

HEALTH SERVICES RESEARCH

Caregivers' Health Literacy and Their Young Children's Oral-health-related Expenditures

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APPENDIX

Materials & Methods

Population

This Institutional review board-approved study was based upon the Carolina Oral Health Literacy (COHL) cohort, which enrolled 1,405 child-caregiver dyads in 7 counties in North Carolina (NC) between July 2008 and July 2009. Detailed descriptions of the sampling procedure, cohort characteristics, measures, and outcomes have been reported in previous publications (Lee *et al.*, 2011, 2012). In brief, participants were low-income, mostly female caregivers and clients of the Special Supplemental Nutrition Program for Women, Infants and Children (WIC). To be eligible for enrollment in COHL, individuals had to be the primary caregiver of a healthy and Medicaid-eligible infant/child aged 60 mos old or younger or expecting a newborn within the ensuing 8 mos, over the age of 18 yrs, and English speaking. For the purposes of the present study, participants were excluded from the analytical sample if the enrolled child: (a) was unborn at the baseline interview ($n = 134$, 9.5% of the cohort), (b) had no available Medicaid data ($n = 29$,

2%), and (c) had fewer than 12 mos of Medicaid data after enrollment in COHL ($n = 108$, 8%). The inclusion criterion of 12 mos did not require continuous enrollment and was set to ensure adequate “insured” follow-up time in the analytical cohort for the occurrence of oral-health-services-related expenditures. We also excluded two caregivers who did not meet the COHL initial eligibility criteria. For analyses that examined health literacy using a word-recognition test, we excluded 58 (4% of) caregivers who reported a language other than English spoken at home, because word-recognition tests are highly dependent on a person's primary language.

Study Procedures, Measures, and Variables

After enrollment, participants completed a structured interview with one of the two trained study interviewers. The study instruments included an array of questions covering a wide range of domains including demography, socio-economic status, health literacy, self-reported oral health status and behaviors, and others (Divaris *et al.*, 2011; Lee *et al.*, 2011). We measured health literacy using 2 validated instruments—the Newest Vital Sign (NVS), a comprehension- and

numeracy-based test (Weiss *et al.*, 2005), and the Rapid Estimate of Adult Health Literacy in Dentistry (REALD)-30, a word-recognition-based test (Lee *et al.*, 2007); of special note, the REALD-30 is an instrument containing dentistry-related words, which was developed for use specifically in the oral health context.

We examined health literacy both as a continuous and a dichotomous measure, wherein continuous scores ranged between 0 and 6 for NVS and 0 and 30 for REALD-30. Univariate distributions of the health literacy measures were inspected with histograms (Appendix Figs. 1 and 2). We defined “low health literacy” categories as NVS < 2 (Osborn *et al.*, 2007) and as REALD-30 < 13 (Vann *et al.*, 2010). Additional variables included caregivers' age (measured in yrs and grouped in quartile-categories), gender, self-reported race (white, African American, American Indian), education (less than high school, high school or general education diploma, some college education, and college or more), marital status (single, married, divorced/separated/other), number of children (1, 2, 3, 4, or more), and children's ages (measured in mos and categorized in full yrs).

To measure children's oral-health-related expenditures, we used Medicaid medical, dental, and hospital claims

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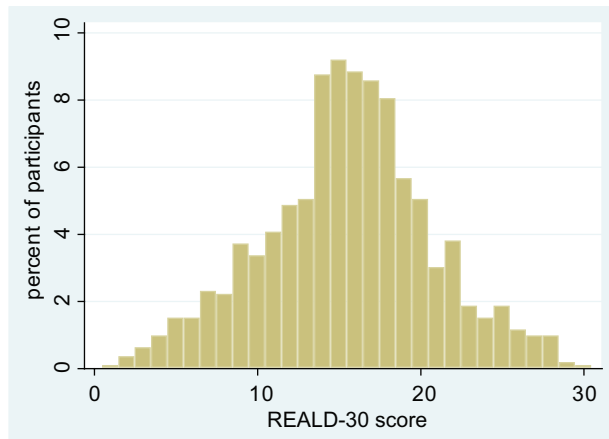
Appendix Table.

