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ORIGINAL ARTICLE

PREDICTIVE FACTORS OF DIABETES MELLITUS SELF-MANAGEMENT (DMSM) PRACTICE: A SYSTEMATIC REVIEW AND META-ANALYSIS

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ABSTRACT

The diabetes mellitus self-management (DMSM) is integral to controlling blood glucose and preventing diabetes complications. There were still gaps in the analysis controversy of the outcome that need to be explored by systematic review and meta-analysis. The review aimed to synthesize the predictive factors associated with practice DMSM practice among Type 2 Diabetes Mellitus (T2DM). This study applied the systematic and meta-analysis method. Three databases, Scopus, PubMed, and Medline, were included in this study to obtain the relevant articles. Keywords used were “self-management”; “diabetes mellitus”; self-care; factors associated with self-management". Comprehensive Meta-Analysis (CMA) was used to analyze and interpret the effect size of the review study. The results showed that 15 predictive factors were associated with DMSM practice, including age, sex, education level, illness duration, and financial barriers. Diabetes knowledge, insulin in treatment, belief of treatment, social support, occupational, personality, diabetes-specific emotional distress, perception of the disease, quality interaction with healthcare providers, and self-efficacy were considered predictive factors. The findings suggested that a wide range of personal and environmental factors were the most influential factors associated with the implementation of DMSM in health care services. Therefore, it is vital to construct theory-based strategies to improve DMSM practice among diabetes population.

Keywords: *Diabetes mellitus self-management; meta-analysis; predictive factors; systematic review; type 2 diabetes mellitus*

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INTRODUCTION

The prevalence of diabetes mellitus (DM) is increasing steadily around the world. The World Health Organization (WHO) calculated that 422 million people live with DM. Among the Asian region, it could be predicted that about 60% of diabetes patients by 2030 (World Health Organization [WHO], 2018). The International Diabetes Federation (2021) reported that the prevalence of diabetes was in the range of 537 million people, and it could be predicted that it will be 643 million people in 2030 and 783 million people by 2045. Most people (80%) lived in low- and middle-income countries, including Indonesia (International Diabetes Federation [IDF], 2013).

Diabetes mellitus (DM) is a noncommunicable disease, and one of the ways to manage DM is through diabetes mellitus self-management (DMSM). DMSM is defined as the ability of patients with Type 2 DM (T2DM) to manage physical and psychosocial symptoms and behavioral challenges to deal with their conditions (Grady & Gough, 2014; Qi, et al., 2021). In the context of diabetes, DMSM is comprised of five domains, including 1) diet control, 2) physical activity, 3) blood glucose monitoring, 4) adherence to medication, and 5) prevention of diabetes complications. T2DM patients are required to make a multitude of daily self-management decisions and perform complex care activities. DMSM is crucial to helping diabetic patients navigate decisions and improve a healthy lifestyle to improve health outcomes (Brunisholz et al., 2014). The practice of diabetes mellitus self-management (DMSM) is an effective strategy to

strengthen blood glucose control over time. This led to improving 24-hour daily living and often included changes in lifestyle behaviors (Pamungkas & Chamroonsawasdi, 2020). DMSM requires patients to reconcile their resources, values, and preferences with a healthy lifestyle that includes diet, active physical exercise, avoiding smoking and alcohol consumption, adherence to medication, monitoring blood glucose, and prevention of complications (Pamungkas et al, 2017). DMSM is also closely related to the concept of self-management practice, which can be connected to the practice of activities that individuals initiate and complete in their own behavior to maintain life, health behaviors, and well-being (Pamungkas & Chamroonsawasdi, 2020). According to the concept of self-management, the individual learns and performs the purposeful activity that requires a certain level of maturity, enabling them to perform effective activity, persistent, controlled, and consistent actions. Therefore, self-management activity is not only a process directed inward, but also the ability to perform activities that are also affected by knowledge, social support, psychological issues, and the ability to participate in DMSM practice.

Some evidence showed that patients who received diabetes self-management training can manage their blood glucose levels, dietary habits, and glycemic index (Emara et al, 2021; Pamungkas et al., 2015). Reyes et al. (2017) also described the importance of DMSM in achieving optimal glycemic control, decreasing diabetes morbidity and mortality, and maintaining health status, including self-monitoring and medication adherence in daily living.

