# Effectiveness of a Self-Management Support Program on Self-Care Behaviors and Diabetic Control among Adults with Uncontrolled Type 2 Diabetes: A Quasi-Experimental Study

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**Abstract:** Type 2 diabetes mellitus is a chronic non-communicable disease with a substantial impact on global public health. Individuals with diabetes are considered immunocompromised and face elevated risks of complications from viral infections, particularly COVID-19. To improve outcomes, effective plasma glucose control and robust self-management strategies are essential. This quasi-experimental study investigated the effectiveness of a self-management support program on self-care behaviors, fasting blood glucose, and hemoglobin A1c levels among adults with uncontrolled diabetes attending diabetic clinics in two hospitals in central Thailand. Thirty-two participants from each setting were purposively recruited by matching their gender, age, body mass index, and similar HbA1c levels. The experimental group received a Self-Management Support Program for 12 weeks; the control group received only usual care. Outcomes measures were the Self-Care Behaviors Questionnaire, fasting blood glucose, and HbA1c levels. Data analysis involved descriptive statistics, paired t-test, independent t-test, and repeated measures ANOVA.

Results indicated that participants in the experimental group who received the program demonstrated significantly higher self-care behaviors and lower fasting blood glucose at week 4, and week 12 than at baseline, and higher than that of the control group. Furthermore, HbA1c levels measured at week 12 were significantly lower than those measured at baseline and lower than those of the control group.

Findings demonstrate the effectiveness of the program in glycemic control and behavior change. Nurses can use this program in practice to empower adults with uncontrolled diabetes to manage themselves. However, further study with long-term follow-up to determine the sustainability of self-care behaviors and glycemic control using randomized controlled trials is needed.

**Keywords:** Blood glucose, Hemoglobin A1c, Self-care, Self-management, Type 2 diabetes, Uncontrolled diabetes mellitus

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## Introduction

Type 2 diabetes mellitus (T2DM) is a major global health concern, affecting an estimated 589 million adults in 2024, and this number is projected to rise to 853 million by 2050.[1] Poor glycemic control (hemoglobin A1c: HbA1c >7%) is prevalent among


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individuals with limited care access and inadequate self-management skills.[2] Such control issues heighten the risk of severe complications—including cardiovascular disease, nephropathy, neuropathy, and retinopathy—ultimately diminishing quality of life and increasing mortality.[3] Furthermore, even though COVID-19 is in the endemic phase, people with T2DM (PW-T2DM) have elevated risks of severe illness and mortality due to chronic hyperglycemia and immune dysfunction.[4,5] These risks highlight the need to shift from provider-centric models to patient-centered care that strengthens self-management capacity.[6,7] Pandemic-related disruptions continue to affect usual diabetes care and behaviors,[8,9] while the rise of eHealth and telehealth offers new opportunities to support people with uncontrolled T2DM through accessible, structured interventions.[10,11]

Recent studies emphasize the effectiveness of culturally adapted models and digital interventions.[12,13] One such model is the Seven Color Balls framework, developed by Tienthavorn,[14] which provides a culturally appropriate, visually intuitive tool for classifying PW-T2DM by glycemic risk. The model facilitates personalized intervention planning and encourages active participation in self-care.[13,15] However, the literature has not evaluated the delivery of the model through telehealth platforms or its integration into structured self-management interventions.

To address this gap, the present study developed and evaluated a culturally tailored self-management support program (SMSP) that integrates the Self-Management Model with the Seven Color Balls framework, delivered through a combination of face-to-face and telehealth support.

## Literature Review and Conceptual Framework

This study evaluated the intervention that integrates the Seven Color Balls Model—a culturally adapted risk stratification tool—with Lorig and Holman's Self-Management Model.[16] The intervention focused on adults with uncontrolled T2DM (AW-UT2DM), a population at particularly high risk for diabetes-related complications due to suboptimal glycemic control, lifestyle demands, and comorbidities.[3]

Self-management in chronic illness refers to an individual's ability to manage the symptoms, treatment, physical and psychosocial consequences, and lifestyle changes associated with living with a chronic condition.[16] It involves daily decision-making and behaviors that help maintain health, prevent complications, and improve quality of life.[8,16] In the context of diabetes, diabetes self-management education (DSME) programs have been widely studied and consistently shown to be effective in improving glycemic outcomes and self-care behaviors.[17] Systematic reviews indicate that DSME interventions significantly improve lifestyle changes and self-care behaviors, and reduce HbA1c levels among PW-T2DM.[17,18] DSME interventions include knowledge of T2DM and its complications, diet control, physical activity, medication adherence, and self-monitoring, often delivered through face-to-face interactions, telephone calls, or online platforms.[19,20] Current studies suggest that telehealth helps PW-T2DM manage themselves and control their blood glucose levels more effectively.[10,11]

Despite the increasing adoption of telehealth for diabetes care, previous studies have reported several limitations.[11,21] Many telehealth-based interventions have primarily provided general educational content rather than tailored, individualized support. Moreover, they often lack real-time follow-up and two-way communication between healthcare providers and client-features that are essential for timely feedback, motivation, and behavior adjustment. These limitations suggest the need for more personalized, interactive telehealth models that are responsive to the individual needs of PW-T2DM.

In Thailand, structured DSME programs have demonstrated similar effectiveness, contributing to improved glycemic control, enhanced self-care practices, and positive psychological outcomes.[13] However, findings from the COVID-19 period highlighted some limitations; for instance, one study reported no significant differences in HbA1c outcomes between telehealth and in-person DSME delivery, suggesting that factors such as digital literacy and regional context may influence effectiveness.[22] These findings emphasize the importance of adapting tele-nursing interventions to the local environment, particularly in rural areas where access to technology and comfort with digital communication remain limited.

