

ORIGINAL RESEARCH

Using virtual education to improve self-efficacy in adults with type 2 diabetes

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ABSTRACT

Objective: To evaluate the effect of an 8-week virtual diabetes self-management education and support (DSMES) program on self-efficacy among adults with type 2 diabetes living in rural South Carolina.

Methods: A quasi-experimental, single-group pre-test/post-test design was used. Twenty-five adults were recruited through convenience sampling at a Federally Qualified Health Center; 20 participants completed the intervention and both assessments. The intervention consisted of weekly virtual DSMES educational modules delivered over 8 weeks, supplemented by follow-up telephone calls and email communication. Diabetes-related self-efficacy was measured before and after the intervention using the 8-item Diabetes Empowerment Scale–Short Form (DES-SF). A Wilcoxon signed-rank test was used to evaluate paired pre-test and post-test total scores.

Results: Post-intervention median DES-SF responses were higher than pre-intervention responses across all eight items. The Wilcoxon signed-rank test demonstrated a statistically significant improvement in diabetes-related self-efficacy following the 8-week virtual DSMES intervention ($p < .05$).

Conclusions: Findings support the feasibility of virtual DSMES as an accessible approach to increasing diabetes-related self-efficacy among adults with type 2 diabetes in rural settings. Larger studies with longer follow-up and direct measurement of self-management behaviors are needed.

Key Words: DSMES, Rural health, Self-efficacy, Type 2 diabetes, Virtual education

1. BACKGROUND

Diabetes is a common health condition that primary care providers encounter daily. Providers have limited appointment times and this creates a barrier for fully providing health education to their patients. Diabetes self-care and health promotion is needed to reduce the complications associated with diabetes. Patient outcomes are greatly impacted by quality education programs. This includes improved glycemic control, adherence to a diabetic diet and less complications, associated with diabetes.^[1] By measuring self-efficacy scores pre and post-intervention, participants are likely to have improved self-efficacy that may positively impact their self-care practices. Enhanced diabetes self-care practices improve health outcomes for patients and lowers the risk of compli-

cations associated with poorly controlled diabetes.^[2] This study was conducted virtually and allowed the participants to use their personal email accounts to access the educational modules. This provided an alternative method of learning for the participants. The purpose of this study was to evaluate the effect of an 8-week virtual diabetes self-management education and support (DSMES) intervention on diabetes-related self-efficacy among adults with type 2 diabetes living in a rural area of South Carolina.

1.1 Problem

Diabetes is a global chronic health condition that can result in long-term micro-vascular and macro-vascular complications such as heart disease, retinopathy, amputations and nephropa-

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thy.^[2] The United States (U.S) has spent over 245 billion dollars in previous years on diabetes care. This includes 176 billion dollars on direct medical costs and another 69 billion on indirect costs from disability, restricted activity, lost workdays and early death.^[2] Many of these costly care expenses can be prevented with tailored preventive care and self-management programs. From a global perspective, the Centers for Disease Control (CDC) supports initiatives and strategies to reduce the risk factors for the management and prevention of type-2 diabetes. One particular initiative is the 5-year cooperative agreement State Public Health Action program 1305. This program is geared to prevent and control diabetes, heart disease and obesity. This type of partnership involves a collaborative effort between local state health departments and four CDC divisions as well as the District of Columbia. This type of initiative is one example of ways to improve diabetes self-management. Linking community resources and clinical services together provides a nationwide perspective on managing the issue associated with diabetes. DSMES programs are a practical way, health care providers can incorporate information concerning the needs, goals and life experiences of patients. Additionally, DSMES programs provide education, coaching, and behavioral change that which is fundamental when carrying out diabetes self-care.^[1]

The study aimed to increase the knowledge of patient's as well as improve their overall quality of life. The study took place at a Federally Qualified Health Clinic (FQHC) in Orangeburg, South Carolina (S.C.) over eight weeks. DSMES via educational modules, along with phone calls and emails to ensure formative evaluation of the research. The Diabetic Empowerment Scale Short-Form (DES-SF) is an evidence-based tool that measures self-efficacy in diabetic patients.^[3] The tool was applied pre and post-intervention. The expected improved self-efficacy in patients was achieved, based on the increase in mean post intervention scores. These outcomes may improve the quality of lives of patients, as well as improve the provider-patient relationship. A Strengths, Weaknesses, Opportunities and Threats (SWOT) Analysis from the organizational assessment helped further identify the strengths, weaknesses, opportunities, and threats to the study. The strengths of the study included offering diabetic education to patients virtually. This was an ideal method for implementing the study, as it was during an active COVID-19 global pandemic. The organization also encourages research and academic scholarship at its community-based facilities, partly because participation helps secure federal funding and supports ongoing program development. One of the threats to the project included the challenges the facility faced, with high cancellation rates among patients. Patient participa-

