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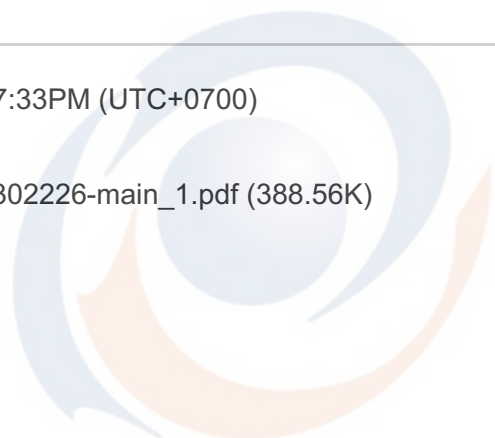
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ORIGINAL ARTICLE

A health-based coaching program for diabetes self-management (DSM) practice: A sequential exploratory mixed-method approach

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KEYWORDS

Type 2 diabetes mellitus;
Intervention program;
Diabetes self-management (DSM);
Mixed-method study

Abstract

Background: Diabetes self-management (DSM) is crucial for glycemic control among type-2 diabetic (T2D) people.

Method: This was a sequential exploratory mixed-method approach to assess whether a health-based coaching program designed to fit the unmet needs of T2D was the best intervention for improving DSM practice. Twenty-eight participants from different backgrounds were involved in phase 1 (Qualitative study) to explore DSM knowledge and practice, any difficulties obstructing such knowledge and practice, and the feasibility of implementing an intervention program nationwide. Sixty patients were recruited for phase 2 (Quasi-experimental study). A health-based coaching program, constructed to fit the unmet needs from phase 1 was implemented among thirty patients in an experimental group. By comparison, 30 patients in the control group received their usual care. Diabetes and DSM knowledge, DSM practice, and health outcomes were measured and compared between the two groups at baseline and after the 12th week of the intervention.

Results: The following problems were found: (1) a low perception of susceptibility to and severity of illness, (2) inadequate DSM knowledge and skills, (3) a lack of motivation to perform DSM practice, and (4) social exclusion and feelings of embarrassment. After the implementation of the program among the experimental group, all the variables improved relative to baseline and to the control group.

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Conclusion: A health-based coaching program can improve DSM knowledge and practice and health outcomes. A nationwide program is recommended to promote DSM practice among Indonesian communities.

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PALABRAS CLAVE

Diabetes mellitus tipo 2;
Programa de intervención;
Autocontrol de la diabetes (ACD);
Estudio de método mixto

Entrenamiento basado en la salud de la mejor intervención para la práctica del autocontrol de la diabetes (ACD): un enfoque con un método mixto exploratorio secuencial

Resumen

Antecedentes: El autocontrol de la diabetes (ACD) es crucial para controlar la glucemia en las personas con diabetes de tipo 2 (DT2).

Método: Un método mixto exploratorio secuencial para valorar si un programa de entrenamiento basado en la salud diseñado para satisfacer las necesidades no cubiertas de la DT2 era la mejor intervención para mejorar la práctica del ACD. Veintiocho participantes desde diferentes puntos de vista participaron en la fase 1 (estudio cualitativo) para explorar el conocimiento y la práctica del ACD, sus obstáculos y la viabilidad de implantar la intervención. Se reclutó a 60 pacientes en la fase 2 (estudio cuasi-experimental). Se implantó un programa de entrenamiento basado en la salud, ideado para satisfacer las necesidades no cubiertas de la fase 1, en 30 pacientes de un grupo experimental. En comparación, se prestó la asistencia habitual a 30 pacientes del grupo de comparación. Se determinaron el conocimiento de la DM y del ACD, la práctica del ACD y los resultados de salud, y se compararon entre los dos grupos en el momento basal y después de la 12ª semana de la intervención.

Resultados: Se hallaron varios obstáculos: 1) baja percepción de la predisposición a la enfermedad y de su gravedad, 2) conocimiento del ACD y habilidades para realizarlo insuficientes, 3) falta de motivación para la práctica del ACD y 4) exclusión social y sensación de vergüenza. Tras la implantación en el grupo experimental, se halló mejoría de todas las variables respecto al momento basal, y eran también mejores que en el grupo de comparación.

Conclusión: El programa de entrenamiento basado en la salud puede mejorar el conocimiento y la práctica del ACD y los resultados de salud. Se recomienda un programa nacional para promover la práctica del ACD en las comunidades indonesias.

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Introduction

Diabetes mellitus (DM) is a worldwide non-communicable disease. In 2016, the World Health Organization estimated more than 422 million world population are affected with DM, and approximately 1.6 million deaths were found¹ (World Health Organization factsheets, 2018). Sixty percent of total DM has occurred in the Asian region, where an increase of urbanization and socioeconomic transition were the contributing factors.² From total estimation, 87.5% of them were uncontrolled glycemic type 2 DM.³ Indonesia is one of the countries in the Western Pacific Region, with a prevalence of DM in the adult population of 6.2%, i.e. 10.6 million in 2019. This prevalence is higher in women (7.7%) than in men (6.5%).⁴ Indeed, the majority of people with DM in Indonesia were also faced with poor glycemic control and long-term complications.

