive, restorative, and emergent dental encounters increase. Also, the proportion of Medicaid patients is inversely correlated to restorative (-0.05, <0.0001) and emergent (-0.04, <0.0001) encounters and directly relate to preventive encounters (0.23, <0.0001).

In addition, significant associations are also identified with the proportion of minority patients and the number of dentists per 10,000 people. The proportion of minority patients is inversely correlated to the proportion of restorative (-0.03, 0.02) encounters and directly related to the proportion of emergent (0.03, <0.0001) encounters. The number of dentists per 10,000 is inversely correlated to restorative (-0.01, 0.01) patient encounters and directly related to the number of preventive (0.02, 0.02) patient encounters.

Table 6.1

Descriptive Characteristics by Type of Service including Results of Univariate Regression Analyses

VARIABLE	Type of Dental Service														
	Restorative					Preventive					Emergent				
	Mean	SD	β	SE	P	Mean	SD	β	SE	P	Mean	SD	β	SE	P
DHPPI Range															
1 (1-30)	0.29	0.16	-0.05	0.01	0.10	0.26	0.15	-0.09	0.03	0.001	0.05	0.12	0.01	0.01	0.17
2 (31-40)	0.24	0.12	-0.03	0.01	0.22	0.34	0.15	-0.01	0.03	0.63	0.04	0.09	0.01	0.01	0.58
3 (41-49)	0.25	0.12	-0.01	0.01	0.77	0.31	0.14	-0.03	0.03	0.35	0.03	0.08	0.01	0.01	0.46
4 (50-80)	0.22	0.09	0.00	0.01	0.98	0.37	0.13	0.05	0.03	0.12	0.03	0.05	0.00	0.01	0.96
5 (81-100)	0.25	0.13	<i>ref</i>	<i>ref</i>	<i>ref</i>	0.31	0.14	<i>ref</i>	<i>ref</i>	<i>ref</i>	0.03	0.06	<i>ref</i>	<i>ref</i>	<i>ref</i>
Policy Changes															
Yes	0.25	0.13				0.32	0.15				0.04	0.09			
No	0.26	0.13	-0.03	0.01	0.00	0.31	0.13	0.00	0.02	0.87	0.03	0.06	0.01	0.01	0.41
Urban															
Yes	0.26	0.14													
No	0.23	0.11	0.01	0.01	0.46	0.32	0.15	0.01	0.01	0.40	0.03	0.08	-0.01	0.00	<.0001
Clinical Sites	4.54	2.63	0.00	0.00	0.00	4.54	2.63	0.01	0.00	<.0001	4.54	2.63	0.00	0.00	0.38
Medicaid	0.29	0.15	-0.05	0.01	<.0001	0.29	0.15	0.23	0.01	<.0001	0.29	0.15	-0.04	0.01	<.0001
200% Poverty	0.66	0.25	0.05	0.01	<.0001	0.66	0.25	0.02	0.01	0.03	0.66	0.25	0.01	0.00	0.01
Minority	0.47	0.32	-0.03	0.01	0.02	0.47	0.32	-0.01	0.02	0.48	0.47	0.32	0.03	0.01	<.0001
Uninsured	0.39	0.18	-0.03	0.01	0.02	0.39	0.18	-0.16	0.02	<.0001	0.39	0.18	0.03	0.01	<.0001
Dentist per Capita	5.98	1.33	-0.01	0.00	0.01	5.98	1.33	0.02	0.01	0.02	5.98	1.33	0.00	0.00	0.21

Note. Estimates and standard error terms were generated on longitudinal data. Adjustments were made for repeated measures on grantees and clustering at the state level.

