

Educational Curriculum to Improve Clinical Outcomes in Diabetes Mellitus Patients: A Systematic Review

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ABSTRACT

Diabetes Mellitus (DM) cannot be treated and controlled with only medicine because there is also a need to provide education to the patients. This is to help them adhere to treatment, adopt healthy lifestyles, and prevent complications that can cause death. Therefore, this systematic review aims to determine the curriculum or content of educational materials that needs to be given to DM patients to improve the achievement of clinical outcomes. Sage, Scient direct, and Pubmed were explored for relevant articles published between 2012 and 2022 using multiple search terms. STROBE tools were used to conduct quality assessments, after which a narrative synthesis of the findings was performed, and 1.619 citations were obtained. After de-duplicating and screening, 18 studies were eligible for inclusion. The educational materials given were related to diet/nutrition (n=17), physical activity (n=15), DM treatment (n=14), complications and risk factors (n= 13), goal setting or Healthy Living with DM (n=13), monitoring blood glucose levels parameters (n=11), description of DM (n=7), mental health (n=5), and foot care DM (n= 4). A total of 18 articles in this systematic review study met the quality criteria based on an assessment using the STROBE checklist to minimize bias. The results showed that educational materials provided to DM patients can improve clinical outcomes. However, the evidence base for educating people with the disease in the community is still limited, and further studies are needed.

Keywords: diabetes mellitus, education, curriculum, clinical outcome

INTRODUCTION

Diabetes as a global non-communicable disease has become a clinical and public health problem that requires special attention for its control. Furthermore, the World Health Organization predicted an increase in its prevalence by 39% between 2000 and 2030 as well as an increment of 366 million cases by 2030 (Wilsd *et al.*, 2004). Uncontrolled diabetes can also become the major cause of heart attacks, stroke, blindness, kidney failure, and lower extremity amputations. It can also lead to higher mortality, morbidity, and healthcare costs if not properly managed. Previous reports also showed that more

than 90% of people with diabetes mellitus (DM) are type 2 DM (T2DM) patients (National Collaborating Centre for Chronic Conditions (UK), 2008), which requires certain lifestyle modifications as a companion to drug treatment. DM self-care activities have become an intact component of effective DM care worldwide due to the chronicity of T2DM, which is highly time-consuming and costly (Xu *et al.*, 2014). DM therapy currently places more emphasis on non-pharmacological treatment, where the role of self-management in the care of the disease must be understood by the patients (Azami *et al.*, 2018). A major step toward improving quality and reducing costs associated

with DM involves the identification of pragmatic interventions that are effective in managing the disease sustainably. It also involves creating value from the point of view of the clinicians, patients, and delivery system (Brunisholz *et al.*, 2014). Treatment management for DM does not only include appropriate drugs, but also consists of guidelines that recommend education on healthy eating patterns, physical activity, and weight control (Association, 2010; Giese, 2016; Nathan *et al.*, 2009). DM education has been proven to be effective in clinical trials due to its beneficial effects in HbA1c control, reducing complications and acute health care utilization, as well as lowering the total cost of treating the disease (Anderson *et al.*, 2003; Boren *et al.*, 2009; Duncan *et al.*, 2009; Gregg *et al.*, 2012; Martin & Lipman, 2013; Morrison *et al.*, 2012).

T2DM patients must take the main responsibility of implementing healthy self-care behaviors because the disease is a chronic metabolic disorder that needs to be managed independently by sufferers. Its treatment also requires a long period, lifestyle modifications, and independence of the sufferer. The high cost of DM control shows that healthcare providers must take an active role in providing education regarding self-management (Ko *et al.*, 2016). Educational interventions have an important role in increasing the knowledge and skills of DM patients. Various systematic review studies that analyzed the effects of DM self-management education interventions revealed that it can increase knowledge, self-care behaviors as well as decrease HbA1C (Chrvala *et al.*, 2016; Gucciardi *et al.*, 2013; Pousinho *et al.*, 2016; Wubben & Vivian, 2008). The purpose of educating DM patients is not only to increase knowledge and skills but also to motivate them to maintain lifestyle modifications, by giving them the confidence to make independent choices regarding basic daily care/lifestyle.

