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Do Medicaid benefit expansions have teeth? The effect of Medicaid adult dental coverage on the use of dental services and oral health

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Abstract

This article examines the effect of Medicaid adult dental coverage on use of dental care and dental health outcomes using state-level variation in dental coverage during 2000–2012. Our findings imply that dental coverage is associated with an increase in the likelihood of a recent dental visit, with the size of the effect increasing with Medicaid payment rates to dentists, and a reduction in the likelihood of untreated dental caries. We are among the first to detect an effect of Medicaid coverage on a clinical health outcome other than mortality. These findings may have implications for states expanding Medicaid coverage to adults with incomes of up to 138% of the federal poverty threshold under the Affordable Care Act as most of these states offer an adult dental benefit.

1. Introduction

Though research has linked poor oral health with pain (Naito et al., 2006), reductions in systemic health (de Oliveira et al., 2010; Sjögren et al., 2008), and inferior social and employment outcomes (Glied and Neidell, 2010; Singhal et al., 2013; Willis et al., 2008), many individuals do not seek care for oral health problems. One study found that 42% of adults with a tooth or mouth problem did not visit the dentist because they could not afford the out-of-pocket payments (Bloom et al., 2012). The costs of obtaining care can be substantial for those without dental insurance. In 2010, uninsured individuals with at least one dental visit paid an average annual cost of \$561 (Government Accountability Office, 2013).

Medicaid is the main public health insurance program for low-income adults in the United States. Beneficiaries typically pay no out-of-pocket cost or a small copayment for covered services, but coverage of adult dental care varies by state. While most states provide coverage of emergency dental services such as the relief of oral pain and infection, many do not cover preventive services such as routine exams and cleanings or restorative services such as fillings and root canals.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at doi: 10.1016/j.jhealeco.2015.08.009.

This article examines the effects of Medicaid adult dental coverage on use of dental care and dental health among non-elderly adults using 2000–2012 data from the National Health Interview Survey (NHIS) and the National Health and Nutrition Examination Survey (NHANES). Our main analysis uses a difference-in-difference-in-difference (DDD) approach that identifies the effects of dental coverage using variation in dental benefits across states, within states over time, and a within-state control group of low-income adults not enrolled in Medicaid. We incorporate Medicaid payment rates to dentists in our analysis for select years to determine whether provider payment generosity affects access to care among beneficiaries with dental coverage.

Medicaid coverage of dental services may increase the use of dental care, and ultimately improve oral health, by reducing the out-of-pocket cost paid by the beneficiary. Though provider payment rates do not have a direct effect on Medicaid beneficiaries' utilization of dental services or dental health, payment generosity may have an indirect effect on these outcomes if providers in states with less generous payment policies decline to participate in Medicaid. Our main measures of utilization are whether an individual had at least one dental visit in the past year or past six months, which are used to capture receipt of recommended care. Dental coverage may improve dental health both because newly covered beneficiaries can treat existing oral health problems at significantly reduced out-of-pocket cost and because of improvements in routine care (e.g., regular dental exams and cleanings) which may prevent future oral health issues. We focus on recent dental coverage status and suggest the former mechanism, less untreated dental disease, for an effect of coverage on dental health. We consider self-reported dental health outcomes available in NHIS and outcomes constructed from oral exam data available in NHANES, which include indicators of dental caries and tooth loss.

Studies of dental coverage in Massachusetts and California find evidence of a positive effect of coverage on the likelihood of a dental visit among adult Medicaid beneficiaries (Nasseh and Vujicic, 2013; Wides et al., 2014). However, only one published national study examines this topic and estimates that Medicaid adult dental coverage is associated with a significant 7.4 percentage point increase in the likelihood of having an annual dental visit (Choi, 2011). Choi's analysis compares outcomes among low income parents and childless adults since childless adults were not eligible for Medicaid in most states prior to 2014. However, since her data do not span any coverage policy changes, she is not able to use policy timing to identify an effect. We extend Choi's analysis by using data that span a longer time horizon (i.e., 2000–2012) and capture within-state variation in coverage. (During our period of study, 15 states changed dental coverage policy including some large states such as California and Florida.) Further, we go beyond prior work by analyzing dental health outcomes and examining whether payment rates to dentists influence the size of the coverage effect. To our knowledge, we are the first to study the effect of Medicaid coverage on dental health outcomes, as well as the first to examine the effect of dental payment rates among adults.

Consistent with past research, we find that Medicaid coverage of dental services increases the likelihood of a recent dental visit. Our results imply that coverage is associated with a significant 12.9 percentage point increase in the likelihood of a yearly dental visit for

Medicaid beneficiaries relative to the control group. This increase in dental visits represents an approximate 34% increase relative to the mean percentage of Medicaid beneficiaries with a dental visit in the past year in states without dental coverage (38%). We also find that Medicaid beneficiaries with dental coverage are 12.1 percentage points less likely to report needing but not receiving dental care due to cost in the past year relative to the control group, which represents a 45% reduction relative to the mean (27%). This latter result suggests that the increase in the likelihood of a dental visit is associated with a reduction in the financial burden of using dental services. Our estimate of the effect of dental coverage on the likelihood of a yearly dental visit is larger in magnitude than Choi's estimated effect, which may be because we use actual Medicaid insurance status. Since Choi cannot identify type of health insurance coverage in her data, she uses parental status to proxy for Medicaid enrollment, making her estimate an underestimate. Our estimate is more in line with the results of a randomized study of the dental market conducted as part of the RAND health insurance experiment, which implied a 15.6 percentage point increase in the likelihood of a yearly visit to the dentist as a result of dental coverage (Manning et al., 1987).

Our analysis suggests that dental coverage not only increases dental care utilization, but also has a significant effect on oral health outcomes. In addition to significant effects of coverage on self-reported oral health, we find that Medicaid beneficiaries with dental coverage are 9.5 percentage points less likely to have any untreated caries compared with the control group based on an oral exam performed by a dentist or trained health technologist. Since we find that about 47% of beneficiaries in states without dental coverage have any untreated caries, the estimated effect represents a 20% reduction relative to the mean.

To our knowledge, we are among the first to find a significant effect of Medicaid coverage on a clinical health measure aside from mortality. Findings from the Oregon Health Experiment, a limited expansion of Oregon's Medicaid program in 2008 to low income adults selected by lottery, provide little evidence of improvement in clinical health conditions such as hypertension and hypercholesterolemia among those newly insured (Baicker et al., 2013). Some studies find that Medicaid coverage is associated with reduced mortality (Currie and Gruber, 1996; Sommers et al., 2012), however these results are in contrast to findings from the Oregon Health Experiment that Medicaid status has no effect on one-year mortality. It is possible that the short, two-year time horizon of the Oregon Health Experiment explains the lack of evidence of a connection between Medicaid coverage and the health outcomes considered. For example, Currie et al. find that new Medicaid eligibility has little effect on current health status among children, but coverage in early childhood may have a positive effect on future health (Currie et al., 2008). Health outcomes that can be improved expeditiously, such as dental caries and tooth loss, may be more likely to respond to health insurance coverage in the short term.

A growing literature has investigated the effect of Medicaid provider payment rates on beneficiary access to care. Decker finds that the Medicaid fee for an office visit is positively associated with the percentage of a physician's practice accounted for by Medicaid patients and with the duration of an office visit (Decker, 2007). Research on dental care in particular indicates that increases in Medicaid fees for dental services are associated with an increased likelihood of a recent dental visit among children (Buchmueller et al., 2013; Decker, 2011).

We find evidence that the Medicaid payment rate to dentists affects adult beneficiaries' access to dental care. Our results imply that a 10 percentage point increase in the ratio of the Medicaid-to-private adult prophylaxis (i.e., dental cleaning) fee paid to dentists (e.g., an increase from the average ratio of 0.52 to 0.62) is associated with an approximate 2.5 percentage point increase in the likelihood of a recent dental visit for beneficiaries with adult dental coverage. These results imply that even if a state offers dental coverage, the magnitude of the effect of coverage on the use of dental care depends on the Medicaid payment rate to dentists and can be small if the payment rate is low.

These findings may have implications for the 30 states (including the District of Columbia) that opted to expand their Medicaid programs to cover adults with incomes of up to 138% (133 plus a 5% income disregard) of the federal poverty threshold under the Affordable Care Act (ACA) as of June 2015 (Kaiser Family Foundation, 2015). Preliminary estimates from the Centers for Medicare and Medicaid Services indicate that enrollment in Medicaid and the Children's Health Insurance Program increased by 10.5 million individuals between September 2013 and April 2015 in these expansion states (Centers for Medicare and Medicaid Services, 2015). Since the ACA does not classify dental services as an essential health benefit for adults, Medicaid adult dental coverage will remain optional. However, the percentage of low-income adults with dental insurance is likely to increase since 21 of the 30 states that implemented the ACA Medicaid expansion currently offer coverage of at least one preventive or restorative dental service beyond emergency care¹. This paper proceeds as follows. Section 2 describes our data sources, sample and statistical approach. Section 3 presents our results. Section 4 provides several robustness checks and Section 5 concludes.

