Original Article

Health-Literacy-Sensitive Diabetes Self-Management Interventions: A Systematic Review and Meta-Analysis

Su Hyun Kim, PhD, RN • Anna Lee, RN

ABSTRACT

Background: Low health literacy is a potential barrier to self-management among patients with diabetes. A variety of strategies for low health literacy have been proposed for diabetes self-management interventions, but interventions accommodating low health literacy have been heterogeneous in terms of content and have produced mixed results.

Aim: To systematically review health-literacy-sensitive diabetes management interventions, with a focus on identifying strategies for accommodating patients with low health literacy, and to examine the efficacy of these interventions to improve health outcomes.

Methods: PubMed, CINAHL, and EMBASE were searched for intervention studies published between January 2000 and January 2015. Two authors separately identified full-texts according to the inclusion criteria and assessed study quality using the quantitative components of the Mixed Methods Appraisal Tool. The final list of studies to be analyzed was made through discussion. The meta-analysis was conducted using a random effects model.

Results: Thirteen studies were selected from the 490 studies found in our initial search. We identified a range of strategies for accommodating those with low health literacy in diabetes self-management interventions, which encompassed four domains: written communication, spoken communication, empowerment, and language/cultural consideration. Using at least one of the spoken communication strategies led to positive cognitive/psychological, self-care, and health outcomes. We found that, overall, health-literacy-sensitive diabetes management interventions were effective in reducing HbA1C level in the meta-analysis.

Linking Evidence to Action: Healthcare providers should consider active implementation of strategies for accommodating people with low health literacy in diabetes self-management interventions. The routine use of spoken communication strategies would be necessary to achieve the best health outcomes in diabetes self-management interventions. More research is needed to determine the individual effects of the key strategies that improve health and reduce health disparity.

INTRODUCTION

Low health literacy, defined as a lack of the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions (Institute of Medicine, 2004), has been considered as a potential barrier to improving health outcomes. According to a systematic review on health literacy, low health literacy is associated with poor health outcomes and poor use of healthcare services (Berkman, Sheridan, Donahue, Halpern, & Crotty, 2011). In particular, patients with diabetes, who must engage in constant self-management, must have adequate health literacy to apply the requisite knowledge, decision-making skills, and problem-solving skills for effective diabetes management (Fransen, von Wagner, & Essink-Bot, 2012). The risk of complications from diabetes is higher among patients with low health literacy, as they are less likely to have adequate knowledge of diabetes and related self-care activities than are those with appropriate health literacy (Al Sayah, Majumdar, Williams, Robertson, & Johnson, 2013).

Researchers, in response, have proposed a variety of interventions to improve health outcomes and reduce the health disparity associated with low health literacy. The strategies frequently recommended to healthcare providers are to improve the usability of health information by using plain language, focusing on actions, limiting the number of messages, acknowledging cultural differences, supplementing instructions with pictures, and checking that patients understand (The Office of Disease Prevention and Health Promotion, 2015).
However, in the literature, interventions developed for patients with low health literacy not only have been heterogeneous in content and context but also have produced mixed results (Bailey et al., 2014; Pignone, DeWalt, Sheridan, Berkman, & Lohr, 2005). In one narrative systematic review, the interventions for reducing literacy-related differences in diabetes outcomes were summarized as patient education, self-management support, disease management, and feedback of health-literacy screening results to providers (Bailey et al., 2014); however, this review did not provide sufficient information on the strategies adopted for accommodating patients with low health literacy or the effectiveness of these interventions.

Thus, efforts to improve diabetes care for people with low health literacy would benefit from a detailed systematic review on the components of diabetes interventions or the strategies specifically designed for patients with low health literacy. Determining the effectiveness of the strategies for accommodating low health literacy through a meta-analysis would also support evidence-based practice for patients with low health literacy. In this systematic review and meta-analysis, we examined health-literacy-sensitive diabetes management interventions, with an emphasis on identifying strategies for accommodating patients with low health literacy. We also evaluated the effectiveness of these interventions for improving health outcomes and reducing the health disparity associated with low literacy.

METHODS

Data Sources

We conducted a literature search to identify studies published between January 2000 and January 2015 using PubMed, CINAHL, and EMBASE. We consulted with two librarians who have expertise in searching academic articles to identify keywords and Medical Subject Heading (MeSH) terms. We employed several combinations of keywords and MeSH search terms in each electronic search engine as follows: “health literacy” [MeSH] OR (“health” [All Fields] AND “literacy” [All Fields]) OR “health literacy” [All Fields] OR “numeracy” [All Fields]; “diabetes mellitus, type 2” [MeSH] OR “type 2 diabetes” [tw] OR “type II diabetes” [tw]; “self-care” [MeSH] OR “self-care” [tw] OR “self-care” [tw] OR “self-management” [tw] OR “self-management” [tw] OR “disease management” [tw] OR “disease-management” [tw]. We also reviewed the reference lists of included studies and systematic reviews to find additional studies. Any disagreements among researchers during the literature search were resolved by discussion and a consensus was reached.