Description of Unique Visits and Annual Oral-health-care–related Medicaid-paid Expenditures among the Children Who Received Oral Health Services in the Carolina Oral Health Literacy Cohort (n = 1,132) between 2008 and 2010

	Children (n)	Unique Visits Mean (range)	Annual Expenditure Mean [range (\$)]
Total	902	3.4 (1-12)	254 (18-4,749)
Visit type			
Dental-office based preventive care	548	2.4 (1-9)	131 (18-515)
Physician-office–based preventive care	607	2.1 (1-7)	56 (21-189)
Dental-office based restorative care	159	1.8 (1-6)	343 (26-2,274)
Hospital-based–restorative care	41	1.0 (1-2)	1,409 (111-4,458)
Dental-office based emergency care	83	1.3 (1-4)	51 (15-555)
Hospital-based–emergency care	16	1.2 (1-2)	1,283 (50-2,578)

Appendix Figure 1.

The distribution of health literacy [word-recognition-based; Rapid Estimate of Adult Literacy in Dentistry (REALD)-30] estimates among the analytical sample of caregivers participating in the Carolina Oral Health Literacy cohort follow-up study (n = 1,132).



that were filed concurrently with or after enrollment in the COHL study, during the calendar years 2008, 2009, and 2010. Ethical approval for the linkage of Medicaid claims with children’s identifiers was obtained from the participating caregivers at the baseline interview. From these claims we identified and characterized unique oral-health–related clinical visits in the domains of preventive, restorative, and emergency dental services. We calculated ‘annualized’ expenditures by adjusting for the time enrolled in Medicaid

and normalizing the Medicaid-paid dollar amounts to 2010 fees. A detailed description of the claim types, diagnostic, and procedure codes used to define care type categories is presented in this Appendix.

Analytical Approach

We used descriptive methods to investigate and illustrate the distribution of health literacy, expenditures, and study covariates overall and by strata of oral health services use (any oral-health–related visit *vs.* no visits). We

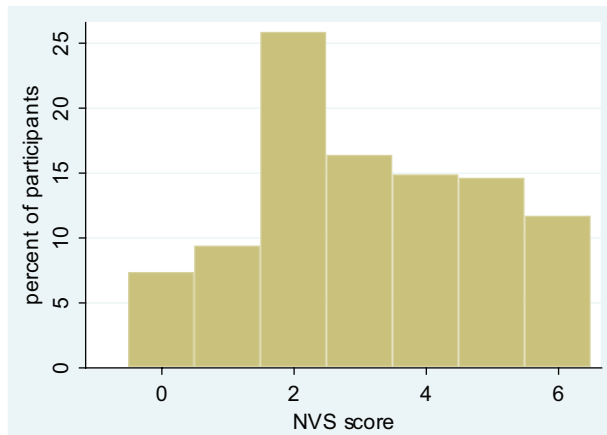
reported expenditures using mean and median 2010 Medicaid-paid annualized dollars, both overall and by visit type. To examine differences between strata, we relied on bivariate methods based on χ^2 tests for categorical variables, median tests for the NVS score, and Student’s *t* test for the REALD-30 score.

We examined the bivariate association between continuous measures of health literacy and expenditures with polynomial smoothing functions using the Epanechnikov kernel (Fan and Gijbels, 1995). To disentangle the effects of health literacy and socio-demographic covariates on expenditures, we used multivariate modeling based on gamma-generalized models, utilizing a log-link (Hill and Miller, 2010). To investigate the effects of the 2 measures of health literacy (REALD-30 and NVS), we constructed 2 independent sets of models for total, preventive, restorative, and emergency care expenditures, one for each measure.