Poor glycemic control has remained as a significant problem among type 2 diabetic mellitus. One of the most critical factors to control and manage DM is a diabetes self-management (DSM) practice.⁵⁻⁷ DSM was defined as an

individual's ability to manage symptoms and physical and psychosocial consequences by focusing on lifestyle modification, including dietary control, active physical exercise, medical adherence, on-time blood glucose monitoring, coping with stress, and prevention of DM complications.⁸

Regular DSM practice becomes crucial for people with DM to prevent hypoglycemia and hyperglycemia. Hypoglycemia may result in seizures or loss of consciousness.^{9,10} Hyperglycemia may increase the risk of cognitive impairment and Alzheimer.¹¹ Moreover, sufficient DSM will enhance patients' healthy life to avoid severe complications such as retinopathy, nephropathy, and neuropathy that contribute to premature mortality, and low quality of life.^{12,13}

A study by Tong et al. demonstrated that competing daily demands, frustration, other emotional distress, and low self-commitment were the critical determinants of poor DSM practice.¹⁴ Some recent studies found barriers associated with poor DSM practices were; low perception of illness, inadequate knowledge and skills on DSM practice, insufficient family involvement to support DSM practice, and social exclusion.⁵

Previous findings indicated regular DSM practice as an effective strategy for glycemic control among diabetic people.⁵ A recent study demonstrated participatory learning through the reflection of thought by sharing ideas and experiences, small group discussion, brainstorm on case studies, role-play, skill-based training, and coaching as an active learning process among adult people to enhance individual's practice for behavioral modification.¹⁵

Though some efforts had been launched in Indonesia to improve glycemic control such as *the Prolanis* program, which emphasized lifestyle modification by providing diabetes self-management education (DSME).⁵ However, a preliminary finding found unmet needs on effective DSME due to insufficient coaching and monitoring from healthcare providers. Poor DSM practice also occurred in West Sulawesi province since most people with DM lack awareness of the importance of DSM practice. They preferred to eat sweet and fatty food. Moreover, they also lacked skills in performing regular physical activity and blood glucose monitoring as well as in dealing with diabetic complications.

West Sulawesi Province is located in Indonesia's western region, with more than ten ethnic groups of variety in their cultural beliefs and living arrangements.⁵ Agricultural products for household used in this area were rice, corn, cassava, yams, and coconut. Community people usually cooked at home and shared meals between people with DM and their family members. The majority of their daily meals were curry with coconut milk. Previous intervention studies related to DSM practice, such as cluster-randomized Control trials and quasi-experimental studies,¹⁶⁻¹⁸ still are a gap and not, in reality, fit various social and cultural contexts and patients' needs in West Sulawesi, Indonesia. Therefore, a suitable solution to fill in the gap is to apply a sequential exploratory mixed-method design using both qualitative and quantitative approaches. An application of the exploratory mixed-method design could harness the strengths and counterbalance weakness of both qualitative and quantitative studies.¹⁹⁻²¹ The unmet needs obtained from the qualitative study were used to guide intervention activities in the later quantitative study. Fruitful findings from this study should be merged into routine services and scaled-up as a nationwide program to promote DSM practice among people with poor glycemic control to reduce premature death and to increase the quality of life for Indonesian communities in the nearby future.

Study objectives

The study has two main aims to support each study phase as follows: (1) to explore the context-specific of the DSM practice and its' problems and barriers among uncontrolled T2D people in West Sulawesi; (2) to examine the effectiveness of the health-based coaching program to promote DSM practice and clinical outcomes among people with DM.

Research methods

A sequential exploratory mixed-method design was applied in this study. It comprised two phases. The first phase was a qualitative study using both in-depth interviews and focus group discussions (FGDs) on exploring the current situation,

barriers and unmet needs in DSM practice to support an appropriate context-specific intervention program that had been extensively systematically reviewed prior to its contextualisation based on the first phase. While the second phase was a quantitative study using a quasi-experimental design. Details of the study phases are summarized in Fig. 1.

Phase I: Qualitative study

Details of methods for data collection and key findings from the first phase as well as how to apply the information to construct a health-based coaching program can be summarized as follows:

Study setting, inclusion & exclusion criteria, and sampling technique

Study setting: Two community health centers and two basic health facilities in Polewali Mandar district, West Sulawesi Province, Indonesia, were included as the study settings to conduct an in-depth interview and FGDs from a different viewpoint of key informants. Moreover, a home visit was carried out to obtain elaborated details of information among patients and their family members as well as to observe the household environment.

