Jurnal 1

by Rian Adi Pamungkas

Submission date: 03-Sep-2020 02:32PM (UTC+0700)
Submission ID: 1378776503
File name: 1-s2.0-S1871402119305831-main.pdf (949.38K)
Word count: 7899
Character count: 41346

Diabetes & Metabolic Syndrome: Clinical Research & Reviews 14 (2020) 53–61

Contents lists available at ScienceDirect

Diabetes & Metabolic Syndrome: Clinical Research & Reviews

journal homepage: www.elsevier.com/locate/dsx

Original Article

Self-management based coaching program to improve diabetes mellitus self-management practice and metabolic markers among uncontrolled type 2 diabetes mellitus in Indonesia: A quasi-experimental study

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ARTICLE INFO

Article history:
Received 7 October 2019
Received in revised form
7 December 2019
Accepted 7 December 2019

Keywords:
Self-management based coaching program
Uncontrolled T2DM
Diabetes self-management practice
Metabolic markers

ABSTRACT

Diabetes mellitus self-management practice is an essential part of diabetes management among uncontrolled type 2 diabetes mellitus (T2DM). This study aimed to examine the effectiveness of the diabetes mellitus self-management (DMSM) based coaching program on improvement of the DMSM practice and metabolic markers. A quasi-experimental study, pre-test, and post-test design with the non-equivalent control group were applied in this study. Sixty samples were selected and were randomly assigned to both the experimental group and the control group. The Diabetes Self-Management Questionnaire (DSMQ) was used to measure the DMSM practice, while metabolic biomarkers were assessed by using the laboratory test. We conducted and compared the DMSM practice and clinical value at baseline and 12 weeks after completing the program. The DMSM based coaching program was a 12-week program with several strategies based on a self-management model. The findings showed that patients who received the DMSM based coaching program have a positive effect on DMSM practice and metabolic marker except for body mass index (BMI). This study revealed that the DMSM based coaching program was practical and feasible for implementation in a broad population with uncontrolled T2DM in Indonesia.

1. Introduction

Diabetes mellitus (DM) is the world's third-largest chronic diseases in the past two decades. DM and its' complications significant increased financial burden to the families and community health, increased disabilities, reduced life expectancy, and ever-increasing costs of care in almost every country [1]. World Health Organization estimated that in 2018, more than 346 million people worldwide have been living with DM. This number will be increased double at the end of 2030 if without any intervention to manage [2]. Nearly 80% of diabetes mortalities occur in low and middle-income countries, including Indonesia. In Indonesia, almost 133 million people were reported as DM, and about 87.5% had not been met with the target goal of glycemic control [3] (see Table 1, Fig. 1).

Almost 80% of DM were T2DM. Glycemic control defined as the conditions of patients with DM who recently had hemoglobin A1c (HbA1c) levels at a level of 5–6% [4]. However, most of the patients were difficult to achieve the target goal of glycemic control. Factors associated with uncontrolled T2DM, including poor medication adherence, lack of blood glucose monitoring, low physical activity, and exceed consumed of unhealthy diet [5].

Poor glycemic control has a negative impact on treatment failures that will lead to poor health outcomes and long-term complications such as retinopathy, nephropathy, and neuropathy that contribute to mortality [6,7]. In the social-economic aspect, uncontrolled T2DM and its complications increase the substantial economic loss, medical costs, and loss of work as well as low quality of life [8]. Therefore, controlling and maintaining blood glucose within the normal range is a mean to reduce diabetes complications.

American Diabetes Association (ADA) recommended diabetes mellitus self-management (DMSM) practice as a critical strategy to empower patients to reach proper health outcomes to increase

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https://doi.org/10.1016/j.dsx.2019.12.002
1871-4021/

Table 1
Diabetes mellitus self-management based coaching program for the experimental group.

Session & strategy	Main activities	Multidisciplinary
Reflection, pre-test, and sharing experience	• Assessment of baseline data, DMSM practice and measuring metabolic markers • Reflecting the current behaviors among diabetic patients • Sharing experience regarding diabetes self- management and problems on diabetes self-management	• Researcher • Research assistant • Medical laboratory staff • Nurses
Goal Setting	• Goal setting on how to perform regular physical activity, to select healthy food from food list, medication adherence, and blood glucose monitoring.	• Researcher
Small group discussion	• Discussion on how to prepare a healthy menu for diabetes patients • Discussion on the importance of physical activity and types of exercise to fit with diabetic patients • Discussion on the importance of regular blood glucose monitoring and medication adherence	• Nurses • Researcher • Dieticians
Case study	• Case study of diabetes complications and practical strategies to solve the problems	• Researcher and assistant
Individual coaching	• Coaching patients to prepare a simple menu to control blood sugar, managing the portion size by using the plate method, hand portion, and how to read food label • Coaching patients to perform physical activity in readiness of performing the physical activity and warm-up exercise and cooling down conditioning after completing the physical activity • Coaching patients to manage the hypoglycemia • Coaching patients to perform self-report on medication adherence	• Dieticians • Researcher • Nurses
Role-play	• Demonstrate how to conduct the self-monitoring blood glucose by using a simple tool kit, and how to record the results into the logbook • Role-play on how to perform foot inspection, and to check the neuropathy by using monofilament test	• Researcher • Research assistant
Follow-up and home visit	• Telephone follow-up (2 times per month) to identify barriers of DMSM practice • Home visit for individual counseling and empowering them to solve the problem of DMSM practice • Face to face follow-up at public health centers	• Researcher • Research assistant
Post-test	• Assessment of DMSM practice, metabolic markers	• Researcher • Laboratory staff