To support culturally appropriate diabetes management, the Seven Color Balls Model, developed in Thailand, supports culturally tailored diabetes self-management by classifying individuals into seven color-coded groups based on fasting blood glucose (FBG) and HbA1c levels.[14] Green and yellow indicate good control; orange and red reflect poor control; black signals severe complications; and light green and white represent prediabetes or risk.[14,23] For example, green (FBG < 125 mg/dL, HbA1c < 7%) receives usual care, while red (FBG > 182 mg/dL or HbA1c > 8%) requires intensive follow-up and individualized counseling.[23]

In addition to clinical stratification, the model supports PW-T2DM engagement through visual tools that enhance health literacy, reinforce motivation, and promote self-monitoring.[14,23] The use of color-coded symbols promotes behavioral change in diet, exercise, emotional regulation, smoking and alcohol reduction, and weight control. Originally developed for community education, it has been integrated into structured diabetes SMSPs in Thailand.[15,24] Health educators have used colored ball visuals to engage participants in interactive learning about diabetes prevention and control.[14,25] Despite its strengths, few programs have systematically aligned the model with self-management frameworks or evaluated its effectiveness post-pandemic.[15,24,25]

Although traditional models have shown positive outcomes, they may not fully address the unique cultural, dietary, and healthcare access challenges in Thailand, particularly in the post-COVID-19 context. While telehealth offers an alternative way, there is still a need to evaluate culturally adapted programs. One such approach is the integration of the Seven Color Balls Model, a culturally tailored tool grounded in Thai health practices, with Lorig and Holman's Self-Management Model,[16] which emphasizes the medical, role, and emotional tasks required for effective chronic disease management. These comprehensive and adaptable strategies emphasize the importance of context-specific interventions to support diabetes self-management and improve health outcomes among Thai AW-UT2DM.

## Study Aim and Hypotheses

This research aimed to determine the effectiveness of SMSP using the Seven Color Balls Model and Lorig and Holman's Self-Management Model[14,16] and telehealth-based follow-up among AW-UT2DM. It was hypothesized that participants who received the program would demonstrate: 1) significantly higher SCB and lower FBG at week 4 (T1) and week 12 (T2) than at baseline (T0), and higher than that of the control group, and 2) HbA1c level at week 12 (T2) was significantly lower than baseline and that in the control group.

## Methods

**Study Design:** This quasi-experimental research employed a two-group pretest-posttest design. This report adheres to the Transparent Reporting of Evaluations with Nonrandomized Designs (TREND).

**Sample and Setting:** Participants were AW-UT2DM who received services from a diabetes clinic at a secondary hospital under the Ministry of Public Health in central Thailand. The inclusion criteria were: aged 35-59, receiving diabetes treatment at a clinic for at least three months, HbA1c levels greater than 7% over the past three months,[28] and diagnosed with T2DM for at least one year. They were excluded if they had complications such as blurred vision, memory loss, paralysis or limb amputations, kidney diseases requiring dialysis, and infectious diseases (e.g., AIDS, tuberculosis).

The sample size was calculated via the G*Power program version 3.1.9.2,[26] requiring 28 participants per group. To account for potential data loss, an additional 10% was included,[27] resulting in a required 32 participants per group.

Two secondary-level public hospitals under the Ministry of Public Health were purposively selected based on feasibility and administrative support. Both hospitals are located in the same central province of Thailand and operate under similar public health protocols, service structures, and staffing patterns. Hospital A was randomly assigned as the control site, and Hospital B as the experimental site. The sample selection was conducted using a matched-pairs design based on characteristics, such as gender, an age difference of no more than five years, and comparable body mass index and HbA1c levels. A list of 64 individuals with diabetes was reviewed, and their eligibility was verified based on inclusion and exclusion criteria. As a result, both the experimental and control groups consisted of 32 participants each. Two participants were lost during the study due to missing scheduled appointments and failing to complete the activities, leaving a final sample of 62 participants (31 per group) for analysis.

**Ethical Considerations:** This research is a part of the study entitled "Development of an Enhanced Self-Management Model in the New Normal for Patients with Uncontrolled Type 2 Diabetes Mellitus." The other paper focusing on the development of self-management model using in-depth interviews nurses and AW-UT2DM and has been submitted for publication elsewhere in Thai, entitled "The challenges and needs in developing a healthcare service model for people with uncontrolled type 2 diabetes mellitus in the new normal era." These two studies were approved by the same Human Subjects Committee of Prachomklao College of Nursing, Phetchaburi Province, with the same number (PCK REC 25/2565). All participants were informed about the purpose of the study, what participation in the study involved, benefits and potential risks, confidentiality and anonymity issues, and the right to withdraw at any time, without repercussions. All participants signed a consent form.

**Instruments:** This study utilized a combination of self-report questionnaires and clinical laboratory assessments to evaluate outcomes. All questionnaires were evaluated by five experts, including nurse lecturers who specialize in diabetic care, to ensure content validity and alignment with the study objectives.

*The Demographic Data Questionnaire* was developed by the principal investigator (PI) and included the following demographic data: gender, age, height, waist circumference, educational level, marital status, occupation, family income, duration of diabetes, blood glucose levels, HbA1c in the past three months, and history of smoking and alcohol consumption.