However, barriers to practicing DMSM are unavoidable and are associated with stress or other emotional distress, low self-commitment, lack of knowledge, low self-efficacy, and insufficient support from family (Miller & Dimatteo, 2013; Tong et al., 2015). Previous studies reported some tendencies toward predictive factors of DMSM practice. However, there were still gaps in the analysis controversy of the factors that need to be explored by systematic review and meta-analysis to determine the factors associated with the practice of DMSM and estimate the most substantial factors by meta-analysis. The study aimed to synthesize the findings of factors associated with the practice of DMSM among T2DM patients.

METHOD

Data sources

This study applied systematic review and meta-analysis to determine the factors associated with DMSM among T2DM patients. Three databases, PubMed, Scopus, and Medline, were extracted from relevant articles. More than 582 articles were obtained and evaluated using a systematic review following the PRISMA framework. Predictive factors in DMSM were applied as the medical subject heading (MeSH) in an abstract and the title of an article. Thirty-eight articles were almost fit for the meta-analysis.

Search strategy

We applied a term to obtain the relevant articles in this review, including “predictive factors on diabetes self-management; “self-management”; “diabetes mellitus”; self-care management; factors associated with self-management". Available titles and abstracts related to the predictive factors in diabetes mellitus self-management were systematically reviewed to find the most suitable articles. To ensure updates and relevant articles, the search for articles was limited to those published between 2014 and 2022.

Eligibility criteria for the study

This study used the PICO model (Participant-Intervention-Comparison-Outcomes) to create inclusion criteria for synthesizing and assessing the articles as follows;
P: Uncontrolled type 2 diabetes mellitus (T2DM) patients I: Predictive factors
C: -
O: The practice of diabetes mellitus self-management (DMSM)

The inclusion criteria for the selected article included 1) published journals in the English; 2) complete articles of correlation study; and 3) the outcomes measured were predictive factors associated with DMSM practice. Studies of quasi-experiments, randomized control trials (RCT), qualitative research, and mixed-method studies were excluded. We excluded review articles, such as literature review, concept analysis, systematic review, and dissertation.

Screening process

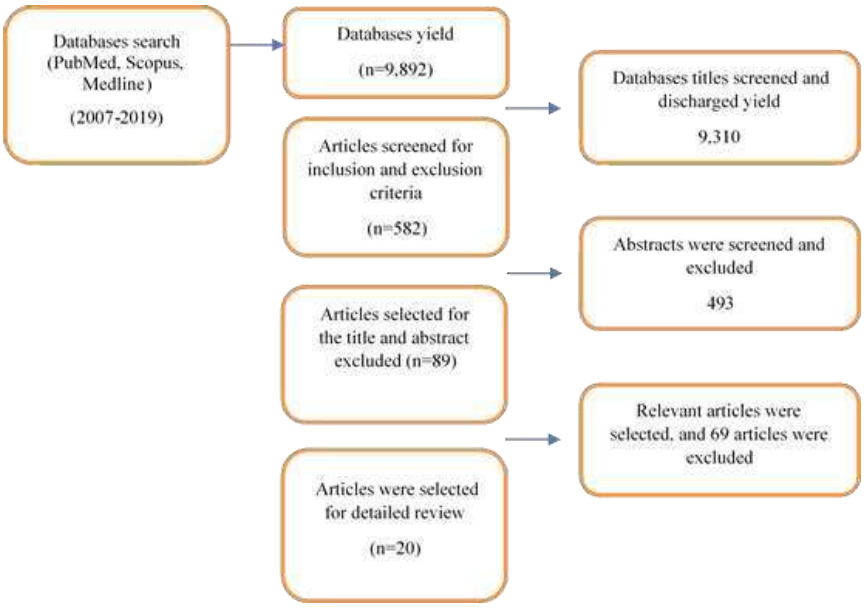

Figure 1. Articles screened process

The first reviewer selected articles according to the inclusion criteria. Two reviewers independently analyzed each title and abstract on an unblinded standardized basis. In this step, studies that measured unclear information on predictive factors in DMSM practice were excluded in this step. The second reviewer re-evaluated the included articles on whether these studies met or not with the inclusion criteria. All studies have been identified and extracted from the matrix table by two authors (Figure 1).

Quality assessment and controlling the risk of bias

A nine-checklist system for observational studies was used to assess the quality of each article. The key domains of this instrument comprised nine items, including 1) study questions, 2) study population, 3) comparability of subjects, 4) exposure, 5) outcome measurement, 6) statistical analysis, 7) results, 8) discussion, and 9) funding/sponsorship. Each item was coded as fully met (Yes = 2), partially met (Partial=1), or not met (No =0). Total scores were estimated for all studies, such as low instrument validity was 0–7; moderate validity of instrument presented scores of 8-14, and high instrument score validity was 15–20.