Inclusion & exclusion criteria: In order to obtain rich information based on the triangulation method,¹⁹ four groups of key informants were recruited to share their different viewpoints in the qualitative study. They comprised eight uncontrolled glycemic persons, eight family members who were the primary caretakers T2D people, six healthcare providers (HCPs), and six village health volunteers (VHVs). All participants were directly involved in sharing their experiences and viewpoints on DSM and its barriers and unmet needs of DM people. Inclusion criteria were summarized by each group as follows: Firstly, uncontrolled T2D who were willing to participate in this study, at least one year to live in South Sulawesi, age ≥ 35 years old, and HbA1c $\geq 6.5\%$. Secondly, caretakers who were stayed together with the DM people and mainly involved in DSM support. Thirdly, HCPs involved in DSME, routine health check-ups, blood glucose monitoring, prevention complications, home visits, and follow-ups. The last group was VHVs, who were assisted HCPs in monitoring patients on regular check-up, and home visits. The exclusion criteria were those who denied to provide information or absent on the date of data collection.

Sampling technique: Purposive sampling based on the inclusion and exclusion criteria was used to select each group of key informants. Saturated data were obtained from each group until no new themes were found.

Data collection process

In this phase, the researchers conducted both an in-depth interview and FGDs. Performing different methods to obtain data from different key informant groups to ensure the method of triangulation in this phase. Details of qualitative data collection were as follows:

In-depth interview

After conducting a systematic review of DM self-management and diabetic management intervention, the

PHASE 1 (Qualitative study)	Program Development	PHASE II (Quantitative study)	Evaluation
<ul style="list-style-type: none"> - Review evidence - In-depth interview - FGDs 	Health-based coaching program	Quasi-experimental Design, pre-test and post-test	Knowledge DMSM practice Clinical markers

Figure 1 The study phases.
FGD: focus group discussions; DMSM: diabetes self-management.

researchers constructed interview guidelines for qualitative data collection. The researchers conducted an in-depth interview with each patient and family caretaker at the community health centers. In case more information is needed, the researchers ask permission to visit their home for further interviews and observation. The research assistants help to record and take notes while each interviewing was conducted. FGDs among HCPs group and VHV group was conducted separately at the same community health centers by the researchers. The research assistants also helped to take notes and audio records.

In this phase, an in-depth interview was conducted among eight patient-caretaker dyads. The main themes to explore regarding DM knowledge, DSM practice and its' barriers, and existing services of diabetic care. All interviewees were asked the open-ended questions (e.g., 'Do you regularly conduct the DSM practice?' 'what are barriers of you to conduct the DSM practice?' 'what previous programs had been implemented in the community?'. All participants were encouraged to be honest regarding their experience while applying the DSM practice. The data saturation was obtained by reaching the sample adequacy and representativeness.

Focus group discussion

Focus group discussion was conducted to gather information from six healthcare providers (HCPs) and six village health volunteers (VHVs). The primary purpose of this FGD was to obtain information about the implementation of diabetes self-management education (DSME) and its barriers while implementing the DSME at the community health center.

The session began with 45 min per session. Participants presented at the meeting were eligible and invited to participate. The researchers provided a brief description of the nature and purpose of the study. After all key informants agreed to participate in this study, they were encouraged to share their experiences while taking care of the DM people. The researchers also asked about the barriers when performing DSM practice. During the discussion, the researchers also explored the existing intervention implemented at community health centers. A digital recorder recorded all information.

Data analysis of the qualitative study

Data were transcribed and translated verbatim from an audio recorder into texts. Content analysis was conducted parallel between two researchers to extract key themes and sub-themes to elaborate contexts of DSM practice and its' barriers based on critical informants' viewpoint. The initial themes were re-checked by the researcher team to narrow the key themes of this study. Then, the theme was written up

as a series draft results section. In the final step of the data analysis, all researcher teams made a consensus to reflect and decide the final results of the principal theme.

Key findings from the qualitative study

Findings from a qualitative study on key-themes and sub-themes extracted from a different viewpoint of key informants were found barriers to DSM practices. The barriers were lack of knowledge on DSM, unfortunate perception of susceptibility and severity of DM complications, lack of motivation, and support from family on DSM practice and felt social exclusion. When considering DSM practice, findings indicated improper DSM practice among T2D people in all aspects. Regard to dietary control, most of the respondents mentioned difficulties in controlling a healthy diet. They ate food as ordinary people did and never follow the dietary recommendation. They lack goal setting to manage a healthy diet to prevent hyperglycemia. Many of them ate sweeten and fatty food with a big portion. Some of them

Table 1 Barriers to diabetes mellitus self-management practice - illustrative quotes from the in-depth interview and focus group discussion among patients, Family caregiver, HCP, and VHV.

Low perception of susceptibility and severity of illness

- I did not eat the medication because of doubt about the expected benefits and efficacy of treatment (patient 6, female, 52 years old)

Inadequate knowledge and skill of diabetes mellitus self-management

- I do not understand what food I should avoid and how to prevent foot ulcers (patient 2, female, 41 years old)
- I am still unclear on how to implement diabetes management. I just provided the routine management such as explanation without media and no booklet (HCP 4, female, 52 years old)

Lack of motivation to perform the diabetes mellitus self-management

- Sometimes I am feeling lazy and lack the motivation to perform physical activity. I was more likely lying down on the bed (patient 1, female, 48 years old)

Social exclusion and felling embarrassment

- I fell ashamed to gather at social activities because my legs hurt and sometimes smell (patient 1, female, 48 years old)
- Some of the patients avoided participating in social activity because they embarrassed by their smells foot. They also felt social exclusion due to victims blaming on their diseases (VHV 3, female, 27 years old)

HCP: Health care provider; VHV: Village health volunteer.

never know the proper kinds of food to eat. When concerning physical activity, most patients did not perform regular physical activity based on the recommendation for DM management due to time constraints. They misunderstood what proper kinds of physical activity to fit with diabetic people.

