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Health Literacy Affects Likelihood of Radiology Testing in the Pediatric Emergency Department

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Abstract

Objective—To test the hypothesis that the effect of race/ethnicity on decreased radiologic testing in the pediatric emergency department (ED) varies by caregiver health literacy.

Study design—This was a secondary analysis of a cross-sectional study of caregivers accompanying children 12 years to a pediatric ED. Caregiver health literacy was measured using the Newest Vital Sign. A blinded chart review determined whether radiologic testing was utilized. Bivariate and multivariate analyses, adjusting for ED triage level, child insurance, and chronic illness were used to determine the relationship between race/ethnicity, health literacy, and radiologic testing. Stratified analyses by caregiver health literacy were conducted.

Results—504 caregivers participated; the median age was 31 years, 47% were white, 37% black, 10% Hispanic, and 49% had low health literacy. Black race and low health literacy were associated with less radiologic testing ($p < 0.01$). In stratified analysis, minority race was associated with less radiologic testing only if a caregiver had low health literacy (aOR 0.5; 95% CI 0.3–0.9) and no difference existed in those with adequate health literacy (aOR 0.7; 95% CI 0.4–1.3).

Conclusion—Caregiver low health literacy modifies whether minority race/ethnicity is associated with decreased radiologic testing, with only children of minority caregivers with low health literacy receiving fewer radiologic studies. Future interventions to eliminate disparities in healthcare resource utilization should consider health literacy as a mutable factor.

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Keywords

Health literacy; emergency service; hospital; radiography; infant; child; preschool; child

Despite the steady improvements in the overall health of the United States, racial and ethnic minorities experience a lower quality of health services, are less likely to receive routine medical procedures, and have higher rates of morbidity and mortality than non-minorities.¹⁻⁴ Differences in resource utilization and radiologic testing based solely on race/ethnicity (hereafter referred to as race) have been described in the pediatric emergency department (ED).⁵⁻⁷ Minorities receive fewer interventions and fewer radiologic studies across multiple disease states, especially at times when the evidence supporting clinical practice is unclear.⁵⁻⁷ Recent multicentered prospective studies have shown that minority pediatric ED patients with intermediate risk for both appendicitis⁶ and mild traumatic brain injury⁷ are less likely to receive diagnostic imaging than their white counterparts. In a sample across multiple disease states, minority race was associated with less radiologic testing compared with their white counterparts.⁸ Additionally, minority pediatric ED patients with chest pain were less likely to have radiology studies performed.⁹ However, these studies did not adjust for other sociocultural influences, including health literacy, which may influence provider decision-making as explained below.

Health literacy, defined as “the ability to obtain, process, and understand basic health information and services to make appropriate health decisions,” is an under-investigated area in health disparities.¹⁰ Within the pediatric ED, over 50% of caregivers possess low health literacy.¹¹ Low health literacy is more common in caregivers of minority race and is found to affect health disparities independently of race, low educational attainment, and low socioeconomic status.¹² Caregivers with low health literacy have poor understanding of illness, which leads to care-seeking for non-urgent conditions.¹¹ Worse expressive communication found in low health literate caregivers leads to an incomplete medical history and disengagement in medical decision-making,^{10,13-15} which providers need for an accurate assessment and recommendation of resource utilization. Limitations of these health literacy skills in an ED environment may influence providers’ decision-making process in obtaining a radiologic study.

We investigated the relationship between race, health literacy and the utilization of radiologic testing in the pediatric ED. We hypothesize that both minority race and low health literacy are associated with less radiologic testing. We also hypothesize that the effect of race on decreased radiologic testing in the pediatric ED differs based on low vs. adequate caregiver health literacy.

METHODS

This was a secondary analysis of a cross-sectional study conducted in the pediatric ED at a Midwest tertiary care hospital to assess the relationship between health literacy and non-urgent ED use.¹¹ The Children’s Hospital of Wisconsin (CHW) pediatric ED treats over 60,000 pediatric patients per year serving an urban, suburban, and referral patient population. Trained research assistants (RAs) recruited a random sample of English or

Spanish speaking caregivers 18 years of age of children 12 years of age from all patients presenting during predefined daytime, evening, and weekend shifts. Caregivers of children across all triage acuity levels, except for the highest acuity level (Emergency Severity Index 1), or patients in active distress were eligible. Caregivers were excluded for previous participation. To obtain a cross-sectional sample of the pediatric ED population, an RA used a random list of ED room numbers to determine eligibility of caregivers. Enrollment was intentionally spread across seasons from June 1, 2011 through May 31, 2012 to account for the seasonal variation of pediatric illness. The study was IRB-approved to use verbal consent without documentation of written consent. After consent, the RA administered the Newest Vital Sign (NVS)¹⁶ to assess health literacy, the Children with Special Health Care Needs (CSHCN) questionnaire¹⁷ to determine chronic illness status, and provided a self-administered survey of sociodemographic information including race.

