**Self-Management Education Program: The Case of Glycemic Control of Type 2 Diabetes**

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**Abstract**

**Objective:** Self-management education is recognized globally as a tool that enables patients to achieve optimum glucose control. While factors influencing the effectiveness of self-management interventions have been studied extensively, the impact of program length on clinical endpoints of patients diagnosed with diabetes is underdeveloped. This paper synthesized information from the existing literature to understand the effect of program length on glycated hemoglobin (A1C) in adults with type 2 diabetes mellitus.

**Methods:** Electronic searches were made on Web of Science, PubMed, Scopus, MEDLINE, EMBASE, PsychINFO and the Cochrane Central Register of Controlled Trials to identify relevant English language publications on diabetes self-management education between 2000 and April, 2019.

**Results:** The review included 25 randomized controlled trials, with 64% reporting significant changes in A1C. The studies classified as long-term (lasting 1 year and above) were associated with the greatest number of interventions achieving statistically significant (87.5% significant vs 12.5% non-significant) differences in changes in A1C between the intervention and the control
subjects, recording an overall between-group A1C mean difference of 0.63% (SD, 0.35; range, 0.2-1.2).

**Conclusion:** Our findings suggest that program length may change the effectiveness of educational interventions. Achieving sustained improvements in patients’ A1C levels will require long-term, ongoing self-management education and support.

**Keywords**
Chronic disease, diabetes mellitus, diabetic patient, type 2 diabetes, self-management education, program length, glycemic control, randomized controlled trial, systematic review

**Introduction**
Chronic diseases have become a primary concern for healthcare systems worldwide. The World Health Organization (WHO) states that 24 million people per year (about 50% of all deaths worldwide) die as a result of chronic conditions. In 2006 alone, chronic diseases were responsible for 35 million deaths worldwide. Projections are that chronic conditions will account for 60% and 70% of the global disease burden by 2020 and 2035 respectively. Chronically ill patients are frequent and long term users of health services. The evidence suggests that about two-thirds of patient encounters with health professionals are for the management of chronic conditions.

One of the major chronic diseases causing worldwide public health challenge is diabetes mellitus (DM). It is the fifth leading cause of death in high-income countries, and is rapidly becoming epidemic in many low and middle-income countries. Globally, the number of people suffering from diabetes in 2014 was estimated at 422 million, and this number is expected to rise to 592 million by 2035, while 175 million people remain undiagnosed. Diabetes care is expensive and the condition can lead to serious complications such as kidney failure, myocardial infarction, stroke, blindness and limb amputation. It imposes a huge economic burden on national healthcare systems. Depending on the country, it could take up between 5 to 15% of total health expenditure.
Three main types of diabetes are known: 1) type 1 diabetes (caused by the body’s failure to produce insulin), 2) type 2 diabetes (resulting from insulin resistance), and 3) gestational diabetes (which occurs in pregnant women without previous diagnosis of diabetes). Of the three, type 2 diabetes is the commonest, constituting approximately 95% of all DM cases. The prevalence varies with age, gender, ethnic background and genetic susceptibility. It is associated with environmental risk factors such as: lack of physical activity, nutritional status and obesity.

Available evidence indicates that early diagnosis and effective management increases the chances of preventing harmful and costly complications associated with diabetes. Evidence has also been established regarding the benefits associated with glycemic control in reducing the risk for and delaying the progression of diabetes complications. Achieving effective glycemic control requires a lifelong adherence to complex lifestyle management, involving regular blood glucose monitoring, self-adjustment of medications and a physically active lifestyle. Self-management education (SME), which is based on the concept of patient empowerment, is recognized globally as a tool that enables patients to achieve optimum glucose control, through increasing knowledge and awareness, and learning behavioral strategies to manage diabetes.

Diabetes self-management education (DSME) is defined as the “ongoing process of facilitating the knowledge, skill and ability necessary for self-care”. The process, which is guided by evidence-based research, incorporates the needs, goals and life experiences of people with diabetes. The overall objectives of DSME are to support self-care behaviors, problem solving, informed decision-making, and active collaboration with healthcare teams, as well as improving clinical outcomes, health status and quality of life. The intervention involves a variety of educational programs, ranging from brief instructions by lay leaders, physicians, dieticians or nurses to more formal and comprehensive programs. In the 1960s and 1970s, DSME
interventions were individually oriented, and mostly delivered in hospital settings by either nurses
or dietitians.8 From 1980 onwards, more specific programs have been developed for diabetes
patients and their families.18 Health professionals with different backgrounds educate patients in
their own domain of expertise. In addition to individual education, more cost-effective
interventions such as: group-based education,19 information technology-based education,20 and
self-help and support group programs.18 have been developed.

The efficacy of DSME is supported by a large number of studies, including randomized controlled
trials. According to Siminerio et al.21 DSME improves glycemic control by as much as 1% in
people with type 2 diabetes. A meta-analysis of 18 randomized studies published between 1966
and 1999 found a significant decrease in mean A1C by 0.43%.22 Another review of 11 studies
from 1988 to 2002 also reported a significant A1C reduction of 1.4% at 4-6 months.23 More
recently, a meta-review of systematic reviews found that 34 out of the 35 included reviews reported
a statistically significant improvement in A1C following a DSME intervention.24