2. Data and methods

2.1. The National Health Interview Survey

The NHIS is a continuous cross-sectional survey of the civilian, non-institutionalized population of the United States conducted by the Centers for Disease Control and Prevention's National Center for Health Statistics (NCHS). The survey follows a multistage area probability design to select a nationally-representative sample of households. Interviews are conducted to obtain information on each member of the household, and within each household, one adult is selected to complete a more detailed survey. Unweighted response rates for 2000–2012 sample adults range from 61% to 74% depending on the survey year².

We analyze dental utilization outcomes in the 2000–2012 NHIS and dental health outcomes available (only) in the 2008 NHIS. Outcomes of interest in the 2000–2012 NHIS include the length of time since the respondent has seen a dentist and whether the respondent needed but did not receive dental care due to cost in the past year. The former question has the following discrete response options: “never,” “6 months or less,” “more than 6 months, but

¹Calculation is based on the authors' analysis of dental coverage policies. States that have elected to implement the ACA Medicaid expansion can offer an Alternative Benefit Package to the expansion population which may differ from the benefit package provided to the traditional Medicaid population in that state. See <https://www.padental.org/Images/OnlineDocs/Advocacy/DayOnTheHill/CHCSMedicaidAdultDentalBenefits.pdf> for more information on dental benefits included in each expansion state's Alternative Benefit Package as of January 2015. Of those states expanding Medicaid that offer adult dental benefits beyond emergency care to the traditional Medicaid population, only one state (North Dakota) will not offer dental benefits to the expansion population.

²Detailed information about the NHIS is available from: <http://www.cdc.gov/nchs/nhis.htm>.

not more than 1 year ago,” “more than 1 year, but not more than 2 years ago,” “more than 2 years, but not more than 5 years ago,” and “more than 5 years ago.” Responses were used to create two binary dental visit variables indicating whether the respondent had seen a dentist within the past six months and whether the respondent had seen a dentist within the past year, respectively. Outcomes of interest in the 2008 NHIS include binary indicators of whether the respondent had a problem with the following oral health issues in the past year: broken or missing teeth, stained teeth, loose teeth, and broken or missing fillings.

2.2. The National Health and Nutrition Examination Survey

The NHANES is a continuous cross-sectional survey of the civilian non-institutionalized U.S. population which combines household interviews with standardized physical examinations in mobile examination centers. The survey examines a nationally-representative sample of individuals residing in counties across the country. Most but not all states are represented in our main analysis sample. Unweighted response rates for 2000–2012 respondents to the household interview component of the survey range from 73% to 84% and rates for the examination component range from 70% to 80%, depending on the survey year³.

Our analysis of NHANES focuses on oral health outcomes, which are constructed using the oral health assessment available for adults in the 2000–2008 and 2011–2012 surveys. The assessment, which is the only source of national data on dental conditions based on an examination rather than self report, includes a tooth count to determine the presence of permanent and primary teeth and a caries count to identify teeth with coronal (surface) caries⁴. Survey years 2000–2004 and 2011–2012 contain more specific information such as whether teeth are missing due to dental disease or for other reasons and whether tooth replacements are present.

Since our aim is to measure untreated dental problems, the oral health outcomes developed based on the NHANES exam data include binary indicators of untreated caries and missing teeth that have not been replaced. While the presence of caries and missing teeth may indicate a lack of routine dental care, the presence of fillings and tooth replacements indicate that dental care was provided. Further, treated caries and permanent tooth replacements are unlikely to cause large reductions in quality of life, while untreated dental problems may cause pain and impede social and work life.

We constructed oral health outcomes using NHANES data as follows. The untreated caries outcome is equal to one if an individual has any untreated coronal (surface) caries and zero otherwise. Since root caries were not assessed in surveys occurring after 2004, these caries are excluded from the definition. We analyze two outcomes based on the tooth count

³Detailed information about the NHANES is available from: <http://www.cdc.gov/nchs/nhanes.htm>.

⁴The method used to conduct the oral exam consisted of a surface based examination (SBE) through 2004 followed by a basic screening exam (BSE). The SBE method counts all tooth surfaces with a carious lesion while the BSE method only identifies whether a subject has at least one carious lesion. We use a measure of presence of any carious lesions which is comparable for the two methods. Dentists conducted the exams through 2004 followed by trained health technologists afterwards. However, data reliability analyses indicate that examiner performance was similar across these two periods. For more information, see Dye et al. (2011). Overview and quality assurance for the oral health component of the National Health and Nutrition Examination Survey (NHANES), 2005–08. *Journal of Public Health Dentistry*, 71(1),54–61.

variables. The first is equal to one if any teeth are missing without replacement and zero otherwise, the second is equal to one if any teeth are missing due to dental disease (i.e., caries/periodontal disease) without replacement and zero otherwise⁵. The NHANES household interview contains information about the length of time since the respondent has seen the dentist, which is comparable to the NHIS dental visit question, in survey years 2000–2004 and 2011–2012. We use this information to construct analogous dental visit outcome variables for the NHANES sample for comparison purposes.

2.3. State coverage policies and payment rates to dentists

We leverage multiple sources to establish Medicaid dental coverage policies for the period 2000–2012. The Kaiser Family Foundation (KFF) publishes coverage policies for select years on its website (Kaiser Family Foundation, 2014a). Further, KFF publishes a semiannual report available for years 2002–2012 which details changes to Medicaid benefit policies⁶. The KFF reports provide two observations of changes to benefit policies per fiscal year, once at the beginning and once at the end of the year. To clarify any uncertainties or discrepancies in coverage policy, we contacted state health departments and conducted an internet search of news articles and state Medicaid websites. Exact dates of changes to coverage policy are used when possible, but when the day or month is unavailable we assume that the policy change occurred at the beginning or middle of the state fiscal year, depending on whether the change was observed in the KFF report for the beginning or end of the year.

We use data on dental coverage policies to define a binary coverage variable equal to one for individuals residing in states that offered coverage for at least six months of the year prior to their interview date and equal to zero otherwise. We chose to use a dental coverage variable representing coverage during the past year rather than point in time coverage for two main reasons. First, all NHIS outcomes are retrospective. Second, recent rather than point-in-time coverage status is likely more relevant to NHANES oral health outcomes. Our definition of coverage includes only those states that provide coverage of preventive and/or restorative services to able-bodied, non-elderly, and non-pregnant adults. We do not distinguish states that provide more vs. less generous coverage (e.g., we do not account for spending caps, service restrictions, etc.) as our data on coverage generosity are less reliable. Since states that cover dental services beyond emergency care typically provide coverage for dental visits, our coverage indicator should be an accurate measure when assessing the dental visit outcomes. Our estimates of the effect of coverage on other outcomes may be underestimated to the extent that less generous states do not provide coverage of the relevant services.

Almost all states offer coverage of emergency dental services which include relief of pain and infection, but fewer states provide coverage of some preventive and/or restorative services. For example, 24 states offered coverage of preventive and/or restorative services in

⁵Outcomes based on missing teeth are defined for 2000–2004 and 2011–2012 since information on whether tooth replacement is present is not available in other years during our period of study. Though the presence of retained root tips indicates that over 90% of the tooth is missing, we do not define them as missing teeth because root tips were characterized as present in survey years 2000–2004 and it is not possible to distinguish root tips from permanent teeth in those years. Further, we do not include missing wisdom teeth in our outcome definitions since the absence of wisdom teeth does not indicate a dental problem.

⁶Reports and other materials are available here: <http://kff.org/about-kaiser-commission-on-medicaid-and-the-uninsured/>.

2012 (Fig. 1). Over the period 2000–2012, between 22 and 27 states covered dental services for adults enrolled in Medicaid, depending on the year. Some states added coverage while others dropped coverage during this period. Table 1 provides the date of each coverage change. Though a similar number of states added and dropped dental coverage, larger states were more likely to drop coverage. In particular, California's Medicaid program dropped coverage of dental services for adults on July 1, 2009 (benefits were partially restored in 2013). The percentage of Medicaid beneficiaries with coverage decreased from 70% in 2000 to just 40% in 2012 (Fig. 2). Although our main estimates assume that the effects of adding and dropping coverage are symmetric, it should be noted that states that dropped dental coverage provide most of our statistical power. We relax the assumption of symmetric responses in the extensions and robustness section of the paper (Section 4).

