

# Relationships Among Health Literacy, Self-Efficacy, Self-Management, and HbA1c Levels in Older Adults with Diabetes in South Korea: A Cross-Sectional Study

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**Purpose:** This study investigated the levels of health literacy, self-efficacy, self-management, and glycated hemoglobin (HbA1c) levels in older adults with diabetes to identify the relationships between these factors.

**Patients and Methods:** This descriptive study consisted of 162 elderly outpatients with diabetes at the departments of endocrinology of three general hospitals in J Province, South Korea. Data were collected using a structured self-report questionnaire between October 21 and November 16, 2019. The data were analyzed using SPSS/WIN version 23.0.

**Results:** Health literacy was positively correlated with self-efficacy ( $rs=0.64$ ,  $p<0.001$ ) and self-management ( $rs=0.44$ ,  $p<0.001$ ) and significantly negatively correlated with HbA1c levels ( $rs=-.42$ ,  $p<0.001$ ). Self-efficacy showed a significantly positive correlation with self-management ( $rs=0.65$ ,  $p<0.001$ ) and a significantly negative correlation with HbA1c levels ( $rs=-.30$ ,  $p<0.001$ ). Moreover, a significant negative correlation was found between self-management and HbA1c levels ( $rs=-.35$ ,  $p<0.001$ ). Hence, health literacy and patient self-management levels were associated with HbA1c levels in older adults with DM.

**Conclusion:** Health education for community-dwelling older adults with diabetes should consider their health literacy levels. Moreover, measures to improve self-management abilities may be needed when developing educational programs for older adults with diabetes.

**Keywords:** diabetes management, health education, prevention, public health, Korea, risk factors

## Introduction

As the global population is growing older, there is a concurrent escalation in the prevalence of diabetes mellitus (DM). In 2019, it was estimated that 135.6 million people aged 65–99, or 19.3% of that age group, were living with DM. It is projected that the number of individuals in the 65–99 age group with DM will reach 195.2 million by 2030 and 276.2 million by 2045.<sup>1</sup> Older adults with DM have higher rates of premature death, functional disability, muscle loss, and comorbidities, such as hypertension, stroke, and cognitive impairment, than those without DM.<sup>2,3</sup> Moreover, for those with diabetes aged  $\geq 65$  years, their per capita annual healthcare expenditures are approximately twice as much as that of any other age group beyond 18 years old.<sup>4</sup> Therefore, careful attention is required to manage DM in the geriatric population as it can result in functional impairments or consequences and increased social burden if not adequately managed.

Although DM is difficult to cure owing to the characteristics of the disease, it is possible to prevent acute and chronic complications and improve quality of life through self-management in daily life.<sup>5</sup> For efficient self-management of DM, the American Association of Diabetes Educators (AADE)<sup>6</sup> has suggested knowledge, skills, self-efficacy, motivation,

problem-solving ability, and coping skills as necessary evaluation variables. Self-efficacy, a major determinant of behavioral change, directly reinforces the implementation of self-management.<sup>7–10</sup> However, previous studies targeting adults have shown contradictory results regarding the effect of self-efficacy on glycosylated hemoglobin (HbA1c) levels, the final outcome indicator of DM; that is, some studies have shown that self-efficacy has an indirect effect on HbA1c levels through self-care in the adult or older adult population<sup>7–9,11</sup> and other studies have shown that it does not.<sup>12,13</sup>

Recently, as health literacy has been shown to be a major factor affecting chronic disease management,<sup>14,15</sup> related research is actively being conducted worldwide. Health literacy refers to an individual's ability to obtain, process, and understand the basic health information and services necessary to make appropriate health-related decisions independently.<sup>16</sup> In diabetes research, it was found that health literacy directly and indirectly affects self-management through self-efficacy among adults with DM;<sup>17</sup> hence, it is a major factor influencing health outcomes.<sup>18–20</sup> However, previous studies identifying the relationship between health literacy and HbA1c levels show conflicting results; that is, several studies, including research conducted on 414 patients aged 60 and above in Thailand, have reported that health literacy and HbA1c levels are significantly correlated,<sup>21–23</sup> whereas others, including a study conducted on 499 patients in Germany,<sup>24</sup> have shown that they are not.<sup>25–27</sup>

In South Korea, the number of studies on health literacy has increased since 2012.<sup>28</sup> However, compared with other countries, research has been limited mainly to surveys measuring health literacy<sup>29,30</sup> and conceptual analysis<sup>31</sup> and has aimed to investigate the relationship between variables that could affect health.<sup>32,33</sup> Furthermore, to the best of our knowledge, there was only one study<sup>34</sup> on the relationship between HbA1c levels and health literacy targeting adults aged >30 years, and no study targeting only the elderly population in South Korea. Therefore, this study aimed to assess health literacy, self-efficacy, self-management, and levels of HbA1c in older adults with DM and to identify the relationships among these variables. We expect this study to contribute foundational information for exploring effective self-management strategies for older adults with DM.

