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Measuring functional, communicative, and critical health literacy among diabetes patients

Hirono Ishikawa, PhD[1)2)], Takeaki Takeuchi, MD MPH D.MSc[1)], Eiji Yano, MD MPH D.MSc[1)]

1) Hygiene & Public Health, Teikyo University
2) Culture & Medicine, Shiga University

Corresponding Author:
Hirono Ishikawa
Culture & Medicine, Shiga University
Seta Tsukinowa-cho, Otsu, Shiga, 520-2192, Japan
hirono-tky@umin.ac.jp

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ABSTRACT

Objective: Health literacy (HL), the capacity of individuals to access, understand, and use health information to make informed and appropriate health-related decisions, has been recognized as an important concept in patient education and disease management. This study examined the psychometric properties of newly developed scales for measuring three different levels of HL (i.e., functional, communicative, and critical HL) in patients with diabetes.

Research Design And Methods: The reliability and validity of the three HL scales were evaluated in a sample of 138 outpatients with type 2. In addition, sociodemographic and clinical characteristics, knowledge of diabetes, information-seeking behaviors, and self-efficacy were assessed for each patient through a self-reported questionnaire and review of electronic medical records.

Results: The scale items were constructed to directly reflect the definition of HL. The internal consistency of the functional, communicative, and critical HL scales was adequately high ($\alpha = 0.84$, $\alpha = 0.77$, and $\alpha = 0.65$, respectively). Three interpretable factors were identified in the exploratory factor analysis. The correlations between the HL scales and the other measures supported the construct validity of the scales. The three HL scales were only moderately correlated with each other, suggesting that each represents a different domain of HL abilities and skills.

Conclusions: Our newly developed HL scales are reliable and valid measures of three types of HL in diabetes patients. Exploring a patient's HL levels may provide a better understanding of the patient's potential barriers to self-management of disease and health-promoting behaviors.

Over the past few decades, patient participation in the health care process has been recognized as a critical determinant of successful disease management. This is especially true in the case of diabetes, which requires extensive and ongoing patient self-care. Health information is an important resource for helping patients to understand and engage in the management of a health condition. Although physicians have historically been the primary source of health and medical information, other sources are becoming more available to the general public, with the increase in media reports and rapid diffusion of the Internet (1–4). Thus, a patient's skills in understanding and applying information about health issues may have a substantial impact on his/her behavior and health (5). These skills have recently been conceptualized as health literacy (HL).

The National Library of Medicine refers to HL 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" (6). Similarly, the World Health Organization defines HL as "the cognitive and social skills which determine the motivation and ability of individuals to gain access to, understand, and use information in ways which promote and maintain good health" (7). Based on this, Nutbeam (8) proposed a model of HL that includes three levels: *functional literacy*, the basic level of reading and writing skills that let someone function effectively in everyday situations; *communicative literacy*, advanced skills that allow a person to extract information, derive meaning from different forms of communication, and apply new information to changing circumstances; and *critical literacy*, more advanced skills for critically analyzing information and using information to exert greater control over life events and situations.

Previous research on HL has focused predominantly on functional HL, or more precisely, the skills necessary to read health information. These studies have suggested that limited functional HL has a negative impact on various patient behaviors and health outcomes (for systematic reviews: 9, 10). Studies involving patients with diabetes have reported that those with limited functional HL have poor knowledge of their disease (11–14) and exhibit perceived difficulties and poor comprehension in communicating with their physician (15, 16). However, the diabetes self-efficacy score was not significantly different among those with different functional HL levels; instead, the self-efficacy score was associated with self-management behaviors (17). Although a previous study indicated that patients with limited functional HL experienced poor clinical outcomes such as a higher hemoglobin A1c (HbA1c) level (18), other studies did not support this association (12–14, 19, 20). Some researchers found higher rates of diabetes complications in patients with limited functional HL (12, 18), but another study reported that the significant differences disappeared after adjusting for confounders (19).

Inconsistent findings on the relationship between HL and diabetes care and outcome suggest that optimal self-management of diabetes may not depend solely on a patient's ability to read health information (19). Greater value may be found in assessing HL beyond the functional level to explore barriers in self-management for patients with diabetes, including the abilities to extract, communicate, critically analyze, and use health information, and to participate in their care and promote their health. Although some of these components have been studied under different labels, such as social interaction skills or problem-solving skills (21), no validated instrument has been created to specifically assess a skill set in dealing with health information. Furthermore, an adequate level of HL would vary, depending on the demands placed on patients by their social environments, including health care

providers, health care systems, the media, and the community (22). While many previous studies on HL have been conducted in the United States, studies in different societies and cultures may provide additional insights in HL research.