Some T2D people reported on monitoring blood glucose levels only when they found some complaints such as when feeling tired or knee pain or before visiting the health center for follow-up. Moreover, most of them seldom to record and track on a pattern of blood glucose results themselves. They thought it should be the responsibility of healthcare providers to provide a blood glucose monitor. When considering medication adherence, some diabetic persons favored using herbal medicine instead of modern medicine. The reason was due to the wrong belief on the benefits and effectiveness of treatment. In addition, some of them did not take diabetic drugs on time due to time constraints when they worked far away from home.

Regarding the prevention of complications, most of them have insufficient knowledge of hypoglycemia and hyperglycemia management. In addition, low awareness of diabetic complications and improper skill on foot inspection and care were also included. All details of key themes and sub-themes of barriers to DSM practices and DSM practices are summarized in [Tables 1 and 2](#).

Health-based coaching program

All information obtained from the qualitative study were used to construct a health-based coaching program. The integrated model of change (I-Changed model)²² was applied to develop a health-based coaching program to improve the

DSM practice among glycemic uncontrolled T2DM patients. The program consisted of six consecutive domains of outcome changes based on an integration of the theory and systematic review²⁵ with empirical findings from the qualitative study in the first phase ([Table 3](#)).

The development of a healthy-based coaching program has several specific objectives: enhancing DM knowledge on DSM practice, raising awareness on the importance of healthy lifestyle behaviors, and enhancing self-efficacy and skill build-up on DSM. Moreover, goal setting on regular performing DSM practice as well as social influence from follow-up and home visits were emphasized. The program consisted of 12 weeks with 45–60 min for each participant per session.

Reflection, assessment, and sharing experience on diabetes management and its' problem. The ultimate goal of these activities were to reflect the current situation of patients' behaviors, barriers and problems on DMSM practice. In this study, researchers assessed the baseline data and reflected the current behaviors among diabetic patients. This strategy helped the researchers to construct further intervention that suit for patients.

Experience sharing regarding DM management and the problems on DM management was conducted to improve ability and to build positive relationship between the patients and their family members as well as the HCPs. Each participant shared their experiences within 45 min.

Small group discussion on DMSM practice. The ultimate goal of a small group discussion was to encourage active learning, and to develop critical-thinking, positive communication, problem solving, and decision making skills. In

Table 2 Key themes and sub-themes of problems and barriers on diabetes self-management (DSM) practice obtained from qualitative study in phase I.

DSM components	Key themes	Sub-themes
Dietary Control	Improper types of food intake and portion size for daily eating	<ul style="list-style-type: none"> • Eating more sweeten food and fatty food • Eating fewer vegetables • Eating more food with a high portion • Insufficient knowledge in food selection for proper control of diabetic
Physical activity	Insufficient physical activity	<ul style="list-style-type: none"> • Misunderstood on the importance of sufficient physical activity • Time constraint to perform daily physical activity
Blood glucose monitoring	Irregular blood glucose monitor	<ul style="list-style-type: none"> • Checking blood glucose only when having some complaints or before visiting the health center for a check-up • Lack of skill to track on a pattern of blood glucose results themselves
Medication adherence	Lack of medication adherence due to wrong belief	<ul style="list-style-type: none"> • Irregular time on taking medication • Prefer to use herbal medicine to substitute modern medicine due to mistaken belief on benefits and effectiveness of treatment
Prevention of diabetes complications	Lack of skill to prevent diabetes complications	<ul style="list-style-type: none"> • Low awareness on prevention of diabetes complications • Unable to perform regular foot inspections to prevent ulcers • Lack of knowledge and skills in dealing with hypoglycemic and hyperglycemic symptoms

Table 3 Health-based coaching program.