psychological balance, and to improve behaviors changed [9,10]. It led to improving 24-h-a-day activity and often includes changes in lifestyle behaviors. DMSM requires patients able to reconcile their resources, value, and preferences with the healthy diet, actively in physical activity, avoiding the smoking cessation and alcohol intake, adherence to medication taking, blood glucose monitoring, and prevent from a complication [5].

DMSM practice could improve the behaviors and metabolic markers, such as fasting blood glucose, total cholesterol level, and blood pressure level [5,11]. A self-management program has been proved as an essential foundation to improve health-related behaviors and the clinical outcomes of T2DM patients. A study conducted using 5A's self-management concept could facilitate the behavioral changed among chronic illness [12]. A previous quasi-experimental study had been done in Indonesia, which was focused on improving dietary and exercise behaviors [13]. However, the study just emphasized education by teaching methods rather than participatory learning among patients themselves. This previous study also lacked implementing five pillars of diabetes mellitus self-management (DMSM) practice including a healthy diet, being active in physical activity, medication adherence, diabetes self-monitoring as well as preventing the diabetes complications, whereas to improve the health outcomes and to avoid diabetes complication patients need to applied DMSM practice ultimately.

In the current study, before program development, the researcher conducted a preliminary study by using a qualitative method to explore the patients' needs and possible obstacles on DMSM practice to ensure the program has been fixed with patients' needs.

The program was not only education but also required participatory learning of patients as active learning and sharing experience with other patients. The researcher also conducted individual coaching, small group discussion, role play, as well as provided demonstration and practice for the patients to improve their knowledge and build up their skills in DMSM practice. The researcher also conducted telephone follow-up and home visits to address the barriers and means to show it while implementing the program. The strategy is essential to assist the patients in dealing with the problems. Therefore, this study proposed to examine the effectiveness of DMSM based coaching program on improving the DMSM practice and metabolic biomarkers among Indonesian communities with uncontrolled T2DM. Findings from this study will be beneficial to local health care services to apply the activities with routine services to improve DMSM practice among the target population to prevent complications and maintain their health status.

2. Methods

2.1. Design

This study was conducted by using a quasi-experimental study, pre-test and post-test design with a non-equivalent control group to examine the effect of DMSM based coaching program on health outcomes among uncontrolled T2DM patients.

2.2. Sample size, setting, and intervention procedure

In the present study, a total of 60 uncontrolled T2DM were recruited from public health centers, Polewali Mandar District, Indonesia. Patients were randomly assigned using a simple random sampling technique into either experimental group ($n = 30$) and control group ($n = 30$). The sample size calculation was based on a comparative study of two mean average from the previous study between the experimental group and the control group. From the previous study of Cai et al. (2016) [14] found mean ± SD of 28.16 ± 5.82 in the experimental group, while in the control group was 21.38 ± 4.17 with significant level 5% for the one-sided test ($Z_\alpha = 1.645$) and 20% power of the test ($Z_\beta = 0.98$). The total sample

Table 2
Comparison of demographic and health information between the experimental and the control group (N = 60).

