Technical Appendix for Health Affairs manuscript

This Appendix includes details about data sources, construction of variables, and analytic methods used to examine the geographic distribution of dental and medical practices providing pediatric oral health services for Medicaid-enrollees and to examine the association between distance from these practices and utilization among a cohort of approximately 1000 infants and toddlers enrolled in the NC Medicaid program from 2008-10.

Geographic distribution of practices

Medical and dental office addresses, including community health centers and local health departments, were obtained from the NC Division of Medical Assistance for the calendar year 2009. We obtained street addresses for 630 unique dental practices serving Medicaid-enrollees younger than 3 years. We examine dentists treating children younger than age three because these children encounter barriers to dental care because fewer dentists see infants and toddlers children (1,2). From administrative claims as identified by unique billing provider number, we obtained street addresses for 409 medical practices having at least one paid-claim for physician-based preventive oral health services (PB-POHS) (D0145, oral evaluation and D1206, fluoride varnish application). PB-POHS are reimbursed about $50 per visit by the state Medicaid program up to 6 times

per child before 3.5 years of age. ArcMap 10.1 (Esri, Redlands, CA, USA) was used to geocode practice locations at the street-level.

The American Community Survey's 2006-2010 five-year estimates provided county-level measures of the total population, population younger than five years, and the percent of population younger than 18 years living in poverty (3). To estimate demand for care, we calculated the number of practices per 1,000 children younger than 5 years. Counties were grouped into four categories: 0 practices; fewer than 1 practice per 1000 children; 1 to 1.9 practices per 1000 children; and 2 or more practices per 1000 children. We constructed a four-group categorical measure of child poverty based on the distribution of the variable to illustrate low and high poverty areas (state mean=23.3%, range=10.1% to 43.9%). Rural/urban continuum codes from the USDA Economic Research Service were used to construct a dichotomous variable indicating counties in metro areas based on the first three continuum codes (4). To examine variation across the state, we calculated county-level descriptive statistics and overlaid this data on our maps with geocoded practice locations.

Distance to care and use

We used baseline data from the Carolina Oral Health Literacy (COHL) cohort study, which enrolled 1,405 low-income child-caregiver dyads, mostly mothers, between July 2008 and

July 2009 at Special Supplemental Nutrition Program for Women, Infants and Children (WIC) clinics in seven counties throughout North Carolina (5-7). Participants were 18 or older, English-speaking, and the primary caregiver of a healthy (category I or II of the American Society of Anesthesiologists Physical Status Classification System), Medicaid-eligible child aged five or younger. Structured interviews covered a wide range of domains including demography, socio-economic status, health literacy, and self-reported oral health status and behaviors. Caregiver interview data was linked to their Medicaid claims for 1,245 children during calendar years 2008, 2009, and 2010.

We were able to geocode home addresses for 1000 dyads (80% match-rate) to identify the closest medical and dental practices. We excluded pregnant women (n=2), children with less than five months Medicaid enrollment (n=46), and children aged 37 months or older in January 2008, the date we began to assess oral health visits (n=35).

Medicaid claims from the calendar years 2008, 2009, and 2010 were used to identify whether or not a child had a dental visit or received PB-POHS. K (dentist-provider) and J (physician-provider) claims were used to identify oral health office-based visits. We examined visits to dental offices for any reason, excluding hospital-based oral health visits. PB-POHS were identified using Current Procedural Terminology (CPT) codes

(D0145, oral evaluation and D1206, fluoride varnish application). Two binary variables were constructed to indicate whether or not a child had a dental visit or received PB-POHS. Dental visits may include preventive and restorative services, whereas medical visits include only preventive services.