Decreases in dental coverage appear to follow a cyclical pattern with the percentage of beneficiaries with coverage decreasing following the 2001 recession, rebounding between 2003 and 2008, and again decreasing after the onset of the recession in December 2007, as illustrated in Fig. 2. This pattern is not surprising since state Medicaid budgets are tied to economic conditions. Our analysis accounts for variation in local economic conditions and dental provider supply over time by including the county-level unemployment rate, which was obtained from the Bureau of Labor Statistics⁷, and the supply of dentists per 1000 population, which was obtained from the Area Resource File⁸, as control variables to avoid attributing changes in outcomes due to fluctuating local conditions to dental coverage policies.

We use the ratio of the Medicaid-to-private fee for adult prophylaxis (CPT code D1110) to examine the effect of provider payment rates on dental utilization and health outcomes⁹. Though managed care organizations (MCOs) provide a substantial portion of Medicaid care in many states, dental benefits are commonly carved out (i.e., provided on a fee-for-service basis) making dental care a good candidate for study of the effects of provider payment rates. For example, of the 36 state Medicaid programs that contracted with MCOs in 2010, 25 implemented a dental carve-out (Kaiser Family Foundation, 2014b). We obtained the Medicaid adult prophylaxis fee from the Lewin Group (Mengers et al., 2001) and the Urban Institute (Zuckerman et al., 2009) reports to MediCal, California's Medicaid program, for the years 2000–2001 and 2008–2009, respectively. The reported fee represents Medicaid's maximum allowed payment. The American Dental Association provided the private adult prophylaxis fee for the same years, as compiled by Fair Health.

Though the mean Medicaid fee increased from \$37.57 to \$40.04 between 2000–2001 and 2008–2009 in inflation-adjusted terms, the mean fee ratio decreased from 0.53 to 0.51 over the same period¹⁰. The fee ratio and Medicaid fee varied substantially across states within each period. For example, the 10th percentile 2008–2009 fee ratio value of 0.34 is just over

⁷Unemployment data are available at: <http://www.bls.gov/bls/unemployment.htm>

⁸The supply of dentists was missing for 2001–2006 and 2008. Values were imputed when missing using linear imputation by county between years.

⁹Past work shows that dental fees for services such as adult prophylaxis, tooth extraction and other services are highly correlated across states (Buchmueller et al., 2013; Decker, 2011).

¹⁰Source: Authors' analysis of adult prophylaxis fee data. The mean fee and fee ratio were calculated by taking a weighted average over Medicaid beneficiaries residing in a state that offered adult dental benefits in a given year using National Health Interview Survey

half of the 90th percentile value of 0.63. (See Appendix Table A.1.) The fee ratio also exhibited within-state variation over time. The 2000–2001 and 2008–2009 fee ratios are moderately positively correlated with a pearson correlation of 0.63.

2.4. NHIS and NHANES samples

We apply several sample exclusions to our treatment and control groups, which are described in more detail in Appendix B. First, we limit the sample to non-elderly adults over age 21 since Medicaid beneficiaries under age 21 may receive dental coverage through the Early and Periodic Screening and Diagnostic benefit. Second, we exclude all individuals with family income above 2.5 times the federal poverty threshold¹¹. Third, we exclude Medicaid beneficiaries that report a second source of insurance and those that report being uninsured at any point during the past year. Finally, we exclude any women that report they are pregnant at the time of the survey. After applying these exclusions, our 2000–2012 NHIS main analysis sample consists of 14,673 Medicaid beneficiaries and 89,496 low income individuals not on Medicaid. Our 2000–2008 and 2011–2012 NHANES main analysis sample consists of 756 Medicaid beneficiaries and 6580 low income individuals not on Medicaid. Table 2 presents mean characteristics of the treatment and control groups in the final NHIS and NHANES samples. Characteristics are weighted using sampling weights available from NCHS to produce nationally-representative estimates.

While restricting the control group to individuals with family income below 2.5 times the federal poverty threshold serves to increase the similarities between the treatment and control groups, differences remain. Individuals in the control group are more likely to be male, married, and have different racial and educational profiles and higher family income compared with the treatment group in both the NHIS and NHANES samples. However, these differences are not a threat to identification of the effect of dental coverage if covariates are balanced with respect to the treatment variable. Table 3 presents the results of a covariate balance test, which compares each covariate for Medicaid beneficiaries vs. control group individuals residing in states with vs. without dental coverage. In contrast to the previous comparison of the treatment and control groups, the results of this test indicate that most covariates do not differ significantly. However, race/ethnicity is a notable exception in the NHIS sample. (Medicaid beneficiaries residing in states with vs. without dental coverage are less likely to be black ($p < 0.05$) and more likely to be Hispanic ($p < 0.10$) compared with their control group counterparts.) To test the robustness of the results to our choice of control group, we consider alternative control groups consisting of only insured low-income individuals, uninsured low-income individuals, and higher income individuals. We also reproduce our main results with no control group. (These results are presented in Appendix C.)

To test the appropriateness of our main control group, we also analyze trends in outcomes for Medicaid beneficiaries compared to the control group in states that did not change dental

data. States that provided adult dental benefits in 2000–2001 and 2008–2009 include CA, CT, IA, ID, IN, KY, MI, MN, NC, ND, NE, NJ, NM, NY, OH, OR, PA, RI, VT, WA, WI. States that provided dental benefits in 2000–2001 but not 2008–2009 include FL, OK, and UT; states that provided dental benefits in 2008–2009 but not 2000–2001 include AK, DC, HI, MA, and WY.

¹¹Our analysis is robust to using different income thresholds.

coverage and prior to dental coverage changes in states that did change coverage. Evidence of a difference in trends prior to changes in dental coverage would suggest that trends would likely have differed in the absence of a change in coverage. We regressed each outcome on Medicaid status, a linear yearly trend, and the interaction between Medicaid status and the yearly trend, as well as a full set of controls used in our main analysis. Coefficient estimates for the interaction between Medicaid status and the yearly trend, which represent the difference in trend for Medicaid beneficiaries compared to the control group, are presented in Table 4. The estimated differences in trend are small in magnitude and none were significant at conventional levels. For example, among low-income adults residing in a state with consistent dental coverage between 2000 and 2006, we estimate that the annual trend in the outcomes having seen a dentist in the past year, having seen a dentist in the past 6 months, and needing but not getting dental care due to cost in the past year differed for Medicaid beneficiaries compared to the control group by 0.0, -0.2, and 0.3 percentage points, respectively.

2.5. Statistical methodology

Our main analysis uses a difference-in-difference-in-difference (DDD) approach that identifies the difference in outcomes for adults on Medicaid and a control group of low-income adults not on Medicaid (first difference), and compares this difference for (1) adults in states that did and did not offer Medicaid adult dental benefits at any given time (second difference), and (2) adults in states that changed dental coverage policies before and after the policy change (third difference). Our main specification to analyze NHIS utilization outcomes and NHANES health outcomes is a linear probability model of the following form:

$$Y_{ist} = \beta_1 \text{Dental}_{st} + \beta_2 \text{Medicaid}_{ist} + \beta_3 \text{Dental}_{st} \times \text{Medicaid}_{ist} + \beta_4 X_{ist} + \gamma_{0s} + \gamma_{1s}t + \tau_t + \epsilon_{ist}$$

(1)

where Y_{ist} represents the dental care utilization or health outcome of interest for individual i in state s at time t , Dental_{st} is a binary variable equal to one if state s offers adult dental coverage at time t and zero otherwise, Medicaid_{ist} is a binary variable equal to one if individual i is enrolled in Medicaid in state s at time t , and $\text{Dental}_{st} \times \text{Medicaid}_{ist}$ is the interaction between dental coverage status and Medicaid enrollment status. The estimated coefficient $\hat{\beta}_1$ represents the effect of dental coverage for control group individuals, $\hat{\beta}_2$ represents the baseline difference in the outcome between Medicaid beneficiaries and control group individuals, and $\hat{\beta}_3$ is the DDD estimator of the effect of dental coverage on the outcome of interest.

The model accounts for a variety of confounding factors that may influence estimates in the vector X_{ist} . Demographic controls include age, age squared, race/ethnicity, sex, education, marital status, general health status, ratio of family income to the poverty threshold, and an urban area indicator. County level controls include the supply of dentists per 1000

population and the annual unemployment rate¹². Demographic controls account for compositional changes in the treatment relative to the control group that may bias estimates, while county level controls account for region-level factors that may influence both coverage policies and dental care utilization and health outcomes. The model also controls for state fixed effects (γ_{0s}), year fixed effects (τ_t), and state-specific linear time trends (γ_{1s}). (The model used to estimate the effect of dental coverage on the 2008 NHIS dental health outcomes is similar to (1) except all quantities are measured during 2008. Because there are no changes in coverage policy during calendar year 2008, state and year fixed effects and state-specific linear time trends are excluded.) Sampling weights are used in all analyses and the error term, represented by ε_{ist} , is clustered at the state level to allow for serial correlation in the policy variable (i.e., dental coverage) within states (Bertrand et al., 2004).

