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Comparison of a Mindful Eating Intervention to a Diabetes Self-Management Intervention Among Adults With Type 2 Diabetes: A Randomized Controlled Trial

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Abstract

Mindful eating may be an effective intervention for increasing awareness of hunger and satiety cues, improving eating regulation and dietary patterns, reducing symptoms of depression and anxiety, and promoting weight loss. Diabetes self-management education (DSME), which addresses knowledge, self-efficacy, and outcome expectations for improving food choices, also may be an effective intervention for diabetes self-care. Yet few studies have compared the impact of mindful eating to a DSME-based treatment approach on patient outcomes. Adults 35 to 65 years old with type 2 diabetes for ≥1 year not requiring insulin therapy were recruited from the community and randomly assigned to treatment group. The impact of a group-based 3-month mindful eating intervention (MB-EAT-D; $n = 27$) to a group-based 3-month DSME "Smart Choices" (SC) intervention ($n = 25$) postintervention and at 3-month follow-up was evaluated. Repeated-measures ANOVA with contrast analysis compared change in outcomes across time. There was no significant difference between groups in weight change. Significant improvement in depressive symptoms, outcome expectations, nutrition and eating-related self-efficacy, and cognitive control and disinhibition of control regarding eating behaviors occurred for both groups (all $p < .0125$) at 3-month follow-up. The SC group had greater increase in nutrition knowledge and self-efficacy than the MB-EAT-D group (all $p < .05$) at 3-month follow-up. MB-EAT-D had significant increase in mindfulness, whereas the SC group had significant increase in fruit and vegetable consumption at study end (all $p < .0125$). Both SC and MB-EAT-D were effective treatments for diabetes self-management. The availability of mindful eating and DSME-based approaches offers patients greater choices in meeting their self-care needs.

Keywords

meditation, patient education, randomized controlled trial, type 2 diabetes mellitus

Living with diabetes can be challenging and illness-related emotional distress is common (Fisher, Glasgow, & Strycker, 2010). Effective self-care requires engaging in extensive self-management behaviors, including eating a healthful diet for weight control. Fewer than half of individuals with type 2 diabetes mellitus (T2DM) meet the recommended daily servings from food groups, including fruits and vegetables (Guenther, Dodd, Reedy, & Krebs-Smith, 2006; Vitolins et al., 2009), and many struggle with food intake regulation compounded by a history of dieting and weight cycling (Savoca & Miller, 2001; Savoca, Miller, & Quandt, 2004). Constant dieting and restrained eating can lead to feelings of dissatisfaction and dysphoric mood states (Herpertz et al., 2000). Therefore, novel approaches to treat the co-occurring problems of managing the stress of diabetes and appropriately managing body weight and food intake are needed.

Growing evidence suggests intervention techniques that enhance mindful self-awareness improve well-being, including anxiety and depression (Hofmann, Sawyer, Witt, & Oh, 2010), eating disorders (Wanden-Berghe, Sanz-Valero, & Wanden-Berghe, 2011), food cravings (Alberts, Mulkens, Smeets, & Thewissen, 2010), and weight loss (Dalen et al., 2010). Mindfulness-based stress reduction (Kabat-Zinn, 1990, 2005) and mindfulness-based interventions, in general, employ a systematic procedure for developing greater

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awareness of moment-to-moment experience of physical sensations, perceptions, affective states, and thoughts without judgment and has been applied to treating various medical issues (Grossman, Niemann, Schmidt, & Walach, 2004). Mindful eating includes awareness of physical hunger and satiety cues, environmental or emotional triggers to eat, and making healthier food choices. The Mindfulness-Based Eating Awareness Training (MB-EAT) program (Kristeller & Wolever, 2011) reduced episodes of overeating in obese individuals and improved eating regulation (Daubenmier et al., 2011; Kristeller & Hallett, 1999; Kristeller, Wolever, & Sheets, 2013).

Diabetes self-management education (DSME) is a necessary component of quality care for all people with diabetes. DSME helps patients develop the knowledge, skill, and ability necessary for effective self-care (Funnell et al., 2007). Previous diabetes programs that incorporated behavioral and psychosocial strategies for facilitating self-care achieved improved outcomes (Gary, Genkinger, Guallar, Peyrot, & Brancati, 2003). Furthermore, prior research found interventions based on theoretical models of change were effective in promoting behavioral change (Elder, Ayala, & Harris, 1999).

Although both DSME and MB-EAT offer promise as effective approaches for diabetes management, little research has compared the efficacy of DSME-based to mindfulness-based approaches in adults with T2DM. Therefore, the purpose of this study was to evaluate the impact of a DSME intervention compared with MB-EAT adapted for adults with T2DM. It was hypothesized the mindful eating intervention would facilitate greater food intake regulation than the DSME approach.