Several studies revealed that health literacy is a significant factor influencing the glycemic control of patients (Parker *et al.*, 1999). Clinical outcomes can be achieved by addressing the literacy of the people affected. Educational interventions by pharmacists have been shown to improve patient adherence to medication and glycemic control (Li *et al.*, 2010; Machado *et al.*, 2007; Smith, 2009). A study examining the effectiveness of rural clinics for DM patients managed by pharmacists revealed that people who received education regarding the disease, lifestyle

modification, and drug therapy management had a significant reduction in A1c ($\geq 1\%$) after 24 months (Wagner, 2001). Therefore, this study aims to determine the educational materials that are important and can be formulated in DM patient education curriculum.

MATERIAL AND METHODS

This review includes research articles published from 2012 to 2022 on 3 major health journal databases, namely PubMed, Sage, and Science direct, which serve as study sources. The literature search was carried out from January until February 2022 using the keywords, Curriculum diabetes mellitus clinical outcome and Curriculum education diabetes mellitus clinical outcome on Sage and Science direct, respectively. Meanwhile, the keywords used on PubMed were ((curriculum) AND (diabetes) AND (educational) AND (clinical outcome)). The inclusion criteria include articles written in English, available in full text, and used the experimental method. Additional requirements are studies to be reviewed in the form of reports or research results describing educational curriculum in patients with DM, with various interventions; and research outputs with clinical outcomes including A1c, BMI, systolic, diastolic, and lipid profile. A total of 1.691 articles were obtained from the search results, of which 327 were duplicates, and the remaining was 1.292. The duplicates were then checked automatically using Mendeley. A total of 858 articles were excluded based on the title screen and abstract, which has no keywords for DM and curriculum education. Furthermore, 233 of them cannot be accessed in full text, while 45 titles were books/encyclopedias. Among the remaining 156 eligible articles, 138 articles did not measure the achievement of clinical outcomes. A total of 18 articles were available to discuss the curriculum for DM patients with clinical outcome measures. The risk of bias was measured by completing the Observational Study Reporting Strengthening Checklist in Epidemiology (STROBE), which was then used to assess article quality (Table I). This instrument consists of 22 items that evaluated the component of the study. A score of '0' was assigned when information was not sufficient to provide assistance during judgment, which indicates a high risk of bias. The quality of each article was rated as 'good' if the STROBE score was 14/22, or graded as 'poor' when the score <14/22. In this systematic review, only studies with a STROBE score of 14 (Elm *et al.*, 2007).

Table I. Assessment of risk of bias of included studies by STROBE Checklist

First author & year	1a	1b	2	3	4	5	6a	6b	7	8	9	10	11	12a	12b	12c	12d
Sanaeinasab, 2020	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1
Ghisi, 2020	1	1	1	1	1	1	1	1	1	1	0	0	1	1	1	0	1
Chai, 2018	1	1	1	1	1	1	1	0	1	1	0	0	1	1	1	0	1
Bell, 2012	1	1	1	1	1	1	1	0	1	1	0	0	1	1	1	0	1
Ji, 2019	1	1	1	1	1	1	1	1	1	1	0	0	1	0	0	0	1
Chong, 2016	1	1	1	1	1	1	1	0	1	1	1	0	1	1	0	0	1
Gupta, 2020	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	1	0
Brunisholz, 2014	1	1	0	1	1	1	1	1	1	1	0	0	0	1	0	0	1
Sabo, 2021	1	1	1	1	1	1	1	1	0	1	0	1	0	1	0	0	1
Kin, 2022	1	1	1	1	1	1	1	0	1	1	0	0	0	1	0	0	0
Font, 2021	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1
Sullivan, 2013	1	1	1	1	0	1	1	1	1	0	0	1	0	1	0	0	1
Shrader, 2013	1	1	1	1	1	0	1	1	1	1	0	0	1	1	0	0	1
Khunti, 2012	1	1	0	1	0	1	1	1	1	1	0	1	1	1	1	0	1
Azami, 2018	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1
Bukhsh, 2018	1	1	1	1	1	1	1	1	1	1	0	1	1	1	1	0	1
Dong, 2018	1	1	1	1	1	1	1	0	1	1	0	0	1	1	1	0	1
Rusdiana, 2018	1	1	1	1	0	1	1	0	1	1	0	0	0	0	0	0	1
First author & year	12e	13a	13b	13c	14a	14b	14c	15	16a	16b	16c	17	18	19	20	21	22
Sanaeinasab, 2020	0	1	1	1	1	0	1	1	1	1	0	0	1	1	1	1	0
Ghisi, 2020	0	1	0	0	1	0	1	1	1	1	0	0	1	1	1	1	1
Chai, 2018	0	1	1	0	1	1	1	1	1	1	0	0	1	0	1	1	0
Bell, 2012	0	1	0	0	1	0	1	1	0	1	0	0	1	0	1	1	0
Ji, 2019	0	1	0	0	1	0	1	1	0	1	0	0	1	0	1	1	0
Chong, 2016	0	1	1	0	1	0	1	1	1	1	0	1	1	0	1	1	0
Gupta, 2020	0	1	0	0	1	1	1	1	1	1	0	0	1	1	1	1	1
Brunisholz, 2014	0	1	1	1	1	0	1	1	1	1	0	0	1	1	1	1	1
Sabo, 2021	0	1	1	0	1	0	1	1	0	0	0	0	1	0	1	1	1
Kin, 2022	0	1	0	0	1	0	1	1	0	0	0	0	1	0	1	1	1
Font, 2021	0	1	0	0	1	0	1	1	1	1	0	0	1	0	1	1	1
Sullivan, 2013	0	1	1	0	1	0	1	1	0	0	0	0	1	0	1	1	1
Shrader, 2013	0	1	1	0	1	0	1	1	1	1	0	0	1	1	1	1	1
Khunti, 2012	0	1	0	0	1	0	1	1	0	0	0	0	1	1	1	1	1
Azami, 2018	0	1	0	0	1	0	1	1	1	1	0	1	1	1	1	1	1
Bukhsh, 2018	0	1	0	0	1	0	1	1	1	1	0	0	1	1	1	1	1
Dong, 2018	1	1	0	0	1	0	1	1	1	1	0	1	1	1	1	1	0
Rusdiana, 2018	0	1	1	0	1	0	1	1	1	1	0	0	1	0	1	1	0