Given this demonstrated efficacy of the existing interventions on glycemic control,25-30 the current
policy challenge is not to find new efficacious treatments, but to implement the proven programs
more cost-effectively.8 Over the last decades, many reports on factors influencing the efficacy and
cost-effectiveness of DSEM programs have been published. Some target intervention attributes
such as: mode of delivery (group sessions vs individual teaching),31,32 delivery setting (community
gathering places vs medical settings),33 timing and program content,34,35 and trainer’s background
(medical, allied health or peer).34,36,37 Others focus on personal characteristics of patients, such as:
health status;38,39 disease duration;40 age, educational level, and partner’s influence;41,42
economic status;43 language and culture;44 and gender difference.40,45,46
While many of these factors affecting the effectiveness of DSEM programs have been studied extensively, the impact of program length on the clinical outcomes of type 2 diabetics has received little research attention. Self-management interventions vary substantially in terms of duration. For instance, the majority of the programs modelled after the Stanford Model usually involve six weeks of education. Others with different theoretical underpinnings have varied time lengths, ranging from 1 day to as long as 5 years and above. It is thus vital to ascertain the impact of program duration on the outcomes of these DSME interventions. Such information will inform policy decisions on how to optimize the design and implementation of more cost-effective self-management programs.

Recently, Chrvala and colleagues conducted a review to assess the effect of DSME interventions on glycemic control. The authors concluded that program duration, in terms of total hours of engagement, could affect the likelihood of achieving significant improvements in clinical outcomes. However, because they included trials enrolling participants with both type 1 and type 2 DM in their analysis (p. 927), their conclusion appears more general rather than being specific to patients with type 2 DM.

The present study therefore is a systematic review of the existing, published, randomized controlled trials to assess the impact of DSME program length on glycated hemoglobin (A1C) in adults with type 2 DM. We chose A1C as the clinical endpoint of this study because glycemic control has been demonstrated to strongly predict both the microvascular (diabetic, nephropathy, neuropathy and retinopathy) and the macrovascular (coronary artery disease, peripheral arterial disease, etc.) complications associated with diabetes. For instance, the UK Prospective Diabetes Study has demonstrated that a 1% reduction in A1C is associated with a 21% decrease in
diabetes related endpoints, an 18% reduction in combined fatal and non-fatal myocardial infarction, a 12% decrease in stroke, a 37% decrease in microvascular endpoints, a 25% reduction in diabetes related deaths and a 7% decrease in all-cause mortality. Moreover, A1C has been considered the primary outcome measure in the majority of the diabetes SME intervention studies. This study contributes to the current knowledge on the factors affecting the efficacy and cost-effectiveness of DSME interventions.

**Methods**

We designed and conducted the systematic literature search according to the PICO S framing (Population, Intervention, Comparison, Outcome and Study design). The population of interest was adults with type 2 DM. The intervention considered was diabetes self-management education (DSME) program. The comparison groups were patients receiving “usual care” or “standard care”. Outcome of interest was glycemic control. Study designs considered were randomized or clinical controlled trials. We framed our research question as: what is the impact of DSME program length on glycemic control in adults with type 2 DM?

**Search strategy**

We identified relevant literature through electronic searches. A librarian from the School of Medical Sciences, Kwame Nkrumah University of Science and Technology was consulted in developing our search strategy, which included the identification of key words and medical subject headings (i.e. MeSH terms). Electronic searches were made on Web of Science, PubMed, Scopus, MEDLINE, EMBASE, PsychINFO and the Cochrane Central Register of Controlled Trials. We restricted the search to only English language medical literature published between 2000 and April 2019. The medical subject headings searched included: “self-management education program” combined with: “type 2 diabetes”, “glycemic control”, and “controlled trial”. We identified additional relevant articles by manually searching the bibliographies of the retrieved papers.
**Study Selection**

After removing duplicate publications, 1,081 records were screened for eligibility. We carefully read the titles and abstracts of these 1,081 papers focusing on two main criteria: 1) Does the paper discuss diabetic patient/individual? 2) Does it focus on self-management education program? A paper had to meet both criteria in order to be considered in the next stage of our review. Following this procedure, we excluded 804 articles.

The remaining 277 articles were retrieved and read fully by three reviewers. A study had to fulfil six inclusion criteria to be eligible for inclusion in the final analysis:

1) Must not be a review article or a report;

2) Should evaluate the effectiveness of diabetes self-management education program on A1C;

3) Should focus on type 2 diabetes patients;

4) Should indicate program length or duration;

5) Must be a randomized controlled trial, comparing an intervention group to a control group;

and

6) Should not compare two or more educational programs (e.g. group vs. individual education).

Any differences in opinion, regarding papers’ eligibility, were discussed and resolved by the reviewers.

Two Hundred and fifty-two (252) articles were further excluded after the full text reading. The most common reason for exclusion was lack of reporting on program length/duration (n = 78). Other common exclusions included article: not assessing program effect on A1C (n= 29), focusing on either type 1 (n= 32) or both type 1 and type 2 (n= 37) diabetes patients, focusing on more than
one chronic disease (n= 28), and comparing the effectiveness of two educational programs (n = 25). The flow diagram in Figure 1 depicts stages of study identification and reasons for paper exclusion. Twenty-five articles were included in the final analysis.

