Glycemic Control in Young Children with Diabetes: The Role of Parental Health Literacy

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Abstract

Objective—This cross sectional study examined the relationship between parental health literacy (HL), diabetes related numeracy, and parental perceived diabetes self-efficacy on glycemic control in a sample of young children with Type 1 DM.

Methods—Seventy primary caregivers of children (age 3–9 years) with Type 1 DM were recruited and surveyed at diabetes outpatient clinic visits. Patients' medical histories were obtained by medical chart review.

Results—Parental diabetes related numeracy (r = −.52, p <.01), but not reading skills (r = −.25, p = NS) were inversely correlated with the child's glycemic control (HbA1c). Parental perceived diabetes self-efficacy was also negatively correlated to their child's HbA1c (r = −.47, p <.01). When numeracy and parental perceived diabetes self-efficacy were included as predictors of HbA1c, the model was significant (F = 12.93, p<.01) with both numeracy (β = − .46, p<.01) and parental perceived diabetes self-efficacy (β = − .36, p=.01) as significant predictors of HbA1c.

Conclusions—Data from this study highlight the importance of considering the role of parental numeracy, in health outcomes for children with Type 1 DM. Practice Implications: Practitioners should assess parental health literacy and consider intervention when needed.

Keywords

Type 1 diabetes; health literacy; glycemic control; children; parents; numeracy

1. Introduction

Type 1 diabetes mellitus is a chronic illness typically diagnosed in childhood that requires lifelong medical care and consistent self-management to prevent significant health complications. It is recommended for young children with diabetes to maintain a certain

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level of glycemic control (i.e. below 8.5% on an HbA1c test) [1]. Diabetes management is complex and challenging, particularly during childhood and adolescence. Families must reconcile tedious self-care tasks, cognitive demands, and deal with logistical burdens such as navigating the health care system and procuring medical supplies. Health literacy (HL) has been defined as: "The degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions" [2]. Each of the three components of HL presents a modifiable barrier to optimal care for patients with diabetes: 1. Reading skills (understanding written texts, such as health management plans), 2. Numeracy skills (accomplishing simple calculations, such as dosing insulin appropriate to blood glucose, diet and activity), and 3. Navigational skills (accessing resources, such as clinics, clinicians, and other services) [3]. Numeracy skills are especially important in diabetes management due to the many calculations needed to implement medical regimens accurately.

Among adults with diabetes, increased risk of hospitalization and increased health costs have been independently associated with HL [4–6]. Health-literacy-based interventions for adults with diabetes have been shown to be beneficial, especially for adults with limited HL skills [7]. A recent study reported that for adolescents with intensive insulin regimens, parents' HL was associated with better diabetes management [8]. Lower parental HL has also been associated with poorer glycemic control in school aged children [9]. In an adolescent sample, teenagers' own numeracy skills have been associated with diabetes outcomes [10]. However, the impact of reading skills or numeracy skills of adult caregivers on young children's diabetes management is unclear and to date no studies have examined the relationship between the HL of parents of young children with Type 1 DM and their physical health.

As with many chronic illnesses, parents of young children with diabetes are largely responsible for disease management. Part of what distinguishes parents who are able to properly manage their child's illness from those who cannot is how efficacious they feel regarding the medical regimen. Perceived parental efficacy has been defined as 'beliefs or judgments a parent holds of their capabilities to organize and execute a set of tasks related to parenting a child' [11]. In general, more perceived efficacy has been associated with better health outcomes [12].

This study examined the relationship between parental health literacy, including reading skills and numeracy skills, and glycemic control in a sample of young children with Type 1 DM. In addition, parental perceived diabetes self-efficacy was examined as a potential mediator of the relationship between HL and glycemic control. Based on the adult HL literature, we hypothesized that parents with lower HL would have children with poorer glycemic control. It was also predicted that parental perceived diabetes self-efficacy would mediate the relationships between HL and glycemic control.

2. Methods

2.1 Participants and Procedures

This is a cross-sectional study in which participants were recruited at their child's regularly scheduled diabetes outpatient appointment in a pediatric endocrinology clinic. The inclusion criteria for this study were for the child between the ages of 3 and 9.9 years old to have been diagnosed with Type 1 DM for at least one year and for the primary caretaker able to read and write in Spanish or English. University human subjects' approval was obtained and followed for all procedures. All eligible primary caregivers who attended outpatient clinic appointments for their children were approached to participate in the study. Few primary caregivers refused to participate and most of those who refused stated not having enough

time as the reason for not participating. Seventy primary caregivers agreed to participate, signed a written consent, and completed assessment measures. HbA1c closest to the date that the study measures were completed was obtained via medical chart review. The physicians instruct patients to go to the lab directly after their medical visit to obtain an HbA1c test.

