

HEALTH SERVICES RESEARCH

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

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Abstract: Caregivers' health literacy has emerged as an important determinant of young children's health care and outcomes. We examined the hypothesis that caregivers' health literacy influences children's oral-health-care-related expenditures. This was a prospective cohort study of 1,132 child/caregiver dyads (children's mean age = 19 months), participating in the Carolina Oral Health Literacy Project. Health literacy was measured by the REALD-30 (word recognition based) and NVS (comprehension based) instruments. Follow-up data included child Medicaid claims for CY2008-10. We quantified expenditures using annualized 2010 fee-adjusted Medicaid-paid dollars for oral-health-related visits involving preventive, restorative, and emergency care. We used descriptive, bivariate, and multivariate statistical methods based on generalized gamma models. Mean oral-health-related annual expenditures totaled \$203: preventive—\$81, restorative—\$99, and emergency care—\$22. Among children who received services, mean expenditures were: emergency hospital-based—\$1282, preventive—\$106, and restorative care—\$343. Caregivers' low literacy in the oral health context was

associated with a statistically non-significant increase in total expenditures (average annual difference = \$40; 95% confidence interval, -32, 111). Nevertheless, with both instruments, emergency dental care expenditures were consistently elevated among children of low-literacy caregivers. These findings provide initial support for health literacy as an important determinant of the meaningful use and cost of oral health care.

Key Words: cohort studies, dental care, health expenditures, health services, Medicaid, WIC.

Introduction

Health literacy is defined as “the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions” (Nielsen-Bohlman *et al.*, 2004) and has recently emerged as an important determinant of health and related outcomes, including a potential role in explaining health disparities (Sentell and Halpin, 2006). Evidence suggests that low health literacy is consistently associated with a higher frequency of being hospitalized,

increased use of emergency care, and increased health-related expenditures (Eichler *et al.*, 2009; Berkman *et al.*, 2011). At the same time, recent studies support a link between caregivers' health literacy and their children's health outcomes—children whose caregivers have low literacy often have worse health outcomes *vs.* those with caregivers with higher literacy (DeWalt and Hink, 2009; Sanders *et al.*, 2009). Accumulating evidence suggests that health literacy also has a pivotal role in the context of oral health (Horowitz and Kleinman, 2008; Parker and Hernandez, 2012). Recent studies have detected links between lower literacy and poor outcomes in the domains of oral health status (Parker and Jamieson, 2010; Lee *et al.*, 2012; Wehmeyer *et al.*, 2013), knowledge (Macek *et al.*, 2010), and quality of life (Divaris *et al.*, 2011).

Both conceptual frameworks (Fisher-Owens *et al.*, 2007; Bramlett *et al.*, 2010) and scientific evidence support the hypothesis that caregivers' low health literacy may be associated with the use of tertiary dental services for their children, which can translate to increased expenditures for oral-health-related services and/or specifically restorative and emergency dental services. In our previous investigations, we have found low

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A supplemental appendix to this article is published electronically only at <http://jdr.sagepub.com/supplemental>.

caregiver literacy to be linked to poorer child oral health outcomes and more detrimental oral-health-related behaviors, including worse oral health status (Miller *et al.*, 2010; Vann *et al.*, 2010), knowledge (Hom *et al.*, 2012), child oral-health-related quality of life (Divaris *et al.*, 2012a), and deleterious feeding practices (Vann *et al.*, 2010). In considering 2 specific and potentially robust deleterious examples in the latter publication, we reported that lower caregiver literacy was associated with nighttime bottle use and no daily brushing/cleaning in very young children. These are behaviors that can set the stage for the development of early childhood caries (ECC), a condition that can progress rapidly in young children, especially when it is considered that caregivers often underestimate their young children's dental needs (Divaris *et al.*, 2012b).

Indeed, these recent findings are consistent and illustrate that children of caregivers with low health literacy may suffer from high levels of oral disease and thus may experience higher dental expenditures compared with children of caregivers with higher literacy. Our study motivation evolved around the hypothesis that differences in oral health status and related oral-health-related expenditures would be manifested predominantly in restorative and emergency-care-related services, which are mainly driven by early childhood caries and its sequelae. To date, these hypotheses have not been tested; therefore, the aims of this study were to examine the oral-health-related expenditures for a cohort of young children and to determine whether their caregivers' literacy affected these expenditures.

