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Targeting cognitive function: Development of a cognitive training intervention for diabetes

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Abstract

Aim: The aim of this project was to develop and demonstrate the feasibility of a comprehensive cognitive training intervention to build self-efficacy for implementation of cognitive strategies in people with diabetes.

Background: People with diabetes are at greater risk than the general population for developing cognitive dysfunction. Some attention has been paid to the effect of cognitive impairments on diabetes self-management, but even when cognitive problems have been identified, few interventions have been tailored for those with diabetes.

Methods: The intervention combines in-person classes and home-based online computer training. Development, in 2017, included (a) adaptation of prior established, tested interventions; (b) interviews with stakeholders; and (c) integration of course content.

Results: Information provided by the stakeholders was used to modify an existing intervention to meet the needs of people with diabetes so that feasibility testing could occur. Despite initial difficulty with recruitment, the intervention was found to be feasible, and nineteen participants found it to be acceptable.

Conclusion: This comprehensive cognitive training intervention targeting type 2 diabetes and cognitive dysfunction demonstrates that existing interventions can be adapted for use with people with diabetes.

KEYWORDS
cognitive training intervention, feasibility study, nurse, self-management, type 2 diabetes

SUMMARY STATEMENT

What is already known about the topic?

- People with type 2 diabetes are at higher risk than the general population for developing cognitive dysfunction.
- Additionally, perceived cognitive problems are associated with worse glycaemic control.
- There is a lack of well-established cognitive training interventions for people with diabetes.

What this paper adds?

- This is the first description of a comprehensive cognitive training intervention designed for people with diabetes.
- Existing theory-based interventions were easily tailored for people with type 2 diabetes.
- Participants demonstrated interest in learning more about cognitive health and ways to prevent or delay cognitive problems.

The implications of this paper:

- Memory, Attention, and Problem-Solving Skills for Diabetes is an intervention that can address both cognitive problems and diabetes self-management.
- The inclusion of self-management measures can help determine the effects of the intervention on everyday life.

1 | INTRODUCTION

People with type 2 diabetes (T2DM) are at greater risk than the general population for developing cognitive dysfunction (Munshi, 2017), owing to conditions such as hyperglycemia, hypoglycemia, oxidative stress, and common co-morbidities including hypertension and hyperlipidaemia. Cognitive deficits in T2DM are most commonly related to memory and executive function, which may also lead to problems with T2DM self-management and hence with activities essential to glycaemic control (Gatlin & Gatlin & Insel, 2014). So far, most studies of cognitive function and T2DM have focused on the risk of developing dementia or on how existing impairments increase the risk for worse glycaemic control (Ganmore & Beeri, 2018; Rapp et al., 2017). Recently, more attention has been paid to how cognitive impairments affect T2DM self-management (Marseglia et al., 2016). However, even when such cognitive problems have been identified, few cognitive interventions have been designed specifically for those with T2DM. None have been comprehensive. In one study, for example, online working memory training was given to 71 participants with T2DM to enhance dietary adherence; after 25 training sessions, working memory improved, but A1C (a blood test reflective of glycaemic control over the previous 8-12 weeks) and food intake did not change significantly. However, this intervention was not comprehensive for either T2DM or cognitive function. It focused on only one cognitive domain and only one T2DM self-management activity (Whitelock et al., 2015).

Healthy adults and participants with chronic conditions in comprehensive cognitive training interventions have shown improvement on neuropsychological tests and reported that the respective interventions' cognitive strategies improved their ability to function in daily life (Becker, Henneghan, Volker, & Mikan, 2017; Rebok et al., 2014; Smith et al., 2009). General principles for comprehensive cognitive training interventions include (a) individual tailoring; (b) collaboration between patients and health-care providers; (c) a focus on mutually set and functionally relevant goals; (d) outcome evaluations examining changes in functional abilities; (e) use of multiple approaches; (f) the affective components of cognitive health; and (g) time for self-evaluation by participants (Sigmundsdottir, Longley, & Tate, 2016). An example of such an intervention is the Advanced Cognitive Training for Independent and Vital Elderly (ACTIVE) programme, which increased engagement and improved long-term memory retention in an elderly population, with improvements in processing speed lasting as long as 10 years (Rebok et al., 2014). Similar interventions adapted for chronic conditions such as heart failure, HIV, and cognitive dysfunction following chemotherapy ("chemo brain") show promise as treatments that might merit investigation for use in those with T2DM (Park, Jung, Kim, & Bae, 2017; Pressler et al., 2015; Towe, Patel, & Meade, 2017).

2 | METHODS

2.1 | Aim

As one of the first studies to examine a comprehensive cognitive training intervention for people with T2DM, the aim was to develop a comprehensive cognitive training intervention to build self-efficacy for implementation of cognitive strategies in people with diabetes. To do this, we adapted a prior comprehensive cognitive training intervention, Memory, Attention, and Problems Solving Skills for Persons with Multiple Sclerosis (MAPSS-MS), to develop our Memory, Attention, and Problems Solving Skills for Persons with T2DM (MAPSS-DM).

