

## REVIEW

# The effectiveness of self-management program to prevent diabetic nephropathy progression: a literature review

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## Abstract

**Aim:** The aim of the literature review was to identify evidence of the effectiveness of self-management programs in preventing progression of diabetic nephropathy. **Design:** A literature review. **Methods:** This review was conducted according to the Cochrane guidelines for systematic review research and complies with the Preferred Reporting Items for Systematic Reviews and Meta-Analysis. We found seven articles from electronic databases such as Science Direct, PubMed, and CINAHL from 2011 to 2021. Three researchers independently conducted study selections, extracted data, and assessed the data quality. **Results:** Seven studies were included (two randomized control trials and five quasi-experimental studies). We examined studies that provided deep analysis and explanation of self-management to prevent progression of diabetic nephropathy. **Conclusion:** All of the studies reported that self-management programs significantly improved behaviors aimed at preventing diabetic nephropathy progression such as dietary, physical activity, medication adherence, and smoking cessation. In addition to behaviors, the program also improved renal function, metabolic markers, and blood pressure.

**Keywords:** diabetic nephropathy, metabolic markers, renal functions, self-management program, type 2 DM.

## Introduction

The prevalence of type 2 diabetes mellitus (DM) is increasing rapidly worldwide, the greater the prevalence of type 2 DM, the greater the risk from its complications. Between 20%–40% of DM patients will develop diabetic nephropathy (DN) five years after their diagnosis (Perkovic et al., 2016; Yakush Williams, 2017), and 70% of end stage renal disease cases result from DM complications (Thojampa, 2017). DN has a direct impact on health expenditure of the country. In 2019, the total cost of type 2 DM complications reached 750 USD billion, including DN (Williams et al., 2020). Thus, preventing DN complications and its progression are very important to reducing this economic burden.

DN is characterized by decreasing estimated glomerular filtration rate (eGFR)  $< 60$  ml/min/1.73 m<sup>2</sup>, albuminuria  $> 30$  mg/g, and uncontrolled blood glucose (de Boer et al., 2020). A study conducted by Anders et al. (2018) reported that the first clinical sign

of DN is microalbuminuria, which will occur when a DM patient has experienced uncontrolled hyperglycemia. According to Gheith et al. (2016), there are five stages to the progression of DN. The first stage is a normal GFR, with duration of DM five years or less, renal size is 20% greater, and renal plasma flow is increased by 10–15% without albuminuria and hypertension. The second stage is the presence of stage 1 with normal GFR or a decrease in GFR in some cases, and thinning of the glomerulus wall. The third stage commonly occurs five to ten years after diagnosis of DM; the signs and symptoms of this stage are glomerulus damage, and microalbuminuria (30–300 mg/day). The fourth stage is decreasing GFR to below 60 ml/min/1.73 m<sup>2</sup>, proteinuria ( $> 300$  mg/day), and occurrence of hypertension. The last stage, also known as end stage renal disease (ESRD), is characterized by GFR of less than 15 ml/min/1.73 m<sup>2</sup>. The progression of DN can be prevented by controlling risk factors (Alicic et al., 2017).

Some previous studies have reported that the greatest risk factors of DN are hyperglycemia, dyslipidemia, smoking, hypertension, and the duration of DM

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(Alicic et al., 2017; Persson & Rossing, 2018). Another study has reported that the risk factors of DN can be divided into two groups: modifiable risk factors and intrinsic risk factors (such as age, sex, ethnicity family history, and duration of DM). Management targets to modify those factors should be performed such as glycemic control, blood pressure (BP), and lipid management (Yakush Williams, 2017).

Some studies have been conducted regarding the control of risk factors of DN by means of self-management. A study by Thojampa (2017) showed that a self-management and family participation enhancing program improved behaviors aimed at preventing DN progression and clinical outcomes including HbA1c, creatinine, eGFR, and blood pressure in a 12-week program involving patients with type 2 DM. A study by Kazawa and Moriyama (2013) found that a self-management program over six-months increased self-management ability, HbA1c, and renal function to delay DN progression in pre-dialysis patients. Another study reported that a program for promoting behavioral change improved self-management behaviors including diet, physical exercise, self-monitoring blood glucose, and medication. Beside those behaviors, this program also decreased HbA1c, BP, body mass index (BMI), and increased eGFR. This program was developed based on the stages of change (Prochaska & DiClemente, 2005).

