Original Manuscript

SOUTHERN GERONTOLOGICAL SOCIETY

Journal of Applied Gerontology
2025, Vol. 0(0) 1–13

DOI: 10.1177/07334648251395792
journals.sagepub.com/home/jag
Sage

The Effectiveness of a Mindfulness-Based Healthy Lifestyle Program for Older Adults With Type 2 Diabetes

Chun-Chin Tsai[1], Hui-I Yu[2], and Mei-Fang Chen[3]

Abstract

Objective: This study evaluated the effectiveness of a mindfulness-based healthy lifestyle program in improving diabetes-related outcomes among older adults with type 2 diabetes.

Methods: A quasi-experimental study recruited 82 older adults with type 2 diabetes from two hospitals in southern Taiwan. Participants chose either the intervention or control group. The experimental group underwent an 8-week mindfulness-based healthy lifestyle program that integrated diet/exercise board games (external wisdom) and mindfulness practices (internal wisdom). The control group received usual diabetes care. Outcome measures—symptom distress, emotional distress, interpersonal communication, self-management behavior, and HbA1C—were assessed at baseline (T0), post-intervention (T1), and 3 months later (T2).

Results: Generalized estimating equation analysis revealed that the experimental group demonstrated significantly greater improvements in interpersonal communication, self-management behaviors, and HbA1C from T0 to T1 and T0 to T2 compared to the control group.

Conclusion: The results support integrating mindfulness and gamified education into diabetes care for older adults.

Keywords

mindfulness, lifestyle, older adults, board games, diabetes

Received: 19 June 2025; revised: 22 September 2025; accepted: 21 October 2025

What This Paper Adds

- A mindfulness-based healthy lifestyle program was developed for older adults with diabetes.
- The program integrated external wisdom (diet and exercise board games) with internal wisdom (a unified mind–body experience of diet and exercise).
- The program improved emotional distress, interpersonal communication, self-management, and HbA1c in older adults with diabetes.

Applications of Study Findings

- Integrating mindfulness with gamified education can significantly improve self-care behaviors, interpersonal communication, and glycemic control among older adults with type 2 diabetes.
- The program can be adapted for use in community centers, senior care facilities, and geriatric clinics to support holistic and engaging chronic disease management.

[1]Department Semiconductor and Electro-Optical Engineering, Southern Taiwan University of Science and Technology, Tainan, Taiwan
[2]Department of Endocrinology and Metabolism, Ditmanson Medical Foundation Chiayi Christian Hospital, Chiayi, Taiwan
[3]Department of Nursing, National Tainan, Junior College of Nursing, Tainan, Taiwan

Corresponding Author:
Mei-Fang Chen, Department of Nursing, National Tainan, Junior College of Nursing, 78, Sec. 2, Min-Tsu Rd, Tainan 700, Taiwan.
Emails: 38914003@yahoo.com.tw, meifang0302@gmail.com

Introduction

A healthy lifestyle is essential for promoting the well-being of older adults with diabetes, as it can improve their physical, mental, and social quality of life (Assar et al., 2019; Brown et al., 2019). Although diet, exercise, and medication adherence are fundamental to diabetes care, older adults often struggle to sustain diet and exercise behaviors (Assar et al., 2019; Wu et al., 2019). In Taiwan, over 20% of individuals aged 65 and above have diabetes, and poor lifestyle habits increase the risk of functional impairment, cardiovascular disease, stroke, nephropathy, retinopathy, and amputations, and are associated with a 10% higher mortality rate (Cho et al., 2018; Forbes, 2020). These challenges affect quality of life, and place strain on the families and healthcare resources.

There are four key barriers to adopting a healthy lifestyle. First, overly restrictive health education, which emphasizes rules rather than balance, making adherence unsustainable (Kristeller & Bowman, 2015). Second, a lack of mindful eating and exercise, such as distracted eating or improper physical activity, leading to ineffective results and low motivation (Fonseca et al., 2024; Tsai et al., 2024a). Third, failure to recognize body signals such as hunger, satiety, or fatigue, causing over- or under-eating and insufficient or excessive exercise (Brown et al., 2019; Kristeller & Bowman, 2015). Fourth, difficulty in changing habits, as cognitive decline and vision impairment make it harder to absorb health information (Fonseca et al., 2024). Mindfulness-based interventions offer a non-invasive and safe approach to addressing these issues. By enhancing self-awareness, older adults can avoid unhealthy habits, accept their condition without judgment, and improve self-management (Hsu et al., 2019). Unlike conventional education, mindfulness does not impose strict rules but instead fosters an understanding of physical needs and the environment, empowering individuals to make healthier choices (Wu et al., 2019). Thus, healthcare professionals can incorporate mindfulness to help older adults develop a sustainable healthy lifestyle, enhancing well-being and preventing complications.

Mindfulness-based interventions include Mindfulness-Based Stress Reduction (MBSR), Mindfulness-Based Cognitive Therapy (MBCT), Acceptance and Commitment Therapy (ACT), Mindful Eating Awareness Training (MB-EAT), and Mindfulness Sport Performance Enhancement (MSPE). Early intervention research predominantly focused on MBSR and MBCT, but these approaches demonstrated limited effects on physiological outcomes such as HbA1c in diabetes management, thereby prompting the development of more targeted programs addressing lifestyle-specific domains (Loucks et al., 2016).

MB-EAT was developed by Jean Kristeller in 1999 and is based on MBSR and Cognitive Behavioral Therapy (CBT), and it was designed to support individuals struggling with eating disorders. MB-EAT integrates mindfulness into the eating experience, addressing aspects such as body image, weight perception, and dietary habits. Key components of mindful eating training include emotional regulation, behavioral adjustment, and cognitive awareness. Through mindfulness, MB-EAT enhances awareness of automatic eating behaviors, aids in emotional regulation, and promotes conscious eating practices such as recognizing hunger cues, satiety, taste satisfaction, and emotional responses to food (Miller, 2017). MSPE was developed by sport psychologist Dr Keith Kaufman and colleagues to integrate mindfulness into athletic performance, adapting MBSR and MBCT, which are effective for stress and emotional regulation, to meet the unique attentional and competitive demands of athletes (Kaufman et al., 2018). MSPE is a structured 4-week group program in which athletes participate in weekly 2.5 to 3-hour sessions, practicing mindfulness strategies to enhance their focus and performance. Mindful movement is a core component, encouraging participants to cultivate present-moment awareness of bodily sensations, posture, and breath while engaging in activity. For example, mindful walking invites individuals to focus on the sensory experience of each step—the pressure of the feet against the ground, the rhythm of leg movement, and the shifting of body weight—thereby strengthening the ability to sustain focus and regulate attention regardless of pace (Hu et al., 2017; Huang, 2019; Kabat-Zinn, 2003). Taken together, MB-EAT and MSPE illustrate how mindfulness can be adapted to both dietary and exercise behaviors, which require the integration of external wisdom and internal wisdom (Kristeller & Bowman, 2015). This integration offers a holistic mind–body framework that supports sustainable self-management and health promotion (Kristeller & Bowman, 2015; Tsai et al., 2024b).

