



The impact of health literacy interventions on glycemic control and self-management outcomes among type 2 diabetes mellitus: A systematic review

Jamila Butayeva¹ | Zubair Ahmed Ratan¹ | Sue Downie² |
Hassan Hosseinzadeh¹

¹School of Health & Society, Faculty of the Arts, Social Sciences and Humanities, University of Wollongong, Wollongong, New South Wales, Australia

²Discipline of Medical and Exercise Science, Faculty of Science, Medicine and Health, School of Medicine, University of Wollongong, Wollongong, New South Wales, Australia

Correspondence

Hassan Hosseinzadeh, 1 Northfield AVE, Gwynneville New South Wales 2500, Wollongong, Australia.
Email: hassanh@uow.edu.au

Abstract

Diabetes imposes an increasing health and economic burden on individuals living with it and their societies worldwide. Glycemic control is necessary to reduce morbidity and mortality of type 2 diabetes mellitus (T2DM). Self-management is the primary tool for managing diabetes. Health literacy (HL) is the primary driver of self-management activities. The aim of this review is to evaluate the impact of HL interventions on glycemic control and self-management outcomes among T2DM. MEDLINE, CINAHL, PubMed, Cochrane, Scopus, and Web of Science were searched for eligible papers. Fifteen randomized controlled trials published in English between 1997 and 2021, used HL-driven intervention, and measured the level of glycohemoglobin A1c (HbA1c) and self-management of T2DM patients were included in this review. The findings showed that HL-driven intervention had a positive impact on glycemic control and improved self-management behaviors. The level of glycemic control and self-management skills were improved through individual and telephone-based intervention respectively. Community worker-led interventions were effective in improvements in diabetes knowledge and self-care behaviors; however, nurse-led interventions were effective in glycemic control. Better glycemic control is achieved in hospital settings compared to outpatient settings. HL interventions yielded better improvement in self-management among people with longer diabetes duration (more than 7 years). It was possible to achieve a large reduction in HbA1c level after a 3-month intervention in hospital settings. HL-driven interventions are effective in glycemic and diabetes self-management outcomes.

KEYWORDS

diabetes mellitus type 2, glucose control and clinical trials, health literacy, self-management

Highlights

- Health literacy (H)L-driven interventions were effective in controlling glyce-mic levels and improving diabetes self-management outcomes.

This is an open access article under the terms of the [Creative Commons Attribution](https://creativecommons.org/licenses/by/4.0/) License, which permits use, distribution and reproduction in any medium, provided the original work is properly cited.

© 2023 The Authors. *Journal of Diabetes* published by Ruijin Hospital, Shanghai Jiaotong University School of Medicine and John Wiley & Sons Australia, Ltd.



- The level of glycemic control and self-management skills were improved better through individual and telephone-based intervention, respectively, in comparing group intervention.
- Community worker led interventions were effective in improvements in diabetes knowledge and self-care behaviors; however, nurse-led interventions were more effective in glycemic control.
- Better glycemic control was achieved in hospital settings compared with outpatient settings.
- HL interventions yielded better improvement in self-management among people with a longer diabetes duration (more than 7 years) than those with short duration of diabetes.
- It was possible to achieve a significant reduction in HbA1c level after a 3-month intervention in hospital settings.

1 | INTRODUCTION

Diabetes imposes an increasing health and economic burden on individuals living with it and for their societies worldwide. There were 537 million people living with all types of diabetes in 2021 and this number is predicted to increase to 643 million and 783 million by 2030 and 2045 respectively.¹ Type 2 diabetes mellitus (T2DM), which accounts for 98.3% of diabetes cases,² is a complex metabolic disorder characterized by insulin resistance and pancreatic beta-cell dysfunction.³ Hyperglycemia caused by T2DM often leads to various microvascular (eg, retinopathy, neuropathy, nephropathy) and macrovascular (coronary artery disease, cerebrovascular disease) complications.⁴ Diabetes is a global health concern that has a significant impact on society and the economy. It results in increased medical expenses, premature death, decreased productivity, and lower quality of life.⁵ According to the American Diabetes Association, the overall expenses associated with diabetes have risen from \$245 billion in 2012 to \$327 billion in 2017, representing a 26% increase over a five-year period. Individuals with diabetes have medical expenditures that are roughly twice as high as those without diabetes.⁶ In 2021, diabetes resulted in health expenditures of at least US\$966 billion globally, reflecting a 316% increase over the last 15 years.¹ Complications related to diabetes in the lower extremities are a significant and expanding source of disability across the globe.⁷

In addition to the morbidity of diabetes it is one of the leading causes of mortality worldwide; for instance, globally, there was a 5% increase in premature mortality due to diabetes between 2000 and 2016.⁸ The number of deaths worldwide related to diabetes has risen sharply from 1.5 million in 2012⁹ to 6.7 million in 2021.¹

Glycemic control is necessary to reduce morbidity and mortality of T2DM. According to a diabetes control and complications trial, normalization glycohemoglobin A1c (HbA1c < 7%) is associated with prevention of diabetes complications such as neuropathy, retinopathy, and nephropathy.¹⁰ Each 1% reduction in HbA1c decreases the risk of microvascular complications by 37%, deaths related to diabetes by 21% and myocardial infarction by 14%.¹¹ Reducing the HbA1c level by 1% is associated with a 13% decrease in diabetes-related total health care costs.¹² Glycemic control is also the most important behavioral and therapeutic goal in diabetes care.¹³ Self-management is the primary tool for managing diabetes¹⁴ and the aim of diabetes self-management is to control blood glucose and reduce the risk of diabetes-related complications.¹⁵ diabetes self-management involves a collaborative effort by health care providers and patients in which individuals with diabetes acquire the necessary knowledge and abilities to make behavioral adjustments that help them manage the disease.¹⁶ Diabetes self-management focuses on healthy eating, physical activity, monitoring blood sugar, medication adherence, problem-solving, and healthy coping mechanisms.¹⁷ Self-management interventions are associated with improving glycemic control, quality of life, and diabetic complications.¹⁸