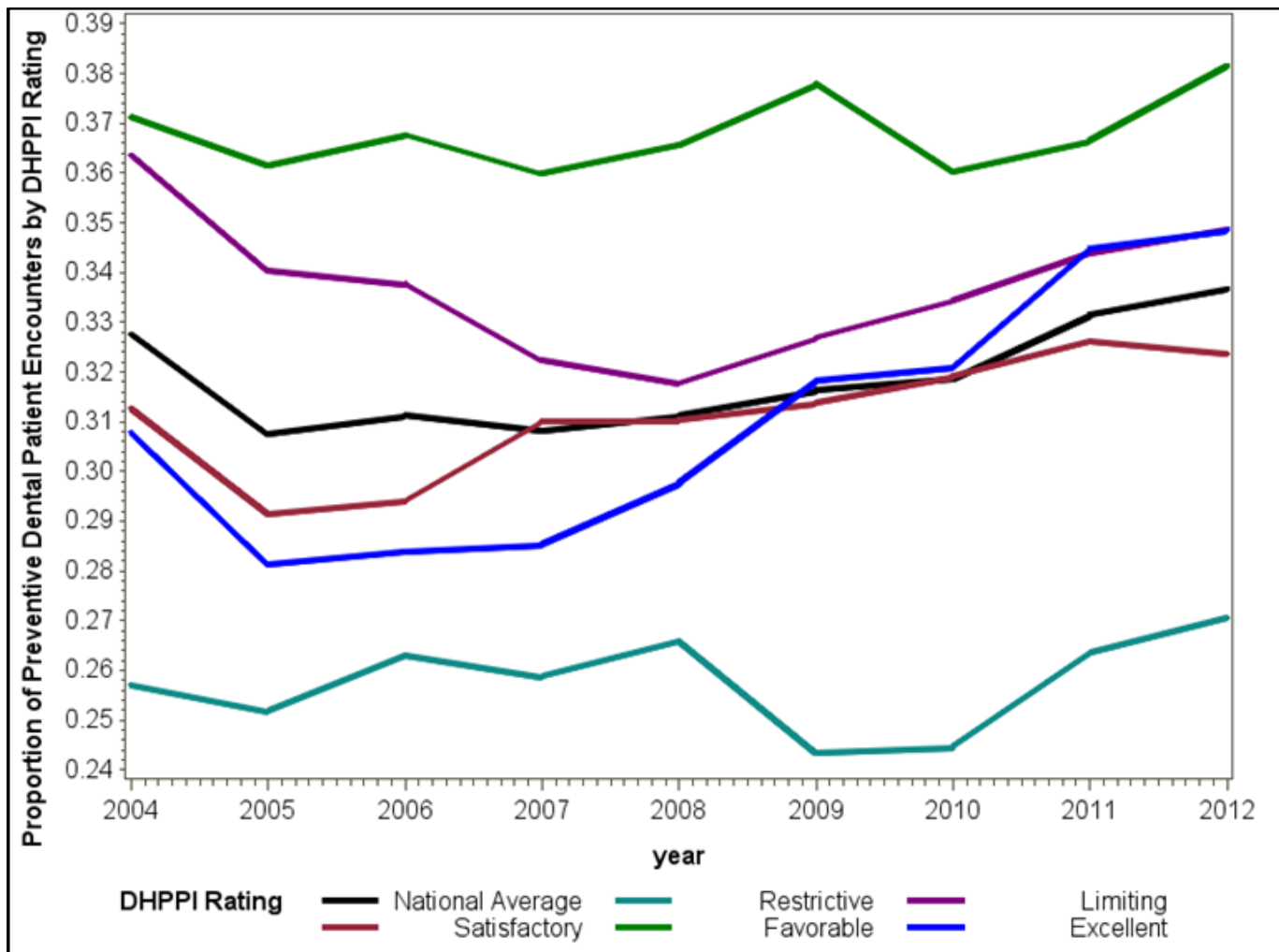


Figure 14. Proportion of Reported Preventive Encounters by DHPPI Category

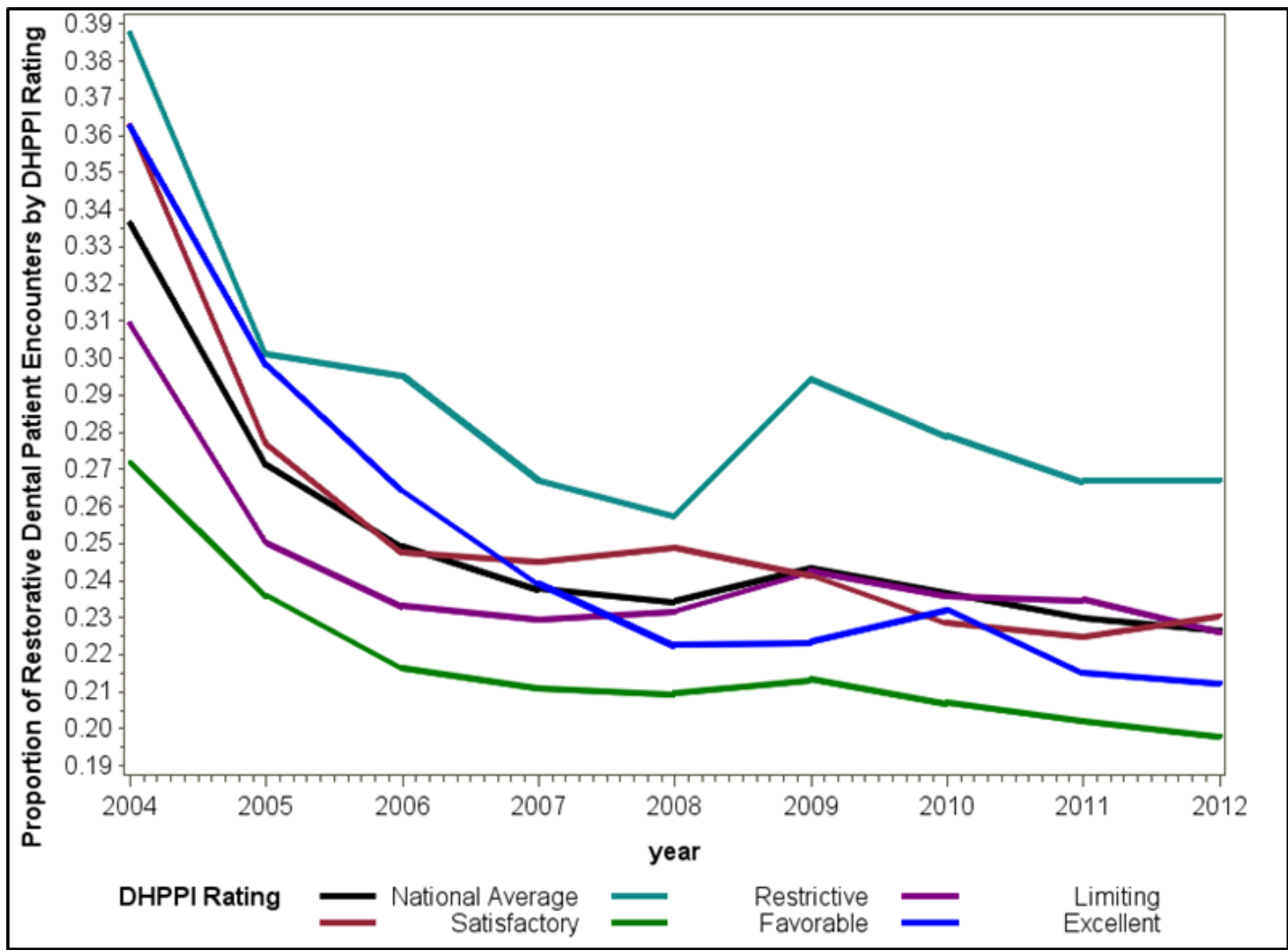


Figure 15. Proportion of Reported Restorative Encounters by DHPPI Category

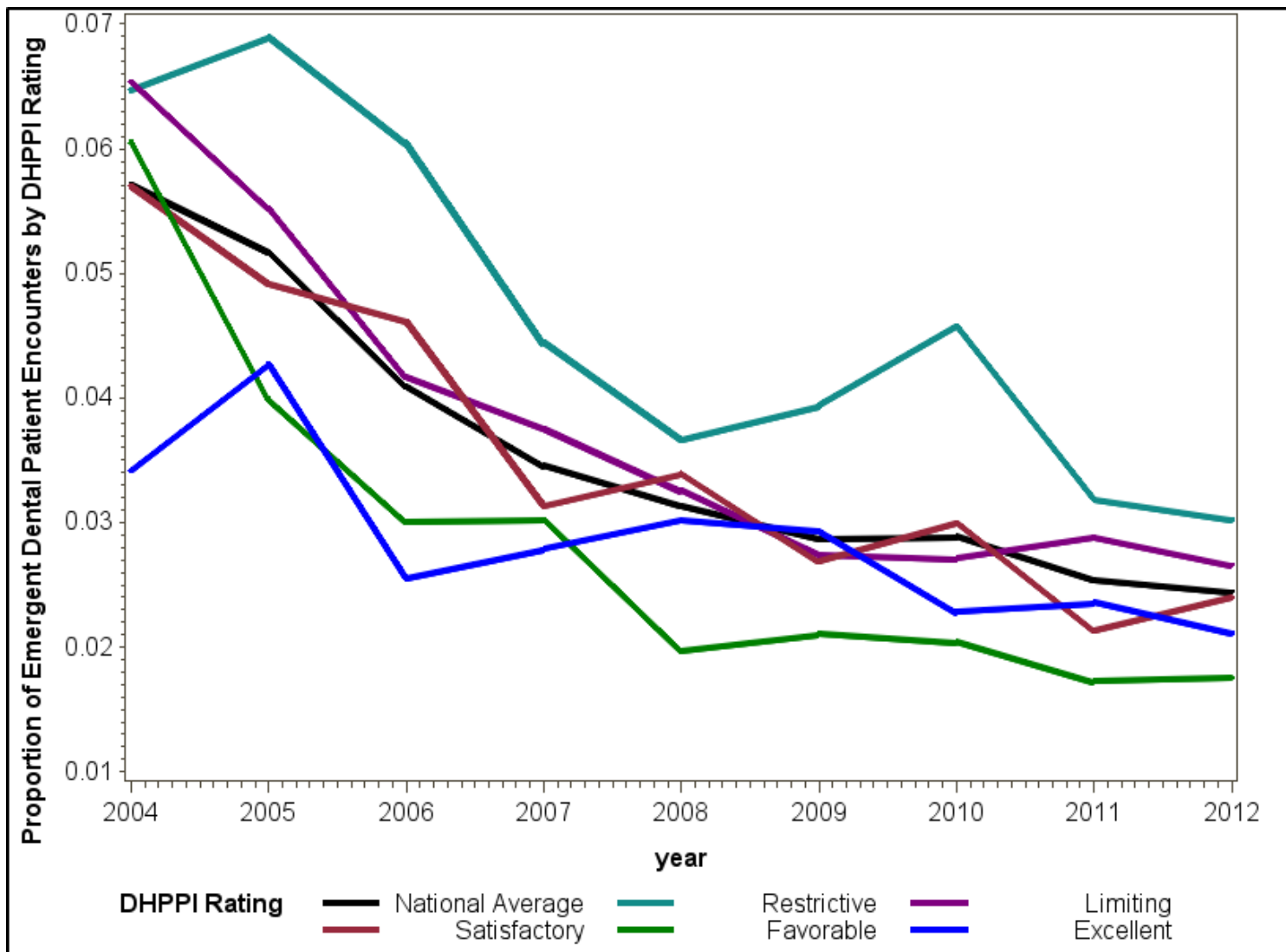


Figure 16. Proportion of Reported Emergent Encounters by DHPPI Category

Multivariable Results

Analytic tests are performed on cross-sectional and longitudinal data. Little variation is apparent in the results from the multiple cross-sectional analyses. For this reason and to streamline the presentation of the findings, only results from the longitudinal analyses, including pre- and post- economic recession, are presented.

DHPPI and policy change measures are included in all regression models. Additional variables are selected for inclusion based on the bivariate test results presented in Table 6.1. The same variables are included in all regression models to enable comparisons. The following variables are included in the analyses: the number of clinical sites, urban setting, proportion of Medicaid patients, proportion of minority patients, dentists per 10,000, and the time period of grantee observation. Only the proportion of uninsured patients was excluded. Reasons for this are presented in Chapter 4.

Separate longitudinal regression models are fit for each dental service type with adjustments for repeated measures and state-level clustering. In addition, regression models also are fit for pre- (2004-2007) and post- (2008-2012) economic recession. Results of the longitudinal models, including all years are presented in Table 6.2, and results from pre- and post-recession periods are presented in Table 6.3.

Table 6.2 demonstrates that after controlling for the effect of numerous factors, state policy environment is a significant predictor of the utilization of certain types of dental services. Grantees located in states with favorable policy environments (level 4) provide proportionately more (0.07, 0.04) preventive services than those in the states with the most supportive environment (level 5), which serves as the reference group.

Approaching statistical significance, grantees located in states with restrictive policy (level 1) provide proportionately fewer preventive dental encounters (-0.06, 0.08) than those in the most supportive states. Also approaching significance, grantees located in states with favorable policy environments (level 4) provide proportionately fewer restorative encounter (-0.05, 0.06) than those in the most supportive states. Most notable, grantees located in states with the most restrictive policy environments provide proportionately more emergent encounters (0.03, 0.03). Having had a policy change was a significant predictor of the proportion of preventive (0.05, 0.02) encounters and restorative (-0.04, 0.01) encounters. This means grantees located in states where policy changes occurred provided proportionately more preventive and proportionately fewer restorative encounters over the nine year period.

Table 6.2

Results from Longitudinal Multivariable Regression Models: Predictors of Dental Services by Type of Service

Variable	Predictors of Dental Patient Encounters									
	Preventive			Restorative			Emergent			
	β	SE	P	β	SE	P	β	SE	P	
DHPPI Range										
1 (1-30)	-0.06	0.03	0.08	0.01	0.02	0.78	0.03	0.01	0.03	
2 (31-40)	0.01	0.03	0.66	-0.01	0.02	0.57	0.01	0.01	0.33	
3 (41-49)	-0.01	0.03	0.86	-0.01	0.02	0.61	0.01	0.01	0.28	
4 (50-80)	0.07	0.03	0.04	-0.05	0.02	0.06	0.00	0.01	0.87	
5 (81-100)	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	
Policy Changes	0.05	0.02	0.02	-0.04	0.01	0.01	0.01	0.01	0.11	
Clinical Sites	0.00	0.00	0.33	0.00	0.00	0.04	0.00	0.00	0.21	
Medicaid	0.14	0.02	<.0001	-0.03	0.01	0.03	-0.02	0.01	0.08	
Poverty	-0.03	0.01	0.00	0.02	0.01	0.00	0.01	0.01	0.05	
Minority	0.01	0.01	0.11	0.03	0.01	<.0001	0.01	0.00	0.15	
Urban Setting	0.03	0.01	0.00	0.03	0.01	<.0001	-0.01	0.00	0.01	
DDS per Capita	0.00	0.01	0.94	-0.01	0.00	0.06	0.01	0.00	0.02	
Time	0.00	0.00	0.16	-0.01	0.00	<.0001	0.00	0.00	0.00	

Increases in the proportion of Medicaid patients are predictive of highly significant increases in the proportion of preventive (0.14, <0.001) encounters and predictive of significant decreases in the proportion of restorative (-0.03, 0.03) encounters. Proportion of patients living at or below 200% poverty is directly related to the proportion of restorative (0.02, 0.001) and emergent (0.01, 0.05) encounters, and inversely related to the proportion of preventive encounters (-0.03, 0.001). This means as the proportion of patients living in poverty increases the proportion of restorative and emergent care increases and the proportion of preventive care decreases. The proportion of minority patients is significantly related to the proportion of restorative (0.03, <0.0001) encounters only. As the proportion of minority patients increases, the proportion of restorative encounters also increases.