The effectiveness of mindfulness interventions for diabetes management can be categorized into four key areas: internal transformation, external environmental changes, behavioral modification, and health improvement. (1) Internal Transformation – Diabetes often involves distressing symptoms such as fatigue, pain, and blurred vision, which can contribute to emotional challenges such as depression, anxiety, and reduced self-esteem (Wu et al., 2019). Mindfulness fosters present-moment awareness, encouraging acceptance of bodily sensations while reducing automatic negative thoughts, thereby alleviating depressive and anxious symptoms (Huang et al., 2019; Nyklíček et al., 2016). (2) External Environmental Changes – Diabetes-related challenges can strain communication with family, friends, and healthcare providers, affecting self-management and glycemic control (Speight et al., 2021). Mindfulness practices emphasizing kindness and gratitude have been shown to improve interpersonal relationships by fostering active listening, empathy, and mutual understanding (Hsu et al., 2019). (3) Behavioral Modification – Mindfulness enhances bodily awareness, reduces binge eating, and promotes healthier dietary and exercise behaviors (Cox et al., 2016; Medina et al., 2017). Through self-awareness and non-judgmental acceptance, individuals are better equipped to make healthier lifestyle choices and sustain long-term adherence to beneficial behaviors. (4) Health Improvement – Glycated hemoglobin (HbA1c) is a key physiological indicator in diabetes management, with a target level of <7.0% (Wang et al., 2018). Mindfulness has been linked to reduced cortisol levels, which may positively impact physiological markers (Eddy et al., 2019). In summary, mindfulness-based interventions enhance diabetes self-management by addressing emotional well-being, interpersonal relationships, behavioral modifications, and physiological outcomes, ultimately promoting holistic health.

Most mindfulness-based interventions have targeted single behaviors, such as eating or exercise, leaving a gap in addressing the integrative approach required for effective diabetes management and in better reflecting real-life needs. Moreover, external wisdom—defined as diabetes-related knowledge—can be difficult for older adults to retain, particularly given the limitations of traditional educational methods (e.g., pamphlets, posters, and videos), which are often rigid and less engaging (Kristeller & Bowman, 2015). Evidence suggests that educational board games enhance learning outcomes and engagement among older adults, positioning them as a promising strategy for health education (Tsai et al., 2025). Building on prior literature (Hsu et al., 2019; Tsai et al., 2023), we developed the Mindful Healthy Lifestyle Program, an integrative intervention that combines external wisdom (diet and exercise board games) with internal wisdom (a unified mind–body experience of diet and exercise) within a structured three-phase framework. This study aimed to describe and evaluate the effectiveness of this program in improving self-management behaviors and health outcomes among older adults with type 2 diabetes in Taiwan.

Methods

Study Design, Sampling and Procedure

This study was a quasi-experimental study based on an intervention–control design. It was performed from October 2022 to July 2023. Patients with type 2 diabetes were recruited by convenience sampling from the endocrinology clinics of two hospitals in Southern Taiwan. The inclusion criteria were (1) diagnosis with type 2 diabetes, (2) clear mental status and ability to communicate, (3) age over 65 years, (4) literate and able to write in Chinese, (5) independent and able to perform self-care, and (6) HbA1c level higher than 8% during the previous 3 months. Individuals who had previously received mindfulness interventions or attended mindfulness courses were excluded from the study.

Physicians screened potential participants for eligibility and explained the purpose and procedures of the study to them. Eligible patients who agreed to participate were then referred to the researchers. The researchers informed the participants that the study was voluntary, that their decision to participate would not affect their treatment, and that they could withdraw from the study at any time. Each participant gave written informed consent before the intervention, and they were then assigned to either the control group or experimental group based on their preference.

G*Power (Germany; version 3.1.1) software was used to estimate the required sample size (Fual, Erdfelder, Lang, & Buchner, 2007). In the pilot 6-month study, the effect size of the mindfulness intervention on HbA1c was found to be 0.65. Therefore, the effect size was set at 0.65, with an α level of 0.05 and a power of 0.8. The final calculated total sample size was 60 participants. Considering a 20% attrition rate, at least 72 participants needed to be recruited, with a minimum of 36 participants per group.

Mindful Healthy Lifestyle Program

Development. The Mindful Healthy Lifestyle Program was developed by physicians, physical education teachers, nutritionists, and mindfulness instructors based on relevant literature (Knol et al., 2020; Tsai et al., 2023), and clinical expertise. The program was designed to promote self-management and health awareness in older adults with type 2 diabetes by integrating external wisdom (diet and exercise board games) and internal wisdom (mindful eating and movement behaviors).

Three-phase Five-step Approach of the Mindful Healthy Lifestyle Program. The program is centered around a three-phase framework of Self-awareness, Practicing, and Adjusting & Keeping, which is then further classified into five steps, termed the SMILE model (Figure 1).

The Self-awareness phase includes the first two steps of the SMILE model, Starting and Motivating, which focus on cultivating present-moment awareness and recognizing behavioral influences. (1) Starting enhances present-moment awareness through body scanning, muscle relaxation, hunger and satiety awareness, and the raisin exercise. (2) Motivating encourages individuals to identify behavioral influences, including emotional and environmental factors, fostering awareness of habitual patterns. The Practicing phase includes the second two steps of the SMILE model, Individual and Learning, aimed at integrating mindfulness into daily life. (3) Individual strengthens personal mindfulness beliefs through mindful breathing, self-acceptance, and self-compassion. (4) Learning applies mindfulness strategies through dietary and exercise-related board games, mindful movement, and mindful eating practices. The Adjusting & Keeping phase includes the final step of the SMILE model, Evaluating, which supports long-term behavior change and self-regulation. (5) Evaluating promotes sustained mindfulness practices through reflective exercises, peer discussions, and home-based mindfulness activities.