Statistical analysis

Meta-analysis was performed using Comprehensive Meta-analysis (CMA), Version 3.0. The standard error and the 95% confidence interval (CI) of β, correlation coefficients or OR were collected to understand the association between predictive factors and DMSM practice. The random-effects model was used to generalize the study results. The Cochran Q statistic and the I^2 statistic were considered for the testing of heterogeneity. Beta coefficients were pooled only when using a similar DMS. Pooled β ratios or Fisher's z scores were estimated using the inverse-variance weighted DerSimonian and Laird procedure for random-effects meta-analysis.

Table 1. Summary of quality assessment for correlational studies (n=20)

Quality assessment of correlational studies	No	Yes	Validity
Design			
1. Was the study prospective?	0	20	19.5
2. Was probability sampling used?	1	19	
Sample			
1. Was the sample size justified?	0	20	20
2. Was the sample drawn from more than one site?	0	20	
3. Was anonymity protected?	0	20	
4. Response rate of more than 60%	0	20	
Measurement			
1. Was the factor measured for reliability?	3	17	18.5
2. Was the factor measured using a valid instrument?	0	20	
Measurement of DV			
1. Are the effects observed rather than self-reported?	4	16	17.6
2. Did the scale used to measure the results have an internal consistency of more than 70?	1	19	
3. Was a theoretical model/framework used for guidance?	1	19	
Statistical analysis			
1. If multiple factors were studied, are the correlations analyzed?	0	20	20
2. Are outliers managed?	0	20	

Overall study validity rating:
(0-7 = low; 8-14 = medium; 15-20 = high

RESULTS

Description of studies

A total of 9,892 studies were obtained from the databases and 20 studies were included in this meta-analysis. A detailed quality assessment of the selected studies is shown in Table 1. The number of studies tested and the results of the meta-analysis results of this study are shown in Table 2.

Eligible factors associated with DMSM practice

Eligible factors associated with the practice of DMSM consist of age, sex, diabetes knowledge, being insulin in treatment, belief in the effectiveness of treatment, social support, occupation, personality traits, diabetes-specific emotional distress, illness perception, quality interaction between a patient and a healthcare provider, and self-efficacy.

1. Age

Age was often associated with poor glycemic control among diabetic patients. Six studies (Ausili et al., 2018; Gharaibeh, 2018; Rachmawati et al., 2019; Yang et al., 2016) investigated the positive association between age and use of the DMSM practice. In aging, people were significantly related to poor DMSM practice due to multiple comorbidities and physical disability.

2. Gender

Two studies examined the association between gender and implementation of DMSM practice (Ausili et al., 2018; Gharaibeh, 2018). After combining the data, it was found that women had better overall DMSM practice than their male counterparts.

3. Diabetes knowledge

Knowledge is essential in implementing the practice of DMSM and preference factors to avoid misconceptions among T2DM patients. This meta-analysis examined the association between knowledge and DMSM practice. The pooled findings confirmed that diabetes knowledge was positively associated with DMSM practice (Ausili et al., 2018; Barengo et al., 2014; Dao-Tran et al., 2018; Jiang et al, 2019; Rachmawati et al., 2019; Tahmasebi & Tavafian, 2015; Yang et al., 2016).

4. Insulin treatment

Insulin therapy helped T2DM patients to control their blood glucose levels in the normal range and prevent diabetes complications. In this study, two studies examined the relationship between insulin in treatment and DMSM practice (Benrazavy & Khalooei, 2019; Houle et al., 2015).

