MEDICAID EXPANSION AND THE DENTAL WORKFORCE: POLICY ISSUES AFFECTING EMERGENCY DEPARTMENT USE FOR NONTRAUMATIC DENTAL CONDITIONS

A Dissertation

by

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Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

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December 2019

Major Subject: Health Services Research

ABSTRACT

In the United States, emergency department use for non-traumatic dental complaints has been on the rise. This rising trend has been associated with substantial consequences: increased demand on emergency departments, inefficient use of healthcare dollars and resources, non-definitive treatment of patients' dental complaints and continual unmet dental care need. As this problematic trend gains the attention of stakeholders and policy makers, there is a need to shed light on the individual, contextual, and policy-related factors that influence visits to the emergency department for non-traumatic dental conditions. This dissertation focuses on three areas: (1) factors that have been associated with emergency department visits for dental conditions in the literature, the settings in which such studies have been conducted, and the potential predictors that have not been investigated, (2) the impact of the 2014 Affordable Care Act Medicaid expansion on emergency department dental visits, with further focus on the differential impact in rural and urban areas, (3) the associations between scope of practice regulations for dental hygienists and emergency department dental visits.

Findings from the systematic review of literature indicate that insurance plays a major role in emergency department visits for non-traumatic dental complaints. Specifically, individuals with publicly funded health insurance such as Medicaid and Medicare, as well as those who are uninsured are more likely to use the emergency department for dental visits. Other important factors associated with emergency department dental visits include age, dental provider density, rurality, dental health professional shortage area designation, and expansion or restriction of Medicaid adult

dental benefits. The second study found that among expansion states that provided Medicaid adult dental benefits, dental emergency department visits declined relative to non-expansion states, and relative to expansion states that did not provide dental benefits. However, dental emergency department visits among Medicaid enrollees increased significantly. Finally, findings from the third study indicate that less restrictive scope of practice regulations are associated with fewer dental emergency department visits, particularly among those aged 20 to 34.

DEDICATION

I dedicate this dissertation to the children and adults who live with the burden of oral diseases, yet have no consistent access to definitive dental care. I hope that the findings of this research will shed some light on what drives your decisions to the use the emergency department for your dental complaints, and the policy solutions that may be effective in increasing access to care. I also dedicate this dissertation to my daughter, Gloria Toluwanimi Ogunyemi, I hope that you grow up in a better world where access to oral healthcare is more equitable.

ACKNOWLEDGEMENTS

I would like to thank my committee members for their support and accessibility throughout the course of this dissertation research. Specifically, I would like to thank Dr. Michael Morrisey, whose insights were invaluable in formulating the research topics and adding context to my research findings. Thank you for the precious hours you spent brainstorming with me until my research ideas were crystalized, and for consistently reassuring me that this work was meaningful. I am indebted to Dr. Jane Bolin, who, early on in the doctoral program, provided me with the right milieu to learn data analysis, make my own mistakes, practice scholarly writing, and showcase my work to wider audiences. Thank you for the many research projects you entrusted me with, and for the numerous accommodations you made for me, enabling me to attain some work-family balance.

I would like to express my sincere gratitude to Dr. Alva Ferdinand for her personal and professional guidance throughout the doctoral program. Before the program even began, you shared with me the story of your career trajectory, enlightening me that regardless of my background, it was possible to grasp the concepts of research if I put my mind to it. Thank you for the invaluable help you rendered so that I could secure the scholarship I needed to continue the doctoral program. Thank you also for working tirelessly to make the dissertation data accessible, and for challenging me to apply methodological rigor to my work. Further, I would like to thank Dr. Daniel Jones, who, despite his intense schedule was willing to be on my committee because he felt that the subject area of this dissertation was truly worth studying.

I owe many thanks to: Maggie Acosta, for responding to my numerous inquiries, and for helping me keep up with the deadlines; Janet Helduser, for her motherly care and guidance with scholarly writing; and Marivel Sanchez, for her friendship. I would also like thank the Center for Health Workforce Studies at the University of Albany, State University of New York for the assistance they provided in examining dental hygienists' scope of practice regulations.

I am deeply grateful to my spouse, Olugbenga Ogunyemi, for the countless sacrifices he made on our behalf so that I could get this dissertation completed. Thank you for your enduring support, words of encouragement, and for challenging me not to relent until this work is finished. I am grateful to my daughter, Gloria, whose laughter and hugs refreshed me during the drudgery of this research. I am indebted to my parents, Emmanuel and Eniola, who sacrificed tremendously so that I could engage in this pursuit. Dad, thank you for encouraging me to step out of my comfort zone, and mum, thank you raising the altars of prayer at every step of my life's journey. Thanks to my mother-in-law, Rosaline Ogunyemi, who cared for Gloria so that I could get this work completed.

I am very grateful to my precious friends: Godshelp and Peace Egharevba, Dr. Michael Adedigba, Ronke and Layi Olutola, Sara Imapour, Lola Adepoju, Inyang Uwak, Elfreda Samman, and Tolu and Folake Oke, for their prayers and tremendous support. Finally, I would like to acknowledge God Almighty, the Guide of my youth, my help in times past, my hope for years to come, and the One who has given me richly all things to enjoy in Christ.

CONTRIBUTORS AND FUNDING SOURCES

Contributors

This work was supervised by a dissertation committee consisting of Professor(s) Michael Morrisey, Alva Ferdinand, and Jane Bolin of the Department of Health Policy and Management at Texas A&M School of Public Health and Professor Daniel Jones of the Department of Public Health Sciences at Texas A&M College of Dentistry.

The State Emergency Department Databases analyzed for Chapters 3 and 4 were provided by Professor Alva Ferdinand.

All other work conducted for the dissertation was completed by the student independently.

Funding Sources

There are no outside funding contributions to acknowledge related to the research and compilation of this document.

NOMENCLATURE

ACA	Affordable Care Act
ED	Emergency Department
NTDC	Non-traumatic Dental Conditions
DHPSA	Dental Health Professional Shortage Area

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1. INTRODUCTION

Oral health has been characterized as the state of being free from chronic mouth diseases and inadequate dentition that limit one's ability to masticate, speak, or function socially without pain or discomfort (1). Dental diseases such as tooth decay and gum disease are preventable through adequate personal oral hygiene practices and periodic professional care. However, these diseases, if left untreated do not resolve spontaneously. They progress over time, eventually resulting dental pain, infection, tooth loss, and rarely, death (2).

Oral health is an integral part of systemic health and overall wellbeing. Tooth loss has been associated with compromised diet quality and nutrient deficiency which increases the risk of chronic diseases (3). Chronic oral infections have been linked to preterm births, low birth weight (4), respiratory and heart diseases (5,6), and diabetes (7). Individuals with poor oral health and inadequate dentition may experience difficulty finding employment, developing social relationships, building healthy self-image, and are more likely to isolate themselves socially (8–10).

Acute dental conditions, often accompanied by symptoms such as intense pain, facial swelling, loss of sleep and disruption of daily activities (11,12), drive affected individuals to seek care. However, when faced with barriers such the high cost of professional care in dental offices, lack of dental insurance, and inadequate dental safety nets, patients may seek care in emergency departments, where these financial barriers are diminished. The Emergency Medical Treatment and Labor Act is a federal law passed in 1986 that mandates Medicare-participating hospitals that provide emergency services to

examine, treat, and stabilize patients regardless of their ability to pay (13). Hence, patients experiencing dental pain are guaranteed access to emergency medical care.

Emergency Department (ED) use for non-traumatic dental conditions has been on the rise both nationally and in individual states. An analysis of the National Ambulatory Medical Care Survey (NHAMCS) showed that the proportion of dental ED visits increased from 1.15 percent to 1.87 percent between 1997/1998 and 2007/2008 (14), and the rates of dental ED visits rose from 3.7 to 5.9 visits per 1000 population between 2001 and 2008 (15). A subgroup analysis of the NHAMCS examining 20 to 29-year olds showed that on average, visits for toothache increased by 6.1 percent between 2000 and 2010, faster than backache complaints and all-cause ED visits (16). Studies examining individual states have also reported similar findings (17–20).

Previous studies have examined individual and contextual factors associated with ED use for dental conditions. At the individual level, dental-related ED use has been shown to vary by socio-demographic factors such as age, race/ethnicity, gender, educational level, type of insurance coverage, and income. With regards to age, a number of studies have reported that young and middle-aged adults are significantly more likely to use to the ED compared to older adults (14,16,18). In addition, there is some consensus in the literature that uninsured and publicly insured patients are more likely to visit the ED for dental conditions compared to privately insured patients (19,21,22). However, previous research investigating the associations between race/ethnicity, gender, rurality and dental ED use have reported contradictory findings (16,23–27).

The financial costs associated with non-traumatic dental ED use cannot be overlooked. A study using the 2006 Nationwide Emergency Department Sample

examining the costs of ED visits for gum disease reported that the mean charge per visit was about $456, while the total charges were about $33.3 million dollars for 85,039 visits (28). Another study using hospital administrative data for dental-related ED visits from five major hospital systems in Minnesota found that hospitals charged 5 million dollars for about 10,000 visits within one year (29). On a broader scale, the use of the ED for dental conditions reflects a wider problem of inefficient use health resources and fragmented dental care, resulting in a continual unmet dental care need (30).

Over time, several attempts have been made at the federal, state and local levels to increase access to dental services and to curb dental ED use. These initiatives include providing dental benefits to eligible adults via Medicaid, lowering the income eligibility criteria for Medicaid, increasing the numbers of dentists who work in underserved areas, and expanding the roles of midlevel dental providers. Regarding adult Medicaid dental benefits, states vary in the scope of dental services offered. As of 2015, four states (Alabama, Arizona, Delaware, and Tennessee) did not offer any form of dental benefits, while forty-six states in total and the District of Colombia offered some form of dental coverage (31,32). However, in times of budget constraints, some state legislatures have withdrawn dental benefits or scaled back the scope of dental coverage offered to adults (33). With respect to dental providers, some states have eased supervision levels required for dental hygienists to perform certain procedures in public health settings, while others have created new categories of midlevel dental providers such as dental therapists or advanced dental therapists (34).

1.1. OVERVIEW OF THE DISSERTATION

This dissertation is organized into three papers that address different aspects of non-traumatic dental ED use. These three papers are presented in Chapters II, III and IV in a journal-style format comprising background, methods, results, discussions, limitations and conclusions. The first paper (Chapter II) is a systematic review of the literature examining factors associated with ED use for dental conditions. The second paper (Chapter III) uses a quasi-experimental approach to investigate the impact of the 2014 Affordable Care Act Medicaid expansion on ED dental visits, with further focus on the differential impact in rural and urban areas. The third paper (Chapter IV) examines the relationship between scope of practice regulations for dental hygienists and dental ED use. Finally, a summary of findings obtained from the papers and their implications for policy and practice are presented in Chapter V. The sections that follow present an overview of the three papers.

The first paper uses a systematic review approach to examine the literature on predictors of emergency department use for dental conditions of non-traumatic origin. With the help of a librarian, the MEDLINE, EMBASE, and CINAHL databases will be searched to identify relevant articles using search terms. Studies that examine dental-related ED use will be selected for abstract review. Non-empirical articles and publications such as letters to editors, commentaries, case reports, and animal studies will be excluded. Full texts of empirical studies that meet the inclusion criteria will be examined. Data will be gathered from selected studies using a prepared abstraction form. Factors associated with non-traumatic dental ED use will be examined using the framework of the Anderson behavioral model (35). Based on this model, these factors will be divided into

predisposing, enabling and need factors. Where appropriate, odds ratios predicting the likelihood of dental ED visits will be extracted to obtain summary estimates using random effects models. Otherwise, a narrative synthesis will be presented.

The second paper will employ a difference-in-differences study design to examine the effects of Medicaid expansion on emergency department use for non-traumatic dental conditions. After the Affordable Care Act (ACA) was passed in 2010, states had the option of expanding their Medicaid insurance programs. In addition, over time, states have varied in the types of Medicaid dental benefits that are offered to their adult enrollees. Using the State Emergency Department Databases from ten states, as well as other state characteristics data, this paper will examine whether, and to what extent some states' decision to expand Medicaid resulted in a change in dental ED use overall, and within rural and urban areas. Further, the study will determine whether there was a change in the payer mix for dental ED visits following the expansion. Overall, this study will add new knowledge in understanding the geographical variation in the impact of the ACA Medicaid expansion in providing dental coverage to low income adults. The results of this study will help inform policy makers in their efforts to reduce rural-urban disparities in access to oral health care.

The third paper will examine the associations between scope of practice laws for dental hygienists and ED use for non-traumatic dental conditions. As in paper 2, the study will use the State Emergency Department Databases which contains discharge records of all visits the ED in a given state that do not result in an admission. Specifically, the study will examine whether dental hygienists' scope of practice regulations have any bearing on ED use, particularly for non-traumatic dental conditions.

Two measures of scope of practice regulations will be examined – Direct Access and the Dental Hygiene Professional Practice Index. To estimate the impact of Direct Access regulations, the difference-in-difference method will be employed, using states whose scope of practice laws have not changed as controls. Other control variables will include county dental health professional shortage area designation, states' Medicaid adult dental benefits, county characteristics, and state and year fixed effects. Findings from this study will provide useful information to policy makers and stakeholders on the influence of legal scope of practice regulations on dental ED use, which is an important indicator of access to oral health services.

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2. EMERGENCY DEPARTMENT VISITS FOR NON-TRAUMATIC DENTAL CONDITIONS: A SYSTEMATIC LITERATURE REVIEW

2.1. BACKGROUND

Emergency department (ED) use for dental complaints has long been recognized as a public health problem (1,2). According to the American Dental Association, there were 2.2 million visits to hospital emergency departments for dental conditions in 2015, with a total cost of about two billion dollars (3). ED visits for dental conditions have been rising annually (2,4,5), and constitute about 1.15 to 2.5 percent of all ED visits (2,6). The use of the ED for dental conditions reflects a wider problem of inefficient use of health resources and fragmented dental care, resulting in a continual unmet dental care need (1). It also reflects barriers in accessing professional dental care (7), poor integration between dental and medical care (6,8), lack of knowledge about services covered under Medicaid (6), and lack of knowledge about community-based dental services (6). Non-traumatic dental conditions refer to diseases affecting the teeth and supporting structures that do not have a traumatic origin (9,10). Most patients with dental conditions presenting at the ED can be managed by a general dental practitioner (11,12). Moreover, treatment provided in the emergency room is often not definitive, and is limited to antibiotics and pain medication (13).

Several studies have examined how individual, contextual, organizational and regulatory factors influence visits to the ED for dental conditions. Dental-related ED use has been shown to vary by socio-demographic factors such as age, race/ethnicity, gender, educational level, type of insurance coverage, and income. However, studies that have

attempted to measure the importance of these factors have reported conflicting findings on the significance of each item. Others have been limited to ED visits among certain demographic groups such as children (14–16), adults (17–19), Medicaid enrollees (10,20), or the privately insured (21).

There is considerable heterogeneity within the literature in the methods used for analyzing dental-related ED use. Some studies have examined primary data (16,18,22), while others have used discharge records, claims data (23–25), or self-reported surveys (17,26) to explore factors associated with dental ED use. Some studies have reported results from analyses of local hospital emergency departments (27), while others have conducted statewide (8,28) or national analyses of electronic claims databases (17,29), raising questions about the generalizability of the findings. In addition, some studies have used narrow definitions in identifying dental-related ED visits (30,31), while others have used a broader range of diagnosis codes. (10,25,32,33). Given the heterogeneity in the type and scope of data analyzed, the settings in which the data has been collected, the various journals in which findings have been reported, and the range of diagnosis codes used, there is a need to synthesize the literature on factors that predict visits to the ED for dental complaints.

Previous systematic reviews have examined some aspects of ED use such as factors that influence the decision to visit the ED (34), factors associated with inappropriate use of the ED (35), and ED use by older adults (36). However, even though a few systematic reviews have been published on some aspects of emergency room use generally, little is known about the predictors associated with the utilization of the emergency department for non-traumatic dental issues across the dental literature. The purpose of the study is to

conduct a systematic review to identify factors that are associated with non-traumatic dental ED visits in the published literature, and to conduct a meta-analysis of these factors, where possible.

2.2. METHODS

2.2.1. Data Sources and Searches

This review was conducted using the Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines (37). The details of the protocol for this systematic review were registered with the PROSPERO International Prospective Register of Systematic Reviews. With the help of a health sciences librarian, we conducted a literature search of the MEDLINE, EMBASE, and CINAHL databases using keywords such as: “emergency department” or “emergency room” or “service”, and “dental”, “toothache”, and “pain.” We identified additional studies by reviewing the reference list of identified records. There were no time restrictions placed on the searches, and publications in languages other than English were not considered. The final database search was conducted in March 2019.

2.2.2. Study Selection

The abstracts of all identified studies were exported to a web-based application, Rayaan (38), to detect duplicate studies and to screen titles and abstracts. One reviewer (A.M.A) reviewed all the titles, abstracts, full texts, while the second reviewer (A.O.F) reviewed a subset of the abstracts and full texts. Discrepancies in determining eligibility of a study were resolved by discussion among the reviewers. During title screening, studies were excluded if they were letters to editors, commentaries, or case reports. We conducted

an abstract review of the remaining studies and excluded studies that had no dental or emergency room component, studies that focused on clinical management of dental conditions in the ED, and studies primarily addressing drug seeking behavior in the ED. We thereafter conducted full text reviews of the remaining studies. We included studies if they analyzed original data and examined factors associated with dental ED use, and if they had attempted to quantify the association between the predictors and the outcome.

At this phase, we excluded qualitative studies, reviews, and descriptive studies that did not include a test for statistical significance, as well as studies that examined predictors of ED use for traumatic dental conditions. Because our primary outcome of interest was dental ED use, we excluded studies that did not specifically examine this outcome. For example, we excluded studies that examined dental ED costs, hospital admissions for dental conditions, follow-up treatment after a dental ED visit, and type of treatment received during a dental ED visit, amongst others. Studies that provided odds ratios measuring the likelihood of dental ED use given the presence of specific predictors were included in the meta-analyses. The flowchart showing the study selection process is displayed in Figure 2.1.

2.2.3. Data Abstraction and Conceptual Framework for Examining Predictors of Dental ED Use

Data were abstracted using a prepared abstraction form. We abstracted the study location (United States, other country), journal type (clinical/medical, dental specialty, dental public health, public health) study design (observational, quasi-experimental), sample size, age group studied (children, adults, all age groups), and data sources (surveys, discharge data, medical records). We gathered information on the criteria used in

identifying dental-related ED visits (ICD-9 diagnosis codes, reason for visit codes, self-reported visits), and the outcome comparators (non-dental ED visits, traumatic dental ED visits).

We abstracted and categorized the predictors of dental ED visits using the Andersen behavioral model for health services use (39). The Andersen model shows how population characteristics influence health behaviors, and how such health behaviors affect health outcomes. Population characteristics are divided into predisposing, enabling and need factors. Hence, we sought information on how these factors influence dental-related ED use.

