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Relationship between Child Health Literacy and Body Mass Index in Overweight Children¹

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Abstract

Objective—To test the relationship between child health literacy and body mass index (BMI) -z score in overweight children.

Methods—Cross-sectional survey of overweight children and parents. Parent and child health literacy was measured by the Short Test of Functional Health Literacy (STOFHLA). Linear regression tested for predictors of childhood BMI z-score, adjusting for confounders.

Results—Of 171 total children, 107(62%) participated, of whom 78 (73%) had complete data for analysis. Mean child BMI Z-score (SD) was 2.3(0.40); median child age (Inter-quartile range) was 11.5(10–16); 53% were female; 80% were Medicaid recipients. Mean child STOFHLA was 22.9 (9.0); mean parental STOFHLA was 29.1(8.6). Child STOFHLA correlated negatively with BMI Z-score ($r=-0.37$, $p=0.0009$) and positively with child eating self-efficacy ($r=0.40$, $p<0.0001$). After adjusting for confounders, child STOFHLA was independently associated with child BMI Z-score (standardized $B=-0.43$, $p<0.0001$). Overall adjusted r-squared for the regression model was 38%. Child STOFHLA contributed 13% to the overall model.

Conclusions—Child health literacy was negatively correlated with BMI Z-scores in overweight children, suggesting the need to consider health literacy in the intersection between self-efficacy and behavior change when planning interventions that aim to improve child BMI.

Keywords

health literacy; child health literacy; body mass index; STOFHLA

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"We confirm all patient/personal identifiers have been removed or disguised so the patient/person(s) described are not identifiable and cannot be identified through the details of the story."

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1. Introduction

Better health literacy, an individual's ability to read and interpret health information needed to make health decisions(1), has been correlated with better health outcomes in adults(2–36). While some investigators have begun to explore the relationship between parental health literacy and child health outcomes(37;38), no recent studies have evaluated the contribution of children's own health literacy to health outcomes.

While it is intuitive that children are under the influence and supervision of adults with regard to their own health care, there are a variety of instances where children's own health literacy their ability to understand how to take medications, for example-may directly affect their health. Children even as young as 4 years old are involved in their own self care(39–50) and in one study, 9–12 year old children with diabetes read carbohydrate details on food labels, estimated the amount of energy they would need for the next few hours, and calculated how much insulin they should inject. (44) Among children with asthma, a recent randomized trial indicated that group education of children ages 9–13 resulted in reduction of asthma morbidity in children, but education of their parents did not provide additional benefit.(51)

The current epidemic of child obesity provides another important context for understanding the potential of health literacy as a contributor to health outcomes in children. For example, a study of a nationally representative sample of 2,314 U.S. schoolchildren children reported that an average of 43% of children's meals were consumed in school(52). Such information has been the impetus for school-based interventions to reduce the prevalence of overweight and obesity, through measures such as modifying the meals provided by school lunch, but also changing the options available in school vending machines. Such measures affirm the belief that children do in fact make unsupervised decisions that can affect their health. In support of this belief, studies looking at the effects of television exposure on children have shown that children exposed to television advertising for unhealthy foods are more likely to request unhealthy foods from their parents(53), eat fewer less fruits and vegetables(54), and eat more energy-dense foods. (55;56). In fact, one study reported an increase of 167 kcal/d for each hour of television viewing, mediated by an increase in consumption of foods commonly advertised on television.(56) In the context of childhood obesity, we propose that children's own ability to obtain, use, and understand health information (food advertising, labeling) impacts their ability to understand the choices they face with regard to self-care (specifically, dietary intake), that in turn, impacts body mass index (BMI).

In response to the concerns about the relationship between literacy and childhood obesity, our research team was awarded a "Clear Health Communication" research grant from Pfizer to test whether an intervention to increase child and parental health literacy improved BMI among overweight children. The current report uses baseline data (before any intervention) from the study to examine the relationship between initial health literacy and a child's BMI Z-score. The *a priori* hypothesis was that higher health literacy scores (both parental and child) would be associated with better BMI scores.

2. Methods

2.1 Design/Setting/Participants

The parent study from which these baseline (pre-intervention) data were drawn enrolled children ages 6–19 with the following inclusion criteria: BMI at least 85th percentile for age and sex, and receiving primary care at the study site, an inner-city academic health center in the Bronx, New York. Children were enrolled with the one legal guardian who usually brought them to clinic visits. Children with diagnosed developmental impairment, hemo-dynamically significant heart disease, or neuromuscular disorders were excluded from the study. The study

site was a community health center that houses a primary care pediatrics clinic, primarily serving a poor African American and Latino population; more than 80% of the pediatric patients are Medicaid recipients. The Institutional Review Board of Montefiore Medical Center approved the study protocol. Written informed parental consent and child assent were obtained from all study participants. A trained bilingual research assistant administered all measures.