Our main specification assumes that differences between Medicaid beneficiaries and low income adults not enrolled in Medicaid are similar across states and in each year. Inclusion of a state-specific time trend allows state trends in the outcome variable to differ, but imposes linearity. In an alternative specification which relaxes these assumptions, we also include interactions between Medicaid status and year, Medicaid status and state, and state and year (which replaces the state specific linear time trend, γ_{1s}). This alternative fully-interacted specification is more flexible but also demands substantial power due to the large number of interaction terms. Therefore, results for the alternative specification are reported for NHIS but not NHANES analyses. To further examine the robustness of our results, we present various checks in Section 4 which include a test of the association between dental coverage and unrelated outcomes and a Granger causality-style test, among others.

After estimating the effect of the binary coverage variable, Dental_{st} , on dental outcomes, we analyze whether the effect of coverage on use of dental care varies with Medicaid payment rates to dentists using the following specification:

$$Y_{ist} = \beta_1 \text{Dental}_{st} + \beta_2 \text{Medicaid}_{ist} + \beta_3 \text{Dental}_{st} \times \text{Medicaid}_{ist} + \beta_4 \text{Dental}_{st} \times \text{Fee}_{st} + \beta_5 \text{Dental}_{st} \times \text{Fee}_{st} \times \text{Medicaid}_{ist} + \beta_6 X_{ist} + \gamma_{0s} + \tau_t + \varepsilon_{ist} \quad (2)$$

where all terms are defined as in Eq. (1), and Fee_{st} represents the mean-centered ratio of the Medicaid-to-private adult prophylaxis fee in state s at time t . The fee ratio in states that do not provide Medicaid adult dental coverage at any given time is set equal to zero. If a state added (dropped) coverage between 2000–2001 and 2008–2009, then the fee ratio would change from zero (the mean-centered fee ratio) to the mean-centered fee ratio (zero). The estimated coefficient $\hat{\beta}_3$ now represents the DDD estimate of the effect of dental coverage when dentists are paid the mean adult prophylaxis fee ratio, $(\hat{\beta}_4)$ represents the effect of an incremental (10 percentage point) increase in the adult prophylaxis fee ratio for the control

¹²State-level averages were used in place of county level variables and the urban area indicator was not used in analysis of NHANES outcomes. Further, we excluded health status from our NHANES analysis since this variable was not available in the 2000 NHANES. (However, including health status and analyzing the period 2001–2012 did not affect our results.) Parental status was not included in our main analysis, but including parental status as a control variable in our NHIS regression analysis did not affect our results. (It is not possible to determine parental status using NHANES.)

group, and $\hat{\beta}_5$ represents the estimated effect of an incremental increase in the adult prophylaxis fee ratio for the treatment relative to the control group. The coefficient estimate $\hat{\beta}_5$ can be interpreted as the effect of providing dental coverage at an incrementally higher payment rate to dentists. Because the adult prophylaxis fee is only available in 2000–2001 and 2008–2009, specification (3) includes state and year fixed effects, but omits the state specific linear time trend included in specification (1).

The variable Fee_{st} in specification (3) is a censored variable that takes on positive values in states that provide dental coverage (i.e., when Dental_{st} equals one) and is equal to zero otherwise. Past work has shown that OLS estimates of the effect of censored independent variables may be biased, and further that inclusion of a censored independent variable may bias estimates of the effects of other control variables (Austin and Hoc, 2004; Rigobon and Stoker, 2007). When censoring is exogenous, as we expect it to be in this case, estimates that use complete cases only (i.e., observations for which Fee_{st} is observed) should be unbiased. Therefore, in an alternative specification, we include only states that provided Medicaid adult dental coverage in all years 2000–2001 and 2008–2009 (CA, CT, ID, IN, IA, KY, MI, MN, NE, NJ, NM, NY, NC, ND, OH, OR, PA, RI, VT, WA, and WI) and estimate the following:

$$Y_{ist} = \beta_1 \text{Medicaid}_{ist} + \beta_2 \text{Fee}_{st} \times \text{Medicaid}_{ist} + \beta_3 X_{ist} + \gamma_{0s} + \tau_t + \epsilon_{ist}$$

where all variables are defined as before, and $\hat{\beta}_2$ represents the effect of an incremental increase in the fee ratio for Medicaid beneficiaries relative to the control group in states with preexisting dental coverage.

3. Results

3.1. Dental care utilization

Our findings suggest that dental coverage has a positive and significant effect on dental visit outcomes for Medicaid beneficiaries relative to the control group, and this result is consistent across data sources. We estimate the effect of dental coverage on the likelihood of having a recent dental visit (past year and past six months) and of reporting needing but not receiving dental care in the past year as in specification (1). Table 5 presents our estimates using NHIS and NHANES data. The first three columns of Table 5 display the mean of the outcome variables for Medicaid beneficiaries in states with and without adult dental coverage and their difference, respectively. All quantities in columns 1–3 are expressed as percentages. The fourth and fifth columns present the estimated effect of dental coverage for the control group ($\hat{\beta}_1$) and Medicaid beneficiaries ($\hat{\beta}_1 + \hat{\beta}_3$), respectively, and the sixth column presents the DDD estimate of the effect of dental coverage for Medicaid beneficiaries relative to the control group ($\hat{\beta}_3$). All regression estimates are expressed as percentage point differences. Standard errors are shown in parentheses below point estimates.

Our DDD estimates suggest that dental coverage increases the likelihood of a yearly dental visit by about 12.9 percentage points for Medicaid beneficiaries relative to the control group ($p < 0.01$), which represents an approximate 34% increase relative to the mean percentage of Medicaid beneficiaries with a dental visit in the past year in states without dental coverage (Table 5). Similarly, we estimate that dental coverage increases the likelihood of a dental visit within the past six months by between 9.5 and 11.8 percentage points ($p < 0.01$), depending on whether the NHIS or NHANES data are considered, representing an increase of between 44 and 63% relative to the mean percentage of Medicaid beneficiaries with a dental visit in the past six months in states without dental coverage. (When using NHIS data and the alternative specification including interactions between Medicaid status and year, Medicaid status and state, and state and year, we estimate dental coverage is associated with a 10.9 percentage point ($p < 0.01$) increase in the likelihood of a yearly dental visit and an 8.1 percentage point increase ($p < 0.01$) increase in the likelihood of a dental visit in the past six months.) Estimated effects for the control group are insignificant and generally relatively small in magnitude. (Results when considering alternative control groups or no control group are similar and are available in Appendix Table C.1.) Because our NHIS dental visit data contain information for all states and due to the much larger sample size in the NHIS compared with NHANES, estimates based on NHIS data are preferred. However, our analysis of the NHANES dental visit variables both provides a cross-check on our NHIS results and confirmation that our analysis of NHANES oral examination data, which is unavailable in NHIS, is not subject to anomalies of the relatively small sample in NHANES.

The identifying assumption of our model requires that the timing of changes in coverage policy is exogenous to changes in dental care utilization and health outcomes. For example, if states implemented dental coverage in response to worsening dental health among the Medicaid population, then dental care utilization may increase when coverage is implemented because of increasing medical need as opposed to reduced cost. However, our DDD estimate using 2000–2012 NHIS data implies a significant reduction of 12.1 percentage points ($p < 0.01$) in the likelihood of reporting needing but not receiving dental care due to cost in the past year for Medicaid beneficiaries relative to the control group, which suggests that the observed increase in the likelihood of visiting the dentist is associated with reduced financial burden. (When using the alternative specification including interactions between Medicaid status and year, Medicaid status and state, and state and year, we estimate dental coverage is associated with a 7.8 percentage point ($p < 0.01$) reduction in the likelihood of needing but not receiving dental care due to cost in the past year.)

3.2. Dental health

In addition to increased use of dental care, we also find that adult dental coverage is associated with improvements in oral health. Our estimates using 2008 NHIS data suggest that Medicaid beneficiaries with dental coverage are approximately 14.5 percentage points ($p < 0.01$) less likely to report a problem with broken/missing teeth or stained teeth in the past year compared with the control group (Table 6). These effects represent a reduction of more than 30% relative to the mean percentage of Medicaid beneficiaries residing in states without dental coverage who reported these problems (46% and 44%, respectively). Dental coverage was also associated with an 8.6 percentage point reduction in the likelihood of

reporting a problem with broken or missing fillings for Medicaid beneficiaries relative to the control group, though this estimate was significant only at the 10% level. The likelihood that Medicaid beneficiaries with vs. without dental coverage reported a problem with loose teeth did not differ significantly from the likelihood for the control group.

Though the NHIS estimates are compelling, identification of the effect of dental coverage is achieved through cross-sectional comparisons between the treatment and control group and not through within-state policy changes over time since health outcome data are only available in one year. However, our estimates using NHANES oral health data, which spans more than a decade, also provide evidence that dental coverage improves oral health outcomes. Our DDD NHANES estimates based on 2000–2008 and 2011–2012 data suggest that Medicaid beneficiaries with vs. without dental coverage are 9.5 percentage points ($p < 0.01$) less likely to have untreated caries compared with the control group, a significant reduction of approximately 20% relative to the mean percentage in states without coverage (47%).