Eligibility Criteria

Inclusion criteria were studies that (a) clearly described that the intervention was developed or adapted for patients with low health literacy; (b) included patients with type 2 diabetes; (c) measured health literacy levels of each participant; (d) used an experimental design; (e) were peer-reviewed and published in English; and (f) measured at least one of the following outcomes: glycosylated hemoglobin (HbA1C), systolic blood pressure (SBP), lipid profile, diabetes knowledge, self-efficacy, or self-care behaviors. Studies solely aiming to develop or validate instruments were excluded.

Study Quality Assessment

We used the quantitative domain of the Mixed Methods Appraisal Tool (MMAT) to examine study quality (Plyue et al., 2011). This tool consists of four criteria for each type of study design, such as clear descriptions of the randomization and allocation concealment, completed outcome data, and low withdrawal rate in randomized controlled trials (RCTs). All items were rated dichotomously (“yes” = 1, “no” = 0). The answers were summed and converted into a score ranging from 0% to 100%. We assessed the study quality separately and resolved disagreements through discussion.

Data Extraction, Synthesis, and Analysis

Two authors separately reviewed abstracts and candidate full-texts from the electronic search according to the eligibility criteria. Decisions to include abstracts for full-text review as well as the final list of studies were made through discussion. After obtaining the final list of studies, we extracted the characteristics of each study, including design, intervention, participants, and findings (Appendix S1, available with the online version of this article). To organize the diverse and heterogeneous strategies for accommodating patients with low health literacy, we categorized the strategies according to a previous study that developed an inclusive list of health-literacy precautions (DeWalt et al., 2011; Table 1).

We used the Comprehensive Meta-Analysis software version 2.2 (Biostat, NJ, USA) to conduct the meta-analysis. We used a random effects model that assumed study-level and sampling variance to calculate effect sizes and standardized mean differences in the change of HbA1C between groups (Cooper, 2010). Multiple effect sizes were calculated when a study included multiple intervention groups. In this review, we obtained the overall effect size for the outcome of HbA1C from eight intervention studies that measured HbA1C. To identify the effectiveness of the interventions on HbA1C in people with differing health-literacy statuses, we calculated separate effect sizes for people with low and high health literacy from three studies that stratified intervention effects by health-literacy status. Health-literacy status was determined based on health-literacy scores in the original study. The use of meta-analytic techniques was not possible for other outcome measures such as knowledge, self-efficacy, or self-care, because of the high diversity in measurement.

RESULTS

The electronic search yielded a total of 484 studies, and 6 studies were found using other resources (Figure 1). Through a review of the abstracts, 42 studies were identified as relevant for full-text review, and 13 studies were selected for final review.
Table 1. Strategies of Diabetes Self-Management Interventions for Patients with Low Health-Literacy

<table>
<thead>
<tr>
<th>Spoken communication</th>
<th>Written communication</th>
<th>Empowerment</th>
<th>Language/cultural consideration</th>
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<tr>
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<td>Clear communication</td>
<td>Teach-back</td>
<td>Follow-up with patients</td>
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<td>Randomized controlled trials</td>
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<td>Moussa (2013)</td>
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<td>Rothman, Malone et al. (2004)</td>
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Randomized controlled trials with more than two arms

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<th>Clear communication</th>
<th>Teach-back Method</th>
<th>Follow-up with patients</th>
<th>Easy-to-read material</th>
<th>Effective health education method</th>
<th>Encouragement of questions</th>
<th>Behavioral activation</th>
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One group pretest-posttest

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<th>Clear communication</th>
<th>Teach-back Method</th>
<th>Follow-up with patients</th>
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<th>Effective health education method</th>
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because they met the eligibility criteria. Among the 13 studies in the narrative analysis, eight were included in the meta-analysis for the effectiveness of the interventions on HbA1C, and three studies were included in the subgroup meta-analysis by health-literacy status.

Study Characteristics
In terms of the overall quality of the studies, two studies satisfied all four criteria (100%) and seven studies satisfied three criteria (75%; Appendix S2, available with the online version of this article). The criterion most often violated was “clear description of allocation concealment.” All except one study were conducted in the United States. Six studies were RCTs with control groups, three studies had more than two intervention groups in the RCT design, and four studies used a one-group pretest–posttest design. The majority of the interventions were educational programs on diabetes management delivered in-person, via telephone, or via computer multimedia. The remaining studies included medication management facilitation through contact with primary care providers (Crowley et al., 2013), and problem-solving training (Hill-Briggs et al., 2011).