*The Self-Care Behaviors Questionnaire (SCBQ)* was adapted with permission from Rungnoei's original SCBQ,[29] developed based on self-care in chronic illness, originally consisting of 38 items, with a reliability coefficient of 0.76. Seven items were added to cover all dimensions of SCB in diabetes. Finally, the SCBQ consisted of 45 items with six dimensions including; diet control (9 items i.e., "I reduce the amount of starch and sugar in each meal"),

exercise (7 items), health maintenance (8 items), rest and stress management (7 items), medication use and illness management (7 items), and prevention of COVID-19 infection (7 items). The items are rated on a 5-point Likert scale (1 = very poor or never performed, 5 = very good self-care behavior or consistent every time or daily). Mean scores are interpreted as a higher score indicating higher SCB, and the cut points are very good level (4.51-5.00), good level (3.51-4.50), moderate level (2.51-3.50), poor level (1.51-2.50), and very poor level (1.0-1.50). The content validity index (CVI) was 0.94. For reliability, Cronbach's alpha coefficient was 0.91 in a pilot test with thirty AW-UT2DM, where subscale values ranged from 0.86 to 0.93. In the actual study, Cronbach's alpha coefficient was 0.92, with subscale values ranging between 0.89 and 0.95.

*Clinical Laboratory Measures,* including FBG and HbA1c, were collected by certified laboratory technicians and analyzed by the laboratory service of the hospital using standardized procedures. FBG was measured using a validated portable glucometer, and HbA1c testing was based on the immunoassay principle, using the turbidimetric inhibition immunoassay (TIIA) method, while hemoglobin levels were measured using the absorbance photometry method.

**The Self-Management Support Program (SMSP)**

The SMSP for AW-UT2DM, based on Lorig and Holman's concept,[16] consists of three key self-management tasks (medical management, role management, and emotional management) and incorporates six essential self-management skills (problem-solving, decision-making, resource utilization, participant-provider partnership, action planning, and self-tailoring). The program was culturally tailored to the Thai context and structured into three phases, as shown in **Appendix, Table A1**.

Phase 1, week 1, the *"Get to Know Diabetes"* session was conducted for two hours, focusing on comprehensive health assessments, risk group identification using the Seven Color Balls Model, and education on disease and behavioral causes. This phase emphasized medical and emotional management through structured teaching, experience sharing, and motivation for change. Participants practiced decision-making and problem-solving and developed personalized action plans with goal-setting support.

Phase 2, from week 2 to 12, the "Control Diabetes, Take Care of Yourself" phase focused on applying self-tailoring and sustaining behavioral changes across diet, exercise, medication adherence, stress management, and COVID-19 prevention. Follow-ups were conducted weekly via telehealth or in person (15-20 minutes), with an emphasis on counseling, participant-provider collaboration, and continuous monitoring. This phase integrated role management, counseling, and continuous behavior monitoring, while strengthening participant-provider partnerships and encouraging the use of health system resources as needed.

Phase 3, weeks 4 and 12, the "Evaluate, Improve, and Maintain Change" phase included 1-hour follow-up sessions. Participants reviewed progress, evaluated clinical and behavioral outcomes, and adjusted their care plans using self-tailoring, decision-making, and action planning strategies.

**Program materials**

The intervention included a set of structured program materials designed to support participant education and behavior change, including a Self-Management Support Manual for Adults with Diabetes (SMSMAD), a Diabetes Care Counseling Record (DCCR), a Diabetes Self-Management Planning Record (DSMPR), and a visual dietary guide known as the Health Wheel based on the Seven-Color Balls model (**Appendix, Table A2**).

**Usual care**

All control group participants were expected to have appointments to see their physicians every month. Before receiving their medication refills, participants received education from a nurse for approximately ten minutes covering topics such as dietary consumption, medication adherence, physical activity, and mental health. For adults with poorly controlled diabetes, the registered nurse provided individual counseling for approximately 15 minutes.

**Data Collection:** After the IRB approval of the proposal, the principal investigator (PI) coordinated with registered nurses, who served as research assistants (RAs) at the diabetes clinic. The PI met with the potential participants on their scheduled clinic visit, introduced themselves, clarified the rights of participants and explained the research procedures to ensure understanding. Prior to conducting the research, the PI obtained informed consent in accordance with the ethical research form. Data collection occurred concurrently over the same 12-week period in both groups, between June 2023 and April 2024. The RAs had experience in diabetes care and received training from the PI prior to the study. The training included research ethics, data collection procedures, the use of instruments, and telehealth communication protocols to ensure data quality and standardization across both groups. The RAs collected the outcomes: SCB, FBG at T0, T1, and T2; and HbA1c at T0 and T2, with awareness of group status and under the supervision of the PI to maintain consistency.

For the experimental group, the PI facilitated in-person small-group sessions (2–3 participants) at the diabetes clinic and provided weekly telehealth follow-up via the LINE application, a widely used mobile platform in Thailand. The RAs assisted in coordinating clinic sessions, monitoring participant engagement, and documenting weekly progress using structured logs. For the control group, the RAs conducted baseline and follow-up data collection at their assigned hospital site, where participants received usual care.

**Data Analysis:** Data were analyzed using SPSS for Windows version 23. The demographic data were analyzed using mean, percentage, and standard deviation. The Kolmogorov-Smirnov test was used to assess normal distribution, and the Chi-square test and Fisher's exact test were used to analyze differences between groups for categorical data. Statistical significance was set at p-value < 0.05. Independent samples t-tests were used to compare HbA1c means between the experimental and control groups at baseline and 12 weeks. Repeated measures analysis of variance was used to determine blood glucose levels and self-care behaviors after adjusting for baseline scores, with 4- and 12-week scores as dependent variables. Before conducting variance analysis, preliminary assumptions—including normality, homogeneity of variances, and sphericity—were tested and met the conditions required for repeated measures ANOVA. When the assumption of sphericity was not fully satisfied, the Greenhouse-Geisser epsilon correction was applied to adjust the degrees of freedom accordingly. Post-hoc comparisons were further adjusted using the Bonferroni method to control for Type I error across multiple pairwise tests.