Characteristics	Experimental group (n = 30)		Control group (n = 30)		p
	n	%	n	%	
General information					
Aged (Min-Max = 34–69)	M = 56.2	SD = 7.63	M = 54.5	SD = 9.20	.439[a]
Sex					.152[b]
Male	6	20	11	36.7	
Female	24	80	19	63.3	
Marital status					–
Married	30	100	50	100	
Had not married	0	0	0	0	
Occupation					.214[b]
Not working	2	6.7	2	6.7	
Housewife	18	60.0	12	40	
Farmer	5	16.7	6	20	
Seller	1	3.3	1	3.3	
Retirement	2	6.7	4	13.3	
Entrepreneur	1	3.3	1	3.3	
Civil servant	1	3.3	4	13.3	
Education					.709[b]
Not study	6	20	1	3.3	
Primary school	6	20	7	23.3	
Secondary school	5	16.7	7	23.3	
High School	10	33.3	8	26.7	
Diploma	0	0	0	0	
Bachelor/master	3	10	7	23.3	
Family history of diabetes					.438[b]
Have diabetes	14	46.7	17	56.7	
No have diabetes	16	53.3	13	43.3	
Clinical factors					
Duration of illness	M = 4.42	SD = 1.56	M = 4.27	SD = 1.66	.720[a]
Comorbidity					.205[b]
No have comorbidity	10	33.3	8	26.7	
Hypertension	3	10.0	7	23.3	
Cholesterol	13	43.3	10	33.3	
Hypertension + cholesterol	2	6.70	2	6.70	
Rheumatoid	2	6.70	0	0.00	
Allergy	0	0.00	3	10.0	
Physiology factors					
Weight (kg)	M ±SD = 55.33 ± 8.25		M±SD = 59.83 ± 10.26		.103[a]
Height (cm)	M ±SD = 152.97 ± 6.98		M±SD = 155.97 ± 6.26		.848[a]
Body mass index (kg/m^2)	M ±SD = 23.70 ± 3.52		M±SD = 24.62 ± 3.50		.065[a]
FBG (mg/dl)	M ±SD = 229.50 ± 62.19		M±SD = 254.40 ± 100		.049[a*]
HbA1c (%)	M ±SD = 8.04 ± 1.96		M±SD = 8.55 ± 2.95		.112[a]
Systolic BP (mmHg)	M ±SD = 128 ± 13.83		M±SD = 128 ± 18.21		.058[a]
Diastolic BP (mmHg)	M ±SD = 83.33 ± 7.11		M±SD = 82 ± 8.86		.178[a]
Cholesterol total (mg/dl)	M ±SD = 204 ± 32.66		M±SD = 199 ± 41.35		.435[a]
LDL (mg/dl)	M ±SD = 117.6 ± 49.61		M±SD = 107.50 ± 37.24		.417[a]
HDL (mg/dl)	M ±SD = 65.17 ± 14.40		M±SD = 65.47 ± 23.81		.001[a]
Behavior factors					
Smoking status					.026[b*]
Current smoking	1	3.3	2	6.7	
Quit from smoking	0	0	6	20.0	
No smoking	29	96.7	22	73.3	
Alcohol drinking status					.313[b]
Drinking	0	0	1	3.3	
No drinking	30	100	29	96.7	
History of exercise					.228[b]
Actively exercise	28	93.3	25	83.3	
No exercise	2	6.7	5	16.7	
Frequency of exercise					.218[b]
Everyday	4	13.3	2	6.7	
Three times per week	4	13.3	4	13.3	
Once a week	21	70.0	17	56.7	
Once a month	0	0	2	6.7	
No active	1	3.3	5	16.7	

Note: FBG (Fasting blood glucose), BP (Blood pressure), LDL (Low density lipoprotein), HDL (High density lipoprotein).
a = p-value from *t*-test.
b = p-value from χ^2-test.
* Significant at p-value <0.05.

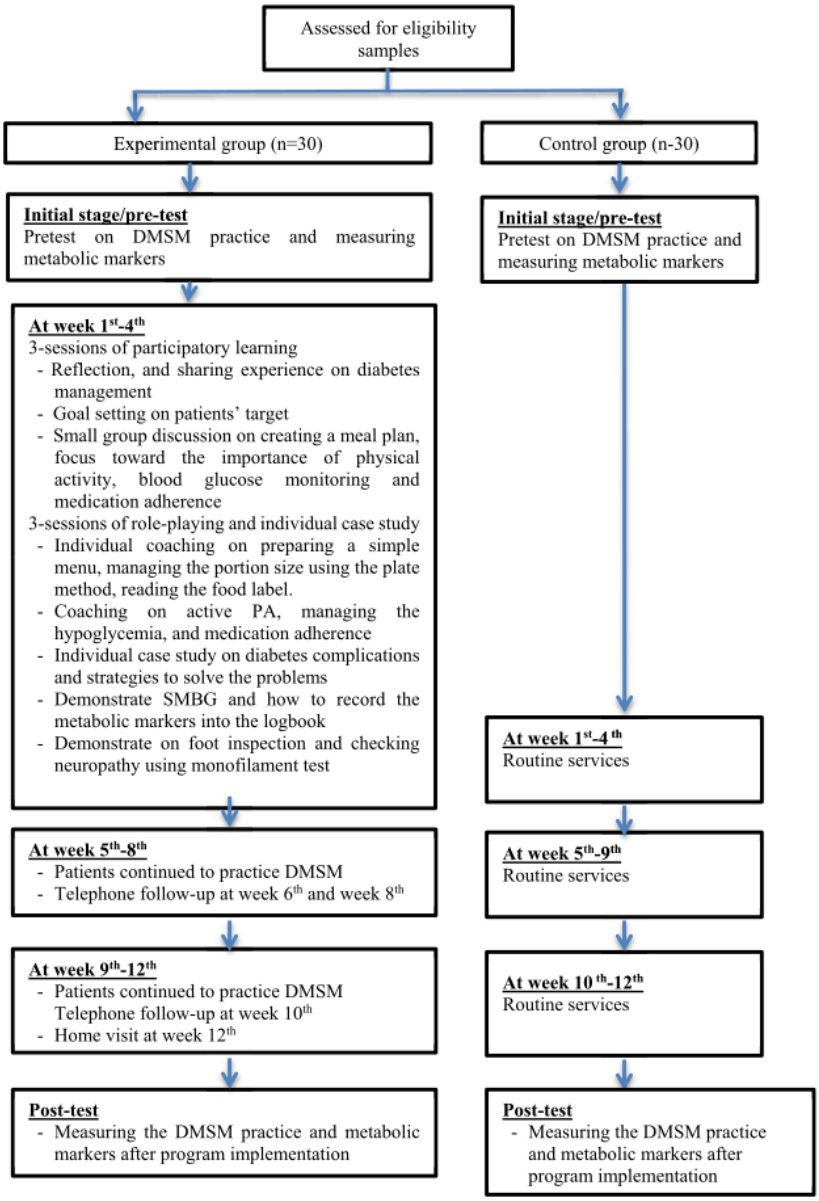

Fig. 1. Samples allocation and program implementation.

for each group was 22. Thus, 20% was added up to prevent loss to follow-up, then the samples per each group were 30 patients.