The domain of outcome changed	Theory-based strategies	Main activities	Multidisciplinary
Knowledge	Reflection, assessment, and sharing experience	<ul style="list-style-type: none"> Reflection and experience sharing on current DSM and its' barriers Pre-test Presentation on diabetes and DSM knowledge 	<ul style="list-style-type: none"> Researcher Research assistant Medical technologist Nurses
Awareness	Persuasive communication	<ul style="list-style-type: none"> Sharing on successful DSM practice and its' influencing factors Inspiring on the importance of healthy lifestyle behaviors for glycemic control 	<ul style="list-style-type: none"> Researcher Research assistant Nurses
Self-efficacy	Role model Case study	<ul style="list-style-type: none"> Brainstorm/small group discussion on how to prevent diabetes complications and to maintain a healthy blood glucose level A scenario of diabetes complications and discussion on proper strategies to solve the problem 	<ul style="list-style-type: none"> Researcher Research assistant
Attitude	Goal Setting Passive and active learning	<ul style="list-style-type: none"> Goal setting on performing regular physical activity, selecting healthy food, and adhering to medication Preliminary session on DSM practice Introduction on DSM checklist for self-report 	<ul style="list-style-type: none"> Researcher Research assistant
Skills	Small group discussion	<ul style="list-style-type: none"> Discussion on healthy eating for diabetes patients, sufficient physical activity Discussion on regular blood glucose monitoring and medication adherence 	<ul style="list-style-type: none"> Nurses Researcher Dieticians
	Role-play	<ul style="list-style-type: none"> Demonstration on self-monitoring blood glucose, interpretation of results, and recording to a logbook Practice on foot inspection, and checking on neuropathy by using monofilament test 	<ul style="list-style-type: none"> Nurses Researcher Dietician
	Individual coaching	<ul style="list-style-type: none"> Coaching on a simple menu preparation and managing portion size by using the plate method Group exercise and personal coaching how to warm-up and cool-down exercise Coaching on the management of hypoglycemia and medication adherence 	<ul style="list-style-type: none"> Nurses Researcher Dietician
Social influence	Follow-up and home visits HCPs and VHVs' support	<ul style="list-style-type: none"> Telephone follow-up to identify barriers of DSM practice Home visit to individual counseling to solve the possibility of DSM barriers 	<ul style="list-style-type: none"> Researcher Research assistant Nurse VHVs

this qualitative study found that patients and their family members were lack of communication on DMSM or patients' conditions, discouragement of patients' problem and refusal to share problem or ineffective communication. These findings led researchers to construct the small group discussion to achieve target goals and to encourage active learning on education process and to build-up critical thinking when facing with DMSM problems.

Brainstorm and group discussion. The ultimate goal of brainstorm and group discussion is the way to generate ideas within a group discussion. In this study found that some of patients faced several barriers during implementing the DMSM program. They were difficult to control diet and

forgot the medication taking when far away from home. Lack of awareness on patients' condition and on negative expression on patients' condition were also faced among the family members. Using brainstorm and group discussion on importance of family members in DMSM practice and explaining the roles of family members in DMSM practice are essentially a way to facilitate creative group decision making and the key to success in DMSM practice.

Goal setting on DMSM practice. The ultimate goal of this activity to provide direction and to promote action towards goal-related DMSM activities. Results from this study found that DMSM patients and their caretakers performed their routine daily without target setting. Misconception and lack

of communication in terms of DMSM practice among them also found from the qualitative findings such as lack of blood glucose monitoring, not adhere to medication taking on time as well as difficult to control unhealthy diet. Goal setting is fundamental and is necessary to prioritize which activities should be done first.

Individual coaching on DMSM practice. The ultimate goal of individual coaching on DMSM practice focused on solution approach to increase personal learning and development. Improved ability to identify solution to fit with specific barriers. In this activity, researchers developed an individual intervention to coach patients in creating a simple menu for DM, managing the portion size by using the plate method, hand portion, and how to read the label food. These strategies were constructed since the key findings of qualitative reported that most of patients ate more sweeten food and fatty food, ate more food with large portion and not to control composition of food. Other key findings also found that some of patients were misunderstood on physical activity for DM patients, lack of blood glucose monitoring, not record the blood glucose results as well as difficult to manage hypoglycemic complications. Using an individual coaching on readiness of performing the physical activity and warm-up exercise and cooling down exercise after performing the physical activity; coaching how to manage the hypoglycemia as well as coaching how to perform self-report on medication adherence improved patients' and families' ability to achieve the goals and obtain solutions when faced the problems.

Role-play on self-monitoring blood glucose and identify diabetes complications. The ultimate goal of the role-play technique using in this study was to encourage practicing skills and to assist patients naturally improve and use their cognitive ability and skills in DM self-monitoring and preventing the DM complications. Key findings of the qualitative study reported that most of DM patients did not understand and misconception on DM complications and how to prevent the complications. Moreover, it was also found that they also lacked of regular blood glucose monitoring, the blood glucose monitoring was done only when the faced with some complaints. By using the role-play method, researchers demonstrated how to conduct a self-monitoring blood glucose by using a simple tool kit, and how to record the results into the logbook. To monitor the risk of neuropathy, researchers also demonstrated how to perform foot inspection, and checking the neuropathy using monofilament test. This strategy improved patients' and families' ability in preventing of diabetic complications.

Follow-up and home visit. Follow-up and home visit are fundamental strategies to ensure the patients and their families are moving forward with the prescribed management plan, such as undergoing testing and taking their medications. Moreover, to improve the likelihood of positive outcomes, follow-up and home visit are critical for minimizing safety and liability concerns. Home visit also helped family members to build strong relationships with the patients. In this study researchers conducted telephone call for regular follow-up and went to communities for home visit to identify barriers of DMSM practice and to solve the possibility of DMSM barriers with the patients and their families with the patients.