2.2 | Design

This study describes the design process and measures to test the feasibility and acceptability of an intervention using a one-group, pretest/posttest design with adults with T2DM. This prospective study was conducted from Spring 2017 at a multisite endocrinology clinic.

2.3 | The intervention

When an intervention is adapted, there is a danger of decreasing its effectiveness (Jansen et al., 2013). To avoid this problem, one must assess the setting and population, adapt the intervention materials with care, consult with developers, and test the adaptation's feasibility (Lee, Altschul, & Mowbray, 2008). This intervention was built primarily on the 8-week MAPSS-MS cognitive training intervention, which was designed to combine a group intervention for building self-efficacy for new cognitive compensatory strategies with individual home-based online practice of those skills. The MAPSS-MS, however, has not been adapted or evaluated for individuals with diabetes (Stuifbergen et al., 2012). Therefore, in adapting the MAPSS-MS for our MAPSS-DM, we also included elements of the National Institute of Diabetes and Digestive and Kidney Diseases' successful lifestyle programme Look AHEAD (Action for Health in Diabetes; Look AHEAD Research Group, 2003). (Table 1 lists the relevant content of the MAPSS-MS and Look AHEAD, along with the adapted content of the MAPSS-DM.)

2.3.1 | Intervention elements

The programmes used to develop the cognitive training intervention—the MAPSS-MS and Look AHEAD—have similar features: (a) goal setting; (b) self-monitoring to achieve those goals; (c) frequent contact to

TABLE 1 Sources of adapted MAPSS-DM content

	MAPSS-MS Cognitive Training Content	Look AHEAD Content	MAPSS-DM Adapted Content
Week 1	Maximizing cognitive functioning and orientation to computer training Attention and processing speed	Impact of lifestyle changes on diabetes risk factors	Understanding T2DM, symptoms, complications, and medications Understanding how cognitive function is related to T2DM Orientation to computer training Discussing effective strategies to facilitate better communication with health care providers, eg, understanding instructions or recommendations from health-care providers Strategies to enhance attention and problem solving
Week 3	Memory and language Executive functioning and visuospatial skills	Educational support for self-management.	Strategies to enhance memory Addressing resources and barriers to self-management (eg, planning ahead for meals and organizing medications) that take into account elements of executive functioning Visuospatial skills required for blood glucose self-monitoring
Week 5	Lifestyle adjustments to maximize cognitive health Stress management	Diet modifications to improve glucose control	Addressing ADA dietary recommendations and how they can benefit cognitive health Discussion of favourite recipes, more healthy food preparation, eating out, and emphasis on portion control Acknowledging and appreciating stress associated with diabetes and cognitive issues. Providing resources for mental health-care services Strategies to manage stress
Week 8	Engaging in physical activity and exercise Maximizing cognitive functioning, pulling it all together	Physical activity modifications to improve glucose control.	Addressing ADA activity recommendations and benefits of following the guidelines on cognitive function Discussion of practical ways to increase activity Review of cognitive skills/training and the potential impact on self-management skills including blood glucose monitoring, medication adherence, diet, and exercise. Addressing resources and barriers to maintaining cognitive function.

provide accountability and sustain focus; (d) use of problem solving and other strategies to address goals and barriers; and (e) emphasis in managing individual situations. The theoretical constructs of social cognitive theory guide these programmes and emphasize self-efficacy. Given the extent to which the MAPSS-MS has been used for cognitive training in chronic illnesses and Look AHEAD has been used in diabetes, we anticipated that they would provide an appropriate basis for a cognitive training intervention in diabetes.

2.3.2 | Development of the intervention

Interviews were conducted with people with T2DM to discuss our adaptation and proposed implementation of the programme. Specific attention was given to the class content, programme logistics, and recruitment methods. Details of these interviews have been described elsewhere (Cuevas, Stuifbergen, Brown, & Rock, 2017). All aspects of the adaptation were discussed with this interviewed group and the research team, as well as with the MAPSS-MS developer, before final decisions were made regarding the new intervention's content. The resulting intervention consisted of four classes held every other week and 135 minutes of at-home online computer training during 8 weeks.

The development of the intervention followed three steps: First, elements of established diabetes and cognitive training interventions were identified. Second, the elements of those interventions were evaluated by stakeholders with T2DM. Third, the identified elements of perceived cognitive problems and interventions were integrated into the intervention's course content.

2.3.3 | Stakeholder evaluation

Ten adults with T2DM were interviewed to obtain perspectives on cognitive training interventions that would help us adapt the MAPSS-MS for persons with T2DM. The interviews suggested four different themes: advice regarding cognitive complaints, cognitive symptoms, the impact of perceived cognitive dysfunction on diabetes self-management, and maintenance of cognitive health. Areas of interest for an intervention included dealing with cognitive barriers to self-management and incorporating a "brain healthy" lifestyle into daily activities. None of the participants had tried formal "brain games" or cognitive training, but they were enthusiastic about taking part in an intervention that could potentially help cognitive function. All felt that they would be able to adhere to an intervention that was 6 to 8 weeks long, but not weekly as in the original interventions. Several expressed interest in an online course.