Table 2. A meta-analysis of a fixed effect model on predictors for DMSM practice

Predictors	Studies (n)	Participants (n)	ES	95%CI	Q-statistic	I^2-value(%)	Fail-safe N (Z)	Study references
Age	7	7487	0.037	0.014-0.060	86.866	94.244	3.235	(14-19, 34)
Fixed effect			0.037	0.014-0.060			3.235	
Random effect			0.045	-0.102-0.191			0.601	
Gender	3	6807	0.033	0.009-0.057	57.388	96.514	2.752	(17-19)
Fixed effect			0.033	0.009-0.057			2.752	
Random effect			0.011	-0.205-0.228			0.105	
Level of education	7	8357	0.051	0.029-0.072	11.729	40.320	4.674	(15, 17, 18, 20, 25, 26, 35)
Fixed effect			0.051	0.029-0.072			4.674	
Random effect			0.069	0.029-0.109			3.374	
Duration of illness	5	7065	0.049	0.026-0.072	10.866	63.188	4.176	(15, 18, 20, 25, 26, 35)
Fixed effect			0.049	0.026-0.072			4.176	
Random effect Financial barriers	7	2166	0.079	0.010-0.147			2.266	(14, 15, 19, 20, 26, 32)
Fixed effect Random effect								
Diabetes knowledge	9	10009	0.084	0.065-0.103	137.10	94.165	8.466	(14, 15, 18-24)
Fixed effect			0.084	0.065-0.103			8.466	
Random effect			0.123	0.021-0.222			2.375	
Being insulin in the treatment	2	895	0.166	0.101-0.229	47.141	97.87	5.010	(25, 26)
Fixed effect			0.166	0.101-0.229			5.010	
Random effect			0.245	-0.226-0.623			1.021	
Belief in treatment effectiveness	3	962	0.064	0.001-0.128	37.001	97.29	7.972	(15, 22, 27)
Fixed effect			0.064	0.001-0.128			7.972	
Random effect			0.057	-0.500-0.166			1.423	
Social support	6	1714	0.193	0.147-0.238	86.782	95.39	8.079	(15, 16, 21, 22, 27, 28)
Fixed effect			0.193	0.147-0.238			8.079	
Random effect			0.166	-0.057-0.374			1.459	
Occupation	2	904	0.268	0.207-0.328	7.745	87.08	8.261	(15, 19)
Fixed effect			0.268	0.207-0.328			8.261	
Random effect			0.253	0.073-0.417			2.741	
Personality	2	906	0.108	0.043-0.172	78.42	98.72	3.262	(21, 29)
Fixed effect			0.108	0.043-0.172			3.262	
Random effect			0.144	-0.411-0.622			0.490	
Diabetes-specific emotional distress	2	1090	0.114	0.069-0.158	17.93	94.42	4.996	(23, 30)
Fixed effect			0.114	0.069-0.158			4.996	
Random effect			0.324	-0.160-0.682			1.324	
Illness perception	3	556	0.270	0.191-0.345	517.49	99.80	6.495	(20, 21, 31)
Fixed effect			0.270	0.191-0.345			6.495	
Random effect			0.627	-0.878-0.993			0.686	
Quality interaction of the patient-healthcare provider	2	526	0.337	0.259-0.411	0.474	0	8.019	(21, 32)
Fixed effect			0.337	0.259-0.411			8.019	
Random effect			0.337	0.259-0.411			8.019	
Self-efficacy	10	4954	0.049	0.021-0.077	238.49	96.22	3.466	(15, 16, 20-24, 27, 28, 33)
Fixed effect			0.049	0.021-0.077			3.466	
Random effect			-0.007	-0.157-0.143			-0.092	

5. Belief in the effectiveness of treatment

T2DM patients with positive beliefs about treatment could influence individual decisions on their diabetes management. Three studies (Barengo et al., 2014; Dao-Tran T, 2018; Gunggu et al., 2016) examined the association between belief in the treatment and DMSM performance. After combining the three previous studies, the results showed a positive association with the practice of DMSM among T2DM patients.

6. Social support

Social support crucially influences the availability and quality of cultural diabetes self-management. Six current studies discussed the importance of support from family, community, and healthcare providers to strengthen DMSM practice (Barengo et al., 2014; Dao-Tran, 2018; Gunggu et al., 2016; Banda et al., 2019; Tahmasebi & Tavafian, 2015; Wardian & Sun, 2014).

7. Occupation

Two studies examined the association between occupation and the implementation of DMSM practice among T2DM patients (Ausili et al., 2018; Barengo et al., 2014).

8. Personality traits

Personality traits, especially types A and D, have been linked to adverse outcomes in various somatic diseases. This could lead to certain aspects of suboptimal health behaviors. In this review, two studies examined the positive relationship between personality traits and DMSM practice among T2DM patients (Morikawa et al., 2019; Tahmasebi & Tavafian, 2015).

9. Diabetes-specific emotional distress

Diabetes-specific emotional distress is the emotional response and relentless burden due to daily self-management. A study was considered to explore the association between diabetes-specific emotional distress and suboptimal DMSM practice among T2DM patients (Quek et al., 2019).