Regarding the study population, two studies recruited only participants with low health literacy (Moussa, Sherrod, &...
The outcomes measured in these studies were highly diverse. We organized the outcomes into three domains according to the framework of health literacy and its associations with diabetes mechanisms and outcomes (Bailey et al., 2014; Appendix S3, available with the online version of this article): (a) cognitive or psychological outcomes (knowledge, self-efficacy, activation, and perceived susceptibility); (b) self-care outcomes (overall self-care behavior, diet, exercise, medication, problem-solving, glucose testing, and foot care); and (c) health outcomes (HbA1C, blood pressure, lipid profile, body mass index, body function, and distress).

Most studies measured only one or two outcome domains. Only four studies assessed all three domains in terms of how they were directly or indirectly influenced by the health-literacy-sensitive diabetes intervention (Hill-Briggs et al., 2011; Khan et al., 2011; Swavely et al., 2014; Wallace et al., 2010). Knowledge and HbA1C were the most frequently measured outcomes in eight and nine studies, respectively. After the interventions, six studies reported improved knowledge (Hill-Briggs et al., 2011; Kandula et al., 2009; Moussa et al., 2013; Negarandeh et al., 2013; Swavely et al., 2014; Wallace et al., 2009) and five studies reported enhanced HbA1C level (Cavanaugh et al., 2009; Hill-Briggs et al., 2011; Rothman, DeWalt et al., 2004; Rothman, Malone et al., 2004; Swavely et al., 2014).

Knowledge was measured at 3 months or less postintervention, except in two studies, which measured knowledge at 6 months postintervention (Gerber et al., 2005) or 12 months postintervention (Gerber et al., 2005; Hill-Briggs et al., 2011). HbA1C was assessed at 3–12 months’ follow-up. Six studies examined whether the interventions had differing effects between people with low and those with high literacy across the three outcome domains (Cavanaugh et al., 2009; Crowley et al., 2013; Gerber et al., 2005; Khan et al., 2011; Rothman, DeWalt et al., 2004; Rothman, Malone et al., 2004; Schillinger et al., 2009).

Strategies of Health-Literacy-Sensitive Diabetes Management Intervention

We identified a wide range of strategies for accommodating those with low health literacy in diabetes self-management interventions (Table 1). Most interventions utilized multiple strategies. To organize these strategies, we categorized them into four domains, which we adopted and modified from a previous study (DeWalt et al., 2010): (a) written communication (easy-to-read materials and effective use of health education); (b) spoken communication (clear communication, use of the teach-back method, and follow-up with patients); (c) empowerment (encouragement of questions, behavioral activation, action plans, and motivational interviewing); and (d) language or cultural consideration. We defined “spoken communication” as the use of oral communication during the patient–clinician interaction (DeWalt et al., 2010). When a multimedia platform with a simple and easy-to-use interface was used as an alternative to traditional educational methods, we categorized it as “easy-to-read material” and “effective use of health education methods” under “written communication” (DeWalt et al., 2010). Strategies to facilitate patients to take responsibility for their health care and to take care of themselves during diabetes management were categorized as “empowerment” (DeWalt et al., 2010). Addressing language and cultural differences in communication with patients from ethnic minority groups by language assistance, improvement of cross-cultural communication skills, or considerations of cultural beliefs and customs was categorized as “language or cultural consideration.”

The most commonly used domain for low health literacy was written communication. Eight of these studies developed easy-to-read materials to improve readability and understanding of written information, such as using easy language, relevant illustrations, and simple format (Cavanaugh et al., 2009; Gerber et al., 2005; Hill-Briggs et al., 2011; Kandula et al., 2009; Khan et al., 2011; Moussa et al., 2013; Negarandeh et al., 2013; Wallace et al., 2009). Four studies tested new educational materials using computer multimedia in conjunction with spoken instruction and video due to the limited ability of print materials to reach patients with low health literacy (Gerber et al., 2005; Kandula et al., 2009; Khan et al., 2011; Moussa et al., 2013). Using written communication strategies with computer multimedia improved knowledge (Kandula et al., 2009; Moussa et al., 2013) and perceived susceptibility (Gerber et al., 2005) but did not affect self-care or health outcomes (Gerber et al., 2005; Kandula et al., 2009; Khan et al., 2011; Moussa et al., 2013).