## Materials and Methods

### Study Design and Participants

This cross-sectional study aimed to identify the correlation between health literacy, self-efficacy, self-management, and HbA1c levels in older adults with DM and identify the factors associated with HbA1c levels. The inclusion criteria were adults aged  $\geq 60$  years who had been diagnosed with type 2 DM for at least 6 months, had no history of dementia or other mental illness, voluntarily consented to participate in the study, and understood and responded to the contents of the questionnaire. The minimum sample size required was calculated to be 157 people using the G\*power 3.1.9.2 program to perform multiple regression analysis with a medium effect size of 0.15, a significance level of 0.05, a power ( $1 - \beta$ ) of 0.85, and 16 independent variables.

### Measurements

#### General Participant Characteristics

General participant characteristics included age (continuous), sex (bivariate), marital status as “yes” (current marital status) or “no” (eg, divorced, widowed, single), number of family members, monthly household income, education level (stratified into uneducated, elementary school, middle school, high school, and university graduation), usual social participation activities (“yes” or “no”), number of participating activities (eg, religious, volunteer, hobbies, senior citizens association), duration of DM (continuous). The calculation of the number of diseases used the following conditions: hypertension, diabetes, cancer, arthritis, and rheumatism, as well as chronic lung, liver, heart, cerebrovascular, and psychiatric illnesses. The categories for the degree of perceived social support are “lack”, “usually”, and “many”.

### Health Literacy

Among the 58 items of the Korean Health Literacy Scale for Diabetes Mellitus (KHLS-DM),<sup>35</sup> 30 items in the subjective evaluation domain were used. This instrument can be effectively utilized to identify individuals with low health literacy levels. In the subjective evaluation domain, scores were converted into 0 points for diabetes-related terms “I don't know” and “I've heard of them, but I don't know”, and 1 point for “I know roughly what they mean” and “I know exactly”.

Participants with a score from 0 to 11 points or less were classified as the low health literacy group, and those with scores from 12 to 30 points were classified as the appropriate health literacy group. The reliability at the time of development was a Cronbach's alpha of 0.83. However, owing to the dichotomous nature of the data, we employed the Kuder-Richardson 20 method to assess internal consistency, revealing a value of 0.95.

## Self-Efficacy

Self-efficacy was measured using the Diabetes Management Self-Efficacy Scale for Older Adults (DMSES-O),<sup>36</sup> which evaluated appropriate exercise (2 items), proper diet (2 items), blood sugar check, and problem solving for low blood sugar (4 items), problem solving for hyperglycemia (2 items), coping with medication and psychological difficulties (3 items), and treatment understanding for the prevention of complications (4 items). Each item was scored on a 4-point scale, with a minimum score of 17 points and a maximum score of 68 points. Higher scores indicated higher self-efficacy. The reliability at the time of development was a Cronbach's alpha of 0.84, and in this study, this was 0.94.

## Self-Management

Self-management was measured using the Korean version of the Summary of Diabetes Self-Management Activities Questionnaire (SDSCA).<sup>37</sup> This Korean version of the SDSCA<sup>38</sup> consists of 17 items, including diet (5 items), exercise (2 items), medication (3 items), blood sugar test (2 items), and foot care (5 items). In this study, 16 questions were used in the final analysis after excluding questions related to insulin self-injection, as insulin was not administered to some study participants. The evaluation method selects the number of days of performing the relevant action for each question from zero to seven, with a minimum score of 0 and a maximum score of 112 points. Higher scores indicated better self-management. At the time of the development of the Korean version of SDSCA, the reliability of Cronbach's alpha was 0.77, and in this study, this was 0.76.

## HbA1c Levels

HbA1c levels were measured using high-performance liquid chromatography certified by the International HbA1c Measurement Standardization Program. We collected the most recent measurements of HbA1c levels within the last 6 months from the medical records. When diagnosing diabetes, HbA1c levels of 6.5% or higher are considered.<sup>39</sup> We classified participants with HbA1c levels below 6.5% as the HbA1c-regulated below the DM diagnostic criterion group (labeled as the "normal HbA1c group" in this study) and those with levels above 6.5% as the increased HbA1c group.