2.3.4 | Integration of course content

The in-person classes for the MAPSS-DM intervention were designed to be delivered by a registered nurse over 8 weeks, with sessions every other week. Specific content was based on feedback from the preliminary interviews and extant literature. All sessions emphasized maximizing cognitive function first and then addressed the interrelated effects of improved cognition on self-management skills and improved glycaemic control on cognition. Each class session followed the same basic format:

a. introduction/revisiting content from the prior class and answering questions;
b. review of progress on computer exercises prescribed in the previous class;
c. practice of cognitive strategies in class;
d. content on weekly topic; and
e. closure—prescribed computer training and cognitive strategy assignments for the upcoming week.

Discussion on how to use this information in day-to-day self-management activities was also included. Participants received notebooks with class content to support what was taught in each session. Table 1 includes descriptions of each of the classes.

As mentioned, strategies to improve cognitive health were practiced in class and on home computers. Like the MAPSS-MS, the MAPSS-DM uses an online computer-based brain-training programme, Brain HQ, which was developed by Posit Science (2017). Tasks are presented in a game-like format, arranged so that as the user moves forward, the tasks become more challenging. Brain HQ is subscription-based, and it runs on standard web browsers. Participants were asked to complete 45 minutes of computer training three times per week and were able to log in from home and complete exercises from any computer with Internet access.

The nurse facilitators for the classes helped participants identify priorities and goals for attempted cognitive strategies each week and provided a "booster" phone call in the weeks when the classes did not meet. These nurses supported the participants by listening, providing feedback, and helping them fine-tune goals to be more specific, actionable, and realistic.

2.4 | Feasibility testing

2.4.1 | Sample/participants

A convenience sample of study participants was drawn from a local multisite endocrinology clinic, such that the participant profile matched the demographic profile of Central Texas. The eligibility criteria included (a) age 40 to 70 years; (b) diagnosis of T2DM; (c) ability to read and speak English; and (d) access to the Internet either via smartphone or computer at home. Exclusion criteria included (a) diagnosis of overt dementia and (b) diagnosis of type 1 diabetes or current gestational diabetes.

During the screening interview, prospective participants completed the Perceived Deficits Questionnaire (Cronbach's α = .84) (PDQ; Lenderking et al., 2014). A score of 10 or greater indicates that one has subjective difficulty with cognitive function. The participants were then assigned to one of two intervention locations based on geographic convenience (n_1 = 9; n_2 = 10). The demographic characteristics of the two groups did not differ significantly.

2.5 | Data collection

Data were gathered by the first author and a graduate research assistant at baseline data collection visits scheduled for each participant between February and April 2017. Demographic data (age and educational status), clinical data (A1C, BMI, and years with diabetes), and initial data for executive function, memory, self-efficacy, and depression were obtained via self-report measures at baseline from participants after they consented to take part in the study. Self-report instruments were chosen for participant surveys, because the administration of other neuropsychiatric tests requires specialized training. Previous studies have supported the use of such surveys; as tools to assess cognitive function, they are comparable with objective neuropsychiatric tests (Troyer & Rich, 2002).

2.5.1 | Diabetes self-care

Diabetes self-management was measured using the 18-item Summary of Diabetes Self-Care Activities (SCDA) on which participants answer questions regarding how many days in the last week they have performed behaviours for diabetes self-management concerning diet, physical activity, blood glucose testing, smoking, and foot care. Inter-item correlations range from r = .20 to .76 for four SDCA subscales, and 4-month test-retest reliability ranged from r = −.05 to.78 in prior studies (Toobert, Hampson, & Glasgow, 2000).

2.5.2 | General self-efficacy

The 10-item General Self-Efficacy Scale was used to assess confidence in ability to influence outcomes. Responses are made on a 4-point scale (1 = *not true at all*, 2 = *hardly true*, 3 = *moderately true*, 4 = *exactly true*) to items such as "I can always manage to solve difficult problems if I try hard enough." Cronbach's alphas range from.76 to.90 (Schwarzer & Jerusalem, 1995).

2.5.3 | Perceived memory ability

The Multifactorial Memory Questionnaire (MMQ) was used to measure perceived memory. This 57-item questionnaire assesses contentment with one's memory, subjective memory capability, and use of memory aids. Participants rate their level of agreement with each item on a 5-point scale (1 = *strongly agree*, 2 = *agree*, 3 = *undecided*, 4 = *disagree*, 5 = *strongly disagree*) for the Contentment subscale. The Ability subscale asks participants to indicate the frequency with which each memory failure has occurred in the past 2 weeks on a 5-point scale (1 = *all the time*, 2 = *often*, 3 = *sometimes*, 4 = *rarely*, 5 = *never*). The third subscale, Strategy, asks participants to rate the frequency of use of certain memory strategies on a 5-point scale (1 = *never*, 2 = *rarely*, 3 = *sometimes*, 4 = *often*, 5 = *all the time*). Cronbach's alphas for the subscales are.95 for Contentment, .93 for Ability, and.83 for Strategy (Troyer & Rich, 2002).