The potential participants were glycemic uncontrolled, who met the inclusion criteria: 1) HbA1c level ≥6.5%, 2) aged 35–59 years, and 3) be able to communicate in the Indonesian language, both verbal and written. Diabetes-related severe complications that caused the patients to be unable to continue participating in this study, and have to be hospitalized for any reason during the intervention process were excluded from the program.

2.3. Diabetes mellitus self-management based coaching program

Diabetes mellitus self-management based coaching program was developed based on the self-management model. The program aimed to improve diabetes self-management practice and metabolic biomarkers among uncontrolled T2DM patients. Patients who were in the experimental group received a 12-week participatory learning program. The program consisted of 3-sessions of participatory learning to increase the patients' understanding of diabetes care. The program comprised 1) reflection on current behavior, assessment on DMSM practice and measuring the clinical outcomes, and sharing experience of diabetes management and problem on diabetes management; 2) goal setting on how to perform the regular physical activity, selecting the health food; and 3) small group discussion on preparing healthy food for diabetes patients, importance of physical activity and how to do an exercise,

blood glucose monitoring as well as medication adherence.

Three sessions of role-playing and case studies were conducted to build up the skill in DMSM practice. It included three mains parts. The first part concerned on individual coaching toward preparing a simple menu, and coaching in readiness of performing the physical activity, managing hypoglycemia as well as performing self-report on medication adherence. The second part focused on a case study of diabetes complications and how to solve the problem. The last part emphasized a self-monitoring blood glucose by using a simple tool kit, and how to record the results into the logbook. The researcher also demonstrated how to perform foot inspection and to check neuropathy by using a monofilament test.

Addressing the barriers of DMSM implementation, the researcher conducted four sessions of follow-up by using telephone call. Home visit and individual counseling were conducted at patients' homes to enhance continuing of DMSM practice. In this session, discussion and sharing on problems they faced while implementing the DMSM practice and how to manage each issue was also discussed.

The participants in the control group were only received a routine services based on guidelines from the community health center. The routine services provided by healthcare providers at community health centers were regular blood glucose check-ups, education programs, and group aerobic exercise.

2.4. Instruments

Three questionnaires were used to collect the data from both the experimental group and the control group. The questionnaires were also checked for content validity by three experts. The researcher conducted a pilot test to examine the reliability of the questionnaires from 30 participants. The questionnaires were divided into three parts, including; 1) socio-demographic and health information (SDHI), 2) diabetes self-management questionnaire (DSMQ), and metabolic markers. Details of each part are as follows:

2.4.1. Socio-demographic and health information (SDHI)

The socio-demographic and health information (SDHI) was applied to measure the general information, clinical factors, physiological factors, and behavioral risk factors. The SDHI was assessed by using the interview questionnaire.

2.4.2. Diabetes self-management questionnaire (DSMQ)

Diabetes self-management questionnaire (DSMQ) was used to measure diabetes mellitus self-management (DMSM) practice, including diet control, physical activity, blood glucose monitoring, medication adherence, and prevention of diabetes complications. The questionnaire was modified from a previous study [15]. The English version of DMSM was translated into the Indonesian translation and back-translated by an expert. The internal consistency showed that Cronbach's alpha coefficient was 0.84, which is considered a reliable questionnaire.

The DMSQ consisted of five components, including a healthy diet (4 items), physical activity (3 items), blood glucose monitoring (4 items), medication adherence (2 items), and complication prevention (3 items). The DMSQ scores ranged 0–3, such as 0 = not at all, 1 = sometime, 2 = often, and 3 = regularly. High rating indicate more considerable diabetes self-management practice.

2.4.3. Metabolic markers

Metabolic markers including HbA1c, systolic and diastolic blood pressure, body mass index (BMI), total cholesterol level, high-density lipoprotein (HDL) level, and low-density lipoprotein (LDL) level were taken into account. The HbA1c, systolic and diastolic blood pressure, BMI, total cholesterol level, HDL, and LDL were measured at the beginning before implementing the program and at three months after program implementation by using the laboratory results.

The BMI was measured by using a standard method of body weight divided by the square meter of body height (kg/m^2). The BMI was classified as BMI<18.5 (underweight), BMI = 18.5–24.9 (normal), BMI = 23–24.99 (overweight), BMI 25–29.9 (obese), and BMI of 30 and higher (severely obese). The systolic blood pressure and diastolic blood pressure were examined by using a mercury sphygmomanometer. The blood pressure was taken in the upper arm with a mercury sphygmomanometer. Individuals should be comfortably seated for approximately 10 min with the legs uncrossed, and the back and arms supported so that the middle of the cuff on the upper arm is at the level of the right atrium (the mid-point of the sternum).

