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A path model linking health literacy, medication self-efficacy, medication adherence, and glycemic control

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ABSTRACT

Objective: To investigate whether medication self-efficacy moderates or mediates the relationship between health literacy and medication adherence. To propose a path model that illustrates the interrelated relationship between health literacy, medication self-efficacy, medication adherence, and hemoglobin A1c (HbA1c).

Methods: This cross-sectional study was performed via a face-to-face survey. Factors that may influence medication adherence and HbA1c were identified from the literature review. One hundred and seventy-four participants included were ≥ 20 years old with diagnosed type 2 diabetes, understood English, and were prescribed at least one oral diabetes medicine. During clinic visits, a questionnaire was administered to evaluate health literacy, medication self-efficacy, and medication adherence. HbA1c values were obtained from electronic medical records. Path analyses were conducted for data analysis. **Results:** Medication self-efficacy mediated but did not moderate the relationship between numeracy and diabetes medication adherence. Participants with higher numeracy skills may develop a greater level of medication self-efficacy, which in turn may result in a higher level of diabetes medication adherence and a lower level of HbA1c.

Conclusion: Enhancing patients' medication self-efficacy and numeracy skills may be imperative in intervention programs to improve diabetes medication adherence.

Practice implications: An improvement in numeracy skills and medication self-efficacy is recommended to enhance diabetes medication adherence.

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1. Introduction

Diabetes was the 7th leading cause of death in the U.S in 2014, affecting at least 29.1 million people [1]. Diabetes care is so costly that approximately every \$1 in \$5 health care dollars in the U.S was spent on caring for patients with diagnosed diabetes [2]. Individuals with diabetes spend 2.3 times more in terms of health care expenditures than those without diabetes in the U.S [2]. Though the US Department of Health and Human Services has made much effort in preventing diabetes incidence and improving the prognosis of patients with diabetes, the cost of diabetes care has steadily risen over the past ten years [3].

The development of complications and high costs associated with diabetes comorbidities can be largely attributed to poor diabetes control [4]. Effective management of type 2 diabetes mellitus (T2DM) relies on a multifaceted effort, integrating a thoroughly modified lifestyle and tailored pharmacotherapy interventions [5]. The use of diabetes medications combined with strict medication adherence are important factors that contribute to achieving optimal glycemic control [6]. Prior research found that patients with T2DM compared to patients with other chronic diseases reported one of the lowest medication adherence rates at 31% [7]. Suboptimal adherence to medication regimens is associated with poor glycemic control as well as increased risks of hospitalization and mortality [4,8]. As such, non-adherence continues to be a central and prevalent barrier to achieving optimal health outcomes in the T2DM population [9].

Patients with diabetes require sufficient self-care skills to manage their disease, including meal planning, weight control, exercise adaptation, and medication use [10]. These skills depend on patients' abilities (e.g., health literacy) to collect, process, comprehend, and follow diabetes-specific information [10]. Also,

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these skills rely on how much confidence patients have in performing given tasks to attain better disease self-management [11,12]. Patients with diabetes who have higher level of health literacy, which comprises of a number of different skills such as document literacy (e.g., proficiency in searching and comprehending medical information) and numeracy skills (e.g., understanding and applying simple numerical concepts to interpret results from glucose meters), are likely to report sufficient knowledge about diabetes and better glycemic control [13–15]. Additionally, increased patient confidence in taking their diabetes medications is correlated with improved medication adherence and better glycemic control [16–18]. As such, behavioral models emphasize the importance of health literacy and self-efficacy in the self-management of patients with diabetes [19–22]. Patients with diabetes have to utilize these key skills in managing medication regimens and tailoring self-care tasks, such as blood glucose monitoring, laboratory data interpretation, dietary intake selection, and diabetes medication administration [19–22].

Despite the well-known direct relationship of medication adherence to health literacy and self-efficacy, there is limited research examining the exact pathway connecting health literacy, self-efficacy, medication adherence, and glycemic control [19,22–27]. The pathways through which these factors are related to one another and, in turn, influence the health behaviors of patients with diabetes remain unclear [22,24]. Studies based on the Theory of Planned Behavior (TPB) underscored that self-efficacy is key to making patients adhere to their medications [28,29]. In the TPB, self-efficacy is considered a type of perceived behavioral control, which is theorized to impact how an individual performs behaviors based on one's perception of the difficulty of tasks and how much control they have [30,31]. While self-efficacy is regarded as a critical component of diabetes care, we do not know if self-efficacy either moderates or mediates the relationship between health literacy, diabetes medication adherence, and glycemic control. On one hand, if self-efficacy moderates the aforementioned relationship between health literacy and medication adherence, the effect of self-efficacy on medication adherence depends on the level of health literacy [32,33]. Therefore, there is a need to identify patients' level of self-efficacy before any intervention is provided. Afterward, a tailored intervention should be developed and implemented accordingly to maximize its effect on medication adherence. On the other hand, if self-efficacy mediates the relationship between health literacy and medication adherence, patients would better adhere to their medications when they have a higher level of self-efficacy [32,33]. As a result, interventions could focus on improving self-efficacy.