2.5.4 | Perceived executive function

Perceived executive function was measured using the Barkley Deficits in Executive Functioning Scale—Short Form (BDEFS-SF). This 20-item scale assesses the frequency with which participants have exhibited certain behaviours in specific executive functioning areas over the past 6 months: self-management to time, self-organization/problem solving, self-restraint, self-motivation, and self-regulation of emotion. Items are measured using a 4-point Likert scale, ranging from 1 = *never or rarely* to 4 = *very often.* Cronbach's alpha for the short form's internal consistency is.92 (Barkley, 2014).

2.5.5 | Depression

Depression is a common co-morbidity for diabetes as well as cognitive dysfunction (Musselman et al., 2014). The measurement of depression helps to determine whether it is a potential confounder for findings of perceived cognitive problems. To measure depression, participants were given the 20-item Center for Epidemiologic Studies Depression Scale (CES-D; Radloff, 1977) on which participants indicate responses on a 4-point scale ranging from *rarely/none of the time* to *most/all of the time* on eight health dimensions: role limitations due to physical problems, social functioning, physical functioning, bodily pain, general mental health, role limitations due to emotional problems, vitality, and general health perceptions. Internal consistency values on this scale, in prior studies, range from .85 to .91; test-retest reliability, from.45 to.70 (Stahl et al., 2008).

2.5.6 | Feasibility goals

At the end of the study, feasibility was assessed in line with Orsmond and Cohn's (2015) guidelines for feasibility studies. The guidelines include (a) no more than 10% of participants should have withdrawn their consent; (b) more than half the participants should have participated in all educational sessions; (c) the time taken to administer the questionnaires would be perceived as feasible for the target population (30-45 min); and (d) the data collected would show variability across participants.

2.5.7 | Acceptability

Evaluation of acceptability is another component of Orsmond and Cohn's (2015) recommendations and questions to assess intervention acceptability were developed by the study team. At the intervention's completion, its acceptability was rated by the participants on a 6-item Likert-type scale with items such as "The activities kept my interest" and "The computer activities helped improve my cognitive skills."

Additionally, responses to 12 open-ended, study-team developed, questions regarding the cognitive strategies tried, and feedback on class sessions and online games were obtained in two focus groups held during the final class session.

Data were collected via an online programme (Qualtrics) or on paper forms if requested by the participant.

2.6 | Ethical considerations

The Institutional Review Board of the university where the study was conducted approved the study before data collection began.

2.7 | Data analysis

Data were analysed using IBM SPSS Statistics version 23 (2013). The data were checked for accuracy and evaluated for violations of statistical tests. Descriptive analyses were performed to obtain a description of demographic and illness-related variables. Correlations were run to examine the relationships between the variables, with significance set at.05. For demographic variables, independent t tests or χ^2 tests were used to assess potential differences for ethnicity at baseline. The goal set by the American Diabetes Association was applied to categorize participants' mean A1C levels (<7%).

3 | RESULTS

3.1 | Recruitment

Ninety-three patients with cognitive complaints were recruited during the screening period (Figure 1). Of these, 32 did not meet the PDQ criteria, and 19 had a history of dementia. Forty-two others declined after initial screening. Of the remaining patients, 19 consented to participate.

3.2 | Participants' characteristics

Baseline data were available for 19 participants (Table 2). Their mean age was 55 years (SD = 10.9), mean time since diagnosis with diabetes was 7 years (SD = 4.8), and mean A1C was 8.3% (SD = 1.8). Thirty-two percent were non-Hispanic white; 52.6%, Hispanic; and 15.8%, African American.

Baseline adherence to diabetes self-care activities was low (Table 3). Participants completed an average of 2.1 d/wk of physical activity and only 1.5 days of specific exercise. Rates of "healthful eating" averaged 2.7 days, and consumption of high-fat foods averaged 4.6 days. Two participants reported they smoked, and the average number of days of smoking in the past week was 0.26. Length of time since diagnosis with T2DM significantly and positively correlated with some of the self-management activities: healthful eating in the past month (r = .586, P < .01), healthful eating in the last week (r = .605, P < .01), eating five or more servings of fruits and vegetables per day (r = .547, P < .5), participating in 30 minutes of physical activity in the last week (r = .701, P < .01), and participating in a specific exercise in the past week (r = .630, P < .01). General self-efficacy was significantly correlated with diet (r = .50, P < .05), exercise (r = .61, P < .01), foot care (r = .51, P < .5), and perceived problems with executive function (r = −.67, P < .1): Higher self-efficacy was associated with greater levels of diabetes self-management adherence and lower levels of executive dysfunction.