Health literacy (HL) is the primary driver of self-management activities. HL is the capacity to read, understand, make decisions, and take actions that affect health status.¹⁹ Low HL has been linked to several negative health outcomes, such as poorer overall health, higher hospitalization and mortality rates, reduced ability to manage chronic illnesses, and increased patient expenses. Individuals with appropriate HL levels are more likely to use available health services and make well-versed health decisions.²⁰ Low HL is a major barrier to the development

of self-management skills.²¹ Further, HL is associated with confidence in self-managing diabetes.²² The low level of HL about the importance of controlling blood glucose is the key barrier to diabetes self-management.²³

There is increasing evidence demonstrating a strong association of HL with diabetes knowledge; however, little is known about the effectiveness of HL-driven interventions specific to T2DM self-management and glycemic control. This systematic review aims to address this gap by assessing the effectiveness of HL intervention on glycemic control (HbA1c) and T2DM self-management using randomized controlled trials (RCTs).

2 | METHODS

2.1 | Search strategy

To identify HL-driven T2DM self-management interventions focusing on glycemic control, we searched six databases including MEDLINE, CINAHL, PubMed, Cochrane, Scopus, and Web of Science. Search terms included “health literacy,” “diabetes mellitus type 2,” “self-management,” “glucose control,” and “clinical trials” (see Box 1).

The protocol of this systematic review is registered in PROSPERO (International Prospective Register of Systematic Reviews) (CRD42022348050). The systematic review was performed using the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines (see Figure 1). Initial search identified 817 studies through the six databases searched. After excluding the duplications of 564 articles and title and abstract screening, 40 articles were eligible for full-text screening. The 40 papers were assessed against the

inclusion criteria (criteria listed further in the next section) and 15 articles were included in the review.

The quality of each study was assessed independently by two authors (Jamila Butayeva, Zubair Ahmed Ratan) using the critical appraisal checklist tool developed by Joanna Briggs Institute (JBI). This tool is the most coherent and sensitive tool for validity, with its focus on congruity.²⁴ The JBI critical appraisal tool is a widely accepted method for evaluating the methodological quality of studies.²⁵ All the disagreements were resolved by discussion with the senior researcher (Hassan Hosseinzadeh). The JBI score was calculated for each study. A JBI score of 70%–100% was considered as high quality, a score of 69%–50% was considered moderate quality, and <49% was considered low quality. Overall mean score for quality was 80.9% (see Figure 2).

2.2 | Inclusion and exclusion criteria

Only HL-driven RCTs published in English and conducted among T2DM patients aged over 18 years were included in this review. Eligible studies had to report both glycemic control and self-management outcomes and use a HL-driven intervention. Trials with a minimum sample size of 100 and an intervention duration of >3 months were included. This is because RCTs using smaller samples and shorter intervention delivery time were seen as a threat to the validity and generalizability of research results.²⁶

BOX 1 Example of search strategy for review.

1. “health literacy” or “health education” or “health knowledge” or “health information” or “health understanding”.
2. “diabetes mellitus type 2” or “diabetes type 2”.
3. “self-management” or “self-care” or “self-regulation” or “self-monitoring”.
4. “glucose control” or “glycemic control” or “sugar control” or “HbA1c”.
5. “clinical trials or randomized controlled trials or controlled clinical trials”.

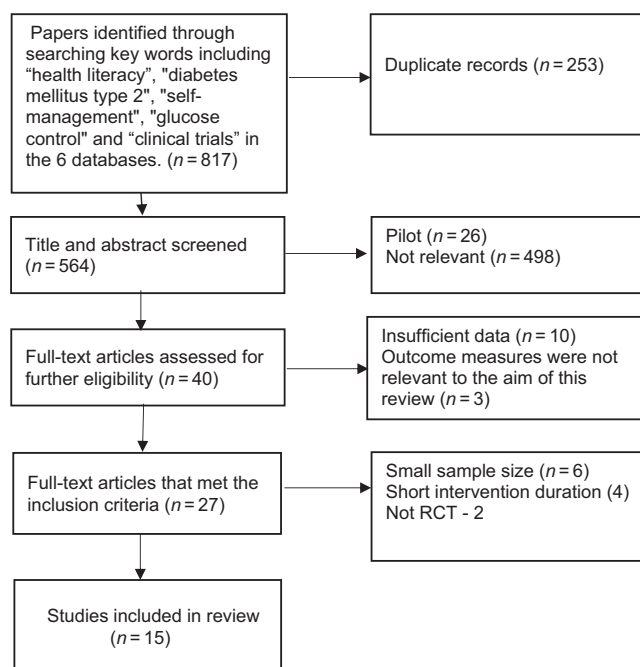


FIGURE 1 Flow chart of study search and selection of selected papers.