1(Presence of item); 0(Absence of item);*Quality is defined by a STROBE score ≥ 14/22 (good) and < 14/22 (poor)

The first reviewer recorded the data from the selected study in an extraction form using Excel, while the second reviewer verified the accuracy and completeness of the extracted data. No ethical approval was required in this review because it only consists of secondary data collection and analysis.

RESULT AND DISCUSSION

This is a systematic review of 18 articles that examined the effect of education on the clinical outcomes of DM patients. A total of 17 of them assessed educational materials about nutrition or healthy diet for the treatment of the disease.

Materials on physical activity or sports for people with DM were used in 15 articles, while those related to treatment were given in 14 articles. Educational media about complications and risk factors were presented in 13 of them, while those on goal setting or Healthy Living with DM were given in 13. Materials on monitoring blood sugar and other clinical parameters were provided in 11 articles, while educational medium on the description of DM was presented in 7. Educational materials on the mental health of DM patients were given in 5 of them. The intervention used in 4 of them was educational medium on diabetic foot care.

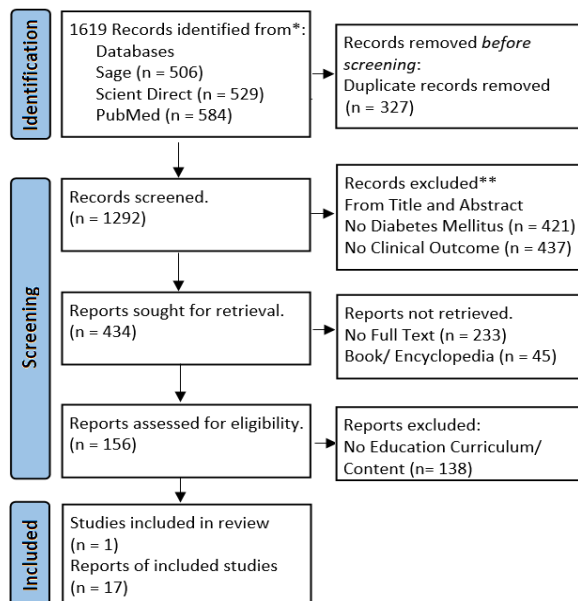


Figure 1. PRISMA flow-chart (2020)