Based on the Andersen model, we construe predisposing factors as including age, gender, marital status, special healthcare need status, and measures of socioeconomic status such as income, employment and education. Enabling factors are further categorized into personal and contextual enablers. Personal enablers refer to health and dental insurance coverage, access to a regular healthcare provider, access to dental care, oral health literacy, and previous visits to the ED for dental and non-dental conditions.

Contextual enablers refer to the availability of community resources – which may be measured by rurality, dental provider density, and dental health professional shortage area (DHPSA) designation. Need factors refer to perceived and evaluated need for dental care, chronic health conditions, and the severity and duration of dental pain. Health behaviors refer to: (i) routine dental and medical care, use of medical services for dental complaints including physician offices and the ER and (ii) personal health behaviors such as oral hygiene practices.

Last, we abstracted information on studies that examined how organizational and policy interventions impact dental-related ED use. For these studies, we were primarily interested in whether the interventions increased, decreased or had no effect on dental-related ED use.

2.2.4. Methodological Quality and Risk of Bias Assessment

Because most of our included studies utilized observational designs, we used the Joanna Briggs Critical Appraisal Tool for Analytical Cross Sectional Studies (40) to assess quality at the study level. This tool contains eight criteria that address aspects of the study such as sample selection, study subjects and setting, identification and measurement of exposure and outcomes, and identification and management of confounding factors. An output of the critical appraisal is provided in Appendix 1.

2.2.5. Data Analysis

Descriptive frequencies were used to show frequency counts of the number of studies that examined each variable that was abstracted. We identified gaps by in the literature primarily by focusing on aspects of the Andersen Behavioral model that have not been explored in any studies. In studies that reported regression findings, the adjusted odds ratios and confidence intervals measuring the associations between the predictor and dental ED use were extracted. For each factor, heterogeneity testing was conducted where at least three studies contributed odds ratios and confidence intervals (41). The I2 statistic was used to estimate the between-study variation in study outcomes that may not be attributed to chance. I2 values over 50% suggest high heterogeneity. Given the high heterogeneity of the studies, DerSimonian and Laird random effects models were used to combine and obtain average point estimates from odds ratios and confidence intervals of included

studies (41). Sub-analyses were conducted and stratified by age where the number of studies were sufficient. The meta-analyses are presented graphically in form of forest plots. Statistical analysis was conducted with Stata 14 (42).

2.3. RESULTS

2.3.1. Descriptive Overview of Studies

A total of 985 articles were identified, of which 723 remained after duplicates were removed. Of these, 366 studies were selected for abstract reviews and 202 studies were retained for full text reviews, out of which a final sample of 57 studies met the inclusion criteria. A descriptive overview of the included studies is presented in Table 2.1. More than two-thirds of the studies examining predictors of dental ED use were published between 2010 and 2018 (68.4%). Most of the studies were published in the United States (89.5%), used observational study designs (91.2%), and had authors in academic institutions (87.7%). A third of the studies were published in public health journals (35.1%). Table 2.2 describes the characteristics of the studies in greater detail. Of the 51 U.S. studies, 15 used nationwide samples, while others used state-specific hospital discharge databases, medical records, and Medicaid or private insurance claims data. A quarter of the studies limited their study population to children (26.3%) or adults (28.1%), while 45.6% of studies examined dental ED use across all ages. Sample size ranged from 200 to 26,791,871 (median = 5930, SD = 3,654,976).

2.3.2. Risk of Bias within Studies

The quality of the studies is described in Appendix 1. Overall, the quality of the studies was high, with an average score of 7.05 out of 8 (Standard Deviation, SD = 1.1).

Majority (n=33) of the studies used specific ICD 9 diagnosis codes or reason for visit codes to identify dental-related ED visits, which is more likely to reduce the risk of bias for cases included in such studies. However, studies which used self-reported measures to identify ED visits for dental conditions were considered to have subjectively measured the main outcome. Even among studies that used ICD 9 diagnosis codes to identify dental ED visits, there was a wide variation in the range of codes used. Some studies controlled for confounding factors such as age, year of visit, and other socio-demographic factors. However, others failed to adjust for confounders, thus increasing the risk of bias.

2.3.3. Proportion of ED Visits That Are Dental Related

Thirty-five studies presented data on the proportion of all ED visits that are dental-related. On average, visits for dental conditions made up about 2.3% (SD = 1.8) of all ED visits. In terms of population-based measures, there were 3.5 to 15.7 dental-related ED visits per 1000 population. Studies focusing on children reported lower dental ED utilization rates (mean = 0.8%, SD = 0.5) compared to studies focused on adults (mean = 3.6%, SD = 2.3). In studies that examined discharge data, ED visits were defined at the visit level, and repeat visits were not considered.

2.3.4. Predisposing Factors That Predict Dental ED Use

Gender: Thirty-four studies evaluated the gender as a predictor of dental ED use. Studies that used females as the reference group in their multivariate regressions are presented in Appendix 2. Males were more likely to visit the ED for dental conditions compared to females (OR 1.06, 95% CI 0.90 – 1.26) although the overall effect was not statistically significant.

Race/ethnicity: Among 9 studies assessing dental ED use among Blacks compared to whites, five studies reported no significant difference between Blacks and whites. This was reflected in the pooled odds ratios (OR 1.01, 95% CI 0.90 – 1.13), as shown in Figure 2.2. On the other hand, Hispanics were significantly less likely to visit the ED for dental conditions compared to whites (OR 0.63, 95% CI 0.54 – 0.72). Two studies reported increased odds among the Native American population, and decreased odds among Asian Pacific Islanders (6,10,20).

Age: Most studies treated age as a categorical variable in their analyses and differed in the cut points used, as well as the reference categories selected. However, some consistent patterns were observed. In studies focusing on children, dental ED use was higher among children aged 6 to18 compared to younger children aged 3 to 5 (29,43). Studies comparing children with adults reported higher dental ED use among adults (1,6,10), and studies focusing on adults reported that aged 20 to 44 were more likely to visit the ED for dental complaints compared to older adults (2,19,29,43–46). The same pattern of use across age groups was observed even when the study was restricted to individuals with public insurance benefits such as Medicaid (29).

Individual-level socio-economic status: A few studies examined dental-related ED use across categories of income, education and employment. A Canadian study reported that low-income working adults who were not eligible for public dental benefits were more likely to present at the ED with dental complaints compared to lower-income adults who received such public benefits (26). Another study reported that the odds of ED use for dental conditions was higher among the less educated (47). Others reported no association between dental ED use and employment (22,47).

Special healthcare need status: Two studies using national emergency department samples reported that adults with Autism Spectrum Disorder (29) and Intellectual and Developmental Disabilities (43) were less likely to visit the ED for dental complaints compared to adults without such disabilities. A North Carolina study reported that children under age four in the head start program with special needs were more likely to use the ED for dental complaints compared to similar children without needs (24).

2.3.5. Enabling Factors That Predict Dental ED Use

Health Insurance: As summarized in Figure 2.3, individuals who were covered by Medicaid (OR 2.20, 95% CI 1.79 – 2.72), Medicare (OR 1.48, 95% CI 1.28 – 1.71), and those who were uninsured (OR 2.68, 95% CI 2.25 – 3.19) consistently demonstrated higher odds of dental ED use compared to the privately insured. Individuals without dental insurance were more likely to use the ED for dental complaints compared to the insured (18,26).

Regular dental care: Five studies examined the role of regular dental care in dental ED use. Generally, they all found that lack of regular dental care was associated with ED use (21,30,48–50). However, Sen and colleagues reported that among Medicaid-enrolled children under age 3, preventive dental visits without sealant placement was associated with increased dental ED use. Widstrom and colleagues found that patients without a regular dentist were more likely to have a ED repeat visit (49).

Dental Provider Density and DHPSA designation: In areas with higher dental provider density, patients were less likely to visit the ED for dental complaints (OR 0.98, 95% CI 0.96 – 1.00). Likewise, residents of areas that had been designated as entire DHPSAs were more likely to experience a dental ED visit compared to non-DHPSA areas

(OR 1.14, 95% CI 1.00 – 1.29). However, these findings were marginally significant (Appendix 3).

Rural-Urban Classification: Rural-Urban classification was evaluated in 14 studies and showed mixed results overall. In studies that used more than 2 categories of rural-urban classification, only the most urban and most rural odds ratios were used to generate summary estimates. When the analyses were stratified by age, children in rural areas were more likely to have a dental ED visit compared to children in urban areas. However, these results were not statistically significant (OR 1.01, 95% CI 0.77 – 1.33) (Appendix 3). On the contrary, adults in rural areas were consistently more likely to have a dental ED visit compared their urban counterparts (OR 1.31, 95% CI 1.12 – 1.52). Studies that examined the odds of a dental ED visit among all age groups reported that rural residents had lower odds of dental ED use compared to urban residents (OR 0.81, 95% CI 0.67 – 0.97). Moreover, Shortridge and Moore reported that in states with generous Medicaid benefits, rural residents had fewer ED visits, mirroring that of the privately insured population (51).

Other enabling factors. Factors such as visits to the ED for other conditions (8,48), and previous dental ED visits (49) were significantly associated with dental ED use. Individuals with chronic health conditions were less likely to visit the ED for dental conditions (43).

2.3.6. Contextual Predictors of Dental ED Use

Neighborhood racial composition: Three studies that examined neighborhood racial composition had mixed findings. One study found that higher levels of neighborhood Black composition was associated with increased use, while the inverse was true for

Hispanics (8). Another study found that the higher proportions of minority groups was associated with lower odds of ED visits (52), while one study reported no effect (45).

Contextual measures of socio-economic (SES) status: Some studies examined SES measures such as poverty, education, community income and employment. Five studies reported that ED used increased with lower levels of median community income and higher levels of unemployment (19,29,43,45,53).

Other contextual measures: Measures such as county Medicaid population and county uninsured population were not associated with ED use (8,52). One study reported that not-for-profit hospitals had higher rates of dental ED use compared to privately-owned hospitals (7).

2.3.7. Need Factors That Predict Dental ED Use

Pain: Dental ED use was associated with increased pain severity, pain of sudden onset (26,49), increased duration of toothache (22,48), and increased disruption of daily activities (18,26). Self-reported oral health status was not significantly associated with dental ED visits (17,18,18). However, patients with good evaluated oral hygiene and low DMFT levels were less likely to use the ED for dental conditions (53).

2.3.8. Timing of Dental ED Visits

Three studies reported that dental ED visits were highest during weekends compared to weekdays (19,50,54), and increased after office hours, between 5 to 9 pm (50,54). However, Wall et al reported that dental ED visits over the weekend dropped over that past decade, and are now more evenly spread throughout the week (2). Studies using more recent data have reported that dental ED visits occur frequently during regular office hours (2,7,33).

2.3.9. Organizational and Regulatory Factors

We identified 4 studies that assessed the effect of expansion of dental public health benefits. We also found 4 studies that evaluated the impact of restricting Medicaid dental services or eliminating the reimbursement for dental services provided. With the exception of one study in Arizona (55) which reported no impact on dental ED visits, restriction of public dental benefits was associated with increased dental ED visits in California (56), Maryland (57), and Massachusetts (58). On the other hand, expanding Medicaid dental coverage was associated with increased dental ED use in Kentucky (59), Minnesota (60), and Oregon (61), but was associated with decreased dental visits in Michigan (62).

2.3.10. Gaps in the Literature

As shown in Table 2.3, a number of individual-level predisposing and enabling factors have been explored as predictors of dental ED use. However, aspects of the health environment such as having a dental or medical home, alternative workforce models providing dental care, and federally qualified health centers providing dental care have not been explored in terms of the roles they play in influencing dental ED use.

2.4. DISCUSSION

A few main findings emerged from our analysis. First, health insurance was the most important predictor of dental ED use. Uninsured individuals were almost thrice as likely to visit the ED with a dental complaint compared to privately insured individuals. It is conceivable that uninsured persons will use the ED because they are assured care, even though they may be charged for services received (63). In the United States, Medicaid patients were twelve percent more likely to use the ED for dental complaints compared to

the privately insured. This finding further reveals the inadequacies of Medicaid programs in providing the much-needed preventive and restorative services that could potentially forestall dental emergencies. These inadequacies are well documented – geographic misdistribution of dentists, fewer dentists providing care to Medicaid enrollees, and limited coverage of dental benefits (64).

The fact that Medicaid enrollees have historically had difficulty in finding a dentist that would accept their coverage, and that some were subsequently offered limited dental coverage in Medicaid expansion states makes it likely that EDs are more accessible to them for the treatment of dental conditions. Expansion of Medicaid programs and restriction of public dental benefits had the same effect of increasing dental ED visits. The initial increase in dental ED visits following expansion has been attributed to factors such as pent up unmet need for dental care, and expansion that is uncoupled with increase in the dental workforce (52). Notably, previous research has suggested that expansion of dental programs must be accompanied by changes that encourage provider participation in Medicaid, and improved patient navigation systems that encourage EDs to steer dental patients towards dental practices and safety net clinics (59). Some research has shown that the initial spike in dental ED visits after coverage is temporary (65). There is also evidence that some Medicaid patients might use the ED despite being covered, due to challenges in accessing care during regular hours, and long wait times (63).

Second, and perhaps not surprisingly, low dental provider density and DPHSA designation were associated with dental ED use. In such areas, Federally Qualified Health Centers might play an important role in increasing access to dental care. Overall, rural adults were more likely to visit the ED for non-traumatic dental complaints compared to

urban adults. Limited Medicaid dental coverage might exacerbate the problem of dental ED visits in rural areas (51). Factors driving dental ED use in rural areas include lower supply of dentists, increased travel time to reach dental offices, a pattern of using the ED for dental care despite having insurance (51,52). Increasing mid-level providers, and hiring dentists who are likely to accept Medicaid insurance are necessary measures to reduce the reliance on ED for dental conditions in rural areas (52).

Third, with regards to age, dental ED use was most prevalent among adults, particularly younger adults between ages 20 and 34. Several reasons have been provided for disproportionate use among young adults. Young adults are less likely to be insured, and much less likely to have dental health insurance (7,66). Additionally, adults who qualify for Medicaid may not receive comprehensive care if they do not belong to special groups such as pregnant women or the disabled. Young adults are also more likely to have lower incomes that may not include health insurance coverage. Hence, the issues of low income coupled with high cost of dental care might prevent young adults from being able to cover out-of-pocket costs for dental care, which are substantial (67). There is evidence that the Affordable Care Act insurance mandate increased dental insurance among adults aged 19 to 25 in middle income households (66), and subsequently led to decreased dental ED use in this subgroup (60).

In terms of other predisposing factors, no clear patterns emerged for dental ED use by gender, and among Blacks. Previous studies have shown that once health insurance and other socio-economic measures were considered, there were no racial differences in ED use (68). However, even after taking insurance into account, Hispanics were consistently less likely to initiate dental ED visits compared to whites. This finding is consistent with

literature that has revealed that Hispanics use the ED less frequently (69), and dental ED use might not be an exception. None of our studies differentiated between acculturated and less acculturated Hispanics, as studies have shown that as Hispanics remain in the United States for much longer, their pattern of utilization of health services might mirror that of whites (69).

Fourth, in more recent times, studies have reported that dental ED visits have increased during regular office hours, indicating that access to dental services is the main barrier, not necessarily timing. Not surprisingly, intense pain of sudden onset, and pain of increased duration was related to increased dental ED use.

2.4.1. Limitations

We note some limitations to this study. First, it is possible that we may have missed some articles. We tried to mitigate this by enlisting the help of a health sciences librarian who guided our search. Second, some articles defined dental-related ED visits narrowly, while others used a broad range of ICD 9 codes in identifying such visits. Nevertheless, the findings were consistent across many of the predictors examined. Last, even though we attempted to capture as many predictors associated with dental ED use both narratively and quantitatively, it is possible that we missed some factors due to the paucity of studies examining such aspects.

2.5. CONCLUSION

This systematic literature review has examined the factors associated with dental ED use and exposed potential predictors that remain unexplored in the literature. Given that strong role that health insurance plays in reducing dental ED visits, effective coverage

of public dental benefits, expanding the safety net for the insured, and increasing the numbers of dental providers continue to be crucial in attempts to reduce visits to the ED for non-traumatic dental complaints.