The SMILE model serves as a catalyst for behavioral transformation, guiding individuals toward mind–body integration. By fostering a balanced and accepting relationship with

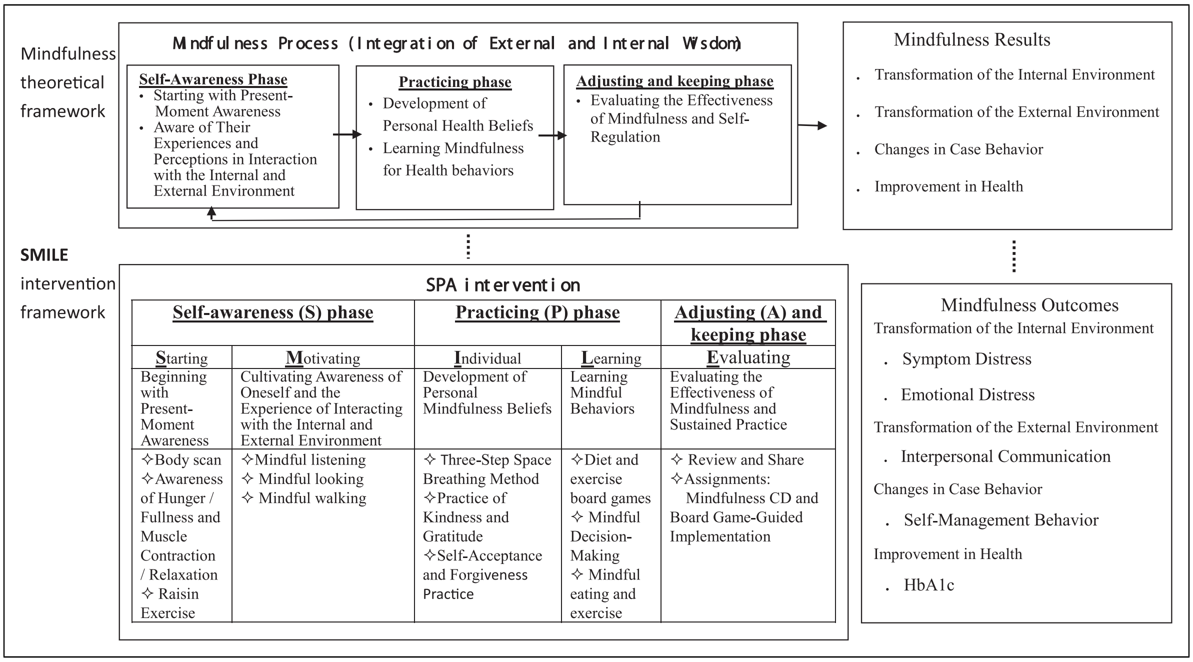

Figure 1. Mindfulness theoretical framework and SPA intervention framework

diabetes, this approach empowers individuals to navigate daily challenges with resilience, enhance their self-efficacy in disease management, and ultimately improve their overall well-being (Hsu et al., 2019; Tsai et al., 2024b).

External Wisdom Component of the Program. The mindfulness-based program integrates external wisdom through an innovative board game designed to enhance engagement and knowledge retention in mindful eating and exercise. The Mindful Eating Board Game (Patent No. M614856) features food cards displaying images, nutritional information and glycemic index values, along with the "My Healthy Plate" guide (Appendix 1). To play the game, each participant first calculates their daily calorie intake and the number of servings for the six major food groups. They then place their food cards into "My Healthy Plate," and the player whose plate best aligns with their personal goals wins that round. This approach aimed to strengthen the participants' understanding of food groups, calorie content, and meal planning strategies.

The Mindful Exercise Cards (Patent No. M614856) includes instructional images, muscle diagrams, and QR codes linking to demonstration videos (Appendix 2). The exercise cards were used to identify which muscle is used for each type of exercise and the correct posture. The participants used the card to ask each other, and those who could correctly identify the muscles corresponding to the exercise and perform it correctly won that round. These tools encourage the participants to develop body awareness, improve posture, and enhance flexibility. Small group board game sessions were arranged each week, and provided a dynamic and interactive learning experience. In addition, the participants received personalized food and exercise cards so they could practice at home, reinforcing self-regulated health behaviors beyond the training sessions.

Internal Wisdom Component of the Program. Beyond cognitive learning, the program emphasizes internal wisdom by fostering a deeper awareness of bodily sensations, emotions, and habitual behaviors through mindful eating and movement practices. During each session, the participants are given a bento box containing whole, natural foods representing a balanced meal to allow the participants to practice mindful eating.

The participants also engaged in structured activities designed to heighten sensory awareness, such as mindful eating exercises using all five senses—sight, hearing, smell, taste, and touch—to fully experience the food. The movement component focused on muscle contraction, relaxation, and posture alignment, supported by resistance bands and yoga mats. To extend mindfulness beyond the sessions, the participants were given a mindfulness audio CD (or they could scan QR codes to access the audio, Appendix 2) along with home practice assignments, which included tracking their behaviors and maintaining a personal set of food and exercise cards. Daily home practice was required, with weekly tasks aligned with the contents of the sessions, encouraging the participants to build long-term self-awareness and sustain their behavioral changes.

Intervention

The experimental group received the Mindful Healthy Lifestyle Program, while the control group received routine clinical care.

Experimental Group: Mindful Healthy Lifestyle Program. The experimental group received the Mindful Healthy Lifestyle Program. The 8-week intervention consisted of eight structured sessions (once per week, each lasting 2 h), aligning with evidence-based mindfulness intervention guidelines (Knol et al., 2020; Tsai et al., 2023). In each two-hour session, the program integrated both external (interactive board games, 30 min) and internal (mindfulness practices, 90 min) wisdom. The detailed session structure is outlined in Table 1.

The sessions were held in a hospital conference room, with a front section for seated learning activities accommodating up to 50 participants, and a back section for physical exercise. To enhance adherence, the participants received reminders to attend the sessions via phone call or text message. The program was led by two experienced instructors: a certified diabetes educator with expertise in board game education, and a professional mindfulness instructor from the University of Oxford specializing in mindful eating and movement.

Control Group: Routine Clinical Care. Participants in the control group received usual care, consisting of monthly educational leaflets and approximately 30 min of individual verbal counseling provided by a diabetes educator or nutritionist. The leaflets, formatted as A4 trifold handouts in Traditional Chinese, addressed core aspects of diabetes self-management, including diet, exercise, medication adherence, self-monitoring of blood glucose, foot care, and lifestyle risk reduction. Because these materials are copyrighted by the hospital, they cannot be reproduced in this manuscript.

Measurements

Structured questionnaires and a physiological indicator were used as assessment tools to evaluate the effectiveness of the intervention.

Questionnaires

Diabetes Symptom Distress Scale. In this study, symptom distress was measured using the modified Diabetes Symptom Distress Scale developed by Arbuckle et al. (2009). This scale primarily assesses the symptoms experienced by older adults with diabetes. The scale is comprised of 34 items over eight dimensions: hyperglycemia (4 items), hypoglycemia (3 items), psychological-cognitive (4 items), psychological-fatigue (4 items), cardiovascular (4 items), neuropathic pain (4 items), neuropathic sensation (6 items), and ocular symptoms (5 items). The respondents first indicate whether they have each symptom with a "yes" or "no." If a symptom is present, they then rate the level of distress on a five-point scale, with one representing "not at all distressing" and five representing "extremely distressing." The scale demonstrated excellent construct validity and criterion-related validity, with Cronbach's alpha values for the total scale and subscales ranging from 0.69 to 0.87 (Arbuckle et al., 2009). Moreover, in a Taiwanese population of patients with type 2 diabetes, the scale demonstrated a Cronbach's alpha of 0.90 (Lin et al., 2019), indicating acceptable reliability in this cultural context (Taber, 2018).