This study sought to examine the psychometric properties of three newly developed scales for measuring functional, communicative, and critical HL among patients with type 2, so that we could propose a measure of HL that overcomes the limitations of previous studies.

RESEARCH DESIGN AND METHODS

Study population and setting. Survey participants were patients with type 2 who visited the outpatient department of general internal medicine at a university-affiliated hospital in Tokyo, Japan. The inclusion criteria were having type 2 and being under continuous care by the four attending physicians of the department who specialize in metabolic diseases. During the study period of October to December 2006, patients eligible for recruitment were randomly selected from the appointment logs of the study physicians. The selected patients were approached in the waiting room after a consultation and were given an explanation of the study purpose and procedures. The age, gender, most current HbA1c level, and complications of each participant were obtained from a review of electronic medical records.

Among the 169 eligible patients identified, 157 patients provided written consent to participate in the study and completed the questionnaire (12 refusals, refusal rate: 7.1%). The major reasons for refusal were a lack of time and poor physical condition on the day of the questionnaire. For the purpose of this study, we excluded patients who had been diagnosed with diabetes within the previous year and those with an HbA1c level lower than 5.8% (N = 19). This resulted in a final sample of 138 patients. During the survey, a research assistant helped patients complete the questionnaire if the patient preferred. Of the 138 patients, 46 (33%) did prefer to receive help.

This study was conducted with the approval of the Ethical Review Committee at Teikyo University School of Medicine.

Measures. *Health literacy.*The scale items were constructed to directly reflect the previously reported definitions of functional, communicative, and critical HL as cited in the Introduction. For functional HL, we reviewed the standard measures currently being used, although none was available in Japanese. The items were examined and adapted through discussions with co-researchers, including clinicians, public health researchers, and social science researchers working in related fields. Ease of use and comprehensibility were tested in a small sample of patients with diabetes (N = 20).

For functional HL, five items were prepared to assess the extent to which patients had experienced difficulties in reading the instructions or leaflets from hospitals and pharmacies, based on previously developed instruments (23, 24). Communicative HL was evaluated with five items assessing the extent to which patients had extracted and communicated diabetes-related information since they were diagnosed with the disease. Similarly, critical HL was assessed by four items focusing on the extent to which patients had critically analyzed the information and used it to make decisions. In addition to the three subscales, the total HL scale was also formed by adding all 14 items. All scale items are presented in Table 2.

Each item was rated on a 4-point scale, ranging from 1 = never to 4 = often. The scores for the items in a scale were summed and divided by the number of items in the scale to give a scale score (theoretical range, 1–4). The scores were reversed for functional HL, so that higher scores indicated higher HL.

Sociodemographic and clinical characteristics. The educational attainment, self-rated economic status, and duration of diabetes were obtained for each patient from

the self-reported questionnaire. The self-rated economic status question asked how the patient perceived the financial situation of his/her family, with five options (lower, lower-middle, middle, upper-middle, upper), which was then grouped into three categories by combining the lower two categories and the upper two categories in the statistical analyses. The age, gender, HbA1c level, and presence of major diabetes complications (i.e., retinopathy, nephropathy, and neuropathy) were obtained from the review of electronic medical records. The patients were divided into three age groups (<65, 65–74, and ≥75 years old) for the analysis.

Other measures. *Diabetes knowledge* was measured with seven true/false questions about a patient's knowledge of diabetes and its care; for example, " An HbA1c level of 8.0 indicates tight control of diabetes" and "In the food exchange lists, a small bowl of rice equals 2 units." Items were developed based on existing diabetes knowledge scales (14, 25, 26) and patient education materials in Japan. The number of correct answers was counted as the diabetes knowledge score (theoretical range, 0–7). Cronbach's α of the scale was 0.65, indicating adequate internal consistency.

The number of health information sources utilized by a patient was measured by counting the sources (i.e., physicians, other health care professionals, family/friends, other diabetic patients/patient groups, health education programs, TV/radio programs, Internet, newspapers/magazines, books, leaflets/newsletters) from which the patient had ever sought or been provided diabetes-related information.

The self-efficacy of diabetes self-care was assessed using the four-item scale of self-care ability in the Diabetes Care Profile (27). The reliability of the scale was similar to the previously reported value (Cronbach's $\alpha = 0.83$).