Children in the sample (54% female) had been diagnosed with Type 1 DM for an average of 3 years (SD = 2.30). Eighty-four percent of the children were White and 16% were African American. Sixty-five percent of the sample was of Hispanic descent. Participants were on one of three insulin regimens, 1. Conventional regimen consisting of twice daily insulin injections including long acting and rapid acting insulins; 2. Multiple daily injections consisting of three or more injections per day with a long acting insulin taken once a day and three or more short acting insulin injections usually given at meal times or for making corrections for high blood glucose levels; 3. Pump therapy (i.e. continuous subcutaneous insulin infusion) consisting of a basal dose of insulin as well as bolus dosing of insulin throughout the day. Thirty percent of the sample was on a pump at the time of the study with the remaining 70% on a subcutaneous insulin. Sixty-percent of the sample was prescribed a meal plan technique for managing blood glucose levels known as carbohydrate counting. This consists of adhering to a set number of grams of carbohydrate intake per meal. The remaining 40% were not on a carbohydrate counting plan because the physicians felt they had yet to master carbohydrate counting and therefore using a sliding scale to adjust short acting insulin depending on blood glucose level.

Primary caregivers (84% mothers) completed two HL measures and two psychosocial measures. Mothers were on average 40 years old (SD= 7.09) and 73% completed at least some college. Thirty-five percent of the families who participated were receiving some type of financial assistance from the government. Participants were given a small monetary gift card and a parking voucher as compensation for participating in this study. All study measures were available in Spanish and English. Families were given the option to complete measures in the language of their choice. Ten percent of participants completed the assessment measures in Spanish.

2.2 Measures

The Short Test of Functional HL in Adults, or STOFHLA, is a self-administered test of reading ability that has been validated in English and Spanish [13]. This measure consists of 36 multiple choice sentence completion tasks that are to be completed after reading one of two passages on health related material, which is preparation for an upper gastrointestinal series and the patient rights and responsibilities section of a Medicaid application. An example item is: *If you _____ (wash, want, cover, or tape) AFDC for any family _____ (member, history, weight, or seatbelt) you will have to _____(relax, break, inhale, or sign) a different application form.* Completion time is estimated to be about 12 minutes. Total scores were used in the analyses and range from 0 to 36, with higher scores indicating greater HL.

The Parental Diabetes Numeracy Test (PDNT) [14] is a self-administered test of numeracy and navigational skills. Participants who self-identified as Spanish being their primary language (n = 7) were given the DNT-15 Latino [15], the Spanish version of the PDNT-14. Both questionnaires consist of multiple choice responses and free response questions. A sample item is: *You are given the following instructions: "Take 1 unit of insulin for every 7 grams of carbohydrate you eat." How much insulin do you give your child when they eat 98 grams at supper?* Participants were offered a calculator to use if desired when answering questions. Scores range from 0 to 14 for the English version and 0 to 15 for the Spanish

version. Because of the different number of items on the scales, percent of items answered correctly was used in analyses, with higher scores indicating greater numeracy skills.

The Perceived Diabetes Self-Management Scale [16], (Cronbach's α=.84 in current sample) measures the degree to which patients with diabetes feel competent in managing their diabetes. It is a measure of perceived diabetes self-efficacy, not actual diabetes management skills. This measure was adapted for this study to apply to parents of children with diabetes and questions were phrased to measure parents' perception of their own ability to complete diabetes related tasks for children [17]. The scale consists of 8 items such as: *I am able to deal with things related to my child's diabetes as well as others* or *I succeed in the projects I undertake to manage my child's diabetes*. Each item is rated on a 5 point Likert scale ranging from strongly disagree to strongly agree. Total scores are utilized, with higher scores indicating greater parental perceived diabetes self-efficacy.

2.3 Statistical Analyses

Spearman correlations were used to determine if there were relationships between reading skills, numeracy, parental perceived diabetes self-efficacy, and HbA1c. Significant correlations were further explored with linear regressions to determine if predictor variables (numeracy, reading skills) were related to HbA1c. Mean substitution was used for any missing items in the participant forms.

3. Results

Neither reading skills nor numeracy was related to treatment regimen, diabetes duration, or ethnicity. Parent numeracy and reading skills were positively correlated, $r = .37$, $p = .02$, such that parents with better numeracy skills also had better reading skills. However, parent numeracy ($r = -.52$, $p < .01$), but not reading skills ($r = -.25$, $p = NS$) were negatively correlated with the child's HbA1c. Similar to numeracy skills, increased parental perception of diabetes self-efficacy was associated with lower child HbA1c ($r = -.47$, $p < .01$), but parental perception of diabetes self-efficacy and numeracy skills were not correlated with each other ($r = .18$, $p = NS$). When numeracy and parental perceived diabetes self-efficacy were entered into a linear regression, the model was significant ($F = 12.93$, $p < .01$, $R^2 = .39$) with both numeracy ($\beta = -.46$, $p < .01$) and parental perception of diabetes self-efficacy ($\beta = -.36$, $p = .01$) being independent predictors of HbA1c. When mother's education level is entered as a covariate the model remains significant, $F = 5.01$, $p = .006$, $R^2 = .26$. Parental perception of diabetes self-efficacy remains a significant predictor of HbA1c ($\beta = -.32$, $p = .039$) but the relationship between numeracy and HbA1c is attenuated ($\beta = -1.86$, $p = .072$).