Problem Areas in Diabetes Scale. Emotional distress was assessed using the Problem Areas in Diabetes Scale (PAID) developed by Polonsky et al. (1995). This 20-item instrument evaluates negative emotions associated with diabetes, including diabetes-related emotional issues, treatment problems, food-related concerns, and lack of social support, with responses rated on a six-point scale from 1 ("no problem") to 6 ("serious problem"). Higher scores indicate greater emotional distress. The Chinese version of the PAID (PAID-C) was validated among 205 Taiwanese adults with type 2 diabetes aged ≥40 years, demonstrating construct validity and acceptable test–retest reliability (Huang et al., 2010).

Interpersonal Communication Scale. Interpersonal communication was measured using the Interpersonal Communication Scale developed by Campbell and Akdemir (2016), which was designed to assess an individual's face-to-face communication ability. The scale consists of seven items over two subscales: External Perception, and Internal Discrepancy. External Perception defines an individual's ability to interact with others (items 1–4), while Internal Discrepancy refers to the desire to eliminate interpersonal distance during communication (items 5–7). Each item is scored using a seven-point Likert scale. The scale has demonstrated construct validity, with an overall Cronbach's alpha coefficient of 0.729. To ensure linguistic and cultural appropriateness for our setting, we conducted forward–back translation, and expert review for content validity (CVI = 1) and internal consistency (Cronbach's $\alpha = 0.88$).

Diabetes Self-Management Behavior Scale. Self-management behavior was measured using the dietary and exercise self-management subscales of the Diabetes Self-Management Behavior Scale developed by Hsu et al. (2007). The scale comprises 10 items scored on a five-point Likert scale from "not implemented at all" to "fully implemented," with higher scores reflecting better self-management. The original validation study conducted in Taiwan demonstrated good construct validity and internal consistency (Cronbach's $\alpha = 0.89$) (Hsu et al., 2007).

Personal, Disease and Treatment Characteristics. Personal, disease, and treatment characteristics were collected using a standardized demographic information form. The recorded variables included age, gender, marital status, education level, duration of illness, number of diabetes-related hospitalizations, presence of diabetes-related complications, and treatment methods. Education level was categorized as no formal education or elementary school, junior or senior high school, and college or higher. Diabetes-related complications were categorized as neuropathy, retinopathy, nephropathy,

Table 1. Mindfulness-Based Healthy Lifestyle Program

Phase	Step	Content
1. Self-awareness phase	S: Start with present focus	Week 1: - Introduction to mindfulness - Raisin exercise Weeks 1–8: - Body scan - Awareness of hunger/satiety Weeks 3–8: Awareness of muscle contraction/relaxation
	M: Motivating self-awareness of behavior and interaction with internal & external environments	Weeks 1–2: Mindful listening Weeks 3–8: - Mindful speaking & listening (awareness of factors and barriers related to diet and exercise, recognizing how environment, stress, and emotions affect choices, discussing chain reactions) - Mindful walking Weeks 5–6: Mindful observation
2. Practicing phase	I: Individual mindful beliefs development	Weeks 1–2: - Mindful cognitive exercises Weeks 3–8: - Three-step breathing space Weeks 5–8: - Loving-kindness and gratitude practice - Self-acceptance and forgiveness practice - Non-judgment and compassion practice
	L: Learning mindful behaviors	Weeks 1–2: - Diet board game: Dietary types and calorie challenge Winner: 1. My healthy plate has a balanced diet. 2. Choose calorie cards that meet my daily needs - Mindful eating and mindful walking practice Weeks 3–4: - Diet and exercise board game: Dietary types and glycemic index upper body exercise challenge Winner: 1. My glycemic index cards are green 2. Choose cards that meet my daily diet types and servings. 3. Identify the muscles corresponding to the exercise and perform it correctly - Upper body mindful yoga and breathing exercises - Mindful eating practice Weeks 5–6: - Diet and exercise board game: planning personal mindful eating Winner: 1. Choose cards that meet my daily diet types, servings and green GI value 2. Identify the muscles corresponding to the exercise and perform it correctly. - Lower body mindful yoga and breathing exercises - Mindful eating practice Weeks 7–8: - Diet and exercise board game: Mindful decision-making diet and exercise Winner: Choose cards that meet my daily diet types, servings and exercise. - Mindful eating and full-body exercise practice
3. Adjusting and keeping phase	E: Evaluating mindfulness effectiveness and sustained practice	Weeks 1–8: - Group sharing and discussion - Home practice: 6 days per week of body scan, three-step breathing, mindful eating and exercise practice and record-keeping, loving-kindness and gratitude practice, self-acceptance and forgiveness practice

cardiovascular disease, or other clinically diagnosed conditions. Treatment methods were categorized as oral hypoglycemic agents, insulin therapy, or a combination of both.

Physiological Indicator – HbA1c. HbA1c was analyzed by laboratory examiners who were blinded to both groups. All HbA1c measurements were performed by a single hospital laboratory, which was certified by the Taiwan Accreditation Foundation. One assist researcher collected all of the HbA1c values from medical records.

Data Collection Procedure

Ethical approval was obtained by the Human Research Ethics Committee. To ensure consistency in recruitment, the research team presented the eligibility criteria and intervention protocol to physicians during a departmental meeting. Physicians referred eligible patients to a diabetes educator, who distributed registration forms and forwarded participants' contact information to the principal investigator. The principal investigator then provided a detailed explanation of the intervention and addressed participants' questions before enrollment. Based on their preference, the participants were assigned to either the control group or experimental group. The control group received clinical routine care, while the experimental group participated in the Mindful Healthy Lifestyle Program. Outcome measures including symptom distress, emotional distress, interpersonal communication, self-management behavior, and HbA1c were assessed at three time points: baseline (T0, before the intervention), post-intervention (T1), and 3 months later (T2). At each time point, questionnaires were collected by a research assistant who was blinded to group assignments, and the completed questionnaires were directly submitted to the researchers. In addition, the co-investigator coordinated the research schedule to issue medical orders for blood tests and assisted in the collection of HbA1c data.

Data Analysis

Data were analyzed using SPSS version 22 (IBM Inc., Armonk, NY). The Student's t test and chi-square test were used to examine intergroup differences in personal characteristics and outcome variables. Paired-sample t tests were used to compare intragroup differences in outcome variables between T0 and T1, between T0 and T2, and between T1 and T2. A generalized estimating equation (GEE) model was used to identify the independent effects of the intervention considering within-person variability, and to account for correlated data resulting from repeated measurements across different time points and multiple observations of the same individual (Zeger & Liang, 1986). The interaction effects of group and time on outcome variables were examined using the GEE model.