Statistical analysis. Cronbach's α coefficients were calculated to examine internal consistency. Exploratory factor analysis with promax rotation was performed to examine the factor structure of the HL. To determine the relationships of the HL scales with other measures, either Pearson's or Spearman's correlation coefficient was calculated for continuous variables; either Wilcoxon's rank-sum test or t-test was used for categorical variables with two groups. A test for a trend across ordered groups was used for categorical variables with more than two ordered groups. Although patients were recruited from four physicians, within-physician clustering was not adjusted because the intra-class correlations were very small. Cases with missing values were excluded from the respective analyses. They were conducted with the Stata 9.2 (Stata Corporation, TX).

RESULTS

Participant characteristics and descriptive results. The sociodemographic and clinical characteristics of the participants are displayed in Table 1. The mean age of the patients was 65 years, and the mean duration since the diagnosis of diabetes was 11.5 years. Based on the most current test results for HbA1c, 25.0% of the patients were in tight control (≤6.5%), 49.3% were in fair control (6.6–7.9%), and 25.7% were in poor control (≥8.0%). The patients had seen the physician at this outpatient service for an average of 6.7 years (SD = 5.7; not shown in Table 1).

The scores for each item of the functional, communicative, and critical HL scales are presented in Table 2. The scores were higher for the functional HL items and relatively lower for the critical HL items.

Reliability: internal consistency. The internal consistency values of the functional, communicative, and critical HL scales were adequate ($\alpha = 0.84$, $\alpha = 0.77$, and $\alpha = 0.65$, respectively). The item-total correlations were all positive and ranged from 0.60 to 0.83 for functional HL, 0.60 to 0.85 for communicative HL, and 0.63 to 0.83 for critical HL. Because the deletion of any item would not result in an increase in Cronbach's $\alpha > 0.02$, it was decided to

retain all items in each scale. Cronbach's α of the total HL scale was 0.78.

Content validity: factor structure. The HL scale was designed to measure three different HL levels. Exploratory factor analysis was performed to assess whether three underlying factors and each item's load on the factors could be identified as designed. The initial factor solution showed four factors with eigenvalues >1 (3.7, 3.1, 1.4, and 1.2), accounting for 26.6, 22.0, 9.8, and 8.6% of the variance, respectively. Although the eigenvalues declined sharply between the second and third factors, a forced factor solution with three promax rotated factors was examined to assess whether the items clustered into three factors of HL as designed. The promax rotation showed that all five functional HL items loaded on the first component and all five communicative HL items loaded on the second component (Table 2). One critical HL item (i.e., "Considered whether the information was applicable to your situations") loaded on both the second and third components, with a slightly higher factor loading on the second. The analysis of reliability suggested that Cronbach's α of the critical HL scale would increase slightly by excluding this item (α = 0.67), while that of total scale would decrease slightly (α = 0.76). Because the item was considered an important component of the theoretical definition of HL, and the difference in the loading and compromise in the internal consistency was relatively small, we decided to include this item in the critical HL scale. Although we ran the subsequent analyses using a scale excluding this item, the results did not change significantly.

Construct validity. Among the three HL scores, the association of functional HL with communicative and critical HL were not statistically significant (r = 0.09, p = 0.291 and r = 0.05, p = 0.548, respectively), while communicative and critical HL scores did have a significant positive association (r = 0.52, p < 0.001).

Bivariate relationships between the HL scores and the other parameters are shown in Table 3. The results were generally consistent with previous findings and with the theoretical basis of the HL concept. The diabetes knowledge score showed a strong positive association with all HL scores, whereas the number of information sources and self-efficacy were not significantly associated with functional HL scores. The functional and critical HL scores were significantly lower among older patients, but there was no significant age-related difference in the communicative HL scores. There were no significant differences in any of the HL scores between genders. The HL scores were generally higher for those with higher educational attainment and economic status, although the relationship between self-rated economic status and critical HL was less clear. With regard to the clinical characteristics, a higher communicative HL score was related to a lower HbA1c level, and the functional HL score was higher for patients with no diabetes complications.

CONCLUSIONS

Unlike previous studies that focused solely on functional HL, this study aimed to measure a broader concept of HL, one including the ability to extract, understand, and use health-related information. The results of this study support the reliability and validity of our HL scales in patients with type 2.

The internal consistency of each HL scale was adequate. An examination of the factor structure suggested three different levels of HL, although the communicative and critical HL scales were closely related to each other. Indeed, a correlation analysis suggested that the associations among the HL scales were all in the positive direction but were statistically significant only between the communicative and critical HL scales. The score on each item was generally higher for functional HL items compared with communicative and critical HL items, which is consistent with the theoretical supposition that communicative and critical HL involve more advanced skills.