Grantees located in urban settings deliver significantly more preventive (0.03, 0.001) and restorative (0.03, <0.0001) encounters, and significantly fewer emergent encounters (-0.01, 0.01) than those in rural settings. Increases in the number of dentists per capita are associated with significant increases in the proportion of emergent encounters (0.01, 0.02), and, approaching significance, decreases in the proportion of restorative encounters (-0.01, 0.06). This means that increases in the number of dentists per capita within a state are predictive of increases in the proportion of emergency dental visits and decreases in the proportion of restorative visits at grantees.

Table 6.3

Results from Longitudinal Multivariable Regression Models: Predictors of Proportion Preventive Dental Encounters Pre- (2004-2007) and Post- (2008-2012) Economic Recession

Variable	Preventive					
	Pre-recession			Post-recession		
	β	SE	P	β	SE	P
DHPPI Range						
1 (1-30)	-0.03	0.04	0.44	-0.05	0.03	0.07
2 (31-40)	0.04	0.03	0.25	0.00	0.02	0.86
3 (41-49)	0.00	0.04	0.95	0.00	0.03	0.98
4 (50-80)	0.09	0.04	0.03	0.05	0.03	0.07
5 (81-100)	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>
Policy Changes	0.05	0.03	0.08	0.04	0.02	0.03
Clinical Sites	0.00	0.00	0.96	0.00	0.00	0.03
Medicaid	0.26	0.04	<.0001	0.21	0.02	<.0001
Poverty	-0.02	0.01	0.11	-0.02	0.01	0.14
Minority	-0.02	0.01	0.06	-0.01	0.01	0.47
Urban Setting	0.02	0.01	0.04	0.03	0.01	<.0001
DDS per Capita	0.00	0.01	0.77	0.00	0.01	0.96
Time	-0.01	0.00	0.01	0.01	0.00	<.0001

Table 6.4

Results from Longitudinal Multivariable Regression Models: Predictors of Proportion Restorative Dental Encounters Pre- (2004-2007) and Post- (2008-2012) Economic Recession

Variable	Restorative					
	Pre-recession			Post-recession		
	β	SE	P	β	SE	P
DHPPI Range						
1 (1-30)	-0.02	0.03	0.41	0.02	0.02	0.25
2 (31-40)	-0.05	0.02	0.02	0.01	0.02	0.62
3 (41-49)	-0.03	0.02	0.18	0.01	0.02	0.77
4 (50-80)	-0.09	0.03	0.00	-0.03	0.02	0.17
5 (81-100)	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>
Policy Changes	-0.04	0.02	0.01	-0.03	0.01	0.01
Clinical Sites	0.00	0.00	0.96	0.00	0.00	0.06
Medicaid	-0.11	0.04	0.00	-0.10	0.02	<.0001
Poverty	0.01	0.01	0.29	0.01	0.01	0.27
Minority	-0.02	0.01	0.06	0.00	0.01	0.59
Urban Setting	0.01	0.01	0.09	0.01	0.01	0.07
DDS per Capita	-0.01	0.01	0.03	0.00	0.00	0.32
Time	-0.03	0.00	<.0001	0.00	0.00	0.43

Table 6.5

Results from Longitudinal Multivariable Regression Models: Predictors of Emergent Preventive Dental Encounters Pre- (2004-2007) and Post- (2008-2012) Economic Recession

Variable	Emergent					
	Pre-recession			Post-recession		
	β	SE	P	β	SE	P
DHPPI Range						
1 (1-30)	0.04	0.02	0.03	0.03	0.01	0.03
2 (31-40)	0.02	0.01	0.21	0.01	0.01	0.33
3 (41-49)	0.03	0.02	0.13	0.01	0.01	0.28
4 (50-80)	0.01	0.02	0.59	0.00	0.01	0.87
5 (81-100)	<i>ref</i>	<i>ref</i>	<i>ref</i>			
Policy Changes	0.01	0.01	0.54	0.01	0.01	0.11
Clinical Sites	0.00	0.00	0.91	0.00	0.00	0.21
Medicaid	-0.06	0.03	0.05	-0.02	0.01	0.08
Poverty	0.01	0.01	0.45	0.01	0.01	0.05
Minority	0.00	0.01	0.75	0.01	0.00	0.15
Urban Setting	-0.02	0.01	0.02	-0.01	0.00	0.01
DDS per Capita	0.01	0.00	0.19	0.01	0.00	0.02
Time	-0.01	0.00	<.0001	0.00	0.00	0.00

Regression results from the pre- and post-economic recession periods are presented in Tables 6.3 (preventive), 6.4 (Restorative), and 6.5 (Emergent). Variations are observed in the influence of policy environment pre- and post-recession and suggest the policy environment may have had a lesser effect post-recession. Pre-recession grantees located in states with favorable practice environments (level 4) provide significantly more preventive encounters (0.09, 0.03) as compared to those in the reference group. Post-recession, the proportion of preventive encounters did not vary significantly across the DHPPI categories, although some were tending towards significance. The largest variation is observed in the changing coefficients and significance for the proportion restorative visits pre- and post-recession by DHPPI category. In the pre-recession period grantees located in states with limiting (level 2) and favorable (level 4) policy environments provide significantly fewer restorative encounters than those in the reference group. In the post-recession period the proportion of restorative encounters did not differ significantly within any group.

Similar to the regression models for all years, grantees located in states with policy changes provide significantly more preventive and fewer restorative encounters. There is little change to the coefficients for policy changes in the regression models for restorative encounters pre- (-0.04, 0.01) and post-recession (-0.03, 0.01); however, policy changes are significantly predictive of increases in preventive encounters in the post-recession period (0.04, 0.03).

Increases in the proportion of Medicaid patients is a significant predictor of increases in preventive encounters and decreases in restorative and emergent encounters in the pre- and post-recession periods. The only difference observed is the proportion of

Medicaid patients is not a significant predictor of the proportion of emergent encounters (-0.02, 0.08) in the post-recession period.

While the proportion of patients living at or below 200% poverty is a significant predictor of decreases in preventive encounters and increases in restorative and emergent encounters in the regression models for the entire nine year period, these significant effects are not observed in the regression models for the pre- and post- recession periods. An increasing proportion of patients living in poverty is significantly predictive of increases in emergent encounters in the post-recession period.

Although the proportion of minority patients is a significant predictor of the proportion of restorative encounters in the regression models for all years, it is not a significant predictor in any of the models for the pre- and post-recession periods. In addition, the effect of geography changed very little in the pre- and post-recession models. The major difference observed in the regression models for restorative encounters is that urban setting is not a significant predictor in the pre- (0.01, 0.09) or post-recession (0.01, 0.07) periods.

Few differences are observed in the effect of dentists per capita in the pre- and post-recession periods. Increases in the number of dentists per capita is only a significant predictor of increases in decreases in restorative encounters (-0.01, 0.03) in the pre-recession period. Also, increases in the number of dentists per capita is only significant predictive of increases in emergent encounters (0.01, 0.02) in the post-recession period.

Discussion

These findings demonstrate the state policy environment is a predictor of the volume of certain types of dental services provided by grantees, which may reflect the

oral health status of underserved communities. Over the nine years examined in this study and in consideration of the changing economic environment, grantees located in states with restrictive policy environments provide proportionately more emergency dental services than those located in states with the most supportive environments. This increased need for emergency dental services among underserved populations seeking care at a health center grantee may be reflective of an environment which does not support prevention.

On the other hand, grantees located in states with favorable policy environments provide proportionately more preventive services and proportionately fewer restorative dental services than grantees located in states policy environments that are either more restrictive or more highly supportive. Because most dental diseases requiring restoration are preventable, it is not surprising that grantees located in states with policy environments supportive of dental hygiene, an oral health profession focused on prevention, are better positioned to provide preventive care and avert dental diseases.

In addition, these findings demonstrate the significant impact of state Medicaid programs on improving access to care and community oral health. Increases in the proportion of Medicaid patients are predictive of increasing rates of preventive dental care and decreasing rates of restorative and emergent care. This likely reflects the success of Medicaid programs at improving access to preventive dental services and averting dental diseases for underserved populations which access care at health centers.

The fact that increases in the proportion of patients living at or below 200% poverty is predictive of decreasing rates of preventive dental care and increasing rates of restorative and emergent care is not surprising. As discussed in Chapter 1, socio-

economic factors play a large role in oral health disparities. These data highlight the disparities that persist among patients in medically underserved communities.