In the last eleven years, Cochrane systematic reviews on the effectiveness of diabetes self-management in patients with DM aimed at preventing its complications in different contexts have appeared in the literature, such as management of lipid profile (Hawthorne et al., 2010), blood glucose management (Menezes et al., 2016), blood pressure control, renal function control (Evangelidis et al., 2019), smoking cessation and self-management (Hildebrand et al., 2020), and control of biomarkers (Pamungkas et al., 2017). However, systematic reviews focusing on the effectiveness of self-management behaviors in preventing DN are limited in number, with some studies only concerned with the effect of self-management activities on diabetes care (Coyle et al., 2013).

## Aim

The aim of the literature review was to establish the effectiveness of self-management in preventing DN progression.

## Methods

### Design

A literature review.

### Eligibility criteria

The review question was specified by using the PICO framework:

- P (population): patients over 18 years with duration of type 2 DM at least two years,
- I (intervention): self-management program,
- C (comparison): usual care,
- O (outcomes): self-management behaviors, clinical indicators, and renal function.

Randomized controlled trials (RCTs) and quasi-experimental studies were included if they met the following inclusion criteria: intervention study of a self-management program (including, but not restricted to DN diet, physical activity, smoking, blood glucose monitoring, and alcohol consumption) in an adult patient with duration of DM of at least two years. We did not select studies according to outcomes. However, we restricted studies to English only with a focus on prevention of DN progression in patients with type 2 DM. Furthermore, studies including a combination of pharmacological treatment, behavioral change, and clinical indicators were included. Studies were excluded if they reported pharmacological therapy only and other types of publication such as reviews, conference papers, chapters, editorial, and dissertations were also excluded.

### Search strategy

The data sources were articles found in the electronic databases Science Direct, PubMed, CINAHL, and Google Scholar from the beginning of 2011 to April 2021. In addition, we performed a manual search. Gray literature was not included due to a lack of information.

The following databases: Science Direct, PubMed, and CINAHL were searched by three independent researchers. The search strategy was based on the PICO guidelines (Schardt et al., 2007) using Medical Subject Heading (MeSH) terms related to diabetic nephropathy, self-management programs, behavioral change, and clinical indicators. We used the following search strategy in each database; “diabetes nephropathy” OR “diabetic kidney disease” AND “self-management program” AND “preventing diabetic nephropathy” OR “preventing diabetic kidney disease” AND “renal function” OR “kidney function”.

### Study Selection inc. PRISMA flow diagram

The first step was the screening of titles, abstracts, and full text of the articles for eligibility by three

researchers. When any of the keywords above was found in an abstract, the full text was retrieved. In the second step, the references of the selected articles were checked for additional eligible articles. In this step, authors applied the relevant inclusion and exclusion criteria. The third step was to further assess the full texts of the articles for eligibility. We used the Preferred Reporting Items for Systematic Reviews and Meta-analyses Statement (PRISMA) (Moher et al., 2009) as presented in the Figure 1.

### Evaluation of quality of articles

For quality assessment, the articles were divided into two groups, namely, the quasi-experimental group, and randomized controlled trial (RCT). Research using quasi-experiment was analyzed using the JBI critical appraisal checklist for quasi-experimental studies. Studies using a RCT design were analyzed using the JBI critical appraisal checklist for randomized controlled trials (Tufanaru et al., 2017).