## Data Collection

This study was approved by the institutional review board of the researchers' affiliated universities (approval number: WS-2019-11). It was performed in accordance with IRB regulations according to the Declaration of Helsinki. Data were collected from October 21 to November 16, 2019, at the endocrinology outpatient departments of three general hospitals in J province, South Korea. All three hospitals where the participants were recruited have a diabetes specialist. The first author and three research assistants explained the purpose and method of the research, protection of personal information, and the possibility of giving up, guaranteeing anonymity, storage, and disposal of data, after which informed consent was obtained from all participants. Participants wrote their responses directly on the questionnaire, or the researcher wrote them down after the participants responded verbally. It took about 20 to 25 min to complete the questionnaire. Surveys were distributed to 175 individuals, and out of the 175 collected, 162 (collection rate, 92.6%) were utilized for the final analysis after excluding 13 questionnaires with missing responses.

## Data Analysis

The collected data were analyzed using SPSS/WIN version 23.0 (Armonk, NY: IBM Corp). Descriptive statistics were used for the participants' general characteristics, health literacy, self-efficacy, self-management, and HbA1c levels.

Before conducting data analysis, a Shapiro-Wilk test was performed to assess the normality of variable values. The results indicated that the assumption of normal distribution was not met. Therefore, to analyze the differences in HbA1c levels according to the participants' general characteristics, the data were analyzed using either the Mann-Whitney *U*-test or Kruskal-Wallis test, with the post hoc test being conducted through the Mann-Whitney *U*-test. To control for the increased risk of Type I errors

associated with multiple comparisons, a Bonferroni correction was applied. The adjusted alpha level for significance was set at 0.05 divided by the number of comparison groups. Moreover, Spearman's rank correlation analysis was used to determine the correlation between the participants' health literacy, self-efficacy, self-management, and HbA1c levels.

As the final step of the analysis, we sought to analyze the variable, HgA1c level, by categorizing it into two groups: the normal HbA1c group and the increased HbA1c group. To examine the relationships between HbA1c level and other variables, we applied the binary logistic regression analysis method.

## Results

### General Participant Characteristics

The age distribution was 60–69 years old with 67 (41.4%), followed by 70–79 years old with 53 (32.7%) and over 80 years old with 42 (25.9%). The participants included 100 (61.7%) females. Most participants were married ( $n = 100$ , 61.7%). Regarding the number of family members living together, most lived alone (58 [35.8%]), followed by 55 (34.0%) who lived with only one family member. Most participants had a monthly household income of less than 1 million won (100 [61.7%]). Regarding education level, most were elementary school graduates (56 [34.6%]). Regarding participation in social activities, 88 (54.3%) participants responded, “I don't usually participate in any activities”, and 74 (45.7%) responded that they were “participating in activities”, of whom 59 (79.7%) responded that the number of activities was one.

DM duration in the participants was predominantly less than 10 years ( $n = 62$  [38.3%]). The next highest group had a duration of 10 to less than 20 years ( $n = 52$  [32.1%]), followed by those with a duration of 20 years or more ( $n = 48$  [29.6%]). Furthermore, 60 participants (37.0%) responded that they had been diagnosed with and are currently undergoing treatment for two conditions, followed by those with three diseases, which was the next highest ( $n = 50$  [30.9%]). Regarding the perceived degree of social support, 94 (58.0%) participants rated “usually” as the highest (Table 1).

**Table 1** General Participant Characteristics ( $n = 162$ )

Variables	Categories	Total n (%)
Sex	Male	62 (38.3)
	Female	100 (61.7)
Age (years)	60–69	67 (41.4)
	70–79	53 (32.7)
	≥80	42 (25.9)
Marital status	Yes	100 (61.7)
	No	62 (38.3)
Number of family member	0 (Living alone)	58 (35.8)
	1	55 (34.0)
	2	26 (16.0)
	≥3	23 (14.2)
Monthly household income (10,000 won)	<100	100 (61.7)
	100–299	44 (27.2)
	≥300	18 (11.1)
Education level	Uneducated	22 (13.6)
	Elementary school	56 (34.6)
	Middle school	35 (21.6)
	High school	40 (24.7)
	≥University	9 (5.6)
Usual social participation activities	No	88 (54.3)
	Yes	74 (45.7)

(Continued)