Method

Research Design

A prospective randomized controlled trial with two parallel interventions was employed. Participants were randomly assigned to treatment group, stratified by race. Computer randomization occurred after the collection of baseline data. Following randomization, participants proceeded through a 3-month intervention followed by a second round of data collection. Follow-up assessments occurred 1 and 3 months after the second data collection.

Participants

Eligibility criteria for participation included being age 35 to 65 years with physician diagnosed T2DM for ≥1 year, body mass index ≥ 27.0, glycosylated hemoglobin ≥ 7.0%, and not requiring insulin therapy. Individuals concurrently participating in a structured weight loss program or women who were pregnant or lactating were ineligible. Participants were recruited through local medical practices, the university newswire, radio and electronic advertisements, and community flyers. All procedures were approved by the institutional review board of the sponsoring institution, and the participants provided written, informed consent.

Diabetes Interventions

Each diabetes program followed a manualized intervention and included 8 weekly and 2 biweekly 2½ hour group sessions led by trained facilitators. A dietitian led all cohorts of the DSME intervention, and the same dietitian and a social worker with extensive training in mindful meditation co-led all cohorts of the MB-EAT intervention. Participant attendance was tracked, and if individuals missed a group session, they were encouraged to attend a make-up session. One- and 3-month follow-up sessions also were provided to facilitate maintenance of change.

MB-EAT for Diabetes (MB-EAT-D) is a variation of the intervention developed originally for binge eating disorder and obesity (Kristeller & Wolever, 2011). Mindful eating is a tool to cultivate attention to increase nonjudgmental awareness of internal experience and automatic patterns related to eating. The training is designed to help individuals interrupt "mindless" and stress-related eating and reengage the natural physiological processes of eating regulation. A primary component was mindfulness meditation and its application to eating. Every session included guided meditations oriented toward the experiences, thoughts, and feelings associated with food intake. Other elements included cultivating awareness between physical and emotional hunger cues, social pressures to eat, and preferences regarding food choices. Each participant received two CD-ROMs to guide their meditation practice. Participants were encouraged to meditate 6 days/week and to practice mini-mediations at other times to cultivate awareness of various experiences (e.g., hunger or stress). Components were presented as ways to cultivate "inner wisdom" (i.e., mindful awareness of inner experiences related to eating) and "outer wisdom" (i.e., personal use of knowledge of food/diabetes needs) as MB-EAT-D also included basic information regarding diet, physical activity, weight regulation, and glycemia; however, no specific diet or activity goals were provided.

The Smart Choices (SC) intervention is a behavioral DSME-based program. The SC intervention was based on social cognitive theory (SCT; McAlister, Perry, & Parcel, 2008) and the theory of meaningful learning (Ausubel, Novak, & Hanesian, 1978) designed to improve diabetes-related knowledge, outcome expectations, and self-efficacy for effective self-care. SC provided in-depth information regarding the effect of the type and quantity of carbohydrates and fats on blood glucose and lipid parameters; all participants received calorie, carbohydrate, and total fat goals. One session on physical activity was included and several sessions included a 15- to 20-minute walk. However, the study design intentionally deemphasized physical activity to maintain the focus on food intake across both conditions. A limited number of new concepts were presented during each SC group session to prevent "information overload" and facilitate meaningful learning. "Rules of thumb" for balancing carbohydrate and fat intake simultaneously and hands-on activities were included in each session to help participants apply concepts and successively build self-efficacy. Participants established self-set goals at the end of each session. Progress in meeting weekly goals and barriers to goal attainment were discussed during the following session. No information regarding mindful eating or meditation was presented.

The 90-minute 1- and 3-month follow-up sessions reviewed the key principles in each intervention, assessed participant progress in their change efforts, and addressed barriers to change. The MB-EAT-D follow-up sessions included meditation practice whereas the SC sessions included time for walking.

The principal investigator attended 20% of the group sessions at random to assess fidelity using a checklist of the predefined components of each intervention. Departures from the curriculums were discussed with facilitators after each session.

Measures

Weight was determined using an electronic scale (Tanita Corporation, Tokyo, Japan) with participants wearing light clothing and no shoes.

The valid 110-item Block 2005 Food Frequency Questionnaire (NutritionQuest, Berkeley, CA) was self-administered to assess usual intake (Block, Woods, Potosky, & Clifford, 1990; Mares-Perlman et al., 1993). Participants received a food portion visual to assist with estimating portions consumed; nine response options regarding frequency were included. Similar foods were grouped together and servings consumed were quantified for each food group (U.S. Department of Health and Human Services & U.S. Department of Agriculture, 2005) per 1,000 kcal to control for energy intake.