Validity assessment

Internal validity of the individual studies was assessed using the Cochrane Collaboration Criteria for four types of bias: selection, performance, attrition and detection biases\(^5\) (See descriptions in Table 1). Studies were scored from 0 to 4, with a score of 4 indicating the absence of the four potential sources of bias and a score of 0 signifying the possibility of the presence of these biases.
Table 1. Assessment of internal validity based on Cochrane Collaboration methodology

| Type of Bias | Description                                                                 | Present = 0 | Absent = 1 |
|--------------|------------------------------------------------------------------------------|-------------|------------|
| Selection    | Systematic differences between baseline characteristics of the study and the control groups |             |            |
| Performance  | Systematic differences between study and control groups in the care that is provided, apart from the intervention being evaluated |             |            |
| Attrition    | Systematic difference between study groups in withdrawals from a study       |             |            |
| Detection    | Systematic difference between study groups in how outcomes are assessed      |             |            |

Data extraction

Data extraction from the selected publications was done by two members of the research team. A subsample of the articles was also evaluated by a second assessor (a third member of the research team), yielding an assessor agreement of 95%. The assessors then discussed the differences and reached a consensus. To ensure data consistency and accuracy, a fourth member verified all the extracted information against each of the selected papers. Information recorded about each study included: authors and year of publication, study sample, study site (country), study aim/objective, length of program, SME provider (dietitian, nurse, peer educator, physician etc.), description of intervention, study outcome (effect on A1C) and conclusions drawn from the findings.

Categorization of interventions

We categorized the studies into 3 program lengths (short, medium and long-term) and compared interventions’ effects on A1C across these categories. For the purpose of this study, we defined short-term programs as interventions having a duration of 3 months or below (i.e. ≤ 3 months); medium-term as ones between 3 and 12 months of duration (>3 months to < 12 months); and long-term as those lasting 12 months or above (≥ 12 months).

Evaluation of program effectiveness
We judged the effectiveness of each program based on the level of significance of the A1C mean difference between the intervention and the control groups. Although a section of the literature considers an intervention effective once the experimental subjects achieve greater reduction in A1C levels than those in the control group, we believe that a successful intervention should, in addition to this, have a statistically significant difference in A1C change between the two groups. Thus, only programs that reported a significant A1C mean difference between the intervention group and the control group were considered effective in the current study.

Results

Methodological quality

Validity scores of the 25 studies were moderate, with a mean of 2.13 and a standard deviation (SD) of 0.85 (range, 0 – 4). Scores for each study on the Cochrane Collaboration Criteria for the four types of bias are shown in the Appendix. Generally, studies (96%) met the criteria for a possible absence of performance bias by demonstrating no possibility of contamination between the study and the control groups and no treatment differences between the groups, apart from the DSME intervention. A moderate number of studies (52%) met the criteria for an absence of selection bias. However, the issue of marked difference in characteristics between the intervention and the control groups at baseline was a major concern for some of the studies (48%). The majority of the studies (56%) did not meet the attrition bias absence criteria. These studies either did not meet a retention rate of ≥ 80%, as recommended by the Cochrane Criteria, or failed to compare the baseline characteristics of those who completed the study and those who dropped out. Almost all of the studies (96%) did not meet the criteria for a possible absence of detection bias by failing to report on blinding of those who carried out the outcome assessment and statistical analysis.

Description of the included studies

Detailed description of the selected studies is presented in Table 1. A total of 5,219 type 2 diabetes patients, made up of 2,746 experimental subjects and 2,545 controls, were included in the 25
studies. The mean age of the participants reported was approximately 58 years, with mean percentage of female to male being 54.2% to 45.8%. The majority of the studies were conducted in the US (40%), followed by the UK (16%). The remaining studies were carried out in Brazil, the Netherlands, Iran, Japan, Greece, China, Norway, Australia, Taiwan, Iraq and Kenya. Sample size ranged from 25 to 824. The studies were conducted between 2002 and 2018. Patients were recruited from several settings including: primary or general medical practice, hospitals, community health centers, churches, outpatient diabetes clinics, university affiliated clinics, and the general community (via advertisements and rosters of previous research studies). Most of the educational interventions were led by health professionals such as: dietitians, nurses, clinical pharmacists, physicians, physiotherapists and community health workers. Two publications did not provide information on SME provider, while two mentioned lay leaders as program instructors.