tion was vital to the success of the project, and depended on the willingness of patients to actively engage with the project manager virtually. The initial proposal to implement a virtual DSMES program at the federally qualified health center was viewed as a positive, effective means of improving health outcomes in patients with type-2 diabetes. The virtual DSMES program provided an alternative way to ensure patients received diabetes education, in a cost-effective way. The DSMES program did not interfere with scheduled appointment visits and was implemented fully using electronic technology.

Data supports the success of implementing DSMES programs and its effectiveness in improving patient outcomes.^[2] Also, assistance and training are available to healthcare providers willing to initiate such programs. The Division of Diabetes Translation developed a series of interactive webinars that can also build the evaluation capacity and quality in data reporting.^[2] The available data documenting the need for a process change were initially presented at a staff meeting. It was determined that providers were encountering challenges in allocating sufficient time for diabetes education during patient appointments. Additionally, quality measures shared by the executive team indicated suboptimal performance in the area of patient education.

1.2 PICOT question

For adult patients diagnosed with type 2-diabetes and living in a rural area of South Carolina, does the implementation of a virtual Diabetes Self-Care Education and Support (DSMES) program compared to current practice, impact scores on the DES-SF within 8 weeks?

1.3 Literature synthesis

Twelve literature studies were reviewed using the electronic databases Medline, CINAHL, EBSCO, BMC, and PubMed. The search criteria included the use of key terms: Type 2-diabetes, self-efficacy, web-based interventions, and diabetes self-management. The peer-reviewed journals consisted of four systematic reviews, two randomized control trials, two mixed method studies, and four quantitative studies, related to the practice problem. The practice problem was identified to improve the health and well-being of people living with type 2-diabetes using web-based technology. The goal was to improve self-efficacy levels in patients by using a virtual DSMES program.

DSMES programs offer an efficient and accessible way to target the healthcare needs of adults living with type 2 diabetes. These web-based activities provide guidance, education, and feedback in a self-guided format. Web-based education has been associated with emotional, cognitive, and

self-care changes that may reduce morbidity and healthcare costs.^[1,4,5] DSMES programs can also promote self-care practices for people living in rural areas.^[1,5-7] Interventions delivered in the home may be particularly useful when transportation and geographic distance are barriers to healthcare access.^[1]

Self-efficacy is a key factor associated with self-management practices in patients with type 2 diabetes. Self-efficacy can be described as confidence in one's ability to perform goal-directed behaviors when confronted with challenges.^[3,4,8,9] Web-based interventions have been associated with improved self-efficacy and other diabetes-related outcomes.^[1,4,5,8,9] Adults with type 2 diabetes make daily decisions regarding nutrition, medications, exercise, and blood glucose monitoring. Higher self-efficacy is associated with improved daily decision-making and self-care behaviors.^[3,8,9]

The DES-SF is a valid and reliable tool that can measure diabetes related self-efficacy. A Cronbach's alpha coefficient of 0.83 confirms its reliability and validity.^[10] The DES-SF is an 8-question Likert Scale tool used by the project manager pre and post-intervention. However, it is not the only tool that can be used to measure self-efficacy. Three studies differ in the tools selected to measure self-efficacy.

Other measures of diabetes self-management and self-efficacy have also been used in prior quality improvement and research studies. The Perceived Diabetes Self-Management Scale is one example of a reliable measure that may be used to assess diabetes self-management.^[9]

Web-based interventions such as virtual DSMES programs may have implications at the local and national levels by providing patient-centered education and support through technology. In this project, virtual delivery was intended to improve access to diabetes education for adults living in rural communities and to provide an alternative to education delivered during routine office visits.