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Table 2.1. Descriptive Overview of Included Studies

Variables	Number of articles	Percentage
Study location		
United States	51	89.5
Other country	6	10.5
Study design		
Observational	52	91.2
Quasi-experimental	5	8.8
First author at academic institution		
Yes	50	87.7
No	7	12.3
Journals where studies were published		
Clinical or medical journals	12	21.1
Dental public health journals	9	15.8
Dental specialty journals	16	28.1
Public Health Journal	20	35.1
Age groups studied		
0 – 18 years only	15	26.3
18 to 64 years	16	28.1
All age groups	26	45.6
Type of data used		
Medical records/discharge data	48	84.2
Surveys	9	15.8
Sample size (average)	531,908	---
Scope of data used in study		
Nationwide data used	15	26.3
Not nationwide study	42	73.7
Year published		
1988 – 1999	6	10.5
2000 – 2009	12	21.1
2010 – 2018	39	68.4

Table 2.2. Characteristics of Included Studies

Author and Year	Study Setting, Data Source	Study Year(s)	Sample size	Age groups in study (years)	Proportion of ED visits that are dental-related
Anderson 2011	New Hampshire, discharge data	2001 - 2008	16238	All	3%
Baicker 2018	Oregon, discharge data	2007 – 2009	2,646	19+	N/A
Battenhouse 1988	Pittsburg, medical records	Not specified, 12 months	1456	0 - 18	N/A
Burgette 2017	North Carolina, survey	2010 – 2014	1,178	0 – 18	NA
Chalmers 2017	Maryland, SEDD	2010 - 2013	55,565	All	2.7 – 2.8%
Chalmers 2016	Kentucky, SEDD	2010 – 2014	199,549	≥21	3.0 – 3.3%
Chi 2014	National, NEDS	2009	26,791,871	3-17 18+	0.8% - children 2.0% - adults
Cohen 2008	Maryland, survey	Not specified, 12 months	272	≥21	8.7%
Cohen 2006	National, MEPS	2001	284,247	All	2.7%
Cohen 2002	Maryland, Medicaid claims data	1991 - 1995	3639	≥21	N/A
Cohen 1996	Maryland, medical records	1991 – 1993	2,895	≥21	3.6 – 4.1%
DeLia 2016	New Jersey, discharge data	2008-2010	98787	All	1.7%
Dorfman 2001	Massachusetts, survey	1998 - 1999	200	0 - 21	1.2%
Fingar 2015	29 states, SEDD	2010	876,040	20 - 64	2.1%
Haddad 2018	Michigan, medical records	2012 - 2016	4,257	N/A	N/A
Hocker 2012	North Carolina, medical records	2010 - 2011	760	All	1.3%
Holmes 1993	Edinburgh (United Kingdom), survey	1987, 1990, 1991	550	All	N/A
Hom 2013	North Carolina, discharge data	2007 - 2009	327	0-18	0.23%
Hong 2015	Kansas, discharge data	2001 - 2010	35136	All	1.9%
Hong 2011	Kansas, discharge data	2001 - 2006	19,316	All	1.7%
Jung 2016	Taiwan, medical records	2012 - 2013	397	0 - 18	0.77%

Table 2.2: Continued

Author and Year	Study Setting, Data Source	Study Year(s)	Sample size	Age groups in study (years)	Proportion of ED visits that are dental-related
Ladrillo 2006	Texas, medical records	1997 - 2001	1102	0-17	0.4%
Laniado 2017	Minnesota, SEDD	2008, 2014	61,078	All	1.8 – 2.3
Lee 2012	National, NHAMCS	2001 - 2008	3,265	All	3.7 - 5.9 visits per 1000 population
Lee 2004	North Carolina, Medicaid claims data, WIC enrollment data	1992 - 1997	21,277	0-5	1%
Lewis 2015	National , NHAMCS	2001 - 2010	1,271,000	20 - 39	9.3 – 15.7 visits per 1000 population
Lewis 2003	National, NHAMCS	1997 - 2000	693	All	0.7%
Ma 2004	Ohio, medical records	1999 - 2001	5930	All	3.7%
Manski 1998	Maryland, medical records	1991 - 1994	2895	≥21	3.8%
Martin 2012	South Carolina, Medicaid claims data, Head Start enrollment data	2007 - 2008	985	3-6	N/A
Martin 2012	South Carolina, Medicaid claims data	2008	95,489	0-4	1.9%*
Mohammed 2017	Arizona, discharge data	2006 – 2012	103,985	All	1.3%
Nakao 2015	National, NEDS	2010	2,274,289	3 and older	0.8% - children 2.1% - adults
Neely 2014	Massachusetts, discharge data	2007 – 2012	N/A	≥21	53.52 – 61.84 per 1000 ED visits
Neff 2010	National, NHANES	2001	1490	18 and older	N/A
Oh 2012	Rhode Island, discharge data	2006 - 2010	39,286	21 - 64	3.0%
Okunseri 2011	Wisconsin, Medicaid claims data	2001 - 2003	23,999	All	N/A
Okunseri 2008	Wisconsin, Medicaid claims data	2001 - 2003	956,774	All	4.3%*
Powers 2000	Texas, Aetna Claims Data	1995 - 1996	2947	5+	N/A
Quinonez 2011	Canada, survey	2008	1005	18+	5.4%
Ramraj 2013	Canada, survey	2007	1049	18 - 64	6.1%

Table 2.2: Continued

Author and Year	Study Setting, Data Source	Study Year(s)	Sample size	Age groups in study (years)	Proportion of ED visits that are dental-related
Rowley 2006	Washington, medical records	1995 - 2003	1079	0-18	N/A
Salomon 2017	Illinois, medical records	2011 - 2013	1405	All	N/A
Sen 2016	Alabama, Medicaid claims data	1998 - 2012	320	0-18	N/A
Serna 2017	Florida, discharge data	2013 - 2015	4,774	All	45.5 -95.2 per 10,000 population
Shortridge 2009	Utah, Vermont, Wisconsin, SEDD	2005	40,440	All	1.3-2.7%
Singhal 2015	California, SEDD	2006 – 2011	121869	≥21	N/A
Sun 2015	Oregon, discharge data	2010	15081	All	2.5%
Tramini 2010	France, survey	2005	1000	All	N/A
Von Kaenel 2001	Ohio, medical records	1998	300	0-18	N/A
Walker 2014	National, NEDS	2008	16,928,424	19-64	0.2-1.0%
Wall 2012	National, NHAMCS	1997/98, 2007/08	3,360,000	All	1.15 – 1.87%
Wallace 2011	Oregon, Medicaid claims data	2002 - 2004	22833	All	N/A
Whiteman 2016	Maryland, medical records	2012 - 2014	55	19 - 59	N/A
Widstrom 1988	Finland, medical records	1985 - 1986	839	All	N/A
Zeng 1994	Washington, medical records	1982 - 1991	1482	0-18	N/A
Zhou 2018	Nevada, SEDD	2009 - 2015	61,922	All	N/A

N/A: Not available. *Includes dental-related visits to primary care providers and the ED.
Note: NIS, Nationwide Inpatient Sample; MEPS, Medical Expenditure Panel Survey; SEDD, State Emergency Department Databases; NHAMCS, National Hospital Ambulatory Medical Care Survey; NEDS, Nationwide Emergency Department Sample; NHANES, National Health and Nutrition Examination Survey; WIC, Women Infants and Children.

Table 2.3. Number of Studies Examining Predictors of Dental ED Use

Factors	Number of analyses	Percentage
Predisposing factors		
Age	45	80.4
Gender	34	60.7
Race/ethnicity	27	48.2
Education	4	7.1
Employment	5	8.9
Income	8	14.3
Special healthcare need status	5	8.9
Enabling factors		
Health insurance coverage	23	41.1
Dental insurance	4	7.1
Regular medical provider	1	1.8
Regular dental provider	5	8.9
Medical home/dental home	0	0.0
Oral health literacy	0	0.0
Visits to the ED for other conditions	2	3.6
Previous dental ED visits	2	3.6
Urban/rural classification of residence	14	25.0
Dental provider density in community	5	8.9
Number of EDs in community	1	1.8
Dental Health Professional Shortage Area Designation	5	8.9
Federally Qualified Health Centers that provide dental care	0	0
Contextual measures of income, poverty, un-insurance, education, racial composition, poverty, and percentage Medicaid population	18	32.1
US Census region	6	10.7
Need factors		
Perceived/evaluated oral health status	4	7.1
Chronic health conditions	2	3.6
Severity of dental pain, daily activities affected due to dental pain	3	5.4
Duration of toothache	2	3.6
Health Behaviors		
Routine professional dental care	5	8.9
Routine medical care	0	0.0
Personal oral hygiene	0	0.0
Timing of visits		
Office hours vs non-office hours	2	3.6
Weekday/weekend	4	7.1
Month of year	1	1.8
Organizational and regulatory factors		
Women, Infants and Children (WIC), Early Headstart		
Restriction of public dental benefits	4	7.1
Expansion of public dental benefits	4	7.1
Alternative dental workforce models	0	0.0
Hospital-level intervention	1	1.8
Hospital payer mix	1	1.8

Figure 2.1. Flowchart Showing Study Selection Process

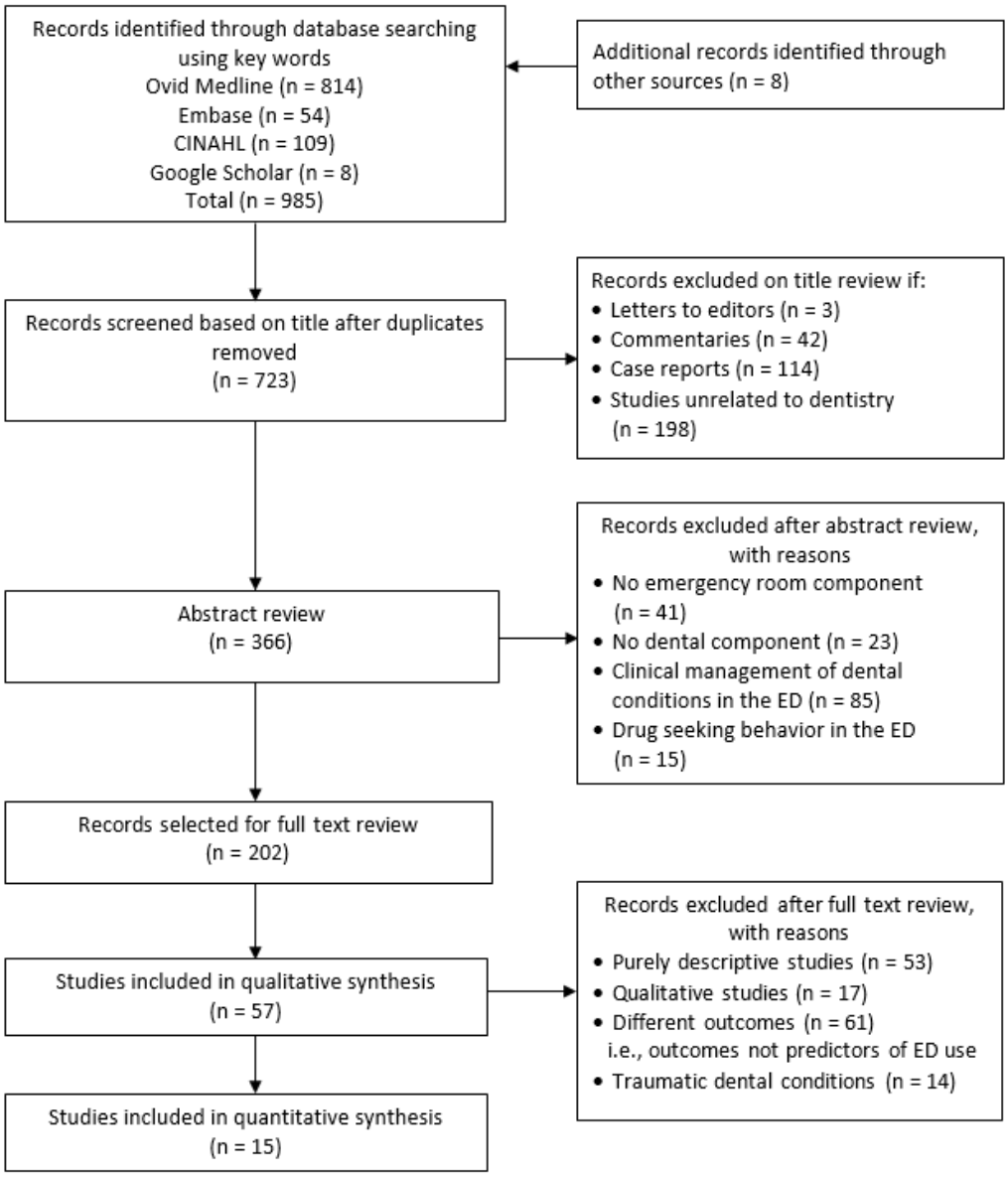


Figure 2.2. Forest Plots, Race

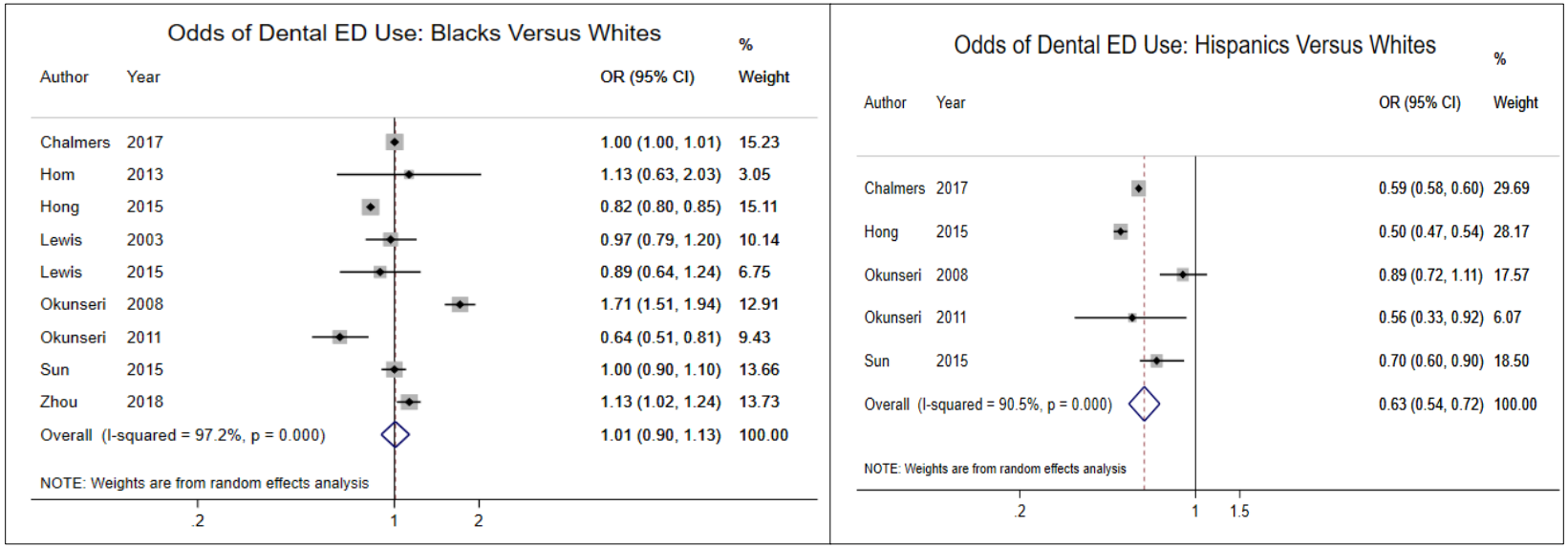
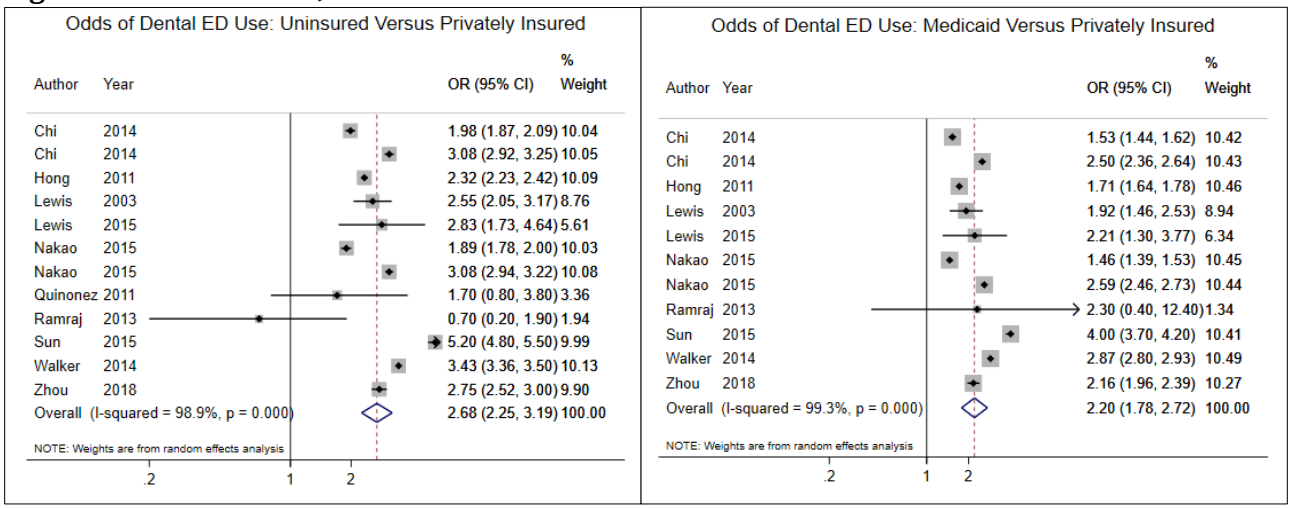
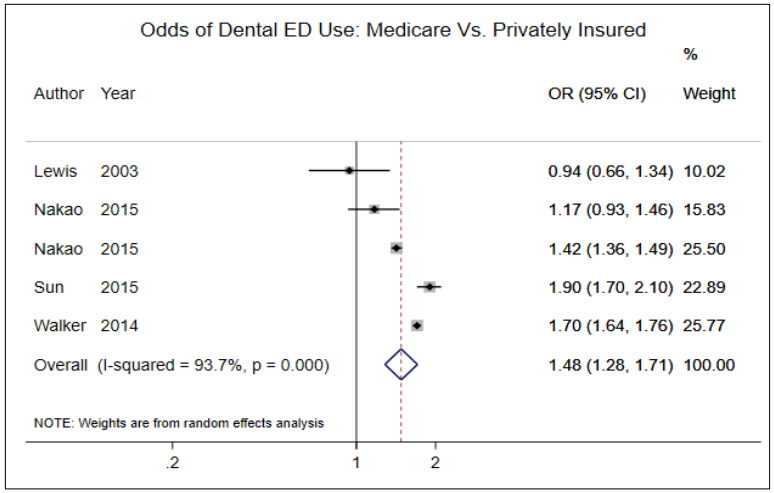


Figure 2.3. Forest Plots, Insurance Status





3. THE DIFFERNTIAL RURAL-URBAN EFFECTS OF MEDICAID EXPANSION ON DENTAL EMERGENCY DEPARTMENT VISITS

3.1. BACKGROUND

Unlike many ailments in other parts of the body, most dental conditions do not spontaneously resolve without professional dental care. In the absence of routine dental care, dental conditions such as tooth decay and gum disease continue to progress, and eventually manifest as severe toothaches, infection, or facial swellings. Moreover, the burden of dental disease is experienced across all age groups. According to the Centers for Disease Control and Prevention, between 2011 and 2014, 18.6% of children and 31.6% of adults in the United States had untreated dental caries (1). In addition, a recent analysis of a nationally representative survey reported that between 2009-2014, 42% of adults aged 30 and older had some form of gum disease (2).

Poor oral health has been associated with increased risk of preterm birth or low-birth weight (3), airway inflammation (4), respiratory diseases (5), cardiovascular diseases (6,7), and diabetes (8). In the short term, patients affected by poor oral health might further experience tooth loss, lost productivity, and difficulty finding employment (9,10). Ideally, during routine visits to the dental clinic, patients receive oral health examinations, and emerging dental conditions are detected and managed as needed. However, only a proportion of the population actually obtains yearly dental visits. In 2016, 64.4% of adults ages 18-64 and 64.3% of adults over 65 had a routine dental visit (1). Simultaneously, utilization of the ED for dental complaints has risen over the last decade (11–14). An analysis of the 2010 State Emergency Department Databases from 29 states showed that

2.1% of all visits to the ED were dental-related. Even though the increase in visits has occurred across all age, insurance, and geographical categories, there have been increases particularly among the uninsured, young and middle-age adults, Medicaid enrollees, and rural residents (15–17).

Patients who do not pursue definitive care in a dental setting for access or coverage related reasons, particularly for non-traumatic dental conditions, often seek care at the ED. Although these conditions are not life-threating and are often triaged as non-urgent or semi-urgent (18), lack of proper dental care provisions, leads to an increased demand for such care at the ED. However, ED management of dental conditions is costly and often not definitive, and reflects a wasteful, inefficient use of resources (19).

Currently, through the Medicaid's Early and Periodic Screening, Diagnostic and Treatment (EPSDT) benefit package, states are required to provide comprehensive and preventive dental care to children below age 21 that are enrolled in Medicaid. However, provision of dental coverage for adults is optional. Among states that provide adult dental benefits, the scope of services offered varies widely in terms of the types of services offered and the subpopulations to which it is offered. For example, some states cover more services for pregnant women and adults with disabilities, but not for other enrollees.