Materials & Methods

A detailed description of the study population, procedures, measures, variables, and analytical approach are presented in the Appendix. In brief, this institutional review board approved study (Lee *et al.*, 2011) 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. 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 COHL, they had to be the primary caregiver of a healthy and Medicaid-eligible infant/child 60 mos old or younger or expecting a newborn within the ensuing 8 mos, over the age of 18 yrs, and English speaking. 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). We defined “low health literacy” categories as NVS < 2 (Osborn *et al.*, 2007) and REALD-30 < 13 (Vann *et al.*, 2010). Additional candidate covariates included caregivers' age, gender, self-reported race, education, marital status, number of children, and children's age.

To measure children's oral-health-related expenditures, we used Medicaid medical, dental, and hospital claims 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 annualized expenditures by adjusting for the time enrolled in Medicaid and normalized Medicaid-paid dollar amounts to 2010 fees.

We examined 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). To examine bivariate associations of health literacy with expenditures, we first used non-parametric graphic and bivariate methods. To disentangle the relationship of health literacy and socio-demographic covariates' effects on expenditures, we used multivariate modeling based on gamma-general-

ized models, utilizing a log-link (Hill and Miller, 2010). For inference, 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.

Results

The final analytical sample included 1,132 child-caregiver dyads (Table 1). Caregivers and children had mean ages of 27 yrs and 19 mos, respectively. The vast majority of caregivers were female with less than college education; there were equal proportions (40%) of whites and African Americans. Based on the word-comprehension instrument, 17% of caregivers were classified as having low literacy. This proportion was 26% with the word-recognition instrument.

The majority (80%) of children had at least one oral-health-related visit; however, only 50% were dental-office-based visits. The likelihood of having a dental-office-based visit increased with children's age, as well as with caregivers' age. The mean annual Medicaid-paid expenditure for all oral-health-related visits among all children was \$203, allocated as follows: \$81 for preventive dental-office-based and medical-office-based care; \$99 for dental-office-based and hospital-based restorative care; and \$22 for dental-office- and hospital-based emergency care (Table 2). Mean expenditures among children who received any oral health service in each respective category (Appendix Table) were higher: hospital-based emergency care—\$1,282, dental-office-based preventive care—\$131, and restorative care—\$343. The pattern of bivariate association between health literacy and expenditures varied by health literacy skill and by care type (Fig.). The highest mean expenditures were noted for REALD-30 scores ≤ 10 , whereas there was a virtually monotonic inverse association between expenditures and NVS. Although higher literacy was consistently associated with increased preventive care expenditures, the restorative and emergency

Table 1.

Socio-demographic Information of the Analytical Cohort of Child-Caregiver Dyads (N = 1,132) Enrolled in the COHL Study, with at Least 12 mos of Medicaid Enrollment during the Study's 3-year Follow-up Period

	Any Oral Health Care Claim		<i>p</i> [†]	Any Dental-office–based Claim	
	n [*] (column %)	n [*] (row %)		n [*] (row %)	<i>p</i> [†]
Total	1,132 (100)	902 (80)		554 (49)	
Race [‡]			.02		.04
White	450 (40)	344 (76)		229 (51)	
African American	450 (40)	363 (81)		230 (51)	
American Indian	223 (20)	190 (85)		93 (42)	
Caregiver's gender			.7		.6
Male	40 (4)	31 (78)		18 (45)	
Female	1,092 (96)	871 (80)		536 (49)	
Caregiver's age (quartiles; range, yrs)	mean (median)		.8		< .0005
Q1 (18.1, 21.9)	20.2 (20.2)	222 (78)		97 (34)	
Q2 (22.0, 25.2)	23.5 (23.5)	228 (82)		137 (48)	
Q3 (25.3, 30.2)	27.6 (27.4)	230 (81)		158 (56)	
Q4 (30.2, 65.6)	36.7 (34.9)	222 (78)		162 (57)	
Child's age (mos; at baseline interviews)			.07		< .0005
0-11	487 (43)	372 (76)		130 (27)	
12-23	237 (21)	190 (80)		118 (50)	
24-35	199 (18)	160 (80)		129 (65)	
36-47	182 (16)	157 (86)		154 (85)	
48-59	27 (2)	23 (85)		23 (85)	
Education			1.0		.09
< High school	276 (24)	218 (79)		126 (46)	
High school/GED	442 (39)	352 (80)		211 (48)	
Some college	357 (32)	287 (80)		181 (51)	
≥ College	57 (5)	45 (80)		36 (63)	
Marital status			.6		< .0005
Single	734 (65)	583 (79)		326 (44)	
Married	288 (25)	230 (80)		164 (57)	
Divorced/separated/other	110 (10)	89 (81)		64 (58)	
Number of children			.3		< .0005
1	445 (39)	354 (80)		167 (38)	
2	378 (33)	309 (82)		215 (57)	
3	179 (16)	142 (79)		105 (59)	
≥ 4	128 (11)	95 (74)		66 (52)	