10. Illness perception

The perception of illness was found to be a significant factor influencing self-care practices, psychological distress, and other health outcomes among people living with T2DM patients. After data fooling, two studies showed a significant association between illness perception and DMSM practice to control health behaviors (Kugbey et al., 2017; Tahmasebi & Tavafian, 2015).

11. Quality interaction between patients and healthcare providers

Patient-provider relationships have recently emerged as cornerstones of quality healthcare. Empathy, secure communication, and shared decision making are essential for a positive patient-provider relationship. In this review study, two studies explored the quality interaction between patients and healthcare providers as predictive factors in DMSM practice (Hyman et al., 2017; Tahmasebi & Tavafian, 2015).

12. Self-efficacy

Self-efficacy plays a significant role in the management of diabetes. Self-efficacy can directly induce motivation to take health-promoting behavior through efficacy expectations and influence the abilities of patients to perform their behaviors. Ten previous studies showed positive effects of self-efficacy on the DMSM practice (Alvarado-Martel et al., 2019; Barengo et al., 2014; Dao-Tran, 2018; Gunggu et al., 2016; Jiang et al., 2019; Banda et al., 2019; Tahmasebi & Tavafisn, 2015; Wardian & Sun, 2014; Zulman et al., 2012).

Summary of weight effect sizes of predictors on DMSM practice

Table 3 summarizes the weight effect sizes of the predictors in the DMSM practice, failsafe N, homogeneity test, and the 95% confidence intervals (CI) for each predictor. Twenty observational studies contributed to this meta-analysis and were pooled to identify predictive factors in DMSM practice. Table 3 summarizes the weighted effect sizes of various predictor variables on the performance of the Diabetes Self-Management Support Measures, along with their heterogeneity as measured by the I^2-value and the number of studies investigating each predictor. A higher number of studies can provide more confidence in the estimation of effect size. "Self-efficacy" has been studied in 10 different studies, which is the highest number in this table. Here is a detailed explanation of the table.

Table 3. The weight effect sizes of predictors (with n ≥ 2) on DMSM practice

Predictor variables	Effect size	I^2-value (%)	Number of studies
Age	0.037	94.244	7
Gender	0.033	96.514	3
Level of education	0.069 (Random effect)	40.320	7
Duration of illness	0.049	63.188	5
Financial barriers	0.08	96.52	7
Diabetes knowledge	0.084	94.165	9
Being insulin in the treatment	0.166	97.87	2
Belief in treatment effectiveness	0.064	97.29	3
Social support	0.193	95.39	6
Occupational	0.268	87.08	2
Personality	0.108	98.72	2
Diabetes-specific emotional distress	0.114	94.42	2
Illness perception	0.270	99.80	3
Quality interaction of patient-healthcare provider	0.337 (Random effect)	0	2
Self-efficacy	0.049	96.22	10

Effect size

The effect size is a quantitative measure of the magnitude of the experimental effect. It represents the strength of the relationship between each predictor variable and the DMSM practice. The larger the effect size, the stronger the relationship. For example, the "quality interaction patient-healthcare provider" has the highest effect size of 0.337, indicating a strong relationship with the practice of DMSM.

I^2-value

The I2-value represents the percentage of variation between studies that is due to heterogeneity rather than chance. A

high I^2 value (close to 100%) suggests that there is substantial heterogeneity, which means that the effect sizes of different studies vary widely. For example, "Illness perception" has an I^2-value of 99.80%, indicating very high heterogeneity among the studies.

DISCUSSION

Age and sex associated with DMSM practice among T2DM patients. According to previous studies, a study in Tunisia showed that 94% of younger patients have poor glycemic control related to a lack of experience in managing their self-management behaviors (Alberti, 2007). Another study conducted in Korea reported that women have less consent to glycemic control than men (Choe, Kim, Ro, & Cho, 2018). However, older patients are likely to adhere more to medical therapy, consume a healthy diet, and tend to keep their follow-up appointments more regularly than younger patients. Those who keep their appointments can achieve better glycemic control. Regarding the gender factor, some studies also reported that women were likely to have poor glycemic control compared to men. This condition was associated with women having less physical activity to control their disease and less of a priority in maintaining healthy behavior (Juarez et al., 2012; Mohamed, Mahfouz, & Badr, 2020). Five studies reported the association between the duration of the illness and the practice of DMSM. A study showed that a longer duration of the disease managed better diabetes management, including self-monitoring blood glucose (SMBG), diet modification, and physical activity (Zhao et al., 2019).