2.2 Measures

2.2.1 Dependent Variable: BMI Z-score—We used a body composition analyzer Scale (Model TBF-410GS, Tanita Corporation of America, Arlington Heights, IL) to weigh each subject. Height was measured using a stadiometer (Seca Model 214, Itin Scale Company, Brooklyn, NY). We entered child age, gender, height, and weight into Epi-Info 2002 nutritional analysis program, to calculate BMI Z-scores. The BMI Z-score offers the ability to evaluate a child's BMI in terms of standard deviations from the mean for children of the same age and gender.

2.2.2 Main Independent Variable: Health Literacy—We administered the Short Test of Functional Health Literacy (STOFHLA) to all children. The STOFHLA is a brief version of the longer TOFHLA(57), which measures both reading comprehension and numeracy and takes 22 minutes to administer. The STOFHLA measures reading comprehension only, and has a high correlation with the TOFHLA ($R=0.91$).⁽⁵⁸⁾ The 7-minute timed test consists of two reading passages; one describes preparation for an x-ray procedure, and one describes the “Rights and Responsibilities” from a Medicaid application form. Each passage presents sentences that are missing 1–2 words, indicated by a blank line. For each blank line, the respondent is asked to choose one of four words that best fits in the blank. In studies of adults, the STOFHLA has been reported to have high internal consistency (Cronbach's $\alpha = 0.97$) and good correlation with the Rapid Estimate of Adult Literacy in Medicine, $r=0.80$.⁽⁵⁹⁾ STOFHLA scores can range from 0–36, with a score ≥ 23 representing “adequate” health literacy. The test is available in English and Spanish; and children were offered the test in their preferred language. The STOFHLA has not previously been used with children, and no test of health literacy has been evaluated for use in children.

2.2.3 Measured Covariates—Self-efficacy is purported to be an important predictor of health promoting behavior.^(60–64), and we in this study thought eating self-efficacy would be related to both BMI and health literacy. Eating self-efficacy was measured using a modified 15-item version of the Eating Self-Efficacy Scale (ESES) questionnaire⁽⁶⁵⁾, previously validated by McCann et al⁽⁶⁶⁾. To improve the measure's literacy level and ease of use, we modified the Likert scale from 9-points to 7-points (1= highest self-efficacy) and simplified the vocabulary in the instructions and some questions; we piloted the revised questionnaire with children in the health center waiting room. The final instrument was written at a middle 3rd grade reading level (Flesh-Kincaid readability⁽⁶⁷⁾). The parent and child questionnaires mirrored each other and subjects were assisted with reading and responding to the questions. Questions included items such as: “how hard is it to stop eating too much ...after work (school); when you feel upset, when you are with friends or family”, etc.

To adjust for parental health literacy, we administered the STOFHLA, described above, to all parents in their preferred language (English or Spanish). Parental weight and height were also measured in the same manner as described for children. Height was entered into the Tanita Analyzer to return a calculated BMI for each parent. Finally, we recorded child age, gender, ethnicity, and grade in school as potential confounders of both BMI Z-score and health literacy skill. We used insurance status (Medicaid/Private/CHP) and parental education as proxies for socioeconomic status.

2.3 Analyses

First, descriptive statistics were used to characterize the survey respondents. We found missing BMI values for some parents, so these parent-child pairs were excluded from the analyses. For the remaining participants, we discovered three points of missing data for parental STOFHLA, and three (other) missing data for parental education. After testing the relationship between parental STOFHLA and parental education ($r=0.44$, $p<0.001$), we imputed the missing data points for parental STOFHLA using median parental education and imputed the missing data points for parental education using the mean parental STOFHLA. To test the reliability of the eating self-efficacy measure in this study, we calculated Cronbach's alpha separately for children and for parents. We used the skew test to assess each variable for normality. Parental baseline BMI and parental STOFHLA were found to be skewed, and so we mathematically converted these two variables into normal variables for analysis.

We used Pearson correlation to test the relationship between child BMI Z-score and child STOFHLA score. Prior to using linear regression, scatter plots were used to evaluate whether the relationship between BMI Z-score and STOFHLA was linear. Then, to test for possible confounders, we conducted a number of bivariate analyses using Pearson correlation to examine the relationship between child BMI Z-score and parental BMI, parental STOFHLA score, child age, parental education, and mean child/parent eating self-efficacy. We used analysis of variance to compare the mean BMI Z-score for groups by gender, ethnicity, and insurance status (Medicaid vs. other). Similar bivariate analyses were conducted to test the association of child STOFHLA with child age, grade in school, eating self-efficacy, parental STOFHLA, and parental education. Linear regression modeling was performed with child BMI Z-score as the dependent variable, and child STOFHLA as the main independent variable. Each variable that had a p value less than 0.5 for its relationship with BMI z-score or STOFHLA on bivariate analysis was considered to be a potential confounder. These variables were entered into the regression equation. Because there were 9 sibling pairs included in the sample, the regression equation was adjusted for clustering on family. Residual-versus-fitted plots, and change in R^2 were used to select the best model fit. All analyses were done using Stata V 9.