N	Author	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	Q10	Q11	Q12	Q13
1	Torres et al, 35	●	●	●	●	●	●	●	●	●	●	●	●	●
2	Santos et al, 33	●	●	●	●	●	●	●	●	●	●	●	●	●
3	Pereira et al, 34	●	●	●	●	●	●	●	●	●	●	●	●	●
4	Torres et al, 32	●	●	●	●	●	●	●	●	●	●	●	●	●
5	Fan et al, 36	●	●	●	●	●	●	●	●	●	●	●	●	●
6	Pai et al, 37	●	●	●	●	●	●	●	●	●	●	●	●	●
7	Yang et al, 38	●	●	●	●	●	●	●	●	●	●	●	●	●
8	Hawthorne et al, 39	●	●	●	●	●	●	●	●	●	●	●	●	●
9	Hawthorne & Tomlinson, 30	●	●	●	●	●	●	●	●	●	●	●	●	●
10	Hailu et al, 39	●	●	●	●	●	●	●	●	●	●	●	●	●
11	Adams et al, 40	●	●	●	●	●	●	●	●	●	●	●	●	●
12	Adolfsson et al, 31 Sweden	●	●	●	●	●	●	●	●	●	●	●	●	●
13	Philis-Tsimikas et al, 27	●	●	●	●	●	●	●	●	●	●	●	●	●
14	Sperl-Hillen et al, 28	●	●	●	●	●	●	●	●	●	●	●	●	●
15	Thanh & Tien, 41	●	●	●	●	●	●	●	●	●	●	●	●	●

● - yes
 ● - no
 ● - unclear

FIGURE 2 Evaluation of the quality of articles using Joanna Briggs Institute (JBI) tool.

3 | RESULTS

3.1 | General study description

All of the 15 selected articles were published in English between 1997 and 2021. Five of them were conducted in developed countries including 2 in the United States,^{27,28} 2 in England,^{29,30} 1 in Sweden,³¹ and 10 in developing countries including 4 in Brazil,^{32–35} 3 in China,^{36–38} 1 in Ethiopia,³⁹ 1 in Nigeria,⁴⁰ and 1 in Vietnam⁴¹ (see Figure 3). Three studies were conducted in hospital settings^{36,37,41} and the rest were conducted in outpatient clinics, diabetes clinics, primary health care, or community health centers (see Table 1). From selected articles three were three-arm RCTs^{28,33,34} and the rest were two-arm RCTs.

3.2 | Patients' characteristics

Overall, 3556 participants were included in the selected studies. The proportion of men and women varied across trials but most of the participants (55%) were female. The sample size ranged from 101 to 623 participants. The participants' age ranged between 18 and 85 years old (see Table 1).

3.3 | Description of interventions

Included studies were heterogeneous in terms of type of intervention, diabetes population, and outcomes assessed. Interventions varied in terms of the type of intervention programs, duration of program, follow-up period, and intervention providers. Intervention time varied from 3 months^{27,28,36,38,40,41} to 12 months.^{33–35} The long follow-up period of 12 months was performed in four studies,^{31,33,34,38} and 6-month follow-up was performed in five studies.^{29,30,32,36,37} In eight studies, interventions were delivered by a nurse,^{28,31,32,34–36,39,40} in two studies interventions were delivered by a diabetes educator,^{37,38} in two studies interventions were delivered by a community worker,^{29,30} in one study the intervention was delivered by a support professional,³³ in one study the intervention was delivered a peer educator,²⁷ and in one study the intervention was delivered by a medical doctor.⁴¹

The most common method of intervention delivery was group education.^{27,29–31,37–41} In three studies, a combination of group and individual education,^{28,32,36} group education and telephone calls,³⁴ and group education and home visits³³ were used. In one study, a combination of group education, home visit, and telephone calls was used.³⁵

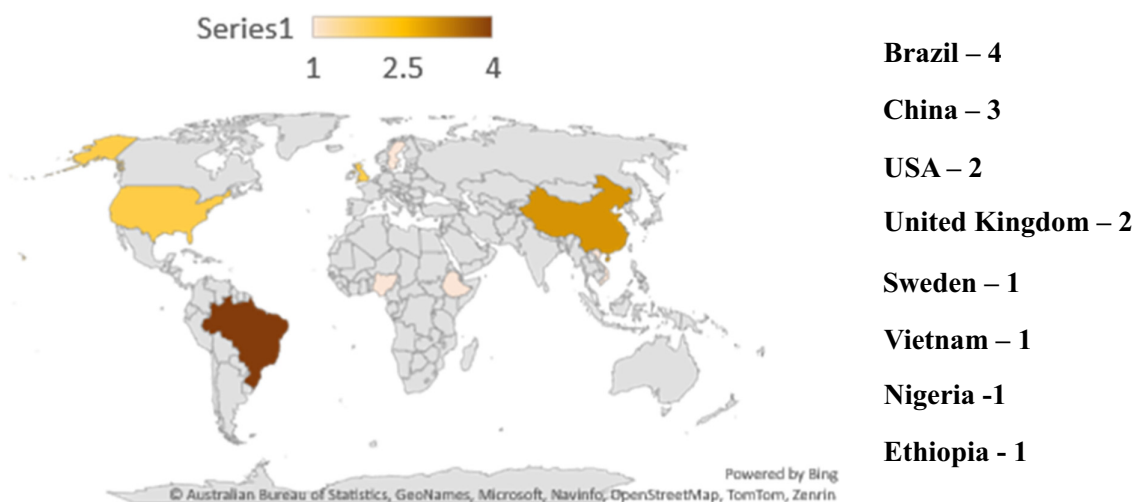


FIGURE 3 Global map indicating countries where selected studies were conducted.

3.4 | Main findings

The selected studies focused on several outcomes, but we concentrated only on HbA1c and self-management outcomes (see Table 2).