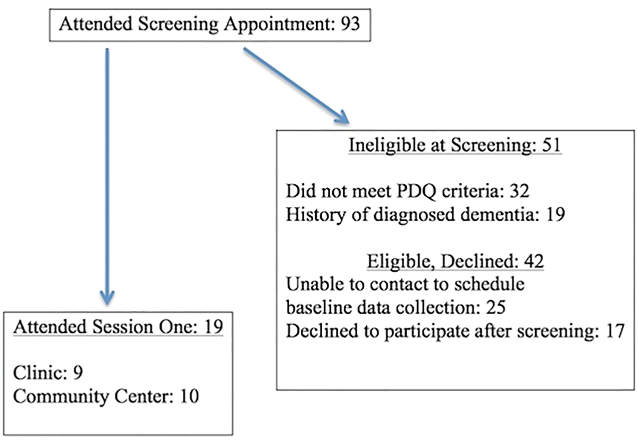

FIGURE 1 Recruitment flow chart

TABLE 2 Participant characteristics (N = 19)

Characteristic	n	Range	%	Mean (SD)
Age in y	19	40-70		55.1 (10.9)
A1C	19	5.4-12		8.3 (1.8)
Length of time with DM (y)	19	2-21		7.1 (4.8)
Hispanic	10		52.6	
Non-Hispanic White	6		31.6	
African American	3		15.8	
Female	11		57.9	

TABLE 3 Diabetes self-care activities

Variable	Range	Mean	SD
Days of healthful eating in the past week	0-7	2.7	1.9
Days of healthful eating in the past month	0-7	3.0	1.6
5 or more servings of fruit and vegetables a day in the past week	0-6	3.0	1.7
Days consuming high-fat foods in the past week	1-7	4.6	1.8
Days with at least 30 min of activity in the past week	0-6	2.1	1.9
Days participating in a specific exercise in the past week	0-6	1.5	1.9
Days checking glucose in the past week	0-7	2.4	2.2
Days checking glucose per health-care provider in the past week	0-7	2.2	2.3
Days checking feet in the past week	0-7	4.0	3.0
Days checking shoes in the past week	0-7	1.3	2.5
Days of smoking in the past week	0-3	0.26	0.80

3.3 | Baseline cognitive function and association with self-management activities

Use of memory strategies was lower than in the original MAPSS-MS intervention, and total executive function scores placed these participants in the 94th percentile, indicating lower perceived executive functioning than in the general population (Barkley, 2014; Stuifbergen et al., 2012) (See Table 4).

Scores on the BDEFS-SF, but not the MMQ, significantly correlated with self-management activities (general diet r = −.665, P < .01; exercise r = −.725, P < .01; foot care r = −.516, P < .05) and positively correlated with eating high-fat foods in the past week (r = .692, P < .01). Rates of self-management adherence with lower perceived executive function were lower for exercise only. A1C was not significantly correlated with the cognitive variables.

TABLE 4 Baseline cognitive variables

Variable	Range	M (SD)
Self-efficacy	23-36	28.42 (4.67)
Memory—contentment	28-54	40.01 (5.84)
Memory—ability	31-86	45.5 (11.38)
Memory—strategies	12-101	32.84 (19.56)
Executive function—time	4-14	10.00 (2.62)
Executive function—self-organization	4-12	8.524 (2.39)
Executive function—restraint	4-14	7.9 (2.95)
Executive function—motivation	4-11	6.89 (2.82)
Executive function—self-regulation	4-14	8.26 (2.49)
Executive function—total	24-57	41.63 (9.93)
Depression	3-23	12.00 (7.50)

3.4 | Feasibility evaluation

Recruitment was a challenge during screening, with an average enrolment of one person per 12 days necessitating an extension of enrolment for 1 month to reach the final sample. One barrier to enrolment was the number of classes participants were required to attend. Initially, the schedule was to have eight weekly 1-hour classes, but after repeated comments regarding potential travel burden, this was changed to four 2-hour classes that would meet every other week. After this change was made, enrolment increased to about three participants per week.

Only one participant withdrew consent after initially agreeing to participate. This occurred after the first session, leaving the final sample size at 19 instead of 20. This still left the study with a good retention rate.

3.5 | Acceptability evaluation

Questionnaire burden was limited. With Qualtrics, the time taken to complete the forms averaged about 25 minutes. The two participants who requested paper copies stated that the surveys took about 20 minutes to complete. Participant acceptability of the intervention and final retention rate was assessed at the end of the project. Fifty-eight percent of participants felt the intervention helped their T2DM self-management, and 74% said they wanted to continue using the cognitive strategies learned in the intervention. However, 32% agreed strongly with the statement, “The amount of time burden for the intervention was high.” Additionally, the cognitive strategies were rated as more helpful than the computer training (53% vs 47%).