Unhealthy eating habits are one of the main factors accelerating the increase in the incidence of DM in developing countries. Furthermore, control of HbA1c levels can be achieved through dietary regulation, which prevents the development of complications of DM. Education related to healthy eating patterns can increase knowledge, attitudes, and consistent practices in a healthy diet that ultimately leads to better DM disease control (Sami *et al.*, 2017). Several studies have reported a strong relationship between the incidence of T2DM and impaired glucose tolerance with high carbohydrate and fat intake (Khatib O, 2004; Lundgren *et al.*, 1989; Marshall *et al.*, 1991). Soft drinks have also been linked to obesity and DM, due to the high fructose content in the corn syrup used in their production, and this can raise blood glucose and BMI to dangerous levels (Nseir, 2010). A previous study stated that the consumption of soft drinks containing glycated chemicals increased insulin resistance (Assy *et al.*, 2008). Excessive consumption of red meat, sweets and fried foods contribute to an increased risk of insulin resistance and T2DM (Panagiotakos *et al.*, 2005). Furthermore, the consumption of fruits and vegetables suppressed the worsening of T2DM because they are rich in antioxidant, fiber, and nutrients that are considered protective against diseases (Villegas *et al.*, 2008). A study on Japanese women revealed that increasing the intake of white rice increased the risk of T2DM (Nanri *et al.*, 2010). This evidence calls for an urgent need to change

lifestyles among the general population as well as to further increase awareness of healthy eating in all groups. T2DM patients need support through education including diet management to encourage them to understand how to manage the disease, as well as provide more appropriate self-care and better quality of life.

DM is a chronic disease that requires continuous treatment for a lifetime, hence, appropriate therapeutic methods are needed with special emphasis on healthy eating patterns or nutrition to control the disease, reduce symptoms, and prevent complications. Education on the management of an effective healthy diet can prevent or control the onset of DM and its complications (Sami *et al.*, 2017). Soluble fiber helps to control blood glucose and cholesterol to a suitable level, examples of foods with soluble fiber include vegetables, whole grains, such as oats and barley, as well as fruits and vegetables, fruits, dried beans, and peas (Bell *et al.*, 2012). A healthy diet consists of a lot of fruit and vegetables, whole grains, low-fat dairy foods, fish, lean meats, poultry, and healthy fats (Bell *et al.*, 2012; Bukhsh *et al.*, 2018; Rusdiana *et al.*, 2018). A previous study focused on the effect of food on blood glucose and the importance of meal planning (Chong, 2016). Furthermore, another study explored the importance of limiting sugar consumption, proper calorie intake for DM, understanding the effects of repeatedly reheated food, and proper meal times (Rusdiana *et al.*, 2018). A previous study was carried out on the planning of healthy diet patterns, eating patterns to lose weight for obese people, as well as healthy and unhealthy food choices for DM (Bukhsh *et al.*, 2018).

Physical activity can help people with DM improve cardiorespiratory fitness, strength, glycemic control, insulin resistance control, lipid profiles, reduce blood pressure, and maintain weight loss (Chudyk & Petrella, 2011; Colberg *et al.*, 2010; Snowling & Hopkins, 2006; Wing *et al.*, 2001). Moderate to high levels of physical activity as well as cardiorespiratory fitness can lead to significantly lower rates of morbidity and mortality in men and women with and without DM. Aerobic and resistance exercises are beneficial for diabetic patients, and it is optimal to conduct both of them. At least 150 minutes per week of aerobic exercise must be carried out combined with a minimum of two sessions per week of resistance exercise. Recommended aerobic exercise include walking, semi-recumbent cycling, moderately brisk walking, jogging, basketball, swimming, and dancing.