3.4.1 | Glycemic control (HbA1c)

All studies evaluated the effect of a HL-driven intervention on HbA1c; 14 studies showed that HL had a significant and positive impact on HbA1c control and 1 study did not find any significant changes in HbA1c level after a HL intervention program.³¹ The largest reduction in HbA1c level (3.4%) was achieved after a 3-month nurse-led individual intervention with a 6-month follow-up in a hospital setting.³⁶ Diabetes education intervention delivered by a nurse in an outpatient setting was more effective in reducing HbA1c (1.5% reduction) among more educated participants.³² Female and educated participants as well as those who participated in more educational sessions had better results in glycemic control in outpatient settings.^{27,30,38} Similarly, educated women and participants who had higher levels of HbA1c at the baseline were more likely to have better improvements in HbA1c in outpatient settings.^{28,29,39} Participants from urban area and those with low body mass index (BMI) levels demonstrated substantially lower outcomes in HbA1c level in outpatient settings.^{27,32,35,39} Surprisingly, participants who did not have any occupation were more likely to have a better glycemic control after long intervention periods of 12 months^{33–35} and 7 months.³⁷ HL-driven interventions were also more effective in HbA1c control among people who had comorbidities and low levels of alcohol consumption.^{28,34,37,41}

3.4.2 | Diabetes self—management

Self-management outcomes were evaluated in nine studies.^{28,30,31,33–35,37,38,41} Of them, five evaluated diabetes knowledge,^{29–32,41} and all of them found a positive correlation between HL interventions and diabetes knowledge. Interventions delivered by community workers compared to those delivered other providers were more likely to improve diabetes knowledge among educated women.²⁹ Nurse-led intervention using group education with a 6-month follow-up delivered in outpatient settings resulted in a greater increased diabetes knowledge compared to tailored education interventions.³⁵

Nine articles evaluated the impact of HL on self-management.^{28–34,37,38} Only two of them did not find any association between HL with self-management behaviors, quality of life, and satisfaction with daily life.^{31,32} Patients with longer disease duration and those received an intervention through home visits achieved better self-care adherence.^{28,29,33,38} A telephone intervention with a 12-month diabetes empowerment program delivered by a nurse was more likely to result in a better self-care practice than group education.³⁴

Regardless of the type and setting of the interventions, better HL improved self-care behaviors including being physically active, problem-solving skills, healthy coping strategies, quality of life, satisfaction with daily life, and managing hyperglycemia in the intervention groups compared to control groups.^{28–30,38}

Educated women showed better results in managing hyperglycemia and regular glucose checks after 6-month community worker-delivered intervention in diabetes clinics compared to noneducated women.^{29,30} Physical activity level and adherence to a healthy diet were more likely to increase in the intervention group compared to

**TABLE 1** Demographic (age, gender) and intervention (settings, program, length, and follow up time) characteristics.

Author, year, country	Population		Intervention				
	Sample size	Age	Settings	Intervention program	Length of intervention	Intervention delivery way	Follow-up
Torres et al, 2018, Brazil ³²	104 (male 26, female 78), control 50, intervention 54	30–70	Outpatient clinic	Diabetes education program by nurse	6 months	Group individual	6 months
Santos et al, 2017, Brazil ³³	238 (male 80, female 158), control 111, intervention 127	30–80	Primary health care centers	Diabetes empowerment program by facilitator and a support professional	12 months	Group, home visits	12 months
Pereira et al, 2021, Brazil ³⁴	208 (male 84, female 124), control 89, intervention 119	18–79	Basic health units	Diabetes empowerment program by nurse and nutritionist	12 months	Group, telephone	12 months
Torres et al, 2009, Brazil ³⁵	341 (male 96, female 245), control 171, intervention 170	30–70	Basic health units	Educational program by nurses and nutritionist	12 months	Group education, home visit, telephone	9 months
Fan et al, 2016, China ³⁶	276 (male 158, female 118), control 138, intervention 138	63 ± 10	Hospital	Diabetes education by nurse	3 months	Group individual	6 months
Pai et al, 2021, China ³⁷	108 (male 51, female 57), control 55, intervention 53	Age 20 <	Hospital	Technology education program by diabetes educator	7 months	Group	6 months
Yang et al, 2015, China ³⁸	245 (male 132, female 113), control 116, intervention 121	20–70	Diabetes clinics	Diabetes education program using CM by diabetes educator	12 weeks	Group	12 months
Hawthorne et al, 2001, England ²⁹	200 (male 95, female 105), control 91, intervention 109	Age 18 <	Diabetes center or diabetes mini clinics	Diabetes health education by community worker	6 months	Group	6 months
Hawthorne and Tomlinson, 1997, England ³⁰	201, (male 93, female 107), control 89, intervention 112	Age 18 <	Diabetes center and general practices	Structured education package by community worker	6 months	Group	6 months
Hailu et al, 2018, Ethiopia ³⁹	220 (male 148, female 72), control 104, intervention 116	30 years <	Medical center	DSME by nurse	6 months	Group	9 months
Adams et al, 2021, Nigeria ⁴⁰	120 (male 46, female 74), control 60, intervention 60	30–80	Outpatient clinic	DSME by nurse	3 months	Group	3 months

(Continues)

TABLE 1 (Continued)

Author, year, country	Population		Intervention				
	Sample size	Age	Settings	Intervention program	Length of intervention	Intervention delivery way	Follow-up
Adolfsson et al, 2007, Sweden ³¹	101 (male 52, female 49), control 51, intervention 50	Age 75 <	Primary care centers	Empowerment education by nurse	7 months	Group	12 months
Philips-Tsimikas et al, 2011, United States ²⁷	207 (male 61, female 146), control 103, intervention 104	21–75	Community health centers	Peer-education curriculum by peer educator	3 months	Group	4 months
Sperl-Hillen et al, 2010, United States ²⁸	623 (male 315, female 308), control 134, intervention 489	Age 85>	Outpatient clinic	Education programs by nurses and dietitians	77 and 90 days	Group individual	4 months
Thanh et al, 2021, Vietnam ⁴¹	364 (male 165, female 199), control 182, intervention 182	40–80	Hospital	Community education by medical doctors	3 months	Group	3 months