Generally, coverage has been classified into four categories: 1) no dental coverage, 2) emergency-only coverage (such as relief of acute pain or uncontrolled bleeding), 3) limited coverage (includes diagnostic, preventive of minor restorative procedures), and 4) extensive coverage (including major restorative procedures) (20,21). As of 2015, four states (Alabama, Arizona, Delaware, and Tennessee) did not offer any form of dental benefits, while forty-six states in total and the District of Colombia offered some form of

dental coverage: 15 states covered emergency-only dental coverage, 17 offered limited benefits, and 15 states offered extensive benefits (20,21). In times of budget constraints, Medicaid adult dental coverage has been withdrawn or limited in some states. During the 2008 economic recession, six states went from extensive to limited coverage, while one state eliminated coverage all together (21–23). However, more recently, some states have reinstated benefits (23).

Specifically, some studies have examined the effects of offering adult dental coverage to newly-covered Medicaid enrollees. One of these studies found that low-income childless adults were more likely to have routine dental visits, while dental utilization decreased among adults with children (25). In terms of dental-related ED visits, one study using the Minnesota State Emergency Database found that Medicaid expansion through the ACA was associated with a decrease in emergency room visits for dental conditions, especially among young adults in the 18-26 category (26). In contrast, another study using the Kentucky Emergency Database found that Medicaid expansion led to increase in the use of the emergency room for dental conditions (27).

In terms of dental ED visits and rurality, a study using the State Emergency Department Database for 29 states in 2010 found that dental provider density, not Medicaid dental coverage, was inversely-related to reduced ED visits in rural counties. However, this did not hold true for urban areas (i.e., neither Medicaid expansion or dental provider density was associated with a change in dental ED visits) (28). However, this study was conducted in 2010, before the Medicaid expansion. To the best of the researcher's knowledge, no study has examined the differential rural-urban impacts of offering Medicaid adult dental benefits since the ACA came into effect.

The purpose of this study is to: 1) analyze the impact of the ACA Medicaid expansion and coverage of dental benefits on ED use for non-traumatic dental conditions; 2) assess the differential rural-urban effects of the policy change on ED use for dental conditions; 3) identify expansion-changes in the payer mix for dental ED visits based on expansion status and dental coverage. As more policymakers and stakeholders contemplate expanding, or scrapping previously expanded Medicaid programs, it is important to evaluate the impact of Medicaid on the utilization of health services.

3.2. METHODS

3.2.1. Data Sources

Data on dental ED visits were obtained from the State Emergency Department Databases (SEDD) for years 2010 to 2014. The SEDD are part of the family of databases developed for the Healthcare Cost and Utilization Project (HCUP), and sponsored by the Agency for Healthcare Research and Quality (AHRQ). Thirty-nine states currently participate in the SEDD. It contains discharge information of all emergency visits at hospital-based emergency departments, regardless of payer, that do not result in hospitalization. Data captured include clinical and resource use information such as diagnoses, procedures and total charges, patient sociodemographic characteristics, expected payment source, contextual information such as county of residence, rural-urban classification of county and county median income (29).

Information on the status of Medicaid expansion for each state in January 2014 was collated from multiple sources such as the Kaiser Family Foundation (24) and scholarly publications (22,30,31). Data on scope of adult dental benefits offered to the Medicaid

population in the states being studied were obtained from the Medicaid and CHIP Payment and Access Commission (MACPAC) reports, and the Center for Health Care Strategies (CHCS) (20,21). County-level information such as the percentage of residents in poverty, or without health insurance, dental health professional shortage area designation and number of active dentists, residents were extracted from the Area Health Resources Files (AHRF). The AHRF complies detailed county-level information collected from multiple sources over many years.

3.2.2. Study Sample

The study focused on adults aged 20 to 64 who visited the ED with a dental complaint between 2010 and 2014. Data from the ten states were obtained: Arizona, Florida, Massachusetts, North Carolina, Nebraska, New Jersey, New York, Rhode Island, Vermont, and Wisconsin. The dental ED visits from each county for each year-quarter were aggregated and merged with county-level information from the AHRF.

3.2.3. Measures

Dependent Variable: The primary outcome variable was the number of dental ED visits per 1,000 county population aged 20 to 64 years. The secondary outcome variables were the percentage of dental ED visits in which the primary payer was listed as Medicaid, uninsured, or private-payer. Dental ED visits without a traumatic origin were identified using the clinical classification codes which cover disorders of the teeth, salivary gland the jaws. Examples of these conditions include dental caries, pulpitis, gingivitis, and periodontitis. The full list of ICD-9 codes used in identifying ED visits is presented in Appendix 1.The five listed diagnosis codes were used to identify visits for dental conditions. Previous research has demonstrated the majority of the diagnosis codes for

dental conditions are often captured in the first five diagnosis codes (27). The unit of analysis was county-year-quarter.

Independent Variables: Primarily, this study is testing the impact of states' decisions to provide Medicaid adult dental benefits and expand Medicaid in January 2014. Hence, the states in the study were divided into four independent groups: 1) a treatment group comprising of states that expanded Medicaid and provided adult dental benefits, 2) comparison group 1, states that provided dental benefits but did not expand Medicaid, 3) comparison group 2, comprising a state that did not provide adult dental benefits but expanded Medicaid, and 4) comparison group 3, comprising a state that did not provide adult dental benefits and did not expand Medicaid. A summary of the classification of the ten states in the study is provided in Table 3.1. A state was indicated to provide dental benefits if it provided extensive or limited coverage to its Medicaid recipients.

Other covariates: In order to identify the differential effect of the policy change on dental ED visits among rural and urban residents, the visits were classified into rural-urban categories. Using the county of residence listed on the discharge record, visits were classified based on the 2013 National Center for Health Statistics (NCHS) Urban-Rural classification scheme which categorizes counties of residence into six levels based on county population. The NCHS classification includes the following categories, ranging from the most urban to the most rural: large central metropolitan, large fringe metropolitan, medium metropolitan, small metropolitan, metropolitan, and non-core. Counties in the first four categories were categorized as urban or metropolitan areas, while counties classified as micropolitan or non-core were categorized as rural. The NCHS classification scheme was updated in 2006 and 2013. Therefore, observations between 2010 and 2012 were

assigned NCHS 2006 figures, while observations between 2013 and 2014 were assigned 2013 NCHS figures.

Other covariates adjusted for included percentage of residents in poverty, percentage of residents without health insurance, dental health professional shortage area (DHPSA) designation and number of active dentists. Counties were assigned DHPSA classification based on whether the whole county was designated a DHPSA, or whether partial areas were designated, or whether no area was designated. The DHPSA categorization is conducted by the Health Resources and Services Administration and is based on population to provider ratio, percent of population below 100 Federal Poverty Level, Water Fluoridation Status, and travel time to the nearest service center (32). DHPSA values for 2010 were used for years 2011, 2012, and 2013, and values for 2015 were used for 2014. The number of professionally active dentists in each county per 10,000 population was obtained using the 2010 population census. In the AHRF, the number of dentists in each county was not collected annually, and was missing for years 2011 and 2012. Hence, the study imputed these numbers using the average annual percent change between years 2010, 213, and 2014 to account for these missing values.

3.2.4. Study Design and Statistical Analyses

Descriptive statistics were used to obtain the baseline sample characteristics and the average number of dental ED visits for the treatment and three comparison groups. Next, the study assessed the average rates of dental ED visits by urban/rural status, DHPSA designation, residents without health insurance and residents in poverty, and year-quarter. Chi-square tests and Kruskal Wallis tests were used to assess whether there were differences between the treatment and comparison groups.

The impact of the policy was measured using a retrospective, quasi-experimental study design. Difference-in-differences ordinary least squares regressions were conducted to obtain the effect sizes associated with the policy. First, unadjusted estimates were obtained by regressing the combined Medicaid expansion and dental coverage variable on the number of dental ED visits per 1,000 county population. Next, the model was adjusted for time varying covariates, state fixed effects, and year-quarter fixed effects. The adjusted linear regression model was estimated using equation one below:

$$\mathbf{Y_{cst} = \alpha_i + \beta_1\,(Dental\_Expansion_s) + \beta_2\,(Post_t) + \beta_3\,(Dental\_Expansion_s * Post_t *)}$$

$$\mathbf{+ \beta_4\,(Dent\_exp*Post*Rural) + X_{cst} + S_s + T_t + \mathcal{E}_{cst}} \qquad \mathbf{(1)}$$

where Y_{cst} is the dental ED count per1000 county population in county *c* in state *s* at time *t* (t = year-quarter). Dental_Expansions is an indicator set to one for counties in states that expanded Medicaid and provided adult dental benefits in January 2014. $Post_t$ is an indicator set to one for dental ED visits occurring after the fourth quarter of 2013. Dental_Expansions * $Post_t$ is an interaction term for ED dental visits in the treatment group after the policy change. X_{cst} refers to time varying covariates including rural-urban residence, dental health professional shortage area designation, number of dentists per 10,000 county residents, residents in poverty, residents without insurance, and county population. S_s refers to county fixed effects, and T_t, year-quarter fixed effects.

β_1 is the difference in dental ED use between treatment and control states before the intervention, β_2 is the effect unrelated to the ACA Medicaid expansion in control states. β_3 is the change in dental ED count per 1000 county population that can be attributed to the policy, β_4 associated with the interaction term is the differential effect of the policy change on rural dental ED visits, $\mathcal{E}_{cst}$ is the random error. Given that there were repeated counts of

dental ED visits obtained from the same counties over the study period, the study adjusted for within-county correlation using heteroscedasticity-robust standard errors clustered at the county-level.

3.2.5. Sensitivity Analyses and Falsification Tests

To test the validity of the results, sensitivity analyses were conducted by specifying alternative models. First, the study tested the parallel trends assumption by conducting the same regression as specified in equation one, but restricting the data to the pre-policy period (2010 – 2014). Second, the robustness of the results was tested by excluding from the analyses states that had some form of Medicaid expansion before 2014. These states included New York and Vermont. Third, the policy impact was tested in the second, third and fourth quarters of the post-reform year, 2014. Finally, the study split the NCHS categories into three, urban, sub-urban and rural to assess whether there was a differential impact of the policy among these sub-populations.

3.3. RESULTS

A summary of the baseline county characteristics associated with dental ED visits in the treatment and comparison groups are presented in Table 3.2. Compared to other study groups, Florida, a non-expansion state that did not provide dental benefits to its adult Medicaid population had the highest average number of dental visits, 3.68 dental ED visits per 1000 population. This was followed by the states in the treatment group, which had a visit rate of 3.23 visits per 1,000 population. Arizona, which did not provide dental benefits, but expanded Medicaid had the lowest dental ED visits rate of 2.14 visits per 1,000 population. In the treatment group, about a third (33.37%) of the ED visits were

made by rural residents, however, the reverse was true for residents in comparison groups 1 (67.59%), and 2 (55.97%). In comparison state 3, Florida, 41.04% of visits were from rural residents.

Across the study groups, most of the visits came from residents in areas where only part of the county was designated as a Dental Health Professional Shortage Area. This was especially true in comparison groups 3 (98.77%) and 4 (94.03%). In the treatment group, residents of counties with a high dentist-to-population ratio made the highest number of dental ED visits (38.17%), while residents of counties with the lowest quartile of dentists made the fewest dental ED visits (13.75%). The average percentage of residents without insurance was the lowest in the treatment group, and highest in comparison groups 2 and 3. There were no clear patterns with regards to the seasonality of the visits across year-quarter. With the exception of year-quarter, all study groups were significantly different from each other with respect to the county-level characteristics.

Figure 3.1 displays the unadjusted trends in the rate of dental ED visits per 1000 county population over the study period. Florida, the non-expansion state without adult dental benefits had the highest rates of dental ED visits throughout the study period, followed by the expansion states that provided dental benefits. Figure 3.2 plots the percentage of dental ED visits covered by each primary payer over the study period. Dental ED visits among Medicaid and uninsured patients remained steady among states that did not expand Medicaid (comparison group 1 and 3). However, between 2013 and 2014, dental ED visits increased among states groups that expanded Medicaid, whether they offered dental benefits or not (treatment group and comparison group 2). There were larger increases in Medicaid-covered dental ED visits in comparison group 3 – the state group

that expanded Medicaid, but did not provide dental benefits. On the other hand, ED visits by the uninsured fell between 2013 and 2014. Regardless of Medicaid expansion or dental benefits status of the states, the percentage of visits among the privately insured remained steady during the study period.

The results of the unadjusted and adjusted models testing the effect of the policy change is presented in Table 3.3. The average number of dental ED visits increased by 0.16, 0.14, and 0.34 visits per 1,000 county population in the comparison groups 1, 2, and 3 respectively, and dropped by 0.14 visits in the treatment group. Regardless of the comparison group, the unadjusted and adjusted models showed that the policy change led to decrease in dental ED visits in the treatment group, relative to the pre-reform period. Compared to the pre-reform period and relative to non-expansion states that provided dental benefits (comparison group 1), dental ED use decreased by 0.307 visits per 1,000 county population per quarter in 2014 (95% Confidence Interval [CI] -0.434, -0.180). This estimate only decreased slightly when time-varying county-level covariates and year-quarter fixed effects were added to the model (adjusted -0.310; 95% CI -0.438, -0.181).

When the treatment group was compared to the expansion state group that did not provide adult dental benefits (comparison group 2), dental ED use decreased by 0.250 visits per 1,000 county population per quarter relative to the pre-reform period (95% CI -0.398, -0.103). This effect was increased in the adjusted model (adjusted -0.522; 95% CI -0.800, -0.245). Finally, relative to the non-expansion state that also did not provide adult dental benefits, dental ED use dropped by 0.473 visits per 1000 county population per quarter (95% CI -0.638, -0.308). This effect remained in the adjusted model (adjusted -0.443; 95% CI -0.609; -0.277).

Table 3.4 shows the differential effect rural-urban effect of expanding Medicaid and providing adult dental benefits in rural and urban areas. With the exception of the adjusted model comparing the treatment group with comparison group1, the estimates show that the policy change led to increased dental ED visits in rural areas compared to urban areas. However, none of these estimates were statistically significant, suggesting that the policy may have had the same effect on dental ED visit rate among urban and rural residents.

Table 3.5 displays how the percentage of payer-specific visits changed after the policy. Regardless of which comparison group was used, Medicaid dental ED visits increased in expansion states offering adult Medicaid dental benefits (treatment group). As expected, visits by the uninsured patients decreased. There was also a decrease in the share of dental ED visits among patients that were privately insured, although this effect was smaller compared to that of Medicaid and uninsured patients. Specifically, compared to the state group that provided dental benefits but did not expand Medicaid (comparison group 1), the percentage of Medicaid dental ED visits increased by 9.22% per quarter in 2014 relative to the pre-reform period (adjusted 9.22, 95% CI 7.17,11.28). The share of visits among the uninsured and privately insured patients fell by 5.30 and 4.15 percent respectively.

A similar pattern was observed when comparison groups 2 and 3 were used as the reference groups. Compared to Arizona, the expansion state that did not provide Medicaid adult dental benefits, the share of dental ED visits covered by Medicaid increased by 8.82 points (95% CI 2.29,15.35), while the share of insured and privately insured patients decreased by 3.95 (95% CI -8.14,0.24) and 1.80 (95% -7.79,4.19) percentage points,

respectively. However, the latter two estimates were not statistically significant. When the treatment group was compared to comparison group 4, a non-expansion state that did not provide adult Medicaid dental benefits, dental ED visits among Medicaid enrollees increased by 7.06 percentage points (95% CI 5.04, 9.08), while the visits dropped by 4.79 percentage points (95% CI -6.57, -3.01) among the uninsured, and 2.71 percentage points (95% -4.33, -1.09) among the privately insured.

The results of the falsification tests and sensitivity analyses are presented. The interaction term between the last pre-reform year-quarter, 2013-quarter 4 and the policy was significant in states that expanded Medicaid without providing dental services (comparison group 2), and in Florida, the state that neither expanded Medicaid nor provided adult dental benefits (comparison group 4) (Appendix 6). When New York and Vermont, states that expanded Medicaid much earlier, where dropped from the model, the estimates of the policy impact relative to all three comparison groups remained fairly unchanged (results not shown). When the first quarter of 2014 was dropped from the model, an increase in dental ED visits relative to the pre-reform period was still observed in the three comparison groups (results not shown). Finally, the rates of dental ED visits dropped the furthest in suburban areas relative to urban and rural areas. However, most of these estimates were not statistically significant (results not shown).

3.4. DISCUSSION

This study assessed the impact of the providing adult Medicaid dental benefits with the 2014 ACA Medicaid expansion on adults aged 20 to 64. The difference-in-differences estimation showed that in expansion states that provided dental benefits, dental ED visits

decreased generally by 0.3 to 0.5 visits per 1,000 population per quarter. This decrease was especially marked when compared to Arizona, the state in comparison group 2 which expanded Medicaid without accompanying Medicaid adult dental benefits.

Compared to other state groups in this study, Arizona had the highest increase in Medicaid and CHIP enrollment in 2014 (33). These findings suggest that expanding Medicaid coverage without providing dental benefits may have led to larger increases in dental ED visits in Arizona. Given that the ACA Medicaid expansion was targeted at childless adults, it is highly probable that the change in dental ED utilization was driven by childless adults. However, there was no means of testing this with the SEDD data. The findings of this study are consistent with that of state-specific studies that have examined the impact of the ACA Medicaid expansion on dental ED visits. Expanding Medicaid dental coverage was associated with increased dental ED use in Kentucky (27), Minnesota (26), and Oregon (34), but was associated with decreased dental visits in Michigan (35).

The share of dental ED visits increased among Medicaid enrollees but dropped among the uninsured. The finding that the Medicaid expansion resulted in increased dental ED use could also be attributed to supply side constraints. Expanding Medicaid without increasing the number of dentists who are willing to accept Medicaid patients could worsen the challenge of access to care. As at 2012, less than half of professionally active dentists accepted Medicaid patients in 25 states, and often, many of the participating dentists placed a limit on the number of patients they are willing to see (36).

One factor that might be responsible for the increase in Medicaid covered dental ED visits is the peculiarity of the Medicaid enrollees. Providers have often cited the problem of broken appointments coupled with the denial of reimbursement and

burdensome bureaucracy as reasons for not participating in Medicaid (37). Hence, the only other available option for receiving care is the dental safety net, and many newly enrolled patients may have had to compete for the available spaces which have been occupied by low income parents, and children on Medicaid and CHIP (38). In sum, regardless of the policy change, other factors such as the number of dentists willing to accept Medicaid, and the availability of the dental safety net play a role in the ability of the newly enrolled patients to get care.

The findings of this study also suggest that there were no significant differences in the impact of the policy in urban and rural areas. Prior to the ACA, it was established that rural residents had higher rates of unmet needs, and higher out-of-pocket spending for medical care due to lower rates of insurance (39,40). In addition, rural residents were also more likely to be older and have lower incomes (41). Hence, one would have expected that there will be more dental ED visits in rural areas following the ACA Medicaid expansion and adult dental coverage. On the other hand, rural dental providers are more likely to participate in Medicaid and accept new Medicaid patients compared to urban providers, possibly because of the higher share of Medicaid patients in rural areas (37,40). Therefore, it is possible that new enrollees had less difficulty finding professional dental care, and did not need to use the ED for their dental complaints.