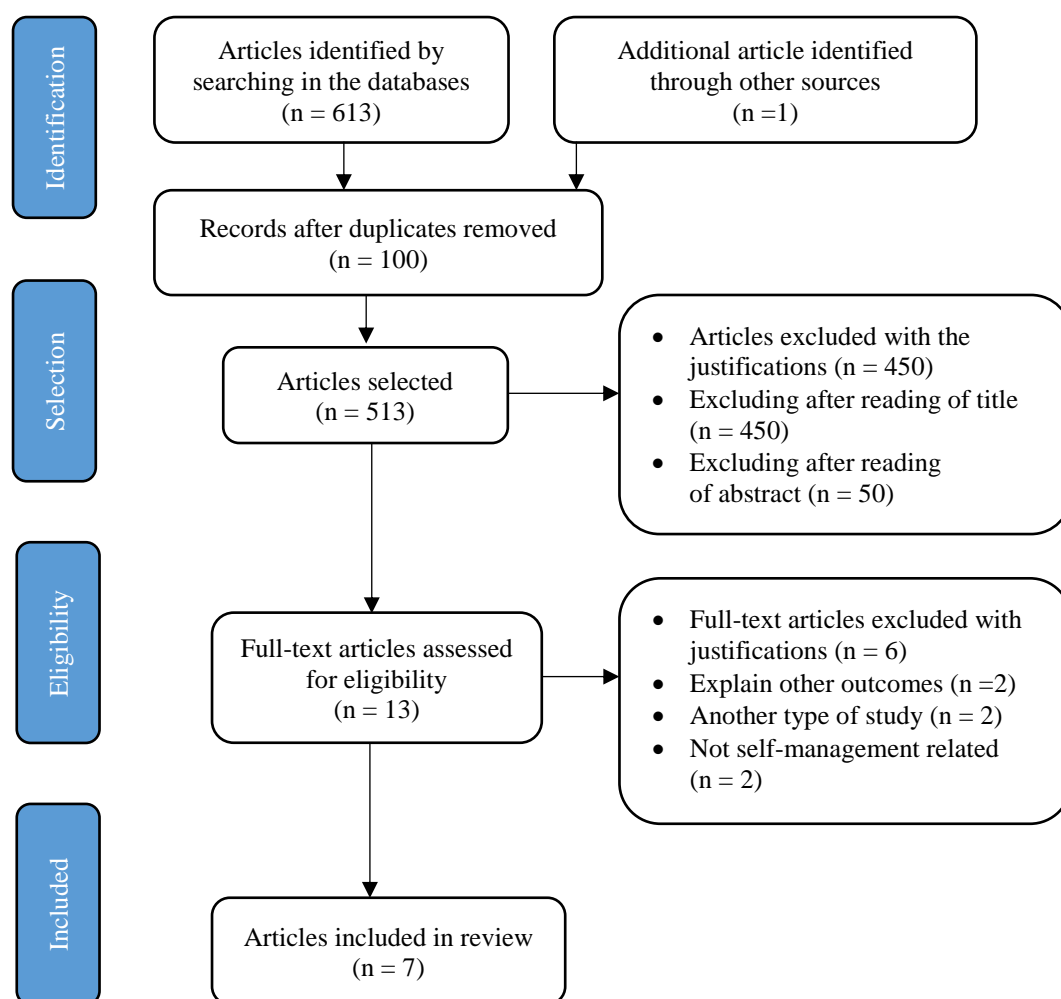
### Data extraction

Characteristics of the included primary studies are presented in Table 1. The element of the studies was author, the year of publication, country, interventions, methods, outcome measure, subject, tools, and results.

### Results

#### Characteristics of the studies

Table 1 shows that two studies used an RCT design (Kazawa et al., 2020; Yeoh et al., 2018) and the others were of a quasi-experimental design (Kazawa & Moriyama, 2013; Koh et al., 2011; Pagels et al., 2015; Thojampa, 2017; Youssef & Phillips, 2016). Studies were conducted in various countries in Asia (Kazawa & Moriyama, 2013; Kazawa et al., 2020; Koh et al., 2011; Thojampa, 2017; Yeoh et al., 2018; Youssef & Phillips, 2016), and Europe (Pagels et al., 2015). The samples of the studies were patients with type 2 DM (Koh et al., 2011; Thojampa, 2017), and five studies reported patients with diabetic nephropathy (Kazawa et al., 2020; Pagels et al., 2015; Yeoh et al., 2018; Youssef & Phillips, 2016).



**Figure 1** Selection process of studies based on PRISMA-ScR

### Professionals who conducted the interventions

In three of studies, interventions were conducted by nurses (Kazawa & Moriyama, 2013; Kazawa et al., 2020; Thojampa, 2017), some studies reported that multidisciplinary professionals worked together on interventions (Pagels et al., 2015; Youssef & Phillips, 2016), and in other studies nurses and physicians conducted the interventions (Koh et al., 2011; Yeoh et al., 2018).