## Results

As shown in **Table 1**, baseline demographic and clinical characteristics were similar between the two groups. Most participants were aged 45 years or older, had a body mass index (BMI) over 22.9 kg/m,$^2$ were married, and had an education level below a bachelor's degree. The majority had been living with diabetes for ten years or more, and a high proportion had underlying comorbidities. HbA1c levels at baseline were predominantly above 7% in both groups. Chi-square and Fisher's exact tests confirmed that there were no statistically significant differences between groups across these characteristics.

**Table 1.** Demographic data of the participants

| Variable | Experimental group (n = 32) | Control group (n = 32) | Statistics value | p-value |
|---|---|---|---|---|
| | n (%) | n (%) | | |
| Gender[2] | | | 0.00 | 1.00 |
| Female | 16 (50.00) | 16 (50.00) | | |
| Male | 16 (50.00) | 16 (50.00) | | |
| Age[1] (years) | Mean = 51.66 (SD = 7.59) | Mean = 52.19 (SD = 7.43) | - | 0. 72 |
| Less than 45 | 5 (15.632 | 4 (12.50) | | |
| 45-59 | 27 (84.38) | 28 (87.50) | | |
| Body mass index[2] (BMI) | | | 0.09 | 0.77 |
| 18.5-22.9 kg/m$^2$ | 7 (21.88) | 8 (25.00) | | |
| Greater than 22.9 kg/m$^2$ | 25 (78.12) | 24 (75.00) | | |
| Marital status[2] | | | 2.40 | 0.12 |
| Single/ Divorced | 9 (28.12) | 15 (46.87) | | |
| Married | 23 (71.88) | 17 (53.13) | | |
| Education[2] | | | 2.00 | 0.16 |
| Less than bachelor's degree | 26 (81.25) | 21 (65.63) | | |
| Bachelor's degree | 6 (18.75) | 11 (34.38) | | |
| Duration of diabetes[2] (years) | | | 1.40 | 0.50 |
| Less than 5 | 6 (18.75) | 8 (25.00) | | |
| 5-9 | 10 (31.25) | 6 (18.75) | | |
| 10 thru highest | 16 (50.00) | 18 (56.25) | | |
| HbA1c level[2] | | | 2.62 | 0.11 |
| Moderate control (7-8%) | 7 (21.87) | 13 (40.62) | | |
| Poor control (> 8%) | 25 (78.13) | 19 (59.38) | | |
| Other underlying diseases[1] | | | - | 0.45 |
| None | 3 (9.37) | 5 (15.62) | | |
| Present | 29 (90.63) | 27 (84.38) | | |

Note. [1]Fisher exact test, [2]Chi-square test

**Comparison of self-care behavior (SCB)**

At baseline, the mean score of overall SCB and in most components—including diet control, exercise, health maintenance, rest and stress management—were not significantly different between the experimental and control groups ($p > 0.05$). However, statistically significant differences were found in the subcomponents of medication use, illness management, and COVID-19 prevention, where the experimental group showed slightly higher scores at baseline ($p < 0.05$). Following the 12-week intervention, participants in the experimental group demonstrated significant improvements in overall self-care behaviors, particularly in diet control, medication adherence, and illness management, with those domains reaching good to high levels. Components such as health maintenance and COVID-19 prevention remained consistently high, while exercise behaviors, although slightly improved, remained low. In contrast, no notable changes were observed in the control group across any of the domains (**Table 2** and **Figure 1**).

Assumptions for repeated measures ANOVA were tested prior to analysis. A violation of the sphericity assumption was detected for several variables, prompting the use of the Greenhouse-Geisser Epsilon adjustment. The results indicated a statistically significant improvement in overall SCB scores in the experimental group across three time points—baseline (T0), Week 4 (T1), and Week 12 (T2)—with p-values < 0.001. All six SCB subcomponents also demonstrated statistically significant changes over time within the experimental group ($p < 0.001$). Post-hoc analyses using the Bonferroni correction further confirmed that mean SCB scores in the experimental group significantly improved between T0 and T1, T0 and T2, and T1 and T2. However, the control group did not exhibit statistically significant changes between any time points ($p > 0.05$). Summary statistics and comparisons are presented in **Tables 2-4**. These findings are visually illustrated in **Figure 1(a)**, which shows a steady increase in self-care behavior scores in the experimental group over time, while scores in the control group remained relatively unchanged.