Table II. Characteristics and Clinical Outcome of included studies

First Author & year	Setting	Design, duration	Number of participants	Methods of delivery Education	Education content	Outcome	Results
Sanaenasab, 2020	3 Diabetic Clinic, Iran	RCT, 7 months (July 2018 - January 2019)	80 Participants	Group discussion, role-playing, watching a short video, and listening to a lecture	Content focuses on important topics about DM self-care, which include understanding DM (etiology and related risk factors), available treatments and their effectiveness, necessary lifestyle modifications regarding a healthy diet (HbA1c), and physical activity, skills in measuring blood sugar with a glucometer, complications of disease if left untreated, how to control these complications, and DM control to prevent anxiety, stress, and depression.	The intervention showed significant improvements within and between groups, for outcomes such as glycemic control index (HbA1c), blood glucose levels, BMI, as well as systolic and diastolic blood pressure.	Improve both clinical and outcomes
Ghisi, 2020	Toronto Rehabilitation Institute, Canada	RCT, 6 months	50 Participants	Large and small group sessions, lectures, a patient guide, and online videos	Topics covered for DM education include treating DM, physical activity, healthy eating, emotional well-being, and DM control	Clinical peak VO2 increased significantly. High VO2max was associated with HbA1c, fasting glucose, and low 2-hour OGTT glucose (Solomon et al., 2015).	Improve clinical outcomes
Chai, 2018	The First Hospital of Dandong, China	RCT, 6 months	118 patients	Lecturing, discussion, audio-visual, and demonstration approaches	Educational materials include setting a healthy diet, physical activity, independent blood glucose monitoring, understanding DM risk factors, and preventing complications.	Significant decrease in clinical parameters such as HbA1c, fasting blood glucose, and postprandial blood glucose in the education group compared to the control group in the sixth month.	Improve clinical outcomes
Bell, 2012	Outpatient DM at Walter Reed Health Care System, Washington, DC.	RCT, 12 months	65 patients	Mobile Phone-Based Video Messages	Content video: Healthy diet, physical activity, medication, monitoring, and risk reduction problem-solving, and coping	The reduction in A1C was greater in participants who received video messages and viewed >10 times per month for 12 months than the group who received routine care.	Improve clinical outcomes
Ji, 2019	Danyang People's Hospital, Jiangsu province, China	RCT, 6 months	91 Participants	Educational video and role-play	Education focus on knowledge and skills about a healthy diet, exercise, self-monitoring of blood glucose levels and specific drug management for insulin injection users, problem-solving related to DM, and lifestyle modifications to reduce risks and complications associated with DM.	The experimental group there was a decrease in HbA1c levels, fasting glucose, and postprandial glucose which were superior to the control group (P <0.05).	Improve clinical outcomes

First Author & year	Setting	Design, duration	Number of participants	Methods of delivery	Education content	Outcome	Results
Gupta, 2020	A tertiary care hospital in North India	RCT, 17 months	81 Participants	Video-based lifestyle education program	Stress management and staying motivated; long-term heart health; managing slip-ups; healthy diet; physical activity; improving strength and flexibility.	There was a significant change in HbA1c, weight, and body mass index in the intervention group compared to people with usual care.	Improve clinical outcomes
Brunisholz, 2014	Intermountain Healthcare, Salt Lake City, United State	RCT; 12 months	1920 participants	Counseling	self-monitoring of glucose levels; diet; sport; specific drug management for participants taking insulin; motivation for self-management; related problem solving, and lifestyle modifications to help reduce risks and complications.	There was a decrease in HbA1c in the treatment clinical group and 0.81% in the control group, and there was a statistically significant difference.	Improve clinical outcomes
Sabo, 2021	Privia Health, Arlington, United States	RCT; 6 months	337 participants	Modules	The curriculum of the National Standards for DM Self-Management Education and Support (Bodenheimer, 2002), includes: (1) the disease process and treatment of DM, (2) nutritional management, (3) physical activity, (4) medications, (5) monitoring of blood glucose, (6) acute complications, (7) chronic complications, (8) mental health, and (9) goal setting.	Patients in the intervention group who completed at least one clinical module had better HbA1c levels (P=0.03) and better DBP (P=0.01) compared to controls group.	Improve clinical outcomes
Kin, 2022	Endocrinology and Metabolic Diseases Polyclinic in Dokuz Eylul University Hospital Turkey	RCT; 6 months	60 Participants	Education booklet, brochure, slides (enriched with pictures and videos), and demonstration	The contents of the education include general information about DM, treatment methods, related complications and management, diabetic foot care, and controls that individuals with DM must have (routine control)	The intervention group was shown to experience significant reductions in A1C, FBG, body mass index (BMI), total cholesterol, LDL, PPG, triglycerides, blood pressure, and HDL increases compared to the control group.	Improve clinical outcomes
Font, 2021	Hospital Clínic de Barcelona	RCT; 6 months	184 patients	Personalized education and standardized group education, which consists of three sessions with 1.5 hours per session, consisting of a maximum of 10 per group)	Educational content covering DM and strategies to improve control; healthy diet, and adaptation; acute/chronic complications; and ability to use insulin therapy.	Intervention group after six months had a statistically significant decrease in HbA1c (9.0% ± 1.3% versus 7.8% ± 1.3%; p= 0.000)	Improve clinical outcomes