2.5. Statistical analysis

The continuous data were expressed as mean and standard deviation (SD). Shapiro-Wilk test was applied for normality test checking the normal distribution. The Chi-square test and independent *t*-test were used to examine the differences between demographic data and health information, including general information, clinical factors, metabolic markers, and behavioral factors. The paired *t*-test was used to measure the difference of mean score within-group before and after receiving the DMSM based coaching program. The researcher used the independent *t*-test to estimate the mean difference between the experimental group and the control group.

2.6. Ethical considerations

The committee of the Ethical Review Board, Faculty of Public Health, Mahidol University, has approved this research (IRB number: MUPH 2018-173). Informed consent was obtained from each participant who willing to participate in this study.

3. Results

3.1. Demographic and health information

The most significant percentage of the participants in the experimental group (80%) and control group (63.3%) were females who have an average age was 56.2 ± 7.63 years in the experimental group and 54.5 ± 9.20 years in the control group. Some of the participants in the experimental group graduated from high school (33.3%), and 26.7% found in the control group. About 20% in the experimental group were illiterate, while only 3.3% found in the control group. Regard the family history of diabetes, nearly half of participants (53.3%) in the experimental group (46.7%) and more than half (56.7%) in the control group had their family history of diabetes mellitus. Some of them (46.7%) mentioned that their parents had been diagnosed as diabetes long term ago. The duration of illness in both experimental and control groups was more than four years (4.42 ± 1.56 and 4.27 ± 1.66 years). Less than half of the experimental group (43.3%) and control group (33.3%) have comorbid diseases of hypertension and high cholesterol. There was no significant difference in the clinical characteristics of the subjects between the experimental and the control group.

The mean BMI of the experimental group was 23.7 ± 3.52 kg/m^2, while in the control group was 24.62 ± 3.5 kg/m^2, which were closed to the overweight level. The mean average of the total cholesterol level for the experimental group was 204 mg/dl (SD = 32.66) and was 199 mg/dl (SD = 41.35) for the control group.

However, the mean average of systolic blood pressure in both groups was normal (128 ± 13.83 mmHg and 128 ± 18.21 mmHg). There was no significant difference in the metabolic markers between the experimental group and the control group.

Regarding the behavioral factors, the majority of the participants in both the experimental group (96.7%) and the control group (73.3%) were non-smoke; only a few patients were current smokers, as 3.3% found in the experimental group and 6.7% in the control group. No patients in the experimental group (100%) drunk alcohol, and more than ninety percent of patients in the control group also avoid drinking alcohol. The majority of the patients in the experimental and control group have a history of exercise with the frequency of activity only once a week (70% and 56.7%).

3.2. Comparison of mean scores of diabetes mellitus self-management (DMSM) practice among uncontrolled T2DM patients before and after program implementation

Table 3 explained the effect of the DMSM based coaching program on DMSM practice among uncontrolled T2DM patients (see Table 2). The results showed that all components of DMSM practice after implementation were significantly improved than before the implementation of the DMSM program. For example, dietary control ($p < 0.001$), actively physical activity ($p < 0.001$), blood glucose monitoring ($p < 0.001$), medication adherence ($p < 0.001$), and prevention of diabetes complications ($p < 0.001$). All components in the experimental group were significantly higher than after receiving the DMSM program than before receiving the DMSM program.

While among the control group, it was found that almost of the DMSM components after implementation were not significantly different compared with before implementation as follows: dietary control ($p = 0.951$), actively physical activity ($p = 0.527$), medication adherence ($p = 0.825$), and prevention of diabetes complication ($p = 0.670$). It found only blood glucose monitoring was a significant difference ($p < 0.001$) after implementing the DMSM program than before implementation program.

Table 4 showed the comparison of the mean score of DMSM practice between the experimental group and the control group. It was found that all components of DMSM practice among the experimental group were significantly higher than the control group after implementation as follows: dietary control (p=<0.001), actively physical activity (p=<0.001), blood glucose monitoring (p=<0.001), medication adherence (p=<0.001), and prevention of diabetes complication (p=<0.001). Before implementation of the DMSM based coaching program, patients of both experimental and control groups were not significantly differenced in all components of DMSM practice.

3.3. Comparison of metabolic markers between the experimental and control group

Table 12 showed the comparison of the mean score of metabolic markers between the experimental group and the control group. The results showed that all components of metabolic markers after implementation were significantly improved than before the implementation of the DMSM program. Details were as follows: HbA1c ($p < 0.001$), systolic blood pressure ($p = 0.006$), diastolic blood pressure ($p < 0.001$), total cholesterol ($p < 0.001$), HDL ($p < 0.001$), and LDL ($p = 0.002$). While only BMI was not found the significant difference ($p = 0.383$).

Among the control group, it was revealed that almost all of the metabolic markers after implementation were not significantly different compared with before implementation of the DMSM based coaching program. For example, HbA1c ($p = 0.093$), systolic blood pressure ($p = 0.715$), diastolic blood pressure ($p < 0.136$), BMI ($p = 0.896$) total cholesterol ($p = 0.639$), HDL ($p = 0.467$), and LDL ($p = 0.378$) after implementing the DMSM based coaching program than before implementing program.