Findings from recent diabetes studies regarding the relationship between health literacy, self-efficacy, and health outcomes have produced inconsistent results [21,22,26,27]. Bains et al. explored the association of health literacy, diabetes knowledge, self-care behaviors, and glycemic control in patients with T2DM [34]. The authors found that health literacy was only associated with diabetes knowledge, not correlated with either diabetes medication adherence or hemoglobin A1c (HbA1c) [34]. Osborn et al., recruited patients with diabetes to investigate the relationship among health literacy, numeracy, diabetes self-efficacy, and HbA1c [21]. The results showed that health literacy and numeracy were both associated with greater diabetes self-efficacy, and greater diabetes self-efficacy was associated with lower HbA1c levels [21]. However, Osborn et al. used a scale of general self-efficacy to predict HbA1c levels. The use of this scale is limiting because self-efficacy is domain-specific and a general self-efficacy scale may not adequately conceptualize the psychological construct central to patients' medication adherence [35]. Given that HbA1c levels could be influenced by various diabetes self-care behaviors (e.g., medication use, blood sugar monitoring, foot care, dietary restriction, and physical exercise), it is imperative to

measure the level of self-efficacy of a particular self-care behavior instead of a general one.

Following this rationale, our study focused on medication adherence in patients with diabetes. To specifically predict medication adherence, we measured self-efficacy pertaining to medication adherence. In addition, perhaps what was missing in Bains et al.'s research was a certain psychosocial factor (i.e., self-efficacy), which was directly related to medication adherence. It is possible that the pathway connecting sociodemographic factors, health literacy, social cognitive factors, self-care behaviors, and health outcomes was obscured, which may have impeded the understanding of mechanisms linking health literacy to diabetes outcomes [22]. To address the gap in the current literature, our study included all four of these factors (i.e., health literacy, self-efficacy, medication adherence, and glycemic control) in the research to investigate a path model that connects these factors in patients with T2DM.

This study aimed to examine whether patients' medication self-efficacy moderates the relationship between health literacy (including literacy versus numeracy) and diabetes medication adherence. Afterward, we examined whether a path model that links health literacy, medication self-efficacy, medication adherence, and glycemic control fits the data. These study findings may provide insight into the mechanism that links sociodemographic factors, health literacy, medication self-efficacy, medication adherence, and health outcomes among patients with T2DM. Understanding the role of medication self-efficacy and how it influences patients' diabetes self-care behaviors may help health care professionals provide appropriately tailored interventions to improve patients' medication adherence and glycemic outcomes.

The conceptual framework used in this study was adapted from the theoretical framework developed by Bailey et al., which illustrates the possible mechanism between health literacy, diabetes-related behaviors, and health outcomes, while accounting for patients' sociodemographic characteristics [22]. Health literacy was divided into several subdomains, which was an extension of the single-domain framework by Paasche-Orlow et al. [24]. This theoretical framework comprises of six constructs including sociodemographic background, health literacy, social cognitive factors, self-care behaviors, intermediate outcomes, and distal diabetes-related health outcomes [22]. In this study, we measured the first five constructs developed by Bailey et al. (Fig. 1). All of the covariates relevant to outcome variables were chosen based on literature review, including sociodemographic background, diabetes- and health-related factors, health literacy, and self-efficacy [17,19–24,26,36]. Fig. 1 delineates the conceptual framework of the study. We hypothesized that patient sociodemographic factors are associated with health literacy, which has several subdomains and is presumed to be associated with social cognitive constructs, such as self-efficacy [37,38]. These constructs are in turn linked to self-management behaviors for diabetes and an intermediate diabetes-related health outcome (i.e., HbA1c). In this study, patient sociodemographic factors included age, gender, education level, and race/ethnicity. Health literacy was composed of two subdomains: document literacy and numeracy. The social cognitive construct was represented by participants' medication self-efficacy. Medication adherence and HbA1c level represented patient self-management behavior and intermediate outcomes related to diabetes care, as proposed by Bailey et al. [22].

2. Methods

This cross-sectional study using a face-to-face survey was conducted at two family medicine clinics in a Midwestern state from March to August 2016. Study procedures were approved by the Health Sciences Institutional Review Board at the University of Wisconsin-Madison.

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