1.4 Evidence-based intervention

The intervention was an 8-week virtual DSMES program designed to provide adults with type 2 diabetes with structured education, self-management support, goal-setting, and opportunities to address barriers to diabetes self-care. Participants accessed weekly educational modules through personal email accounts and received follow-up telephone calls and email communication to support engagement and formative evaluation. The intervention was selected because DSMES is an evidence-based approach to diabetes education and support. It can be adapted to improve access for patients experiencing geographic or transportation barriers.^[1,11] The American Diabetes Association recommends DSMES as part

of comprehensive diabetes care.^[12]

The DES-SF is an evidence-based tool that measures self-efficacy. Evidence shows the DES-SF is a valid and reliable measure of diabetes-related psychosocial self-efficacy.^[3] The tool is a useful outcome measure for various educational programs related to diabetes management. However, the reliability was not recalculated for the current project because the analysis focused on pre-intervention and post-intervention changes rather than psychometric evaluation of the instrument within the study sample. Therefore, the current findings rely on the established validity and reliability of the DES-SF reported in previous research.

Using an established measurement tool strengthens the study. However, because this project used a single-group pre-test/post-test design, the improvement cannot be attributed only to the virtual DSMES intervention. Without a comparison group, other factors during the 8-week period may have contributed to the change in self-efficacy.

2. THEORETICAL FRAMEWORK: SELF-EFFICACY THEORY AND TRANSLATIONAL SCIENCE MODEL

Bandura's Self-Efficacy Theory proposes that perceived capability influences whether a person initiates a behavior, the effort invested in the behavior, and persistence when barriers occur.^[13] For adults with type 2 diabetes, self-efficacy is particularly relevant because daily diabetes management requires repeated decisions and behaviors. The virtual DSMES intervention was therefore designed to provide information, guided practice, feedback, encouragement, and opportunities to address barriers that could strengthen participants' confidence in performing diabetes self-management behaviors. The DES-SF was selected as the primary outcome because it directly measures diabetes-related psychosocial self-efficacy.^[3,10]

Translational science provides a bridge between evidence generated through research and its application in real-world clinical and community settings.^[14] In this study, evidence supporting DSMES and virtual education was translated into a practical intervention for adults with type 2 diabetes receiving care in a rural setting. The translation process included identifying a clinical education gap, adapting evidence-based diabetes education for virtual delivery, implementing the intervention within the organizational setting, and evaluating change in self-efficacy before and after the intervention. This framework is relevant because the intended outcome was the application of evidence-based education within routine care to improve a patient-centered outcome. Together, Self-Efficacy Theory explains the mechanism by which the

intervention was expected to influence confidence and behavior, whereas the Translational Science Model explains how evidence was moved into practice and evaluated in the clinical setting.^[13,14]

2.1 Organizational setting

The project was implemented virtually, although recruitment took place within the HopeHealth medical facility in Orangeburg, South Carolina. HopeHealth is a Federally Qualified Health Center serving multiple communities in South Carolina. Recruitment took place in the primary care office with support from a nurse practitioner, nurses, and an administrative assistant.

2.2 Population description

The population for the project included, adults aged 18-65, diagnosed with type 2- diabetes, that reside in a rural area of South Carolina. The sample size included 20 participants, which were recruited by the project manager during routine office visits. Posters were displayed in the waiting areas and exam rooms regarding information about participating in the study. Inclusion criteria included men and women between the ages of 18-65. They were required to have access to the Internet, a private email account, smartphone device, tablet or computer. This ensured active participation was more likely to occur. The exclusion criteria included patients who resided in urban areas, type 1-diabetic patients, and patients diagnosed with pre-diabetes (A1C 5.7-6.4).

2.3 Considerations and challenges for implementation

The most recent and relevant challenges for implementation included changes in clinic workflow and scheduling. These operational adjustments impacted the normal day-to-day activities of staff and patients. The workflow changes raised concerns around the initial plan for recruitment. Initially, all non-urgent in-person visits were reduced or rescheduled to accommodate new clinic procedures. It was a difficult time for patients to consider participating in the study. These workflow challenges encouraged creativity in the early recruitment phases. Phone calls and emails were used to contact potential participants, allowing patients to speak directly with a healthcare provider to answer any health-related questions. Despite these efforts, the challenge limited the project manager's ability to obtain a larger sample size.

2.4 Outcomes

Of the 25 participants recruited for the project, 20 completed the follow-up telephone calls and post-intervention surveys and were included in the final analysis. Five participants were lost to follow-up, resulting in a 20% attrition rate (5/25). The primary outcome was the change in diabetes-related

self-efficacy from baseline to 8 weeks, as measured by the DES-SF. Post-intervention median responses were higher than pre-intervention median responses across all eight DES-SF items, indicating an overall improvement in participants' reported diabetes-related self-efficacy following the 8-week virtual DSMES intervention.