Table 6 showed the comparison of metabolic markers between the experimental and the control group. The results revealed that there were positive effects on the reduction of patients' metabolic markers among the experimental group after the implementation of the DMSM based coaching program compared to before. Findings were summarized as, HbA1c ($p < 0.001$), systolic blood pressure ($p = 0.003$), diastolic blood pressure ($p = 0.035$), total cholesterol ($p = 0.024$), HDL ($p = 0.001$) and LDL ($p = 0.005$) respectively. Whereas, the body mass index showed no significant difference between the experimental group who received the DMSM based coaching program than a control group who received the usual care ($p = 0.329$).

4. Discussion

4.1. Socio-demographic data and health-related information

Most of the patients in both experimental (80%) and control group (63.3%) were females. The average patients' age of the experimental group was 56.5 ± 7.63 years old, and the control group was 54.2 ± 9.20 years old. The results indicated that T2DM tends to be found more among females. The previous study also showed that females were increased risk of T2DM since they have

Table 3
The comparison of mean score on patients' DMSM practice, before and after receiving intervention among the experimental and the control group.

Variable	Pre-test		Post-test		t	df	p
	Mean	SD	Mean	SD			
Patients' DMSM practice among the experimental group							
a. Dietary control	3.97	1.497	9.33	1.971	−11.76	29	<0.001*
b. Actively physical activity	3.43	2.063	6.87	1.358	−7.13	29	<0.001*
c. Blood glucose monitoring	4.53	1.776	10.23	1.478	−15.45	29	<0.001*
d. Medication adherence	2.57	1.382	4.97	.999	−8.38	29	<0.001*
e. Prevention of diabetes complication	1.90	2.074	6.27	1.258	−11.08	29	<0.001*
Patients' DMSM practice among the control group							
a. Dietary control	5.20	2.074	5.17	1.840	0.63	29	.951
b. Actively physical activity	3.53	1.978	3.77	1.251	-.641	29	.527
c. Blood glucose monitoring	5.33	2.845	7.40	1.354	−3.781	29	<0.001*
d. Medication adherence	3.03	1.790	3.10	.607	-.223	29	.825
e. Prevention of diabetes complication	1.97	1.810	2.13	1.196	-.431	29	.670

Note: DMSM (Diabetes self-management).
* Significant at p-value <0.05.

Table 4
Comparison of means scores on patients' DMSM practice between the experimental and the control group before and after implementing the DMSM based coaching program.

Variable	*Experiment group (n = 30)*		*Control group (n = 30)*		t	df	p
	Mean	SD	Mean	SD			
Before the implementation of the DMSM program							
a. Dietary control	3.97	1.497	4.37	1.273	−1.115	58	.845
b. Physical activity	3.43	2.063	3.23	1.455	.434	58	.080
c. Blood glucose monitoring	4.53	1.776	4.07	1.574	1.077	58	.614
d. Medication adherence	2.57	1.382	3.03	1.790	−1.130	58	.149
e. Prevention of diabetes complication	1.90	2.074	1.97	1.810	-.133	58	.316
After the implementation of the DMSM program							
a. Dietary control	8.83	1.802	5.17	1.840	7.798	58	<0.001*
b. Physical activity	6.87	1.358	3.77	1.251	9.197	58	<0.001*
c. Blood glucose monitoring	10.23	1.478	7.40	1.354	7.741	58	<0.001*
d. Medication adherence	4.97	.999	3.10	.607	8.742	58	<0.001*
e. Prevention of diabetes complication	6.27	1.258	2.13	1.196	13.046	58	<0.001*

Note: DMSM (Diabetes self-management).
*Significant at p-value <0.05.

Table 5
The comparisons of mean scores on metabolic markers, before and after implementation DMSM based coaching program within the experimental and within the control group.

Variable	*Pre-test*		*Post-test*		*t*	*df*	*p*
	Mean	*SD*	*Mean*	*SD*			
Metabolic markers within the experimental group							
a. HbA1c	8.04	1.960	6.44	1.144	5.998	29	.001*
b. Systolic BP	128.67	13.83	120.00	11.14	2.982	29	.006*
c. Diastolic BP	83.33	7.112	72.50	8.685	6.089	29	.001*
d. BMI	23.70	3.529	23.58	2.800	.207	29	.838
e. Total cholesterol	204.33	32.66	176.13	22.38	4.308	29	.001*
f. HDL	65.17	14.40	91.80	20.73	−6.955	29	.001*
g. LDL	117.63	49.61	89.10	14.91	3.446	29	.002*
Metabolic markers within the control group							
a. HbA1c	8.55	2.953	8.240	2.60	1.739	29	.093
b. Systolic BP	128.33	18.21	129.67	14.30	-.369	29	.715
c. Diastolic BP	82.00	8.867	78.00	10.95	1.533	29	.136
d. BMI	24.32	3.51	24.28	2.69	.132	29	.896
e. Total cholesterol	199.73	41.35	198.30	38.47	.475	29	.639
f. HDL	65.47	23.81	61.57	19.34	-.737	29	.467
g. LDL	107.50	37.24	109.57	35.66	.896	29	.378

Note: HbA1c (Hemoglobin A1c), BP (Blood pressure), BMI (Body mass index), HDL (High density lipoprotein), LDL (Low density lipoprotein).
* Significant at p-value <0.05.