4 | DISCUSSION

This paper presents the method and baseline data for research in which we are developing an adaptive approach to treating perceived cognitive dysfunction in patients with diabetes. The intervention targets patients with both disorders (diabetes and cognitive dysfunction) and integrates evidence-based treatments in in-person class sessions to increase self-efficacy for dealing with cognitive problems and home-based online cognitive training. The MAPSS-DM maintains the key components of the MAPSS-MS to preserve effectiveness, while focusing on the needs of people with T2DM. Despite the strong links between diabetes and cognitive dysfunction, there are currently no other comprehensive interventions to address cognitive dysfunction and its impact on diabetes self-management.

The goal of this work is to improve diabetes self-management through cognitive training. Adding the component of cognition to the study of T2DM self-management is a novel focus that matches patients' experiences of dealing with diabetes (Cuevas & Brown, 2017). The programme's nurse-led, group-based delivery offers a feasible option for implementation in a variety of settings, including community groups and health-care organizations. Cognitive training interventions have been used for other non-neurologic chronic conditions. For example, the MEMOIR study also used BrainHQ (Pressler et al., 2015). In that project, both memory and processing speed were improved in a sample of patients with heart failure. Von Ah et al. (2012) used an older version of BrainHQ in an intervention with women recovering from breast cancer and found intervention effects transferred to improvements in perceived cognitive functioning, symptoms distress, and quality of life—all clinically significant variables. In addition, participants noted that BrainHQ had elements that “enhanced enjoyment” and maximized usage. Von Ah et al also included the Squire Subjective Memory Questionnaire and the CES-D, but most studies testing cognitive rehabilitation interventions in chronic conditions have used performance-based neuropsychological tests instead of such self-report measures. MAPSS-MS used a combination of self-report and neuropsychological performance tests (Stuifbergen et al., 2012). Future plans for the MAPSS-DM intervention will also include both self-report surveys and neuropsychological performance tests.

The present study also showed a relationship between cognitive function and facets of diabetes self-management. These correlations should be interpreted cautiously because of the small sample size, but they present relationships that warrant investigation. Our baseline results are consistent with those of other studies that have demonstrated lower adherence to diabetes self-management activities with self-reported executive function (Vincent & Hall, 2015). The most common dysexecutive symptoms in our sample were (a) self-management to time, (b) self-organization, and (c) self-regulation of emotion, which showed poorer rates than the average for the general population without diabetes (Barkley, 2014). Despite these levels of dysexecutive symptoms, the results indicate that perceived executive function was not related to glycaemic control at baseline. However, longitudinal studies have demonstrated that decreased executive function is related to decreased glycaemic control, measured by A1C. Health-care providers should also keep in mind the potential for cognitive function to affect diabetes self-management, as studies have demonstrated the need for executive dysfunction screening in people with T2DM either by self-report or by formal neuropsychiatric testing. The baseline results presented here seem to suggest that cognitive screening is justified to identify those who might benefit most from assessments to avoid complications such as a decrease in independent functioning.

A unique characteristic of this sample is the higher number of underrepresented minorities, which suggests that the target population was well represented even with a small sample. This is important, because underrepresented minorities with T2DM struggle more with diabetes self-management adherence and have higher rates of cognitive dysfunction than do non-Hispanic Whites. Recruitment, however, was a challenge, and adapting strategies in the future to offer virtual/online classes to minimize logistical barriers to participation, partnering with more than one clinical provider, and increasing contact with participants may help to facilitate recruitment and retention. It is possible that having a remote, online course might decrease problems with enrolment in the future, since distance to the intervention sites may have excluded other potential participants. Social media advertising as a recruitment strategy may also be helpful for study implementation.

4.1 | Limitations

A strength of this project is that it was based on existing evidence and took a systematic approach to adapting an established intervention. However, the difficulty with recruitment, reflected by the large number of patients screened, may indicate that further exploratory research is needed to inform the intervention's readiness for this population. Additionally, because of the small number of participants, generalizability is limited. But since there is little research involving this type of intervention in diabetes, it is of relevance to report the early barriers in this study because they might impact the feasibility of future procedures.

5 | CONCLUSION

The MAPSS-DM is a promising intervention. In a time when rates of co-morbid diabetes and cognitive dysfunction are rising, it is important to explore how interventions can become more sensitive to both conditions. The MAPSS-DM will provide the first evaluation of a comprehensive cognitive rehabilitation intervention for people with diabetes. Thus, despite our difficulty with recruitment, further testing of comprehensive cognitive training interventions for people with diabetes is recommended. A collaborative, multidisciplinary intervention can help provide a guide for feasible studies that contribute to more tailored approaches to management of diabetes and cognitive problems. Additionally, documentation of study processes will allow others to replicate the study and understand the contextual differences important to future dissemination. In the future, efficacy testing will build knowledge specific to promoting the cognitive health of people with T2DM.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

AUTHORSHIP STATEMENT

HC, AS, and SB designed the study. HC collected the data. HC analysed the data. HC, AS, and SB prepared the manuscript. All authors approved the final version for submission.