Results

Personal, Disease and Treatment Characteristics

Of the 88 subjects invited to join the study, 85 agreed to participate. Based on their preference, they were assigned to either the control group or experimental group. Overall, 42 participants in the experimental group and 40 participants in the control group completed the study at T1 and T2. Retention rates for the experimental group and control group were 95.5% and 97.6% at T1 and T2, respectively. There were no significant differences between the two groups in terms of age, gender, marital status, education level, duration of illness, hospitalization due to diabetes, other chronic diseases, or treatment methods, indicating that the groups were comparable (Table 2).

Differences in Outcome Variables within and Between the Experimental and Control Groups

The experimental group achieved significant improvements in emotional distress, interpersonal communication, self-management behavior, and HbA1c between T0 and T1 and between T0 and T2 (Table 3). Between T1 and T2, the experimental group had significantly improved emotional distress and self-management behavior, but there was no significant change in interpersonal communication or HbA1c. Symptom distress did not significantly differ between T0 and T1, between T0 and T2, or between T1 and T2. In the control group, symptom distress, emotional distress, interpersonal communication, and self-management behavior did not significantly differ between T0 and T1, between T0 and T2, or between T1 and T2. Only HbA1c significantly differed between T0 and T2.

After adjusting for baseline levels of interpersonal communication, self-management behavior, and HbA1c at T0, the experimental group had significantly greater improvements in interpersonal communication, self-management behavior, and HbA1c compared to the control group during both from T0 to T1 and from T0 to T2. Notably, only emotional distress showed a significantly greater improvement in the experimental group compared to the control group from T0 to T2. In contrast, no significant differences were observed between the groups in terms of symptom distress across any of the time intervals examined (T0–T1, T0–T2, or T1–T2).

Discussion

At 3 months after completing the intervention, the participants who received the Mindful Healthy Lifestyle Program had significant improvements in emotional distress, interpersonal communication, self-management behaviors, and HbA1c level compared to those in the control group. These findings align with mindfulness theory, which suggests that mindfulness exerts its effects by modulating the internal environment (e.g., alleviating symptom burden and emotional distress), influencing the external environment (e.g., enhancing interpersonal communication), fostering behavioral adaptations (e.g., promoting self-management practices), and ultimately contributing to improved health outcomes (Priya & Kalra, 2018; Tsai et al., 2024a).

The findings of this study indicate that mindfulness-based strategies significantly improved both psychosocial and physiological outcomes in older adults with diabetes, aligning with the results of a meta-analysis published by Zeng et al. (2024). These results suggest that interventions such as Mindful Eating Awareness Training (MB-EAT) and Mindfulness Sport Performance Enhancement (MSPE) offer a holistic mind–body approach to self-management, integrating cognitive, behavioral, and physiological dimensions of diabetes care. To systematically conceptualize the mindfulness process, we delineated it into three distinct phases: Self-awareness, Practicing, and Adjusting & Keeping (SPA phases). Analogous to the immersive and sensory engagement of a spa experience, this framework underscores the role of multisensory stimulation in fostering mental and physical equilibrium, thereby promoting sustainable health behaviors and long-term adherence to self-management strategies. Building upon the SPA framework, we further developed the SMILE model, an integrative intervention that synthesized external wisdom from interactive board game–based learning with internal wisdom cultivated through guided mindfulness practices. The external wisdom component utilized visual and textual educational materials, including food images, calorie content, glycemic index, exercise instructions, and QR codes linked to instructional videos to enhance the participants' conceptual understanding of diabetes-friendly diets and exercise regimens. Concurrently, the internal wisdom component focused on enhancing mind–body awareness through mindfulness-based eating and movement exercises, thereby fostering greater attentional regulation, awareness, and behavioral adaptability. By integrating cognitive learning with experiential mindfulness practices, this dual approach appeared to enhance adherence to self-management behaviors, resilience in daily challenges, and self-efficacy in diabetes management. The findings further suggest that the synergistic interaction between external and internal wisdom played a pivotal role in reinforcing sustained health-promoting behaviors, thereby contributing to improved glycemic control, psychological well-being, and overall quality of life among older adults with diabetes.

The findings of no significant differences in symptom distress in the experimental group across T0, T1, and T2 are in

Table 2. Characteristics of the Experimental and Control Groups

	Experimental group (n = 42)		Control group (n = 42)			
Variables	*n* (%)	Mean (SD)	*n* (%)	Mean (SD)	t value χ^2	*p*
Age (years)		68.38 ± 4.27		68.48 ± 5.09	−0.09	.928
Sex						
Male	8 (19.0)		11 (27.5)		0.82	.365
Female	34 (81.0)		29 (72.5)			
Marital status						
Single or Widowed	11 (26.2)		12 (30.0)		0.147	.701
Married	31 (73.8)		28 (70/0)			
Education level						
Elementary school and No formal education	4 (9.5)		3 (7.5)		1.58	.453
Junior or senior high school	25 (59.5)		29 (72.5)			
College or higher	13 (31.0)		8 (20.0)			
Duration of diabetes (years)		8.12 ± 3.25		7.45 ± 3.83	0.76	.451
Hospitalization due to diabetes						
No	30 (71.4)		27 (67.5)		0/149	.699
Yes	12 (28.6)		13 (32.5)			
Diabetes complications						
No	15 (35.7)		14 (35.0)		0.005	.946
Yes	27 (64.3)		26 (65.0)			
Treatment method						
OHA	25 (59.5)		27 (67.5)		0.695	.706
OHA and insulin	14 (33.3)		10 (25.0)			
Insulin	3 (7.1)		3 (.5)			

OHA = oral hypoglycemic agent.

Table 3. Differences in Outcome Variables Within and Between the Experimental and Control Groups