Table 1.
Continued

	Any Oral Health Care Claim		p†	Any Dental-office–based Claim	
	n* (column %)	n* (row %)		n* (row %)	p‡
Word recognition (REALD30)			.6		.3
Adequate (≥ 13)	843 (74)	669 (79)		420 (50)	
Low (< 13)	289 (26)	233 (81)		134 (46)	
REALD-30 score (mean)	15.6	15.5	.9	15.8	.1
Comprehension (NVS)			.8		.09
High	943 (83)	753 (80)		472 (50)	
Low	189 (17)	149 (79)		82 (43)	
NVS score: mean (median)	3.1 (3)	3.1 (3)	.8	3.2 (3)	.04

*Estimates among participants with non-missing information in stratum; †corresponding to χ^2 tests of equivalence; ‡the analytical sample included nine additional caregivers of Asian/other race.

care costs followed a bimodal distribution, with peaks in the lowest and the highest ranges of REALD-30, indicating a complex phenomenon.

Mean annual expenditures were higher among American Indians, older caregivers and older children, and those with low health literacy in the oral health context; for example, an adequate REALD-30 score was \$187 *vs.* \$250 for a low score. Children of college-educated caregivers generally had more preventive and restorative and fewer emergency expenditures *vs.* those of caregivers with less education. Emergency dental care expenditures were highest among children who were 2 yrs old at baseline, as well as those of low-literacy caregivers, American Indians, older, and married and those with four or more children.

The final multivariate models included terms for caregivers' and children's ages, race, education, and number of children (REALD-30 models) or marital status (NVS models). As evidenced by the relatively wide confidence intervals (Table 3), none of the average marginal effects of low health literacy departed substantially from the null hypothesis of no association; however, several differences and trends were evident. Because of increased emergency and restorative care, low oral health literacy

(REALD-30) was associated with increased annual expenditures, a statistically non-significant average difference of \$40 (95% CI, -45, 111). Low literacy, as measured by comprehension—numeracy (NVS), had a weaker, inverse effect on annual dental expenditures, attributable mainly to less restorative care. Nevertheless, expenditures for emergency care were consistently increased among caregivers with low literacy [REALD-30—45 (95% CI, -81, 171); NVS—53 (95% CI, -63, 170)], whereas differences in preventive care were essentially null [REALD-30—6 (95% CI, -5, 17); NVS—0 (95% CI, -12, 12)].

Discussion

To our knowledge, this is the first investigation utilizing actual claims data to examine health literacy and health care patterns of an established population-based cohort and as such, it offers novel insights into the oral health care/health literacy arena. Our findings add to the body of evidence that points to deleterious effects of caregivers' low health literacy on their children's health care and health outcomes. Low caregiver literacy has been linked to poorer child oral health outcomes and more detrimental oral-health-related behaviors,

including worse oral health status, knowledge, child oral-health-related quality of life, and deleterious feeding practices (Vann *et al.*, 2010; Hom *et al.*, 2012; Divaris *et al.*, 2012a). A recent systematic review by DeWalt and Hink (2009) found mixed results regarding the association between caregivers' health literacy and the use of child health care services but included one study that examined hospitalizations among asthmatic children, finding evidence of association with low caregiver health literacy (DeWalt *et al.*, 2007).