3. Results

Overall, 171 children were referred for participation in the obesity management program and study. Of these, 107(62%) children agreed to participate. Seventy-eight (73%) children from 69 families had parental body mass index measured at baseline, and could therefore be included in this analysis. Children excluded for missing parental data had higher STOFHLA scores. (Table 1) Overall, the study sample was representative of the health center population (largely Latino and African-American, Medicaid-insured). The mean child body mass index was 30.9, with a mean child BMI Z-score of 2.3, range 1.44–2.95. The mean child STOFHLA was 22.9 (range 0–36) and mean parental STOFHLA was 29.1 (range 3–36). All children completed the English version of the STOFHLA; one parent completed the Spanish version. Internal reliability coefficients (Cronbach's alpha) for the self-efficacy scales were: child eating self-efficacy (0.83), parental eating self-efficacy (0.83).

On simple bivariate analyses, there was a weak negative correlation between child STOFHLA and child BMI Z-score, $r=-0.37$, $p=0.0009$ (Figure 1) and a weaker positive correlation between child STOFHLA and parental STOFHLA ($r=0.22$, $p=0.05$). Child BMI Z-score increased with parental BMI ($r=0.32$, $p=0.004$) and decreased with child age ($r=-0.37$, $p=0.0009$). There was no relationship between child BMI Z-score and ethnicity, insurance status, gender, and child or parent eating self-efficacy (all p values >0.49).

Mean child STOFHLA score did not differ by gender (girls vs. boys: 24 vs. 20, $p=0.10$), but there was a moderate positive correlation with age ($r=0.4520$, $p<0.0001$) and grade in school

($r=0.457$, $p=0.0001$) and a negative correlation with poor eating self-efficacy ($r=-0.45$, $p<0.0001$). There was no relationship between child STOFHLA and parental STOFHLA, parental education level, ethnicity, and insurance status (all p values > 0.49).

Table 2 shows the results of the regression modeling. Child BMI Z-score was independently associated with child age, parental BMI, child eating self-efficacy, and child STOFHLA. The adjusted R-squared for the overall model was 34%, with child STOFHLA contributing 13%. Child STOFHLA (standardized beta= -0.43) and eating self-efficacy (standardized beta= -0.39) were the strongest predictors of child BMI Z-score, followed by parental BMI (standardized beta = 0.27). For every 1 point increase in child literacy score, the BMI z-score decreased by 0.02 points (95% CI: 0.01 to 0.02).

4. Discussion and Conclusion

4.1 Discussion

A thorough review of the literature reveals one previous study of children with Type 1 diabetes, which found no relationship between children's literacy skill and their own health, as measured by hemoglobin A1C.(68) In contrast, we found, in this cross-sectional sample of overweight children, that higher literacy was significantly correlated with a lower body mass index, adjusted for age and gender.

We believe these results raise important questions for future research. First, the uncertainty regarding our measure of child health literacy underscores the need to develop a reliable and valid measure of child health literacy. This measure has to be age appropriate, and incorporate measures of not only numeracy and reading comprehension, but also listening and speaking skills. Construction of a test of health literacy for use in children would also need to take into account children's cultural context, and the neurocognitive, physical and psychological changes that children encounter as they grow from the early school years through adolescence. Second, how health literacy influences BMI needs to be more fully explored. Future researchers looking at this relationship may consider using the Newest Vital Sign,(69) which uses a food label to assess literacy. Also, qualitative work is needed to explore the relationship between self-efficacy, weight, and literacy issues within the context of both culture and family.

This study represents exploratory work in a new area, and as such, there are important limitations that should be noted. First, the cross-sectional design limits any inferences we can make about cause and effect. We cannot know whether higher literacy enables better food choices and healthier weight, or whether a more unhealthy weight results in cognitive deficits that impact literacy level. Indeed, studies in adults have demonstrated a relationship between obesity and impaired cognition in both observational and longitudinal studies.(70–73) The findings are also consistent with other studies in children indicating an inverse relationship between BMI and academic achievement (74–77). Second, the sample size is small and from a single site, drawn from participants in a program for overweight children in a particularly homogenously disadvantaged population – hence, the findings should not be generalized to other populations. It would be important to look at the relationship between literacy and BMI across both normal weight and overweight children. Finally, there exist no tests of health literacy that have been validated for use in children. In fact, to our knowledge, this is the first study to report using any test of health literacy in children. Our findings show that the test is feasible for use in children – all children answered the STOFHLA by themselves, without help; preliminary validation data from this study also show that the STOFHLA score increases with grade level. Future work, with a larger sample size will be important to explore in better detail how the STOFHLA performs across age and development in children, and the extent to which the STOFHLA may be modified for use in younger children.