Since the SC intervention was based on SCT, diabetes-related knowledge, outcome expectations, and self-efficacy were assessed. A reliable and valid multiple choice instrument, which assessed knowledge regarding dietary sources of nutrients, the relation between nutrients and health, food label information, and diabetes meal planning, was administered (Miller & Achterberg, 1999). Each question included five response options with "not sure" as an option. Twenty items assessed declarative knowledge (i.e., knowledge regarding facts and objects), and 12 items assessed procedural knowledge (i.e., applying knowledge to solve problems).

An outcome expectations inventory was used to assess both positive (10 items) and negative (5 items) expectations regarding healthy food choices (e.g., "I can make healthy food choices by reading the amount of total fat on the food label."), glycemic control (e.g., "If I eat foods high in fiber, I will have better control of my blood glucose."), and quality of life (e.g., "If I eat a healthy diet, I will not be able to eat the foods I like when I eat out."). The inventory included 11-point response options (0 = *strongly disagree* to 10 = *strongly agree*); negatively stated items were reverse scored.

Self-efficacy is behavior specific and can vary across behaviors and contexts (Bandura, 1997). Therefore, an 18-item diabetes-specific nutrition self-efficacy questionnaire (Miller, Edwards, Kissling, & Sanville, 2002) was administered to assess promoters of diabetes self-management (e.g., "I can control the amount of total carbohydrate I eat each day.") and barriers to self-management (e.g., "I cannot determine the amount of carbohydrate to eat based on my blood glucose level."). The questionnaire included 11-point response options (0 = *strongly disagree* to 10 = *strongly agree*); negatively stated items were reverse scored.

The MB-EAT-D intervention was designed to minimize overeating. Therefore, the 25-item Eating Self-Efficacy Scale was administered to assess difficulty in controlling overeating in various situations (e.g., when angry, when preparing food; Glynn & Ruderman, 1986). Response options ranged from 1 (*no difficulty*) to 7 (*most difficulty controlling eating*).

The MB-EAT-D intervention also was designed to reduce inattentive eating and overeating. The Three-Factor Eating Questionnaire (TFEQ) was administered to assess cognitive control of food intake, susceptibility to nonphysical hunger, and disinhibition of control (Stunkard & Messick, 1985). The original questionnaire consists of 36 true/false items and 15 forced-choice items. One item from the disinhibition factor ("When I am with someone who is overeating, I usually overeat too.") was inadvertently omitted in this study. Thus, the restraint/cognitive control score was calculated from 21 items, disinhibition from 15 items, and hunger from 14 items.

Anxiety and depression can be triggers for overeating. Mindfulness approaches were shown to be effective in reducing these symptoms (Hofmann et al., 2010). The 21-item Beck Anxiety Inventory measures symptoms of anxiety during the previous week (Beck, Brown, Epstein, & Steer, 1988). The 21-item Beck Depression Inventory–II measures severity of depressive symptoms in the previous 2 weeks (Beck, Steer, Ball, & Ranieri, 1996). Both inventories use 4-point response scales with a total score ranging from 0 to 63.

The Five-Facet Mindfulness Questionnaire, a measure sensitive to mindfulness in the general population, was administered to assess the effects of the interventions to increase the capacity to engage mindfulness during a wide range of daily experiences (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006). The instrument includes five subscales: nonreactivity to inner experience (7 items); observing sensations, thoughts, and feelings (8 items); acting with awareness (8 items); describing with words (8 items);

and nonjudging (8 items). Response options ranged from 1 (*never or very rarely true*) to 5 (*very often or always true*).

Statistical Methods

The Fisher exact test or two-sample *t* test compared between-group differences in participant characteristics at baseline. A mixed-effect ANOVA model compared change in outcome measures across time and used REML (restricted maximum likelihood) analysis. Contrast analysis was used to evaluate between-group differences in outcomes; corrections for multiple comparisons were made using the Bonferroni method. The time-by-group interaction effect assessed group differences in outcome changes across time. Change in outcomes from baseline to immediate postintervention and the change from baseline to the 3-month follow-up assessment are presented. Change in outcomes from baseline to the 1-month follow-up assessment are not presented since they are similar to the 3-month follow-up results. Participants with at least two observed measures were included in the analyses. There were few missing values (≤9%); the analyses did not impute data except for the TFEQ, where missing values were imputed by the first observed value.