**Table 2.** Mean of self-care behavior, fasting blood glucose, HbA1c levels between the experimental and control groups

| Variable | Experimental group (n = 31) | | | Control group (n = 31) | | |
|---|---|---|---|---|---|---|
| | T0 | T1 | T2 | T0 | T1 | T2 |
| | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) | Mean (SD) |
| Self-care behavior | | | | | | |
| Diet control | 3.474 | 3.671 | 3.884 | 3.494 | 3.490 | 3.513 |
| | (0.289) | (0.227) | (0.233) | (0.269) | (0.261) | (0.263) |
| Exercise | 1.949 | 2.405 | 2.978 | 2.346 | 2.346 | 2.337 |
| | (0.753) | (0.405) | (0.267) | (0.675) | (0.675) | (0.649) |
| Health maintenance | 3.539 | 3.793 | 4.179 | 3.345 | 3.345 | 3.345 |
| | (0.434) | (0.285) | (0.342) | (0.484) | (0.484) | (0.476) |
| Rest and stress management | 3.074 | 3.285 | 3.507 | 3.189 | 3.185 | 3.208 |
| | (0.499) | (0.370) | (0.372) | (0.516) | (0.516) | (0.507) |
| Medication use and illness management | 3.184 | 3.713 | 4.041 | 3.409 | 3.414 | 3.455 |
| | (0.368) | (0.328) | (0.291) | (0.401) | (0.402) | (0.359) |
| COVID-19 Prevention | 3.968 | 4.092 | 4.323 | 3.001 | 3.005 | 3.028 |
| | (0.617) | (0.555) | (0.425) | (0.192) | (0.190) | (0.213) |
| Overall score | 3.217 | 3.880 | 4.236 | 3.157 | 3.156 | 3.175 |
| | (0.261) | (0.179) | (0.155) | (0.247) | (0.248) | (0.235) |
| Fasting blood glucose | 178.774 | 155.742 | 133.323 | 201.870 | 174.770 | 169.900 |
| | (36.033) | (37.497) | (12.183) | (61.630) | (48.600) | (66.180) |
| HbA1c levels | 9.09 | - | 7.21 | 8.71 | - | 8.82 |
| | (1.39) | - | (0.58) | (1.64) | - | (2.19) |

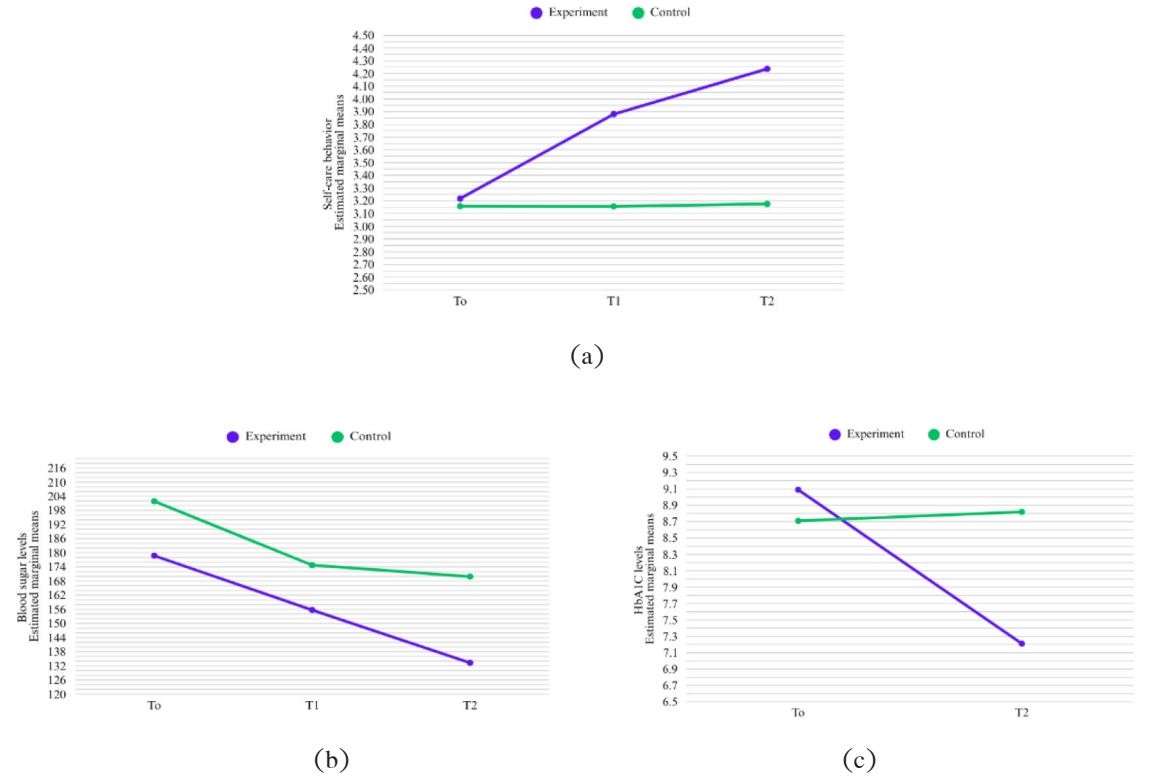


**Figure 1.**

(a) Mean SCB scores among AW-UT2DM in the experimental group across three time points
(b) Mean FBG among AW-UT2DM in the experimental and control groups across three time points
(c) Mean HbA1c levels among AW-UT2DM in the experimental and control groups at two time points

**Table 3.** Comparison of mean self-care behavior, fasting blood glucose across three time points (repeated measures ANOVA)

| Variable | Source of variation | Repeated measures ANOVA | | | | p-value |
|---|---|---|---|---|---|---|
| | | SS | df | MS | F | |
| Self-care behavior | Intercept | 2,239.82 | 1 | 2,239.82 | 16,937.92 | < 0.001 |
| | Group | 17.60 | 1 | 17.60 | 133.07 | < 0.001 |
| | Error | 7.93 | 60 | 0.13 | | |
| Fasting blood glucose | Intercept | 5,316,402.78 | 1 | 5,316,402.77 | 1,237.44 | < 0.001 |
| | Group | 32,008.60 | 1 | 32,008.60 | 7.45 | 0.008 |
| | Error | 257,778.62 | 60 | 4,296.31 | | |