2.5 Data management plan

A convenience sampling approach was used to recruit readily available participants. The study employed a quasi-experimental, single-group pre-test/post-test design. The minimum sample size was determined using G*Power based on a Wilcoxon signed-rank test, assuming a moderate effect size (Cohen's $d = 0.50$), a significance level of $\alpha = .05$, and statistical power of 80%. Based on these standardized parameters, the calculated minimum sample size was 34 participants. Twenty participants completed the study, although 25 participants were initially recruited. The primary outcome was the change in DES-SF score between baseline (week 1) and post-intervention (week 8). Statistical analyses were conducted using SPSS version 25 with an alpha level of .05. The Wilcoxon signed-rank test was used to compare paired pre-test and post-test scores.

2.6 Ethical issues and considerations

IRB approval was not required for this project based on the determination applicable to the project before implementation. HopeHealth also did not require a separate IRB submission. Written informed consent was obtained from all participants before participation. Participants were assigned unique identification numbers, and potentially identifiable information was removed prior to data analysis. Study data, surveys, and consent forms were stored securely in a locked file drawer. Study materials were retained for 7 years and were scheduled for destruction according to the study plan.

2.7 Nursing implications

The findings have implications for nursing practice, particularly in rural and community-based primary care settings. The improvement in diabetes-related self-efficacy following the virtual DSMES intervention suggests that nurses, advanced practice registered nurses, and diabetes educators may use virtual education to provide structured diabetes self-management support when transportation, distance, scheduling, or access to onsite education creates barriers to care.^[1,5,6] Virtual delivery may also provide an opportunity to reinforce goal setting, problem-solving, self-management skills, and patient confidence between routine clinical visits.^[2,7,9] All participants in this project had access to an internet-enabled device and a private email account, the find-

ings are most applicable to patients who have the technological resources necessary to participate in virtual education.

The baseline characteristics of the sample may also influence diabetes-related self-efficacy. Participants were adults with type 2 diabetes who lived in a rural area and had access to the Internet, a private email account, and a smartphone, tablet, or computer. These characteristics may have facilitated engagement with the virtual intervention and may distinguish this sample from patients who experience limited digital access.^[1,5,6] The project used convenience sampling at a single Federally Qualified Health Center, and five of the 25 recruited participants did not complete the study, resulting in 20% attrition. In addition, the available project records do not provide information regarding participants' sex, race or ethnicity, diabetes duration, educational attainment, income, or other socioeconomic characteristics. Consequently, the influence of these factors on baseline self-efficacy or response to the intervention cannot be determined. Future studies should collect and report these characteristics to provide a more complete understanding of factors that may influence diabetes-related self-efficacy.

3. RESULTS

A nonparametric Wilcoxon signed-rank test was used to compare participants paired pre-intervention and post-intervention DES-SF scores. The analysis demonstrated a statistically significant improvement in DES-SF scores following implementation of the 8-week virtual DSMES program ($p < .05$). The median responses for each of the eight DES-SF items were higher following the intervention. These findings indicate an overall improvement in participants' reported diabetes-related self-efficacy following the virtual DSMES intervention. A total median score was not estimated. The item-level median findings and Wilcoxon signed-rank analysis were therefore used to describe the change in diabetes-related self-efficacy (see Figures 1-8).