All models included children’s and caregivers’ ages and race as *a priori* covariates. The inclusion of additional covariates (education, marital status, and number of children) in the model for total oral health care expenditures was determined by likelihood ratio tests and a *p* < .10 criterion (Maldonado and Greenland, 1993; Vittinghoff and Glidden, 2012). We based inferences on an effect estimation

Appendix Figure 2.

The distribution of health literacy [comprehension- and numeracy-based; Newest Vital Sign (NVS)] estimates among the analytical sample of caregivers participating in the Carolina Oral Health Literacy cohort follow-up study (n = 1,132).



rather than a hypothesis-testing approach (Gardner and Altman, 1986); to this end, we relied upon model-predicted average marginal effects (Basu and Rathouz, 2005) and 95% confidence intervals of caregivers' low health literacy, measured in 2010 Medicaid-paid annualized dollar fees. All analyses were conducted with Stata 12.1 (StataCorp LP, College Station, TX, USA) statistical software.

Definition of Oral-health-related Visit Types

To measure children's oral-health-related expenditures, we first obtained all child Medicaid claim history available for the period between January 2004 and December 2010. This essentially represented the "lifetime history" of Medicaid claims for the COHL children's cohort up to December 2010. To be consistent with a prospective cohort study design and allow for causal inference, we considered only claims that were filed concurrently with or after enrollment in COHL, the time-point when health literacy was measured. This resulted in a Medicaid-paid dataset of claims including the calendar years 2008, 2009, and 2010.

In a second step, we used K (dentist-provider), J (physician-provider), and M (hospital-based) claims to identify, enumerate, and characterize unique oral-health-related clinical visits in 6 categories:

dental-office-based preventive, physician-office-based preventive, dental-office-based restorative, hospital-based restorative, dental-office-based emergency, and hospital-based emergency. First, we first identified emergency dental-office-based visits (category 1) using D0140 and D0160 dental codes. Second, if a non-preventive dental care code (D2xxx – D9xxx) was identified and that visit was not previously classified as an emergency (category 1), that visit was labeled as a restorative dental-office-based visit (category 2) if a hospital claim was not concurrently filed, and as hospital-based restorative if a hospital claim was filed that day (category 3). Emergency hospital-based dental care visits (category 4) were identified by oral-health-related diagnosis (ICD9 520-529 codes) and Current Procedural Terminology (CPT) procedure codes (99281, 99282, 99283, 99284, 99285, and RC450) filed concurrently with emergency room claims (category 5). Finally, physician-office-based preventive care was identified by Medicaid codes D0120, D0145, D0150, D1203, D1206, D1330, D1405, W8002, and W8003, where no hospital-based claim was filed on the same day. For analytical purposes, we consolidated the above 6 categories in preventive (dental-office- and physician-office-based preventive and diagnostic care), restorative (dental-office- and

hospital-based restorative care), and emergency (dental-office- and hospital-based emergency care) dental care. We used the identified oral-health-related visits to derive an indicator variable denoting children who had no dentally related visits during the 3-year study period.

Estimation of Oral-health-related Medicaid Expenditures

To estimate oral health care expenditures from the health system's perspective, we used Medicaid-paid dollar amounts instead of billed fees, which were typically higher. As a first step, we summed all Medicaid-paid dollar amounts associated with each oral-health-related visit, including indirect costs. For instance, anesthesia, medications, and operating room services (RC250, RC255, RC258, RC636, RC370, RC371, RC710, RC410, RC360, RC361, and RC510) expenditures were considered as part of the cost of oral-health-related hospital visits. As another example, expenditures for dental diagnostic procedures (*i.e.*, radiographs) were considered part of restorative and emergency visits, if they were performed concurrently.

To account for changes in Medicaid fees, we adjusted all Medicaid-paid amounts for claims filed during 2008-2010 to 2010 Medicaid fees. Because children's enrollment varied during the period of observation, we further adjusted the expenditures by controlling for their 'months enrolled in Medicaid'. To facilitate interpretation, we derived 'annualized' expenditures and used these amounts for all descriptive and analytical purposes.

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