| Study                | Country      | Objective                                                                 | Sample                  | SME provider                      |
|---------------------|--------------|---------------------------------------------------------------------------|-------------------------|-----------------------------------|
| Wolf et al.         | USA          | To assess the efficacy of a lifestyle intervention program that can be translated into clinical practice for obese patients with type 2 diabetes | 144(intervention = 73, control = 71) | Registered dietitians             |
| Samuel-Hodge et al. | USA          | To develop and test a culturally appropriate, church-based intervention to improve diabetes self-management | 201(intervention = 117, control = 84) | Peer educators, Registered dietitian |
| Scain et al         | Brazil       | To evaluate the effectiveness of a structured, group education program in metabolic control in type 2 diabetics | 104 (intervention = 52, control = 52) | Trained nurse educators           |
| Goudswaard et al.   | The Netherlands | To evaluate the short and long-term efficacy of a self-management education program in type 2 diabetes patients treated in primary care | 58(intervention = 28, control = 30) | Diabetes nurses                   |
| Shakibazadeh et al. | Iran         | To assess the effectiveness of a Persian Diabetes Self-Management Education program | 280 (intervention = 140, control = 140) | A nurse, dietitian and counselor |
| Deakin et al        | UK           | To develop a patient-centered, group based self-management program and assess its effectiveness on clinical and psychological outcomes. | 314(intervention = 157, control = 157) | Diabetes research dietitian       |
| Forjuoh et al       | USA          | To assess the effectiveness of the Chronic Disease Self-Management Program (CDSMP) on glycated hemoglobin and selected self-reported measures | 196 (intervention = 101, control = 95) | Peer educators                    |
| Moriyama et al      | Japan        | To develop and assess the efficacy of a 12 month self-management education program for type 2 diabetics | 65(intervention = 42, control = 23) | Nurse educator                    |
| Authors          | Country | Objective                                                                 | Participants | Intervention Details                                                                 |
|------------------|---------|---------------------------------------------------------------------------|--------------|---------------------------------------------------------------------------------------|
| Merakou et al.   | Greece  | To assess the impact of a brief patient group education intervention in people with type 2 diabetes | 193 (intervention = 138, control = 55) | Trained health visitors                                                                |
| Spencer et al.   | USA     | To assess the effectiveness of a culturally tailored, behavioral theory-based community health worker intervention for improving glycemic control | 164 (intervention = 72, control = 92) | Community health workers                                                              |
| Sun et al.       | China   | To evaluate a structured and integrated intervention on diabetes management in type 2 diabetics | 150 (intervention = 100, control = 50) | Nutritionists                                                                        |
| Choe et al.      | USA     | To evaluate the effect of case management by a clinical pharmacist on glycemic control and preventive measures in type 2 diabetics | 80 (intervention = 41, control = 39) | Clinical Pharmacist                                                                  |
| Servick et al.   | USA     | To evaluate behavioral intervention with technology-based self-monitoring on bio-physiologic outcomes | 299 (intervention = 147, control = 149) | Clinical diabetes educators                                                          |
| Rosal et al.     | USA     | To test whether a theory based, literacy, and culturally tailored self-management intervention improves glycemic control among low-income Latinos with type 2 diabetes | 252 (intervention = 128, control = 124) | A trained team of 2 leaders and an assistant |
| Jacobs et al.    | USA     | To demonstrate that pharmacists working with physicians and other providers in an ambulatory care setting can improve glucose, blood pressure and lipid control for patients with type 2 diabetes | 396 (intervention = 195, control = 201) | Pharmacists                                                                          |
| Johansen et al.  | Norway  | To compare a structured education program with standard care              | 120 (intervention = 60, control = 60) | Nurse, physician, nutritionist, physiotherapist, Nutritionist, nurse and intervention assistant |
| Rosal et al.     | USA     | To determine the feasibility of conducting a clinical trial of an innovative self-management intervention to improve metabolic control, and to obtain preliminary data of possible intervention effects | 25 (intervention = 15, control = 10) | Nurses, dietitian and CHWs                                                          |
| Brown et al.     | USA     | To determine the effects of a culturally competent diabetes self-management intervention | 252 (intervention = 126, control = 126) | Trained health professionals                                                         |
| Davies et al.    | UK      | To evaluate the effectiveness of a structured group education program on biomedical, psychosocial and lifestyle measures in people with newly diagnosed type 2 diabetes. | 824 (intervention = 437, control = 387) | Trained health professionals                                                         |
| Dyson et al.     | UK      | To develop a video-based lifestyle education program for people newly diagnosed with type 2 diabetes and to evaluate changes in knowledge, biomedical indices and quality of life. | 42 (intervention = 21, control = 21) | Trained health professionals                                                         |
| William et al.   | Australia | To evaluate an Australian Telephone-Linked Care (TLC) diabetes program designed to improve diabetes management | 117 (intervention = 57, control = 60) | Trained health professionals                                                         |
| Huang et al.     | Taiwan  | To evaluated the effect of registered dietitian–led management of diabetes on glycemic control and macronutrient intake in type 2 diabetic patients in primary care | 154 (intervention = 75, control = 79) | Registered dietitians                                                                 |
| Abdullah et al.  | Iraq    | To examine the impact of a 3-month self-management intervention on glycemic control | 45 (intervention = 22, control = 23) | Trained health professionals                                                         |
| Khunti et al.    | UK      | To find out whether the benefits of a structured program for newly diagnosed type 2 diabetes patients are sustainable | 604 (intervention = 332, control = 272) | Trained health professionals                                                         |
| Gathu et al.     | Kenya   | To assess effects of DSME in comparison to usual diabetes care by family physicians | 140 (intervention = 70, control = 70) | Certified diabetes educators                                                        |
**Interventions’ effects on changes in AIC**

The selected studies and their outcomes are grouped under the short, medium and long-term classifications in Tables 2, 3 and 4 respectively. In all, 16 (64%) studies reported significant differences in A1C changes between the intervention and the control groups. Nine (36%) studies showed no significant effects. In one of these studies, a significant difference in A1C change between the groups was recorded at the initial stage of the intervention (0.53%, \( p = 0.008 \)), but this decreased and lost significance during the follow-up assessment (0.25%, \( p = 0.293 \)). In the remaining eight studies, though significant reductions were recorded at the end of the interventions, between group differences were not significant.