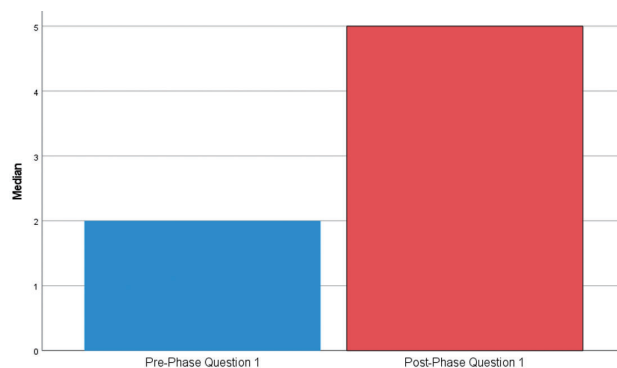


Figure 1. Diabetes care dissatisfaction

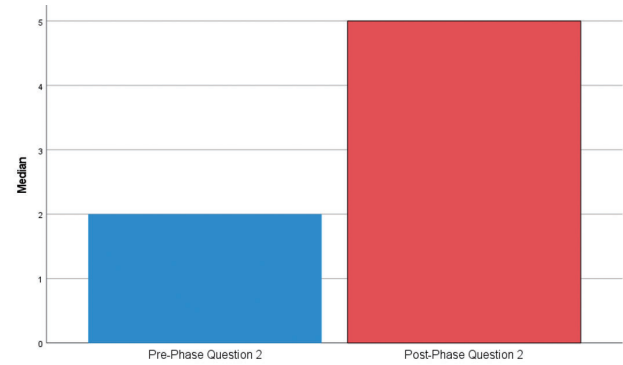


Figure 2. Diabetes goals and workable planning

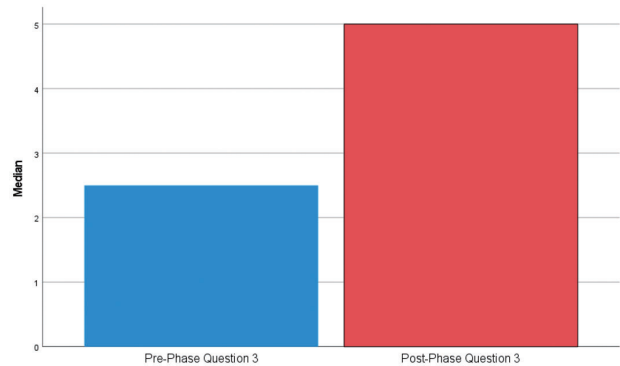


Figure 3. Overcoming barriers to diabetes goals

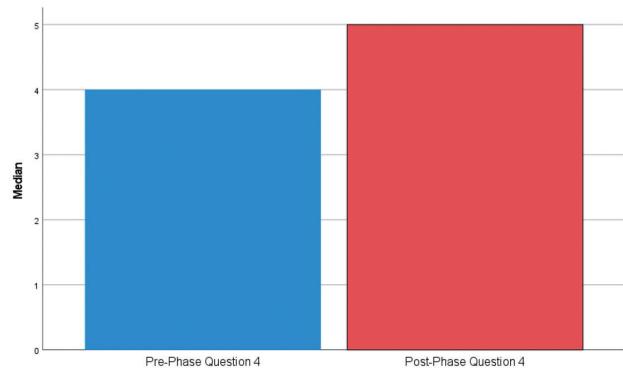


Figure 4. Feeling better about having diabetes

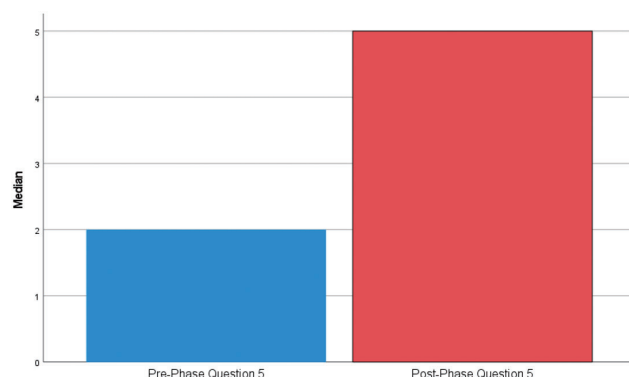


Figure 5. Coping with diabetes-related stress

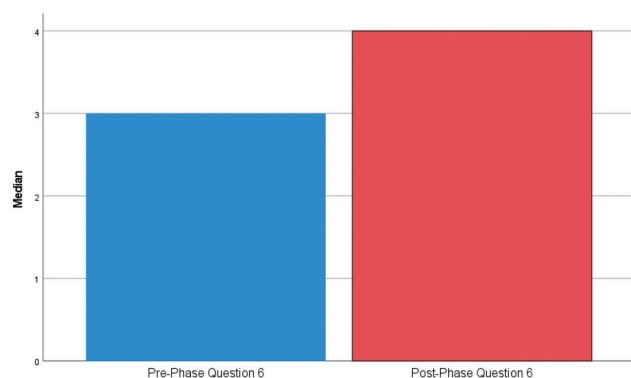


Figure 6. Seeking support for diabetes care

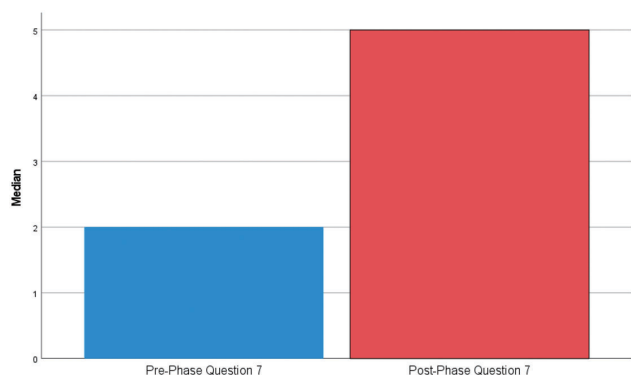


Figure 7. Motivation for diabetes self-care

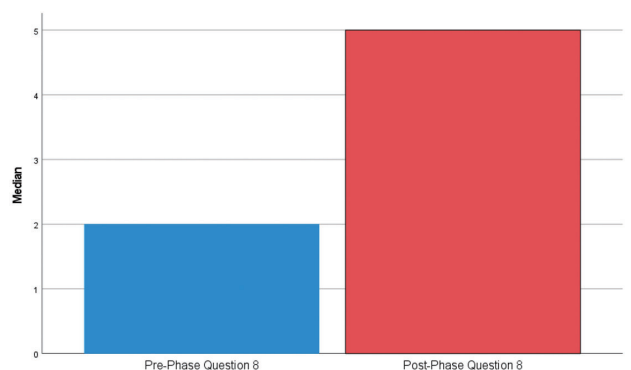


Figure 8. Diabetes care decision-making and self-awareness

4. DISCUSSION

The findings suggest that an 8-week virtual DSMES intervention was associated with higher diabetes-related self-efficacy among the 20 participants who completed the study. The item-level median responses increased across all eight DES-SF items. These findings are consistent with prior evidence that diabetes education and technology-supported interventions can improve self-management-related outcomes and may be particularly useful when transportation or geographic distance limits access to care.^[2,6-9,11,12] The rural setting and

the requirement for participants to have access to internet-enabled technology are important characteristics of the sample and may have facilitated engagement with virtual education while also limiting generalizability to adults without reliable technology access.

The findings also align with the theoretical framework. From a Self-Efficacy Theory perspective, education, feedback, encouragement, and strategies for overcoming barriers may strengthen perceived capability to perform diabetes self-management behaviors.^[13] The increase in DES-SF responses provides preliminary evidence that the intervention was associated with the targeted psychosocial outcome. From a Translational Science perspective, the project moved evidence supporting DSMES from the literature into a real-world virtual intervention at a community-based health center and evaluated an outcome in the clinical population served.^[14] This translation is particularly relevant to nursing practice because nurses and APRNs can adapt evidence-based education to the workflow, technology resources, and access barriers of the population they serve.