Knowledge of diabetes is one of the most important predictive factors to improve healthy behavior. Lack of knowledge is a preference factor for misconceptions on perceived health information and misconceptions within DMSM practice. Diabetes patients always face some barriers to misconceptions of insulin risk (Peyrot et al., 2012), myths, and doubts about specific types of foods and food preparation for diabetes patients (Laranjo et al., 2015).

Insulin injection is an essential strategy to manage blood glucose levels and maintain successful x self-management behavior of duration among T2DM patients. The injection has been recommended for patients with diabetes and healthcare providers as an integrated part and an option after behavior modification to improve the blood glucose level of DMSM practice (Gorska-Ciebiada, Masierek, & Ciebiada, 2020). However, its impact as a psychological effect on patient uptake and adherence to CBG tests and insulin injection remains significant and important for T2DM patients to cope with (Shlomowitz & Feher, 2014). Intense fear of self-injection is the most plausible reason for precipitating psychological distress (Pamungkas & Chamroonsawasdi, 2020).

Social support crucially influences the availability and quality of cultural diabetes self-management. A study reported that family support affects patient self-management behaviors (Miller & DiMatteo, 2013). Patients who received support could solve the problem and establish positive communication for diabetes care. It could influence the positive relationship among them on managing and maintaining self-management behaviors. For this reason, family social support was effective in improving diabetes self-management behaviors.

Predictors of diabetes-specific emotional distress had a large effect size with respect to DMSM practice. Patients with emotional distress led to uncontrolled diabetes self-management, which will affect emotional responses, including discouraged about treatment goals, worrying about hypoglycemia condition or severe complications, and incorrectly defining the concrete goals for DMSM (Zulman, Rosland, Choi, Langa, & Heisler, 2012). The previous study reported that depressive problems and health-related distress and perceived family support significantly effect dietary behavior practice (Rondhianto, Ridha, & Budi, 2023). Illness perception has been considered an influencing factor in self-care practice. A study showed the positive effect of diabetes management practice, psychological issues, and health outcomes among patients with T2DM (Kugbey et al., 2017). The relationship between disease perception and diabetes outcomes was influenced by participation in self-management with the representation of their illness (Nyarko, 2014).

Regardless of the interaction between patient and provider, communication skills are needed for DMSM practice. A healthcare provider must have a positive communication skill and relationships with patients to provide support in an appropriate way for DMSM practice. Good interpersonal relationships between patients and providers could achieve optimal goals and improve diabetes outcomes (Renaldi, Riyadina, Qamar, & Sauriasari, 2021). Unfortunately, many patients confirmed that there are some barriers to collaborative DMSM practice, which affects adherence (Pamungkas, Chamroonsawasdi, Vatanasomboon, & Charupoonphol, 2019).

Bandura (1997) introduced the concept of self-efficacy in the context of cognitive behavior modification in patients with chronic diseases. Stronger personal efficacy has been reported among individuals to be interconnected with healthy physical outcomes, meeting goals, and greater social integration. When patients believe that they can perform self-management behaviors, it can positively impact their confidence in practicing self-management activities (Dehghan et al., 2017). A study reported that people with the highest self-efficacy effect significantly control blood glucose (Cosansu & Erdogan, 2014).

STRENGTH AND LIMITATION

This systematic review focused on predictive factors associated with health outcomes. It was considered as the rigorous information to obtain factors associated with DMSM practice. Another strength was concerned on representative of the studies with variety of cultural groups among different countries. However, the limitation of this study was concerned on only 20 published articles. The total number of studies might not cover all target group in different setting. Another limitation found in this study included the difficulty of generalization of the contribution of factors and the relatively small number of studies in some factors were included in the meta-analysis.

CONCLUSION AND RECOMMENDATION

In conclusion, this study was the first study in Indonesia and provided 15 predictive factors associated with DMSM including age, sex, level of education, duration of the illness, financial barriers, diabetes knowledge, being insulin in treatment, belief in the control of treatment, social support, occupational, personality, diabetes-specific distress, perception of the illness, quality interaction between patient and healthcare provider, and self-efficacy. The implication for clinical practice was to provide information on the factors that influence DMSM. This study was also the first step to developing the best theory-based intervention for diabetes patients. Future research should be conducted with a wide range of personal and environmental factors that were the

most significant factors associated with the implementation of DMSM in health care services. Therefore, theory-based strategies must be constructed to improve DMSM practice among the diabetes population.

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