Since significant changes occurred for fruit and vegetable intake and weight control, we examined relationships among these and psychosocial outcomes. Pearson correlations were computed to determine the association between the change from baseline to study end in potential mediators (e.g., factors from TFEQ, eating self-efficacy, and mindfulness) and the change from baseline to study end for weight and fruit and vegetable consumption for all participants combined.

Power analysis for the primary outcome weight change (power = .80; 2-tailed $\alpha = .05$) based on a previous nutrition intervention for T2DM indicated that 29 people per treatment group were needed to detect a 2.7 kg difference between groups (Gutschall, Miller, Mitchell, & Lawrence, 2009). All analyses were completed using SAS JMP version 9.0 (SAS Institute Inc., Cary, NC).

Results

Four hundred fifty people inquired about the study. Forty-four did not respond to repeated contact and 406 were assessed for eligibility. Of those, 245 did not meet inclusion criteria and 93 declined to participate. Thirty-two participants were randomized to MB-EAT-D; 27 received the allocated intervention and completed data collection. Thirty-six were randomized to SC; 25 received the allocated intervention and completed data collection. There was no significant difference in attrition between treatment groups ($p > .05$), and there were no significant differences in baseline participant characteristics between those who did and did not complete the study (all $p > .05$). There also were no significant differences in demographic characteristics between treatment groups (Table 1) or between treatment groups at baseline on outcome variables except for hunger susceptibility on the TFEQ scale (Table 2).

Comparison of the Change in Outcomes Between Groups

There was no significant difference between groups with regard to the change in weight at study end (Table 2). The weight loss findings have been discussed in more detail elsewhere (Miller, Kristeller, Headings, Nagaraja, & Miser, 2012). The relation among potential mediators of weight change is presented in Table 3.

There was no significant difference between groups in the change in dietary intake across food groups. However, there was a significant increase in servings/1,000 kcal of fruits and vegetables for the SC group (all $p < .01$; Table 2). The change from baseline to study end in diabetes and nutrition-related knowledge and mindful observing were significantly different between treatment groups (all $p < .05$). The SC group reported greater increase in knowledge and efficacious beliefs in reducing barriers to diabetes self-management than the MB-EAT-D group (data not shown), whereas the MB-EAT-D group reported greater increase in observing daily experiences than the SC group.

Change in Outcomes for Each Treatment Group

Significant increases were observed at both the immediate postintervention and 3-month follow-up periods in knowledge, outcome expectations, and nutrition and eating-related self-efficacy scores in both groups (all $p < .0001$). Both groups reported significant increase in cognitive control of eating and significant decrease in disinhibition of control (all $p < .001$). The SC group reported significant decrease in hunger susceptibility ($p < .001$). Both groups experienced significant reduction in depressive symptoms at study end, and the SC group experienced significant reduction in anxiety postintervention and at study end (all $p < .01$). A significant increase in mindful observing and in nonjudging scores were obtained in the MB-EAT-D group, whereas a significant increase in describing scores were obtained for the SC group (all $p < .01$) at study end. There was no significant change in acting with awareness or mindful nonreactivity for either group over time.

Relationships Among the Change in Outcomes

Correlational analyses found the change in body weight was significantly associated with the change in self-efficacy for overcoming barriers to self-management, cognitive control, disinhibition of control, hunger, and eating self-efficacy (all $p < .05$; Table 3). Improvement in diabetes knowledge, outcome expectations, self-efficacy regarding promoters of diabetes management, and cognitive restraint were significantly associated with increased fruit consumption (all $p < .05$). In

Table 1. Demographic and Diabetes Characteristics of Participants at Baseline.

Characteristic	MB-EAT-D[a] (n = 27) %	Smart Choices (n = 25) %	p
Female	63.0	64.0	1.00
Caucasian	81.5	72.0	.52
Married	66.7	68.0	1.00
Bachelor's degree or higher	48.2	60.0	.42
Employed full-time	77.8	84.0	.73
Household income ≥$60,000/year	51.9	63.6	.56
Received previous diabetes education	65.4	80.0	.20
Self-monitor blood glucose	69.2	76.0	.76
Want more information about overall diabetes care	63.0	62.5	1.00
	Mean ± *SD*	Mean ± *SD*	p
Age (years)	53.9 ± 8.2	54.0 ± 7.0	.94
Diagnosed with diabetes (years)	6.9 ± 3.9	5.9 ± 3.4	.31

[a]Mindfulness-Based Eating Awareness Training for Diabetes (MB-EAT-D) group.

contrast, the change in diabetes knowledge, disinhibition of control, susceptibility to hunger, eating self-efficacy, and mindful observing were significantly associated with the change in vegetable consumption (all $p < .05$).