Measures

Health Literacy/Numeracy and Race—We measured health literacy using the NVS, a validated measure using a nutrition label to measure print literacy and numeracy.¹⁶ The NVS is available in both English and Spanish, is easy to administer in the pediatric ED with minimal training, and requires 2 to 6 minutes to complete the six questions. The score was dichotomized into low (0–4 correct) or adequate health literacy (5–6 correct) as used by prior studies of health literacy in the pediatric ED.^{11,18} Caregivers self-identified race which was categorized as non-Hispanic White, non-Hispanic Black, Hispanic, and other in analysis. Those that chose more than one race were identified in as black, white, or Hispanic for analysis.

Radiologic Testing—Trained RAs, blinded to the health literacy level of the caregiver, conducted a chart review after the ED visit to determine radiologic testing utilized. Radiologic studies included any plain radiographs, computed tomography, magnetic resonance imaging, fluoroscopy, or ultrasonography. If no radiologic tests were performed, the visit was recorded as having no radiologic studies utilization.

Statistical Analyses

Demographic characteristics were summarized using descriptive statistics. Proportions of patients for which radiologic testing was performed were compared by a chi-square test. Logistic regression was performed with an outcome variable of any use of radiologic studies (binary; yes or no) and included caregiver health literacy, race, child insurance, child chronic illness, and triage level as covariates to be included in the final model. We considered variables for the model if significant in the bivariate analysis ($p < 0.10$) and analyzed using bidirectional stepwise logistic regression with significant ($p < 0.05$) variables retained. Child insurance status was forced into the model to adjust for socioeconomic status. No significant interactions between race and health literacy or race and insurance were found in the regression model.

To compensate for the possible confounding of adjusting for both race and health literacy in the regression model, a stratified analysis was performed as it may be more revealing. The stratified analysis included both chi-square and logistic regression. In the stratified analysis,

due to small numbers in the individual minority categories, race was dichotomized into white vs. minority, adjusting for child insurance, chronic illness status, and triage level. Study data were collected and managed using REDCap electronic data capture tools hosted at the Medical College of Wisconsin. SAS, Version 9.3 (SAS Institute, Inc, Cary NC) was used for all statistical analyses.

RESULTS

We approached 744 caregivers, with 532 (71%) consenting for the study, and 504 (67.7%) completing all study materials (Figure; available at www.jpeds.com). The sample consisted of young caregivers, with a median age of 31 years (Table I). Of the participants, 46% were white, 37% were black, 10% were Hispanic caregivers, 6% were other (mainly Asian), and 48.5% had low health literacy. Caregiver minority race was associated with low health literacy ($p < 0.0001$). Low caregiver health literacy was associated with more public insurance ($p < 0.001$) and higher triage level ($p < 0.0001$) but was not associated with differences in the presence of a chronic illness in a child ($p = 0.38$) (Table I). Caregiver minority race was associated with more public insurance ($p < 0.001$) and higher triage level ($p < 0.0001$), but no difference in the presence of a chronic illness in a child ($p = 0.78$).

Just over 20% of whites had low health literacy whereas significantly more Blacks, Hispanics, and other minority had low health literacy (76%, 83%, and 59%, respectively; $p < 0.0001$). Minority race caregivers have a significantly higher percentage of low health literacy than White caregivers (Black $p < 0.0001$; Hispanic $p < 0.0001$; Other $p < 0.01$).

In the study sample, 41.7% of children had radiologic testing performed. Children received less radiologic testing if the caregiver had low health literacy (37% vs. 47%; Odds Ratio (OR) 0.7, 95% Confidence Interval (CI) 0.5–0.9, $p = 0.02$) or black race (33% vs. 49% in white race; OR 0.5, 95% CI 0.3–0.9, $p < 0.001$). In multivariable analysis, adjusted for health literacy of the caregiver, black race remained associated with less radiologic testing (adjusted OR (aOR) 0.6, 95% CI 0.4–0.97, $p = 0.04$) as compared with white race.

When stratified by level of health literacy, children of minority caregivers with low health literacy received less testing (aOR 0.5, 95% CI 0.3–0.9) as compared with white caregivers with adequate health literacy. There was no difference in radiology testing between minority caregivers with adequate health literacy as compared with white caregivers with adequate health literacy (aOR 0.7; 95% CI 0.4–1.3) (Table II).