Nine studies were classified as short-term programs; five reported significant differences in changes in A1C between the intervention and the control groups, while four showed no significant differences (Table 2). The overall difference in the mean change in AIC between the experimental and the control subjects for the seven studies was 0.45% (SD, 0.36) with a range of 0.02 to 1.4. With the medium-term programs, eight studies were identified; four reported significant differences in between-group changes, while four showed no significant differences (Table 3). Overall difference in the mean change in AIC between the groups was 0.48% (SD, 0.27; range, 0.1 - 0.85). The long-term interventions had eight studies; seven recorded significant differences in between-group changes, whereas one indicated no significant difference (Table 4). The studies recorded an overall difference in between-group A1C mean change of 0.63% (SD, 0.35; range, 0.2- 1.2).
| Study            | Description of intervention                                                                                                                                                                                                 | Length (months) | Outcome                                                                                                                                                                                                 | Conclusion                                                                                                                                                      |
|------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Scain et al.55   | An 8-hour interactive education program, delivered in weekly sessions of 2 hours each, to a group of 8 to 10 subjects.                                                                                                     | 1               | A1C significantly differed between the intervention group (IG) and the control group (CG) by 0.4% (p = 0.007) at 4 months, 0.5% (p = 0.009) at 8 months, and 0.4% (p = 0.04) at 12 months.          | The program improved glycemic control in patients with type 2 diabetes                                                                                       |
| Shakibazadeh et al.57 | Eight 2.5-hour educational workshop offered over a 4-week period; followed by two booster sessions, each 2 weeks apart.                                                                                                          | 2               | A1C differed between the IG and the CG by 0.78%, 0.2 to 1.36 (p = 0.008)                                                                                                                               | The program was effective in improving A1C levels                                                                                                              |
| Deakin et al.58  | Six weekly sessions, each lasting 2 hours, with an average of 16 participants plus four to eight cares.                                                                                                                                                                       | 1.5             | The IG had greater reduction in A1C compared with the CG. Mean A1C difference between the two groups was 0.4% (CI 95%, 0.1 to 0.7, p <0.001) at 4 months and 0.7% (CI 95%, 0.3 to 1.0, p <0.001) at 14 months. | Participation in the SEM program (X-PERT) led to improvements in glycemic control                                                                             |
| Forjuoh et al.59 | A 6-week classroom based program teaching participants techniques to facilitate enhanced decision making, action planning, and effective communication                                                                                  | 1.5             | Reductions in A1C did not differ significantly between the two groups (mean difference = 0.016%, p = 0.885)                                                                                                  | The SME program did not lower A1C levels any better than routine care                                                                                         |
| Merakou et al.61 | A structured group educational program using Conversation Maps; participants were divided into 19 groups (3-8 people per group) and each group attended a 6-hour educational program, spread in 3 sessions, over a period of 3 weeks.              | <1              | Significant difference in mean A1C was observed between the groups, 1.4% (95% CI: 1.1 to 1.7, P < 0.001)                                                                                                    | The intervention was more effective, compared with routine care, in diabetes self-management                                                                |
| Rosal et al.69   | The intervention involved: 1 hour individual session, 10 group sessions (lasting 2.5 to 3 hours per session), and two 15-minute individual sessions                                                                                                                                  | 2.5             | A1C significantly differed between the IG and the CG by 0.56% (p < 0.05) at 3 months and 0.73% (p < 0.01) at 6 months.                                                                                   | The program resulted in significant improvements in A1C levels                                                                                                  |
| Davies et al.71  | A six-hour long, structured group education program deliverable in either 1 day or 2 half day equivalents and facilitated by two educators                                                                                                                                          | <1              | The difference in A1C levels between the IG and the CG was not significant: 0.05% (95% CI, 0.10% to 0.20%)                                                                                               | The program resulted in no significant improvements in hemoglobin A1C levels                                                                               |
| Author(s) | Intervention Description                                                                 | Duration | Findings                                                                 | Conclusion |
|----------|------------------------------------------------------------------------------------------|----------|--------------------------------------------------------------------------|------------|
| Abdullan et al.\(^75\) | Three two-hour educational sessions on dietary habits and physical activity designed according to Health Belief Model | 3        | The difference in A1C levels between the IG and the CG was not significant: -0.26 (p = 0.64) | No substantial change was seen in A1C. |
| Khunti et al.\(^76\) | A structured group education program for six hours delivered in the community by two trained professional educators | <1       | No significant difference in AIC between the IG and the CG: -0.02 (95% CI, -0.22 - 0.17) | The program resulted in no improvement in A1C. |
| Study                | Description of intervention                                                                 | Length (months) | Outcome                                                                 | Conclusion                                                                 |
|---------------------|---------------------------------------------------------------------------------------------|-----------------|-------------------------------------------------------------------------|---------------------------------------------------------------------------|
| Goudswaard et al.56 | Six educational sessions, given at intervals of 3-6 weeks; sessions took between 15 and 45 minutes, resulting in a total contact time of 2.5 hours. | 6               | A1C changed from 8.2 to 7.2 in the IG, and from 8.8 to 8.4 in the CG. Mean Hba1c% in the study group fell by 0.7 more than in the CG (CI 95%, 0.1, 1.4; P = 0.025). | The education was effective in improving glycemic control and in delaying the need for insulin therapy for diabetes patients. |