Discussion

The findings from this study demonstrate that both the MB-EAT-D and SC interventions were effective in improving some outcomes. Despite no significant difference between groups in weight loss, both groups lost weight. Participants reported significant improvements following treatment in diabetes-related knowledge, outcome expectations, and self-efficacy; cognitive control and disinhibition of control regarding eating behaviors; and symptoms of depression. Furthermore, these changes were maintained for up to 3 months.

SC participants also reported significant increase in fruit and vegetable consumption. Higher consumption of fruits and vegetables has been shown to be potentially protective against coronary heart disease, stroke, obesity, and certain cancers (Ness & Powles, 1997; Steinmetz & Potter, 1996). In this study, consumption of fruits at baseline was similar to the mean intake of 1.0 serving/day in the 2000 Behavioral Risk Factor Surveillance Study (BRFSS), whereas baseline consumption of vegetables was greater than the mean intake of 2.02 servings/day in the BRFSS (Serdula et al., 2004). The SC intervention focused on making healthy food choices and discussed the benefits of consuming fruits and vegetables; SC participants increased consumption of these foods. The MB-EAT-D intervention focused on savoring food in smaller quantities and did not emphasize consumption of specific foods. Thus, MB-EAT-D could be enhanced by adding more specific dietary recommendations consistent with diabetes management.

The SC group also had greater gain in diabetes-related knowledge and self-efficacy. The SC intervention followed principles from learning theory and instructional design, included in-depth information regarding the nutritional management of diabetes, presented the information in meaningful "chunks" by limiting the amount of new material presented, and successively built on material presented and skills developed during preceding sessions. Only basic concepts regarding the nutritional management of diabetes were presented during MB-EAT-D by design to focus on the mindfulness training. Therefore, these results are consistent with the objectives of each intervention.

Moreover, participants in both groups reported greater ability to minimize overeating in various situations based on Eating Self-Efficacy scores. Findings from the TFEQ confirmed participants in both groups expressed greater cognitive control of their eating and less disinhibited eating behavior. Baseline scores on the TFEQ were similar to pretreatment scores of women seeking weight loss treatment previously (Foster et al., 1998). Prior research found that higher cognitive restraint scores among overweight individuals were associated with greater weight loss and maintenance of weight loss (Foster et al., 1998; Keranen et al., 2009), whereas eating beyond satiety (high disinhibition) was associated with greater body weight and obesity (Bryant, Kiezebrink, King, & Blundell, 2010; Dykes, Brunner, Martikainen, & Wardle, 2004; Keranen, Strengell, Savolainen, & Laitinen, 2011). Correlational findings from the current study are consistent with these prior reports. Impulsivity, or acting without thinking, was associated with higher scores on the disinhibition scale (Yeomans, Leitch, & Mobini, 2008), suggesting a tendency to act impulsively is associated with a tendency to overeat. Training in mindful eating and the SC goal-based approach both raised conscious control of eating behaviors and reduced perceptions of uncontrolled eating in this study.

Table 2. Mean (±*SE*) Outcomes at Baseline and Change in Outcomes Across Time for the MB-EAT-D[a] ($n = 27$) and Smart Choices ($n = 25$) Treatment Groups.

Baseline Values	Weight (kg)	Energy (kcal)	Vegetables (Servings/1,000 kcal)[b]	Fruits and Fruit Juices (Servings/1,000 kcal)	Grains (Servings/1,000 kcal)	Meat, Fish, Poultry, Eggs (Servings/1,000 kcal)[b]
MB-EAT-D	106.04 (±3.66)	1,851 (±129)	3.08 (±0.45)	0.84 (±0.10)	5.60 (±0.68)	2.54 (±0.25)
Smart Choices	103.38 (±3.80)	2,019 (±131)	3.97 (±0.60)	1.20 (±0.21)	5.53 (±0.60)	2.76 (±0.32)
p Value[c]	.6169	.3628	.1663	.1588	.7932	.8666
Change Score at immediate postintervention[d]						
MB-EAT-D	−1.78 (±0.54), $p = .0012$	−298 (±109), $p = .0068$	0.24 (±0.28), $p = .0224$	0.27 (±0.14), $p = .0493$	−0.03 (±0.19), $p = .8903$	0.06 (±0.09), $p = .7203$
Smart Choices	−3.25 (±0.57), $p < .0001$	−574 (±114), $p < .0001$	0.80 (±0.29), $p = .0035$	0.38 (±0.14), $p = .0095$	−0.37 (±0.20), $p = .0703$	0.10 (±0.10), $p = .3360$
Change score at 3-month follow-up[d]						
MB-EAT-D	−1.53 (±0.54), $p = .005$	−490 (±109), $p < .0001$	0.04 (±0.28), $p = .1603$	0.20 (±0.14), $p = .1552$	−0.19 (±0.19), $p = .3417$	0.24 (±0.09), $p = .0346$
Smart Choices	−2.92 (±0.54), $p < .0001$	−682 (±111), $p < .0001$	0.65 (±0.28), $p = .0019$	0.46 (±0.14), $p = .0013$	−0.49 (±0.20), $p = .0126$	0.07 (±0.10), $p = .4278$
p Value[e]	.0728	.2198	.2047	.1789	.2639	.3560