Phase II quantitative study

Study design and samples

A quasi-experimental study, pre-test, and post-test design with a non-equivalent control group were conducted to examine the effectiveness of a health-based coaching program on DSM practice and health outcomes in terms of biological markers among uncontrolled T2D people.

Sixty T2D people were selected based on the inclusion criteria and were randomly allocated into the experimental group and the comparison group by using a lottery sampling method. The inclusion criteria were: (1) glycemic uncontrolled with HbA1c level is equal or more than 6.5%, (2) a native speaker in the Indonesian language, (3) aged between 35 and 59 years, (4) without severe complications that need to be hospitalized. Both groups had a similar socio-cultural background and were stayed in similar geographical areas for at least one year.

Data collection procedure

The instrument for data collection was comprised of: (1) self-administered questionnaire with two parts included as socio-demographic and health information (SDHI), DM and DSM knowledge,²³ and DSM practice construction based on DM self-management questionnaire (DSMQ)²⁴; (2) Recording form to collect information on biological markers obtained from a patient's profiles at the community health center.

The DM and DSM knowledge part comprised 10 items of true, false, and not sure answers. The score was = 1 for a correct answer, while the rest were = 0. The total scores were ranged between 0 and 10 and were classified into 3 groups as poor (less than 60% of total scores or less than 6 scores); fair (between 60 and 79% of total scores or equal to 6–7 scores) and good (equal or more than 80% of the total score of equal or more than 8 scores).

The DSM questionnaire (DSMQ) consisted of five dimensions, including diet (4 items), physical activity (3 items), blood glucose monitoring (4 items), medication adherence (2 items), and complication prevention (3 items). The DSMQ was adapted from a previous study of Pamungkas et al.³ Each item score was ranged between 0 and 3, with indicated as; 0 = not at all, 1 = sometimes, 2 = often, and 3 = regularly. Total scores were ranged between 16 and 48 and were classified into 3 groups using the same cut off point of the knowledge part as poor (less than 36 scores), fair (36–42 scores), and good (more than 42 scores) DSM practice.

Validity and reliability test of the questionnaire

The questionnaire was examined for content and construct validity by three experts in the field of non-communicable diseases comprised; one doctor, one professor, and one nursing professor. It was translated into the Indonesian language and translated back by the same native speaker who knows the local language well. It was pilot tested among 30 respondents in a nearby district to determine its reliability. The reliability test results using Cronbach's Alpha coefficient on DSM knowledge was 0.84, and DSM practice was 0.84, respectively. Some words were changed according to the local language to make respondents easy to understand and respond.

The researchers with four trained research assistants from the fourth-year student nurses joined data collection by interviewing each patient in both groups. The blood test was done at each community health center in both intervention and control groups at a baseline and twelfth week after the program was conducted. The patient's profile was also obtained from each health center to clarify each patient's illness history. The researchers and research assistants implemented the eight-week program. During the home visit, both local healthcare providers and village health volunteers were accompanied to each patient's home.

Data analysis for quantitative study

This phase was aimed to examine the differences between mean scores on DM and DSM knowledge, DSM practice, and biological markers before and after program implementation within the experimental group. Moreover, all mean scores between the experimental and the comparison group after implementation were also compared. A paired *t*-test was used to examine the differences within the experimental group, while an independent *t*-test was used to compare the differences between the two groups. The level of statistical test was at $p < 0.05$.

Results

Comparison of socio-demographic and health information

From Table 4.1, it was found that socio-demographic and health information between the experimental and the comparison group were not significantly different toward age, sex, marital status, occupation, educational background, and family history of having DM. Regard to clinical factors and biological markers; they were also no significant difference between the two groups. When concerning behavior factors, they were not significantly different between the experimental and the comparison group (p -value > 0.05).

Comparison of mean scores different on DSM knowledge, DSM practice, and biological markers within the experimental group and the comparison group

The findings found that mean scores of different within the experimental group after implementation in all aspects of DM and DSM knowledge, DSM practice, and metabolic markers were significantly higher than before implementation ($p < 0.05$), except only BMI, which was not found significant. While among the comparison group, the mean scores of different after implementation in almost all aspects were not significantly higher than before implementation ($p > 0.05$), except only blood glucose monitoring was found to be significant (Table 4.2).

Comparison of mean scores of changes (after-before) on DSM knowledge, DSM practice, and biological markers between the experimental group and the comparison group

When compared the mean scores of changes (after-before) on DSM knowledge, DSM practice, and biological markers between the experimental group and the comparison group, there were significant differences in all aspects (p -value < 0.05), as showed in Table 4.3.