Table 6
Comparison of means scores on patients' metabolic markers between the experimental and the control Group.

Variable	*Experiment group*		*Control group*		*t*	*df*	*p*
	Mean	*SD*	*Mean*	*SD*			
Pre-test of metabolic markers							
a. HbA1c	8.043	1.960	8.553	2.952	-.788	58	.434
b. Systolic BP	128.67	13.83	128.33	18.21	.080	58	.937
c. Diastolic BP	83.33	7.112	82.00	8.867	.643	58	.523
d. Body mass index	23.70	3.529	24.32	3.510	-.680	58	.499
e. Total cholesterol	204.33	32.661	199.73	41.355	.478	58	.643
f. HDL	65.17	14.406	65.47	23.815	.895	58	.953
g. LDL	117.63	49.611	107.50	37.246	-.059	58	.375
Post-test of metabolic markers							
a. HbA1c	6.440	1.144	8.240	2.605	−3.464	58	.001*
b. Systolic BP	120.00	11.142	129.67	12.72	−3.130	58	.003*
c. Diastolic BP	72.50	8.685	78.00	10.95	−2.155	58	.035*
d. Body mass index	23.58	2.800	24.28	2.690	-.984	58	.329
e. Total cholesterol	176.13	22.38	198.30	38.479	−2.315	58	.024*
f. HDL	91.80	20.73	61.57	19.349	5.839	58	.001*
g. LDL	89.10	14.910	109.57	35.663	−2.900	58	.005*

Note: HbA1c (Hemoglobin A1c), BP (Blood pressure), BMI (Body mass index), HDL (High density lipoprotein), LDL (Low density lipoprotein).
* Significant at p-value <0.05.

less physically active regarding control their diseases when compared to males [16]. It was consistent with another study reported that most females are lacked diabetes treatment and took this issue less of a priority than males toward diabetes management [17].

This study also found that most of the diabetes patients did not meet the target goals of HbA1c less than 6.5%, which means they are uncontrolled glycemic T2DM. They have been living as uncontrolled glycemic T2DM for more than four years. Consistent with the previous study, which conducted in Jordan, reported that patients with long-term duration of illness were more likely to have uncontrolled glycemic T2DM [18]. Another study also showed that a more prolonged period of disease was positively associated with uncontrolled diabetes [19].

The average BMI among patients in both experimental groups and the control group were 23.70 ± 3.52 and 24.62 ± 3.50. This finding was indicated that most of the patients in the experimental group and the control group were overweight. Similarly, previous studies found that patients with higher BMI levels were more likely to be uncontrolled T2DM than those patients who have a normal BMI [20,21]. Another study also reported that higher waist circumference was positively associated with uncontrolled T2DM [19]. The mean score of HbA1c in the experimental and the control group was 8.04% and 8.55%, respectively. This study also reported that only 31.66% of men and 26.00% of women had controlled the level of HbA1c [19]. It was due to men had provided more attention and priority on health.

The mean average of total cholesterol levels of patients in the experimental group was 204 ± 32.66 mg/dl, and the control group was 199 ± 41.35 mg/dl. The Low-Density Lipoprotein (LDL) level in the experimental group was 117.63 ± 49.61 mg/dl, and the control group was 107.5 ± 37.24 mg/dl. The results indicated that most patients have hypercholesterolemia. The results were congruent with the previous studies found that high cholesterol level was more likely to be found among uncontrolled T2DM and as a significantly higher risk of microvascular complications [20,22]. Another study also showed that most patients have an LDL level greater than 100 mg/dl. Thus, the condition was associated with uncontrolled T2DM [19].

4.2. The effectiveness of the diabetes mellitus self-management based coaching program on diabetes mellitus self-management practice among uncontrolled T2DM patients

The results in this study showed that the DMSM practice was significantly increased in the experimental group. The improvement of DMSM practice was due to an application of the self-management concept. In this study, the researcher conducted a 12-week DMSM based coaching program including 3-sessions of participatory learning, 3-sessions on role play, and individual case study, as well as 2-sessions of telephone follow-up and home visits. The first process was reflecting the current DMSM behavior, brainstorming, and sharing experience. The findings could provide valuable information toward the context of DMSM implementation among uncontrolled T2DM. The second process was a small group discussion on preparing a healthy meal for diabetes patients, the importance of physical activity, regular blood glucose monitoring, as well as medication adherence. The strategies were essential to improve the patients' understanding of diabetes and DMSM practice for uncontrolled T2DM. The finding was consistent with a previous study mentioned that in-depth information could improve DMSM practice and prevent patients' misunderstanding of diabetes care [23]. Another study also indicated that providing individual education enabled the patient to feel free to obtain more knowledge and adequate problem-solving skill when they faced the barriers [24].