The finding of higher expenditures for emergency dental care services among children of caregivers with low literacy is important, with public health implications. It is often stated that dental disease is a preventable condition. Analysis of data among this cohort indicates that prevention of emergency dental visits could have resulted in savings of \$47,126 for the 95 children who received these services over the 3-year time period. Although this was not statistically confirmed, analysis of our data suggests that health literacy may play a role in saving real health care dollars by optimizing the use of preventive services. Some support for this notion was provided in our data, where routine care expenditures

Table 2.

Distribution of Annualized Oral-health–related Medicaid Expenditures Normalized to 2010 Fees, Overall and Stratified by Socio-demographic and Health Literacy Variables among the 1,132 Child-Caregiver Dyads Enrolled in the COHL Study, with at Least 12 mos of Medicaid Enrollment during the Study's 3-year Follow-up Period

	Total Expenditures, mean (median)	Preventive ¹ Care, mean (median)	Restorative ² Care, mean (median)	Emergency ³ Care, mean (median)
Entire sample	203 (67)	81 (63)	99 (0)	22 (0)
Race				
White	182 (65)	79 (60)	93 (0)	10 (0)
African American	209 (70)	83 (63)	96 (0)	30 (0)
American Indian	232 (75)	84 (66)	117 (0)	32 (0)
Caregiver's gender				
Male	123 (47)	70 (47)	37 (0)	15 (0)
Female	206 (68)	82 (63)	102 (0)	22 (0)
Caregiver's age (quartiles; range, yrs)				
Q1 (18.0, 21.9)	156 (47)	60 (47)	80 (0)	16 (0)
Q2 (22.0, 25.2)	196 (70)	87 (66)	92 (0)	17 (0)
Q3 (25.2, 30.2)	175 (82)	90 (70)	76 (0)	9 (0)
Q4 (30.2, 65.6)	284 (84)	88 (70)	149 (0)	46 (0)
Child's age (mos; at baseline interview)				
0-11	78 (47)	51 (46)	21 (0)	6 (0)
12-23	192 (77)	83 (68)	98 (0)	12 (0)
24-35	326 (115)	100 (80)	158 (0)	68 (0)
36-47	392 (194)	130 (126)	232 (0)	30 (0)
48-59	353 (160)	147 (136)	201 (0)	5 (0)
Education				
< High school	208 (63)	73 (60)	121 (0)	14 (0)
High school/GED	198 (65)	82 (60)	89 (0)	28 (0)
Some college	186 (67)	84 (63)	77 (0)	25 (0)
≥ College	315 (96)	103 (93)	211 (0)	2 (0)
Marital status				
Single	191 (63)	76 (59)	96 (0)	18 (0)
Married	236 (85)	91 (72)	112 (0)	33 (0)
Divorced/separated/other	195 (77)	88 (71)	84(0)	22 (0)
Number of children				
1	133 (57)	69 (57)	57 (0)	7 (0)
2	249 (84)	92 (71)	132 (0)	25 (0)
3	279 (93)	94 (73)	157 (0)	27 (0)
≥ 4	203 (64)	74 (56)	72 (0)	57 (0)
Word recognition (REALD-30)				
Adequate (≥ 13)	187 (67)	81 (63)	85 (0)	20 (0)
Low (< 13)	250 (65)	81 (63)	140 (0)	28 (0)
Comprehension (NVS)				
Higher	203 (68)	82 (63)	102 (0)	20 (0)
Low	200 (65)	78 (63)	88 (0)	34 (0)

¹Includes preventive and diagnostic care dental office visits and physician office preventive visits.

²Includes dental-office– and hospital-based restorative care visits.

³Includes dental-office– and hospital-based emergency dental care visits.

Figure.