| Spencer et al.62    | Three-activity intervention: 1) education classes, 2) 2 home visits per month to address participants' specific self-management goals, and 3) 1 clinic visit with the participant and his/her care provider | 6               | A1C significantly reduced from 8.6 to 7.8 in the IG. Change in A1C level for the CG was not significant. The difference in the change in A1C level between the 2 groups was 0.80% | Intervention participants had significantly greater improvements in A1C levels compared with the control group. |
| Sun et al.63        | Education with frequent blood glucose monitoring, nutritional counseling, meal plans with diabetes-specific nutritional meal replacement and weekly progress updates with study staff | 6               | A1C level significantly reduced by 0.85% in the IG, while the CG recorded no change. Mean A1C differed between the 2 groups by 0.85% | The program resulted in significant improvements in A1C levels. |
| Servick et al.65    | Group counselling sessions guided by Social Cognitive Theory- sessions were held weekly in the first 2 months, biweekly in the subsequent 2 months, and monthly in the last 2 months | 6               | A1C reduced in the IG by 0.5% (p<0.001) at 3 months and 0.6%(p<0.001) at 6 months, and the CG by 0.3%(p<0.001) at 3 months and 0.2% (p<0.05) at 6 months; but between group differences (0.2% at 3 months and 0.4% at 6 months) were not significant | Though the intervention was effective in improving glycemic control, no significant between group differences were observed. |
| Rosal et al.66      | An intensive phase of 12 weekly sessions, and a follow-up phase of 8 monthly sessions - the first session was an individual 1-hour meeting; the remaining sessions were conducted in groups lasting for approximately 2.5 hours | 11              | A significant difference in A1C change between the groups was observed at 4 months (0.53%, p = 0.008), but this decreased and lost significance at 12 months (0.25%, p = 0.293) | Immediate effects could not be sustained over the duration of the intervention. |
| Dyson et al.72      | Video intervention involving three lifestyle videos watched by patients in their own time    | 6               | The difference in the change in A1C level between the 2 groups (0.1%) was not significant (p = 0.843) | The intervention could not improve A1C levels significantly over the 6-month period. |
| Williams et al.73   | A telephone-linked care diabetes system designed to improve diabetes management. Participants were trained to make weekly calls to the system over 6 months. Topics covered with the calls were: blood glucose monitoring, healthy eating, physical activity and medication taking | 6               | A1C levels decreased by 0.8% in IG compared with 0.2% in the CG, resulting in a significant difference of 0.6% between the two groups. | The intervention resulted in significant improvements in A1C levels. |
| Gathu et al.77      | An empowerment and interactive teaching model focusing on behavioral assessment, goal-setting and problem-solving | 6               | No significant difference was noted in A1C between the two groups, with a mean difference of 0.37 (95% confidence interval: -0.45 to 1.19; p = 0.37). | The program resulted in no significant improvements in hemoglobin A1C levels. |
| Study | Description of intervention | Length (months) | Outcome | Conclusion |
|-------|-----------------------------|----------------|---------|------------|
| Wolf et al.53 | Individual and group education and support: participants attended six-4 hour individual sessions and six-1 hour small group sessions; support was provided via brief monthly phone contacts. | 12 | A1C differed between the IG and the CG by 0.57% (p = 0.008) at 4 months; 0.35%, (p = 0.10) at 8 months; and 0.20% (p = 0.45) at 12 months. | The intervention improved glycemic control in patients with type 2 diabetes |
| Samuel-Hodge et al.54 | An 8-month intensive phase, consisting of 1 individual counselling visit, 12 group sessions, monthly phone contacts and 3 encouragement postcards; followed by a 4-month reinforcement phase, including monthly phone contacts | 12 | At 8 months, participants' mean A1C was 7.4% for IG and 7.8% CG, with a difference of 0.4% (95% confidence interval, 0.1-0.6, p = 0.009). At 12 months, the mean difference between groups (0.2%) was not statistically significant (p = 0.33). | The program was effective at improving short, but not long-term metabolic control |
| Moriyama et al.60 | Monthly face-to-face individual interview sessions, lasting 30 minutes for each patient, and biweekly telephone calls throughout the intervention period | 12 | A1C changed from 7.44 to 6.85 in the IG, and from 7.28 to 7.25 in the CG. Mean A1C% in the IG fell by 0.56 more than in the CG. | The program worked successfully in improving patients' A1C levels |
| Choe et al.64 | The case management involved evaluation and modification of pharmacotherapy, self-management education, and reinforcement of diabetes complications screening processes through clinic visits and telephone follow-up. | 12 | The IG achieved greater reduction in A1C levels than those in the CG (2.1% vs 0.9%, p = 0.03). Mean A1C difference between the two groups was 1.2% | The intervention was successful at improving glycemic control and diabetes process-of-care measures |
| Jacobs et al.67 | The intervention included: obtaining a comprehensive medication review; performing physical assessment; ordering laboratory tests; reviewing modifying and monitoring patients' medication therapy; facilitating self-monitoring of blood glucose; and providing reinforcement on dietary guidelines and exercise. | 12 | Significant improvement in A1C occurred in the IG compared with the CG (a reduction of 1.8% in the IG compared with 0.8% in the CG). Mean A1C difference between the two groups was 1.0% (p = 0.003) | The study demonstrated substantial improvements in A1C levels |
| Johansen et al.68 | The program involved: an educational course, one individual appointment with a nutritionist, free participation in a 10-week training program, and an encouragement to exercise at least three times a week. | 24 | Improvement in A1C was greater among patients in the IG than those in the CG (between group change of 1.0% (p = 0.001) | The study showed improved patient outcomes |
| Brown et al.70 | The intervention involved: 3 months of weekly instructional sessions on nutrition, self-monitoring of blood glucose, exercise, and other self-care topics; and 6 months of weekly support group sessions to promote behavior change | 12 | Mean A1C significantly differed between the IG and the CG by 0.76% | The intervention successfully lowered patients' A1C levels |
| Huang et al. | Ongoing instruction on self-monitoring of glucose, medications, exercise, hygiene (foot care), and complication management; provision of individualized nutrition counselling and dietary plans to reinforce the concept of controlling portion sizes of foods every 3 months | 56 subjects in the intervention group with poor baseline glycemic control had a greater reduction in mean A1C (0.7%) than 60 control subjects (0.2%) (P = 0.034). Mean A1C significantly differed between the groups by 0.5% | The intervention significantly improved glycemic control in patients with poorly managed type 2 diabetes |
Comparing the three program lengths, the long-term studies were associated with the greatest number of interventions achieving statistically significant differences in changes in A1C between the intervention and the control groups (87.5% significant vs 12.5% non-significant, and accounting for 43.8% of the 16 studies that reported significant changes). This was followed by the short-term interventions (55.6% significant vs 44.4% non-significant, and representing 31.2% of the 16 significant studies), while the medium-term programs were associated with the least number (50% significant vs. 50% non-significant, and accounting for 25% of the 16 significant studies) (Figs. 2 and 3).