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REFERENCES

Barkley, R. A. (2014). The assessment of executive functioning using the Barkley Deficits in Executive Functioning Scales. In S. Goldstein, & J. A. Naglieri (Eds.), *Handbook of executive functioning* (pp. 245–263). New York: Springer.

Becker, H., Henneghan, A. M., Volker, D. L., & Mikan, S. Q. (2017). A pilot study of a cognitive-behavioral intervention for breast cancer survivors. *Oncology Nursing Forum*, *44*, 255–264. https://doi.org/10.1188/17.ONF.255-264

Cuevas, H. E., & Brown, S. A. (2017). Self-management decision making of Cuban Americans with type 2 diabetes. Advance online publication. *Journal of Transcultural Nursing*, *29*, 222–228. https://doi.org/10.1177/1043659617696977

Cuevas, H. E., Stuifbergen, A. K., Brown, S. A., & Rock, J. L. (2017). Thinking about cognitive function: Perceptions of cognitive changes in people with type 2 diabetes. *The Diabetes Educator*. Advance online publication, *43*, 486–494. https://doi.org/10.1177/0145721717729806

Ganmore, I., & Beeri, M. S. (2018). The chicken or the egg? Does glycaemic control predict cognitive function or the other way around? *Diabetologia*, *61*(9), 1913–1917. https://doi.org/10.1007/s00125-018-4689-9

Gatlin, P. K., & Insel, K. C. (2014). Severity of type 2 diabetes, cognitive function, and self-care. *Biological Research for Nursing*, *17*(5), 540–548. https://doi.10.1177/109980041557565

IBM Corp. (2013). IBM SPSS Statistics for Windows, Version 23.0. Armonk, NY:Author.

Jansen, S. C., Haveman-Nies, A., Duijzer, G., Ter Beek, J., Hiddink, G. J., & Feskens, E. J. M. (2013). Adapting the SLIM diabetes prevention intervention to a Dutch real-life setting: Joint decision making by science and practice. *BMC Public Health*, *13*, 457–411. https://doi.org/10.1186/1471-2458-13-457

Lee, S. J., Altschul, I., & Mowbray, C. T. (2008). Using planned adaptation to implement evidence-based programs with new populations. *American Journal of Community Psychology*, *41*, 290–303. https://doi.org/10.1007/s10464-008-9160-5

Lenderking, W. R., Steenrod, A., Rüdell, K., Klapper, S., Howard, K., & Gaudig, M. (2014). Options for evaluating treatment benefit in MCI and prodromal Alzheimer's disease: Content validity of the Perceived Deficits Questionnaire (PDQ) in patients with early symptoms of cognitive decline. *Advances in Alzheimer's Disease*, *13*, 43682. https://doi.org/10.4236/aad.2014.31001

Look AHEAD Research Group (2003). Look AHEAD (Action for Health in Diabetes): Design and methods for a clinical trial of weight loss for the prevention ofcardiovascular disease in type 2 diabetes. *Controlled ClinicalTrials*, *24*, 610–628. https://doi.org/10.1016/S0197-2456(03)00064-3

Marseglia, A., Fratiglioni, L., Laukka, E. J., Santoni, G., Pedersen, N. L., Bäckman, L., & Xu, W. (2016). Early cognitive deficits in type 2diabetes: A population-based study. *Journal of Alzheimer's Disease*, *53*, 1069–1078. https://doi.org/10.3233/JAD-160266

Munshi, M. N. (2017). Cognitive dysfunction in older adults with diabetes: What a clinician needs toknow. *Diabetes Care*, *40*, 461–467. https://doi.org/10.2337/dc16-1229

Musselman, D. L., Ziemer, D. C., McNutt, M. D., Seay, J. S., Royster, E. B., Larsen, B., … Harvey, P. D. (2014). Depression, deficits in functional capacity, and impaired glycaemic control in urban African Americans with type 2 diabetes. *Journal of Psychiatric Research*, *52*, 21–27. http://doi.org/10.1016/j.jpsychires.2014.01.006

Orsmond, G. I., & Cohn, E. S. (2015). The distinctive features of a feasibility study: Objectives and guiding questions. *Occupation, Participation, and Health.*, *35*(3), 169–177.