The improvement of DMSM practice for uncontrolled T2DM patients was also due to the development of personal goal setting and action plans. In this study, patients set the personal goals on doing regular exercise, selecting a healthy diet as well as achieving the target of blood glucose level. The goals were based on individual barriers and needed to solve it. The goal-setting became crucial and was recommended to promote behavior change [24]. The goal setting and action plans aimed to obtain the effect of behavior change and improve clinical metabolic [25].

Individual coaching and providing a personal case study on diabetes self-management also contributed to improving the DMSM practice in patients with uncontrolled T2DM. In this session, the researcher provided the individual coaching on preparing a proper meal for diabetes patients, managing portion size by using the plate method, and reading the food label. This strategy was sufficient to improve patients' skills in food preparation, food selection, as well as to manage the portion size during mealtime. Furthermore, the researcher coached how to conduct the self-monitoring blood glucose by using simple tool kits and record it into the logbook individually to build up the DMSM skill. To prevent complications from foot ulcers, the researcher demonstrated foot inspections as well as neuropathy checking by using a monofilament test. All strategies were crucial and sufficient to improve decision-making skills, communication skills, and strong analytical skills to manage the problems. Similar to previous studies revealed that individual diabetes coaching was adequate to improve health outcomes [26] and can support the ongoing of the disease and complex needs of patients in the DMSM program [27].

Receiving the weekly follow-up and home visit were also reported as crucial strategies to address the barriers in DMSM practice and to support directly in maintaining the DMSM practice. These strategies could improve patients' confidence and expectation to maintain positive behaviors. This finding was similar to the previous study revealed that telephone follow-up and home visits have a positive effect on improving diabetes self-management practice [28]. Another study also showed that regular monitoring improve dietary and exercise behavior [29].

4.3. The effectiveness of the diabetes mellitus self-management based coaching program on metabolic markers among uncontrolled T2DM patients

In this study, metabolic markers such as HbA1c, blood pressure, BMI, total cholesterol, HDL, and LDL were measured before and after receiving the DMSM program. The findings confirmed to answer the effectiveness of the program on improving all metabolic markers except for BMI scores. The total mean scores of metabolic markers among patients in the experimental group after receiving the DMSM program was a significant difference before and after receiving the program. These results also showed the positive effect between patients in the experimental group who received the DMSM based coaching program was found more than patients in the control group who received the usual care from the community health center. Several reasons contributed to improving the metabolic markers after receiving the DMSM based coaching program, including:

In this study, the researcher conducted participatory learning by discussing healthy food for diabetes. This strategy improved patients' ability for healthy food selection. The researcher also coached patients on creating a simple menu, managing the portion size by using the plate method, and how to read the food label to build-up skills on selecting a healthy diet based on the recommendation, arranging meal plan, and recognizing the portion size using the plate method. Moreover, how to read the food label to build-up skills on selecting a healthy diet based on the recommendation, arranging a meal plan, and recognizing the portion size using the plate method were emphasized. Increasing knowledge and ability to control patients' eating habits as well as giving appropriate responses in eating challenges during the program implemented could maintain dietary control. Thus, patients can meet the target goals of HbA1c reduction. This finding was consistent with the previous study, which found that proper controlling of dietary behaviors was significantly improves the metabolic markers [30].

Regular physical activity was the most influential factor to improve metabolic markers. In this study, patients perform physical exercise based on the guideline of the study. Most of them perform walking or aerobics three times per week. Besides that, the patient in the experimental group also demonstrated regular aerobic-based groups at community health centers. Regular aerobic exercise may improve insulin sensitivity and lead to glycemic control as well as most beneficial at the early stages of T2DM progression [31]. The previous study showed that regular exercise significantly reduced the values of HbA1c [32].

Unfortunately, the effect of the DMSM based coaching program showed no significant difference in BMI status between the experimental and the control group. This study showed there was a BMI change score but only a few. It may be caused by a shortened period of the program implementation because, in this study, we conduct the program only three months' follow-ups. Longer duration of exercise may show a positive effect on BMI change. It was consistent with the previous study that showed that eight years of regular exercise training revealed significant improvement in BMI [33]. Another meta-analysis also described at least six months follow-up might affect BMI change [7], while obesity demonstrated as a powerful risk factor for many health outcomes, including T2D, cardiovascular diseases, and all-causes of mortality [33].

5. Conclusion

This present study examined the effectiveness of DMSM based coaching program on improving the DMSM practice and metabolic markers for uncontrolled T2DM. The results showed that the

DMSM based coaching program was practical and feasible to implement in the broad population of uncontrolled T2DM in Indonesia. Further study needs to examine the DMSM based coaching program using the randomized control trials in a different setting to ensure the effectiveness of the DMSM based coaching program on health outcomes.

Declaration of competing interest

We declare no conflict of interest in this manuscript. The funding sponsors also served no role in the writing of the script or the decision to conduct this manuscript.

Acknowledgment

The authors would like to thanks the Indonesia Endowment Fund for Education (LPDP Scholarship) for the granting of this study. We also thank the patients and staff from community health centers in Polewali Mandar district for valuable information related to diabetes management.

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