Baseline Values	Dairy (Servings/1,000 kcal)[b]	Fats/Oils, Sweets, Soda (Servings/1,000 kcal)	Diabetes and Nutrition Knowledge Score[f]	Nutrition Outcome Expectations[g]	Nutrition and Diabetes Self-Efficacy[g]	Eating Self-Efficacy[h]
MB-EAT-D	1.25 (±0.17)	3.12 (±0.28)	14.73 (±1.03)	7.08 (±0.19)	7.33 (±0.24)	4.17 (±0.24)
Smart Choices	1.18 (±0.15)	3.19 (±0.35)	13.72 (±1.05)	6.98 (±0.20)	7.05 (±0.25)	4.31 (±0.25)
p Value[c]	.5918	.3849	.4959	.7074	.4236	.6808
Change score at immediate postintervention[d]						
MB-EAT-D	0.02 (±0.08), $p = .8199$	−0.04 (±0.13), $p =.7566$	6.82 (±0.83), $p < .0001$	1.35 (±0.20), $p < .0001$	1.68 (±0.26), $p < .0001$	−1.03 (±0.20), $p < .0001$
Smart Choices	0.06 (±0.08), $p = .8416$	0.05 (±0.14), $p = .7006$	8.49 (±0.88), $p < .0001$	1.45 (±0.22), $p < .0001$	1.99 (±0.28), $p < .0001$	−1.05 (±0.22), $p < .0001$
Change score at 3-month follow-up[d]						
MB-EAT-D	0.0 (±0.08), $p = .7262$	0.12 (±0.13), $p = .3571$	5.74 (±0.84), $p < .0001$	1.32 (±0.20), $p < .0001$	1.27 (±0.26), $p < .0001$	−1.01 (±0.20), $p < .0001$
Smart Choices	0.09 (±0.08), $p = .6558$	0.20 (±0.14), $p = .1497$	8.27 (±0.84), $p < .0001$	1.61 (±0.21), $p < .0001$	1.85 (±0.26), $p < .0001$	−1.06 (±0.20), $p < .0001$
p Value[e]	.5732	.6987	.0352	.3150	.1204	.8636

(continued)

Table 2. (continued)

Baseline Values	TFEQ Cognitive Control/Restraint[i]	TFEQ Disinhibition of Control[i]	TFEQ Hunger Susceptibility[i]	BDI Depressive Symptoms[j,k]	BAI Anxiety Symptoms[j]
MB-EAT-D	8.26 (±0.76)	8.37 (±0.64)	5.29 (±0.59)	10.11 (±1.74)	6.70 (±1.27)
Smart-Choices	7.44 (±0.79)	8.56 (±0.66)	7.99 (±0.61)	11.12 (±1.81)	7.72 (±1.32)
p Value[c]	.4559	.8365	.0021	.8133	.5817
Change score at immediate postintervention[d]					
MB-EAT-D	5.18 (±0.72), $p < .001$	−2.18 (±0.55), $p < .001$	−1.30 (±0.52), $p = .0144$	−2.91 (±1.17), $p = .0161$	−1.27 (±1.01), $p = .5817$
Smart Choices	6.93 (±0.77), $p < .001$	−2.95 (±0.59), $p < .001$	−3.50 (±0.56), $p < .001$	−3.99 (±1.26), $p = .0385$	−2.38 (±1.08), $p = .0300$
Change score at 3-month follow-up[d]					
MB-EAT-D	5.26 (±0.72), $p < .001$	−2.47 (±0.56), $p < 0.001$	−1.31 (±0.53), $p = 0.0151$	−3.37 (±1.17), $p = 0.0021$	−1.22 (±1.01), $p = 0.2310$
Smart Choices	6.08 (±0.72), $p < .001$	−2.40 (±0.56), $p < .001$	−2.21 (±0.54), $p < .001$	−5.00 (±1.19), $p = .0016$	−2.84 (±1.02), $p = .0062$
p Value[e]	.4239	.9277	.2412	.9400	.2598