### Effectiveness of self-management program to prevent DN progression

Of the seven articles identified, all studies reported the effectiveness of self-management intervention on improving HbA1c (Kazawa et al., 2020; Koh et al., 2011; Pagels et al., 2015; Thojampa, 2017; Yeoh et al., 2018), GFR and creatinine (Kazawa et al., 2020; Koh et al., 2011; Pagels et al., 2015; Yeoh et al., 2018; Youssef & Phillips, 2016), urea (Koh et al., 2011; Pagels et al., 2015; Youssef & Phillips, 2016), blood pressure (Kazawa et al., 2020; Koh et al., 2011; Pagels et al., 2015; Thojampa, 2017) self-management behavior (Kazawa et al., 2020; Pagels et al., 2015; Thojampa, 2017) self-efficacy (Kazawa & Moriyama, 2013; Thojampa, 2017), dietary behavior (Kazawa & Moriyama, 2013), world health organization-quality of life (WHO-QoL) (Kazawa & Moriyama, 2013), self-monitoring blood glucose (Kazawa

& Moriyama, 2013; Yeoh et al., 2018), exercise behavior (Kazawa & Moriyama, 2013; Pagels et al., 2015) blood glucose (Koh et al., 2011; Yeoh et al., 2018), and body weight (Kazawa et al., 2020; Pagels et al., 2015; Yeoh et al., 2018; Youssef & Phillips, 2016).

Most studies indicated that interventions were conducted on individuals (Kazawa et al., 2020; Koh et al., 2011; Pagels et al., 2015; Yeoh et al., 2018; Youssef & Phillips, 2016), while in some studies, interventions involved groups (Kazawa & Moriyama, 2013; Pagels et al., 2015; Thojampa, 2017). Studies were conducted in community service (Thojampa, 2017), clinical (Kazawa & Moriyama, 2013; Koh et al., 2011; Pagels et al., 2015; Yeoh et al., 2018; Youssef & Phillips, 2016), and other settings (Kazawa et al., 2020).

Regarding the intervention, self-management was organized through instruction both face to face at the clinic and at home (Kazawa & Moriyama, 2013; Pagels et al., 2015; Thojampa, 2017; Yeoh et al., 2018) via tablet computer (Kazawa et al., 2020) and mobile phone, and included follow-up sessions (Kazawa et al., 2020), and others (Koh et al., 2011; Youssef & Phillips, 2016).

**Table 1** Characteristics of studies (Part 1)

Authors (year), country	
<b>Kazawa &amp; Moriyama (2013), Japan</b>	
<b>Interventions</b>	self-management skills acquisition intervention was conducted during six- month educational program evaluation conducted at three months and six months
<b>Methods</b>	quasi experimental, one group, pre and post test design
<b>DV / outcome measures</b>	self-efficacy self-management ability HbA1c renal function
<b>Subject (n)</b>	30 patients with diabetes nephropathy
<b>Tools</b>	self-efficacy questionnaire WHO-QoL26 medical records for laboratory data
<b>Results</b>	improved self-efficacy, self-management skills at three month and six month evaluation QoL showed a slight increase with time but was not statistically significant HbA1c and renal function were improved at three month and six month evaluation

**Table 1** Characteristics of studies (Part 2)

<b>Authors (year), country</b>	
<b>Kazawa et al. (2020), Japan</b>	
<b>Interventions</b>	self-management education by using tablet computer (with developed application) intervention was delivered over six-month period self-management behaviors using model of behavioral change by Prochaska and DiClemente
<b>Methods</b>	RCT: triangulation methods involving quantitative and qualitative methods duration of six months respondents came from community
<b>DV / outcome measures</b>	behavioral change (self-management behaviors including diet, exercise, self-monitoring, medication) health outcomes including GFR, HbA1c, BP, BMI psychological indicators: self-efficacy and QoL
<b>Subject (n)</b>	40 respondents then randomly assigned (IG: 21; CG: 19)
<b>Tools</b>	guidebook for preventing DKD video education tablet computer (iPad mini iOS7.1.1) clinical devices questionnaire for self-management behaviors questionnaire for psychological indicators
<b>Results</b>	there were no significant differences regarding clinical indicators, self-management behaviors, and psychological indicators at the baseline after six months of program improved self-management behaviors to prevent DN in IG improved psycho-logical indicators in IG improved clinical indicators (GFR, HbA1c, BP, BMI)
<b>Koh et al. (2011), Malaysia</b>	
<b>Interventions</b>	1 km treadmill walk was performed, speeded gradually increased from a baseline of 3 km/h to 7 km/h and gradient from 0 to 2% intervention conducted over three months
<b>Methods</b>	quasi experimental, with three groups pre and post test design
<b>DV / outcome measures</b>	urine specimen (first morning void, immediately prior to exercise, one hr and two hrs after exercise) to assess renal function including albumin FBG HbA1c renal function
<b>Subject (n)</b>	35 patients with DM divided into four groups (normoalbuminuria group, microalbuminuria group, overt proteinuria group, and people without diabetes)
<b>Tools</b>	clinical devices at the Monash Medical Centre
<b>Results</b>	exercise improved FBG, HbA1c and renal function there was no significant difference in patient without diabetes
<b>Pagels et al. (2015), Sweden</b>	
<b>Interventions</b>	a group-based, multidisciplinary and multidimensional support program (MSP) the intervention was led by diabetology, and nephrology nurses (consisting of disease knowledge, skill training, and motivational approach) duration of program was six months
<b>Methods</b>	a quasi-experimental design
<b>DV / outcome measures</b>	clinical indicators (HbA1c, BMI, waist circumference, BP) physical activity
<b>Subject (n)</b>	58 patients with DKD patient came from renal outpatient clinic had GFR of more than equal 30
<b>Tools</b>	clinical devices
<b>Results</b>	improved all clinical indicators and physical activity compared to baseline data