Using ArcGIS Network Analyst, we calculated two continuous measures of distance to care based on the driving time in minutes from each child's home address to the nearest dental practice or medical practice providing PB-POHS. Appendix Exhibit 1 illustrates the overall distribution of the percent of children with visits (dental or PB-POHS) and distance to the nearest practice. The continuous variable measuring distance to medical practices with PB-POHS was skewed left, with a mean of 9 minutes (SD=7) and a range of 0 to 51 minutes. Similarly, distance to dental practices was skewed left, with a mean of 7 minutes (SD=6) and a range of 0 to 38 minutes. We calculated pairwise Spearman's correlation coefficients among distance to care and the indicator of PB-POHS (-0.03, P-value=0.41) and the indicator of a dental visit (-0.06, P-value=0.05). Exhibit 1 also illustrates the bivariate relationships of distance to care with the probability of a visit. We observed a linear relationship between distance to care and the probability of PB-POHS or a dental visit, except among higher values of distance (PB-POHS>23 minutes; dental>17 minutes), which was driven by

fewer than five percent of observations. Because we were concerned that these few extreme observations may influence our results, we explored truncating the distance measure at the 90th and 95th percentile. We found that regression coefficients in adjusted models were similar in magnitude and statistical significance with and without truncation; therefore we present results for these continuous measures of distance to care without truncation.

Additional explanatory variables were categorized based on domains from a conceptual framework describing the probability of making a dental visit: structure (individual- and community-level demographic variables); history (preventive behaviors and past dental use); cognition (health and oral health literacy); and expectations (no variables were available to measure this domain) (8).

Variables relating to the structure domain were measured at the child-, caregiver-, Census tract-, and county-levels. Child-level covariates obtained from the baseline COHL survey included: age in years (<1 year [reference group], 1 year, 2 years, 3 years and older), number of children in family (1 [reference group], 2, 3, 4 or more) and months enrolled in Medicaid. Caregiver covariates included: race (white [reference group], black, American Indian, Asian) and Hispanic ethnicity. Models also included a continuous measure of the proportion of

children younger than 18 years living poverty within a Census tract (3), a continuous measure of demand for oral health services at the county level (number of practices per 1000 children younger than 5 years), and an indicator of a metropolitan county, derived from rural-urban continuum codes (4).

Variables relating to the history domain reflect prior experience with dental care. The models included indicators, obtained from the baseline COHL survey, that the caregiver had a dental visit during past year and that he or she reported brushing the child's teeth daily.

To reflect the cognition domain, we included caregiver indicators of low oral health literacy (dental model only) and low health literacy (PB-POHS model only). Oral health literacy was measured using the Rapid Estimate of Adult Literacy in Dentistry, a validated word recognition test, with a range of 0 to 30 (indicating highest literacy) (9). Health literacy was measured using Newest Vital Sign, a comprehension and numeracy-based test, with a range of 0 to 6 (indicating highest literacy) (10). As with prior studies, we collapsed these scales to dichotomous measures indicating low literacy (oral health literacy scores<13 and health literacy scores<2) (11,12).

Descriptive analyses compared characteristics of children who received and did not receive dental visits and PB-POHS. We

estimated chi-squared and t-tests to examine the bivariate associations of distance from care with receipt of dental visits and PB-POHS, respectively.

Adjusted logistic regression models determined whether distance from these practices affected the log odds of receiving a dental visit and PB-POHS. Huber-White empirical standard errors adjusted for intra-group correlation due to clustering of children within counties. We also estimated model-predicted mean outcomes, indicating the probability of a visit as a function of distance to care, ranging from a distance of 5 to 30 minutes from the nearest practice, with 95% confidence intervals generated using 500 bootstrap replications. Analyses were conducted with Stata 13 (StataCorp LP, College Station, TX, USA) statistical software.

Results

Main results are presented in the manuscript. Below, we provide additional information to support our findings.

Geographic distribution of practices

Appendix Exhibit 2 provides county-level descriptive statistics for all counties, counties without Medicaid providers of pediatric oral health services, and counties with less than 1 practice per 1,000 children younger than 5 years. Compared to the state average, counties without these dental practices (n=9)

had lower populations, more medical practices with PB-POHS, and a higher percent of the population under age five that was black. Fewer counties lacked PB-POHS (n=4). These counties had few dental practices, high child poverty, and were more likely to be in non-metropolitan areas compared to the state average. Counties with less than 1 dental practice per 1,000 children younger than 5 years (n=39) had fewer medical practices with PB-POHS per capita compared to the state average. Counties with less than 1 PB-POHS practice per 1,000 children (n=56) had higher populations than the state average.