Baseline Values	FFMQ Observing	FFMQ Describing	FFMQ Acting With Awareness	FFMQ Nonjudging	FFMQ Nonreactivity	Total FFMQ Score[l]
MB-EAT-D	3.33 (±0.12)	3.45 (±0.17)	3.32 (±0.15)	3.44 (±0.17)	3.34 (±0.12)	3.38 (±0.11)
Smart Choices	3.49 (±0.13)	3.44 (±0.17)	3.53 (±0.16)	3.72 (±0.18)	3.24 (±0.13)	3.50 (±0.11)
p Value[c]	.3577	.9677	.3478	.2605	.5785	.4486
Change score at immediate postintervention[d]						
MB-EAT-D	0.30 (±0.12), $p = .0144$	0.20 (±0.11), $p = .0683$	0.09 (±0.13), $p = .4855$	0.37 (±0.13), $p = .0075$	0.04 (±0.11), $p = .7456$	0.19 (±0.08), $p = .0139$
Smart choices	0.02 (±0.13), $p = .8690$	0.11 (±0.12), $p = .3761$	0.08 (±0.14), $p = .5582$	0.17 (±0.14), $p = .2528$	0.14 (±0.12), $p = .2158$	0.09 (±0.08), $p = .2498$
Change score at 3-month follow-up[d]						
MB-EAT-D	0.38 (±0.12), $p = .0020$	0.21 (±0.11), $p = .0604$	0.29 (±0.13), $p = .0228$	0.39 (±0.13), $p = .0049$	0.19 (±0.11), $p = .1035$	0.29 (±0.08), $p = .0002$
Smart Choices	0.05 (±0.12), $p = .6916$	0.34 (±0.11), $p = .0025$	0.31 (±0.13), $p = .0169$	0.17 (±0.14), $p = .2163$	0.06 (±0.11), $p = .6115$	0.16 (±0.08), $p = .0327$
p Value[e]	.0135	.3926	.9202	.2613	.4309	.2511

[a]Mindfulness-Based Eating Awareness Training for Diabetes (MB-EAT-D) group. [b]p values are based on the comparison of means using log(x). [c]Student t test within an ANOVA for between-group comparison at baseline; p value < .05 used for statistical significance. [d]p value < .0125 used for statistical significance to account for the Bonferroni correction of the 4 comparisons for the within-group changes from baseline to immediate postintervention and from baseline to 3-month follow-up. [e]Student t test within an ANOVA to compare the between-group change from baseline to 3-month follow-up; p value < .05 used for statistical significance. [f]For the knowledge test, 20 points were possible for declarative knowledge and 12 points were possible for procedural knowledge for a total score of 32 possible points. [g]For outcome expectations and nutrition self-efficacy, response options ranged from 1 = *strongly disagree* to 10 = *strongly agree*. [h]For eating self-efficacy, response options ranged from 1 = *no difficulty controlling eating* to 7 = *most difficulty controlling eating*. [i]Factor from the Three-Factor Eating Questionnaire (TFEQ) in which response options included "true" or "false" for Part I of the questionnaire and a 4-point Likert-type scale for Part II of the questionnaire. [j]For the Beck Depression Inventory (BDI) and Beck Anxiety Inventory (BAI), response options ranged from 0 to 3; higher scores indicate greater symptomatology. [k]p Values are based on the comparison of means using log(1 + x). [l]For the Five-Facet Mindfulness Questionnaire (FFMQ), response options ranged from 1 = *never or very rarely true* to 5 = *very often or always true*.

Table 3. Pearson Correlations Among the Change in Potential Behavioral Mediators and Change in Fruit and Vegetable Intake and Body Weight From Baseline to 3-Month Follow-Up for All Participants Combined.

Change in Outcome	Body Weight (kg)	Fruits and Fruit Juices (Servings/1,000 kcal)	Vegetables (Servings/1,000 kcal)
Diabetes and nutrition total knowledge score	−0.17	0.42**	0.28*
Nutrition outcome expectations positive	−0.15	0.28*	0.04
Nutrition outcome expectations negative	−0.03	0.35**	0.25
Nutrition self-efficacy regarding promoters of diabetes self-management	0.08	0.41**	0.17
Nutrition self-efficacy regarding barriers to diabetes self-management	−0.38**	0.25	0.15
Negative affect	0.30*	0.09	−0.37**
Socially acceptable circumstances	0.58***	0.05	−0.35**
TFEQ cognitive control/restraint regarding eating behaviors	−0.28*	0.29*	0.04
TFEQ disinhibition of control regarding eating behaviors	0.36**	−0.21	−0.38**
TFEQ hunger susceptibility	0.39**	−0.28	−0.34*
Five-Facet Mindfulness Questionnaire Observing	0.03	−0.20	−0.30*
Five-Facet Mindfulness Questionnaire Describing	0.01	0.11	−0.25
Five-Facet Mindfulness Questionnaire Awareness	−0.24	0.19	−0.01
Five-Facet Mindfulness Questionnaire Nonjudging	−0.15	0.05	−0.04
Five-Facet Mindfulness Questionnaire Nonreactivity	−0.18	0.22	−0.09

Note. TFEQ = Three-Factor Eating Questionnaire.
*$p \leq .05$. **$p \leq .01$. ***$p \leq .001$.