We do not find support for an effect of dental coverage on the likelihood of having missing teeth when analyzing 2000–2004 and 2011–2012 NHANES data. We estimate that Medicaid beneficiaries with vs. without dental coverage are approximately 2.5 percentage points less likely to have missing teeth that have not been replaced compared with the control group, but this effect is not statistically significant. Since the loss of a tooth due to dental disease may occur over several years if not decades, detecting an effect of changes in dental coverage on this outcome could be difficult. Further, coverage of expensive services is likely less common compared with inexpensive services, but our data on dental coverage policies do not include the specific services covered. This may also explain why we do not detect an effect of dental coverage on missing teeth since tooth implants are far more expensive than fillings or tooth caps.

3.3. The effect of provider payment rates on dental utilization outcomes

Table 7 presents estimates of the effect of increases in the adult prophylaxis fee ratio on the likelihood of a dental visit within the past year. Estimates are based on analysis of NHIS data since dental visit information is not available in NHANES for years 2008–2009. An estimate of the effect of dental coverage (without incorporating the fee ratio) for the reduced sample including only years 2000–2001 and 2008–2009 is provided for comparison with our estimate using all years 2000–2012. We estimate that coverage increases the likelihood of a yearly dental visit by 14.3 percentage points ($p < 0.01$) using the reduced sample compared with 12.9 percentage points ($p < 0.01$) using the full sample. Using specification (2), we estimate that a 10 percentage point increase in the fee ratio is associated with 2.5 percentage point increase ($p < 0.05$) in the likelihood of a dental visit within the past year for Medicaid beneficiaries with vs. without coverage relative to the control group. Results are similar when including only states that offered coverage in all years as in specification (3).

Dental coverage provided at the mean fee ratio is associated with a 14.3 percentage point ($p < 0.01$) increase in the likelihood of a dental visit in the past year for Medicaid beneficiaries relative to the control group, an estimate similar to the one obtained using specification (1). However, coverage provided with a provider payment rate corresponding to the 10th

percentile value of the adult prophylaxis fee ratio distribution (0.34) is associated with a smaller increase in the likelihood of a dental visit in the past year of 9.0 percentage points ($p < 0.05$). Conversely, coverage provided with a payment rate corresponding to the 90th percentile value of the fee ratio distribution (0.73) is associated with an 18.9 percentage point ($p < 0.01$) increase in the likelihood of a yearly dental visit. Fig. 3 provides a graphical depiction of the effect of dental coverage on the likelihood of a yearly dental visit for each decile of the adult prophylaxis fee distribution. The figure indicates that states that implement dental coverage for adult Medicaid beneficiaries are likely to experience an economically significant increase in use of dental care even if they pay relatively low rates to dentists. However, states that pay extremely low rates to dentists (e.g., near the bottom of the fee ratio distribution) may experience little increase in the likelihood that Medicaid beneficiaries have a yearly dental visit compared with before the policy was implemented.

4. Extensions and robustness checks

We conducted several checks to test the robustness of our results. These tests use NHIS data because some outcomes were available in NHIS and not NHANES and most tests require a larger sample size. First, we estimated our preferred specification for the outcomes “seen general practitioner in the past year”, “seen specialist in the past year”, and “needed but did not get prescription drugs due to cost in the past year” using 2000–2012 data. These outcomes represent commonly used medical services that are unrelated to dental care. A significant effect of dental coverage on these outcomes would indicate that dental coverage and general Medicaid generosity are correlated and/or state-level factors unrelated to dental coverage may have led to both an increase in medical care utilization and an increase in the likelihood of providing dental coverage. Our point estimates of the effect of dental coverage on the likelihood of having seen a general practitioner in the past year, having seen a specialist in the past year, and needing but not getting prescription drugs due to cost are decreases of 1.5, 0.6, and 1.1 percentage points, respectively (Table 8). Not only are none of these estimated effects significant at conventional levels, but the estimates for having seen a general practitioner and having seen a specialist are also opposite in sign to the estimated effect on use of dental services. To investigate the possibility that adult dental coverage is correlated with other state-level factors that affect the use of dental care in particular, we examined the effect of dental coverage on dental care utilization outcomes for 18–20 year old Medicaid beneficiaries, for whom we expect to find no effect since these individuals are covered under the Early and Periodic Screening, Diagnostic, and Treatment benefit. The results of this analysis, which are presented in Appendix C, suggest that adult dental coverage is not correlated with dental outcomes among Medicaid beneficiaries in this age group.

Second, we estimated a dose-response type model that compared individuals more and less likely to be eligible for Medicaid rather than participants and non-participants. Participation in Medicaid among eligible adults may be endogenous, which could bias our DDD estimates if individuals who are more likely to use dental care have a higher participation rate in states that provide adult dental coverage. We applied state-level income eligibility rules for 2003, 2008, and 2012, respectively, to define a group more likely to be eligible for Medicaid. Using eligibility rules for a single year avoided confounding from changes in the

composition of the eligible population, while repeating the analysis for different eligibility years served to reinforce the robustness of the results. We estimated the effects of dental coverage on those more compared to less likely to be eligible for Medicaid using specification (1), but replacing the indicator for Medicaid status with an indicator for being eligible for Medicaid based on a given year's eligibility rules. Since we used eligibility rules applicable to parents, our main analysis sample was restricted to individuals with children in the household. The results of this analysis are shown in Table 9. All estimated effects are of the expected sign and statistically significant at conventional levels (regardless of which year's eligibility rules are used to define the eligible sample). As expected, the estimated effects are smaller than the corresponding estimates based on Medicaid enrollment presented in Table 4 since not all of those eligible for Medicaid participate in the program. For example, we estimated that adult dental coverage is associated with an increase of between 3.5 and 4.1 percentage points in the likelihood of a dental visit in the past year for those more compared to less likely to be eligible for Medicaid.

Third, we implemented a test of Granger causality using a sample of states that dropped and did not add coverage during our study period, which includes CA, FL, ID, OK, and WA. We used states that dropped rather than added coverage since these states represent a much larger share of our observations, as can be seen in Fig. 2¹³. We estimated a specification similar to (1) using 2000–2012 data, except we replace the dental coverage indicator with the following mutually exclusive, binary coverage variables: indicators equal to one for dates between one year and six months and between six months and the day before dropping coverage, respectively, an indicator equal to one beginning on the date when coverage was dropped and during the following six month period, an indicator equal to one between six months and one year after coverage was dropped, and an indicator equal to one for dates more than one year after coverage was dropped. A significant coefficient estimate of the interaction between Medicaid status and the indicators for the period prior to dropping coverage would suggest possible policy endogeneity. Table 10 presents estimates for our dental utilization outcomes. Our estimates associated with the period before coverage is dropped are small and statistically insignificant. The effect of dropping coverage at the time of implementation is negative, though not statistically significant for the dental visit outcomes, which is expected since these variables are retrospective. The effect on dental visits becomes statistically significant six months after the policy change. The effect of eliminating dental coverage on a dental visit in the past year is similar between six months and one year after coverage is dropped and more than one year after coverage is dropped, whereas the effect on a dental visit in the past six months is more concentrated between six months and one year after coverage is dropped. The effect on reporting needing but not receiving dental care due to cost is more immediate following elimination of coverage. Though this variable is also retrospective, it is plausible that changes in perceived need occur before changes in actual utilization (i.e., dental visits).

Finally, we examined the assumption in our main specification that the effects of dropping and adding dental coverage are symmetric by separately analyzing the effects of changes to

¹³We do not include states that both added and dropped coverage during our study period since the lagged effects of one policy change could coincide with the anticipatory effects of a second policy change in these states.

dental coverage policy in states that dropped and added coverage, respectively, during our study period¹⁴. We used specification (1), except the dental coverage indicator was replaced by either a “drop” or “add” dummy variable, as appropriate. Similar to our combined dental coverage indicator, these dummy variables were lagged by 6 months as the outcomes considered are retrospective. Table 11 presents the results of this analysis, with the results for the samples residing in a state that dropped and added coverage presented in the first and second columns, respectively. When considering the dental visit outcomes, our findings indicate that the magnitude of the effect of adding dental coverage is larger than the effect of dropping coverage. We estimate that adding dental coverage is associated with an increase of about 15.0 percentage points in the likelihood of a dental visit in the past year compared to a reduction of about 9.5 percentage points in states that dropped coverage. Results for the likelihood of a dental visit in the past 6 months are similar. When considering the effect of dental coverage on the likelihood of needing but not getting dental care due to cost, the estimated effects of adding and dropping coverage appear to be more symmetric, though neither estimate is significant at conventional levels for these reduced samples. These results are subject to the caveat that we have less power to estimate the effects of adding dental coverage since the states that added coverage tended to be smaller states. (The sample residing in a state that dropped coverage during our study period includes 25,905 observations compared to 2304 observations in states that added coverage.) However, adding dental benefits may have a larger impact than dropping benefits if Medicaid beneficiaries continue to use dental care in states that provided dental coverage over a long period of time even when coverage is eliminated (i.e., habit formation). Further, Medicaid beneficiaries residing in a state that added coverage may have been without coverage for several years and therefore have more unmet need for dental care (i.e., pent-up demand). Since states that dropped coverage between 2000 and 2012 tended to be larger states, our main results are more representative of the effects of dropping rather than adding coverage.