First Author & year	Setting	Design, duration	Number of participants	Methods of delivery Education	Education content	Outcome	Results
Sullihvan, 2013	Optum, Eden Prairie, Minnesota	RCT; 6 Months	272,386 patients	Counseling	DM management program, medical nutrition therapy, Health education (not specified for DM), Weight management, exercise classes	The A1C levels of patients who received the Education intervention were significantly lower than those who were not educated at the 3 and 6-month evaluations. The reduction was statistically significant between the baseline and 6 months.	Improve clinical outcomes
Shrader, 2013	N/A	RCT; N/A	60 Participants	Classes Educational	Better management of DM DM and healthy eating Monitoring blood glucose Continuing your journey with DM.	Patients who attended more than one education class had a clinical statistically significant decrease of 3% in A1C (p < 0.05). Systolic and diastolic blood pressure as well as LDL-C also decreased. However, none of these changes were statistically significant.	Improve clinical outcomes
Khunti, 2012	13 primary care sites across England and Scotland	RCT; 12 Months	604 Participants	The structured group education	The educational curriculum prioritizes healthy lifestyle factors for DM patients, such as food choices, physical activity, and reducing or preventing cardiovascular risk factors.	There was a greater decrease in HbA1c, BMI, LDL, systolic and diastolic blood pressure in the intervention group compared to the control group, but not statistically significant.	Improve clinical outcomes
Azami, 2018	Outpatient endocrine clinic on teaching hospital in Ilam city, Iran	RCT; 6 Months	142 participants	Booklet, short movie clips of 10 minutes, and group-based educational sessions	(1) diet, (2) physical activity, (3) medication, (4) monitoring of blood glucose, (5) foot care, and (6) healthy living with DM	There was a significant increase in clinical performance in HbA1c, blood pressure, and body weight among patients in the intervention group.	Improve clinical outcomes
Bukhsh, 2018	Tertiary care diabetes clinic of Capital Hospital, in Islamabad, Pakistan	RCT; 6 Months	80 Participants	Counseling	Disease (DM), symptoms, clinical goals, self-care activities, including self-monitoring of blood glucose, physical activity, importance of regular drug intake, and a healthy diet, as well as education.	There was a significant decrease in HbA1c levels as the clinical main outcome of intervention reducing risk.	Improve clinical outcomes
Dong, 2018	Second Affiliated Hospital of Hainan Medical University, China	RCT; 12 Months	120 participants	Educational text messages through the established WeChat platform	Educational content includes self-monitoring of blood glucose, diet, exercise, adherence to medication, management of hypoglycemia and hyperglycemia, as well as weight control for diabetic patients.	In the intervention group there was a greater decrease in HbA1c clinical outcomes compared to the control group	Improve clinical outcomes
Rusdiana, 2018	Primary Health Care in Binjai city, North Sumatra, Indonesia	RCT; 3 months	80 participants	Counseling	Healthy diet, physical activities, monitoring, problem-solving, taking medication, reducing risks, and healthy coping	In the pretest, HbA1c was 8.66%, and it reduced to 7.889% after the intervention. The FBG also reduced from 218.39 mg/dl to 149.02 mg/dl after 3 months.	Improve clinical outcomes

Table III. DM patient education Curriculum

Study	Describing the diabetes	Healthy diet	Physical activity	Medications/ Treatment	Monitoring blood glucose and other parameters	Complications & Risk Factors	Mental Health	Goal Setting/ Healthy Living with DM	Diabetic Foot care
Sanaeinasab, 2020	✓	✓	✓	✓	✓	✓	✓	✓	
Ghisi, 2020		✓	✓	✓	✓	✓	✓	✓	
Chai, 2018		✓	✓	✓	✓	✓	✓	✓	
Bell, 2012		✓	✓	✓	✓	✓	✓	✓	
Ji, 2019		✓	✓	✓	✓	✓	✓	✓	
Chong, 2016	✓	✓	✓	✓	✓	✓	✓	✓	✓
Gupta, 2020		✓	✓	✓	✓	✓	✓	✓	
Brunisholz, 2014		✓	✓	✓	✓	✓	✓	✓	
Sabo, 2021	✓	✓	✓	✓	✓	✓	✓	✓	✓
Kin, 2022	✓	✓	✓	✓	✓	✓	✓	✓	
Font, 2021	✓	✓	✓	✓	✓	✓	✓	✓	
Sullivan, 2013	✓	✓	✓	✓	✓	✓	✓	✓	
Shrader, 2013		✓	✓	✓	✓	✓	✓	✓	
Khunt, 2012		✓	✓	✓	✓	✓	✓	✓	
Azami, 2018		✓	✓	✓	✓	✓	✓	✓	✓
Bukhsh, 2018	✓	✓	✓	✓	✓	✓	✓	✓	✓
Dong, 2018		✓	✓	✓	✓	✓	✓	✓	
Rusdiana, 2018		✓	✓	✓	✓	✓	✓	✓	