This study has several important strengths. Because the sample was drawn from children enrolled in a program for overweight children, we had data on important covariates, including eating self-efficacy, which we could test in the regression model estimating child's BMI Z-score. The finding that child, but not parent, eating self-efficacy is correlated with BMI Z-score is another important clue to the potential of children to impact their own health.

4.2 Conclusion

In this exploratory study, child health literacy was negatively correlated with BMI Z-score in overweight children, suggesting the need to consider the role of health literacy in the intersection between self-efficacy and behavior change when planning interventions that aim to improve child BMI.

4.3 Practice Implications

Because this was an exploratory study, we hesitate to recommend specific changes in practice based on our findings. However, we do suggest that practitioners who care for children consider the potential role of a child's own health literacy as they develop a treatment plan.

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Figure 1.

Table 1

Characteristics of study sample and sample excluded for missing data.

	Study sample (n=78 parent-child pairs)	Excluded for missing data (n=29 parent-child pairs)	
Variable			n
Child age (Median, IQ range)	11.5(10–16)	11.0(9–15)	28
Grade in school (Median, IQ range)	6(5–11)	7(5.5–10)	24
Child BMI [Mean (SD); range]	30.9 (5.1); 20.93–41.53	32.1(8.2); 21.2–52.0	23
Child BMI z-score [Mean (SD); range]	2.3 (0.4); 1.44–2.95	2.4(0.5); 1.53–3.24	23
Child STOFHLA [Mean (SD); range]	22.9(9.0); 0–36	26.6(11.6); 0–36	23
n(%) adequate literacy*	41(52%)	18(78%)	
Parental BMI [Mean (SD); range]	33.3(8.5); 20.6–56.9	NO DATA	0
Ethnicity (n,%)			
• African-American	27(35%)	3(18%)	17
• Latino	49(62%)	14(82%)	
• White	2(3%)	0(0%)	
Insurance (n, %)			26
• Medicaid	61 (78%)	19(73%)	
• Non-Medicaid	17 (22%)	7(27%)	
Parental Education (n,%)			14
<12 th grade	19(24%)	7(50%)	
12 th grade/GED	31(40%)	1(7%)	
>12 th grade/GED	28(36%)	6(43%)	
Parent STOFHLA [Mean (SD); range]	29.1(8.6); 3–36	29(8.8); 14–35	9
n(%) adequate literacy	60 (77%)	7(78%)	
Child eating self-efficacy [Mean (SD); range] [‡]	3.4(1.0); range 1.3–5.7	3.5(1.1); range 1.5–6.0	28
Parent eating self-efficacy [Mean (SD); range] [‡]	3.1(1.1); range 1.0–6.0	3.1(1.3); range 1.5–5.2	10

IQ= interquartile. SD=standard deviation. BMI=body mass index. STOFHLA=Short test of health literacy in adults.

* Adequate literacy defined as STOFHLA>22.

⁷ Self-efficacy ranges from 1–7, with 7 = lowest efficacy. Study sample and excluded sample were compared with t-test or chi-square as appropriate; no statistically significant differences except for parental education ($p=0.03$) and % children with adequate STOFHLA ($p=0.04$).

Table 2

Regression Model for Predictors of Child BMI Z-score

Variable	Coeff	95% CI	Std. Beta	p value	Adj. R ²
Child Age	−0.032	−0.064, 0.001	−0.21	0.055	0.12
Parental BMI	0.012	0.003, 0.020	0.27	0.006	0.17
Child eating self-efficacy	−0.140	−0.214, −0.066	−0.39	<0.0001	0.21
Child STOFHLA	−0.016	−0.025, −0.008	−0.43	<0.0001	0.34

STOFHLA=Short Test of Functional Health Literacy in Adults. BMI=body mass index. Linear regression, with child BMI z-score as the dependent variable. Coefficients are adjusted for clustering –i.e., multiple children in one family. Only variables that had a significant correlation with child BMI Z-score or child STOFHLA of at least $p=0.50$ on bivariate analyses were entered into the regression model: child age, parental BMI, child eating self-efficacy, parental eating self-efficacy, and parental STOFHLA. Variables were retained in the model if the p value was under 0.20.