Illustration of the association between caregivers' health literacy (**A**—REALD-30: word-recognition test, developed for the oral health context; **B**—Newest Vital Sign: comprehension and numeracy test) and their children's Medicaid oral-health-related expenditures, among the 1,132 child-caregiver dyads enrolled in the Carolina Oral Health Literacy project, with follow-up to December 2010. Vertical lines indicate "low health literacy" thresholds that were previously reported by Vann *et al.* (2010) (< 13 REALD-30 score) and Osborn *et al.* (2007) (<2 Newest Vital Sign score).

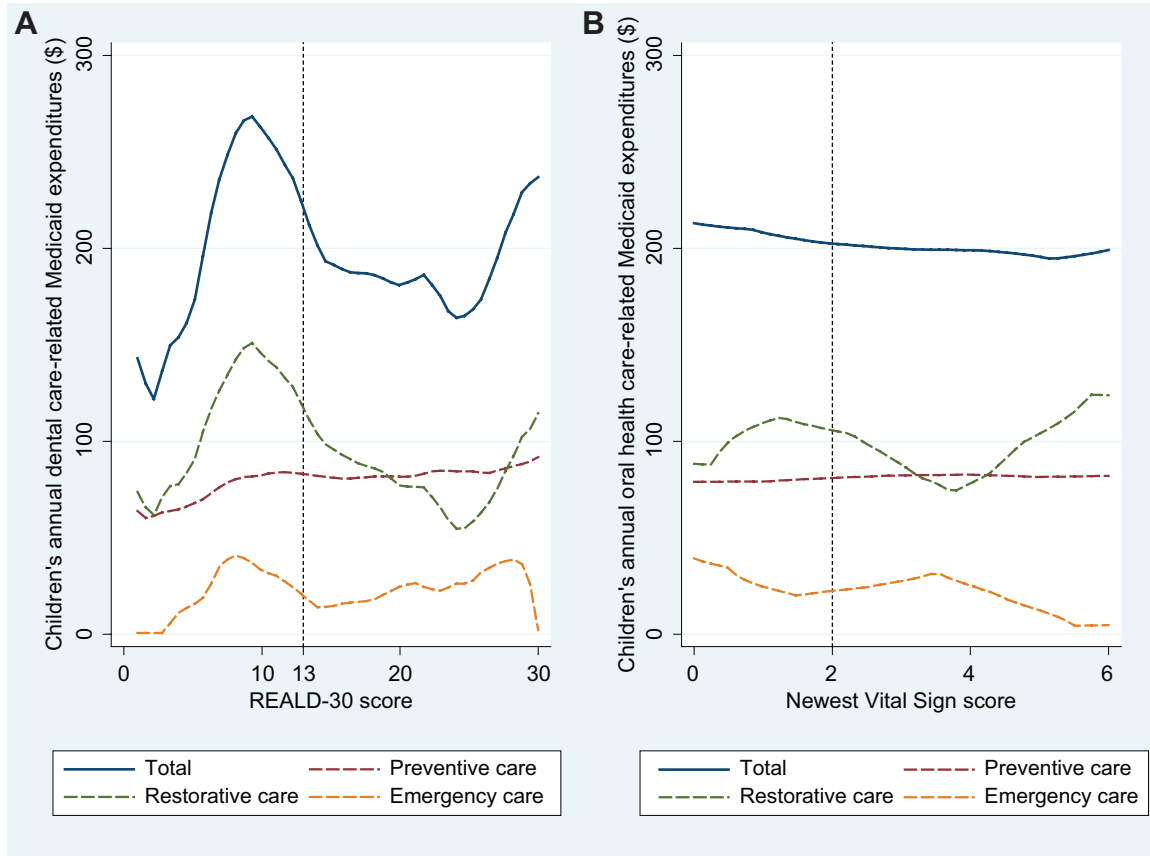


Table 3.

Effects of Low Oral Health Literacy on Oral-health-care-related Medicaid-paid Annual Expenditures, Adjusted to 2010 Dollar Fees (and 95% confidence intervals) Obtained by Marginal Effects Estimation Following Gamma-generalized Modeling¹ among the 1,132 Children of the COHL Cohort during the Study's 3-year Follow-up Period

	All Oral Health Care	Preventive Care	Restorative Care	Emergency Care
Word recognition ²				
REALD-30 "low" score ³	40 (-32, 111)	6 (-5, 17)	28 (-97, 153)	45 (-81, 171)
Comprehension				
NVS "low" score ⁴	-27 (-106, 51)	0 (-12, 12)	-62 (-191, 67)	53 (-63, 170)

¹The multivariate models had gamma family and log-link specifications and included terms for caregivers' and children's ages, race, education, and number of children (REALD-30 models); caregivers' and children's ages, race, education, and marital status (NVS models).