Fig. 2 Effects of the DSME interventions on glycated hemoglobin (A1C)
Discussion

Diabetes is a complex, chronic condition that requires both high quality clinical care and effective self-management. While many factors affecting the effectiveness of SEM programs have been studied extensively, the impact of program length on the clinical outcomes of type 2 diabetics has received little research attention. The current study was therefore conducted as an attempt to fill this gap.

Generally, the outcomes reported by the studies showed positive effects. Even the ones that showed no significant changes, none indicated that patients’ A1C levels worsened after participating in the educational programs. Our findings therefore support the literature that diabetes SME programs produce beneficial effects on patients’ glycemic control.\textsuperscript{78,79}

Our analysis revealed that the majority of the long-term interventions were more effective on changes in A1C levels. Participants enrolled in the long-term programs also achieved the greatest overall mean reduction in A1C compared with the control subjects. Although not enough published studies on the topic exist for detailed comparisons, a 2009 technical report presented to the Ontario Health Technology Advisory Committee in Canada shares our findings. The report, which was based on a
systematic review of type 2 diabetes SEM programs, concluded that interventions with the largest effects on glycemic control appear to be those of at least 1 year in duration.80

One factor that differentiated the long-term studies from both the short and the medium-term interventions was that most of the participants enrolled in the long-term programs received ongoing reinforcement in addition to the educational sessions. This was done through clinic visits, weekly support group sessions, and follow-up telephone calls. Reinforcing the themes addressed during the educational sessions might have provoked thoughts and emotional experiences, thus helping to consolidate the educational experiences. This may partly explain why the majority of the long-term interventions were more effective on changes in A1C levels.

The claim that initial improvements in SME outcomes diminish after 6 months is partly supported by our review. The medium-term studies had most (87.5%) of the interventions lasting 6 months. Initially, the interventions recorded significant improvements. However, not all could sustain these gains to the end or immediately after program implementation. It is possible the short-term interventions would have reported similar results if long term follow-up assessments were made. What this seems to suggest is that one-time education is not sufficient for patients to sustain a lifetime of diabetes care. As theories of science and behavior change argue, “Changing one’s health behavior is a complex process which does not occur rapidly”. Thus, patients will need ongoing self-management and support for a sustained behavior change.

Program length in terms of days, weeks, months or years may not be the same as program length in terms of total hours of engagement. For instance, we found that two of the included studies had the same total hours of engagement (6 hours). However, whereas one was spread over a period of 3 weeks, the other was delivered in either 1 day or 2 half day equivalents. In another study, though the total contact time was short (2.5 hours), educational sessions were spread over a period of 6 months (sessions were given at intervals of 3-6 weeks and took between 15 and 45 minutes per session). Thus, depending on program intensity, an intervention can last several days, but with few contact hours. It
is therefore vital for researchers to clarify this difference when analyzing the effect of program length on SEM interventions’ outcomes.

We observed that the majority of the studies included in this review did not blind those measuring and analyzing the main outcomes of the interventions. This observation is not surprising because research indicates that few randomized controlled studies actually report blinding data analysts and outcome assessors.84 As argued, outcome assessors who are aware of the actual treatment may unintentionally or consciously alter their assessment, thereby posing the risk of detection bias.85 Blinding data collectors, outcome assessors and data analysts is thus crucial to ensure unbiased ascertainment of outcomes.86 Researchers find it difficult to blind outcome assessors because in most cases, as we observed in our analysis, the principal investigators are themselves the outcome adjudicators. To avoid this methodological error, future research should consider using independent individuals unaware of treatment allocations as outcome assessors.

**Strengths and Limitations**

This study is among the few that have attempted investigating the impact of DSME program length on glycemic control in adults with type 2 diabetes. It provides a clear state of the art that may inform policy decisions about more cost-effective ways of implementing SEM interventions. Conclusions are based on high quality evidence, as randomized controlled trials are considered the strongest research design for evaluating the effects of health interventions.87 That notwithstanding, the study has some methodological limitations which are worth acknowledging. Meta-analysis would have been the most appropriate method for determining the summary effects of the interventions in each of the three program lengths. However, because of intervention heterogeneity, it was not suitable to conduct a meta-analysis. The interventions differed with respect to a number of factors including: personal characteristics of participants, mode of program delivery (e.g. group, individual, telephone, mail, online, video, etc.), and SME provider type. These factors had the potential to impact the programs’ outcomes, hence the inappropriateness of meta-synthesizing the information. Another limitation
pertains to the rigorous inclusion and exclusion criteria we adopted. For instance, restricting the search strategy to only studies published in peer-reviewed English journals from 2000 to April, 2019 may have resulted in excluding useful information that may not have been peer-reviewed, may be in other languages or published before 2000. Finally, focusing the analysis on only one clinical endpoint (A1C) may not represent a comprehensive evaluation of the success of the interventions. A1C was not the only primary outcome measure of the included studies; other physical, behavioral and psychological endpoints were also considered.

**Conclusion**

Our findings suggest that program length may change the effectiveness of educational interventions. Long-term SMEs with reinforcement components appear to have the largest effects on glycemic control. Achieving sustained improvements in patients’ A1C levels will therefore require long-term, ongoing self-management education and support.