**Table 1** Characteristics of studies (Part 3)

<b>Authors (year), country</b>	
<b>Thojampa (2017), Thailand</b>	
<b>Interventions</b>	self-management support and family participation enhancing program SM based on social cognitive theory duration of the intervention was 12 weeks
<b>Methods</b>	quasi-experimental study 50 adults with type 2 DM (25 EC and 25 CG) delivering intervention by using FGD method
<b>DV / outcome measures</b>	DV: delayed progression of DKD by measuring self-management activities, self-efficacy and clinical outcomes (GFR, creatinine, BP, HbA1c)
<b>Subject (n)</b>	50 adults with type 2 DM 25 EC and 25 CG subjects from Hospital diagnosed with type 2 DM at least five years
<b>Tools</b>	self-management activity questionnaire (SMAQ) self-efficacy questionnaire (SEQ) clinical devices
<b>Results</b>	there were no significant different at the baseline between EG and CG in week 12 improved self-management activities improved self-efficacy improved clinical outcomes (GFR, creatinine, BP, HbA1c)
<b>Yeoh et al. (2018), Singapore</b>	
<b>Interventions</b>	the programs were education in continual glucose monitoring (CGM) and education of SMBG for 12 weeks there were two groups, 1 <sup>st</sup> group received CGM, and the 2 <sup>nd</sup> group received SMBG
<b>Methods</b>	RCT
<b>DV / outcome measures</b>	HbA1c self-reported in hypoglycemia and hyperglycemia
<b>Subject (n)</b>	30 patients with type 2 DM
<b>Tools</b>	clinical device iPro device
<b>Results</b>	improve HbA1c in SMBG group for HbA1c, both groups showed improvement in self-reported hypoglycemia and hyperglycemia
<b>Youssef &amp; Phillips (2016), Cairo</b>	
<b>Interventions</b>	aerobic exercises and resistance exercises for three months
<b>Methods</b>	quasi experimental, pre-post test design
<b>DV / outcome measures</b>	kidney function (creatinin, urea) sodium, Hb, glucose, BP, and physical performance
<b>Subject (n)</b>	30 samples randomly assigned to aerobic exercise group and resistance group (30)
<b>Tools</b>	clinical devices exercise performance tools
<b>Results</b>	all clinical outcomes improved three months after intervention. However, aerobic exercise more significant

BMI – body mass index; BP – blood pressure; CG – control group; DKD – diabetes kidney disease; DV – dependent variable; EC – experimental group; FBG – fasting blood glucose; FGD – focus group discussion; GFR – glomerular filtration rate; Hb – hemoglobin; HbA1c – hemoglobin A1c; IG – intervention group; QoL (quality of life); RCT (randomized control trial); SMBG (self-monitoring blood glucose); WHO-QoL 26 – World Health Organization-Quality of Life 26

## Discussion

This review aimed to prove the effectiveness of self-management in preventing DN progression. Studies reported that self-management could improve self-efficacy, behavior aimed at preventing DN, and reduce renal function including GFR, creatinine, and urea. In addition to improvements in improve renal function, there was also a decrease in metabolic markers including HbA1c, and fasting blood glucose (Hisni, 2019; Hisni et al., 2019; Kazawa & Moriyama,

2013; Kazawa et al., 2020; Pagels et al., 2015; Thojampa, 2017). DN occurred five years or more after diagnosis of type 2 DM, with uncontrolled metabolic markers due to lack of adherence to treatment regimens.