The relationships between the HL scores and the other measures were generally in the expected directions, supporting the validity of the scales. At the same time, the correlations among the scales were only moderate, indicating that each HL scale reflects a unique construct. Limited functional HL is related to poor knowledge of diabetes, as previously reported (11–14), and all three of the HL scales were positively associated with diabetes knowledge. The number of information sources used by patients to obtain diabetes information was not correlated with functional HL. In contrast, those with higher communicative and critical HL scores consulted a greater number of information sources, which is reasonably interpreted from the definitions of communicative and critical HL. Furthermore, as has been suggested by a previous study (17), self-efficacy of diabetes self-care did not significantly differ with the functional HL score. On the other hand, the communicative and critical HL scores had significant positive correlations with self-efficacy, suggesting that advanced levels of HL may be more closely related to higher self-efficacy in the management of diabetes.

With regard to sociodemographic factors, advanced age, lower educational attainment, and lower economic status tended to be associated with lower HL, which was generally consistent with a recent meta-analysis study (28). However, the significance of the associations with each of these factors was different among the three HL scales, indicating that each HL scale reflects a unique construct. Using these scales in further investigations may allow the identification of patient characteristics that are likely to affect each type of HL.

As in previous studies (12–14, 19, 20), our study did not find a significant relationship between functional HL and the HbA1c level, whereas a higher communicative HL score was related to a lower HbA1c level. This suggests that the skills of extracting, communicating, and applying information might be more important in managing diabetes than the skills necessary to read the information. On the other hand, a lower functional HL was significantly associated with higher rates of diabetes complications. These bivariate relationships between HL and health outcomes should be carefully examined in future studies with larger samples, considering the potential confounders. It is possible that patients with lower functional HL were older and more likely to have complications. However, our *post hoc* analysis suggested that these findings remained significant even after adjusting for patient sociodemographic characteristics (i.e., age, gender, education, and self-reported economic status) and duration of diabetes (data not shown). Our findings may suggest that HL has direct relationship with clinical outcome in patients with diabetes and that each HL level might act in a different way. The ways in which each HL level influences patient self-care behaviors and health outcomes should be further explored.

Several limitations should be noted in interpreting the findings of this study. First, this study was conducted at a single university hospital in a metropolitan area and with a sample of patients who had an established relationship with their physician. It is possible that the patients in this study were better educated and less likely to be illiterate than those at local clinics or in rural areas. Additionally, the findings may be specific to the Japanese context. This may limit the generalization of our findings, but it is noteworthy that a difference in the degree of HL was observed in this relatively homogenous sample of patients. Although the sociocultural context as well as practice style may differ between Japanese and Western settings, the associations of HL with patient characteristics and with the other measures in our study are generally similar to those reported in previous Western studies.

A second possible limitation of our study is that HL was measured based on a

self-reported questionnaire. It has been indicated that individuals with reading problems are often ashamed and hide their inability to read (29), which might have led to an overestimation of the HL levels in this study. Moreover, our scale items may not cover the whole concept of the three levels of HL as defined by Nutbeam (8). Furthermore, because standard measures of functional HL such as S-TOFHLA or REALM-R were not available in Japanese, we were unable to examine the relationship between our HL scale and these measures, an issue that should be explored in a future study with an English-speaking population. Further revisions and validation of our HL scales, along with an examination of their predictive validity and Despite these limitations, this study suggests that HL is a measurable and important concept in considering education for patients with chronic diseases such as diabetes. Beyond previous measures focusing solely on functional HL, our scales included three levels of HL, each of which might have different effects on patient outcomes. Our scales also proved to be easy to administer in a clinical setting.

There has been a major concern that much of the diabetes-related health information requires literacy skills that are well above the population average, rendering them of little value to patients with limited literacy (30). Previous studies reported a greater benefit of face-to-face disease management programs for patients with limited literacy (13, 20), which might suggest that those patients were less capable of seeking relevant information from other sources and applying it to the management of their disease as compared to patients having higher HL. Physicians ought to be aware of these types of differences among patients and adopt flexible strategies of patient education that identify and accommodate their patients' needs and abilities in managing disease. Exploring the functional, communicative, and critical HL levels of patients may help physicians better understand their patients' potential barriers to engaging in self-management of disease and health-promoting behaviors. Furthermore, because the characteristics of the health system significantly contribute to poor communication, especially for patients with limited HL (22), it is necessary to consider changing the systems to provide health care and health information in a way that could reduce HL demands for such patients.