²Analyses were restricted to individuals who reported having English as the primary language spoken at home (n = 1,070).

³Defined as REALD-30 < 13 (Vann *et al.*, 2010); defined as NVS < 2 (Osborn *et al.*, 2007).

tended to increase across the oral health literacy spectrum *vs.* the bimodal distribution expenditures for restorative and emergency care services. The latter could be a reflection of high levels of oral disease in the low-literacy group and a relatively high use of oral health services in the highest literacy group. Similarly, although total expenditures showed a decreasing trend according to health literacy as measured by NVS, this gradient was small and not statistically significant. However, these patterns need to be interpreted with caution, because small proportions of participants had either very high (*i.e.*, 3% had REALD-30 \geq 25) or very low (*i.e.*, 4% had REALD-30 $<$ 5) health literacy scores. Therefore, inferences across the spectrum of these scales should be made with caution. Moreover, we acknowledge that the category of emergency oral health services expenditures may be driven, to some extent, by non-dental-carries-related etiologies, such as dental trauma.

Our findings should be viewed in light of the study's limitations. The study cohort was a predominantly low-income, English-speaking, non-probability sample of female caregivers who were clients of WIC in 7 NC counties, and therefore may not be representative of other population-based samples. Additionally, WIC participation alone has been shown to confer benefits in terms of appropriate use of services for children (Lee *et al.*, 2004); nevertheless, our findings suggest that effects of health literacy may be evident within the WIC population. Moreover, 20% of children had no oral-health-related expenditures over the 3-year study period. It is impossible to infer whether this phenomenon represents a true "zero need" and/or "zero demand" for care, or perhaps a systematic "selection-out" of seeking care. However, it may be plausible to assume that all mechanisms were in play.

Many investigators have suggested that literacy includes a complex set of skills including reading, comprehension, and numeracy. While no single instrument can capture all the domains of health literacy, one strength of this investigation was the inclusion of 2 instruments:

one to capture word recognition/reading and one to capture comprehension and numeracy. Indeed, using these instruments, we obtained different results in terms of overall and restorative care expenditures, a finding that provides additional insights into the necessary skills needed to obtain appropriate care.

Disparities in access to dental services for children constitute a persistent problem with substantial health, social, and economic impacts. In this investigation, we examined, prospectively, a population-based cohort's administrative claims and found evidence of a modest association between caregivers' literacy and their children's oral-health-related expenditures, which was not statistically confirmed. These findings add to the growing body of evidence linking caregivers' literacy with their children's oral-health-related outcomes. Future research in health literacy should help clarify relevant causal pathways and modifiable factors, and eventually guide the development and testing of health-literacy-related interventions (DeWalt and Hink, 2009). Further validation of this study's findings with a longer study period or a larger community-based cohort would provide additional support for the development of an intervention to alleviate the negative effects of low literacy for caregivers of young children. Although health literacy may not be easily and sustainably modifiable, literacy-level-appropriate interventions may be effective. Possible strategies could include health-literacy-modulating approaches such as motivational interviewing, group counseling, peer support, outreach workers, and improved print and visual materials (Kaakko *et al.*, 2002; Taggart *et al.*, 2012). To mention one possible intervention avenue, the WIC program (9.2 million participants in the USA in fiscal year 2010) has always had a strong interest in oral health, and it offers both the logistical capacity and caregiver access for staging a health-literacy-appropriate intervention. Such interventions will need to account for the complex nature of the seeking of and the access to oral health care services. Ultimately, the alleviation of the effects of low health literacy is likely

to be achieved best through avenues that involve the community, health professionals, and health systems.

Acknowledgments

The COHL Project is supported by a grant from the NIDCR (Grant # RO1DE018045). The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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