Data from the current sample was compared to previously published samples [13–14,16]. In general the current sample demonstrated greater HL than those in previous studies (see Table 1). Specifically, the percent of items answered correctly on the STOFHLA in the current sample was significantly higher than the norms presented in the administration manual, $t(60) = 20.44$, $p < .001$. Similarly, the mean number of items answered correctly on the PDNT in the current sample was significantly higher than those reported in the normative sample for English speakers [13], $t(60) = 2.91$, $p = .005$ (no norms were available for Spanish speakers). In contrast, parental perception of diabetes self-efficacy reported by the current sample were similar to those in previous research [16], $t(48) = 1.35$, $p = ns$. Due to the small number of participants in this study who completed measures in Spanish, comparisons between English respondents and Spanish respondents were not conducted.

4. Discussion and Conclusions

4.1 Discussion

This is the first study to assess the role of parental HL in the health of young children with Type 1 DM. Findings from this study highlight the importance of considering the role of parental health literacy, especially numeracy, in creating interventions to improve the glycemic control of young children with diabetes. Results from this sample indicated that parental numeracy skills, but not reading skills, were positively related to young children's disease outcomes. Contrary to our hypotheses, parental perception of diabetes self-efficacy did not mediate the relationship between numeracy and health outcomes. However, both numeracy and parental perceived diabetes self-efficacy were found to be independent predictors of glycemic control. The limitations of this study include the cross sectional design which limits the ability to look at predictive relationships between HL of parents and health outcomes in children over time and a small sample size which impeded more complex analyses. Additionally, the current sample scored significantly higher on numeracy and reading skills than those presented in previous studies, which may have affected the results. This is especially true regarding the STOHFLA scores which near ceiling. This may be a result of parents with lower reading skills self-selecting not to participate in the study or a function of the literacy measure used in this research. Certainly, in the area of diabetes management, numeracy is extremely important, as parents are expected to measure and administer exact insulin doses and adjust doses of medication depending on glucose results and carbohydrates consumed as part of a child's daily dietary intake. The numeracy measure used in this study was specific to diabetes, which might explain why it was related to HbA1c and reading skills were not.

4.2 Conclusions

Results from this study highlight the importance of the numeracy component of health literacy in parents of young children with diabetes health outcomes. These results suggest that better glycemic control in children is associated with better numeracy skills in parents. Future research should consider the use of multiple assessments over time to ensure the direction of these relationships and attempt to include participants with a wider range of HL skills. It will also be important for future studies to assess whether parental numeracy is the more important predictor in children's health outcomes. If so, diabetes-related numeracy interventions to assist parents in implementing medical recommendations properly, particularly for parents who are charged with making dosing adjustments would be helpful.

4.3 Practice Implications

The results from this study have important potential clinical implications when treating young children with diabetes. Due to the relationship between parental diabetes numeracy skills and glycemic control, it will be important for medical staff to assess for difficulty with numeracy and not assume all parents have the necessary mathematical skills to follow treatment recommendations. Simple and short numeracy screening measures could be used as part of standard care. If parents are found to have low numeracy skills or this is suspected, more detailed explanations of the medication regimen and concrete examples during medical visits, including written instructions, tailoring messages, partitioning information, and making instructions interactive may be helpful [18]. For patients with diabetes, numeracy screeners could also assist physicians in deciding which type of insulin regimen would be most appropriate given the families' abilities. If specific numeracy screening is unavailable, educational level could be used as a proxy. Future studies should continue to assess the relationship between parental numeracy skills and glycemic control and the role of interventions that address numeracy to improve diabetes care and outcomes.

Acknowledgments

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Table I

Sample Description

	Sample Mean (SD)	Normative Mean	Single Sample T-test
Child's Age	6.77 (1.98)		
Mother's Age	40.07 (7.09)		
HbA1c	8.40 (1.35)	8.0	$t(53) = 2.17$, p =.ns
Numeracy (PDNT)	.69 (.24)	.61	$t(60) = 2.91$, p =.005[*]
Reading Skills (STOFHLA)	34.13 (3.14)	25.92	$t(60) = 20.44$, p <.001
Parental Perceived Diabetes Self-Efficacy	4.13 (.81)	3.97	$t(48) = 1.35$, p =ns

[*] Compared English speakers in the sample to the English norms of the PDNT

Table 2

Regression Models Predicting HbA1c

Model 1	B	SE (B)	β	t
Numeracy	−2.67	.76	−.46	−3.52**
Parental Self-Efficacy	−.08	.03	−.36	−2.73**

Model 2	B	SE (B)	β	t
Numeracy	−1.52	1.07	−.29	−1.86
Parental Self-Efficacy	−.06	.03	−.32	−2.16*
Mother's Education	−.17	.10	−.26	−1.68

Note.

**
p <.01,

*
p <.05.