Variables	Mean (SD)	B	95% CI	*p* Value
Symptom distress				
Intercept		68.85	65.32/72.38	<.001
Group (EG vs. CG)		−0.874	−5.84/4.09	.730
Time overall				.219
EG at T2	68.69 (23.07)			
EG at T1	68.50 (11.52)			
EG at T0	67.98 (11.29)			
CG at T2	68.83 (11.42)			
CG at T1	68.80 (7.11)			
CG at T0	68.85 (7.17)			
EG at T1 vs. EG at T0	1.52 (25.98)		−6.57/9.62	.706
EG at T2 vs. EG at T0	0.71 (25.05)		−7.09/8.52	.854
EG at T2 vs. EG at T1	−0.81 (2.81)		−1.69/0.07	.069
CG at T1 vs. CG at T0	−0.05 (15.33)		−4.95/4.85	.984
CG at T2 vs. CG at T0	−0.25 (15.40)		−4.90/4.95	.992
CG at T2 vs. CG at T1	−0.03 (0.95)		−0.33/0.28	.868
Time*Group overall				.180
EG * (T1 vs. T0) vs. CG * (T1 vs. T0)		1.57	−7.50/10.64	.734
EG * (T2 vs. T0) vs. CG * (T2 vs. T0)		0.74	−8.11/9.58	.870
Emotional distress				
Intercept		61.48	−12.71/10.57	<.001
Group (EG vs. CG)		−1.07	52.93/70.02	.857
Time overall				<.001
EG at T2	45.62 (20.32)			
EG at T1	47.90 (21.25)			
EG at T0	60.40 (26.47)			
CG at T2	62.50 (27.70)			
CG at T1	62.88 (28.34)			
CG at T0	61.48 (27.92)			
EG at T1 vs. EG at T0	−12.50 (27.66)		−3.88/−21.12	.006
EG at T2 vs. EG at T0	−14.79 (26.79)		−6.44/−23.14	.001
EG at T2 vs. EG at T1	−2.29 (4.04)		−1.03/−3.54	.001
CG at T1 vs. CG at T0	−1.40 (42.97)		−12.34/15.14	.838
CG at T2 vs. CG at T0	−1.03 (42.47)		−12.56/14.61	.879
CG at T2 vs. CG at T1	0.38 (1.17)		−0.75/0.01	.051
Time*Group overall				<.001
EG * (T1 vs. T0) vs. CG * (T1 vs. T0)		−13.90	−29.43/1.63	.079
EG * (T2 vs. T0) vs. CG * (T2 vs. T0)		−15.81	−31.07/−0.55	.042
Interpersonal communication				
Intercept		31.32	28.53/34.13	<.001
Group (EG vs. CG)		1.25	−2.91/5.40	.557
Time overall				.006
EG at T2	38.10 (9.83)			
EG at T1	37.93 (9.88)			
EG at T0	32,57 (10.28)			
CG at T2	31.30 (9.06)			
CG at T1	31.48 (9.15)			
CG at T0	31.33 (9.15)			
EG at T1 vs. EG at T0	5.36 (11.31)		1,83/8.88	.004
EG at T2 vs. EG at T0	5.52 (11.22)		2.03/9.02	.003
EG at T2 vs. EG at T1	0.17 (0.54)		−0.01/0.33	.051
CG at T1 vs. CG at T0	0.15 (0.53)		−0.02/0.32	.083

(continued)

Table 3. (continued)

Variables	Mean (SD)	B	95% CI	*p* Value
CG at T2 vs. CG at T0	−0.03 (1.03)		−0.47/0.02	.878
CG at T2 vs. CG at T1	−0.18 (1.24)		−0.35/0.30	.377
Time*Group overall				.002
EG * (T1 vs. T0) vs. CG * (T1 vs. T0)		5,21	1.82/8.59	.001
EG * (T2 vs. T0) vs. CG * (T2 vs. T0)		5.75	2.39/9.11	.003
Self-management behavior				
Intercept		40.63	38.29/42.96	<.001
Group (EG vs. CG)		−2.46	−5.54/0.62	.118
Time overall				<.001
EG at T2	51.90 (6.06)			
EG at T1	51.21 (7.37)			
EG at T0	38.17 (9.23)			
CG at T2	39.78 (7.74)			
CG at T1	39.68 (8.09)			
CG at T0	40.63 (7.62)			
EG at T1 vs. EG at T0	13.05 (10.60)		9.75/16.35	<.001
EG at T2 vs. EG at T0	13.74 (10.06)		10.60/16.87	<.001
EG at T2 vs. EG at T1	0.69 (1.44)		0.24/1.14	.003
CG at T1 vs. CG at T0	−0.95 (4.96)		−2.42/0.72	.233
CG at T2 vs. CG at T0	−0.85 (4.92)		−0.27/0.47	.281
CG at T2 vs. CG at T1	0.10 (1.15)		−0.02/0.25	.586
Time*Group overall				<.001
EG * (T1 vs. T0) vs. CG * (T1 vs. T0)		14.00	10.49/17.51	<.001
EG * (T2 vs. T0) vs. CG * (T2 vs. T0)		14.58	11.23/17.95	<.001
HbA1c				
Intercept		8.38	8.14/8.61	<.001
Group (EG vs. CG)		0.08	−0.27/0.43	.643
Time overall				<.001
EG at T2	7.80 (0.73)			
EG at T1	7.88 (0.88)			
EG at T0	8.46 (0.85)			
CG at T2	8.50 (0.64)			
CG at T1	8.42 (0.71)			
CG at T0	8.38 (0.77)			
EG at T1 vs. EG at T0	1.50 (1.89)		0.33/0.84	<.001
EG at T2 vs. EG at T0	3.22 (2.93)		0.39/0.92	<.001
EG at T2 vs. EG at T1	1.72 (2.47)		−0.06/0.20	.279
CG at T1 vs. CG at T0	−0.19 (1.04)		−0.11/0.02	.163
CG at T2 vs. CG at T0	−0.08 (0.84)		−0.22/−0.03	.014
CG at T2 vs. CG at T1	0.11 (0.40)		−0.16/0.01	.058
Time*Group overall				<.001
EG * (T1 vs. T0) vs. CG * (T1 vs. T0)		−0.63	−0.38/−0.88	<.001
EG * (T2 vs. T0) vs. CG * (T2 vs. T0)		−0.78	−0.51/−1.05	<.001

SD = standard deviation; B = regression coefficient; CI = confidence interval; EG = experimental group; CG = control group; T0 = baseline (before intervention); T1 = post-intervention; T2 = 3 months later; HbA1c = glycated hemoglobin A1c.

contrast with previous research suggesting that higher levels of mindfulness are associated with reduced symptom distress (Zimmaro et al., 2020). A potential explanation is that the participants initially experienced mild symptom distress, which may have constrained the extent of measurable improvement, resembling a floor effect (Andrade, 2021). In addition, the Mindfulness-Based Healthy Lifestyle Program primarily targeted behavioral and psychological regulation, including self-management, interpersonal communication, and emotional distress, rather than directly addressing physical symptom alleviation. This aligns with the theoretical framework of mindfulness-based interventions, which posits that mindfulness enhances psychological resilience and emotional regulation, while its effects on physical symptoms are often indirect and mediated by individual perception (Tsai et al., 2024b). Notably, only emotional distress showed a significant improvement in the experimental group compared to the control group from T0 to T2, whereas no significant difference was observed between T0 and T1. This suggests that the therapeutic effects of the intervention may require a longer duration to manifest significant improvements (Kosugi et al., 2021).

Several limitations of the present study warrant consideration. First, the participants were recruited from two hospitals in southern Taiwan, which may limit the generalizability of the findings; future research should endeavor to recruit a more diverse and heterogeneous sample to facilitate a more comprehensive evaluation of the Mindful Healthy Lifestyle Program. Second, the control group received approximately 30 min of conventional education per month, whereas the intervention group received eight 2-hour sessions over a 2-month period. Although the intensive nature of the intervention may have contributed to the favorable outcomes observed, it could also impede implementation of the program into routine clinical practice, thereby necessitating further modifications to optimize adherence rates. Third, the quasi-experimental design allocated participants based on personal preference, and this may have introduced selection bias, thereby limiting the internal validity of the findings. Future investigations should consider using a randomized controlled design to mitigate this limitation. Fourth, the efficacy of the program was assessed only up to 3 months after completing the intervention. Further studies with a longer follow-up period are needed to confirm the long-term effects.