Some self-management concepts were guided by nursing interventions, such as self-management based on social cognitive theory, 5 A's self-management concept, diabetes self-management according to the American Diabetes Association, and self-management

concepts consisting of self-monitoring, self-evaluation, and self-reinforcement based on Kanfer and Gaelick-Buys (1991).

Self-management program to improve behaviors, metabolic markers, and renal function to prevent DN progression DN is a complication of DM with a high prevalence worldwide (American Diabetes Association, 2018). DN is characterized by decreasing GFR, increasing urea, creatinine, and uncontrolled hyperglycemia. Risk factors of DN include uncontrolled type 2 DM, obesity, high BMI, and metabolic marker damage (Migdalis et al., 2020). To investigate patients who have high risk of DN, health professionals should examine renal function, HbA1c, fasting blood glucose, and carry out urine analysis, including proteinuria, glucosuria, and albuminuria (Anders et al., 2018).

While self-management studies have been conducted in recent years, in Indonesia they have been restricted to a focus on nursing studies. A self-management program was effective in improving self-efficacy, self-management behaviors, and psychological output including serum creatinine and GFR among patients with DM who developed early CKD. This intervention was conducted over a period of three months with two measurements (Li et al., 2011). A study conducted by Thojampa (2017) in Thailand revealed that a self-management program improved self-management activity, renal function, metabolic markers, and blood pressure. The intervention was conducted in a group over a 12-week period. Testing was performed three times: prior to the intervention or in the first week, in the sixth week, and at the end of the study after 12 weeks. The self-management concept used in the study was self-management according to Bandura (1989), focusing on social cognitive behaviors. Another study used a 5 A's self-management concept to prevent DM complications, including CVD (Hisni et al., 2019), which can be implemented to prevent DN progression.

Self-management programs to prevent DN progression consisted of: 1) dietary management, which involved a protein intake of no more than 0.8 g/kg containing 35% soy protein, 30% vegetable protein and 35% animal protein. Both diets had 2000 mg potassium, 2000 mg sodium, and 1500 mg phosphorus (Azadbakht et al., 2003); 2) physical activity that should be done 15 minutes a day, three times a week – the type of exercises included a range of motions, and non-weight bearing aerobic exercises for ten minutes a day, five days a week, with the duration gradually increased until 15 minutes was achieved (Youssef & Phillips, 2016), with exercises dependent on patient ability; 3) patients with or

without DN were instructed to pay attention to medication adherence such as metformin, and medication for reducing lipid profiles, and renal function and blood pressure as risk factors of DN (Shen et al., 2017); 4) smoking cessation for those who still active smoked (Cai et al., 2018).

Self-management can be used widely both in patients with chronic illness and acute illness. The findings of this systematic review can be applied by health workers, especially nurses. DM is a metabolic and chronic illness producing complications including DN. DN is characterized by decreasing urine albumin, eGFR, and increasing creatinine. Patients living with type 2 DM for at least five years should have their renal function examined regularly. They should also apply self-management including dietary behaviors, physical activity, smoking cessation, and medication adherence to prevent DN. These behaviors will improve both metabolic markers and renal function. However, studies focusing on this topic are still limited. Thus, more studies with long-term follow-ups and active control groups are needed to gain an understanding of the specific effect of self-management behaviors in preventing DN progression.

### **Limitation of study**

There were some limitations to the review. Firstly, the study reviewed both quasi-experimental and randomized controlled trials. Secondly, the target population in this study was adult patients with DM. Involving other populations such as the elderly and family members might highlight the effectiveness of self-management in preventing DN progression in patients with DM. Thirdly, only published articles were selected for this review; therefore, there might be some publication bias in the results.

### **Conclusion**

This literature review revealed that, according to some experts, self-management concepts, conducted both individually and in groups, had a significant effect on prevention of DN progression by improving behaviors including dietary, physical activity, smoking, and medication. Besides improving behaviors, self-management also improved metabolic markers, renal function, and blood pressure. These concepts can be led by nurses, physicians, and other health professionals, and require four to 12 weeks to achieve their aims.

### **Ethical aspects and conflict of interest**

There was no conflict of interest that might influence the results or interpretation.



## Funding

This work was supported by the *Lembaga Pengelola Dana Pendidikan* (LPDP) (grant No. 20201221645634).

## Author contributions

Conception and design (DH, PS, TSH, DA), data analysis and interpretation (DH, PS, DD), collected the data and reviewed the included studies (DH, DD). All authors read and approved the final manuscript.

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