**Table 4.** Comparison of the mean scores of self-care behavior and fasting blood glucose between the experimental and control groups in each phase using Bonferroni test

| Comparison | Mean difference | SE | p-value | 95%CI | |
|---|---|---|---|---|---|
| | | | | Lower | Upper |
| **Self-care behavior** | | | | | |
| Experimental group | | | | | |
| T0 vs T1 | -0.66 | 0.02 | < 0.001 | -0.72 | -0.61 |
| T0 vs T2 | -1.02 | 0.05 | < 0.001 | -1.13 | -0.90 |
| T1 vs T2 | -0.36 | 0.03 | < 0.001 | -0.44 | -0.28 |
| Control group | | | | | |
| T0 vs T1 | 0.00 | 0.00 | 1.000 | -0.00 | 0.01 |
| T0 vs T2 | -0.02 | 0.01 | 0.051 | -0.04 | 0.00 |
| T1 vs T2 | -0.02 | 0.01 | 0.058 | -0.04 | 0.00 |
| **Fasting blood glucose** | | | | | |
| Experimental group | | | | | |
| T0 vs T1 | 23.03 | 6.86 | 0.006 | 5.65 | 40.42 |
| T0 vs T2 | 45.45 | 6.65 | < 0.001 | 28.58 | 62.32 |
| T1 vs T2 | 22.42 | 6.93 | 0.009 | 4.86 | 39.98 |
| Control group | | | | | |
| T0 vs T1 | 27.10 | 9.64 | 0.026 | 2.66 | 51.54 |
| T0 vs T2 | 31.97 | 11.49 | 0.028 | 2.83 | 61.10 |
| T1 vs T | 4.87 | 10.01 | 1.000 | -20.52 | 30.26 |

**Comparison of fasting blood glucose**

At baseline, the mean FBG was not significantly different between the groups, indicating comparability before the intervention. Over the 12-week period, repeated measures ANOVA revealed statistically significant reductions in FBG within and between groups ($p < 0.001$). Post-hoc analyses using the Bonferroni correction showed that participants in the experimental group experienced substantial improvements, with a reduction of approximately 23 mg/dL from baseline to Week 4 and a total reduction of over 45 mg/dL by Week 12 ($p < 0.001$). In the control group, a reduction of about 27 mg/dL was observed from baseline to Week 4, but no significant improvement occurred between Week 4 and 12. As shown in **Figure 1(b)**, FBG levels decreased markedly in the experimental group, while the control group showed only a slight reduction that plateaued after Week 4, suggesting that SMSP is effective in reducing FBG levels (**Tables 2-4**).

For HbA1c, levels at baseline were not significantly different between the intervention and control groups. After 12 weeks, the experimental group showed a statistically significant reduction in HbA1c levels, while no significant change was observed in the control group. See **Figure 1(c)**, where HbA1c levels declined sharply in the experimental group, while levels remained relatively stable in the control group. An independent t-test confirmed that the between-group difference in HbA1c at week 12 was statistically significant ($p < 0.001$).

## Discussion

This study demonstrated the effectiveness of the SMSP in improving SCB, lowering FBS, and lowering HbA1c. The program focuses on enhancing knowledge and understanding of diabetes and self-care while promoting awareness of behavioral changes for blood glucose control. It systematically

improves self-management skills by empowering AW-UT2DM to assess their blood glucose control status based on the Seven Color Balls model. Additionally, the program includes a weekly tele-nursing consultation for continuous monitoring and guidance, along with a self-management handbook and a behavior modification record. These tools help AW-UT2DM set goals for blood glucose control and undergo periodic assessments to refine their self-care plans. As a result, the participants successfully improved their self-care behaviors.

Additionally, although the intervention period was 12 weeks, aligning with the biological window for HbA1c change, this timeframe may have been insufficient to observe the full extent of glycemic improvement in all participants. Longer follow-up periods are recommended in future studies to assess the sustainability and progression of HbA1c reduction beyond the immediate post-intervention phase. Although most self-care domains improved, exercise behavior remained at a low level throughout the intervention period. This persistent barrier may reflect broader contextual challenges faced by Thai adults, such as limited time, motivation, or access to safe and convenient spaces for physical activity. National surveillance data confirm a significant decline in moderate-to-vigorous physical activity among Thai adults during the pandemic, with the proportion meeting recommended PA levels dropping from 74.6% pre-pandemic to 54.7% in 2020.[30] These findings highlight the need for future program adaptations that incorporate practical strategies to promote physical activity, such as home-based exercise plans or integration with mobile health tracking tools. While the control group received usual care and general health advice, some reductions in blood glucose were also observed. However, these were less consistent and not accompanied by significant improvements in self-care behavior. This discrepancy underscores the limitations of standard diabetes education when not paired with continuous, structured, and personalized support.[31]

These findings indicate that in the current post-pandemic and endemic phase of COVID-19, AW-UT2DM require information and advice that is direct, concise, and delivered through convenient and fast services. There should also be a system for monitoring, evaluating, and providing ongoing support at home. This is especially important as the post-pandemic era entails significant changes, requiring individuals to be adaptable and flexible in their work, personal lives, and relationships. AW-UT2DM may face additional stress as they navigate these changes and often deal with health issues or comorbidities. Consequently, their need for health information in this era emphasizes the importance of speed, clarity, and directness. This includes information on blood glucose control,[32] nutritional advice—especially regarding food choices—guidelines for safe and effective exercise,[1] access to online health services,[33] personalized counseling,[9] and ongoing infection prevention strategies.[34,35]

The results align with prior research, highlighting the benefits of a structured SMSP for diabetes control. Participants in the SMSP demonstrated significant improvements in self-care behaviors, dietary control, medication adherence, and exercise routines, leading to better glycemic outcomes compared to the control group. Our study was supported by a previous study, which reported that a SMSP delivered via the LINE application significantly enhanced diabetes self-care behaviors and lowered HbA1c levels in people with uncontrolled diabetes.[36,37] International studies also affirm that the effectiveness of structured diabetes self-management education programs significantly improves HbA1c levels, medication adherence, and overall health outcomes.[19,38,39]