5 Conclusions

Our findings indicate that Medicaid coverage of dental services for adults increases the likelihood of having a dental visit in the past six months or year. For example, estimates using the NHIS data imply that Medicaid adult dental coverage is associated with an increase of 12.9 percentage points (33.9%) in the probability of having had a dental visit in the past year. The magnitude of this effect varies with the level of the Medicaid-to-private fee ratio for dentists. For example, Medicaid dental coverage is associated with an increase in the probability of a dental visit in the past year of 9.0 percentage points in states with a fee ratio of 0.34 (the 10th percentile of the fee ratio distribution) compared to 19.0 percentage points in states with a fee ratio of 0.73 (the 90th percentile). We also find that Medicaid coverage of dental services reduces the likelihood of reporting needing but not receiving dental care due to cost and reduces the likelihood of negative oral health outcomes. We find a significant effect on both self-reported oral health outcomes using NHIS and

¹⁴States that both added and dropped coverage during our study period were excluded from this analysis. Including these states is problematic because the period prior to the second policy change is not an appropriate benchmark. For example, Massachusetts dropped coverage in July 2002 and later added coverage in July 2006. An indicator for the addition of coverage would be equal to zero before and one after July 2006, so that the comparison period would include a period with dental coverage.

clinical health outcomes (untreated caries) using NHANES. The estimated effects of coverage on oral health are, in some cases, similar in magnitude to the effect on a recent dental visit. Since most of the health outcomes considered are easily diagnosed and treated, these results are not implausible. The ability to treat oral health problems in the short term also limits the generalizability of these results to health problems that require longer term care. However, detecting an effect of insurance coverage on outcomes that require longer term care is also more difficult making the oral health outcomes we examine a strong example to consider when analyzing the relationship between Medicaid coverage and health.

An estimated 9.5 million individuals gained Medicaid dental insurance as a result of state Medicaid expansions in 2014 and 2015, making the effects of dental insurance on utilization and health outcomes among the Medicaid population of interest¹⁵. A simple back-of-the-envelope calculation using our results implies that these Medicaid expansions could lead to an additional 1.2 million ($9.5 \text{ million} \times 0.1288$) annual dental visits based on the increase in enrollment as of April 2015. This calculation is subject to the caveats that the expansion population differs from the traditional Medicaid population, some individuals in the expansion population may have had private dental coverage prior to gaining Medicaid coverage, and newly enrolled individuals may have difficulty identifying a provider that accepts Medicaid as a form of insurance. This simple calculation also assumes that dental coverage is offered at the current mean payment rate to dentists. Our results indicate that the magnitude of the increase in visits will vary with the level of fees paid to dentists. The ACA required that Medicaid fees for some primary care services be increased to Medicare rates in 2013 and 2014, and some states have chosen to maintain these increases after 2014. However, no federal provision currently applies to dental fees even though, on average, Medicaid paid about half of what private insurers paid for adult prophylaxis in 2008–2009.

In addition to the increase in dental coverage among low-income adults newly enrolled in Medicaid in states that previously offered dental benefits to the traditional Medicaid population, some states offered dental benefits to adults on Medicaid for the first time in 2014 (e.g., Colorado and South Carolina). An influx of new dental patients may put strain on the dental care workforce. However, recent work shows that dentists may respond to increased demand by making greater use of dental hygienists with only modest increases in patient wait times (Buchmueller et al., 2014).

Although dental patients may be unlikely to experience negative effects of the Medicaid expansions, increased utilization of dental services may increase Medicaid spending, particularly in the short term. However, our results also suggest that providing dental care may have effects that reduce spending in the long term. In particular, our findings imply that individuals who gain dental coverage are likely to enjoy better oral health. With fewer oral health problems, non-routine visits to the dentist could decrease over time. Past work also shows that dental coverage may lead to substitution of routine care for emergency care, which could lead to a reduction in overall spending on dental care (Wallace et al., 2011).

¹⁵Calculation is based on authors' analysis of dental coverage policies for the expansion population and the increase in enrollment in expansion states as of August 2014 available from the Centers for Medicare and Medicaid Services here: <http://www.medicaid.gov/affordablecareact/medicaid-moving-forward-2014/downloads/august-2014-enrollment-report.pdf>.

While quantifying these effects in terms of expenditures is beyond the scope of this paper, our work suggests that Medicaid beneficiaries both use and benefit from adult dental services when these services are offered.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Fig. 1. State dental coverage policies in 2012. *Source:* Author's analysis of Medicaid dental coverage policies.

Fig. 2.

Percentage of adult Medicaid beneficiaries with dental coverage, NHIS 2000–2012. *Source:* Author's analysis of Medicaid dental coverage policies merged with the National Health Interview Survey, 2000–2012. Recession dates were obtained from the National Bureau of Economic Research and are available here: <http://www.nber.org/cycles.html>.

Fig. 3.

Regression estimates of the effect of dental coverage at various levels of the adult prophylaxis fee ratio on the likelihood of a yearly dental visit, NHIS 2000/2001 and 2008/2009^a.^a Results are estimates from linear probability models with controls including age, age squared, race/ethnicity, sex, education, marital status, health status, ratio of family income to the poverty threshold, and an urban area indicator, and county level controls including the supply of dentists per 1000 population and the annual unemployment rate, state fixed effects, and year indicators. Errors are clustered at the state level and sampling weights are used to create nationally-representative estimates. All estimates represent percentage point changes. The sample includes 3768 Medicaid beneficiaries and 24,260 low income adults not on Medicaid ($n = 28,028$)

Table 1

Summary of dental coverage policy changes, 2000–2012.

Never covered dental (19 states)

AL, AZ, CO, DE, GA, IL, KS, LA, ME, MD, MS, MT, NH, NV, SC, TN, TX, VA, WV

Always covered dental (17 states)

CT, IN, IA, KY, MN, NE, NJ, NM, NY, NC, ND, OH, OR, PA, RI, VT, WI

Added dental (5 states)

AK (3/29/2007), AR (7/1/2009), DC (10/1/2006), SD (1/1/2002), WY (7/1/2007)

Dropped dental (5 states)

CA (7/1/2009), FL (7/1/2002), ID (7/1/2011), OK (7/1/2002), WA (7/1/2011)

Dropped and Added dental (5 states)

HI (added 7/1/2006, dropped 7/1/2009), MA (dropped 7/1/2002, added 7/1/2006), MI (dropped 10/1/2003, added 10/1/2005, dropped 4/1/2009, added 10/1/2010), MO (added 7/1/2003, dropped 7/1/2005), UT (dropped 7/1/2002, added 7/1/2005, dropped 7/1/2006)

Source: Author's analysis of dental coverage policy changes from internet research and contact with state departments of health.

Table 2

Weighted mean sample characteristics, treatment vs. control groups, NHIS and NHANES 2000–2012.^a

Characteristic	NHIS		NHANES	
	Adults on Medicaid	Low income adults not on Medicaid	Adults on Medicaid	Low income adults not on Medicaid
Age	39.68 (0.13)	39.35** (0.08)	40.19 (0.58)	39.28** (0.27)
Male	31.93 (0.55)	48.59*** (0.23)	33.92 (2.08)	50.02*** (0.63)
Married	33.02 (0.60)	51.29*** (0.29)	28.23 (2.48)	48.51*** (1.18)
Family income (% FPI)	92.98 (0.67)	145.83*** (0.36)	85.88 (2.68)	140.02*** (1.30)
Race/ethnicity^b				
Hispanic	23.70 (0.58)	24.18 (0.35)	16.56 (2.44)	23.30 (1.88)
White, non-Hispanic	44.67 (0.77)	54.98 (0.40)	48.77 (3.44)	56.70 (2.40)
Black, non-Hispanic	26.36 (0.63)	15.26 (0.29)	29.94 (2.82)	13.73 (1.15)
Asian/other race	5.26 (0.32)	5.58 (0.17)	4.72 (1.10)	6.26 (0.61)
Education^c				
Less than high school	39.64 (0.59)	23.93 (0.28)	44.09 (2.38)	27.77 (1.00)
High school graduate	34.71 (0.56)	33.09 (0.25)	27.50 (2.00)	29.17 (0.90)
Some college or college graduate	25.65 (0.49)	42.98 (0.33)	28.22 (2.19)	42.86 (1.20)
Sample size (unweighted)	14,673	89,496	757	6813

^a All estimates are expressed as percentages, except for age which is expressed in years. Sampling weights are used to produce nationally-representative estimates. Standard errors are in parentheses below estimates and are clustered by state. The sample consists of individuals aged 22–64 not enrolled in Medicare with family income below 2.5 times the poverty threshold. All women pregnant at the time of the survey were excluded. Medicaid beneficiaries with a second source of insurance and those who reported being uninsured at some time during the previous year were excluded. The NHIS sample includes years 2000–2012 and the NHANES sample includes years 2000–2008 and 2011–2012. *T*-tests were used to test the difference in mean (dichotomous) characteristics between Medicaid beneficiaries and low income adults not on Medicaid in each survey.