**Table 1** (Continued).

Variables	Categories	Total n (%)
Number of participating activities	1	59 (79.7)
	2	11 (14.9)
	≥3	4 (5.4)
Duration of DM (years)	<10	62 (38.3)
	10~19	52 (32.1)
	≥20	48 (29.6)
Number of diseases	1	34 (21.0)
	2	60 (37.0)
	3	50 (30.9)
	4	13 (8.0)
	≥5	5 (3.1)
Perceived Social Support	Lack	35 (21.6)
	Usually	94 (58.0)
	Many	33 (20.4)

## Health Literacy, Self-Efficacy, Self-Management, and HbA1c Levels of the Participants

The average health literacy and self-efficacy scores were  $11.27 \pm 8.44$  and  $45.46 \pm 12.79$ , respectively. The average level of self-management was  $60.56 \pm 18.06$  points.

The average HbA1c level of the participants was  $7.42 \pm 1.61\%$ . The HbA1c level was less than 6.5% in 41 participants (25.3%) who had adequate blood sugar control; however, 121 participants (74.7%) had HbA1c levels more than 6.5% and poor glycemic control (Table 2).

## HbA1c Levels According to the General Participant Characteristics

There was a statistically significant difference in HbA1c levels according to monthly household income ( $\chi^2=8.68$ ,  $p=0.013$ ) and whether or not participants usually participated in social activities ( $Z=-2.33$ ,  $p=0.019$ ). The HbA1c level of the group with a total monthly income of 3 million won, or more ( $73.44 \pm 17.30$ ) was lower than that of the group with less than 1 million won ( $7.50 \pm 1.62$ ) and 1 million to 2.99 million won ( $7.58 \pm 1.63$ ). The HbA1c level of the group with social participation ( $7.20 \pm 1.66$ ) was lower than that of the group without social participation ( $7.61 \pm 1.56$ ) (Table 3).

**Table 2** Health Literacy, Self-Efficacy, Self-Management, and HbA1c Levels of the Participants (n=162)

Variables	Categories	Mean±SD	Possible range	Total n (%)
Health literacy	Lower group (0~11)	4.87±3.03	0~30	92 (56.8)
	Normal group (12~30)	19.67±5.27		70 (43.2)
	Total	11.27±8.44		162 (100)
Self-Efficacy		45.46±12.79	17~68	
Self-management		60.56±18.06	0~112	
HbA1c	<6.5%	5.90±0.46		41 (25.3)
	≥6.5%	7.94±1.54		121 (74.7)
	Total	7.42±1.61		162 (100)

**Table 3** HbA1c Levels According to the General Participant Characteristics (n=162)

Variables	Categories (n)	Mean±SD	Z/ $\chi^2$ (p)
Sex	Male (62) Female (100)	7.47±1.81 7.39±1.48	-0.32 (0.754)
Age (years)	60~69 (67) 70~79 (53) ≥80 (42)	7.27±1.39 7.52±1.88 7.54±1.59	0.88 (0.643)
Marital status	Yes (100) No (62)	7.48±1.61 7.32±1.81	1.27 (0.529)
Number of family member	0 (Living alone) (58) 1 (55) 2 (26) ≥3 (23)	7.60±1.74 7.64±1.79 6.99±1.25 6.96±0.95	3.83 (0.280)
Monthly household Income (10,000 won)†	<100 (100)a 100~299 (44)b ≥300 (18)c	7.50±1.62 7.58±1.63 6.62±1.36	8.68 (0.013) a,b>c
Education level	None (22) Elementary school graduation (56) Middle school graduation (35) High school graduation (40) ≥University (9)	7.84±1.81 7.74±1.88 7.28±1.29 6.92±1.21 7.19±1.63	6.93 (0.140)
Usual social participation activities	No (88) Yes (74)	7.61±1.56 7.20±1.66	-2.33 (0.019)
Number of participating activities	1 (59) 2 (11) ≥3 (4)	7.20±1.73 7.34±1.52 6.75±0.89	0.21 (0.902)
Duration of DM(years)	<10 (62) 10~19 (52) ≥20 (48)	7.53±1.71 7.24±1.52 7.49±1.59	1.22 (0.543)
Number of diseases	1 (34) 2 (60) 3 (50) 4 (13) ≥5 (5)	7.50±1.68 7.43±1.57 7.32±1.67 7.40±1.23 7.84±2.32	0.49 (0.975)
Perceived Social Support	Lack (35) Usually (94) Many (33)	7.59±1.90 7.36±1.57 7.42±1.41	0.14 (0.931)

Note: †Mann-Whitney U-test used to analyse post hoc test.