Discussion

This paper demonstrates a sequential exploratory mixed method design to develop and implement a health-based coaching program to enhance DSM practice among uncontrolled T2DM patients. A combination of two phases of data collection can ensure suitable intervention strategies fit with local contexts of DM in the Indonesian community. An application of the exploratory mixed-method design could harness the strengths and counterbalance weakness of both quantitative and qualitative studies.²⁵ A qualitative design was used to elicit in-depth information about DSM practice and its' barriers among T2D persons in DSM practice. Moreover, a systematic review of related kinds of literature, both international and Indonesian studies as an elicit preliminary information to combine with data obtained from a qualitative study using triangulation techniques can be used for appropriate development of the program contents.²⁶

An application of the integrated model of change (I-change model) guided us to develop a health-based coaching program fixed with unmet needs in glycemic Control among T2D. The model is widely used for behavioral change modification by supporting a formulation of intervention strategy linked with determinant and precondition factors of unmet needs in healthy behaviors.^{27,28} Therefore, the program fits the local contexts of the Indonesian community and be able to apply as a wide-range program in other communities with similar cultural backgrounds like Indonesia.

This model facilitated patients on active learning experiences by sharing ideas, brainstorm, goal setting, individual coaching, role-play, and practicing to build-up skills in DSM. Several studies proved this learning experience as the most effective learning style for adulthood.^{29,30}

The combination of raising awareness and enhancing the DSM practice's positive attitude will help T2D people on goal setting and support their self-efficacy to maintain effective DSM practice for controlling their blood sugar. Previous studies also supported our findings in similar ways of blending these strategies to improve healthy behaviors.³¹ We also encouraged patients' active involvement in the learning process, with the group discussion to enhance knowledge, skill, and self-confidence in DSM practice. It has been proved that participatory learning experiences are effective strategies to facilitate patients and caretakers on healthy behaviors and promote effective day-to-day daily living. A systematic review study recommended applying a combination of DSME strategies to improve the patients' and skills in DSM practice and self-awareness among people with DM.³²

This study has several strengths because we used a sequential exploratory mixed-method design with two

Table 4.1 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					
<i>Aged (Min–Max = 34–69)</i>	M = 56.2	SD = 7.63	M = 54.5	SD = 9.20	.439
Sex					.152
Male	6	20	11	36.7	
Female	24	80	19	63.3	
Marital status					
Married	30	100	50	100	
Had not married					
Occupation					.214
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
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	
Bachelor/mastes	3	10	7	23.3	
Family history of diabetes					.438
Have diabetes	14	46.7	17	56.7	
No have diabetes	16	53.3	13	43.3	
Clinical factors					
<i>Duration of illness</i>	M = 4.42	SD = 1.56	M = 4.27	SD = 1.66	.720
Comorbidity					.205
No have comorbidity	10	33.3	8	26.7	
Hypertension	3	10.0	7	23.3	
Cholesterol	13	43.3	10	33.3	
Hypertension+	2	6.70	2	6.70	
Cholesterol					
Rheumatoid	2	6.70	0	0.00	
Allergy	0	0.00	3	10.0	
Physiology factors					
<i>Weight (kg)</i>	M ± SD = 55.33 ± 8.25		M ± SD = 59.83 ± 10.26		.103
<i>Height (cm)</i>	M ± SD = 152.97 ± 6.98		M ± SD = 155.97 ± 6.26		.848
<i>Body mass index (kg/m²)</i>	M ± SD = 23.70 ± 3.52		M ± SD = 24.62 ± 3.50		.065
<i>FBG (mg/dl)</i>	M ± SD = 229.50 ± 62.19		M ± SD = 254.40 ± 100		.049
<i>HbA1c (%)</i>	M ± SD = 8.04 ± 1.96		M ± SD = 8.55 ± 2.95		.112
<i>Systolic BP (mmHg)</i>	M ± SD = 128 ± 13.83		M ± SD = 128 ± 18.21		.058
<i>Diastolic BP (mmHg)</i>	M ± SD = 83.33 ± 7.11		M ± SD = 82 ± 8.86		.178
<i>Cholesterol total (mg/dl)</i>	M ± SD = 204 ± 32.66		M ± SD = 199 ± 41.35		.435
<i>LDL (mg/dl)</i>	M ± SD = 117.6 ± 49.61		M ± SD = 107.50 ± 37.24		.417
<i>HDL (mg/dl)</i>	M ± SD = 65.17 ± 14.40		M ± SD = 65.47 ± 23.81		.001

phases. Firstly, a systematic review for theoretical based and previous studies merged with a contextual analysis from the qualitative research delivered fruitful information to tailor our intervention program to implement in the second

phase. Secondly, stakeholder involvement from different viewpoints such as T2DM patients, their families, HCPs, and VHV can provide diversity aspects to construct appropriate program activities to deal with DSM practice. Lastly, the

Table 4.2 Comparison of mean scores different (after–before) on DSM knowledge, DSM practice, and biological markers within the experimental group and the comparison group.