The finding that increases in the number of dentists per capita within a state are predictive of significant increases in emergency dental services is surprising. It is certainly counter intuitive that greater dental workforce capacity would be a predictor of greater unmet oral health care needs. However, as discussed in Chapter 1, health center grantees deliver care primarily to communities recognized as medically underserved. By virtue of being medically underserved, these communities have a shortage of health care providers, including dentists. Therefore, state-level measures of dental workforce capacity are not likely to reflect the capacity that exists in underserved communities. This finding may point to larger issues in the professional practice of dentists. Additional research is needed to elucidate these patterns.

Summary

Previous chapters demonstrated that state policy environment affects the availability and level of access to dental services in medically underserved communities with grantees of the U.S. Health Center program. The findings in this chapter provide important insight into the influence of state level workforce policies and oral health care needs of Americans accessing dental care in medically underserved communities. These findings suggest that policy environments which promote higher levels of autonomy for a workforce focused on disease prevention and health promotion may reduce the burden of disease and improve population oral health. The final chapter considers the collective results of the analyses performed for this dissertation and their implications for policy, practice, and future research.

CHAPTER 7. Discussion, Implications, and Future Directions

The policy environment of a state, either supportive or restrictive of an oral health workforce focused on prevention and health promotion, is to some extent a predictor of the availability of dental services, the level of access to dental care, and oral health status of medically underserved communities that receive federal support from the U.S. Health Center program. This study is the first of its kind to examine the influence of the health workforce policy environment of a state on community health centers and the underserved Americans for whom they provide care. The findings of this study are useful for informing policy at the federal, state, and community level. In addition, the framework and methods developed for this study may be used to monitor future trends, employed as tools for policy evaluation, and adapted for future studies to examine other types of state policy. This final chapter delves into the findings presented in previous chapters and considers implications for policy and future directions for research.

Discussion

The data generated by this dissertation demonstrate that the context created by state policy environment has a significant impact on grantees of the U.S. Health Center program, and ultimately, on the oral health of underserved communities. This section further considers findings from dissertation analyses and their implication for oral health delivery and access in underserved communities.

Understanding the influence of state policy environment for the dental hygiene profession, quantified by the Dental Hygiene Professional Practice Index (DHPPI), on oral health service delivery, dental care access, and oral health status in medically underserved communities is the primary objective of this dissertation. Chapter 4

examines whether, and to what extent, state policy environment is a predictor of the dental service delivery status of grantees of the U.S. Health Center program, more commonly known as Federally Qualified Health Centers. Chapter 5 explores oral health utilization data from health center grantees that deliver dental services to determine whether, and to what extent, state policy environment is a predictor of the proportion of patients accessing dental services. Finally, Chapter 6 considers whether, and to what extent, state policy environment serves as a predictor of the oral health status of medically underserved communities, using the proportion of dental patient encounters for preventive, restorative and emergent dental services as proxy measures for oral health need and indicators of community oral health status.

Availability of Dental Services

While all grantees of the U.S. Health Center program are required to ensure access to selected dental services for the community they serve, not all grantees operate dental programs and provide these services directly to their patients. As reported in Chapter 4, approximately 20% of all grantees report they do not operate a dental service program. As mentioned in earlier chapters, grantees cite the relatively high cost of dental service delivery programs and a shortage of oral health providers available and willing to practice in underserved communities as major barriers to delivering dental services directly in their community.

In order to meet their federal funding requirements, many grantees that do not operate dental programs establish contracts with privately practicing dentists in their communities. However, the provision of dental services through contracts with private dental offices may not be an ideal arrangement for 'ensuring access to dental care' for

people residing in medically underserved areas where significant travel times may be required to access the nearest source of dental care.

Findings presented in Chapter 4 demonstrate state policy environment is a significant predictor of dental services delivery status of health center grantees. This effect is observed in multivariable regression models for each year from 2004 to 2012, cumulatively over the nine years, and in the period's pre- and post-economic recession. From the cross-sectional results in Chapter 4, grantees located in states with the most restrictive policy environments are significantly less likely to deliver dental services than those located in states with the most supportive policy environments throughout the nine years included in the study. Specifically, grantees located in states with restrictive policy environments are 0.38 times as likely or 62% less likely to deliver dental services in 2005 as those in the located in the most supportive states, and 0.43 times as likely or 57% less likely in 2011. While the effect of policy as a predictor may have lessened slightly over the nine years included in this study, grantees located in states with restrictive policy remain statistically significantly less likely to deliver dental services to their community than grantees in highly supportive states.

Findings from the longitudinal analyses presented in Chapter 4 are similar to those from cross-sectional analyses. Over the nine year period, grantees located in states with restrictive policy are 0.28 times as likely or 78% less likely to deliver dental services as those located in states with the most supportive policy environment. Some lessening in the effect of policy is observed in the period prior to (2004 to 2007) and following (2008 to 2012) the economic recession. In the pre-recession period, grantees located in states with the most restrictive policy environment are 0.31 times as likely or 69% less

likely and grantees located in states with the second most restrictive environment are 0.35 times as likely or 65% less likely to deliver dental services as those located in states with the most supportive practice environments. In the post-recession period, there are no statistically significant differences in the likelihood of dental service delivery between grantees located in the different policy environments.

Trends observed in the effect size of policy environment on dental service delivery are not surprising. The measure used as an indicator of policy environment is developed based on state policy environment in 2001. Changes in state and federal policy, as well as changes to administrative practices of grantees or changes in the population are likely have some effect on the dental service delivery status of grantees.

Title VII of the American Reinvestment and Recovery Act (ARRA) of 2009 is an example of federal policy likely to have influenced the dental services delivery status of grantees during the study period¹². Through ARRA, \$2.5 billion dollars were allocated to Health Resources Services Administration (HRSA) at the Department of Health and Human Services (DHHS) to improve health resources and services in America's underserved communities. Of this funding, \$2 billion was specifically allocated to the U.S. Health Center program for grants to health centers for construction, renovation, or operation as authorized under section 330 of the Public Health Service Act ("PHS Act"). The remaining \$500 million was allocated to programs addressing health professions workforce shortages.

¹² Complete information on ARRA is available through the federal government at: <http://www.gpo.gov/fdsys/pkg/BILLS-111hr1enr/pdf/BILLS-111hr1enr.pdf>

The findings of this dissertation suggest ARRA funding likely impacted, to some extent, the delivery of dental services by grantees. Future research is need to understand the specific effect ARRA had on dental service delivery; however, ARRA may explain some of the variation in results from regression analyses for later years in the study.

In addition to trends observed in the influence of state policy environment, changes in state dental hygiene practice policy are identified as a significant, inverse predictor of dental service delivery status in later years. This findings, observed in the regression results for 2011 in table 4.2, suggest that grantees located in a state where key policy changes occurred between 2002 and 2011 are 0.49 times as likely or 51% less likely as those located in states where no policy changes occurred to deliver dental services. The states where key policy changes occurred are indicated in Table 3.6 found in Chapter 3.

The distribution and frequency of policy changes and the inverse relationship between policy change and dental service delivery status following implementation of ARRA suggest that, to some extent, state policy environment may have potentially affected the ability of grantees to leverage the \$2 billion in federal funding. To build upon these findings, future research could focus on understanding the relationship between changes in state policy and grantee dental service delivery status.

It is important to note that updating the DHPPI or generating a new index was outside the scope of this study. This study does, however, control for key policy changes which occurred within a state and are considered likely to affect the relationship between state policy environment and dental service delivery of grantees. The finding of a statistically significant relationship between key policy changes and dental service

delivery status points to need for enhanced methods to quantify and track health workforce policy environments over time. Such mechanisms would be useful for studying and evaluating the influence of policy over time and in changing environments.

Access to Care

Chapter 5 considers the impact of state policy environment on the reported level of access to dental care among patients served by health center grantees. As described in earlier chapters, health center grantees are an important part of America's oral health care safety-net. They deliver dental care in medically underserved communities to populations that experience many barriers to dental care and, consequently, struggle with oral health disparities.

As previously discussed, health center grantees are required by their federal funding agreement to 'ensure access to preventive dental services' for their community. The majority of the preventive dental services, presented in Chapter 1, are required of grantees fall within the scope of training and practice for dental hygienists. Understanding whether, and to what extent, state policy environment for the practice of dental hygiene is a predictor of access to dental care through grantees, as measured by the proportion of unique patients receiving a dental examination within a given year, provides important insight into the role such state policies have in access to dental care among medically underserved communities.

Results from Chapter 5 demonstrate the state policy environment may to some extent be a predictor of access to dental care at health center grantees. Descriptive results presented in Table 5.1 suggest that grantees located in states with the most restrictive

policy environment provide dental services to 6% fewer patients than grantees located in states with the most supportive policy environments.

While state policy environment is not a strong predictor of access in the longitudinal multivariable regression models, results from the post-recession period are tending towards significance. In the post-recession period, grantees located in states with restrictive policy environments provide dental services to fewer (-0.07 or 7%) patients than those located in states with the most supportive policy environments. At first glance, seven percent fewer patients with access to dental care may not seem meaningful or substantively significant; however, considering that health center grantees deliver health care to millions of underserved Americans on an annual basis the actual number of patients for whom restrictive practice environment is a potential barrier to dental care access is significant.