DISCUSSION

We found that both low caregiver health literacy and minority race are associated with less utilization of radiologic testing in the pediatric ED. When accounting for race in multivariable analysis of the entire cohort, health literacy was not associated with less radiologic testing. Nonetheless, in stratifying by health literacy, we find that the racial difference in radiologic testing only occurs in those children whose caregivers also have low health literacy. This suggests that a caregiver's health literacy acts as a mitigating factor for the utilization of radiologic testing in minority children as the possession of adequate health literacy eliminated the difference in radiologic testing. We found caregiver health literacy as

a novel factor involved in provider decision-making regarding resource utilization in the pediatric ED.

Our data suggest that both caregiver race and health literacy play integral roles in differential management of radiologic testing for patients in pediatric EDs. These findings are similar to recent studies showing decreased radiologic testing for racial minorities evaluated in the pediatric ED for mild traumatic brain injury,⁷ acute appendicitis,⁶ and chest pain.⁹ Our findings also echo a recent study in the pediatric ED highlighting racial disparities in ordering both laboratory and radiologic testing.⁸ However, our findings expound on this disparity as the decreased radiologic testing in our cohort held true across multiple disease processes, multiple disease severities, and other patient-level factors.⁸ This suggests that disparities in radiologic testing in the pediatric ED exist in broad disease processes.

Prior work suggests that differences in radiologic testing are most prevalent when the clinical picture is unsure or risk of disease is intermediate.^{6,7} Furthermore, in indeterminate cases where there is not an objective clinical decision rule available, providers may rely on provision of an adequate history and shared decision-making to determine resource utilization in the ED. Unfortunately, both providing an adequate history and shared decision-making skills are lacking in caregivers with low health literacy.^{10,13,19} Without these skills, a caregiver may not ask questions nor participate in medical decision-making, leading a provider to make the decision about testing without the input of the caregiver.¹³ Our finding of decreased radiologic testing in those children of caregivers with low health literacy supports the concept that the lack of health literacy skills may lead to differences in resource utilization, though likely not the only reason for differences. The presumption that a provider would have done more testing due to lack of information is not supported by our findings. Other possible explanations for our findings include that providers may be more cautious about the cost of studies and harm from radiation in children of low health literacy caregivers, or caregivers with adequate health literacy may be more aggressive in seeking testing due to shared decision-making.¹³ We could not evaluate these factors in our study. It must be considered that some caregivers may prefer less imaging as found in some minority patients.²⁰ It is concerning that differential testing continues to exist in the low health literacy minority cohort in our study, suggesting that low-health literacy compounds the effects of race in healthcare disparities. Furthermore, given that the effects of health literacy may be modified, this study suggests that health literacy may be a target to decrease health disparities.

Given that radiologic studies have a risk associated from the radiation exposure, in this case, this health disparity may be actually protective for minorities. In other cases, such as IV medication for abdominal pain, this disparity may be indicative of worse care.⁵ Nonetheless, when a health disparity exists where there is no biologic basis for differential testing, we must question the process by which the obtainment of radiologic studies is determined.

Our study has limitations. This was a single center study, limiting the generalizability to other centers and practice patterns. However, the site of recruitment was an urban, tertiary-care, level-one trauma pediatric hospital with a large coverage area suggesting that results

could be generalizable to similar stand-alone pediatric facilities. Also, this was a secondary analysis of prospectively collected data limiting the ability to evaluate other socio-cultural factors. We were not able to separate races in the multivariable analysis, and difference may occur by race. Also, residual confounding may have remained despite the multivariable models. Radiologic testing was categorized broadly, and does not reflect all resource utilization, nor does the performance of a radiologic study imply that the resource utilization is medically indicated. This study was limited in the ability to distinguish each of the subcategories of radiologic testing and perform multivariate analysis on all subgroups. We did not have enough Spanish-speaking subjects to analyze this subgroup more thoroughly. The decrease in radiologic testing may also occur because of certain groups (e.g. low health literacy or minority race) present more often for non-urgent ED visits and we did not provide adjustment based on diagnoses.¹¹ However we provided adjustment for a non-urgent condition by including triage level in the multivariable analysis as ESI triage levels are associated with resource utilization and would adjust for arrival of a non-urgent vs. urgent visit.²¹

Both minority race/ethnicity and health literacy play important roles in pediatric ED resource utilization. When considering radiologic testing, a synergistic effect occurs with minorities with low health literacy receiving less radiologic testing. Health literacy is an important factor in health disparities and should be considered for future studies of health disparities in racial minority populations.