In terms of spoken communication strategies, five studies used the “clear communication” strategy, such as using common words, limiting content to 3–5 key points, repeating key points, and drawing pictures when speaking to patients (Cavanaugh et al., 2009; Negarandeh et al., 2013; Rothman, DeWalt et al., 2004; Rothman, Malone et al., 2004; Swavely et al., 2014). Four studies utilized the teach-back method to ensure that participants understood diabetes education (Negarandeh et al., 2013; Rothman, DeWalt et al., 2004; Rothman, Malone et al., 2004; Swavely et al., 2014). Follow-ups with patients were conducted in four studies through phone calls or in-person meetings to check changes or actions to ensure diabetes self-management (Rothman, DeWalt et al., 2004;
In this review, we identified a diverse range of strategies for accommodating patients with low health literacy in diabetes self-management interventions. These strategies fell into four domains: (a) written communication, (b) spoken communication, (c) empowerment, and (d) tailoring communication to patients’ language and cultural practices and beliefs.

The most commonly used strategy was developing easy-to-read materials as a form of written communication, in isolation or in combination with other strategies. In this review, all interventions using written communication as a main strategy were delivered through computer multimedia or web-based programs adapted for easy access and content. Written communication strategies were effective in improving some cognitive and psychological outcomes but not self-care or health status. This finding indicates that diabetes education programs utilizing multimedia devices are effective in improving knowledge in patients who have low health literacy within a short-term time period. However, in the long term, such programs are insufficient for producing change in health behavior or better health outcomes. Although patients with low health literacy showed a willingness to learn and use a computer to improve their diabetes knowledge and manage their diabetes (Moussa et al., 2013), without face-to-face interaction as an additional strategy, there may be limitations in achieving positive health outcomes on a long-term basis.

However, using at least one of the spoken communication strategies led to positive results on cognitive or psychological outcomes as well as self-care and health outcomes (Cavanaugh et al., 2009; Rothman, DeWalt et al., 2004; Rothman, Malone et al., 2004; Swavely et al., 2014; Wallace et al., 2009). This finding underscores the critical importance of oral communication strategies in interactions with patients with low health literacy for diabetes education. As shown in a recent qualitative study, even though diabetes educational materials are generally accompanied by easy-to-follow instructions or are used with educational technology, many challenges for improving health behavior remain, such as language discordance and lack of consideration of health beliefs (Mohan, Riley, Boyington, & Kripalani, 2013). Spoken communication centered on patients accommodating low health literacy may improve patients’ health through discussion about their illness experiences as well as agreements on treatment options regarding diabetes management (Stewart et al., 2000). To achieve the best health outcomes in diabetes self-management interventions, the routine use of spoken communication strategies, such as the teach-back method, clear communication, and follow-up with patients, is necessary.

Behavioral activation and action plans, both empowerment strategies, were shown to be effective in improving self-care behavior and glucose control in the intervention groups in this review (Rothman, DeWalt et al., 2004; Rothman, Malone et al., 2004; Swavely et al., 2014; Wallace et al., 2009). The studies using two intervention arms showed that the effectiveness of empowerment strategies was stronger when using a more intensive format, or with frequent contact with healthcare providers (Hill-Briggs et al., 2011; Schillinger et al., 2009).
2.1 Intervention effects for patients overall

Heterogeneity $Q = 34.6$, $df = 8$ ($p < .001$), $I^2 = 76.88$

2.2 Intervention effects for patients with low health literacy

Heterogeneity $Q = 10.49$, $df = 2$ ($p = .005$), $I^2 = 80.93$

2.3 Intervention effects for patients with high health literacy

Heterogeneity $Q = 22.94$, $df = 2$ ($p = .000$), $I^2 = 91.28$

Figure 2. Interventions effects on HbA1C level for the overall pool of patients (2.1), patients with low health literacy (2.2), and patients with high health literacy (2.3).

By focusing on patients’ actual behavior changes rather than on the ways of delivering information, empowerment strategies appeared to help patients successfully enact behavior change (Seligman et al., 2007). The repeated use of empowerment strategies might lead to more successful outcomes. More research is needed to understand the effects of diverse empowerment strategies on health outcomes through behavior change and identify the minimum intensity of interventions by mapping them to a behavioral theory, such as social cognitive theory (Seligman et al., 2007).
In the meta-analysis, the small significant reduction in HbA1C level suggests that multiple strategies for accommodating patients with low health literacy in diabetes management interventions successfully improves overall glycemic control in patients with diabetes. The multiple strategies used in these interventions, however, limited our ability to draw conclusions on which strategy is the most effective in improving health outcomes or reducing health disparities. We identified only one study that compared two types of educational strategy for patients with low health literacy—the pictorial image and teach-back methods—that showed similar effects on knowledge and self-care behavior, as compared to usual care (Negarandeh et al., 2013).