It is worth noting, however, that none of the included publications in this review directly measured the association between program length and SME outcomes. As such, the effects of the interventions we observed may be due to factors other than program duration. For instance, we observed that the long-term interventions employed a mix of program delivery modes. Also, patients recruited into the various interventions had different baseline A1C values. Moreover, disease duration varied among the study participants. Our findings should therefore be interpreted as suggestive rather than being conclusive. This points to the need for more methodologically rigorous research to be conducted with diverse subject populations in real-world clinical and community settings to understand the actual impact of SME program length on physiological, behavioral and patient reported outcomes. Our study could provide background information for further developments.
**Implications for practice**

Based on the evidence presented, one-time education may not be an effective intervention for achieving longer-term glycemic control in adults with type 2 diabetes. However, while one-time educational programs are not recommended, the current situation, where the majority of the SME interventions are organized separately from healthcare systems (mostly by voluntary organizations), makes it difficult for long-term, ongoing SEM programs to be provided. Integrating SME programs into diabetes care pathways is the surest way of achieving a lifelong patient education and support. As full integration has not been attained yet, organizers of SME interventions should consider providing additional sessions periodically to reinforce what patients are taught in the educational programs. This will not only ensure cost-efficiency, but will also result in long-lasting benefits to health and psychosocial outcomes.

**Key points:**

- Diabetes mellitus is a complex, chronic condition that requires both high quality clinical care and effective self-management
- Achieving effective glycemic control increases the chances of preventing the harmful and costly complications associated with diabetes
- Diabetes self-management education improves glycemic control by as much as 1% in adults with type 2 diabetes
- Understanding the factors affecting the effectiveness of self-management education offers researchers and educators the opportunity of delivering more cost-effective educational interventions
- Program length/duration may influence the effect of self-management education intervention on glycemic control in adults with type 2 diabetes
- Achieving sustained improvements in patients’ glycemic control levels will require long-term, ongoing self-management education and support interventions
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## Appendix

Table 5. Assessment of methodological quality of the included studies

| Study                  | Selection Bias | Performance bias | Attrition bias | Detection bias | Total Score | Remarks                                                                 |
|------------------------|----------------|------------------|----------------|----------------|-------------|--------------------------------------------------------------------------|
| Wolf et al. 45          | 1              | 1                | 0              | 0              | 2           | 20% of participants who dropped out were not described and compared to those who remained in the study, no blinding of outcome assessors |
| Samuel-Hodge et al. 46  | 1              | 1                | 1              | 0              | 3           | Outcome assessors were not blinded to participant groups                |
| Scain et al. 47         | 1              | 1                | 0              | 0              | 2           | No information was provided on participant drop out, no blinding of outcome assessors |
| Goudswaard et al. 48    | 1              | 1                | 1              | 0              | 3           | No blinding of outcome assessors                                        |
| Shakibazadeh et al. 49  | 1              | 1                | 0              | 0              | 2           | High dropout rate - 35% of study group, no information on blinding of outcome assessors |
| Deakin et al. 50        | 1              | 1                | 1              | 1              | 4           | Outcome assessors were blinded to treatment assignment                  |
| Forjuoh et al. 51       | 0              | 1                | 0              | 0              | 1           | Both researchers and participants were aware of randomization, no blinding of outcome assessors |
| Moriyama et al. 52      | 0              | 1                | 1              | 0              | 2           | No blinding of outcome assessors, difference between study and control groups at baseline |
| Merakou et al. 53       | 0              | 1                | 1              | 0              | 2           | Some difference between study and control groups at baseline           |
| Spencer et al. 54       | 0              | 1                | 1              | 0              | 2           | Some difference between study and control groups at baseline           |
| Sun et al. 55           | 1              | 1                | 1              | 0              | 3           | No blinding of outcome assessors,                                     |
| Choe et al. 56          | 1              | 1                | 1              | 0              | 3           | No blinding of outcome assessors,                                     |
| Servick et al.          | 1              | 1                | 0              | 0              | 2           | Patients lost to follow up were slightly different at baseline characteristics from the completers |
| Rosal et al. 58         | 1              | 1                | 0              | 0              | 2           | No specific information on dropout rate, no blinding of outcome assessors |
| Jacobs et al. 59        | 0              | 1                | 0              | 0              | 1           | High withdrawal rate, but no comparison with completers, no blinding of outcome assessors, difference between study and control groups at baseline |
| Johansen et al. 60      | 0              | 1                | 1              | 0              | 2           | Outcome assessors were not blinded to participant groups               |
| Rosal et al. 61         | 0              | 1                | 1              | 0              | 2           | No blinding of outcome assessors                                       |
| Brown et al. 62         | 1              | 1                | 0              | 0              | 2           | No blinding of outcome assessors                                       |
| Davies et al. 63        | 0              | 1                | 1              | 0              | 2           | Some difference between study and control groups at baseline           |
| Dyson et al. 64         | 1              | 1                | 1              | 0              | 3           | No blinding of outcome assessors                                       |
| William et al. 65       | 1              | 1                | 1              | 0              | 3           | No blinding of outcome assessors                                       |
| Huang et al. 66         | 1              | 1                | 0              | 0              | 2           | High dropout rate- 25% of study group- but authors failed to compare their baseline characteristics with those who completed the study |
| Khunti et al.           | 0              | 1                | 1              | 0              | 2           | Some difference between study and control groups at baseline           |
| Abdullah et al.         | 0              | 1                | 0              | 0              | 1           | Failed to compare characteristics of study and control group at baseline |
| Gathu et al.            | 0              | 0                | 0              | 0              | 0           | Randomization was not blinded                                          |