Distance to care and use

Appendix Exhibit 3 provides the regression results from the logistic regression models examining the association between distance from oral health services and utilization of oral health services. In columns 2-6, we see that distance from PB-POHS was not associated with having a medical visit (coefficient= -0.01, 95% CI=-0.05, 0.03). The average probability of a medical visit with PB-POHS was 52% (95% CI=47%, 58%) when 10 minutes from the nearest provider and 49% (95% CI=30%, 67%) when 30 minutes away (P=0.65) (Exhibit 5A in the manuscript).

Only structural factors were significantly associated with receipt of PB-POHS. Longer enrollment in Medicaid and living in a county with a higher child poverty rate were positively

associated with receipt of PB-POHS. Older age and living in a metropolitan county were negatively associated with receipt of PB-POHS.

As illustrated in columns 7-11 of Appendix Exhibit 3, distance from dental providers was inversely associated with utilization (coefficient= -0.03, 95% CI=-0.05, -0.01). Greater distance from a dental practice was associated with a decreased likelihood of having a dental visit (coefficient= -0.03, P=0.01). On average, the probability of a dental visit decreased from 46% (95% CI=43%, 59%) when 10 minutes from the nearest dental practice to 37% (95% CI=28%, 45%) when 30 minutes away, a 24% decline in the probability of a dental visit (P=0.007) (Exhibit 4B in the manuscript).

As with PB-POHS, several factors in the structure domain were significantly associated with the probability of a dental visit. For example, longer enrollment in Medicaid and older age were positively associated with having a dental visit. Children with caregivers who reported daily brushing, a component of the history domain, were significantly more likely to have a dental visit.

Appendix References

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Appendix exhibit list

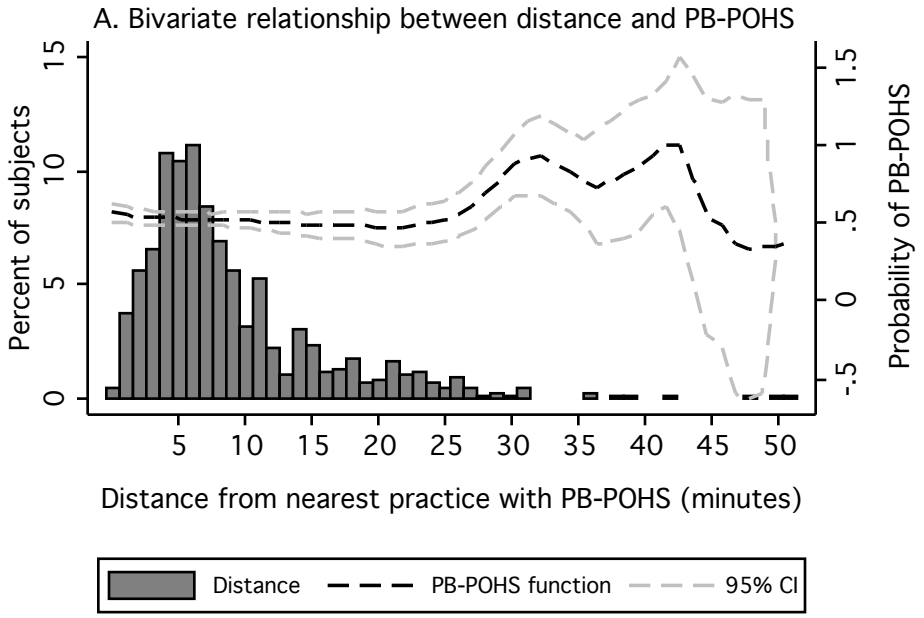
Appendix Exhibit 1 (figure)
Caption/headline: Examining distribution of variable measuring distance to care
Source: Combination of national and individual survey data and North Carolina Medicaid claims data, 2008–10.