## Limitations

Several limitations may have affected the study's outcomes. First, the absence of double blinding for research assistants and participants may have introduced

bias during data collection and analysis. Second, the intervention and control groups were recruited from different hospital settings, which, despite similar protocols, varied in staff, environment, and service delivery—potentially influencing participants' experiences. Third, simultaneous data collection in two distinct locations may have introduced contextual disparities. In addition, requiring a smartphone and LINE access may have excluded participants unfamiliar with these tools, limiting generalizability. Although the 12-week intervention aligns with the HbA1c biological response, it may have been too short to capture complete glycemic improvements. Future studies should include longer follow-up, more diverse samples, and alternative delivery methods to assess the long-term effectiveness of SMSP in AW-UT2DM care.

## Conclusion and Implications for Nursing Practice

The SMSP based on Lorig and Holman's model and the Seven Color Balls model, effectively improved self-care behaviors and glycemic control among AW-UT2DM. It enhanced participants' ability to regulate blood glucose and modify health behaviors. Integrating SMSP into usual diabetes care is recommended. In outpatient clinics, registered nurses can feasibly implement the SMSP. Successful implementation requires training in risk classification, behavioral goal-setting, and self-management counseling, along with tele-nursing communication for remote follow-up. Healthcare systems should endorse policies, provide staffing flexibility, and ensure access to telehealth platforms (e.g., LINE). Nurses can incorporate SMSP into regular appointments through planned assessments, personalized goals, and focused counseling.

However, further research should be conducted to evaluate the long-term outcomes of using the SMSP for AW-UT2DM, focusing on monitoring the sustainability of SCB and HbA1c levels and preventing other complications. The SMSP should be expanded for use among groups at risk for diabetes and other chronic diseases, such as high blood pressure and heart disease. This can be achieved by adjusting the materials and creating manuals and learning resources relevant to the specific contexts of these other chronic conditions.

## Author Contributions

Conceptualization: N.R., S.K., N.P.
Method and design, Tool development and validation: N.R., S.K.
Data collection, Analysis and interpretation: N.R., P.D., C.D.
Discussion of the results, Drafting and revising the manuscript, Editing the manuscript: N.R., N.P.
Final approval of the submitted version: N.R., S.K.

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## Appendix

**Table A1.** The self-management support program for adults with uncontrolled type 2 diabetes

| Week/Session | Process | Action | Lorig and Holman's Tasks and Skills Used |
|---|---|---|---|
| **Phase 1**<br>**Week1**<br>Get to know diabetes<br>(1 hr.) | Comprehensive health assessment, goal setting & action planning | 1) Health assessment and risk group identification using the Seven Color Balls model | Medical management<br>Decision-making |
| | | 2) Education on disease, behavior, and experience sharing | Medical & emotional management |
| | | 3) Motivation for behavioral change | Emotional management<br>Participant-provider partnership |
| | | 4) Set goals and behavior plans | Role management<br>Action planning<br>Self-tailoring |
| | | 5) Develop problem- solving & decision-making skills | Problem-solving<br>Decision-making |
| | | 6) Interdisciplinary coordination (e.g., pharmacist, dietitian) | Resource utilization |
| **Phase 2**<br>**Week 2-12**<br>Control diabetes, take care of yourself<br>(15-20 min/wk.) | Self-tailoring & taking action for sustained behavioral changes | 1) Promote self-care in diet, exercise, rest, stress, substance use, medication, and COVID-19 prevention | Medical, role & emotional management<br>Self-tailoring |
| | | 2) Promote participant-provider communication | Participant-provider partnership<br>Resource utilization |
| | | 3) Provide tele-nursing counseling and continuously monitor behavioral changes | Emotional management<br>Participant-provider partnership<br>Self-tailoring |
| | | 4) Refer for specific needs (e.g., physician, pharmacist, dietitian) | Resource utilization |
| **Phase 3**<br>**Week 4, 12**<br>Evaluation for improvement<br>(1 hr./wk.) | Evaluation & improvement | 1) Evaluate clinical and behavioral outcomes (Measuring the outcomes) | |
| | | 2) Improve the care plan | Action planning<br>Self-tailoring<br>Decision-making |

**Table A2.** Program materials

| Instrument Name | Purpose | Key Components | Conceptual Basis |
|---|---|---|---|
| Self-Management Support Manual for Adults with Diabetes (SMSMAD) | To provide structured health education during service delivery | - Definition, etiology, and classification of diabetes<br>- Signs and symptoms<br>- Acute and chronic complications<br>- Post-pandemic self-care guidelines<br>- Lifestyle modification strategies | Culturally adapted to post-COVID care needs; designed by PI to support self-management |
| Diabetes Care Counseling Record (DCCR) | To track health status and counseling outcomes using a standardized format | - Demographic and health profile (age, weight, height)<br>- Biometric measures (FBG, HbA1c)<br>- Counseling session details<br>- Behavioral and clinical outcomes<br>- Monitoring of medication, diet, physical activity | Supports continuity of care; enables individualized tracking and outcome documentation |
| Diabetes Self-Management Record (DSMR) | To empower participants in planning and monitoring personal health behaviors | - Basic health data<br>- Personal goals (e.g., dietary change, exercise adherence)<br>- Action plans for behavior modification<br>- Weekly self-monitoring logs<br>- Reflection and adjustment section | Facilitates self-regulation based on Lorig and Holman's Self-Management Model; aligns with the participatory care approach |
| Health Wheel: "Reduce Sweet, Oily, and Salty Food; Reduce Risk, Reduce Comorbidities" | To assess dietary risks, guide behavior change, and illustrate health outcomes | - Wheel I: Glucose/HbA1c risk levels categorized by color (dark green: optimal, red: high-risk)<br>- Wheels II & III: Nutritional guidelines and behavioral suggestions<br>- Wheel IV: Examples of foods to avoid (e.g., sweetened beverages, deep-fried items) | Based on the "Seven - Color Balls" model by Tienthavorn, it integrates principles of surveillance, control, and prevention tailored to the Thai dietary culture. |