Conclusions and Clinical Implications

The present study demonstrates that a mindfulness-based healthy lifestyle program can significantly enhance both psychological and physiological outcomes in older adults with type 2 diabetes. Specifically, the participants in the experimental group had marked improvements in emotional distress, interpersonal communication, self-management behaviors, and glycemic control (as indicated by a reduction in HbA1c level) immediately following the intervention and at 3 months of follow-up. These findings underscore the potential of mindfulness-based interventions as an effective adjunct to conventional diabetes care.

From a clinical standpoint, integrating mindfulness strategies into routine diabetes management may facilitate improved self-care practices and psychosocial well-being, particularly in populations where adherence to diet and exercise regimens is challenging. The observed enhancements in both subjective and objective measures of health suggest that mindfulness-based programs can contribute to more holistic diabetes management. Future research using a randomized controlled design, extended follow-up duration, and more diverse patient population is warranted to further validate these results and clarify the underlying mechanisms driving these benefits.

ORCID iD

Mei-Fang Chen https://orcid.org/0000-0003-0071-5316

Ethical Considerations

This study was approved by the Human Research Ethics Committee of National Cheng-Kung University (IRB No NCKU HREC-E−110-609).

Author Contributions

Chun-Chin Tsai: conceptualization and design, methodology, data collection, data analysis, interpretation and editing. Hui-I Yu: data collection and analysis. Mei-Fang Chen: conceptualization and design, data analysis, interpretation and editing.

Funding

The authors disclosed receipt of the following financial support for the research, authorship, and/or publication of this article: This work was supported by the National Science and Technology Council, Republic of China (Taiwan) (111-2314-B-439-002-).

Declaration of Conflicting Interests

The authors declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data Availability Statement

The datasets generated and/or analyzed in the present study are not publicly available, but they can be obtained from the corresponding author on reasonable request.

Supplemental Material

Supplemental material for this article is available online.

References

Andrade, C. (2021). The ceiling effect, the floor effect, and the importance of active and placebo control arms in randomized controlled trials of an investigational drug. *Indian journal of psychological medicine*, *43*(4), 360–361. https://doi.org/10.1177/02537176211021280

Arbuckle, R. A., Humphrey, L., Vardeva, K., Arondekar, B., Danten-Viala, M., Scott, J. A., & Snoek, F. J. (2009). Psychometric evaluation of the diabetes symptom checklist-revised (DSC-R)--a measure of symptom distress. *Value in Health: The Journal of the International Society for Pharmacoeconomics and Outcomes Research*, *12*(8), 1168–1175. https://doi.org/10.1111/j.1524-4733.2009.00571.x

Assar, M. E. l.,, Laosa, O., & Rodriguez, M. L. (2019). Diabetes and frailty. *Current Opinion in Clinical Nutrition and Metabolic*

Care, *22*(1), 52–57. https://doi.org/10.1097/MCO.0000000000000535

Brown, K., Lee, L. T., & Selleck, C. (2019). Effectiveness of diabetes self-management education in community health. *Journal of Doctoral Nursing Practice*, *12*(1), 96–101. https://doi.org/10.1891/2380-9418.12.1.96

Campbell, J. M., & Akdemir, O. A. (2016). The development of interpersonal communication scale: The study of validity and reliability. *Turkish Studies*, *11*(19), 859–872. https://doi.org/10.7827/TurkishStudies.11272

Cho, N. H., Shaw, J. E., Karuranga, S., Huang, Y., da Rocha Fernandes, J. D., Ohlrogge, A. W., & Malanda, B. (2018). IDF diabetes atlas: Global estimates of diabetes prevalence for 2017 and projections for 2045. *Diabetes Research and Clinical Practice*, *138*, 271–281. https://doi.org/10.1016/j.diabres.2018.02.023

Cox, A. E., Ullrich-French, S., Cole, A. N., & D'Hondt-Taylor, M. (2016). The role of state mindfulness during yoga in predicting self-objectification and reasons for exercise. *Psychology of Sport and Exercise*, *22*(1), 321–327. https://doi.org/10.1016/j.psychsport.2015.10.001

Eddy, P., Wertheim, E. H., Hale, M. W., & Wright, B. J. (2019). Trait mindfulness helps explain the relationships between job stress, physiological reactivity, and self-perceived health. *Journal of Occupational and Environmental Medicine*, *61*(1), e12–e18. https://doi.org/10.1097/JOM.0000000000001493

Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behavior Research Methods*, *39*(2), 175–191. https://doi.org/10.3758/BF03193146

Fonseca, L. M., Schmidt, J. J., Snoek, F. J., Weinstock, R. S., Chaytor, N., Stuckey, H., Ryan, C. M., & van Duinkerken, E. (2024). Barriers and facilitators of self-management in older people with type 1 diabetes: A narrative review focusing on cognitive impairment. *Diabetes, Metabolic Syndrome and Obesity: Targets and Therapy*, *17*, 2403–2417. https://doi.org/10.2147/DMSO.S410363

Forbes, A. (2020). Reducing the burden of mortality in older people with diabetes: A review of current research. *Frontiers in Endocrinology*, *17*(11), 133. https://doi.org/10.3389/fendo.2020.00133

Hsu, C. M., Huang, P. H., Wang, C. H., & Huang, S. Y. (2007). An assessment of self-management behaviors among patients with type 2 diabetes in the community. *Southern Taiwan Journal of Medicine*, *3*(2), 76–83.

Hsu, S. M., Tang, S. M., & Chen, M. F. (2019). Application of mindfulness to health-promoting behaviors in patients with chronic diseases: The SMILE strategy. *Hu Li Za Zhi The Journal of Nursing*, *66*(6), 20–26. https://doi.org/10.6224/JN.201912_66(6).04

Hu, M. L., Chen, T. C., & Huang, T. Y. (2017). An overview of mindfulness-based stress reduction. *Chang Gung Nursing*, *28*(4), 588–598. https://doi.org/10.3966/102673012017122804002

Huang, F. Y. (2019). The development of mindfulness education in Taiwan from the perspective of mindfulness healing mechanisms. *Applied Psychological Research*, *70*, 41–76. https://doi.org/10.3966/156092512019060070003

Huang, M. F., Courtney, M., Edwards, H., & McDowell, J. (2010). Validation of the Chinese version of the problem areas in diabetes (PAID-C) scale. *Diabetes Care*, *33*(1), 38–40. https://doi.org/10.2337/dc09-0360

Kabat-Zinn, J. (2003). Mindfulness based interventions in context: Past, present, and future. *Clinical Psychology: Science and Practice*, *10*(2), 144–156. https://doi.org/10.1093/clipsy/bpg016

Kaufman, K. A., Glass, C. R., & Pineau, T. R. (2018). *Mindful sport performance enhancement: Mental training for athletes and coaches*. American Psychological Association.