Abbreviations: CM, conversation map; DSME, diabetes self-management education.

the control group after interventions delivered by nurses and dietitians in outpatient settings.^{28,32}

4 | DISCUSSION

Our systematic review of 15 included articles showed that HL intervention was effective in glycemic control and improving diabetes knowledge and self-management skills among diabetes patients. Fourteen out of 15 included RCTs showed that HL interventions resulted in significant improvements in HbA1c levels. However, HL-driven interventions delivered through individual education at hospital settings were more effective in decreasing uncontrolled levels of HbA1c compared to HL-driven interventions delivered using group education. This might be due to tailored education and physical proximity to health care services at the hospitals, which might facilitate the impact of HL interventions.⁴² Literature suggests that tailored education based on patient needs motivated them to adhere to life adjustment measures.⁴³ In line with a recent systematic review,⁴⁴ our findings showed that HL interventions resulted in more improvements in HbA1c levels among patients with suboptimal glucose levels where the baseline mean of HbA1c was >9%.^{28,29,39} This finding suggests that T2DM patients with poorly controlled HbA1c levels are more likely to benefit from HL intervention.⁴⁵ There was a positive relationship between the amount of time participants spent on education sessions during HL education

intervention and improvement in glycemic control. In other words, in line with a recent systematic review,⁴⁶ participants who engaged more with HL interventions achieved more improvements in glycemic control. Our findings showed that nurse-led interventions were associated with better glycemic control,^{28,32,34–36,39,40} which may be explained by the fact that practice nurses are capable of dealing with complicated health problems and can give information and support to patients and their families efficiently, which are essential in empowering patients to adopt new behavior.⁴⁷ Our review highlights that after participating in a 3-month peer-education program, individuals in urban areas are more likely to achieve better glycemic control compared to those in rural areas.³⁹ This might be explained by the literature suggesting that people residing in rural areas tend to perceive ill health and mortality as natural phenomena, whereas individuals living in urban areas are less accepting of ill health and more likely to seek health care advice.⁴⁸ There was also a positive linear correlation between BMI and HbA1c levels and participants with higher BMI index had higher level of HbA1c. Participants with low BMI level had lower HbA1c level after interventions in some studies.^{27,32} This is consistent with previous literature, which showed that BMI is a significant predictor of poor HbA1c control⁴⁹ and the increase in BMI levels leads to rising in insulin levels resulting in increasing HbA1c levels.⁵⁰

Five articles that examined diabetes knowledge showed significant improvements in diabetes knowledge

**TABLE 2** Main outcomes including HbA1c and self-management behaviors among the selected studies.

Author, year, country	Study measures	Results			p value
		Control	Intervention 1	Intervention 2	
Torres et al, 2018, Brazil ³²	HbA1c	NA	(individual education) 7.9 ± 1.6	(group education) 7.6 ± 1.4	.002
	Self-care management	NA	3.6 ± 0.7	3.7 ± 0.5	.641
	Diabetes knowledge	NA	11.1 ± 2.6	10.2 ± 2.0	.017
	Quality of life	NA	112.9 ± 18.1	107.6 ± 18	.825
Santos et al, 2017, Brazil ³³	HbA1c	7.4	(home visit) 7.0	(group education) 7.1	.0000 (group) .9900 (home visit)
	Diabetes Empowerment Scale	4	4.25	4.13	.0000 (group) .0000 (home visit)
	Self-care adherence	3	5	4.05	.0001 (group) .0001 (home visit)
Pereira et al, 2021, Brazil ³⁴	HbA1c	8.3	(telephone education) 7.3	(group education) 6.9	.003 (group) < .001 (telephone)
	Self-care practices	2.5	4.2 ± 1.1	3.4 ± 1.1	.786 (group) < .001 (telephone)
	Diabetes empowerment	30	34.0	32.2 ± 3.3	.211 (group) < .001 (telephone)
Torres et al, 2009, Brazil ³⁵	HbA1c	8.29	7.93	NA	< .05
Fan et al, 2016, China ³⁶	HbA1c	NA	(individual education) 6.21 ± 0.56	(group education) 6.95 ± 3.12	.027
Pai et al, 2021, China ³⁷	HbA1c	NA	6.70 ± 0.74	7.307 ± 1.31	< .05
	Perceived Diabetes Self-Management Scale	NA	31.67 ± 5.07	27.59 ± 5.16	< .05
Yang et al, 2015, China ³⁸	HbA1c	9.77	7.55	NA	< .01
	Self-care behavior	NA	NA	NA	NA
Hawthorne et al, 2001, England ²⁹	HbA1c	8.4	7.7	NA	< .01
	Diabetes knowledge	NA	NA	NA	.05
Hawthorne et al, 1997, England ³⁰	HbA1c	8.64	8.3	NA	NA
	Diabetes knowledge	NA	NA	NA	NA
Hailu et al, 2018, Ethiopia ³⁹	HbA1c	Reduction by 2.57%	Reduction by 2.88%	NA	.208
Adams, 2021, Nigeria ⁴⁰	HbA1c	6.8 1 ± 0.3	5.6 ± 1.0	NA	< .001
Adolfsson et al, 2007, Sweden ³¹	HbA1c	7.4	7.3	NA	NA
	Self-efficacy	4.0	9.8	NA	.272
	Diabetes knowledge	5.1	14.8	NA	.012
	Satisfaction with daily life	0.0	2.5	NA	.588

(Continues)

TABLE 2 (Continued)