While not statistically significant, the findings from Chapter 5 suggest trends in the effect of state policy environment as a predictor of dental care access among grantees during the study period. These trends differ from those observed in Chapter 4 where policy environment is examined as a predictor of grantee dental service delivery status. Whereas, policy environment is not a significant predictor of dental care access over the study period or in the pre-recession period, data suggest that it may have had some effect in the post-recession period.

A number of possible explanations for the temporal trends observed in access to dental care are discussed in Chapter 5, including changes in the policy or economic environments, changes in health center administration, and changes within the population. In addition to the factors discussed in Chapter 5, ARRA, discussed in the

previous section, is likely to have had some influence on access to dental care at grantees. ARRA allocated funding to support infrastructure development for health center grantees' array of services. Although the exact amount is unknown, a portion of this funding likely supported renovations or construction projects to expand and enhance existing programs. Projects such as these may have increased the proportion of patients accessing dental care.

Also, ARRA is likely to have influenced dental workforce capacity for grantees and in medically underserved communities. In addition to supporting health centers, ARRA funding was allocated to support workforce initiatives such as the National Health Service Corps (NHSC), discussed in Chapter 1. Increases in funding for the NHSC program acted to increase in the number of health (including oral health) clinician positions eligible for financial incentives. This likely had some impact on the number of oral health professionals working in medically underserved communities and employed by grantees.

As discussed previously, evaluating the impact of ARRA on health center grantees and access to care is not the focus of this dissertation. However, the finding of this dissertation suggest that ARRA funding, either for dental infrastructure enhancement or increasing oral health workforce capacity, likely has had some impact on dental service delivery and access to dental care for grantees. These findings may suggest ARRA funding favored grantees located in states with policy environments supportive of the dental hygiene workforce. Future research focused on the specific mechanisms through which ARRA funding influenced dental service delivery and access to dental care among grantees is needed to determine whether such a relationship truly exists.

Oral Health Status

Dental hygiene is a profession focused on dental disease prevention and oral health promotion. Chapter 6 examines whether state policy environment for the dental hygiene profession is a predictor of the oral health care needs and oral health status of medically underserved communities. The proportion of patient encounters attributable to preventive, restorative and emergent dental services are examined and serve as proxy measures of the oral health care needs. This is further theorized to be an indicator of the oral health status of the medically underserved communities which receive dental services at grantees of the U.S. Health Center program.

The findings presented in Tables 6.2 and 6.3 demonstrate state policy environment is a significant predictor of the volume of certain types of dental services within medically underserved communities. Among the key findings in Chapter 6, grantees located in states with restrictive policy environments provide statistically significantly more (0.03 or 3 %) emergency dental patient encounters than grantees located in states with the most supportive policy environments. This finding suggests policy environments more restrictive of a workforce focused on dental disease prevention and oral health promotion may, to some extent, have a harmful effect on the oral health status of medically underserved communities.

Interestingly, grantees located in states with favorable policy environments provide statistically significantly more (0.07 or 7%) preventive dental services than grantees located in states with the most supportive policy environments. While the relationship between restrictive state policy and emergency dental encounters was hypothesized, it was not expected that favorable policy environment would create the

optimal context for access and oral health. It was assumed that grantees located in states with the highest level of support for the dental hygiene profession would be more optimal. This surprising finding, however, is reflected in the descriptive data throughout this dissertation.

Optimal Policy Environment

Descriptive findings throughout this dissertation consistently point to the fact that favorable, not excellent, policy environments provide the optimal context for availability, access, and oral health. For example, Table 4.1 and Figure 12, demonstrate the largest proportion (89.6%) of grantees located in states with favorable policy environments (second highest level of support for the dental hygiene profession) report delivering dental services directly to their patients. Whereas, only 84.6% of grantees located in states with excellent policy environments and 72.6% of grantees located in states with restrictive policy environments report delivering dental services.

These findings are also reflected in descriptive data presented in Chapters 5 and 6. In Table 5.1, grantees located in states with favorable policy environments report a mean of 18% of patients accessing dental services, as opposed to 16% among grantees in states with excellent policy environments and 12% among grantees in states with the most restrictive policy environment. Again, favorable policy environment is the optimal environment for access to dental care. In Chapter 6, Table 6.1, grantees located in favorable policy environments report providing the highest proportion of preventive patient encounters and the lowest proportion of restorative and emergent encounters of grantees located in any policy environment.

Altogether, the descriptive findings from this dissertation suggest favorable policy environments provide the optimal context for grantees to ensure access to dental care and improve oral health. Examining policy from states with favorable environments is helpful in understanding these findings.

Understanding State Policy Environment

States with favorable policy environments are identified in the DHPPI Index found in Chapter 3 and include Connecticut, Maine, Minnesota, Missouri, Nevada, New York, and Utah. All these states have provisions which enable dental hygienists to provide preventive services to underserved patients without direct professional oversight by a licensed dentist. Additionally, Connecticut, Maine, Missouri, Minnesota, and Nevada have had provisions enabling dental hygienists to be directly reimbursed for services provided to Medicaid recipients since 2003¹³.

Connecticut has virtually no restrictions on the practice of dental hygiene, and Maine, Missouri, Minnesota, Nevada and New York have removed most restrictions and/or have specific provisions which support expanded dental hygiene practice with underserved population and in public health settings¹⁴. For example, Missouri has provisions which enable dental hygienists to deliver preventive dental services to children enrolled in the state's Medicaid program. Minnesota has provisions for collaborative practice with dentists in public health settings, enabling dental hygienists to practice

¹³ Source: America Dental Hygiene Association. *States which directly reimburse dental hygienists for services under state Medicaid program*. Available at: https://www.adha.org/resources-docs/7519_Direct_Reimbursement_Medicaid_by_State.pdf

¹⁴ Source: America Dental Hygiene Association. *Direct Access States*. Available at: https://www.adha.org/resources-docs/7513_Direct_Access_to_Care_from_DH.pdf

unsupervised under a formal agreement with a licensed dentist. The remaining states-- Maine, Nevada, and New York--offer the fewest restrictions in public health settings. Of the states with favorable policy environments, Utah is the most restrictive. In Utah, dental hygienists may deliver services unsupervised only following examination by a licensed dentist in both public health and private practice settings.

States with favorable practice environments have the fewest restrictions for the practice of dental hygiene in public health settings, but do not enable complete professional autonomy. Findings of this dissertation suggest that such provisions create the optimal environment for health center grantees to operate dental programs and provide dental services directly to their patients. This further suggests state policy environments promoting either the highest or lesser levels of professional autonomy do not create more optimal environments for improving access or oral health in medically underserved communities.

The relationship between greater restriction and fewer dental programs among grantees is not surprising. Grantees located in states restricting the practice of dental hygiene through provisions such as direct professional oversight are not able to leverage the dental hygiene workforce to the same extent as grantees located in states with fewer restrictions. For example, in Maine, a grantee may employ a dental hygienist and obtain Medicaid reimbursement for the services they provide to Medicaid recipients in the community. In contrast, grantees located in states with restrictive policy environments, such as Mississippi which require direct supervision of dental hygiene practice in all settings, do not have the ability to either employ dental hygienists to practice or obtain Medicaid reimbursement for preventive dental services provided by a dental hygienist to

their patient community without concurrently employing a practicing dentist. Variations in policy influence the practice environment which logically impact the availability of dental services. This dissertation demonstrates such variations likely impact dental service availability, access to care, and oral health status in medically underserved communities.

The fact that excellent policy environments, which promote the highest level of professional autonomy, are not optimal for grantees to operate dental programs was surprising. States promoting the highest levels of professional autonomy have the fewest restrictions on dental hygiene professional practice. These states include Colorado, California, New Mexico, Oregon, and Washington.

Each of these states have provisions which enable the unsupervised practice of dental hygiene. In addition, all of these states have had provisions enabling dental hygienist to be reimbursed directly by their state Medicaid programs since the late 1990's and very early 2000's¹⁵. Logically, fewer restrictions for the dental hygiene workforce would create an optimal environment for delivering preventive dental services in underserved communities. However, the descriptive findings in this dissertation suggest grantees located in states with excellent policy environments operate fewer dental programs, deliver dental services to fewer patients, and provide proportionately fewer preventive and treat more dental disease than those located in states with favorable environments. Recent literature examining the independent practice of dental hygienists

¹⁵ ¹⁵ Source: America Dental Hygiene Association. *States which directly reimburse dental hygienists for services under state Medicaid program*. Available at: https://www.adha.org/resources-docs/7519_Direct_Reimbursement_Medicaid_by_State.pdf

in states with ‘excellent’ policy environments may provide insight into the factors influencing this finding.

The independent practice of dental hygienists working in alternative settings has been examined in recent literature (Braun et al., 2013; Mertz & Glassman, 2011). In the mid-1980’s California implemented the Registered Dental Hygienist in Alternative Practice (RDHAP) model to improve access to preventive dental care for underserved populations. RDHAPs complete an approved continuing education course and licensure examine which enable them to practice independently in ‘underserved setting,’ broadly defined to include Dental Health Professional Shortage Areas, residences of the homebound, nursing homes, hospitals, residential care facilities, and other public health settings (Mertz & Glassman, 2011).

While the RDHAP model does demonstrate promise for improving access to dental care for underserved populations, it has not had a large impact on oral health workforce capacity in medically underserved communities. The most recent data on the practice characteristics of the 287 RDHAPs actively licensed to practice in California suggest that the majority (87.6%) practice in residential setting or with homebound patients and only 4.2% report practicing in community/migrant health centers (Mertz & Glassman, 2011). Why RDHAPs favor practicing in residential and homebound settings as opposed to community health centers, such as those operated by the U.S. Health Center program, is not clear. Additional research is needed in this area to understand what is driving these practice choices and determine whether the RDHAP could be implemented in community health center settings.