Findings from the Five-Facet Mindfulness Questionnaire (FFMQ) revealed a significant increase in mindful observing and nonjudging for the MB-EAT-D group, consistent with the focus of the intervention. Mindful eating includes the practice of observing thoughts and feelings regarding food without judgment and without attempting to change, avoid, or react to the sensations (Kristeller & Wolever, 2011). Instead, the practice includes observing the sensations associated with hunger and food cravings, disengaging from ruminative thoughts about food, and maintaining control when exposed to food cues. The MB-EAT-D group maintained or increased changes on the FFMQ. At study end, a significant increase in describing was observed for the SC group. Participation in an intensive intervention, which includes group discussion about goal attainment and problem solving, may account for the change in describing for these participants. Additional research is needed to evaluate the potential mechanisms of action in mindfulness training for diabetes self-management and the long-term impact of such training.

Correlational analyses was conducted to further explore determinants of eating behaviors and revealed potentially different determinants for fruit intake than for vegetable intake. Constructs from SCT and cognitive restraint were positively associated with the change in fruit intake, whereas mindful observing, eating self-efficacy, hunger susceptibility, and disinhibition of control were negatively associated with the change in vegetable intake. Prior mediational analyses found nutrition-related knowledge and self-efficacy were predictors of the combined intake of fruits and vegetables (Campbell et al., 2008; Shaikh, Yaroch, Nebeling, Yeh, & Resnicow, 2008). These findings are consistent with the findings for fruit intake in the present study. However, few studies have examined predictors of the change in fruit versus vegetable intake. The current findings suggest vegetable intake improves with decreases in distorted hunger experiences but decreases when overeating in response to social and emotional triggers. Future research with the appropriate sample size and formal mediational analyses is needed to confirm these findings and whether predictors for fruit intake differ from vegetable intake.

Although the present findings are promising, some limitations should be noted. First, the sample had limited racial and ethnic diversity; replication of the study with larger and more diverse populations is desirable. Second, we did not screen individuals for severe psychopathology or cognitive impairment prior to study enrollment. Although we are not aware of anyone enrolled in the study with a disorder, nor was evidence of these disorders exhibited during the study, future studies may want to screen individuals for these conditions. Third, 24% of participants enrolled in the study withdrew prior to completing the interventions. Other studies experienced similar rates of attrition from group-based diabetes interventions (Sperl-Hillen et al., 2011; Weinger et al., 2011). The study required a significant time commitment with a predefined group schedule. Of the 16 participants who withdrew, 7 withdrew due to scheduling conflicts and competing time demands. Finally, the impact of the MB-EAT-D and SC interventions beyond 3 months is not known; future research should evaluate the long-term impact on outcomes.

Implications for Practice

Diabetes patients may benefit from both training in mindful eating and DSME. The availability of both treatment approaches offers patients choices in meeting their self-care needs. Practitioners should assess patients' diabetes-related knowledge, outcome expectations, self-management skills and efficacy beliefs, previous education received, and individual interests, and then help patients identify whether they would benefit more from a DSME approach or a mindful approach to eating behaviors. Since both educational approaches require multiple sessions, patients might benefit from a DSME-based intervention prior to engaging in training for mindful eating to obtain the foundational knowledge and skills for effective diabetes self-care (e.g., the relationship between carbohydrate intake and postprandial glucose responses, goal setting, self-monitoring). Mindful eating may be an effective tool for helping patients regulate eating behaviors and body weight in the long term throughout the course of the disease. Eating in response to physiological cues to eat rather than environmental or emotional cues to eat may help patients sustain healthy eating patterns. A logical sequence for education and training may be DSME-based education first followed by mindfulness training to offer educational sessions in a reasonable time period. However, additional research is needed to support this assumption. The acquisition of effective self-management behaviors and a mindful perspective toward eating requires commitment and practice and patients need ongoing support. Diabetes education programs could incorporate training in mindful eating to supplement educational programs and as a means of providing continuing support.

Authors' Note

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