In the subgroup meta-analysis stratifying patients by health-literacy level, a significant moderate effect on HbA1C level was found only in people with low health literacy. This indicates that health-literacy-sensitive diabetes management interventions are more beneficial for such patients than for those with higher health literacy. The meta-analysis findings supported the results from another narrative systematic review indicating the effectiveness of diabetes interventions in reducing literacy-related differences in health outcomes (Bailey et al., 2014). However, interpretations of this finding must be made cautiously because the subgroup analysis was conducted with only three studies measuring differing intervention effects on HbA1C between patients with low and those with high health literacy (Gerber et al., 2005; Rothman, DeWalt et al., 2004; Rothman, Malone et al., 2004).

This review has several limitations. First, there are limitations derived from the characteristics of the selected studies for the current review. These limitations included nonconcealment of allocation in many RCTs, poor descriptions of the strategies accommodating low health literacy, use of multiple strategies without theoretical justification, which makes it difficult to separate their effects, and overall lack of analysis of intervention effects stratified by health-literacy level. Several studies did not recruit patients with diabetes based on the criterion of glucose control and health-literacy status, which might have influenced the validity of the findings. Second, our review excluded studies that did not measure health literacy directly, and we may have failed to identify interventions that could be advantageous to patients with low health literacy. Third, the meta-analysis was not possible for outcomes other than HbA1C because of the high variability in measurements of these outcomes.

In order to examine the effects of strategies for accommodating patients with low health literacy on health disparities, further research should stratify the effects by health-literacy level. Strategies for accommodating those with low health literacy are applicable as a universal precaution in healthcare practice. However, results stratified by health-literacy level would determine whether the intervention helped to reduce the differences in outcome associated with health-literacy status (Pignone et al., 2005). In addition, there must be more rigorous intervention studies that carefully specify the individual strategies for accommodating patients with low health literacy to identify which strategies are the most effective in obtaining positive health outcomes.

This review has important clinical implications for healthcare providers. Given the positive effect of health-literacy-sensitive interventions on glycemic control, healthcare providers should actively incorporate strategies for accommodating patients with low health literacy in diabetes self-management interventions. Healthcare providers might prioritize the implementation of spoken communication strategies if they have difficulty modifying their diabetes education with complex and lengthy strategies to accommodate patients with low health literacy. Afterwards, they can consider adding strategies such as written communication, empowerment, and language or cultural consideration.

The more-positive outcomes were associated with interventions that utilized strategies of spoken communication and empowerment as compared to multimedia interventions. The healthcare provider–patient relationship may be an important influence on patients’ health outcomes and needs to be taken into account in diabetes management interventions (Kaplan, Greenfield, & Ware, 1989). Thus, healthcare providers should consider utilizing interpersonal strategies for patients with low health literacy rather than relying on multimedia devices. Additional evidence from further research could facilitate the application of strategies for accommodating those with low health literacy in diabetes self-management interventions.

**CONCLUSIONS**

In this review, we identified various strategies for accommodating patients with low health literacy in diabetes self-management interventions. These strategies fell into the domains of written communication, spoken communication, empowerment, and language or cultural consideration. We found that, overall, health-literacy-sensitive diabetes management interventions were effective for improving glycemic control. Further research is necessary to identify key strategies for accommodating patients with low health literacy, and to test the effectiveness of these strategies stratifying patients on health-literacy level. Healthcare providers should consider active implementation of strategies for accommodating patients with low health literacy in diabetes self-management interventions in their clinical practice. *WVN*

**LINKING EVIDENCE TO ACTION**

- Healthcare providers should consider active implementation of strategies for accommodating patients with low health literacy in diabetes self-management interventions in their clinical practice.
Diabetes education programs utilizing multimedia devices, without face-to-face interaction as an additional strategy, might be insufficient to achieve positive health outcomes for patients with low health literacy on a long-term basis.

To achieve the best health outcomes in diabetes self-management interventions in patients with low health literacy, the routine use of spoken communication strategies is necessary.

Behavioral activation and action plans, both empowerment strategies, are effective in improving diabetic self-care behavior and glucose control in patients with low health literacy.

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References


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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article at the publisher’s web site:

**Appendix S1.** Characteristics of the included studies.

**Appendix S2.** Results of Mixed Methods Appraisal Tool (MMAT) quality rating.

**Appendix S3.** Summary of outcomes of health-literacy-sensitive interventions for diabetes management.
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