Author, year, country	Study measures	Results			p value
		Control	Intervention 1	Intervention 2	
Philips-Tsimikas, 2011, United States ²⁷	HbA1c	NA	(individual education) 9.1	(group education) 9.7	.01
Sperl-Hillen et al, 2010, United States ²⁸	HbA1c	7.77	7.52	7.66	< .001 (group) < .001 (individual)
	Food score	12.37	12.99	12.89	.006 (group) < .001 (individual)
	Physical activity	121.37	145.24	122.37	.64 (group) < .08 (individual)
Thanh et al, 2021, Vietnam ⁴¹	HbA1c	8.15 ± 1.8	7.56 ± 1.64%	NA	.001
	Diabetes knowledge	8.57 ± 2.86	10.52 ± 2.08	NA	< .001

Abbreviation: HbA1c, glycohemoglobin A1c.

after HL interventions.^{29–32,41} HL interventions resulted in a greater impartment in diabetes knowledge when it was delivered by community workers compared other health care providers, which is in line with the findings of a recent systematic review showing that HL interventions were positively correlated with diabetes knowledge and glycemic control.⁵¹ This might be explained by the fact that community workers are more likely to share similar cultural, linguistic, and socioeconomic backgrounds with patients, which are essential for providing interventions meeting real-world needs.⁵² Our findings also showed that more educated women were more likely to achieve greater impartments in diabetes knowledge when HL interventions were delivered by community workers compared to noneducated women. Similarly, a recent study showed that patients with high literacy level were 1.85 times more likely to gain diabetes knowledge required to manage their diabetes compared to their less educated counterparts.⁵³ This might be because highly educated people are most likely to understand the salience of health information and are more capable to put new information in practice.⁵⁴

Seven out of nine RCTs that assessed diabetes self-management found that HL interventions were linked to improved self-management outcomes^{28–30,33,34,37,38} such as physical activity, healthy diet, diabetes knowledge, problem-solving, and quality of life. We found that that telephone-based HL interventions among patients with a longer diabetes duration were more likely to yield positive improvements in self-management behaviors especially among less educated participants compared to

face-to face group education.^{33,34} This might be because telephone-based interventions may aid less educated people to understand the context of education and give them more chances to ask questions and seek support. Surprisingly, intervention delivered through home visits among patients who had longer diabetes duration were effective in improving self-management outcomes.^{28,29,33,38} According to literature home visits allow health professionals to see patients' living conditions and involve family members and caregivers in health education, which are critical in gaining better improvements in behavior change interventions.⁵⁵ The reason for the patients with a longer diabetes duration responding well to HL interventions might be because they are more likely to experience the consequences of uncontrolled diabetes, which might motivate them to engage well in HL interventions.

5 | LIMITATIONS

This study offers invaluable information about the impacts of HL intervention on glycemic control and diabetes self-management outcomes; however, it has some limitations. Only studies published in English were included in this review, which might lead to the exclusion of high-quality studies published in other languages. Most of the selected studies were conducted in developed countries, which may limit the generalization of the findings of this review to patients living in developing countries. The heterogeneity of study settings, intervention strategies used, and study participants' socioeconomic



characteristics make generalization of the findings to similar populations difficult. A lack of information about the professional background of those who delivered the interventions could affect the quality of the information delivered during the interventions. Using different outcome measures and tools made analysis difficult. The study outcomes were presented for less than 1 year so long-term effects could not be examined. Only RCTs were included in this review, which might limit the generalizability of these findings to real-world settings.

6 | CONCLUSION

Findings from our review of 15 articles suggests group and telephone-based HL interventions and interventions delivered by nurses and/or community workers and interventions in hospital settings yield promising outcomes in glycemic control and self-management, even after a short duration. Overall, HL-driven interventions are effective in glycemic and diabetes self-management outcomes.

AUTHOR CONTRIBUTIONS

Hassan Hosseinzadeh: Study design, methodology, data analysis, assessing the quality of the selected papers, reviewing the paper, and final approval. Jamila Butayeva: literature searching, methodology, data analysis, assessing the quality of selected articles, and drafting and finalizing the paper. Zubair Ahmed Ratan: Data analysis, reviewing the paper, and assessing the quality of articles. Sue Downie: data analysis and reviewing the paper. The final version of the paper was approved by all of the authors.

ACKNOWLEDGEMENTS

We would like to thank the Ministry of Science and Education of the Republic of Azerbaijan for providing a PhD scholarship for Jamila Butayeva, the first author. No specific external funding was received for this work. Open access publishing facilitated by University of Wollongong, as part of the Wiley - University of Wollongong agreement via the Council of Australian University Librarians.

FUNDING INFORMATION

This review did not receive any funding.

DISCLOSURE

The authors have nothing to disclose.