In this study, the increase in dental ED use in expansion states providing adult Medicaid coverage was sustained in the second, third and fourth quarters of 2014. Due to the limited years of data available, it is not known whether this pattern continued in 2015. After Oregon's Medicaid expansion through random lottery selection of participants in 2008, the enrollees continued to use the ED at a higher rate for two years (43). The reverse

was true for Kentucky, where the immediate increase in ED use following the 2014 Medicaid expansion declined in 2015 (44). In our study, is possible that the pattern of care-seeking among the previously uninsured continued even after they gained insurance. A study assessing the impact of the Medicaid expansion in Maryland showed that high utilizers continued to use the ED for ambulatory-care sensitive conditions even after the expansion (45). A national study that examined the use of dental services following the ACA Medicaid expansion reported that low-income childless adults were more also likely to report having a dental visit (25). Hence it is likely that the newly enrolled used both dental offices and the ED in receiving care, as was the case in Oregon (43).

It is difficult to ascertain whether the ED dental visits were due to pent up needs or whether they were truly acute. Prior evidence has shown that ED visits for dental conditions are often classified as urgent or semi-urgent, and that individuals often utilize dental services at a high rate as soon as care becomes available (18). Hence, it is possible that these visits were due to pent up needs. Notwithstanding, the ED has very little resources to definitively treat dental conditions. This further highlights the need to improve the avenues by which Medicaid enrollees can receive definitive care after an expansion.

There are several limitations to this study. First, this study uses data from ten states. Data on ED use across all 50 states and the D.C. would have been ideal. Notwithstanding, ED data of states from all four census regions of the United States are represented in the study. Second, due to the limitations of the data, it was not possible to identify the specific effect of the ACA Medicaid expansion on low-income childless adults, given that they were the main target of the policy. Third, at the time of this study, data was limited to the first year following the expansions, hence one cannot ascertain that the effect on dental ED

visits was sustained in the later years. Future research should examine the impact using more years of data. Fourth, the states' decision to expand Medicaid and provide dental benefits was not random. Last, we could not account of the manner in which the expansion was conducted in different states (46).

3.5. CONCLUSION

In conclusion, this study has found that among states that expanded Medicaid, dental ED visits declined overall relative to comparison states, but visits among Medicaid enrollees increased significantly. In addition, as was the example in Arizona, expanding Medicaid without accompanying dental coverage was associated with spike in dental ED visits. Emergency departments in expansion states can take advantage of the surge in Medicaid-covered ED visits to channel patients toward community dental health clinics.

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Figure 3.1. Rate of Dental ED Visits per 1,000 County Population Aged 20 – 64 (2010 – 2014)

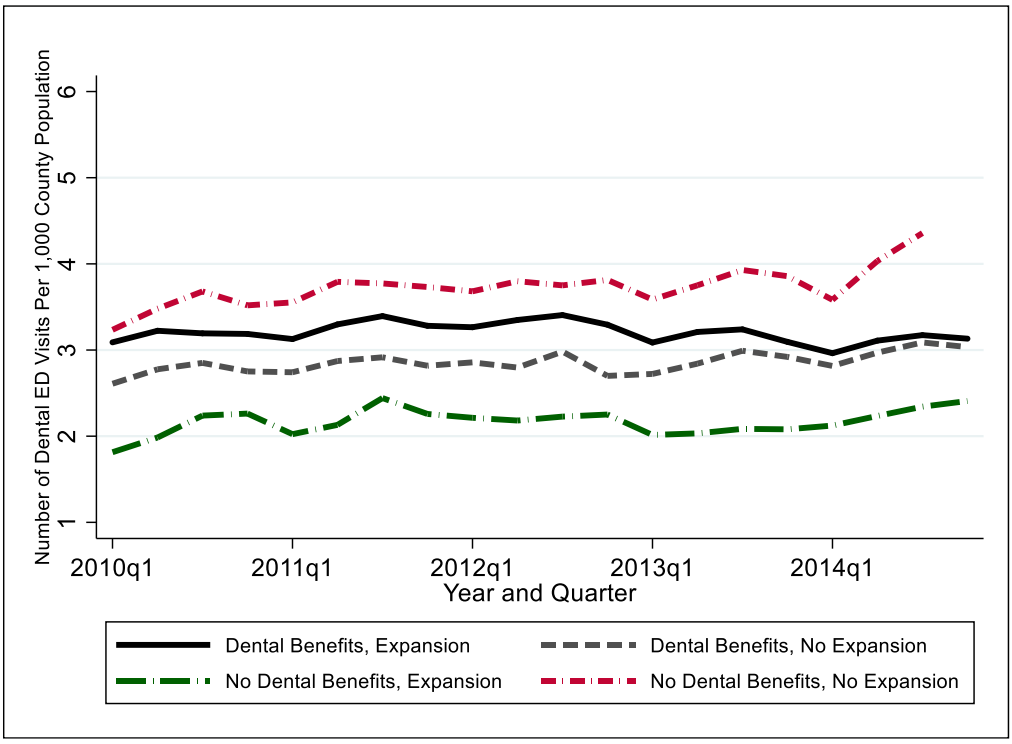

Figure 3.2. Unadjusted Trends in the Percentage of Dental ED Visits by Insurance Status

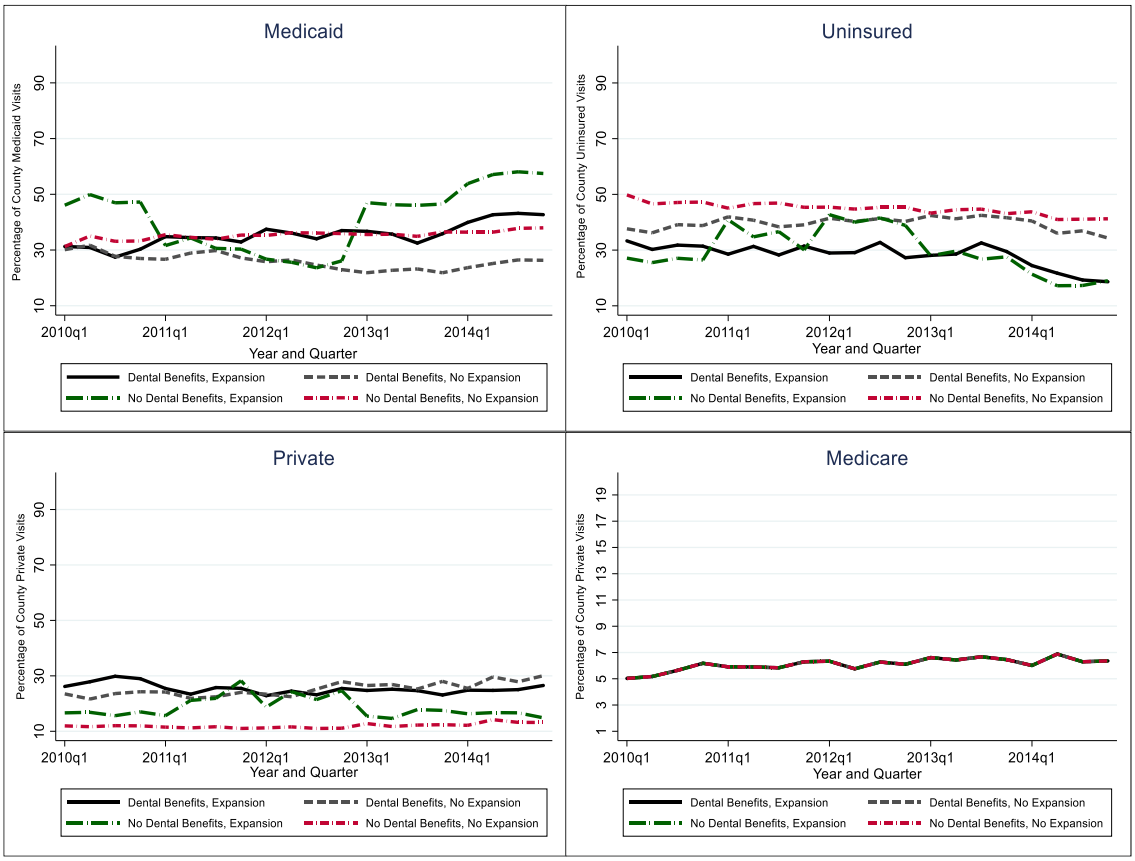

Table 3.1. Classification of Study States Based on Medicaid Expansion Status and Provision of Medicaid Adult Dental Benefits

Policy Classification	States	Group
States providing Medicaid adult dental benefits and expanding Medicaid	MA, NJ, NY, RI, VT	Treatment
States providing Medicaid adult dental benefits and not expanding Medicaid	NE, NC, WI	Comparison group 1
States not providing Medicaid adult dental benefits and expanding Medicaid	AZ	Comparison group 2
States not providing Medicaid adult dental benefits and not expanding Medicaid	FL	Comparison group 3

Table 3.2. County Characteristics Associated with Dental ED visits Before the Expansion

Characteristics		**Treatment group**	**Comparison group 1**	**Comparison group 2**	**Comparison group 3**
	All Visits	Dental coverage, Medicaid expansion	Dental coverage, no Medicaid expansion	No Dental coverage, Medicaid expansion	No Dental coverage, no Medicaid expansion
Number of visits, mean (SD)	3.04 (0.02)	3.23 (0.04)	2.81 (0.04)	2.14 (0.06)	3.68 (0.05)
Urban/Rural status of counties (%)					
Urban residents	46.11	66.63	32.41	44.03	58.96
Rural residents	53.89	33.37	67.59	55.97	41.04
DHPSA (%)					
Whole County	6.78	11.21	0.56	98.77	0.00
Partial County	67.09	63.77	65.3	1.23	94.03
None	26.13	25.01	34.14	0.00	5.97
Dentists per 10,000 population					
1 (Low)	26.36	13.75	29.12	33.33	36.94
2	25.55	21.13	27.31	27.98	26.49
3	22.96	26.09	22.64	16.46	20.15
4 (High)	23.38	38.17	18.77	22.22	14.18
Percentage of residents					
< 65 without insurance, mean (SD)	15.7 (5.77)	10.89 (0.08)	15.7 (4.59)	20.8 (3.44)	23.04 (4.22)
In poverty, mean (SD)	15.76 (5.59)	13.10 (4.22)	15.38 (5.38)	21.76 (5.89)	19.35 (5.35)
Year-Quarter (%)					
Year-Quarter 1	25.03	25.01	25.04	25.1	25
Year-Quarter 2	24.96	24.96	24.93	25.1	25
Year-Quarter 3	24.96	25.01	24.91	25.1	25
Year-Quarter 4	25.06	25.01	25.12	24.69	25

Notes: Estimates were obtained based on author's analysis of the State Emergency Department Databases for ten states. DHPSA is Dental Health Professional Shortage Area.
ANOVA and chi-square tests were used to test for significant differences between groups. With the exception of Year-Quarter, all groups were significantly different each other with respect to county characteristics.

Table 3.3. Changes in Average Number of Dental ED Visits per 1,000 County Population with Medicaid Expansions and Dental Coverage

	Pre-expansion	Post-expansion	Difference	Simple DiD (95% C.I)	Adjusted DiD (95% C.I)
Treatment Group Dental Benefits, Expansion	3.23	3.09	-0.14		
Control Group 1 Dental Benefits, No Expansion	2.82	2.98	0.16	-0.307 (-0.434, -0.180)***	-0.310 (-0.438, -0.181)***
Control Group 2 No Dental Benefits, Expansion	2.14	2.28	0.14	-0.250 (-0.398, -0.103)***	-0.522 (-0.800, -0.245)***
Control Group 3 No Dental Benefits, No Expansion	3.68	4.02	0.34	-0.473 (-0.638, -0.308)***	-0.443 (-0.609, -0.277)***
*P<0.05. **P<0.01. ***P<0.001. .					

Table 3.4.Rural-urban Changes in Average Number of Dental ED Visits per 1,000 County Population with Medicaid Expansions and Dental Coverage

Post x expansion x rural	Simple DiD (95% C.I)	Adjusted DiD (95% C.I)[a]
Treatment Group Dental Benefits, Expansion		
Control Group 1 Dental Benefits, No Expansion	0.02 (-0.256, 0.304)	-0.01 (-0.293, 0.265)
Control Group 2 No Dental Benefits, Expansion	0.15 (-0.178, 0.481)	0.72 (-0.257, -0.402)
Control Group 3 No Dental Benefits, No Expansion	0.07 (-0.286, 0.420)	0.01 (-0.348, 0.376)
*P<0.05. **P<0.01. ***P<0.001. [a] Full regression output shown in Appendix 5.		

Table 3.5. Changes in Payer-Mix for Dental ED Visits in Counties with Medicaid Expansions and Dental Coverage

	Share Medicaid	Share Uninsured	Share Private
Treatment Group Dental Benefits, Expansion			
Control Group 1 Dental Benefits, No Expansion	9.22(7.17,11.28)***	-5.30(-7.37,-3.23)***	-4.15(-6.08,-2.22)***
Control Group 2 No Dental Benefits, Expansion	8.82(2.29,15.35)**	-3.95(-8.14,0.24)	-1.80(-7.79,4.19)
Control Group 3 No Dental Benefits, No Expansion	7.06(5.04,9.08)***	-4.79(-6.57,-3.01)***	-2.71(-4.33,-1.09)**
*P<0.05. **P<0.01. ***P<0.001. .			

4. DENTAL HYGIENISTS' SCOPE OF PRACTICE REGULATIONS AND EMERGENCY DEPARTMENT VISITS FOR NON-TRAUMATIC DENTAL CONDITIONS

4.1. BACKGROUND

Dental disease is highly preventable, yet across all age categories, many in the United States suffer from poor oral health. In year 2000, the U.S Surgeon General Report identified untreated dental caries as the most common chronic disease of childhood (1), with a disproportionate burden among low income and minority children (1,2). An analysis of the 2011 to 2012 National Health and Nutrition Examination Survey (NHANES) found that about 27 percent of adults have untreated dental disease (3). Analysis of the same survey for years 2009 to 2014 found that 42 percent of adults aged 20 to 64 had gum disease, with about 7.8 percent experiencing severe gum disease (4).

Poor oral health has been attributed to a range of personal factors such as inadequate oral health literacy, consumption of sugary foods and beverages, tobacco use, and fear of dental procedures (5,6). However, inadequate access to oral health services has also been identified as a major predictor of oral health outcomes. Factors affecting access include the high cost of dental care, inability to obtain dental insurance (7), geographic misdistribution of dentists, difficulty finding dentists that accept Medicaid, lack of integration of dental and medical care, poor interdisciplinary collaboration within the dental work force, and regulatory barriers that prevent practice of alternative delivery methods of care (8).

In the United States, the dental workforce consists of dentists, dental hygienists, and dental assistants. The use of alternative mid-level providers such as dental therapists is being tested in states such as Alaska and Minnesota, but not nationally (9). Dentists and dental hygienists are both licensed professions that provide complementary services to patients but may serve as substitutes for each other in the provision of some services (10). Basically, dental hygienists are mid-level providers that are trained to provide preventive and prophylactic services such as plaque and tartar removal, application of sealants, oral health needs assessment, oral hygiene education and counselling, radiography, and treatment planning (11). The tasks performed by dental hygienists, and the settings in which they are permitted to work differs by state.

The scope of practice describes the parameters under which a health professional can operate under the law given their education, experience, and skills (12). Specifically, scope of practice for dental hygienists represent oral health services they are allowed to offer, the settings in which services can be offered and the supervision levels under which they must perform these services. Within the dental profession, scope of practice laws are broadly defined by state statues in the dental practice acts or dental hygiene practice acts. These acts are further expanded by regulations delineated by the state Boards of Dentistry or Boards of Dental Examiners (13). Even though most dental hygienists obtain education from nationally accredited schools, their legal scope of practice is determined by state regulations. Unlike many professions that are self-governing, dental hygiene is regulated under the purview of dentistry (13). However, states such as Oregon, Maryland, Texas, California, and Missouri have separate dental hygiene committees that provide recommendations to the dental board concerning the dental hygiene profession (13). As the

number of dental hygienists have grown, their involvement in developing legislations have grown stronger (10,14). This growth has been accompanied by expansion of the range of tasks performed, and a movement towards greater autonomy in the provision on dental services.

Over time, some measures have been developed to appraise the legal environment in which dental hygienists are permitted to practice. Among these measures are Direct Access and the Dental Hygiene Professional Practice Index (DHPPI). In 2004, the American Dental Hygienists' Association (ADHA) defined Direct Access as "the ability of a dentist to initiate treatment based on their assessment of a patient's needs without the specific authorization of a dentist, treat the patient without the presence of a dentist, and maintain a provider–patient relationship" (15). The DHPPI was developed by the Center for Workforce Studies based on a grant by the National Center for Health Workforce Analysis at the Health Resources and Services Administration (HRSA). This instrument was created to measure the ability of dental hygienists to provide services within their scope of training, and the extent to which the practice constraints impacted the ability of dental hygienists to provide care for underserved populations outside of the dental office (13). The four major components of the DHPPI include regulation, supervision, tasks permitted and reimbursement. Higher scores of the DHPPI reflect increased tasks allowed, greater autonomy, and increased possibilities of direct reimbursement for services provided.

The components of the DHPPI are briefly described. Regulation: the DHPPI measures how the dental hygiene practice is regulated through entry requirements, whether or not a dental hygienist is restricted to a patient of record of the primary employing

dentist, the composition of the state dental board, and the ability of dental hygienists represented on the board to vote. Supervision: this is measured by the levels of dentist oversight required in different practice settings. These settings include dental offices and public health settings such as federally qualified health centers, community dental clinics, schools, and long-term care facilities. There are five types of supervision levels: personal, direct, indirect, general, and unsupervised. Personal supervision entails that a dentist must be proximately and actively involved in the assessment, authorization and delivery of treatment to the patient. Direct supervision entails that a dentist must be physically present, and authorize the procedure being performed by the dental hygienist. Indirect supervision implies that the dentist has granted prior authorization for a procedure being performed and is available to the dental hygienist. General supervision entails that the dentist may authorize a task, but need not be present at the time of service delivery.

Tasks permitted: the DHPPI measures the tasks that may be performed under varying levels of supervision. Usually, the extent to which a dental procedure can be reversed determines whether a dental auxiliary may perform such services. Some states allow dental hygienists to perform remediable tasks without direct supervision while others require direct supervision regardless of the task. Reimbursement: the DHPPI measures the ability of dental hygienists to directly bill Medicaid or commercial insurers for their services. Most states prohibit dental hygienists from practicing solely or in-group, which prevents dental hygienists from independently providing services outside of the dental office or health facility. Therefore, in spite of relaxed supervision requirements in some states, most dental hygienists may not be directly reimbursed for their services.