^{**} $p < 0.05$,

^{***} $p < 0.01$.

^b Chi-square tests were used to test for differences in race/ethnicity between Medicaid beneficiaries and low income adults not on Medicaid. Race/ethnicity was significantly different at the 1% level in both the NHIS and NHANES samples.

^c Chi-square tests were used to test for differences in education between Medicaid beneficiaries and low income adults not on Medicaid. Education was significantly different at the 1% level in both the NHIS and NHANES samples.

Table 3Covariate balance test, NHIS and NHANES 2000–2012^a.

Characteristic	Coefficient on interaction term	
	NHIS	NHANES
Characteristic		
Age	−0.32 (0.59)	0.80 (1.24)
Male	−1.72 (1.69)	−1.69 (4.13)
Married	2.91 (1.92)	−0.03 (5.09)
Family income (% FPT)	−0.08 (0.25)	−6.14 (6.28)
Race/ethnicity		
Hispanic	4.82 [*] (2.62)	1.26 (4.90)
White, non-Hispanic	1.80 (2.90)	−4.43 (6.53)
Black, non-Hispanic	−5.68 ^{***} (1.88)	2.60 (4.06)
Asian/other race	−0.94 (0.69)	0.57 (3.38)
Education		
Less than high school	−3.32 ^{**} (1.58)	2.35 (5.61)
High school graduate	0.88 (1.35)	−1.65 (4.31)
Some college or college graduate	1.44 (1.18)	−0.70 (6.31)

^a Using linear probability models, we regress each demographic characteristic on Medicaid status, dental coverage status, and the interaction between these two binary indicators. Estimates use weights and errors are clustered by state. Estimates represent the coefficient on the interaction term and are expressed in terms of percentage point effects. Standard errors are in parentheses below estimates. Controls also include state and year effects and state-specific linear time trends. The 2000–2012 NHIS sample includes 14,673 Medicaid beneficiaries and 89,496 low income adults not on Medicaid ($n=104,169$). The 2000–2008 and 2011–2012 NHANES sample includes 757 Medicaid beneficiaries and 6813 low income adults not on Medicaid.

^{*} $p < 0.10$.

^{**} $p < 0.05$.

^{***} $p < 0.01$.

Regression estimates of the difference in trends in utilization outcomes for Medicaid beneficiaries relative to the control group prior to changes in dental coverage policy.^a

Table 4

Outcome	Seen dentist, past year	Seen dentist, past 6 months	Did not get dental care because of cost
All states with consistent dental coverage prior to July 2006 ^b	0.01 (0.52)	-0.15 (0.50)	0.30 (0.30)
States that never offered dental coverage or added coverage ^c	0.76 (0.97)	0.27 (0.71)	0.42 (0.72)
States that always offered dental coverage or dropped coverage ^c	0.13 (0.28)	0.32 (0.22)	-0.15 (0.14)

^aEach outcome was regressed on Medicaid status, a linear yearly trend, and the interaction between Medicaid status and the linear yearly trend. Other controls included age, age squared, race/ethnicity, sex, education, marital status, health status, ratio of family income to the poverty threshold, an urban area indicator, the county-level supply of dentists per 1000 population, the annual county-level unemployment rate, state fixed effects, and a state-specific linear yearly trend. Errors were clustered at the state level and sampling weights were used to produce nationally-representative estimates. Results shown are the coefficient estimates for the interaction between Medicaid status and the linearly yearly trend and are expressed in terms of percentage points. Standard errors are in parentheses below estimates.

^bStates that did not change dental coverage policy between 2000 and July 2006 include AL, AK, AZ, AR, CA, CO, CT, DE, DC, GA, HI, ID, IL, IN, IA, KS, KY, LA, ME, MD, MN, MS, MT, NH, NE, NV, NJ, NM, NY, NC, ND, OH, OR, PA, RI, SC, TN, TX, VT, VA, WA, WV, WI and WY. Estimates shown in the first row of the table include individuals interviewed between January 2000 and July 2006 residing in any of these states.

^cStates that never offered dental coverage or added coverage include WY, AL, AK, AR, AZ, CA, CO, DC, DE, GA, HI, IL, KS, LA, ME, MD, MS, MT, NH, NV, SC, TN, TX, VA, WV, and WY. States that always offered dental coverage or dropped coverage include CA, CT, ID, IN, IA, KY, MN, NE, NJ, NM, NY, NC, ND, OH, OR, PA, RI, VT, WA, and WI. States that changed dental coverage policy were included in the analysis sample until the date of the policy change. States that did not change dental coverage policy were included in the analysis sample for the full study period (January 2000–December 2012).

Table 5

Regression estimates of the effect of Medicaid coverage of adult dental services on dental utilization outcomes, NHIS and NHANES (2000–2012).^a

	Medicaid beneficiaries, outcome means		Regression estimates, percentage point difference, dental coverage vs. no dental coverage		DDD estimate
	Dental coverage	No dental coverage	Difference	Low income adults	
NHIS					
Seen dentist past year	56.48	38.01	18.47***	0.84	12.88***
	(0.75)	(0.84)	(1.11)	(1.35)	(1.74)
Seen dentist, past 6 months	35.49	21.53	13.96***	1.45	9.46***
	(0.69)	(0.62)	(0.91)	(1.15)	(1.41)
Did not get dental care because of cost	12.77	27.06	-14.29***	-0.54	-12.06***
	(0.56)	(0.84)	(0.98)	(1.33)	(1.93)
NHANES					
Seen dentist past year	52.06	36.08	15.98***	4.92*	12.95**
	(3.48)	(3.74)	(4.90)	(2.68)	(4.91)
Seen dentist, past 6 months	34.68	18.74	15.95***	1.95	11.79**
	(2.99)	(3.50)	(4.62)	(3.08)	(4.81)

^aResults are estimates from linear probability models with controls including age, age squared, race/ethnicity, sex, education, marital status, health status, ratio of family income to the poverty threshold, and an urban area indicator, and county level controls including the supply of dentists per 1,000 population and the annual unemployment rate, state fixed effects, year indicators, and linear state-specific time trends. Health status and urban area indicators were excluded from the NHANES analysis as these variables were unavailable in some or all years. The NHANES analysis also excludes state-specific linear time trends as the dental visit variables are only available in 2000–2004 and 2011–2012. Errors are clustered at the state level and sampling weights are used to produce nationally-representative estimates. All estimates represent percentage point changes. Standard errors are in parentheses below estimates.

* $p < 0.10$,

** $p < 0.05$,

*** $p < 0.01$.

Dental utilization outcomes were available in all years 2000–2012 in NHIS and in 2000–2004 and 2011–2012 in NHANES. The 2000–2012 NHIS sample includes 14,673 Medicaid beneficiaries and 89,496 low income adults not on Medicaid ($n = 104,169$). The 2000–2004 and 2011–2012 NHANES sample includes 524 Medicaid beneficiaries and 4111 low income adults not on Medicaid ($n = 4635$).

Regression estimates of the effect of Medicaid coverage of adult dental services on dental health outcomes, NHIS (2008) and NHANES (2000–2012).^a

^a Results are estimates from linear probability models with controls including age, age squared, race/ethnicity, sex, education, marital status, health status, ratio of family income to the poverty threshold, and an urban area indicator, and county level controls including the supply of dentists per 1000 population and the annual unemployment rate. Errors are clustered at the state level and sampling weights are used to create nationally representative estimates. All estimates represent percentage point changes. Standard errors are in parentheses below estimates.

 $p < 0.01$.

b_7 The 2008 NHIS sample includes 745 Medicaid beneficiaries and 4398 low income adults not on Medicaid ($n = 5143$). State and year effects were excluded from the NHIS analysis since NHIS health outcomes were only available in 2008.