Suggested resistance sports as well as moderate to high levels of aerobic physical activity have been shown to reduce morbidity and mortality in men and women with T1DM and T2DM. A large cohort study on people with T2DM, showed that regular physical activity and/or moderate to high cardiorespiratory fitness (Church *et al.*, 2005; Gregg *et al.*, 2003; Hu *et al.*, 2001; Hu *et al.*, 2005) can reduce cardiovascular events and mortality. Additional benefits of aerobic exercise include improved cardiorespiratory fitness in T1DM and T2DM (Nielsen *et al.*, 2006) and slow progression of peripheral neuropathy (Balducci *et al.*, 2006). Resistance training improves glycemic control (decreased A1C), lowers insulin resistance, and increases muscle strength in adults with T2DM (Gordon *et al.*, 2009).

Physicians and other healthcare professionals can raise awareness of the importance of physical activity by promoting regular exercise as a key component of therapy and identifying resources in the community (Lin *et al.*, 2010). Patients must be promoted to set specific physical activity goals, anticipate possible barriers, such as weather, and competing time commitments as well as develop strategies to overcome these barriers (DeWalt *et al.*, 2009). Several studies revealed that structured physical activity counseling with skilled health workers (MacIntyre *et al.*, 2004; Petrella *et al.*, 2003; Wolf *et al.*, 2004) increased the level of physical activity, improved glycemic control (MacIntyre *et al.*, 2004), reduced the need for oral antihyperglycemic agents and insulin (Wolf *et al.*, 2004), and caused a simple but sustainable weight loss (Norris *et al.*, 2005). Education materials that can be given to DM patients include regular exercise to help control blood sugar levels, reduce the risk of heart disease and stroke, control weight, increase energy, lose weight or maintain a healthy weight (Bell *et al.*, 2012; Bukhsh *et al.*, 2018; Chong, 2016; Rusdiana *et al.*, 2018). A previous study was carried out to help individuals initiate and manage a regular daily 30-minute physical exercise program (Bukhsh *et al.*, 2018; Chong, 2016; Rusdiana *et al.*, 2018), while another study determined the right type of exercise for DM (Rusdiana *et al.*, 2018). Bukhsh *et al.*, 2018 revealed the relationship between physical activity and hypoglycemia (Bukhsh *et al.*, 2018). Exercise can be given as an intervention for patients suffering from DM-related complications (Bukhsh *et al.*, 2018).

Educational interventions about the use of DM medications are important to improve

adherence to therapy in T2DM. Positive outcomes and lower mortality in DM patients are associated with good adherence (Krapek *et al.*, 2004; Rhee *et al.*, 2005; Simpson *et al.*, 2006). Several studies have shown a significant positive relationship between DM knowledge and adhering to therapy (Al-Qazaz *et al.*, 2011; Lerman, 2005; Vlasnik *et al.*, 2005). The low level of patient knowledge causes a lower level of patient adherence to treatment (Albright *et al.*, 2001). Education material about medication for people can be given in terms of the importance of taking hypoglycemic drugs and encouraging them to use their drugs (Bukhsh *et al.*, 2018; Rusdiana *et al.*, 2018), correct technique for using insulin (Bell *et al.*, 2012; Bukhsh *et al.*, 2018; Chong, 2016), explain the purpose, action, use, side effects and administration of the drug (Bell *et al.*, 2012; Chong, 2016), the type of medicine for each patient (Bell *et al.*, 2012; Rusdiana *et al.*, 2018), as well as the right time and frequency of taking medication (Rusdiana *et al.*, 2018).