Several studies have examined the economic and clinical impacts of scope of practice laws. In terms of economic outcomes, a study on the oral health of Air Force recruits found that stricter entry requirements for dentists were associated with higher prices of dental services, but not improved quality of the dental services delivered. They also reported fewer qualified dentists in states with tighter regulations and greater rates of tooth decay among the recruits (16). A study of dental insurance claims found that regulations restricting the practice of dental hygienists increased the prices of basic dental services by 12% and direct reimbursement of dental hygienists for their services was associated with 3-4% increase in the use of dental services (17). Wanchek (18) reported that stringent licensure requirements and practice restrictions, as measured by the DHPPI, were associated with lower dental hygienists per capita, reduced dental hygienist wages, and fewer dental visits. In addition, higher DHPPI scores and self-employment for dental hygienists have been significantly associated with increased earnings for dental hygienists (10,14).

Regarding clinical outcomes, studies using the Behavioral Risk Factor Surveillance System (BRFSS) reported that higher DHPPI scores were associated lower levels of tooth loss due to tooth decay or gum disease (12,14). In states with higher scores, residents were more likely to have received oral prophylaxis from a dental hygienist (14). Further, Maxey et al (19) found that between year 2004 and 2012, higher DHPPI scores were consistently associated with the proportion of patients at Federally Qualified Health Centers that received a dental examination. To the researcher's knowledge, no study has investigated the association between the legal scope of practice environment and emergency department (ED) use for non-traumatic dental conditions.

Using repeated cross- sectional data, this study examines whether some states' scope of practice laws for dental hygienists are associated with ED use for non-traumatic dental conditions. The study also examines the impact of these state policies on dental ED use among different age cohorts, and within communities designated as dental health professional shortage areas.

4.2. METHODS

4.2.1. Data Sources and Study Sample

This study used longitudinal data obtained from the State Emergency Department Databases (SEDD) for 11 states over years 2007 to 2014. The SEDD is one of the databases made available by the Healthcare Cost and Utilization Project (HCUP), under the oversight of the Agency for Healthcare Research and Quality (AHRQ). Information on ED visits for non-traumatic dental conditions were obtained for the following states: Arizona, Florida, Massachusetts, North Carolina, Nebraska, New Jersey, New York, Rhode Island, Utah, Vermont, and Wisconsin. For Utah, only data from years 2007 to 2013 were available.

Information on state polies permitting Direct Access for dental hygienists was obtained primarily from the American Dental Hygienist's Association (ADHA) website and archives (15). The ADHA is the entity that defined Direct Access and has monitored the status of all fifty states for over nine years. The DHPPI score for each state in year 2014 was obtained from the Center for Health Workforce Studies (12). State and county-level characteristics of each state in the study were extracted from the Area Health Resources Files (AHRF). Discharge records for non-traumatic dental visits obtained from

the SEDD were aggregated to the county-year-quarter level and merged with the AHRF using the patient's county of residence.

4.2.2. Measures

Dependent variables: The main outcome of interest was the number of non-traumatic dental ED visits from each county over the study period. This outcome was defined as the number of dental ED visits per 1000 county population for each county-year-quarter. Secondarily, visits for dental conditions which have been deemed to be sensitive to primary or preventive dental care were identified for each county-year-quarter (20). The ICD-9 diagnosis codes used to identify all visits for non-traumatic dental conditions and specific visits for primary care-sensitive dental conditions is available in Appendix 4. The first five diagnosis codes were used to identify the dental visits (21).

Independent variables: This study used two measures of scope of practice regulations – Direct Access and the DHPPI index, to examine the influence of state policy regarding dental hygienists on dental ED use. In order to measure the impact of Direct Access policy on ED use for dental conditions, the states were grouped into three categories based on whether or not they had passed Direct Access policy during the study period. The first group, which is the treatment group, comprised Florida and Massachusetts which passed Direct Access policy in June 2011 and January 2009, respectively. The second group, comparison group 1, comprised North Carolina, New Jersey, and Utah, which did not pass Direct Access policy during the study period. The third group, comparison group 2, comprised Arizona, Nebraska, New York, Rhode Island, Vermont, and Wisconsin, which had already passed Direct Access legislation before the study period (2007). Analyses involving comparison group 2 were only conducted in the sensitivity

analysis. With regards to the second scope of practice measure, the 2014 DHPPI scores assigned to each state were used as the main predictor in separate analyses. The status of the states on the two scope of practice measures are presented in Table 4.1.

Other covariates: The impact of the states' Direct Access policy was tested on dental visits originating from areas designated as whole or partial Dental Health Professional Shortage Areas (DHPSAs). The Health Resources and Services Administration Bureau of Health Workforce designates shortage areas in order to identify communities where obtaining dental care is difficult, and to allocate resources needed to alleviate the unmet dental need in such areas. Counties are classified as whole, partial or non-shortage areas based on criteria such as population-to-provider ratio, percentage in poverty, water fluoridation status, and travel time to nearest source of care. DHPSA designation was assigned in 2010 and 2015. Hence, 2010 values were used for 2007 to 2013, while 2015 values were used for 2014.

With regards to other covariates, the dentist-to-population ratio was obtained by dividing the number of active dentists in a county by the county population obtained from the U.S. Census Bureau. As the number of dental hygienists in each county was not available for all the years in the study period, the number of dental hygienists in each state was obtained from the Bureau of Workforce Statistics and divided by the state population. In addition, the rural-urban status of the counties were obtained using the NCHS classification (22), which categorizes counties into six categories ranging from large central metropolitan areas to non-core. The first four categories were classified as urban, while the last two categories were classified as rural.

4.2.3. Study design and statistical analyses

Two types of study design were employed for the different scope of practice measures were examined. The first method examined the effects of Direct Access policy using a difference-in-differences quasi-experimental study design. States that changed their legislation to permit Direct Access for dental hygienists were used as the treatment group, and states whose legislations remained unchanged were used as the control group. This method is suitable because information on the Direct Access status of each state was accessible for each year of the study period. The second method used a cross-sectional study design to measure the association between the DHPPI index and dental ED use in 2014, the year for which DHPPI values are available for the study period.

Measuring the impact of Direct Access: Unadjusted and adjusted difference-in-differences ordinary least squares regressions were used to assess the impact of Direct Access policy. The unadjusted estimates were obtained by regressing the outcome on a variable indicating Direct Access status, an indicator variable for the post-policy period, and the interaction of both. The adjusted difference-in-differences ordinary least squares regression model assessing the impact of Direct Access policy is described below:

$$Y_{cst} = \alpha_i + \beta_1 \text{Direct\_Access}_s + \beta_2 \text{Post}_t + \beta_3 \text{Direct\_Access}_s * \text{Post}_t +$$

$$B_4 \text{Direct\_Access}_s * \text{Post}_t * \text{DPHSA}_c + X_{cst} + S_s + T_t + \varepsilon_{cst}$$

where Y_{cst} is either the number of non-traumatic dental ED visits per 1000 county population or the number of ED visits for primary care-sensitive non-traumatic dental conditions for each county *c* in state *s* at year-quarter *t.* POST is an indicator for visits in county-year-quarter *t* that occurred after the Direct Access policy was passed. DIRECT_ACCESS is an indicator variable for states that passed Direct Access

regulations. X_{cst} represents the time varying, county-level covariates including DHPSA designation, rate of professionally active dentists per 10,000 county population, percentage of residents in poverty, and percentage of residents that are uninsured. X_{cst} also includes the number of dental hygienists per 10,000 state population. S_s and T_t represent county and year-quarter fixed effects.

αi is the baseline average count of visits, and $\beta 1$ represents the effect that is not related to the Direct Access regulation. β_2 represents the difference between states before the regulation was passed. β_3 represents the effect of the Direct Access regulation. It is interpreted as the change in dental ED count per 1000 county population relative to the pre-policy period. β_4 measures the effect on dental ED visits originating in whole and partial shortage areas compared to non-shortage areas. ε is the random error. Standard errors were clustered by county to account for within-county correlation of the error terms.

Measuring the impact of regulation via the DHPPI index: Ordinary least square regression models were used to test the association between the scope of practice policy environment as captured in the DHPPI and ED visits for non-traumatic dental conditions. This analysis was restricted to the 10 states for which 2014 data were available. The main predictor variable was the 2014 DHPPI index for the states, and county-level covariates such as DHPSA designation, rural/urban classification, dentists per 1000 county population, percentage of residents uninsured and in poverty, and dental hygienists per 1000 state population and 2014 year-quarters were adjusted for. In addition, separate regressions were conducted to assess the differential influence of the DHPPI index on dental ED visits across different age cohorts. Age cohorts were chosen based on distinct

patterns of dental ED use observed in the literature across the age spectrum (23). These were classified as ages 0 to 19, 20 to 34, 35 to 49, and 50 to 64.

4.2.4. Sensitivity Analysis

To assess the validity of findings from the difference-in-difference analysis, the parallel trend assumption was tested, which tests the assumption that if the Direct Access policy were not passed, the pattern of dental ED visits will mirror that of non-Direct Access states. The presence of pre-trends were tested by interacting the policy change with time, and restricting the data to the pre-policy periods in Florida and Massachusetts. These tests were conducted separately for the two states in the treatment group because they passed the regulation regarding direct access at different times. Further falsification tests were conducted using an alternative control group comprising states that already passed Direct Access regulation before the study period. Finally, the effect of the policy was tested on those visits to the ED for trauma-related joint disorders and locations, conditions not expected to be impacted by Direct Access regulation. If the estimates of the Direct Access regulation was statistically different from zero, this would suggest that the difference in differences estimates may be biased. All analysis were conducted using Stata 14 (24).

4.3. RESULTS

The baseline characteristics of counties in the study states are displayed in Table 4.2. Compared to states with Direct Access regulation, states without non-Direct Access legislation had fewer dental ED visits (2.18 vs. 2.39 dental ED visits per 1000 county population), more visits among rural residents (52.07% vs 38.27%), fewer dentists per

10,000 county population (4.27 vs. 4.29), and fewer dental hygienists per 10,000 state population (55.49 vs. 56.21). There were more dental ED visits from counties classified as non-DHPSAs in non-Direct Access states (24.94% vs. 4.94%). However in Direct Access states, there were higher number of visits from residents of areas classified as whole (9.88% vs. 3.55%) or partial DHPSAs (85.17% vs 71.51%). On average, both groups were similar with regards to the percentage of dental ED visits from residents in areas with the average uninsured population, and average poverty levels.

Figure 4.1 plots the unadjusted trends in dental ED visits in each study state. Florida and Massachusetts, the Direct Access states in this study, had similar trends in the rate of dental ED visits before 2011. However, after 2011, there was a diversion in the trends of visits, with Florida having larger increases in dental ED visits, and Massachusetts having a decline in the number of dental ED visits. Among the non-Direct Access states, during the study period, North Carolina, had the highest rate of dental ED visits. New Jersey and Utah had the lowest rates of dental ED visits compared to all the other states in the study.

The unadjusted and adjusted difference-in-differences estimates for the change in dental ED visits related to the Direct Access regulation are presented in Table 4.3. The adjusted estimates show that in the treatment states, all dental-related ED visits declined by 0.105 visits per 1000 county population per quarter relative to the pre-regulatory period and comparison group 1 (95% confidence interval [CI] -0.326 to 0.116). On the other hand, ED visits for dental conditions likely to benefit from primary care increased by 0.051 visits per 1000 county population per quarter relative to the pre-regulatory period and

comparison group 1 (95% CI -0.015, 0.116). However, none of these estimates reached statistical significance.

The adjusted difference-in-differences estimates shown in Table 4.4 indicate that relative to the pre-regulatory period and non-Direct Access states, the Direct Access regulation was associated with a decrease in dental ED visits (adjusted -0.619 95% C.I -1.203, -0.034), and primary care-sensitive visits (adjusted -0.298 95% C.I -0.571,-0.024) in areas designated as whole DHPSAs. However, in partial shortage areas, all dental ED visits, and visits for primary-care sensitive dental conditions increased by 0.155 (95% CI -0.292, 0.602) and 0.115 (95% CI -0.026, 0.204) visits per 1000 county population per quarter. Only the latter estimate was statistically significant.

Table 4.5 presents the association between DHPPI scores and dental ED visits in 2014 regardless of age, and within different age cohorts. In the model that was not stratified by age, DHPPI scores were associated with decreased dental ED visits; one point increase in DHPPI scores was associated with a decrease of 0.038 (95% CI -0.042,-0.035) dental ED visits per 1000 county population per quarter. In the age-stratified analysis, the decline in dental ED visits was most marked within the 20 to 34 (-0.135 95% CI -0.148,-0.123), and the 35-49 age cohorts (-0.050 95% CI -0.056,-0.044).

With regards to other covariates, rural children (0.122 95% CI 0.059, 0.185) and rural residents aged 20 to 34 (0.916, 95% CI 0.534, 1.298) had significantly higher dental ED compared to their urban counterparts. Across the age spectrum, there were more visits from residents of whole professional shortage areas compared to areas designated as non-shortage areas. This was especially marked among residents aged 20 to 34 and those aged 35 to 49. There were 3.5 more visits per county-year-quarter in areas designated as whole

DHPSA among those aged 20 to 34, and 1.73 more dental ED visits per 1000 county population per quarter among those aged 35 to 49 compared to similar residents in non-DHPSAs. In terms of the dental workforce, the dental hygienists per 10,000 state population was inversely associated with dental ED use across the age groups. However, increasing the number of dentists practicing in each county was associated with a decrease in dental ED use in the non-age stratified model (-0.039 95% CI [-0.061,-0.017), and among adults between ages 20 to 34 (-0.270 95% CI -0.347,-0.194). County poverty level was associated with increased dental ED use, while the percentage of uninsured residents was associated with decreased dental ED use.

Falsification tests for pre-trends showed mixed results (Appendix 8). In Florida, in the last four quarters before the Direct Access regulation changed, there were no significant pre-trends. However, there were some statistically significant pre-trends in a year before Direct Access policy was passed. In Massachusetts, there were no statistically significant pre-trends in before the regulations were changed. Second, sensitivity analyses comparing the effect of Direct Access policy in the treatment group relative to control group 2, the states that already passed Direct Access regulation before the study period, yielded no significant estimates related to the policy change (Appendix 9). When the policy impact was tested on ED visits for trauma-related joint disorders and dislocations, the coefficient was statistically different from zero. This finding suggests that estimates measuring the effect of Direct Access legislation in Florida and Massachusetts may be biased, or that state-level factors unrelated to Direct Access may have produced the findings of decreased ED visits.

4.4. DISCUSSION

This study examined the impact of states' Direct Access policy for dental hygienists on ED visits for non-traumatic dental conditions. The study also assessed the influence of the legal scope of practice environment as measured by the DHPPI on dental ED use. Two main findings emerged from this study. First, this study found that in places designated as whole DHPSAs, regulation permitting direct access for dental hygienists was associated with reduced dental ED use in such areas. ED visits for primary care sensitive dental conditions also declined following Direct Access regulation in whole DHPSAs. However, these findings were not robust to falsification tests.

It has been suggested that one of the mechanisms by which Direct Access policy works is that it creates alternate portals of entry into the oral health system (25). Maxey (2017) demonstrated that in states with more liberal scope of practice laws, more underserved patients were able to receive care at Federally Qualified Health Care centers (FQHCs), which are more likely to be located in areas designated as whole or partial DHPSAs (19). Direct access to care at FQHCs is even more important because uninsured and Medicaid patients are more likely to receive care in such centers (26).
Another mechanism by which Direct Access might increase access to care is that in states with liberal scope of practice laws, FQHCs might be able to request reimbursement directly for preventive or educational services offered to patients by dental hygienists (19). Hence, dental hygienists have the potential to expand the quantity of oral health services provided (18). Strategically placing dental hygienists in areas that serve high need populations will enhance access to care and improve the oral health of the population served (12).

The age-stratified models assessing the influence of the DHPPI index on dental ED use showed that less stringent scope of practice environment was associated with decreased dental ED use across all the age cohorts. Previous research has shown that employment of dental hygienists significantly impacts use of health services by all age groups (18). This finding demonstrates that regardless of age, all members of the population potentially benefit when dental hygienists are allowed to practice within their scope of training, particularly outside of the dental office, as captured by the DHPPI.

In particular, this study found that young (ages 20-34) and middle aged adults (ages 35-50) had fewer dental ED visits in states with higher DHPPI scores. This is noteworthy given prior research that shows that individuals between ages 20 and 34 have the highest rates of dental ED use, and the lowest rates of dental office visits (27,27–29). Individuals in this age cohort are also more likely to be uninsured, and have low income (28,30,31). Hence, expanding dental hygienists' scope of practice could potentially create alternate portals to engage those aged 20 to 34, and the preventive care they receive will ensure that emerging oral diseases are caught early. Given that dental hygienists focus on preventing oral health diseases and promoting oral health, the services they provide to the young adults may help the latter develop oral health behaviors that may last a life time.

The findings from other covariates that were controlled for mirror that of prior research. The study showed that rural children, residents of rural areas aged 20 to 34, and residents of whole DHPSAs had increased dental ED use, controlling for other factors (32–34). Likewise, increasing the number of dentists and dental hygienists was associated with decreased dental ED use (27,35–37).

4.4.1. Limitations

This study has several limitations. First, it would have been ideal to examine data from all fifty states in order to obtain a national picture of the influence of scope of practice policies on dental complaints in the ED. However, such data was not available to the researcher. Second, due to the claims data constraints, it was difficult to determine whether dental conditions that were treated in the ED were directly associated with a dental hygienist's intervention. The data does not contain information about patients' previous visits to dentists or dental hygienists. Third, the scope of practice regulations, as measured by Direct Access and the DHPPI, measure the legal practice environment for dental hygienists. However, these instruments may not accurately measure the actual tasks and supervision levels allowed in dental offices and public health settings.

4.5. CONCLUSION

Overall, there is evidence that states will benefit from permitting Direct Access for dental hygienists, particularly in underserved areas. In addition, increasing access to dental hygienists especially outside out of the traditional dental office could reduce the number of ED visits for non-traumatic dental complaints, particularly among young and middle aged adults. This study also provides evidence that state policy regarding the dental workforce does influence oral health outcomes and access to oral health services, as evidenced by dental ED use. As more interventions to improve population oral health are explored, policy makers and stake holders must also address the scope of practice policies for mid-level providers.