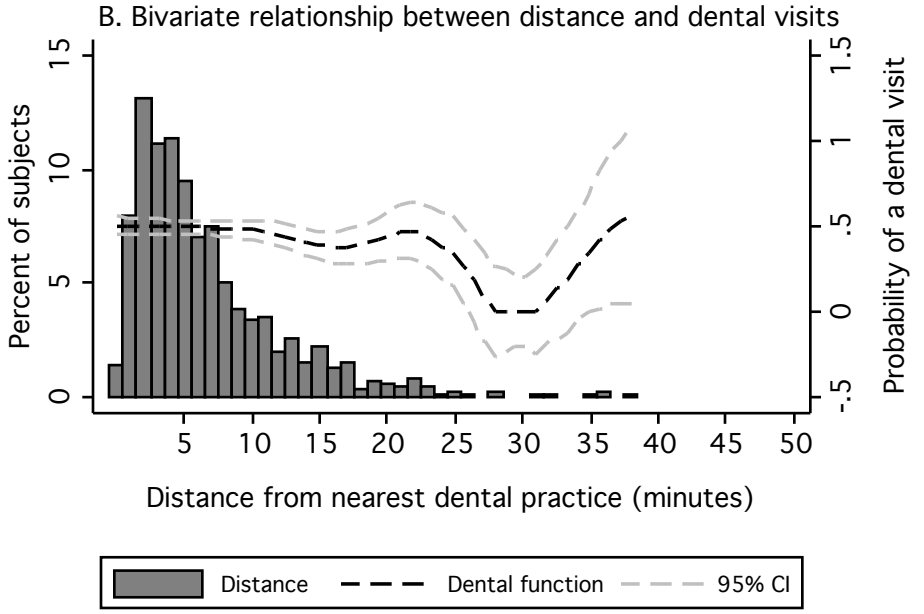
Appendix Exhibit 2 (table)
Caption/headline: Characteristics of counties in North Carolina
Source: 2006-10 American Community Survey, 2010 Census, 2003 Rural/Urban continuum codes, and practice addresses from the NC Division of Medical Assistance during 2009.

Appendix Exhibit 3 (table)
Caption/headline: Results of regression models examining association between distance to care and use of oral health services among young children enrolled in NC Medicaid (N=917)
Source: Combination of national and individual survey data and North Carolina Medicaid claims data, 2008–10.
Notes: *Standard errors clustered at county.

Appendix Exhibit 1. Examining distribution of variable measuring distance to care

Source. Combination of national and individual survey data and North Carolina Medicaid claims data, 2008–10.





Appendix Exhibit 2. Characteristics of counties in North Carolina

Mean number or % (Standard Deviation)	All counties (N=100)	Counties with <1 dental practice per 1000 children <5 yr (N=39)	Counties without dental practices (N=9)	Counties with <1 PB-POHS medical practice per 1000 children <5 yr (N=56)	Counties without PB-POHS (N=4)
Total number of medical practices with PB-POHS	4.09 (4.40)	5.51 (4.74)	0.89 (0.78)	5.18 (5.37)	0
Total number of dental practices that see Medicaid-enrollees aged <3 years	6.14 (9.81)	5.97 (8.70)	0	9.21 (12.13)	0.25 (0.50)
Total population	92,712 (135,623)	116,110 (147,010)	16,193 (8,488)	139,973 (165,744)	16,501 (9,377)
Number of children <5 yr of age	6,219 (10,140)	8,119 (11,323)	900 (497)	9,634 (12,506)	994 (595)
Percent of population <5 yr of age	6.09 (1.06)	6.50 (1.07)	5.43 (0.76)	6.50 (1.06)	5.82 (0.57)
Number of medical practice with PB-POHS per 1000 children <5 yr of age, among counties with PB-POHS	1.08 (1.04)	0.95 (0.57)	1.34 (1.39)	0.60 (0.23)	0
Number of dental practice that see Medicaid-enrollees aged <3 yr per 100 children <5 yr of age, among counties with dental practices	1.09 (0.82)	0.73 (0.16)	0	0.98 (0.36)	0.30 (0.60)
Percent of population <18 yr of age living in poverty	25.15 (7.68)	24.18 (6.56)	26.12 (12.54)	24.74 (7.46)	30.12 (14.20)
Categorical measure of child poverty					
0 to 14.9%	5	2.6	33.3	3.6	25
15% to 24.9%	53	61.5	22.2	57.1	0
25% to 34.9%	31	28.2	11.1	28.6	25
35% or more	11	7.7	33.3	10.7	50
Indicator of metropolitan county	46	56	22.2	66	25