Materials related to the general complications of T2DM need to be provided to increase awareness regarding the incidence of DM complications that can reduce the quality of life and cause death. An increase in patient vigilantism against the incidence of complications helps to reduce morbidity and mortality. Materials that can be given include Identification and prevention of complications of diabetic foot, eye, cardiovascular, and kidney (Bukhsh *et al.*, 2018; Chong, 2016; Rusdiana *et al.*, 2018). Other materials addressed how to treat acute complications and personal health habits, such as education on good health habits in daily life, including foot and skin care, dental care, recognizing and preventing infection (Chong, 2016).

DM patients need to know the parameters that must be monitored to control the development of DM. Monitoring blood sugar levels is not only carried out by health professionals but patients or families must be able to perform this process independently. Therefore, they need to be exposed to several educational materials for people with DM, such as how to use a glucometer, blood glucose targets and HbA1c range, the ideal time and reason for self-monitoring (Bell *et al.*, 2012; Bukhsh *et al.*, 2018), the importance of monitoring cholesterol, and blood pressure regularly (Bell *et al.*, 2012). These material can also focus on increasing the knowledge of patients and families about the purpose of self-monitoring of the sugar level, how to record blood glucose readings, and understand the results (Chong, 2016; Rusdiana *et al.*, 2018).

DM patients need knowledge about their disease condition to help them identify the symptoms they are experiencing and ensure they get treatment as early as possible and appropriately. Some educational materials that need to be given to people with DM include general introduction about DM, its types, signs, symptoms associated (Bukhsh *et al.*, 2018; Chong, 2016), pathophysiology, and treatment (Chong, 2016).

T1DM or T2DM tend to have an increased risk of anxiety, depression, and an eating disorder diagnosis. The mental health comorbidities of DM can reduce patient adherence to treatment, thereby increasing the risk of serious acute and chronic complications, such as blindness, stroke, decreased quality of life, amputation, cognitive decline, and premature death. If the mental health comorbid is not diagnosed and treated, it can increase the cost of treatment and increase the burden on the health care system (Ducat *et al.*, 2014). Therefore, it is important to provide knowledge to DM patients on how to identify these problems as well as manage them.

Education of DM patients regarding foot care can change their behavior to prevent the incidence of ulcers and amputations. Foot care education showed an increase in the knowledge, willingness, and motivation of patients, which contributed significantly to changes in the behavior of DM patients about the management of their condition. It also provided better results in terms of body weight and blood pressure, both of which contributed positively to the prevention of diabetic ulcer (Nemcová & Hlinková, 2014). Furthermore, it has increased patient and health care staff awareness about the prevention and management of diabetic ulcers and can reduce lower extremity amputation rates (Alwahbi, 2010). Diabetic foot care education through flipchart displays and demonstrations on cleaning, drying, and examining feet. Several studies revealed that it can improve patients' ability to care for their feet and is effective in reducing the occurrence of diabetic ulcers (Saurabh *et al.*, 2014). The consensus diabetic foot care guideline recommends the provision of education on observing signs of pre-ulcers. Secondly, washing feet with soap and water, dry feet and the area between the fingers after washing. Thirdly, trimming the toenails weekly and in a straight cross-section). Fourthly, wearing clean socks made of cotton/non-slip with the right size. Lastly, check the inside and outside of the shoes/footwear before and after wearing them (Abrar *et al.*, 2020).

After receiving various kinds of educational materials, DM patients also need to gain knowledge about effective ways to set and implement goals for better self-management of the condition (Chong, 2016).

Limitation

There is a possibility of publication bias as only published data were included in this review. Twelve studies, marking up 66%, included in the analysis had an intervention time of less than 12 months, while one did not specify the length, hence, long-term outcomes were not assessed. In terms of outcome, this review mainly focused on glycemic control (HbA1c), and other clinical parameters such as lipid profile and blood glucose levels. The studies used in this review using intervention research complexes, such as the DSME trial are primarily conducted to determine the effectiveness rather than efficacy in traditional RCTs. The outcomes are often complex and consist of several interactive elements, and this is challenging to blind patients. Even if randomization was performed, there is still the potential for confounding bias, which can negatively impact the integrity of complex intervention trials.

CONCLUSION

Based on the results of a systematic study, providing education to DM patients can increase the achievement of clinical outcomes of patients. The materials that must be given to people with the disease to improve their clinical outcomes include setting nutritional management; physical exercise; monitoring blood glucose levels and other parameters; complications and risk factors; DM general knowledge; Medication/Treatment; Goal therapy and healthy living with DM; Mental health; and DM foot care.

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