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Figure 4.1. Rate of Dental ED Visits per 1,000 County Population by Study State

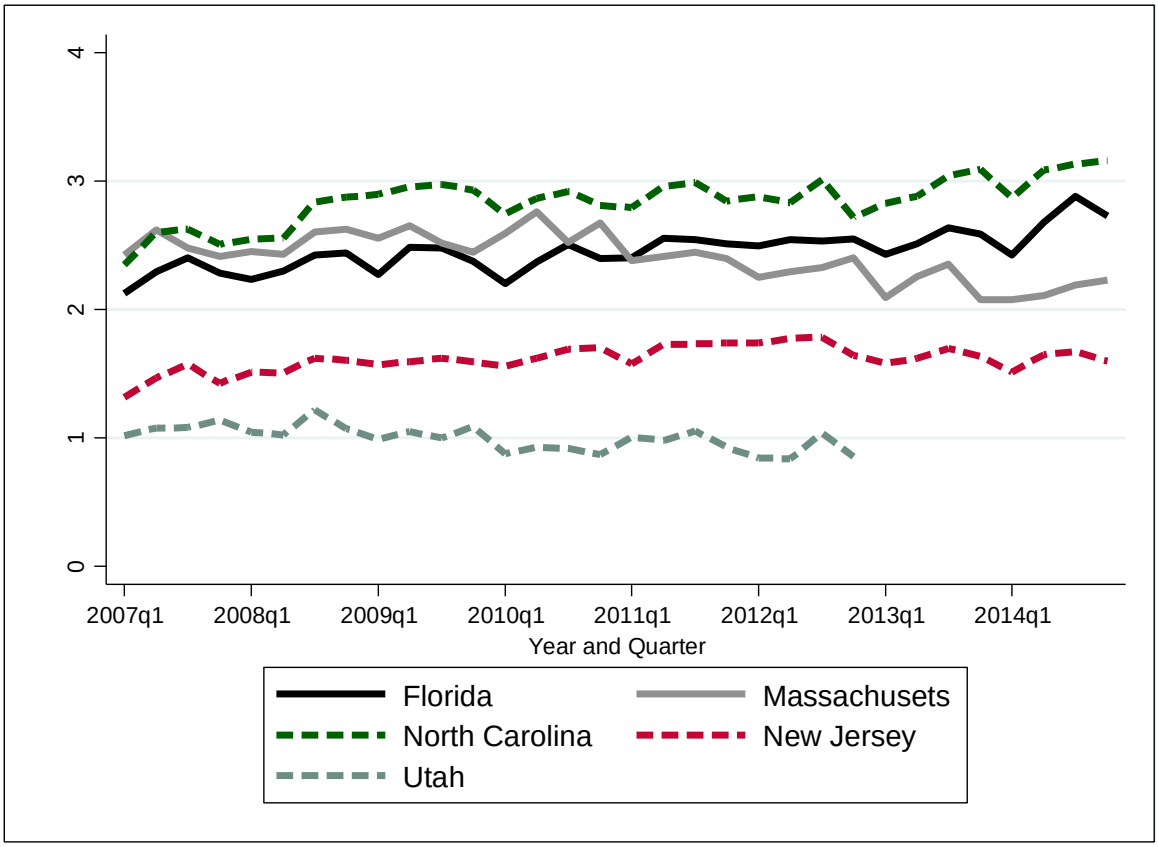


Table 4.1. Direct Access Status and 2014 DHPPI Score of States

States	2014 DHPPI Score	Direct Access during study period?	Group
Florida	41	Yes	Treatment group
Massachusetts	82	Yes	
North Carolina	33	No	Control group 1
New Jersey	40	No	
Utah	48	No	
Arizona	75	Yes	Control group 2
Nebraska	77	Yes	
New York	57	Yes	
Rhode Island	40	Yes	
Vermont	47	Yes	
Wisconsin	58	Yes	

DHPPI: Dental Hygiene Professional Practice Index.

Notes: Florida and Massachusetts passed Direct Access policy in June 2011 and January 2009, respectively. North Carolina, New Jersey, and Utah were non-Direct Access states during the study period. Arizona, Nebraska, New York, Rhode Island, Vermont, and Wisconsin were Direct Access states before the study period.

Table 4.2. County Characteristics Associated with Dental ED visits Before Direct Access Regulation

Characteristics	All Groups	Treatment Group	Comparison Group 1
	All Visits	States with Direct Access regulation	States without Direct Access regulation
Number of visits in county-year-quarter, mean (SD)	2.30 (0.023)	2.39 (0.031)	2.18 (0.036)
Urban/Rural status of counties (%)			
Urban residents	55.55	61.73	47.93
Rural residents	44.45	38.27	52.07
DHPSA (%)			
Whole County	7.04	9.88	3.55
Partial County	79.06	85.19	71.51
None	13.90	4.94	24.94
Dentists per 10,000 county population	4.28(0.052)	4.29 (0.068)	4.27 (0.082)
Dental hygienists per 10,000 state population	55.88 (0.219)	56.21 (0.395)	55.49 (0.035)
Percentage of residents			
< 65 without insurance, mean (SD)	19.85 (0.123)	20.47 (0.205)	19.09 (0.108)
In poverty, mean (SD)	15.62 (0.110)	15.91 (0.145)	15.26 (0.167)
Year-Quarter (%)			
Year-Quarter 1	26.47	27.78	24.85
Year-Quarter 2	26.54	27.78	25.02
Year-Quarter 3	23.55	22.22	25.19
Year-Quarter 4	23.44	22.22	24.94
Sample size (county-year-quarters)	7,139	2592	4547

ED, Emergency Department. SD, Standard Deviation
There were 2592 and 4547 county-year-quarters in the treatment and comparison groups, respectively.

Table 4.3. Changes in the Average Number of Dental ED Visits per 1,000 County Population after Direct Access Regulation

Post x Direct Access	**Pre-Direct Access**	**Post- Direct Access**	**Difference**	**Simple DiD (95% C.I)**	**Adjusted DiD (95% C.I)[a]**
All non-traumatic dental ED visits					
Treatment Group - Direct Access	2.39	2.52	-0.13	-0.074 (-0.233, 0.084)	-0.105 (-0.326, 0.116)
Control Group- No Direct Access	2.18	2.45	-0.27		
ED visits for dental conditions that are likely to benefit from primary care					
Treatment Group - Direct Access	0.56	0.63	-0.07	0.045 (-0.008, 0.097)	0.051 (-0.015, 0.116)
Control Group- No Direct Access	0.51	0.54	-0.03		

*P<0.05. **P<0.01. ***P<0.001. ED, Emergency Department.

[a] Adjusted regressions controlled for DHPSA designation, number of professionally active dentists per 10,000 county population, the number of dental hygienists per 10,000 state population, percentage of residents in poverty, percentage of residents that are uninsured, and county and year-quarter fixed effects. Full regression output for adjusted model shown in Appendix 7.

Table 4.4. Changes in the Average Number of Dental ED Visits per 1,000 County Population after Direct Access Regulation

Post x Direct Access x DHPSA	**Simple DiD (95% C.I)**	**Adjusted DiD (95% C.I)**
All dental-related ED visits		
DHPSA Category		
None	Reference	Reference
Partial	0.224 (-0.296, 0.744)	0.155 (-0.292, 0.602)
Whole	-.194 (-0.877, 0.488)	-0.619 (-1.203, -0.034)*
ED visits for dental conditions that are likely to benefit from primary care		
DHPSA Category		
None	Reference	Reference
Partial	0.136 (0.032, 0.239)*	0.115 (0.026,0.204)*
Whole	-0.152 (-0.407, 0.104)	-0.298 (-0.571,-0.024)*

*P<0.05. **P<0.01. ***P<0.001. ED, Emergency Department; DHPSA, Dental Health Professional Shortage Area

[a] Adjusted regressions controlled for the number of professionally active dentists per 10,000 county population, the number of dental hygienists per 10,000 state population, percentage of residents in poverty, percentage of residents that are uninsured, and county and year-quarter fixed effects.

Table 4.5: Associations between the 2014 DHPPI and Dental ED Use by Age Cohort

	All age groups	0 – 19	20 – 34	35 – 49	50 - 64
DHPPI 2014 Composite Score	-0.038*** (-0.042,-0.035)	-0.008*** (-0.010,-0.006)	-0.135*** (-0.148,-0.123)	-0.050*** (-0.056,-0.044)	-0.013*** (-0.015,-0.011)
Urban-rural classification					
Urban	Reference	Reference	Reference	Reference	Reference
Rural	0.144** (0.035,0.254)	0.122*** (0.059,0.185)	0.916*** (0.534,1.298)	0.198 (-0.000,0.396)	-0.027 (-0.086,0.032)
DHPSA Designation					
None	Reference	Reference	Reference	Reference	Reference
Whole	1.206*** (0.789,1.623)	0.702*** (0.462,0.942)	3.532*** (2.076,4.988)	1.732*** (0.976,2.489)	0.622*** (0.397,0.848)
Partial	0.131* (0.004,0.257)	0.079* (0.006,0.152)	0.531* (0.089,0.973)	0.057 (-0.173,0.286)	0.078* (0.010,0.147)
Dentists per 10,000 county population	-0.039*** (-0.061,-0.017)	-0.007 (-0.019,0.006)	-0.270*** (-0.347,-0.194)	-0.019 (-0.059,0.020)	0.004 (-0.008,0.016)
Dental Hygienists per 10,000 state population	-0.010*** (-0.014,-0.006)	-0.005*** (-0.007,-0.002)	-0.027*** (-0.041,-0.013)	-0.010** (-0.017,-0.003)	-0.003* (-0.005,-0.001)
Percentage in poverty	0.092*** (0.080,0.105)	0.035*** (0.027,0.042)	0.169*** (0.126,0.212)	0.144*** (0.122,0.167)	0.042*** (0.035,0.048)
Percentage uninsured	-0.077*** (-0.090,-0.063)	-0.017*** (-0.024,-0.009)	-0.217*** (-0.263,-0.171)	-0.067*** (-0.091,-0.044)	-0.024*** (-0.032,-0.017)

Table 4.5: Continued

	All age groups	0 – 19	20 – 34	35 – 49	50 - 64
Year-Quarter					
2014 q1	Reference	Reference	Reference	Reference	Reference
2014 q2	0.168* (0.037,0.300)	0.076* (0.000,0.151)	0.469* (0.011,0.927)	0.292* (0.054,0.530)	0.054 (-0.017,0.125)
2014 q3	0.225*** (0.094,0.357)	0.088* (0.012,0.164)	0.623** (0.163,1.083)	0.332** (0.093,0.571)	0.107** (0.035,0.178)
2014 q1	0.169* (0.038,0.301)	0.023 (-0.053,0.099)	0.418 (-0.041,0.878)	0.408*** (0.170,0.647)	0.040 (-0.031,0.111)
Constant	4.132*** (3.669,4.596)	1.159*** (0.893,1.426)	15.001*** (13.382,16.621)	4.509*** (3.667,5.350)	1.259*** (1.009,1.510)
County-year-quarter	1776	1776	1776	1776	1776
R^2	0.427	0.211	0.364	0.324	0.273

All values shown are Beta coefficients.
DHPPI, Dental Hygiene Professional Practice Index; DHPSA, Dental Health Professional Shortage Area.
*P<0.05. **P<0.01. ***P<0.001.

5. CONCLUSIONS

It is well established that the ability of individuals to maintain oral health or obtain professional dental care is influenced by individual-level factors, place-placed characteristics, and the dental workforce, and the health policy environment. This three-paper dissertation has examined the literature on factors that influence ED visits for non-traumatic dental conditions, and investigated the impact of two state-level policies that were intended to increase access to dental care and consequently reduce dental ED visits.

This dissertation has employed two primary methods: a systematic review of the literature and a "difference-in-difference" approach to measure the impact of the Affordable Care Act Medicaid expansion and dental hygienists' Direct Access polices. In the first study, a systematic review approach was used to conduct an in-depth search of the literature to identify articles that have examined factors that predict dental ED use. In the second and third papers, the difference-in-difference approach was used to measure the impact of two policies using repeated cross-sectional data. Using states that did not have these polices as controls, these studies have demonstrated the influence of the ACA Medicaid Expansion and Direct Access to dental hygienists in states where such regulations were in effect.

Findings from the systematic review showed that the type of health insurance available to individuals is highly predictive of dental ED use. Medicaid and uninsured patients were twice and thrice more likely to visit the ED for a dental condition respectively, compared to the privately insured. In addition, emergency department visits for dental complaints are influenced by age. Adults are more likely to use the ED for dental

complaints compared to children and older adults. In areas designated as dental health provider shortage areas, and in areas with fewer dental providers, there were increased dental ED visits. In terms of policy, most studies reported that both expansion and restriction of Medicaid dental coverage were associated with increased emergency department visits for dental complaints. Hence, it is clear that access to care plays a major role in emergency department visits for non-traumatic dental complaints.

The second study used State Emergency Department Databases from 10states, in which states were grouped into four mutually exclusive groups based on whether they expanded Medicaid in 2014 and whether they provided dental benefits to the Medicaid adult population. The difference-in-differences estimation showed that in expansion states that provided dental benefits, dental ED visits decreased by 0.3 to 0.5 visits per 1,000 population per quarter, however, visits covered by Medicaid increased substantially. This study has demonstrated that Medicaid expansion alone, without a corresponding increase in the capacity to manage the newly enrolled individuals could worsen the challenge of access to care. Emergency departments in expansion states can take advantage of the surge in Medicaid-covered ED visits to stir patients toward community dental health clinics. The difference-in-differences estimates also showed that following the policy change, dental ED visits increased in rural areas relative to urban areas. However, these estimates were not statistically significant. Further study using more states might be able to truly capture the differential impact of the Medicaid expansion in rural and urban areas.

In the third paper, the associations between the legal scope of practice environments and dental ED visits was examined. Two scope of practice measures were examined in 11 states – Direct Access and the Dental Hygienists' Professional Practice

Index (DHPPI). The study found that in places designated as whole DHPSAs, regulation permitting direct access for dental hygienists was associated with reduced dental ED use in such areas. ED visits for primary care-sensitive dental conditions also declined following Direct Access regulation in whole DHPSAs. However, these findings were not robust to sensitivity analyses. Less restrictive scope of practice regulations, as measured by the DHPPI were associated with decreased dental ED use regardless of age, but the effects were particularly marked on dental ED visits among individuals aged 20 to 34. This study demonstrated that state policies regarding the dental workforce does influence oral health outcomes, as evidenced by dental ED use.

Despite the fact that this dissertation has examined critical aspects of dental ED use, there are still areas for further research. For example, the systematic review discovered gaps in the literature on potential factors influencing dental emergency department visits that have not been explored. These factors include scope of practice regulations for dental hygienists, use of alternative workforce models such as dental therapists, access to care in Federally Qualified Health Centers (FQHCs), dental homes, and accountable care organizations. In addition, a national study with more years of post-policy data is needed to capture the effect of the ACA Medicaid expansion on dental ED visits in rural areas, and to examine whether these changes were sustained beyond year 2014.

As policymakers and stakeholders contemplate expanding Medicaid programs, this dissertation adds to the evidence that these policy changes must not stop with expanding Medicaid alone. More efforts must be directed at expanding the avenues by which the newly enrolled are able to obtain dental care. Further, as more interventions to improve population oral health are explored, policymakers and stake holders must also address the

scope of practice regulations for mid-level providers, particularly in public health settings and underserved areas.

APPENDIX A

QUALITY OF INCLUDED STUDIES

	1. Were the criteria for inclusion in the sample clearly defined?	2. Were the study subjects and the setting described in detail?	3. Was the exposure measured in a valid and reliable way?	4. Were objective, standard criteria used for measurement of the condition?	5. Were confounding factors identified?	6. Were strategies to deal with confounding factors stated?	7. Were the outcomes measured in a valid and reliable way?	8. Was appropriate statistical analysis used?	Total Score
Anderson 2011	Y	Y	Y	Y	N	N	Y	Y	6
Baicker 2018	Y	Y	Y	Y	Y	Y	Y	Y	8
Battenhouse 1988	Y	Y	Y	Y	N	N	Y	Y	6
Burgette 2017	Y	Y	Y	Y	Y	Y	N	Y	7
Chalmers 2017	Y	Y	Y	Y	Y	Y	Y	Y	8
Chalmers 2016	Y	Y	Y	Y	Y	Y	Y	Y	8
Chi 2014	Y	Y	Y	Y	Y	Y	Y	Y	8
Cohen 2008	Y	Y	Y	N	Y	Y	Y	Y	7
Cohen 2006	Y	Y	Y	Y	N	N	Y	Y	6
Cohen 2002	Y	Y	Y	Y	Y	Y	Y	Y	8
Cohen 1996	Y	Y	Y	Y	Y	Y	Y	Y	8
DeLia 2016	Y	Y	Y	Y	Y	Y	Y	Y	8
Dorfman 2001	Y	Y	Y	N	N	N	Y	Y	5
Fingar 2015	Y	Y	Y	Y	Y	Y	Y	Y	8
Haddad 2018	Y	Y	Y	Y	Y	N	Y	Y	7
Hocker 2012	Y	Y	Y	Y	N	N	Y	Y	6
Holmes 1993	Y	Y	Y	Y	N	N	Y	Y	6
Hom 2013	Y	Y	Y	Y	Y	Y	Y	Y	8
Hong 2015	Y	Y	Y	Y	Y	Y	Y	Y	8

Key: Y, Yes; N, No; NA, Not Applicable; U, Unknown.

Appendix 1 Continued

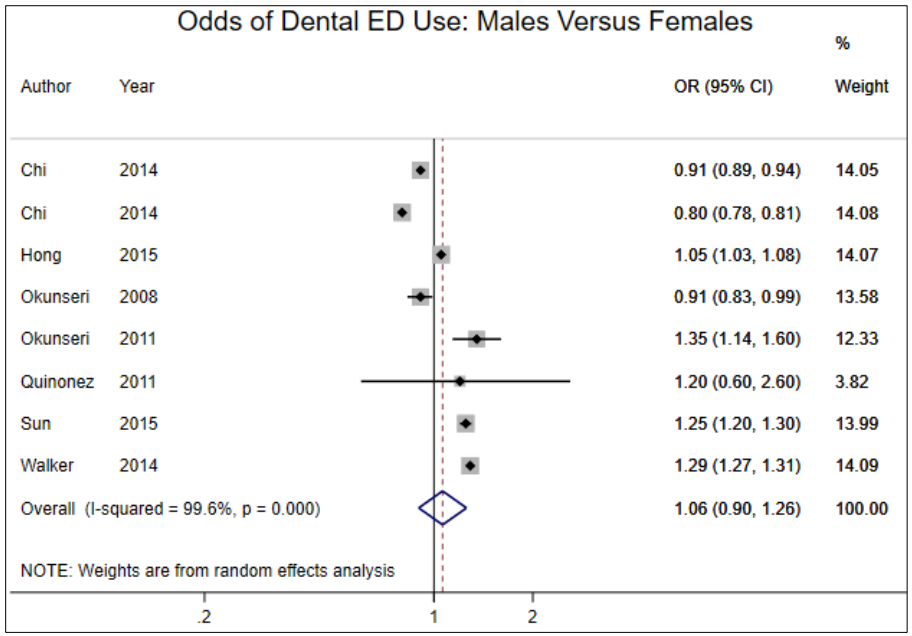
	1. Were the criteria for inclusion in the sample clearly defined?	2. Were the study subjects and the setting described in detail?	3. Was the exposure measured in a valid and reliable way?	4. Were objective, standard criteria used for measurement of the condition?	5. Were confounding factors identified?	6. Were strategies to deal with confounding factors stated?	7. Were the outcomes measured in a valid and reliable way?	8. Was appropriate statistical analysis used?	Total Score
Hong 2013	y	Y	Y	Y	Y	Y	Y	Y	8
Jung 2016	Y	Y	Y	Y	Y	N	Y	Y	7
Ladrillo 2006	Y	Y	Y	Y	Y	Y	Y	Y	8
Laniado 2017	Y	Y	Y	Y	Y	Y	Y	Y	8
Lee 2012	Y	Y	Y	Y	Y	N	Y	Y	7
Lee 2004	Y	Y	Y	Y	Y	Y	Y	Y	8
Lewis 2003	Y	Y	Y	Y	Y	Y	Y	Y	8
Lewis 2015	Y	Y	Y	Y	Y	Y	Y	Y	8
Ma 2004	Y	Y	Y	Y	N	N	Y	Y	6
Manski 1998	Y	Y	Y	Y	N	N	Y	Y	6
Martin 2012	Y	Y	Y	Y	Y	Y	Y	Y	8
Martin 2012	Y	Y	Y	Y	Y	Y	Y	Y	8
Mohamed 2017	Y	Y	Y	Y	Y	Y	Y	Y	8
Nakao 2015	Y	Y	Y	Y	Y	Y	Y	Y	8
Neely 2014	Y	Y	Y	Y	N	N	Y	N	5
Neff 2010	Y	Y	Y	Y	Y	Y	Y	Y	8
Oh 2012	Y	Y	Y	Y	N	N	Y	Y	6
Okunseri 2008	Y	Y	Y	Y	Y	Y	Y	Y	8
Okunseri 2011	Y	Y	Y	Y	Y	Y	Y	Y	8
Powers 2000	Y	Y	Y	Y	Y	Y	Y	Y	8
Key: Y, Yes; N, No; NA, Not Applicable; U, Unknown.									