Park, J. H., Jung, Y. S., Kim, K. S., & Bae, S. H. (2017). Effects of compensatory training interventionfor breast cancer patients undergoing chemotherapy: A pilot study. *Supportive Care in Cancer*, *25*, 1887–1896. https://doi.org/10.1007/s00520-017-3589-8

Posit Science. (2017). Brain HQ. https://www.brainhq.com

Pressler, S. J., Titler, M., Koelling, T. M., Riley, P. L., Jung, M., Hoyland-Domenico, L., … Giordani, B. (2015). Nurse-enhanced computerized cognitive training increases serum brain-derived neurotropic factor levels and improves working memory in heart failure. *Journal of CardiacFailure*, *21*, 630–641. https://doi.org/10.1016/j.cardfail.2015.05.004

Radloff, L. S. (1977). The CES-D scale: A self-report depression scale for research in the generalpopulation. *Applied Psychological Measurement*, *1*, 385–401. https://doi.org/10.1177/014662167700100306

Rapp, S. R., Luchsinger, J. A., Baker, L. D., Blackburn, G. L., Hazuda, H. P., Demos-McDermott, K. E., … Look AHEAD Research Group (2017). Effect of a long-term intensive lifestyle intervention on cognitive function: Action for health in diabetes study. *Journal of the American Geriatric Society*, *65*(5), 966–972. https://doi.org/10.1111/jgs.14692

Rebok, G. W., Ball, K., Guey, L. T., Jones, R. N., Kim, H.-Y., King, J. W., … for the ACTIVE Study Group (2014). Ten-yeareffects of the advanced cognitive training for independent and vital elderly cognitive training trial on cognition and everyday functioning in older adults. *Journal of theAmerican Geriatrics Society*, *62*, 16–24. https://doi.org/10.1111/jgs.12607

Schwarzer, R., & Jerusalem, M. (1995). Generalized self-efficacy scale. In J. Weinman, S. Wright, & M. Johnston (Eds.), *Measures in health psychology: A user's portfolio. Causal and control beliefs* (pp. 35–37). Windsor, UK: NFER-NELSON.

Sigmundsdottir, L., Longley, W. A., & Tate, R. L. (2016). Computerised cognitive training in acquiredbrain injury: A systematic review of outcomes using the International Classification ofFunctioning (ICF). *Neuropsychological Rehabilitation*, *26*, 673–741. https://doi.org/10.1080/09602011.2016.1140657

Smith, G. E., Housen, P., Yaffe, K., Ruff, R., Kennison, R. F., Mahncke, H. W., & Zelinski, E. M. (2009). A cognitive training program based on principles of brain plasticity: Results from the Improvement in Memory with Plasticity-based Adaptive Cognitive Training (IMPACT) study. *Journal of the American Geriatrics Society*, *57*, 594–603. https://doi.org/10.1111/j.1532-5415.2008.02167.x

Stahl, D., Sum, C. F., Lum, S. S., Liow, P. H., Chan, Y. H., Verma, S., … Chong, S. A. (2008). Screening for depressive symptoms: Validation of the center for epidemiologic studies depression scale (CES-D) in a multiethnic group of patients with diabetes in Singapore. *Diabetes Care*, *31*, 1118–1119. https://doi.org/10.2337/dc07-2019

Stuifbergen, A. K., Becker, H., Perez, F., Morison, J., Kullberg, V., & Todd, A. (2012). A randomizedcontrolled trial of a cognitive rehabilitation intervention for persons with multiple sclerosis. *Clinical Rehabilitation*, *26*, 882–893. https://doi.org/10.1177/0269215511434997

Toobert, D. J., Hampson, S. E., & Glasgow, R. E. (2000). The summary of diabetes self-care activities measure: Results from 7 studies and a revised scale. *Diabetes Care*, *23*, 943–950. https://doi.org/10.2337/diacare.23.7.943

Towe, S. L., Patel, P., & Meade, C. S. (2017). The acceptability and potential utility of cognitive training to improve working memory in persons living with HIV: A preliminary randomized trial. *Journal of the Association of Nurses in AIDS Care*, *28*, 633–643. https://doi.org/10.1016/j.jana.2017.03.007

Troyer, A. K., & Rich, J. B. (2002). Psychometric properties of a new metamemory questionnaire for older adults. *The Journals of Gerontology. Series B, Psychological Sciences and Social Sciences*, *57B*, P19–P27. https://doi.org/10.1093/geronb/57.1.P19

Vincent, C., & Hall, P. A. (2015). Executive function in adults with type 2 diabetes: A meta-analytic review. *Psychosomatic Medicine*, *77*, 631–642. https://doi.org/10.1097/PSY.0000000000000103

Von Ah, D., Carpenter, J. S., Saykin, A., Monahan, P., Wu, J., Yu, M., … Unverzagt, F. (2012). Advanced cognitive training for breast cancer survivors: A randomized controlled trial. *Breast CancerResearch and Treatment*, *135*, 799–809. https://doi.org/10.1007/s10549-012-2210-6

Whitelock, V., Nouwen, A., Houben, K., van den Akker, O., Miller, I. N., Narendan, P., … Higgs, S. (2015). Does neurocognitive training have the potential to improve dietary self-carein type 2 diabetes? Study protocol of a double-blind randomised controlled trial. *BMC Nutrition*, *1*, 11–18. https://doi.org/10.1186/s40795-015-0006-x

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