Knol, L. L., Lawrence, J. C., & de la O, R. (2020). Eat like a chef: A mindful eating intervention for health care providers. *Journal of Nutrition Education and Behavior*, *52*(7), 719–725. https://doi.org/10.1016/j.jneb.2020.02.024

Kosugi, T., Ninomiya, A., Nagaoka, M., Hashimoto, Z., Sawada, K., Park, S., Fujisawa, D., Mimura, M., & Sado, M. (2021). Effectiveness of Mindfulness-Based Cognitive Therapy for Improving Subjective and Eudaimonic Well-Being in Healthy Individuals: A Randomized Controlled Trial. *Frontiers in psychology*, *12*, 700916. https://doi.org/10.3389/fpsyg.2021.700916

Kristeller, J. L., & Bowman, A. (2015). *The joy of half a cookie: Using mindful eating to break the cycle of mindless eating and bad habits*. TarcherPerigee.

Lin, L. Y., Lee, B. O., & Wang, R. H. (2019). Effects of a symptom management program for patients with type 2 diabetes: Implications for evidence-based practice. *Worldviews on Evidence-Based Nursing*, *16*(6), 433–443. https://doi.org/10.1111/wvn.12400

Loucks, E. B., Gilman, S. E., Britton, W. B., Gutman, R., Eaton, C. B., & Buka, S. L. (2016). Associations of mindfulness with glucose regulation and diabetes. *American Journal of Health Behavior*, *40*(2), 258–267. https://doi.org/10.5993/AJHB.40.2.11

Medina, W. L., Wilson, D., de Salvo, V., Vannucchi, B., de Souza, E. L., Lucena, L., Sarto, H. M., Modrego-Alarcón, M., Garcia-Campayo, J., & Demarzo1, M. (2017). Effects of mindfulness on diabetes mellitus: Rationale and overview. *Current Diabetes Reviews*, *13*(2), 141–147. https://doi.org/10.2174/1573399812666160607074817

Miller, C. K. (2017). Mindful eating with diabetes. *Diabetes Spectrum: A Publication of the American Diabetes Association*, *30*(2), 89–94. https://doi.org/10.2337/ds16-0039

Nyklíček, I., van Son, J., Denollet, J., & Pouwer, F. (2016). Does mindfulness-based cognitive therapy benefit all people with diabetes and comorbid emotional complaints equally? Moderators in the DiaMind trial. *Journal of Psychosomatic Research*, *91*, 40–47. https://doi.org/10.1016/j.jpsychores.2016.10.009

Polonsky, W. H., Anderson, B. J., Lohrer, P. A., Welch, G., Jacobson, A. M., Aponte, J. E., & Schwartz, C. E. (1995). Assessment of diabetes-related distress. *Diabetes Care*, *18*(6), 754–760. https://doi.org/10.2337/diacare.18.6.754

Priya, G., & Kalra, S. (2018). Mind–body interactions and mindfulness meditation in diabetes. *European Endocrinology*, *14*(1), 35–41. https://doi.org/10.17925/EE.2018.14.1.35

Speight, J., Skinner, T. C., Dunning, T., Black, T., Kilov, G., Lee, C., Scibilia, R., & Johnson, G. (2021). Our language matters: Improving communication with and about people with diabetes. A position statement by diabetes Australia. *Diabetes Research and Clinical Practice*, *173*, 2–11. https://doi.org/10.1016/j.diabres.2021.108655

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education*, *48*(6), 1273–1296. https://doi.org/10.1007/s11165-016-9602-2

Tsai, C. C., Chan, H. S., Lien, W. L., Chu, H. Y., & Chen, M. F. (2024a). Structural equation modeling of dispositional mindfulness, internal environmental factors, external environmental factors, and self-care behaviors in people with type 2 diabetes. *Applied Nursing Research: ANR*, *77*, Article 151799. https://doi.org/10.1016/j.apnr.2024.151799

Tsai, C. C., Hwang, H. L., Chen, P. Y., & Chen, M. F. (2024b). The effect of a bone-preserving board game program on the knowledge, attitudes and preventive behaviors of osteoporosis in older adults. *Geriatric Nursing*, *56*, 212–217. https://doi.org/10.1016/j.gerinurse.2024.02.007

Tsai, C. C., Hwang, H. L., Chen, P. Y., & Chen, M. F. (2025). The effect of the stable sugar winner board game on dietary knowledge, attitudes, and behavioral self-efficacy in preventing diabetes among community-dwelling older adults. *Geriatric Nursing*, *66*(Pt A), Article 103579. https://doi.org/10.1016/j.gerinurse.2025.103579

Tsai, C. C., Lee, H. L., Wu, C. S., Chen, P. Y., Chen, T. W., & Chen, M. F. (2023). The efficacy of a mindfulness-based exercise program in older residents of a long-term care facility in Taiwan. *Geriatric Nursing*, *50*(9), 227–233. https://doi.org/10.1016/j.gerinurse.2023.01.021

Wang, C. Y., Tu, S. T., Sheu, W. H. H., Chen, I. C., Chuang, L. M., Wu, M. S., & Yu, C. J. (2018). National survey of ABC (A1C, blood pressure, cholesterol) of diabetes health promotion institutes in Taiwan::2002-2018. *Journal of the Formosan Medical Association*, *117*(11), 952–954. https://doi.org/10.1016/j.jfma.2018.08.013

Wu, F. L., Tai, H. C., & Sun, J. C. (2019). Self-management experience of middle-aged and older adults with type 2 diabetes: A qualitative study. *Asian Nursing Research*, *13*(3), 209–215. https://doi.org/10.1016/j.anr.2

Zeger, S. L., & Liang, K. Y. (1986). Longitudinal data analysis for discrete and continuous outcomes. *Biometrics*, *42*(1), 121–130. https://doi.org/10.2307/2531248

Zeng, Q., Li, C., Yu, T., & Zhang, H. (2024). Comparative effects of exercise interventions and mindfulness-based interventions for cognitive impairment and quality of life in breast cancer survivors during or after cancer treatment: A systematic review and Bayesian network meta-analysis. *American Journal of Physical Medicine & Rehabilitation*, *103*(9), 777–788. https://doi.org/10.1097/PHM.0000000000002531

Zimmaro, L. A., Carson, J. W., Olsen, M. K., Sanders, L. L., Keefe, F. J., & Porter, L. S. (2020). Greater mindfulness associated with lower pain, fatigue, and psychological **distress** in women with metastatic breast cancer. *Psycho-Oncology*, *29*(2), 263–270. https://doi.org/10.1002/pon.5223