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TABLE 1. Patient characteristics

N = 138

		Mean	SD	Range
Age (years)		65.0	9.9	[33-92]
Duration of diabetes (years)		11.5	9.4	[1–54]
HbA1c (%)		7.4	1.3	[5.8–12.6]
		N	%	
Gender	Male	73	52.9	
	Female	65	47.1	
Education	Middle school	30	21.7	
	High School	60	43.5	
	Vocational school/ 2-year college	19	13.8	
	University or higher	17	12.3	
	Missing	12	8.7	
Self-rated economic status	Lower	21	15.2	
	Middle	80	58.0	
	Upper	24	17.4	
	Missing	13	9.4	
Complications	Retinopathy	53	38.4	
	Nephropathy	16	11.6	
	Neuropathy	23	16.7	
	None	72	52.2	

TABLE 2. Item content, means, and factor loadings of the HL scales

			Factor loadings		
	Mean	SD	Factor 1	Factor 2	Factor 3
Functional health literacy	**3.39**	**0.75**			
In reading instructions or leaflets from hospitals/pharmacies, you....					
found that the print was too small to read	3.19	1.12	0.70	0.11	0.04
found characters and words that you did not know	3.41	0.88	0.85	0.08	–0.01
found that the content was too difficult	3.43	0.84	0.84	0.13	–0.08
needed a long time to read and understand them	3.27	1.04	0.81	–0.10	0.06
needed someone to help you read them	3.65	0.86	0.76	–0.13	0.10
Communicative health literacy	**2.56**	**0.70**			
Since being diagnosed with diabetes, you have....					
collected information from various sources	2.43	1.04	0.09	0.82	0.26
extracted the information you wanted	2.18	1.00	0.03	0.81	0.23
understood the obtained information	2.89	0.88	0.14	0.49	0.26
communicated your thoughts about your illness to someone	2.70	0.91	–0.06	0.74	–0.31
applied the obtained information to your daily life	2.60	0.99	–0.08	0.60	0.30
Critical health literacy	**1.96**	**0.63**			
Since being diagnosed with diabetes, you have....					
considered whether the information was applicable to your situation	2.71	0.98	0.19	0.41	0.40
considered the credibility of the information	1.87	0.92	0.02	0.05	0.84
checked whether the information was valid and reliable	1.76	0.96	0.02	0.27	0.78
collected information to make health-related decisions	1.51	0.77	-0.10	0.34	0.44

TABLE 3. Bivariate relationships of HL scales with other measures

	Total HL			Functional HL			Communicative HL			Critical HL		
1)	r	p-value		r	p-value		r	p-value		r	p-value	
Diabetes knowledge	0.37	<0.001		0.20	0.017		0.31	<0.001		0.26	0.002	
Number of information sources	0.40	<0.001		0.03	0.714		0.44	<0.001		0.40	<0.001	
Self-efficacy	0.30	<0.001		0.14	0.109		0.32	<0.001		0.18	0.037	
HbA1c	–0.04	0.666		0.04	0.663		–0.20	0.020		–0.07	0.404	
2)	Mean	SD	p-value	Mean	SD	p-value	Mean	SD	p-value	Mean	SD	p-value
Age (years)												
<65	2.73	0.46	0.035	3.49	0.77	0.010	2.57	0.73	0.476	2.05	0.60	0.027
65–74	2.69	0.43		3.42	0.53		2.62	0.64		1.97	0.63	
≥75	2.40	0.63		3.02	1.03		2.39	0.74		1.70	0.70	
Gender												
Male	2.63	0.50	0.458	3.40	0.76	0.730	2.48	0.71	0.163	1.96	0.62	0.978
Female	2.69	0.48		3.37	0.76		2.65	0.67		1.97	0.65	
Education												
Middle school	2.48	0.48	0.006	3.20	0.88	0.167	2.45	0.78	0.157	1.70	0.65	0.002
High School	2.64	0.47		3.43	0.66		2.51	0.75		1.94	0.59	
Vocational school/ 2-year college	2.82	0.53		3.51	0.82		2.65	0.64		2.13	0.72	
University or higher	2.84	0.42		3.47	0.78		2.73	0.50		2.26	0.50	
Self-rated economic status												
Lower	2.51	0.45	0.011	3.02	0.91	0.031	2.49	0.68	0.025	1.99	0.65	0.418
Middle	2.62	0.50		3.44	0.72		2.45	0.72		1.90	0.63	
Upper	2.88	0.43		3.53	0.68		2.89	0.61		2.14	0.63	
Complications												
None	2.73	0.48	0.083	3.49	0.72	0.039	2.58	0.68	0.717	2.03	0.59	0.217
≥1	2.59	0.49		3.27	0.77		2.54	0.72		1.89	0.68	

Note 1) Spearman's correlation coefficients were estimated when functional HL and HbA1c were involved. Otherwise Pearson's correlation coefficients were estimated.
2) For gender and complications, Wilcoxon's rank-sum test and t-test were used. Otherwise, the test for trends across ordered groups was used.