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Abbreviations

CSHCN	Children with Special Health Care Needs
ED	Emergency department
NVS	Newest Vital Sign
OR	Odds Ratio
aOR	Adjusted Odds Ratio
CI	Confidence Interval

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Figure 1.
Participant flow through study

Table 1

Caregiver and Child Characteristics

	Overall n (%)	Low Health Literacy Caregivers n (%)	Adequate Health Literacy Caregivers n (%)	<i>p</i> ^b
Caregiver	504	244 (48.4)	260 (51.6)	
Age, y, median (range)	31.0 (18–69)	28.0 (18–69)	35.0 (19–64)	<0.0001
Sex				<0.05
Female	429 (86.3)	226 (52.7)	203 (47.3)	
Male	68 (13.7)	27 (39.7)	41 (60.3)	
Foreign born				<0.01
Yes	76 (15.4)	51 (67.1)	25 (32.9)	
No	419 (84.6)	201 (48.0)	218 (52.0)	
Spanish speaking	2 (0.3)	2 (0.8)	0	
Ethnicity/race				<0.0001
White	236 (46.8)	58 (24.6)	178 (75.4)	
Black	186 (36.9)	142 (76.3)	44 (23.7)	
Hispanic	48 (9.5)	40 (83.3)	8 (16.7)	
Other	34 (6.8)	20 (58.8)	14 (41.2)	
Education				<0.0001
Less than HS	61 (12.3)	49 (80.3)	12 (19.7)	
Graduated HS	125 (25.1)	90 (72.0)	35 (28.0)	
1–4 years college	155 (31.1)	76 (49.0)	79 (51.0)	
College degree	157 (31.5)	40 (25.5)	117 (74.5)	
Child				
Age, y, median (range)	4.0 (0.1–12.0)	3.0 (0.1–12)	4.0 (0.1–12)	0.03
Ethnicity/race				< 0.001
White	216 (44.2)	49 (22.6)	168 (77.4)	
Black	195 (39.9)	147 (74.2)	51 (25.8)	
Hispanic	42 (8.6)	37 (78.7)	10 (21.3)	
Other	33 (6.8)	21 (61.8)	13 (38.2)	
Insurance				<0.001
Private	162 (33.1)	32 (19.8)	130 (80.2)	
Public	322 (65.9)	212 (65.8)	110 (34.2)	
None	5 (1.0)	5 (100)	0	
Chronic illness^a				0.38
Yes	217 (43.6)	116 (53.4)	101 (46.6)	
No	281 (56.4)	139 (49.5)	142 (50.5)	
Triage level				<0.0001
2	48 (9.7)	21 (43.8)	27 (56.3)	
3	246 (49.6)	112 (45.5)	134 (54.5)	
4	159 (32.1)	87 (54.7)	72 (45.3)	

	Overall n (%)	Low Health Literacy Caregivers n (%)	Adequate Health Literacy Caregivers n (%)	p ^b
5	43 (8.7)	35 (81.4)	8 (18.6)	

^aChildren with Special Healthcare Needs Questionnaire

^bComparisons between demographic characteristics and health literacy were performed using chi-square testing, other than age, which was a Wilcoxon Rank Sum Test.

Table 2

Child Radiologic Testing Stratified by Caregiver's Health Literacy

	N	Percent with radiologic testing	OR (95% CI) of radiologic testing	P	aOR ^b (95% CI) of radiologic testing	P
Adequate Health Literacy						
White	177	49.7	1.0		1.0	
Minority race ^a	53	39.7	0.7 (0.4–1.2)	0.24	0.7 (0.4–1.3)	0.28
Low Health Literacy						
White	57	49.1	1.0 (0.5–1.8)	0.88	1.0 (0.5–1.9)	0.94
Minority race ^a	191	33.0	0.5 (0.3–0.8)	<0.001	0.5 (0.3–0.9)	0.02
Insurance				0.26 ^c		0.48 ^c
Private	162	46.9	1.0		1.0	
Public	322	39.1	0.7 (0.5–1.1)	0.10	0.9 (0.5–1.8)	0.68
None	5	40.0	0.8 (0.1–4.6)	0.76	3.3 (0.5–23.5)	0.23
Chronic illness						
Yes	209	46.4	1.0		1.0	
No	275	38.6	0.7 (0.5–1.0)	0.07	0.9 (0.6–1.3)	0.50
Triage Level				<0.001 ^c		<0.001 ^c
2	46	63.0	1.0		1.0	
3	243	47.8	0.5 (0.3–0.9)	0.03	0.6 (0.3–1.1)	0.08
4	153	30.7	0.2 (0.1–0.5)	<0.001	0.3 (0.2–0.6)	<0.001
5	40	17.5	0.1 (0.05–0.3)	<0.001	0.1 (0.05–0.4)	<0.001

^aHispanic ethnicity, black race, and other race (predominantly Asian)^bThe regression model included health literacy and race combined as one variable, child chronic illness, insurance status, and triage level. Adequate health literacy and white race is the referent group.^cOverall p-value