In addition, the State of Colorado offers the highest level of professional autonomy for the dental hygiene profession. In Colorado, there are no supervision requirements, and dental hygienists may be reimbursed directly by the Colorado State Medicaid program. This environment enables dental hygienists to practice completely independently.

Recently, the co-location of dental hygienists and pediatric medical services was examined as a possible method of improving access to care for disadvantaged children in the State of Colorado (Braun et al., 2013). The Colorado study is the first of its kind to examine the possibility of co-locating dental hygienists and medical services. Five dental hygiene practices were established adjacent to five pediatric medical practices. These dental hygiene practices have separate administrative processes for patient scheduling and billing but are located in the same facility. After 2 years, 2,071 children, 56% from racial and ethnic minority groups and 79% with government sponsored health insurance programs, had received preventive dental services (Braun et al., 2013). While this model successfully reached children from the target population, the separation of administrative structures has been identified as a major barrier to the implementation of the model. Providers are frustrated with a bidirectional lack of communication regarding available appointment times and follow-up. Also, the “double” cost of having separate administrative systems is a noted barrier.

The Colorado study offers a glimpse of dental hygiene practice in a completely autonomous environment. As autonomous health professionals, dental hygienists successfully deliver preventive dental care for vulnerable populations. However, rather than working as part of the primary care team in the pediatric offices, dental hygienists

operating an autonomous practice in the Colorado study experience challenges interfacing with other health care providers. The separation of reimbursements may be the largest contributor to this lack of professional integration. In the Colorado study, dental hygienists have no incentive to work as a part of the primary care team. Rather they provided dental services to patients were referred to them from the pediatric office.

It may be that policy environments which promote complete professional autonomy, as in Colorado, silo dental hygienists in practice. In such environments, dental hygienists may lack an incentive to practice in underserved areas, choosing instead to practice in other health care settings where they have more control over their professional practice.

Drawing on findings from the Colorado and California studies, dental hygienists from states with excellent practice environments may lack incentive to practice at health centers, preferring instead to operate independent practices or practice in other settings, as is the case with RDHAPs California. On the other hand, dental hygienists in states with favorable environments with specific provisions for public health may have greater incentive to practice in community health centers, such as those operated by health center grantees.

Additional Considerations

A number of factors are recognized as influencing dental service delivery and utilization at health center grantees. Administrative characteristics of grantees, aggregate patient characteristics, and state level factors were analyzed and included in regression analyses as appropriate and to the text available in the datasets used in this study. The

inclusion of these factors controls, to some extent, their influence on the relationship between policy environment and dental service delivery status.

Also, this study took into consideration the potential for intra-class correlations among grantees located within the same state. Grantees from the same state are subject to the same policy context. In addition to health workforce policy, there are other factors are likely to be important dimensions of state policy contexts, such as state Medicaid programs and other state-based initiatives to improve access to dental care. These may influence the dental service delivery status of grantees. In order to control for potential correlations between grantees located in the same state, mixed effects models are used to adjust for within subject (repeated measures) correlations and between subject correlations (state level clustering). Future research should endeavor to identify and explore other dimensions of the state policy context that impact the dental health of their residents.

Policy Implications

The findings of this dissertation have important implications for health policy at a number of levels. At the federal level, the findings of this dissertation have obvious relevance for Health Resource Services Administration, Department of Health and Human Service which administers the U.S. Health Center program. Although, it is not likely that the U.S. Health Center program selectively granted funding to grantees located in states with more supportive policy environments for dental hygienists, findings suggest to some extent this did occur. While the specific factors for this are not known, it is possible grantees located in states with more supportive environments may be more motivated and/or better positioned to apply for, and obtain, competitive funding from the

U.S. Health Center program. Also, findings demonstrate grantees located in states with more supportive environments deliver dental services to a larger portion of their patients. This suggests a supportive state policy environment may, at some level, provide an administrative or operational advantage over restrictive environment for dental service delivery, the result of which is greater utilization and reach of dental services. Finally, the fact that dental patients from medically underserved communities located in states with more restrictive policy environments have greater emergent dental care needs than those located in more supportive states highlights a desperate need for preventive dental services. State health workforce policy environment plays a role in the complex series of factors contributing to this finding. However, this identification of unmet preventive dental care needs represents a strategic opportunity for the U.S. Health Center program to develop and implement innovative strategies to improve dental disease prevention and promote oral health.

New models for the delivery of preventive dental services that leverage the workforce, such as the integration of dental hygienists into the primary care delivery of health center grantees, should be explored as potential mechanisms to overcome restrictive policy environments and improve access and oral health outcomes. For example, grantees located in states requiring professional supervision of dental hygiene practice may consider opportunities to leverage physicians for the oversight of dental hygienists. While such a model would require additional research in order to be operationalized, it may present a viable method of increasing availability and access to preventive dental services and promoting oral health.

Nationally, these findings have important implications for organizations such as the National Association of Community Health Center (NACHC). As the primary advocacy organization for community health centers in the U.S., these findings offer insight into influence of state policy on the organizations that NACHC represents. As such, NACHC should consider widely disseminating the findings of this dissertation to constituent organizations and stakeholders. It should engage discussions at the national and state levels about the importance of state policy to dental care delivery in medically underserved communities. NACHC should specifically engage state components and stakeholders from restrictive policy environments in discussions regarding the need for expanded preventive dental services in community health centers. It should actively promote and support research into new models of preventive dental care delivery within health centers and lead advocacy efforts to develop informed state policy.

This dissertation has obvious relevance for the American Dental Hygiene Association (ADHA), its state components, and practicing dental hygienists. Organized dental hygiene should consider widely disseminating the findings of this dissertation and initiate discussions at the national, state, and local levels on the impact state policy environment has on the profession and oral health. Similar to the recommendations above for NACHC, ADHA should focus on engaging stakeholders within restrictive policy environments. State components of ADHA should partner with State Primary Care Associations and other health care and consumer health organizations to engage policy makers in discussions on the effect of state policy environment. Practicing dental hygienists should consider or seek out opportunities to advance preventive dental service delivery in medically underserved communities, especially those located in states with

restrictive policy environment. Policy changes frequently start with grassroots efforts. As such, practicing dental hygienists must play an important role in advocacy for the profession, but even more important, they must be advocates for the oral health of underserved communities.

Finally, state boards should consider these findings and their implication for population oral health. As described in Chapter 2, state boards were established to ‘ensure the welfare of the people.’ The findings of this dissertation suggest dental or dental hygiene licensing boards in states with restrictive policy environments may not be fulfilling this duty to their state and its people. In these state, reasons for restrictive policy should be revisited and reconsidered in light of current knowledge on the safety and quality of preventive dental care delivered by licensed dental hygienists. If no reasonable explanation exists, decision makers in these states should consider amending practice acts to better meet the needs and ensure oral health of underserved constituents.

These agencies, organizations, and professionals represent the group for whom this dissertation has the most relevance or policy implications. However, the findings of this dissertation are relevant to a wide group of stakeholders, many of whom are not mentioned here or have no collective voice in the public, such as the people residing in medically underserved communities for whom this dissertation has the largest implication.

Recommended Policy Actions

The following bullets summarize key policy recommendations generated based on the findings of this dissertation.

Federal Government

- Health Resources Services Administration, Department of Health and Human Services
 - Direct funding and focus programming to enhance the delivery of preventive dental services at community health centers located in states with restrictive policy environments.
 - Support and promote the development and implementation of innovative workforce and reimbursement models for preventive dental care delivery at community health centers.
 - Support the development and maintenance of state health workforce policy indices for licensed health professions, such as dental hygiene, physician assisting, and nursing, among others.
 - Provide support for research/evaluation projects which examine the influence of state level policies, such as professional regulation, on the effectiveness and efficiency of federal initiatives, such as the U.S. Health Center program.

National Organizations

- National Association of Community Health Centers
 - Disseminate the findings of this dissertation widely among its constituent organizations and stakeholders.
 - Engage conversations at the national and state level on the impact of state policy on dental service delivery and access at community health centers and the oral health of underserved communities.

- Advocate for and support the development and implementation of innovative workforce and reimbursement models for preventive dental care delivery at community health centers.
- Advocate for state policy environments which enhance health service delivery, encourage access, and promote health among underserved Americans.
- American Dental Hygiene Association
 - Disseminate the findings of this dissertation widely among the profession of dental hygiene and stakeholders.
 - Engage discussions at the national and state levels on the impact of state policy environment for dental hygiene on availability, access and oral health in America's underserved communities.
 - Advocate for state policy that enhances availability, access and oral health.
 - Promote capacity for professional advocacy among state components, especially within states with restrictive policy environments.

State

- State Boards of Dentistry and/or Dental Hygiene
 - Examine and consider information on the impact of "Practice Acts" on constituent's oral health to determine whether current policy aligns with promoting the health, safety and welfare of their citizens.