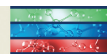
ORCID

Zubair Ahmed Ratan <https://orcid.org/0000-0001-7309-9599>

Hassan Hosseinzadeh <https://orcid.org/0000-0002-8638-5372>

REFERENCES

1. Sun H, Saeedi P, Karuranga S, et al. IDF Diabetes Atlas: global, regional and country-level diabetes prevalence estimates for 2021 and projections for 2045. *Diabetes Res Clin Pract.* 2022; 183:109119.
2. Liu J, Ren ZH, Qiang H, et al. Trends in the incidence of diabetes mellitus: results from the global burden of disease study 2017 and implications for diabetes mellitus prevention. *BMC Public Health.* 2020;20(1):1-12.
3. Kahn SE, Cooper ME, Del Prato S. Pathophysiology and treatment of type 2 diabetes: perspectives on the past, present, and future. *Lancet.* 2014;383(9922):1068-1083.
4. Fowler MJ. Microvascular and macrovascular complications of diabetes. *Clin Diabetes.* 2011;29(3):116-122.
5. Dall TM, Yang W, Halder P, et al. The economic burden of elevated blood glucose levels in 2012: diagnosed and undiagnosed diabetes, gestational diabetes mellitus, and prediabetes. *Diabetes Care.* 2014;37(12):3172-3179.
6. ADA. Economic Costs of Diabetes in the U.S. in 2017. *Diabetes Care.* 2018;41(5):917-928.
7. Zhang Y, Lazzarini PA, McPhail SM, van Netten JJ, Armstrong DG, Pacella RE. Global disability burdens of diabetes-related lower-extremity complications in 1990 and 2016. *Diabetes Care.* 2020;43(5):964-974.
8. Quesada JA, Carratalá-Munuera C, Carbonell-Soliva A, et al. Trends in premature mortality from diabetes mellitus in Costa Rica in the period 2000–2020. *Postgrad Med.* 2022:1-13.
9. Roglic G. WHO global report on diabetes: a summary. *Int J Noncommun Dis.* 2016;1(1):3.
10. Rodríguez-Gutiérrez R, Montori VM. Glycemic control for patients with type 2 diabetes mellitus: our evolving faith in the face of evidence. *Circ Cardiovasc Qual Outcomes.* 2016;9(5):504-512.
11. Stratton IM, Adler AI, Neil HA, et al. Association of glycaemia with macrovascular and microvascular complications of type 2 diabetes (UKPDS 35): prospective observational study. *BMJ.* 2000;321(7258):405-412.
12. Lage MJ, Boye KS. The relationship between HbA1c reduction and healthcare costs among patients with type 2 diabetes: evidence from a US claims database. *Curr Med Res Opin.* 2020; 36(9):1441-1447.
13. Khattab M, Khader YS, al-Khawaldeh A, Ajlouni K. Factors associated with poor glycemic control among patients with type 2 diabetes. *J Diabetes Complications.* 2010;24(2):84-89.
14. England LJ, Dietz PM, Njoroge T, et al. Preventing type 2 diabetes: public health implications for women with a history of gestational diabetes mellitus. *Am J Obstet Gynecol.* 2009;200(4): 365.e1-365.e8.
15. Ahola AJ, Groop PH. Barriers to self-management of diabetes. *Diabet Med.* 2013;30(4):413-420.
16. Tomky D, Tomky D, Cypress M, et al. Aade position statement. *Diabetes Educ.* 2008;34(3):445-449.
17. Boren SA, Fitzner KA, Panhalkar PS, Specker JE. Costs and benefits associated with diabetes education a review of the literature. *Diabetes Educ.* 2009;35(1):72-96.
18. Kamradt M, Bozorgmehr K, Krisam J, et al. Assessing self-management in patients with diabetes mellitus type 2 in