Source. 2006-10 American Community Survey, 2010 Census, 2003 Rural/Urban continuum codes, and practice addresses from the NC Division of Medical Assistance during 2009.

Appendix Exhibit 3. Results of regression models examining association between distance to care and use of oral health services among young children enrolled in NC Medicaid (N=917)

	Logistic regression model examining receipt of a medical visit with PB-POHS*				Logistic regression model examining receipt of a dental visit*			
Variables	Coefficient	95% Confidence Interval		P-value	Coefficient	95% Confidence Interval		P-value
Intercept	-0.11	-1.40	1.18	0.87	-3.58	-4.48	-2.67	0.00
Structural factors								
Drive time (in minutes) to nearest medical practice with PB-POHS	-0.01	-0.05	0.03	0.65				
Drive time (in minutes) to nearest dental practice that sees Medicaid-enrollees aged <3 yr					-0.03	-0.05	-0.01	0.01
Number of medical practice with PB-POHS per 1000 children <5 yr	0.26	-1.28	1.79	0.74				
Number of dental practice that see Medicaid-enrollees aged <3 yr per 100 children <5 yr					-0.54	-1.61	0.53	0.33
% population in census tract <18 yr living in poverty	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.35
Indicates child lives in a metropolitan county	-1.16	-1.74	-0.59	0.00	0.78	0.31	1.26	0.00
Child's age in years (reference group=<1 year)								
1 year	-0.20	-0.73	0.34	0.48	1.00	0.87	1.13	0.00
2 years	-0.81	-1.40	-0.21	0.01	1.51	1.26	1.76	0.00
3 years and older	-1.51	-2.34	-0.69	0.00	2.86	2.33	3.40	0.00
Number of children in family (reference=1 child)								
2	-0.35	-0.69	-0.01	0.04	0.18	-0.06	0.42	0.14
3	-0.68	-1.02	-0.33	0.00	0.18	-0.44	0.80	0.57
4 or more	-0.33	-0.87	0.21	0.23	-0.41	-0.68	-0.15	0.00
Caregiver is Hispanic	0.10	-0.32	0.52	0.64	0.10	-0.26	0.47	0.58
Caregiver's race (reference=white)								
African American	0.25	-0.09	0.59	0.15	-0.13	-0.63	0.36	0.60
American Indian	0.28	-0.21	0.76	0.26	0.09	-0.18	0.36	0.50
Asian	-0.90	-2.46	0.65	0.25	-1.84	-3.09	-0.58	0.00
Historical factors								
Caregiver reports brushing child's teeth daily	0.17	-0.19	0.53	0.37	0.35	0.02	0.69	0.04
Caregiver had a dental visit in the last year	0.09	-0.18	0.35	0.53	0.17	-0.17	0.51	0.33
Cognitive factors								
Indicator caregiver has low oral health literacy					-0.14	-0.51	0.23	0.46
Indicator caregiver has low health literacy	0.16	-0.26	0.58	0.47				
Pseudo R-squared value	0.1169				0.2031			
Log pseudolikelihood	-560.14				-505.82			