Study Limitations

A number of recognized limitations in this study are discussed in Chapter 3 and throughout the document. These represent important threats to internal and external

validity of this study that should be considered when examining the findings of this dissertation. Previously discussed limitations include those associated with the use of secondary data sources (information bias). In addition to limitations already discussed, a lack of information on dental services which grantee patients received from contracting private practice dentists threatens the internal validity of these findings. However, as discussed in previous chapters, grantees deliver health services in defined medically underserved communities with pervasive shortages of health care professional. For this reason, it is unlikely the inclusion of these services into analyses would drastically change the findings of this study. In addition, this research focuses exclusively on the availability and access to dental services and the oral health needs of populations who receive dental care at health centers which received community health center funding from the U.S. Health Center program between 2004 and 2012. These findings may not apply to other health care settings or other populations.

Future Directions

The findings of this dissertation highlight the need for future research to further understand the effect of state level health workforce policy environment on health service delivery, access, and health in medically underserved communities. As suggested earlier in this chapter, this should include research on the implementation and effect of specific changes in the policy environment over time. Also discussed earlier in this chapter, future studies should examine the impact of ARRA on distribution of financial resources for dental service delivery by grantees to determine whether, and to what extent, state policy environment is a determinant of ability to leverage federal funding. In addition, as discussed earlier, new models for the delivery of preventive dental services at grantees of

the U.S. Health Center program should be developed and tested, especially in medically underserved communities with unmet dental care needs are greatest.

Finally, the framework and methods of this dissertation may be used or adapted to study the effect other state policies on grantees of the U.S. Health Center program and the medically underserved communities to whom they provide health care services. The need for a mechanism to monitor the effect of state policy on dental service utilization and oral health status was recently highlighted in an article published in the *American Journal of Public Health Dentistry* (Mandal et al., 2014). This dissertation contributes timely information relevant in national discussions.

In addition to being used to examine oral health policy, the framework and methods could be adapted to study the impact of state regulation for other professions, such as the physician assistant and nurse practitioner workforces, on utilization of primary health care services at health center grantees and health outcomes within medically underserved communities. The UDS contains quality measure for primary care which could be incorporated into such studies.

Conclusions

There is great need for additional research in the area of health workforce policy and how it affects health care access and health outcomes. An enormous amount of American resources are committed to health care. The alignment of key policies, and their continual evaluation and adjustment, are critical to ensuring a functioning and efficient health care system that promotes and maintains American health. This dissertation demonstrates the policy environment of a state, either supportive or restrictive of an oral health workforce focused on prevention and health promotion, is a

predictor of the availability of dental services, the level of access to dental care, and oral health status of medically underserved communities that receive federal support from the U.S. Health Center program. State policy stands between federal money and underserved communities. The findings of this dissertation demonstrate the need for better alignment of state and federal policy to create more optimal environments for dental service delivery, improve access, and promote oral health for Americans from medically underserved communities.

APPENDICES

Appendix A. Model Fit Statistics

Table A.1

Model Fit Statistics for Full and Final Models

		Fit Statistic AIC or QIC*	
CHAPTER 4		FINAL MODEL	FULL MODEL
	2005*	756.296	760.8349
	2008*	896.9654	899.5157
	2011*	848.4825	857.4886
	Longitudinal	49084.77	50158.61
	Pre-recession	18229.64	18322.15
	Post-recession*	28431.77	28429.62
<hr/>			
CHAPTER 5			
	Longitudinal	-15565.9	-15543.7
	Pre-recession	-5957.7	-5935.8
	Post-recession*	-10153.8	-10137.7
<hr/>			
CHAPTER 6			
	Preventive	-10869.6	-10858.7
	Preventive Pre-recession	-3547.5	-3689.3
	Preventive Post-recession	-7535.6	-7531.6
	Restorative	-11234.5	-11228.5
	Restorative Pre-recession	-3699.6	-3542.8
	Restorative Post-recession	-8527.4	-8522.6
	Emergent	-16912.1	-16893.6
	Emergent Pre-recession	-5627.6	-5608.3
	Emergent Post-recession	-12369.4	-12353.8

Note: Final Models excluded variables that were not significant predictors in univariate analyses. All covariates were included in full regression models.

Appendix B: Supplemental Table Cross-Sectional Multivariable Regression Analyses in Chapter 4

Table A.2

Results of Cross Sectional Regression Analyses including All Study Variables

VARIABLES	2005 (n=824)				2008 (n=974)				2011 (n=1016)			
	OR	95% CI		P	OR	95% CI		P	OR	95% CI		P
DHPPI												
Range												
1 (1-30)	0.50	0.16	1.61	0.25	0.37	0.14	1.00	0.05	0.46	0.18	1.19	0.11
2 (31-40)	0.32	0.11	0.94	0.04	0.55	0.25	1.18	0.12	0.75	0.32	1.73	0.49
3 (41-49)	0.72	0.19	2.70	0.63	0.66	0.26	1.69	0.39	0.60	0.21	1.68	0.33
4 (50-80)	1.12	0.34	3.71	0.85	1.21	0.37	3.93	0.75	0.76	0.24	2.42	0.65
5 (81-100)	ref	ref	ref	ref								
Policy												
Changes	0.84	0.44	1.60	0.60	0.80	0.46	1.40	0.43	0.49	0.24	1.00	0.05
Urban setting	0.67	0.44	1.01	0.06	1.01	0.73	1.40	0.95	1.03	0.74	1.45	0.85
Clinical Sites	1.28	1.18	1.39	<.0001	1.26	1.18	1.35	<.0001	1.28	1.18	1.39	<.0001
Medicaid	14.50	0.73	288.04	0.08	17.91	5.12	62.71	<.0001	7.23	2.04	25.60	0.00
Poverty	2.32	1.17	4.59	0.02	3.70	1.74	7.87	0.00	1.79	0.76	4.20	0.18
Minority	0.77	0.38	1.56	0.47	0.73	0.35	1.53	0.41	1.00	0.45	2.22	1.00
Dentists per 10,000	1.16	0.93	1.45	0.20	0.98	0.81	1.20	0.88	1.04	0.82	1.32	0.73

Note: These results reflect multivariable regression models including all variables regardless of theoretical significance, hypothetical effect, or significance in univariate regression analyses. These were generated as a part of the model fitting process. Details for the processes used for model fitting in this study can be found in Chapters 3 and 4.

Appendix C: Supplemental Table Longitudinal Multivariable Regression Analyses in Chapter 4

Table A.3

Results from Longitudinal Regression Model including All Variables

VARIABLES	All Years				2004-2007				2008-2012			
	95% CI				95% CI				95% CI			
	OR	Lower	Upper	P	OR	Lower	Upper	P	OR	Lower	Upper	P
DHPPI												
Range												
1 (1-30)	0.26	0.06	1.04	0.06	0.36	0.10	1.26	0.11	0.26	0.08	0.92	0.04
2 (31-40)	0.43	0.14	1.33	0.14	0.33	0.12	0.93	0.04	0.50	0.16	1.52	0.22
3 (41-49)	0.57	0.16	2.09	0.40	0.66	0.20	2.14	0.49	0.54	0.16	1.83	0.33
4 (50-80)	1.01	0.24	4.31	0.99	1.22	0.32	4.73	0.77	0.80	0.19	3.38	0.76
5 (81-100)					ref	ref	ref	ref	ref	ref	ref	ref
Policy												
Change	0.56	0.24	1.34	0.19	0.75	0.34	1.67	0.48	0.47	0.20	1.12	0.09
Urban Setting	1.54	0.94	2.51	0.09	0.73	0.43	1.24	0.24	1.59	0.98	2.58	0.06
Clinical Sites	1.50	1.41	1.61	<.0001	1.38	1.27	1.50	<.0001	1.45	1.35	1.57	<.0001
Medicaid	25.48	7.94	81.77	<.0001	160.74	18.77	1376.36	<.0001	30.05	7.76	116.43	<.0001
Poverty	4.47	2.56	7.81	<.0001	2.82	1.38	5.80	0.00	4.11	2.02	8.33	<.0001
Minority	1.08	0.47	2.48	0.86	0.60	0.25	1.47	0.27	0.89	0.39	2.04	0.79
Dentists per												
10,000	1.03	0.76	1.38	0.87	1.07	0.81	1.40	0.64	-	-	-	-
Time	1.10	1.05	1.15	0.00	1.22	1.09	1.37	0.00	1.10	1.02	1.20	0.02

Note: These result represent regression analyses including all study variables. These models were generated as a part of the model fitting process.

Appendix D: Supplemental Table Longitudinal Multivariable Regression Analyses in Chapter 5

Table 5.2

Longitudinal Predictors of the Proportion of Grantee Patients Accessing Dental 2004-2012 (n=6830)

VARIABLE	All Years			2004-2007			2008-2012		
	β	SE	P	β	SE	P	β	SE	P
DHPPI Range									
1 (1-30)	-0.06	0.03	0.05	-0.03	0.02	0.23	-0.07	0.03	0.04
2 (31-40)	-0.03	0.03	0.24	-0.01	0.02	0.50	-0.04	0.03	0.18
3 (41-49)	-0.01	0.03	0.71	-0.01	0.02	0.63	-0.01	0.03	0.69
4 (50-80)	0.01	0.03	0.72	0.01	0.03	0.79	0.00	0.04	0.97
5 (81-100)	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>	<i>ref</i>
Number of Clinical Sites	0.00	0.00	0.07	0.00	0.00	<.0001	0.00	0.00	0.18
Policy Changes Occur in State	-0.01	0.02	0.71	0.00	0.02	0.85	-0.02	0.02	0.46
Proportion of Patients with Medicaid	0.09	0.01	<.0001	0.18	0.03	<.0001	0.16	0.02	<.0001
Proportion Minority Patients	-0.05	0.01	<.0001	-0.04	0.01	0.0002	-0.06	0.01	<.0001
Time	0.01	0.00	<.0001	0.03	0.00	<.0001	0.01	0.00	<.0001

Note: Longitudinal regression analyses included adjustments for repeated measures and state clustering. Results from longitudinal bivariate and cross-sectional analyses were used for variable selection. Variables significantly associated or predictive of the proportion of patients accessing dental services were included.