# ประสิทธิผลของโปรแกรมส่งเสริมการจัดการตนเองต่อพฤติกรรมการดูแลตนเองและการควบคุมระดับน้ำตาลในเลือดในผู้ใหญ่ที่เป็นเบาหวานชนิดที่ 2 ที่ควบคุมระดับน้ำตาลไม่ได้ : การวิจัยแบบกึ่งทดลอง

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**บทคัดย่อ** : โรคเบาหวานชนิดที่ 2 เป็นโรคไม่ติดต่อเรื้อรังซึ่งส่งผลกระทบต่อสุขภาพของประชากรทั่วโลก ผู้เป็นเบาหวานถือว่าอยู่ในกลุ่มที่มีภูมิคุ้มกันต่ำและมีความเสี่ยงเพิ่มขึ้นในการเกิดภาวะแทรกซ้อนจากการติดเชื้อไวรัส โดยเฉพาะ โควิด-19 ดังนั้น การควบคุมระดับน้ำตาลในเลือดอย่างมีประสิทธิภาพควบคู่กับกลยุทธ์การจัดการตนเองที่เข้มแข็งจึงเป็นสิ่งจำเป็น การวิจัยกึ่งทดลองนี้มีวัตถุประสงค์เพื่อประเมินประสิทธิผลของโปรแกรมส่งเสริมการจัดการตนเองต่อพฤติกรรมการดูแลตนเอง ระดับน้ำตาลในเลือดขณะอดอาหาร และระดับน้ำตาลเฉลี่ยสะสมในผู้ใหญ่ที่เป็นเบาหวานชนิดที่ 2 ที่ควบคุมไม่ได้ โดยเก็บข้อมูลจากคลินิกเบาหวานของโรงพยาบาล 2 แห่งในจังหวัดภาคกลางของประเทศไทย ซึ่งได้จากการสุ่มแบบง่าย และคัดเลือกกลุ่มตัวอย่างโดยใช้วิธีจับคู่ ตามเพศ อายุที่มีความแตกต่างไม่เกิน 5 ปี ดัชนีมวลกายและระดับ HbA1c ที่ใกล้เคียงกัน ได้กลุ่มทดลองและกลุ่มควบคุม กลุ่มละ 32 คน กลุ่มทดลองได้รับโปรแกรมส่งเสริมการจัดการตนเองเป็นระยะเวลา 12 สัปดาห์ ในขณะที่กลุ่มควบคุมได้รับการดูแลตามปกติ เก็บรวบรวมข้อมูลก่อนทดลอง สัปดาห์ที่ 4 และสัปดาห์ที่ 12 หลังเริ่มต้นการทดลอง โดยใช้แบบสอบถามพฤติกรรมการดูแลตนเองและการตรวจทางห้องปฏิบัติการ วิเคราะห์ข้อมูลโดยใช้สถิติเชิงพรรณนา การทดสอบค่าทีแบบจับคู่ การทดสอบค่าทีแบบอิสระ และการวิเคราะห์ความแปรปรวนแบบวัดซ้ำ (repeated measures ANOVA)

ผลการวิจัยพบว่า กลุ่มทดลองซึ่งได้รับการดูแลตามโปรแกรมฯ มีพฤติกรรมการดูแลตนเองสูงขึ้นอย่างมีนัยสำคัญทางสถิติ และระดับน้ำตาลในเลือดขณะอดอาหารลดลงอย่างมีนัยสำคัญในสัปดาห์ที่ 4 และสัปดาห์ที่ 12 เมื่อเทียบกับค่าก่อนเริ่มโปรแกรมฯ และเมื่อเปรียบเทียบกับกลุ่มควบคุม นอกจากนี้ ระดับน้ำตาลเฉลี่ยสะสมที่วัดในสัปดาห์ที่ 12 ลดลงอย่างมีนัยสำคัญเมื่อเทียบกับค่าเริ่มต้น และต่ำกว่ากลุ่มควบคุม ผลการวิจัยแสดงให้เห็นว่าโปรแกรมนี้มีประสิทธิภาพในการควบคุมระดับน้ำตาลในเลือดและส่งเสริมการปรับเปลี่ยนพฤติกรรม พยาบาลสามารถนำโปรแกรมนี้ไปใช้ในการเสริมสร้างพลังอำนาจของผู้ใหญ่ที่มีภาวะเบาหวานควบคุมไม่ได้ให้สามารถจัดการตนเองได้ อย่างไรก็ตาม ควรศึกษาในรูปแบบการวิจัยเชิงทดลองแบบสุ่มและมีกลุ่มควบคุม และติดตามผลในระยะยาวเพื่อประเมินความยั่งยืนของพฤติกรรมการดูแลตนเองและการควบคุมระดับน้ำตาลในเลือด

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**คำสำคัญ :** ระดับน้ำตาลในเลือด ระดับน้ำตาลเฉลี่ยสะสม การดูแลตนเอง การจัดการตนเอง เบาหวานชนิดที่ 2 โรคเบาหวานที่ควบคุมไม่ได้

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