Variables	Experiment group		Comparison group	
	$\bar{d} \pm SD$	(p-Value)	$\bar{d} \pm SD$	(p-Value)
<i>Diabetes and DSM knowledge</i>	4.26 ± 0.86	<.001*	1.03 ± (–0.388)	.162
<i>DSM practice</i>				
Dietary behaviors	5.36 ± 0.474	<0.001*	–0.03 ± (–0.234)	.951
Physical activity	3.44 ± (–0.705)	<0.001*	0.24 ± (–0.727)	.527
Blood glucose monitoring	5.7 ± (–0.298)	<0.001*	2.07 ± (–1.491)	<0.001*
Medication adherence	2.4 ± (–0.383)	<0.001*	0.07 ± (–1.183)	.825
Prevention of complications	4.37 ± (–0.816)	<0.001*	0.16 ± (–0.614)	.670
<i>Metabolic markers</i>				
HbA1c	–1.6 ± (–0.816)	.001*	–0.31 ± (–0.353)	.093
Systolic BP	–8.67 ± (–2.69)	.006*	1.34 ± (–3.91)	.715
Diastolic BP	–10.83 ± 1.573	.001*	–4 ± 2.083	.136
BMI	–0.12 ± (–0.729)	.838	–0.04 ± (–0.82)	.896
Total cholesterol	–28.2 ± (–10.28)	.001*	–1.43 ± (–2.88)	.639
HDL	26.63 ± 6.33	.001*	–3.9 ± (–4.47)	.467
LDL	–28.53 ± (–34.7)	.002*	2.07 ± (–1.58)	.378

DSM: Diabetes self-management; 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 4.3 Comparison of mean scores of changes (after–before) on DSM knowledge, DSM practice, and biological markers between the experimental group and the comparison group.

Variables	Experiment group $\bar{d} \pm SD$	Comparison group $\bar{d} \pm SD$	p-Value
<i>Diabetes and DSM knowledge</i>	4.26 ± 0.86	1.03 ± (–0.388)	<.001*
<i>DSM practice</i>			
Dietary behaviors	5.36 ± 0.474	–0.03 ± (–0.234)	<0.001*
Physical activity	3.44 ± (–0.705)	0.24 ± (–0.727)	<0.001*
Blood glucose monitoring	5.7 ± (–0.298)	2.07 ± (–1.491)	<0.001*
Medication adherence	2.4 ± (–0.383)	0.07 ± (–1.183)	<0.001*
Prevention of complications	4.37 ± (–0.816)	0.16 ± (–0.614)	<0.001*
<i>Metabolic markers</i>			
HbA1c	–1.6 ± (–0.816)	–0.31 ± (–0.353)	.001*
Systolic BP	–8.67 ± (–2.69)	1.34 ± (–3.91)	.003*
Diastolic BP	–10.83 ± 1.573	–4 ± 2.083	.035*
BMI	–0.12 ± (–0.729)	–0.04 ± (–0.82)	.329
Total cholesterol	–28.2 ± (–10.28)	–1.43 ± (–2.88)	.024*
HDL	26.63 ± 6.33	–3.9 ± (–4.47)	<.001*
LDL	–28.53 ± (–34.7)	2.07 ± (–1.58)	.005*

DSM: Diabetes self-management; HbA1c: Hemoglobin A1c; BP: Blood pressure; BMI: Body mass index; HDL: High-density lipoprotein; LDL: Low-density lipoprotein.

* Significant at p-value < 0.05.

outcome of changes after implementing the health-based coaching program can be maintained even the program was terminated. Our learning process aims to strengthen T2D persons on DSM practice by raising awareness, changing attitudes, and increasing self-efficacy and skills in managing blood glucose.

Some limitations have also been noted, such as the program was conducted within twelve weeks, which might not

be enough to evaluate long-term behavioral changes and clinical outcomes, especially BMI status. Moreover, the DSM practice among DM people could not be directly observed. Therefore, the results obtained from a self-administered questionnaire may subjective to bias.

Further studies should emphasize participatory action research by involving patients, family members, and communities to design intervention strategies to fit with

community context. A longitudinal study should be conducted for continuously follow-up DSM practice among T2D persons for at least 2–3 years to verify changes in the health outcomes, especially BMI and HbA1c level. The program is effective in improving DSM practice and health outcomes among DM group. It should be implemented as a wide-range program in different communities. Before applying for the program, family members, and VHV or community key leaders should understand their roles to facilitate T2DM on DSM practice to avoid barriers during program implementation.

Conclusion

This present study was a sequential exploratory mixed-method to develop and implement a health-based coaching program on improving the DSM practice and metabolic markers for uncontrolled T2DM. The qualitative study found that four themes of barriers in DSM including (1) low perception on susceptibility and severity of illness, (2) inadequate DSM knowledge and skills, (3) lack of motivation to perform DSM practice, and (4) social exclusion and feeling embarrassment. In the quantitative study also showed that DM knowledge, DSM practice, and metabolic markers were improved than baseline and better than the comparison group after implementation of the health-based coaching program. Therefore, the health-based coaching program practical and feasible to implement among uncontrolled T2D in every health setting in Indonesia.

Ethical consideration

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

Authors' contributions

RA and KC designed the research, analyzed the data, and wrote the paper. PC and PV advised on this study.

Conflict of interest

We declared no conflict of interest in this study. The funding sponsor also had no role in the writing of the manuscript or the decision to publish this manuscript.

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