- Germany: validation of a German version of the summary of diabetes self-care activities measure (SDSCA-G). *Health Qual Life Outcomes*. 2014;12(1):1-10.
19. Nutbeam D, Lloyd JE. Understanding and responding to health literacy as a social determinant of health. *Annu Rev Public Health*. 2021;42(1):159-173.
 20. Johnson A. Health literacy, does it make a difference? *Australian J Adv Nurs*. 2014;31(3):39-45.
 21. Mackey LM, Doody C, Werner EL, Fullen B. Self-management skills in chronic disease management: what role does health literacy have? *Med Decis Making*. 2016;36(6):741-759.
 22. Osborn CY, Cavanaugh K, Wallston KA, Rothman RL. Self-efficacy links health literacy and numeracy to glycemic control. *J Health Commun*. 2010;15(S2):146-158.
 23. Winston RA, Shaya FT, Pradel FG, Laird A, Saunders E. Barriers to self-management of diabetes: a qualitative study among low-income minority diabetics. *Ethn Dis*. 2011;21:27.
 24. Hannes K, Lockwood C, Pearson A. A comparative analysis of three online appraisal instruments' ability to assess validity in qualitative research. *Qual Health Res*. 2010;20(12):1736-1743.
 25. Munn Z, Barker TH, Moola S, et al. Methodological quality of case series studies: an introduction to the JBI critical appraisal tool. *JBI Evid Synth*. 2020;18(10):2127-2133.
 26. Vasileiou K, Barnett J, Thorpe S, Young T. Characterising and justifying sample size sufficiency in interview-based studies: systematic analysis of qualitative health research over a 15-year period. *BMC Med Res Methodol*. 2018;18(1):1-18.
 27. Philis-Tsimikas A, Fortmann A, Llevo-Ocana L, Walker C, Gallo LC. Peer-led diabetes education programs in high-risk Mexican Americans improve glycemic control compared with standard approaches: a project Dulce promotora randomized trial. *Diabetes Care*. 2011;34(9):1926-1931.
 28. Sperl-Hillen J, Beaton S, Fernandes O, et al. Comparative effectiveness of patient education methods for type 2 diabetes: a randomized controlled trial. *Arch Intern Med*. 2011;171(22):2001-2010.
 29. Hawthorne K. Effect of culturally appropriate health education on glycaemic control and knowledge of diabetes in British Pakistani women with type 2 diabetes mellitus. *Health Educ Res*. 2001;16(3):373-381.
 30. Hawthorne K, Tomlinson S. One-to-one teaching with pictures—flashcard health education for British Asians with diabetes. *Br J Gen Pract*. 1997;47(418):301.
 31. Adolfsson ET, Walker-Engström ML, Smide B, Wikblad K. Patient education in type 2 diabetes—a randomized controlled 1-year follow-up study. *Diabetes Res Clin Pract*. 2007;76(3):341-350.
 32. Torres HDC, Pace AE, Chaves FF, Velasquez-Melendez G, Reis IA. Evaluation of the effects of a diabetes educational program: a randomized clinical trial. *Rev Saude Publica*. 2018;52:8.
 33. Santos JCD, Cortez DN, Macedo MML, Reis EA, Reis IA, Torres HC. Comparison of education group strategies and home visits in type 2 diabetes mellitus: clinical trial. *Rev Lat Am Enfermagem*. 2017;25:25.
 34. Pereira PF, Santos JCD, Cortez DN, Reis IA, Torres HC. Evaluation of group education strategies and telephone intervention for type 2 diabetes. *Rev Esc Enferm USP*. 2021;55:e03746.
 35. Torres HDC, Franco LJ, Stradioto MA, Hortale VA, Schall VT. Evaluation of group and individual strategies in a diabetes education program. *Rev Saude Publica*. 2009;43:291-298.
 36. Fan M-H, Huang BT, Tang YC, Han XH, Dong WW, Wang LX. Effect of individualized diabetes education for type 2 diabetes mellitus: a single-center randomized clinical trial. *Afr Health Sci*. 2016;16(4):1157-1162.
 37. Pai L-W, Chiu SC, Liu HL, Chen LL, Peng T. Effects of a health education technology program on long-term glycemic control and self-management ability of adults with type 2 diabetes: a randomized controlled trial. *Diabetes Res Clin Pract*. 2021;175:108785.
 38. Yang YS, Wu YC, Lu YL, et al. Adherence to self-care behavior and glycemic effects using structured education. *J Diabetes Investig*. 2015;6(6):662-669.
 39. Hailu FB, Hjortdahl P, Moen A. Nurse-led diabetes self-management education improves clinical parameters in Ethiopia. *Front Public Health*. 2018;6:302.
 40. Adams O, Shabi OM, Akinola BK, Gabriel OE, Bello IS, Akinpelu O. The role of diabetes self-care education and practice in the management of type 2 diabetes mellitus (T2DM). *Family Med Prim Care*. 2021;23(4):391-399.
 41. Thanh HTK, Tien TM. Effect of group patient education on glycemic control among people living with type 2 diabetes in Vietnam: a randomized controlled single-center trial. *Diabetes Ther*. 2021;12(5):1503-1521.
 42. Melo LPD, Campos EAD. The group facilitates everything: meanings patients with type 2 diabetes mellitus assigned to health education groups. *Rev Lat Am Enfermagem*. 2014;22:980-987.
 43. Shantha GPS, Kumar AA, Kahan S, Cheskin LJ. Association between glycosylated hemoglobin and intentional weight loss in overweight and obese patients with type 2 diabetes mellitus: a retrospective cohort study. *Diabetes Educ*. 2012;38(3):417-426.
 44. Murphy ME, Byrne M, Galvin R, Boland F, Fahey T, Smith SM. Improving risk factor management for patients with poorly controlled type 2 diabetes: a systematic review of health-care interventions in primary care and community settings. *BMJ Open*. 2017;7(8):e015135.
 45. Cheng L, Sit JWH, Choi KC, Chair SY, Li X, He XL. Effectiveness of interactive self-management interventions in individuals with poorly controlled type 2 diabetes: a meta-analysis of randomized controlled trials. *Worldviews Evid Based Nurs*. 2017;14(1):65-73.
 46. Chrvala CA, Sherr D, Lipman RD. Diabetes self-management education for adults with type 2 diabetes mellitus: a systematic review of the effect on glycemic control. *Patient Educ Couns*. 2016;99(6):926-943.
 47. Cheng HY, Chair SY, Wang Q, Sit JW, Wong EM, Tang SW. Effects of a nurse-led heart failure clinic on hospital readmission and mortality in Hong Kong. *J Geriatr Cardiol*. 2016;13(5):415-419.
 48. Gessert C, Waring S, Bailey-Davis L, Conway P, Roberts M, VanWormer J. Rural definition of health: a systematic literature review. *BMC Public Health*. 2015;15(1):1-14.
 49. Jha SC, Dey S, Ranjan R. To determine the correlation between BMI and glycated hemoglobin (HbA1c) level in patients of type 2 diabetes mellitus. *Eur J Mol Clin Med*. 2022;9(3):3014-3018.



50. Agrawal N, Agrawal MK, Kumari T, Kumar S. Correlation between body mass index and blood glucose levels in Jharkhand population. *Int J Contemp Med Res*. 2017;4(8):1633-1636.
51. Alharbi ER, Sofar SM, Wazqar DY. Effect of health educational guidelines on self-management practices among patients with chronic obstructive pulmonary disease: a scoping review. *Evid Based Nurs Res*. 2022;4(4):55-68.
52. Han H-R, Kim K, Murphy J, et al. Community health worker interventions to promote psychosocial outcomes among people living with HIV—A systematic review. *PLoS One*. 2018;13(4):e0194928.
53. Tefera YG, Gebresillassie BM, Emiru YK, et al. Diabetic health literacy and its association with glycemic control among adult patients with type 2 diabetes mellitus attending the outpatient clinic of a university hospital in Ethiopia. *PLoS One*. 2020;15(4):e0231291.
54. Shankar J, Ip E, Khalema E, et al. Education as a social determinant of health: issues facing indigenous and visible minority students in postsecondary education in Western Canada. *Int J Environ Res Public Health*. 2013;10(9):3908-3929.
55. Liang Y-H, Wang KH, Huang HM, Shia BC, Chan SY, Ho CW. Reducing medication problems among minority individuals with low socioeconomic status through pharmacist home visits. *Int J Environ Res Public Health*. 2022;19(7):4234.

How to cite this article: Butayeva J, Ratan ZA, Downie S, Hosseinzadeh H. The impact of health literacy interventions on glycemic control and self-management outcomes among type 2 diabetes mellitus: A systematic review. *Journal of Diabetes*. 2023;15(9):724-735. doi:[10.1111/1753-0407.13436](https://doi.org/10.1111/1753-0407.13436)