## Correlation Between Health Literacy, Self-Efficacy, Self-Management, and HbA1c Levels

The participants' health literacy was significantly positively correlated with self-efficacy ( $r_s=0.64$ ,  $p<0.001$ ) and self-management ( $r_s=0.44$ ,  $p<0.001$ ). However, participants' health literacy was found to have a significant negative correlation with HbA1c levels ( $r_s=-.42$ ,  $p<.001$ ).

There was a significant positive correlation between self-efficacy and self-management ( $r_s=0.65$ ,  $p<0.001$ ) and a significant negative correlation between self-efficacy and HbA1c levels ( $r_s=-.30$ ,  $p<0.001$ ). Moreover, self-management and HbA1c levels ( $r_s=-.35$ ,  $p<0.001$ ) showed a significant negative correlation (Table 4).

**Table 4** Correlation Between Health Literacy, Self-Efficacy, Self-Management, and HbA1c Levels (n=162)

Variables	Health Literacy rs(p)	Self-Efficacy rs(p)	Self-Management rs(p)	HbA1c rs(p)
Health literacy	1.00			
Self-Efficacy	0.64 (<.001)	1.00		
Self-management	0.44 (<.001)	0.65 (<.001)	1.00	
HbA1c	-0.42 (<.001)	-0.30 (<.001)	-0.35 (<.001)	1.00

**Note:** Correlation analysis using Spearman's rank.

## Factors Associated with HbA1c Levels

To analyze factors associated with HbA1c levels, we conducted an analysis, revealing a statistically significant difference in HbA1c levels based on monthly household income and whether or not participants usually participated in social activities. We considered health literacy, self-efficacy, and self-management as independent variables, with HbA1c levels as the dependent variable, uncovering significant correlations. The dependent variable, the level of HbA1c, was categorized using a threshold of 6.5%. Individuals with HbA1c levels below 6.5% were classified into the normal HbA1c group, while those with levels equal to or above 6.5% were categorized into the increased HbA1c group.

Health literacy was found to be associated with HbA1c levels ( $p < 0.001$ ); the higher the level of health literacy, the higher the probability of belonging to the normal HbA1c group ( $B = 0.11$ ). If the health literacy level increased by 1 point, the probability of belonging to the normal HbA1c group increased by 1.12 times compared with the probability of belonging to the increased HbA1c group ( $OR = 1.12$ , 95%  $CI = 1.05 \sim 1.18$ ). Self-efficacy was not associated with HbA1c levels ( $p = 0.373$ ). Self-management was shown to be associated with HbA1c levels ( $p = 0.012$ ); the higher the level of self-management, the higher the probability of belonging to the normal HbA1c group ( $B = 0.04$ ). When the level of self-management increased by 1 point, the probability of belonging to the normal HbA1c group increased by 1.04 times more than the probability of belonging to the increased HbA1c group ( $OR = 1.04$ , 95%  $CI = 1.01 \sim 1.07$ ). Monthly household income and current level of social participation were not associated with HbA1c levels ( $p = 0.670$  and  $p = 0.666$ , respectively).

Hence, as the health literacy and DM self-management levels of the older adults with DM increased, the probability of belonging to the normal HbA1c group was significantly higher than that of the increased HbA1c group (Table 5).

## Discussion

This study investigated health literacy, self-efficacy, self-management, and HbA1c levels in older adults with DM and sought to identify the relationship between them and the factors associated with HbA1c levels.

**Table 5** Factors Associated with HbA1c Levels (n=162)

Variables	B	SE	p	OR	95% CI
Health literacy (ref. Lower group)	0.11	0.03	<0.001	1.12	1.05~1.18
Self-Efficacy (ref. None)	-0.02	0.03	0.373	0.98	0.93~10.3
Self-management (ref. None)	0.04	0.02	0.012	1.04	1.01~1.07
Monthly household income (ref. <100, 100~200)(10,000 won)	-0.14	0.32	0.670	0.87	0.47~1.63
Usual social participation activities (ref. no)	-0.19	0.45	0.666	0.82	0.34~1.98

**Notes:** Dummy variable reference was normal HbA1c group=1, Increased HbA1c group=0.

**Abbreviations:** SE, Standard error; OR, Odds ratio; CI, Confidence interval.

As seen in Table 2, we found that 56.8% of participants had low health literacy levels. Similarly, previous studies<sup>33,40</sup> on older adults have also shown that the level of health literacy of older adults living in the community is relatively low. Hence, health literacy should be assessed when conducting health management education for this population, along with the provision of appropriate education.