The NHANES sample used to examine untreated caries included 9580 low income individuals and 756 Medicaid beneficiaries for years 2000–2008 and 2011–2012. The sample used to examine missing teeth without replacement included 3976 low income individuals and 510 Medicaid beneficiaries for years 2000–2004 and 2011–2012. All analyses include state and year effects. Analysis of the untreated caries outcome also includes state-specific linear time trends. Health status and urban area indicators were excluded from the NHANES analysis as these variables were unavailable in some or all years.

Table 7

Regression estimates of the effect of Medicaid coverage of adult dental services and payment rates to dentists on the likelihood of an annual dental visit, NHIS (2000–2001 and 2008–2009)^a.

	Low income adults	Medicaid beneficiaries	DDD estimate
Seen dentist, past year			
Coverage only (2000–2012)	0.84 (1.35)	13.72 *** (1.94)	12.88 *** (1.74)
Coverage only (2000/2001,2008/2009)	–1.94 (1.56)	12.28 *** (3.55)	14.34 *** (3.10)
Coverage at mean fee ratio	–1.83 (1.54)	12.45 *** (3.44)	14.28 *** (3.30)
Coverage at 10th percentile fee ratio ^b	–0.97 (1.62)	8.04 * (4.27)	9.01 ** (3.81)
Coverage at 90th percentile fee ratio ^c	–2.58 (1.98)	16.32 *** (3.56)	18.90 *** (4.02)
Effect of 10 pp increase in fee ratio	–0.41 (0.50)	2.12 ** (0.95)	2.54 ** (1.10)
States that provided coverage in all years^d			
Effect of 10 pp increase in fee	–0.41 (0.69)	2.10 ** (0.85)	2.51 ** (1.08)

^aResults are estimates from linear probability models with controls including age, age squared, race/ethnicity, sex, education, marital status, health status, ratio of family income to the poverty threshold, and an urban area indicator, and county level controls including the supply of dentists per 1000 population and the annual unemployment rate, state fixed effects, and year indicators. Errors are clustered at the state level and sampling weights are used to create nationally-representative estimates. All estimates represent percentage point changes. Standard errors are in parentheses below estimates.

*
 $p < 0.10$,

**
 $p < 0.05$,

 $p < 0.01$.

The 2000–2001 and 2008–2009 sample includes 3768 Medicaid beneficiaries and 24,260 low income adults not on Medicaid ($n = 28,028$).

^bThe 10th percentile fee ratio across all years is 0.34.

^cThe 90th percentile fee ratio across all years is 0.73.

^dStates that provided adult dental coverage to Medicaid beneficiaries in all years 2000–2001 and 2008–2009 include CA, CT, ID, IN, IA, KY, MI, MN, NE, NJ, NM, NY, NC, ND, OH, OR, PA, RI, VT, WA, WI. This sample includes 2458 Medicaid beneficiaries and 12,492 low income adults not on Medicaid ($n = 14,950$).

Table 8

Regression estimates of the association between Medicaid coverage of adult dental services and unrelated outcomes, NHIS (2000–2012).^a

Outcome	Medicaid Beneficiaries, outcome means (%)		Regression estimates, dental coverage vs. no dental coverage	
	Dental coverage	No dental coverage	Low income adults	Medicaid beneficiaries
Seen GP, past year	72.48	71.99	1.39 (1.18)	-0.13 (1.27)
Seen specialist, past year	27.16	26.65	0.15 (0.71)	-0.49 (1.24)
Did not get prescription drugs due to cost	13.75	9.41	-0.86 (0.94)	-1.93 (1.34)
				-1.53 (0.94)
				-0.64 (1.14)
				-1.07 (1.40)

^aResults are estimates from linear probability models with controls including age, age squared, race/ethnicity, sex, education, marital status, health status, ratio of family income to the poverty threshold, and an urban area indicator, and county level controls including the supply of dentists per 1000 population and the annual unemployment rate, state fixed effects, year indicators, and linear state-specific time trends. Errors are clustered at the state level and sampling weights are used to create nationally representative estimates. All estimates represent percentage point changes. Standard errors are in parentheses below estimates. The 2000–2012 sample includes 14,673 Medicaid beneficiaries and 89,496 low income adults not on Medicaid ($n = 104,169$).

Table 9

Intent-to-treat regression estimates of the effect of Medicaid coverage of adult dental services on dental utilization outcomes, NHIS 2000–2012^a.

	Eligibility year		
	2003 ^b	2008 ^b	2012 ^b
Outcome			
Seen dentist, past year	3.81 *** (1.29)	3.50 ** (1.34)	4.09 *** (1.48)
Seen dentist, past 6 months	3.51 *** (1.13)	4.64 *** (1.31)	4.32 *** (1.25)
Did not get dental care because of cost	-7.38 *** (1.35)	-6.67 *** (1.27)	-8.87 *** (1.48)

^aResults are estimates from linear probability models regressing each outcome against a Medicaid eligibility indicator, dental coverage status, and the interaction between the two as well as controls including age, age squared, race/ethnicity, sex, education, marital status, health status, ratio of family income to the poverty threshold, an urban area indicator, the county-level supply of dentists per 1000 population, the annual county-level unemployment rate, state fixed effects, year indicators, and linear state-specific time trends. Errors are clustered at the state level and sampling weights are used to produce nationally-representative estimates. Results represent the coefficient estimates on the interaction between the eligibility indicator and dental coverage status and are expressed in terms of percentage point changes. Standard errors are in parentheses below estimates. The sample includes 49,626 low-income parents.

**
 $p < 0.05$,

 $p < 0.01$.

^bThe three columns of Table 9 represent the results of separate regressions using alternative years of Medicaid eligibility rules to define the eligibility indicator. Eligibility rules for each year were obtained from the Kaiser Family Foundation and can be found here:<http://kff.org/medicaid/>. Eligibility thresholds for working parents at the time of application that incorporated earnings disregards were used. Income eligibility thresholds as a percentage of the federal poverty threshold were defined based on a family of three.

Table 10

Percentage point change in outcome variables for Medicaid beneficiaries relative to low income adults not on Medicaid, before and after dental coverage dropped, NHIS 2000–2012.^a

Outcome	Time prior to coverage drop		Coverage drop implemented		Time post coverage drop	
	1 Year	6 Months			6 Months	1 Year
Seen dentist, past year	-0.27 (4.78)	0.60 (9.03)	-6.37 (5.46)		-10.63** (2.98)	-8.96** (2.22)
Seen dentist, past 6 mo	4.43 (7.94)	1.09 (4.59)	-2.77 (7.24)		-12.49** (3.16)	-6.65*** (1.33)
Did not get dental care due to cost	1.05 (8.30)	1.19 (9.66)	14.27*** (2.32)		5.09 (8.26)	9.31* (3.62)

^aResults are estimates from linear probability models with controls including age, age squared, race/ethnicity, sex, education, marital status, health status, ratio of family income to the poverty threshold, and an urban area indicator, and county level controls including the supply of dentists per 1000 population and the annual unemployment rate, state fixed effects, year indicators, and linear state-specific time trends. Errors are clustered at the state level and sampling weights are used to create nationally representative estimates. All estimates represent percentage point changes. Standard errors are in parentheses below estimates.

* $p < 0.10$,

** $p < 0.05$,

*** $p < 0.01$.

The 2000–2012 sample includes 3633 Medicaid beneficiaries and 22,272 low income individuals not on Medicaid ($n = 25,905$) residing in states that dropped Medicaid coverage of adult dental services at some time during the period 2000–2012 and did not subsequently add coverage. These states include CA, FL, ID, OK, and WA.

Table 11

Regression estimates of the effect of adding vs. dropping Medicaid coverage of adult dental services, NHIS 2000–2012^a.

	Dropping coverage ^b	Adding coverage ^c
NHIS		
Seen dentist past year	–9.52 ** (2.95)	15.04 ** (4.07)
Seen dentist past 6 months	–8.19 ** (1.89)	18.96 ** (4.79)
Did not get dental care because of cost	7.98 (4.84)	–8.25 (7.65)

^aResults are estimates from linear probability models with controls including age, age squared, race/ethnicity, sex, education, marital status, health status, ratio of family income to the poverty threshold, and an urban area indicator, and county level controls including the supply of dentists per 1000 population and the annual unemployment rate, state fixed effects, year indicators, and linear state-specific time trends. Errors are clustered at the state level and sampling weights are used to produce nationally-representative estimates. All estimates represent percentage point changes. Standard errors are in parentheses below estimates.

**
 $p < 0.05$.

^bThe sample includes 3633 Medicaid beneficiaries and 22,272 low income adults not on Medicaid ($n = 25,905$) residing in states that dropped and did not add adult dental coverage during the period 2000–2012. These states include CA, FL, ID, OK, and WA.

^cThe sample includes 203 Medicaid beneficiaries and 2101 low income adults not on Medicaid ($n = 2304$) residing in states that added and did not drop adult dental coverage during the period 2000–2012. These states include AK, AR, DC, SD, UT, and WY.