Appendix 1 Continued

	1. Were the criteria for inclusion in the sample clearly defined?	2. Were the study subjects and the setting described in detail?	3. Was the exposure measured in a valid and reliable way?	4. Were objective, standard criteria used for measurement of the condition?	5. Were confounding factors identified?	6. Were strategies to deal with confounding factors stated?	7. Were the outcomes measured in a valid and reliable way?	8. Was appropriate statistical analysis used?	Total Score
Quinonez 2011	Y	Y	Y	N	Y	Y	N	Y	6
Ramraj 2013	Y	Y	Y	N	Y	Y	N	Y	6
Rowley 2006	Y	Y	Y	?	Y	Y	Y	Y	7
Salomon 2017	Y	Y	Y	Y	Y	Y	Y	Y	8
Sen 2016	Y	Y	Y	Y	Y	Y	Y	Y	8
Serna 2017	Y	Y	Y	Y	Y	?	Y	Y	7
Shortridge 2009	Y	Y	Y	Y	Y	Y	Y	Y	8
Singhal 2015	Y	Y	Y	Y	Y	Y	Y	Y	8
Sun 2015	Y	Y	Y	Y	Y	Y	Y	Y	8
Tramini 2010	Y	Y	Y	Y	YY	Y	Y	Y	8
Von Kaenel 2001	Y	Y	Y	Y	Y	N	Y	?	6
Walker 2014	Y	Y	Y	Y	Y	Y	Y	Y	8
Wall 2012	Y	Y	Y	Y	Y	N	Y	Y	7
Wallace 2011	Y	Y	Y	Y	Y	Y	Y	Y	8
Whiteman 2016	Y	Y	Y	?	Y	Y	Y	Y	7
Widstrom 1988	Y	Y	Y	Y	Y	Y	Y	Y	8
Zeng 1994	Y	Y	Y	Y	N	N	Y	Y	8
Zhou 2018	Y	Y	Y	Y	Y	Y	Y	Y	8
Key: Y, Yes; N, No; NA, Not Applicable; U, Unknown.									

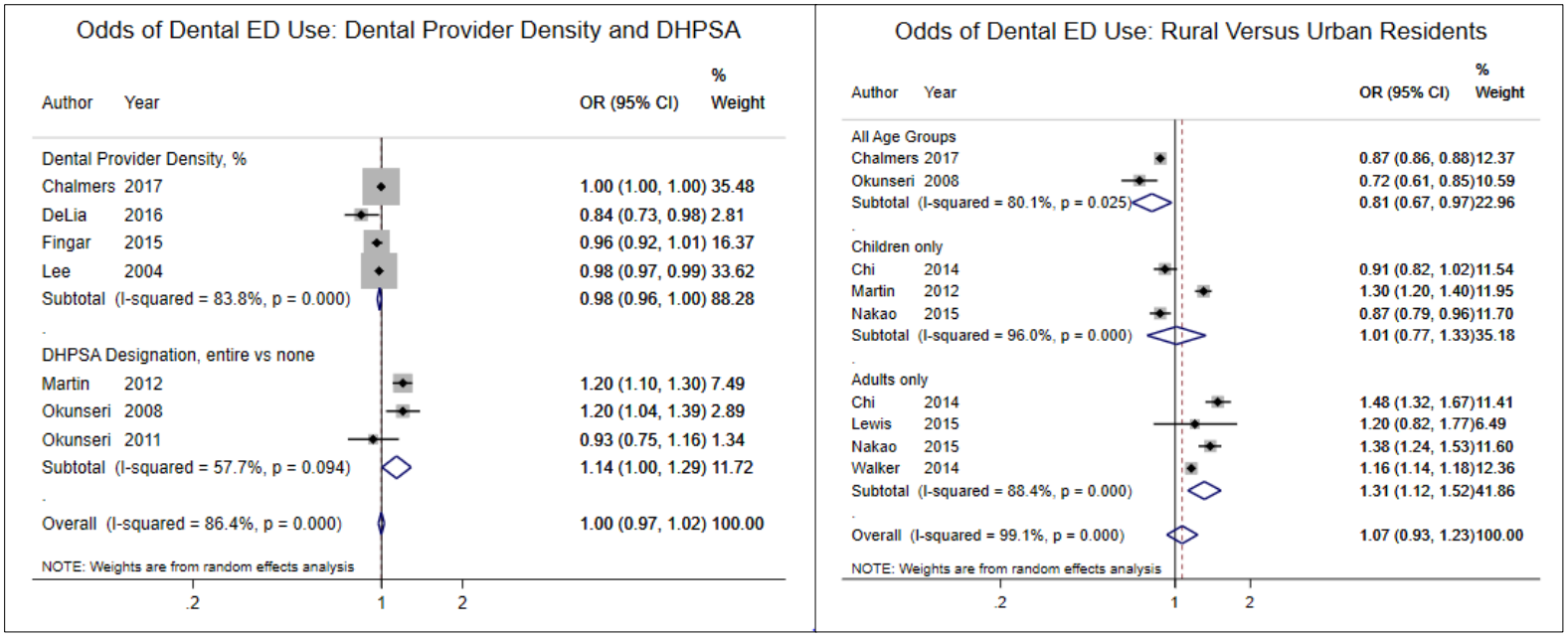
APPENDIX B

FOREST PLOT, MALES VERSUS FEMALES



APPENDIX C

FOREST PLOTS, DENTAL PROVIDER DENSITY, DHPSA DESIGNATION, RURALITY



DHPSA: Dental Health Provider Shortage Area

APPENDIX D

ICD- 9-CM CODES USED TO IDENTIFY NON-TRAUMATIC DENTAL CONDITIONS

All Non-traumatic Dental Conditions

5200 5201 5202 5203 5204 5205 5206 5207 5208 5209 5210
52100 52101 52102 52103 52104 52105 52106 52107 52108 52109
5211 52110 52111 52112 52113 52114 52115
5212 52120 52121 52122 52123 52124 52125
5213 52130 52131 52132 52133 52134 52135
5214 52140 52141 52142 52149
5215 5216 5217 5218 52181 52189 5219
5220 5221 5222 5223 5224 5225 5226 5227 5228 5229
5230 52300 52301 5231 52310 52311 5232 52320 52321 52322 52323 52324 52325
5233 52330 52331 52332 52333 5234 52340 52341 52342 5235 5236 5238 5239
5240 52400 52401 52402 52403 52404 52405 52406 52407 52409
5241 52410 52411 52412 52419 5242 52420 52421 52422 52423 52424 52425 52426 52427 52428 52429
5243
52430 52431 52432 52433 52434 52435 52436 52437 52439
5244 5245 52450 52451 52452 52453 52454 52455 52456 52457 52459 5246
52460 52461 52462 52463 52464 52469
52470 52471 52472 52473 52474 52475 52476 52479
5248 52481 52482 52489 5249 5250 5251 52510
52511 52512 52513 52519 5252 52520 52521 52522 52523 52524 52525 52526 5253
52540 52541 52542 52543 52544 52550 52551 52552 52553 52554
52560 52561 52562 52563 52564 52565 52566 52567 52569
52571 52572 52573 52579 5258 5259
5260 5261 5262 5263 5264 5265 52661 52662 52663 52669
52681 52689 5269 78492 V523 V534 V585 V722

Non-Traumatic Dental Conditions That Would Likely Benefit from Better Prevention or Primary Care

5206 5207 5210 5220 5221 5230-5239

APPENDIX E

FULL REGRESSION OUTPUT: RURAL-URBAN DIFFERENCE-IN-DIFFERENCES (DID) REGRESSION ANALYSIS

	Comparison Group1	Comparison Group2	Comparison Group 3
	Coefficient (95% CI)	Coefficient (95% CI)	Coefficient (95% CI)
Dental Expansion x Post	-0.28 (-0.45,-0.12)***	-0.50 (-0.78,-0.22)***	-0.43 (-0.63,-0.24)***
Dental_Expansion x Post x Rural	-0.01 (-0.29,0.27)	0.07 (-0.26,0.40)	0.01 (-0.35,0.38)
DHPSA			
None	Reference	Reference	Reference
Partial County	0.32 (0.01,0.62)*	0.24 (-0.04,0.52)	0.21 (-0.07,0.48)
Whole County	0.08 (-0.13,0.29)	-0.00 (-0.19,0.18)	-0.02 (-0.20,0.16)
Dentists per 10,000 population			
1 (Low)	-0.04 (-0.34,0.25)	-0.40 (-0.88,0.07)	-0.19 (-0.64,0.27)
2	0.12 (-0.08,0.32)	-0.05 (-0.47,0.37)	-0.00 (-0.41,0.41)
3	0.02 (-0.10,0.14)	-0.01 (-0.23,0.20)	0.11 (-0.06,0.28)
4 (High)	Reference	Reference	Reference
Poverty	0.01 (-0.03,0.04)	0.01 (-0.03,0.05)	0.01 (-0.03,0.05)
Uninsured	-0.01 (-0.06,0.05)	-0.01 (-0.06,0.05)	-0.03 (-0.09,0.03)
County population	0.00 (-0.00,0.00)	0.00 (-0.00,0.00)	-0.00 (-0.00,0.00)
Constant	2.23 (1.02,3.44)***	2.73 (1.60,3.86)***	3.66 (2.09,5.23)***
Number of county-year-quarters	6913	2606	3619

*P<0.05. **P<0.01. ***P<0.001.
This table presents the full regression output for Table 4.

APPENDIX F

TESTS FOR PRE-REFORM TRENDS (FALSIFICATION TESTS)

Year_Quarter x Dental Expansion	Comparison Group1 Coefficient (95% CI)	Comparison Group2 Coefficient (95% CI)	Comparison Group 3 Coefficient (95% CI)
Year 2010 Quarter 1 x Dental Expansion	Reference	Reference	Reference
Year 2010 Quarter 2 x Dental Expansion	-0.00 (-0.12,0.12)	0.08 (-0.12,0.28)	-0.11 (-0.30,0.08)
Year 2010 Quarter 3 x Dental Expansion	-0.15 (-0.33,0.03)	-0.20 (-0.42,0.01)	-0.34 (-0.54,-0.14)**
Year 2010 Quarter 4 x Dental Expansion	-0.03 (-0.22,0.15)	-0.23 (-0.48,0.02)	-0.19 (-0.43,0.06)
Year 2011 Quarter 1 x Dental Expansion	0.00 (-0.18,0.19)	-0.02 (-0.26,0.23)	-0.28 (-0.54,-0.02)*
Year 2011 Quarter 2 x Dental Expansion	0.01 (-0.16,0.17)	0.06 (-0.14,0.26)	-0.37 (-0.65,-0.08)*
Year 2011 Quarter 3 x Dental Expansion	0.03 (-0.16,0.22)	-0.19 (-0.40,0.03)	-0.28 (-0.52,-0.04)*
Year 2011 Quarter 4 x Dental Expansion	0.08 (-0.13,0.30)	-0.10 (-0.31,0.12)	-0.33 (-0.56,-0.10)**
Year 2012 Quarter 1 x Dental Expansion	0.04 (-0.20,0.27)	-0.06 (-0.39,0.28)	-0.24 (-0.53,0.05)
Year 2012 Quarter 2 x Dental Expansion	0.13 (-0.13,0.39)	-0.09 (-0.42,0.25)	-0.28 (-0.58,0.02)
Year 2012 Quarter 3 x Dental Expansion	0.01(-0.29,0.31)	0.04 (-0.28,0.35)	-0.22 (-0.53,0.10)
Year 2012 Quarter 4 x Dental Expansion	0.17 (-0.11,0.45)	-0.07 (-0.48,0.34)	-0.36 (-0.66,-0.06)*
Year 2013 Quarter 1 x Dental Expansion	-0.10 (-0.36,0.16)	-0.12 (-0.38,0.15)	-0.37 (-0.70,-0.03)*
Year 2013 Quarter 2 x Dental Expansion	-0.10 (-0.34,0.14)	-0.03 (-0.30,0.24)	-0.43 (-0.75,-0.10)*
Year 2013 Quarter 3 x Dental Expansion	-0.19 (-0.45,0.07)	-0.17 (-0.44,0.10)	-0.56 (-0.86,-0.25)***
Year 2013 Quarter 4 x Dental Expansion	-0.33 (-0.57,-0.08)**	-0.17 (-0.40,0.05)	-0.63 (-0.97,-0.28)***
Constant	1.49 (-0.12,3.11)	2.59 (1.09,4.09)***	3.63 (1.87,5.39)***
Number of county-year-quarters	5504	2082	2887

Notes: Year 2014 excluded. All control variables were included in the models.
*P<0.05. **P<0.01. ***P<0.001.

APPENDIX G

CHANGES IN DENTAL ED VISITS AFTER DIRECT ACCESS REGULATION (FULL REGRESSION OUTPUT)

	All non-traumatic dental ED visits	**ED visits for dental conditions that are likely to benefit from primary care**
Post x Direct Access	-0.105 (-0.326,0.116)	0.051 (-0.015,0.116)
Urban/Rural status of counties		
Urban	Reference	Reference
Rural	0.286 (-0.049,0.620)	0.142 (0.048,0.236)**
DHPSA		
None	Reference	Reference
Partial County	1.187 (0.590,1.783)***	0.222 (0.032,0.412)*
Whole County	0.497 (-0.014,1.009)	0.071 (-0.084,0.226)
Dentists per 10,000 county population	0.024 (-0.056,0.104)	0.010 (-0.018,0.038)
Dental Hygienists per 10,000 state population	-0.013 (-0.020,-0.007)***	-0.002 (-0.005,0.000)
Percentage in poverty	0.007 (-0.020,0.033)	0.000 (-0.007,0.008)
Percentage uninsured	0.056 (0.003,0.110)*	0.012 (-0.004,0.028)

*P<0.05. **P<0.01. ***P<0.001.

Each model includes county, and year-quarter fixed effects and controls for county population estimates.

APPENDIX H

TESTS FOR PRE-TRENDS (FALSIFICATION TESTS)

	Pre-reform trends in Florida	**Pre-reform trends in Massachusetts**
Year 2007 Quarter 1 x Direct Access	Reference	Reference
Year 2007 Quarter 2 x Direct Access	-0.040 (-0.177,0.097)	-0.011 (-0.282,0.260)
Year 2007 Quarter 3 x Direct Access	0.035 (-0.134,0.205)	-0.190 (-0.593,0.214)
Year 2007 Quarter 4 x Direct Access	0.012 (-0.168,0.192)	-0.157 (-0.418,0.105)
Year 2008 Quarter 1 x Direct Access	-0.083 (-0.254,0.088)	-0.127 (-0.372,0.119)
Year 2008 Quarter 2 x Direct Access	-0.015 (-0.189,0.159)	-0.143 (-0.419,0.132)
Year 2008 Quarter 3 x Direct Access	-0.140 (-0.291,0.011)	-0.221 (-0.561,0.119)
Year 2008 Quarter 4 x Direct Access	-0.115 (-0.328,0.098)	-0.191 (-0.494,0.112)
Year 2009 Quarter 1 x Direct Access	-0.333 (-0.532,-0.135)**	*Direct Access legislation passed in January 2009*
Year 2009 Quarter 2 x Direct Access	-0.176 (-0.403,0.052)	
Year 2009 Quarter 3 x Direct Access	-0.182 (-0.409,0.045)	
Year 2009 Quarter 4 x Direct Access	-0.271 (-0.477,-0.064)*	
Year 2010 Quarter 1 x Direct Access	-0.293 (-0.511,-0.076)**	
Year 2010 Quarter 2 x Direct Access	-0.219 (-0.428,-0.010)*	
Year 2010 Quarter 3 x Direct Access	-0.141 (-0.398,0.117)	
Year 2010 Quarter 4 x Direct Access	-0.159 (-0.392,0.075)	
Year 2011 Quarter 1 x Direct Access	-0.139 (-0.387,0.108)	
Year 2011 Quarter 2 x Direct Access	-0.105 (-0.386,0.175) *Direct Access legislation passed in June 2011*	

All control variables were included in the models.
*P<0.05. **P<0.01. ***P<0.001.

APPENDIX I

CHANGES IN OUTCOMES AFTER DIRECT ACCESS REGULATION, USING COMPARISON GROUP 2

	All non-traumatic dental ED visits	ED visits for dental conditions that are likely to benefit from primary care
Post x Direct Access	0.023(-0.170,0.217)	0.053(-0.015,0.120)
Urban/Rural status of counties		
Urban	Reference	Reference
Rural	-0.016(-0.269,0.236)	0.052(-0.023,0.127)
DHPSA		
None	Reference	Reference
Partial County	0.081(-0.080,0.242)	0.025(-0.058,0.108)
Whole County	-0.052(-0.158,0.055)	-0.007(-0.067,0.053)
Dentists per 10,000 county population	0.014(-0.046,0.073)	0.002(-0.014,0.017)
Dental Hygienists per 10,000 state population	0.001(-0.003,0.005)	-0.002(-0.004,0.000)
Percentage in poverty	-0.007(-0.029,0.015)	0.002(-0.007,0.011)
Percentage uninsured	0.003(-0.040,0.045)	-0.001(-0.017,0.015)
Number of county-year-quarters	10043	10043
R^2	0.046	0.023

Comparison group 2 includes Arizona, Nebraska, New York, Rhode Island, Vermont, and Wisconsin, which were Direct Access states before the study period.