The participant's ability to use health literacy showed a significant positive correlation with self-efficacy and self-management (Table 4). This indicates that higher health literacy is associated with higher levels of self-efficacy and self-management. Moreover, similar to previous studies,<sup>21–23</sup> there was a significant negative correlation between the ability to use health literacy and HbA1c level, showing a close relationship between these two variables in patients with DM. Our results indicated that self-efficacy was associated with a level of diabetes self-management (Table 4). Therefore, for individuals with diabetes, it is crucial to provide methods such as dietary guidance, exercise recommendations, information on adequate rest, as well as professional counseling, and ongoing support from family or healthcare professionals to enhance their self-efficacy and self-management skills. Self-efficacy and self-management were found to have a significant negative correlation with HbA1c levels (Table 4), supporting the results of previous studies that self-efficacy directly strengthens self-management abilities, consequently affecting HbA1c levels.<sup>41</sup> Therefore, when developing an educational program for older adults with DM, it is essential to devise methods to improve their self-efficacy and self-management abilities, particularly when HbA1c levels are high.

In this study, health literacy and self-management were associated with HbA1c levels in older adults with DM (Table 5). The higher the level of health literacy and diabetes self-management, the higher the probability of belonging to the normal HbA1c group than the increased HbA1c group. This supports previous studies showing that good self-management<sup>42</sup> and better health literacy lower HbA1c levels.<sup>21–23</sup> Most older adults with DM in the community have two or more diseases but are vulnerable in terms of health literacy and self-management and belong to the representative vulnerable class with low income and education, which can further worsen their health condition. Therefore, it is necessary to secure social networks that can provide interest and comprehensive support to vulnerable groups. Helping vulnerable older adults self-manage through mentoring on social networks may have a positive effect on blood sugar control. Our results show significant differences in the level of health literacy, self-efficacy, and self-management according to the participant's social activity participation, number of social participation activities, and perceived social support. Those who participated in social activities had higher levels of health literacy, self-efficacy, and self-management than those who did not. Similarly, the higher the number of social participation activities, the higher the health literacy, self-efficacy, and self-management abilities. This implies that the more active the social activities there are, the more health literacy levels can be improved by sharing health information among the participating groups. In addition, the higher the level of perceived social support, the higher the levels of health literacy, self-efficacy, and self-management. Hence, to improve the health literacy, self-efficacy, and self-management of seniors in the community, it may be necessary to promote social networks. By mentoring vulnerable older adults with DM, their level of perceived social support may increase, ultimately having a positive effect on blood sugar control. However, there was no significant relationship between the number of participants with social activity and perceived social support with HbA1c levels. However, there was a significant difference in the presence or absence of social participation activities. This differs from the study by Oh et al<sup>42</sup> that identified perceived social support as a factor associated with HbA1c levels. Therefore, there is a need to conduct repeated research using a precise tool that can accurately measure the degree of social support rather than a simple questionnaire. The use of a communication strategy to deliver medical information to patients with low health literacy by having them repeat what they understood when the medical professional explained it to them resulted in improved medication compliance.<sup>5,20</sup> Therefore, a strategy is required to provide a level-specific approach using medical information delivery methods for individuals with low health literacy. In addition, by utilizing social networks, we may increase the level of health literacy when delivering medical information. There is a need to find ways to compensate for low health literacy by presenting it using pictures or describing or explaining it in layman's terms rather than using technical terminology.

This study had several limitations. First, as we could not use both subjective and objective evaluation domains to measure health literacy, further studies are required to investigate the relationship between health literacy and HbA1c levels by measuring both domains. Second, as this study was conducted in one province, the results may not be

generalizable to all older adults with DM. Hence, further multi-center studies are required to improve the health indicators of older adults with DM who visit university hospital clinics or public health centers. Lastly, there is a limitation that HbA1c was not measured at the same time point as the other parameters.

## Conclusions

This study showed that health literacy and self-management were associated with HbA1c levels in older adults with DM. Therefore, it may be necessary to secure social networks to improve the health literacy and self-management of community-dwelling older adults with DM and develop and apply customized programs that can enhance health literacy and self-management. Moreover, the provision of equitable medical services to older adults with DM who are vulnerable to health literacy and self-management is required. Health education programs considering health literacy should be developed, and health education should be appropriate to the health literacy level of the individual.

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