Several limitations should be considered when interpreting the findings. The study included a small convenience sample of 20 participants from a single community-based setting, which limits the generalizability of the findings. The 20% attrition rate may have also introduced attrition bias. In addition, the study measured diabetes-related self-efficacy rather than objective glycemic outcomes or sustained self-management behaviors. The 8-week intervention period and lack of long-term follow-up limit the ability to determine whether improvements in self-efficacy were maintained over time. Future studies should include larger, adequately powered samples, longer follow-up periods, and additional measures of diabetes self-management and clinical outcomes.

Recommendations

Future research should use larger, adequately powered samples from multiple community-based settings to improve the generalizability of findings. Longer follow-up periods are also recommended to determine whether improvements in diabetes-related self-efficacy are maintained over time. Future studies should consider including objective measures of glycemic control, such as HbA1c, as well as measures of diabetes self-management behaviors. Strategies to improve participant retention should also be considered to reduce attrition and strengthen study findings.

5. CONCLUSIONS

This study provides preliminary evidence that an 8-week virtual DSMES intervention was associated with improved diabetes-related self-efficacy among adults with type 2 di-

abetes living in a rural community setting. The findings support virtual DSMES as a feasible, patient-centered approach for extending diabetes education when transportation, scheduling, or geographic barriers limit access to in-person services. However, the small convenience sample, 20% attrition, short intervention period, and absence of long-term behavioral or clinical outcomes require cautious interpretation. Larger studies with rigorous designs and longer follow-up are needed to determine whether improvements in self-efficacy are sustained and translate into improved diabetes self-management and clinical outcomes.

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AUTHORS CONTRIBUTIONS

Not applicable.

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Not applicable.

CONFLICTS OF INTEREST DISCLOSURE

The author declares that there is no conflict of interest.

INFORMED CONSENT

Obtained.

ETHICS APPROVAL

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PROVENANCE AND PEER REVIEW

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available on request from the corresponding author. The data are not publicly available due to privacy or ethical restrictions.

DATA SHARING STATEMENT

No additional data are available.

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