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CURRICULUM VITAE

Hannah L. Maxey

EDUCATION:

Doctor of Philosophy, Indiana University Richard M. Fairbanks School of Public Health IUPUI, 2014

Concentration: Health Policy and Management

Minor: Epidemiology

Master of Public Health, Indiana University School of Medicine, 2011

Concentration: Health Policy and Management

B.G.S., Bachelor of General Studies, Indiana University Purdue University Indianapolis, 2007

Concentration: Chemistry, Biology, and Psychology

A.S., Associate of Science, Indiana University South Bend, 2000

Concentration: Dental Hygiene

LICENSURE:

Indiana State Dental Hygienist License

Issued: July 2000

PROFESSIONAL ORGANIZATION MEMBERSHIPS:

Academy Health, 2013- Present

American Public Health Association, 2010- Present

American Dental Hygiene Association, 2001 – Present

Indiana Public Health Association, 2011- Present

Indiana Rural Health Association, 2011 – Present

Indiana Dental Hygiene Association, 2001- Present

Special Care Dentistry Association, 2009-2011

PROFESSIONAL HONORS AND AWARDS:

Delta Omega, National Honorary Society in Public Health, received May 2012.

1st Place Award, Graduate/Resident Poster Presentation, Indiana Rural Health Association annual conference (2011).

1st Place Award, Graduate/Resident Poster Presentation, Indiana Rural Health Association annual conference (2010).

Most valuable employee award, Marion County Health Department (2007).

TEACHING:

Associate Instructor, August 2012- December 2014
Richard M. Fairbanks School of Public Health at IUPUI
Course: H120 Contemporary Healthcare Issues

Guest Lecturer, September 2012
Department of Public Health, Indiana University School of Medicine
Course: Introduction to U.S. Health Systems, P504/H501

Guest Lecturer, September 2011
Dental Hygiene Program, Indiana University School of Dentistry, Indianapolis, IN
Course: Community Practice of Dental Hygiene

Associate/Assistant Instructor, August – December 2011
Department of Public Health, Indiana University School of Medicine
Course: Introduction to U.S. Health Systems, P504/H501

Clinical Instructor, August 2010 – August 2012
Dental Hygiene Program, Indiana University School of Dentistry, Indianapolis, IN
Course: Advanced Clinical Dental Hygiene

GRANTS/CONTRACTS/FELLOWSHIPS:

ACTIVE GRANTS/FELLOWSHIPS

Indiana University, Research Grant-in-Aid, Dissertation Fellowship (2013) Principal Investigator Maxey, H., \$32,000.

COMPLETED GRANTS/CONTRACTS

Indiana State Department of Health, Office of Primary Care, Research Grant-in-Aid, Evaluation of National Health Service Corps (NHSC) Clinician Impact in Indiana and Existing Retention Strategies (2013), Principal Investigator Zollinger, T., (Maxey, H. served as primary author and investigator) (2013), \$32,500.

Center for Excellence in Cardiovascular Research (CECARE), Principal Investigator Arrieta, A., (Maxey, H. served as second author on grant proposal) (2012). Indiana Clinical and Translational Sciences Institute, \$76,259.

Indiana State Department of Health, Office of Primary Care, Research Grant-in-Aid, Statewide Health Workforce Database Project (2012), Principal Investigator Lewis, C., (Maxey, H. served as grant author and project consultant), \$23,000.

Indiana State Department of Health, Office of Primary Care, Research Grant-in-Aid, Medically Underserved Area and Health Professional Shortage Area Applications for Federal Designation to Impact Indiana Health (2010), Maxey, H., \$62,322.

SUBMITTED BUT NOT FUNDED GRANTS/CONTRACTS

Anthony Wayne Service Foundation, Principal Investigator Maxey, H., (2010).
Anthony Wayne Services, \$25,000.

SERVICE:

UNIVERSITY SERVICE:

Chair, Indiana Dental Hygiene Workforce Task Force, Indiana University School of Dentistry (2013).

Founding Dean Search and Screen Committee Member, Indiana University Richard M. Fairbanks School of Public Health at IUPUI (2012). Chair: Champion, V.

PROFESSIONAL SERVICE:

Annual Conference Planning Committee Member, Oral Health Section, American Public Health Association (Present).

Community Advisory Council (CAC) member, Community Health Engagement Program (CHEP), Indiana Clinical and Translational Sciences Institute (Present).

Oral Health Track Planning Committee Member, Annual Conference, Indiana Rural Health Association (2012).

PATIENT CARE/CLINICAL SERVICE:

Program Manager, 2009-2010
Indiana University School of Dentistry, Indianapolis, IN
Program: Oral Health Solutions
Level of Impact: State of Indiana

Dental Hygienist and Outreach Program Coordinator, 2002-2009
Marion County Health Department, Indianapolis, IN
Level of Impact: Marion County

Clinical Dental Hygienist, 2000-2002
Brandywine Dental Group, Greenfield, IN

PUBLICATIONS:

PUBLICATIONS/TECHNICAL REPORTS

Maxey, H., Norwood, C., Walters, S. & Sheff, Z. (2013). *2013 Indiana National Health Service Corps Project: Recruitment, Retention and Evaluation Associated with American Recovery and Reinvestment Act of 2009*. Indianapolis, IN: Indiana

University Center for Health Policy, Department of Health Policy and Management, Indiana University Richard M. Fairbanks School of Public Health IUPUI.

Maxey, H., (2013). *Indiana Dental Hygiene Task Force Report*. Indianapolis, IN: Indiana University School of Dentistry.

Maxey, H., Malcolm, A., Norwood, C., Sheff, Z., & Walters, S. (2012). *Indiana Primary Health Care: Description, Distribution, Challenges, & Strategic Recommendation to Empowered Decision Making*. Indianapolis, IN: Indiana University Center for Health Policy, Department of Public Health, Indiana University School of Medicine.

Williams, M. J., Barrett, K., Bradley, L., Conway, A., Henderson, F., Maxey, H., & Mills, C. (2011). *Indiana Health Insurance Exchange Symposium overview*. Indianapolis, IN: Indiana University Center for Health Policy, Department of Public Health, Indiana University School of Medicine.

Maxey, H. & Stewart, T. (2008). You may be surprised; Try these food and drink options for healthier smiles and bodies. Essay printed in the *Healthy Mouth, Healthy Life* pamphlet distributed in the November 2008 addition of the *Indianapolis Woman*.

ABSTRACTS/PRESENTATIONS:

Norwood, C., Sheff, Z., Zollinger, T., Maxey H., Walters SJ. (2014). The Impact of ARRA Funding on Health Professional Recruitment, Retention, and Program Capacity in Indiana. Poster presentation at 2014 Academy Health Annual Research Meeting, San Diego, CA.

Maxey, H. (2014). Understanding the Effect of Health Workforce Policy on Dental Service Delivery by U.S. Health Center Program Grantees. Oral presentation to be given at the 2014 American Academy of Medical Colleges Health Workforce Conference, Washington, D.C.

Maxey, H. & Sheff, Z. (2013). Physician Workforce Data as a Strategic Issue: Characteristics predictive of response to a state level survey. Oral presentation for Medical Care Section at the 2013 American Public Health Association Annual Conference, Boston, MA.

Maxey, H. & Sheff, Z. (2013). Physician Workforce Data as a Strategic Issue: Characteristics predictive of response to a state level survey. Poster presented at the 2013 American Academy of Medical Colleges Physician Workforce Conference, Alexandria, VA.

Maxey, H., Norwood, C., Walters, S. & Sheff, Z., (2013). *Indiana's Health Workforce: Description, Distribution, and Strategic Recommendation to Empowered*

Decision Making. Oral presentation at the Indiana Rural Health Association Annual Meeting held in Indianapolis, IN.

Maxey, Hannah (2012). Data management and access to oral healthcare in rural Indiana. Poster presented at 2012 American Public Health Association Annual Session held in San Francisco, CA.

Maxey, Hannah (2012). Indiana health professions shortage update. Oral presentation given at the 2012 Indiana Area Health Education Centers Network Annual Meeting held in Indianapolis, IN.

Maxey, Hannah (2011). Innovative examination of existing data: Impacting access to oral health care in Indiana. Poster presented at 2011 Indiana Rural Health Association Annual Conference held in Indianapolis, IN.

Maxey, Hannah (2010). Enhancing dental care access within the Amish community of LaGrange County. Poster presented at the 2010 Indiana Rural Health Association Annual Conference held in Indianapolis, IN.

Hine, W., Maxey, H., Swiezy, N., West, D. & Yoder, K. (2010). Communication and desensitization aides for patients with autism and other intellectual/developmental disabilities in the general dental practice. Poster presented at the 2010 Special Care Dentistry Association Annual Session held in Chicago, IL.

Maxey, H. (2007). Bridging the language barrier to positively impact oral health. Presentation at the 2007 Indiana Public Health Association Annual Session held in Bloomington, IN.