KMANPUB | Health Nexus Vol. 4 No. 3 (2026): 1-10

Article history:
Received 10 March 2026
Revised 13 June 2026
Accepted 20 June 2026
Published online 01 July 2026

Effectiveness of Combined Healthy Lifestyle Education and Yoga Therapy on Self-Reflection and Personal Insight in Overweight Adults at Risk of Type 2 Diabetes

Mojgan Agahheris[1], Ezzatolah Kordmirza Nikoozadeh[2], Maryam Abdolkarimy Nazary[3*], Afagh Saleh[4]

1. Professor in Health Psychology, Department of Psychology, Payame Noor University, Tehran, Iran
2. Professor in Psychology, Department of Psychology, Payame Noor University, Tehran, Iran
3. Ph.D. Student in Health Psychology, Department of Psychology, Payame Noor University, Tehran, Iran
4. PhD Student in Health Psychology, Department of Psychology, Payame Noor University, Tehran, Iran

*** Corresponding author email address:** m_agah@pnu.ac.ir

A r t i c l e I n f o

Article type:
Original Research

How to cite this article:
Agahheris, M., Kordmirza Nikoozadeh, E., Abdolkarimy Nazary, M., & Saleh, A. (2026). Effectiveness of Combined Healthy Lifestyle Education and Yoga Therapy on Self-Reflection and Personal Insight in Overweight Adults at Risk of Type 2 Diabetes. *Health Nexus, 4*(3), 1-10.
https://doi.org/10.61838/kman.hn.5836

A B S T R A C T

This study examined the effectiveness of a combined healthy lifestyle education and yoga therapy program in improving self-reflection and personal insight among overweight adults at risk of developing type 2 diabetes. A quasi-experimental pretest–posttest design with a follow-up assessment and a non-intervention control group was used. Forty eligible adults attending health-related services in Tehran were selected through purposive sampling and randomly allocated to an experimental group (n = 20) or a control group (n = 20). The experimental group participated in a structured 10-session weekly program integrating education on nutrition, physical activity, sleep, stress management, self-care, goal setting, and maintenance of healthy behavior with yoga postures, breathing exercises, relaxation, body awareness, mindfulness, and self-compassion practices. The control group received no intervention during the study period. Self-reflection and personal insight were measured with the Self-Reflection and Insight Scale. Data were analyzed using descriptive statistics and mixed repeated-measures analysis of variance. Significant time-by-group interactions were observed for self-reflection, personal insight, and the total score. In the experimental group, mean self-reflection increased from 39.65 at pretest to 53.40 at posttest, and mean personal insight increased from 24.80 to 34.60. These improvements remained largely stable at follow-up, whereas the control group showed no meaningful change. The interaction effect sizes were large for self-reflection (partial $\eta^2 = .651$), personal insight (partial $\eta^2 = .616$), and the total score (partial $\eta^2 = .709$). Pairwise comparisons confirmed significant improvements from pretest to posttest and from pretest to follow-up, with no significant decline between posttest and follow-up. The findings suggest that integrating lifestyle education with yoga-based mind–body practices may strengthen constructive self-observation and clearer understanding of health-related thoughts, emotions, and behaviors in overweight adults at elevated diabetes risk. Larger trials with active controls, longer follow-up periods, and objective metabolic outcomes are required.

Keywords: *healthy lifestyle; yoga therapy; self-reflection; personal insight; overweight; diabetes risk*

1. Introduction

Type 2 diabetes is a major chronic noncommunicable disease characterized by persistent hyperglycemia arising from impaired insulin action, inadequate insulin secretion, or both. Its development reflects the interaction of genetic susceptibility with metabolic, behavioral, and environmental influences. Long-term dysglycemia is associated with vascular, cardiac, renal, retinal, and neurologic complications and can substantially reduce functional capacity and quality of life (1, 2). Prediabetes represents an intermediate state in which glucose regulation is abnormal but does not yet meet diagnostic criteria for diabetes. This state is clinically important because progression to type 2 diabetes is common, but it is not inevitable. Current prevention guidance emphasizes weight management, improved diet quality, regular physical activity, and reduced sedentary behavior for individuals at elevated risk (3).

Overweight and obesity are among the most important modifiable contributors to insulin resistance and type 2 diabetes. Excess adipose tissue, particularly visceral fat, is linked to low-grade inflammation, disturbed glucose metabolism, and reduced insulin sensitivity. The global burden is substantial: the WHO estimated that approximately 2.5 billion adults were overweight in 2022, including about 890 million living with obesity (2). Adults with excess body weight and additional signs or risk factors for prediabetes therefore constitute a priority population for preventive intervention. The Diabetes Prevention Program demonstrated that an intensive lifestyle intervention centered on modest weight reduction and increased physical activity lowered the incidence of type 2 diabetes by 58% in high-risk adults and was more effective than metformin during the initial trial period (4).

Although lifestyle education can improve knowledge and provide practical behavioral targets, information alone does not guarantee sustained change. Eating patterns, physical inactivity, irregular sleep, and ineffective responses to stress are often maintained by automatic habits, immediate reinforcement, emotional cues, and limited awareness of behavioral triggers. Successful prevention therefore requires psychological processes that help individuals observe their behavior, compare it with health goals, identify obstacles, and adjust their actions over time. In group-based diabetes prevention, psychological pathways such as self-efficacy, self-regulation, and perceived control have been associated with behavioral improvement, indicating that the effects of lifestyle programs are partly mediated by how individuals interpret and manage their own behavior (5).

Self-reflection and personal insight are related but distinct metacognitive capacities relevant to this process. Self-reflection refers to deliberate examination and evaluation of one's thoughts, emotions, and actions. Personal insight refers to the clarity and accuracy with which a person understands the causes, patterns, and consequences of those internal experiences and behaviors. Grant et al. (2002) developed the Self-Reflection and Insight Scale to distinguish the tendency to examine the self from the quality of understanding produced by that examination (6). A person may think frequently about personal experiences without gaining constructive insight; reflection can become repetitive or self-critical when it is not accompanied by clearer understanding. Conversely, reflection that generates insight may support flexible problem solving, self-directed change, and more deliberate health choices (6, 7).

These processes may be especially relevant for overweight adults at risk of diabetes. Constructive self-reflection can help identify situations associated with emotional eating, prolonged sitting, missed exercise, insufficient sleep, or inconsistent adherence to health recommendations. Personal insight can then help the individual understand why these patterns recur and which thoughts, emotions, social situations, or bodily states function as triggers. Such understanding is important because weight- and diabetes-related behavior is rarely determined by knowledge alone. An individual may understand dietary recommendations yet continue to eat in response to stress, may value exercise yet interpret ordinary fatigue as a reason for avoidance, or may underestimate the effect of sleep disruption on appetite and self-control. Strengthening self-observation and insight could therefore improve the translation of health knowledge into sustained action.

Yoga therapy may complement lifestyle education by directly training attention to bodily sensations, breathing, emotional states, and present-moment experience. Yoga-based programs typically combine physical postures, controlled movement, breath regulation, relaxation, and

Health Nexus
E-ISSN: 2981-2569

focused attention. Proposed psychological mechanisms include improved attentional control, body awareness, emotion regulation, stress modulation, and self-regulation (8). Interoceptive awareness—the ability to notice and interpret internal bodily signals—may help individuals discriminate between physiological hunger and emotional urges, between physical fatigue and avoidance, or between ordinary stress arousal and more serious symptoms. Integrative movement and mindfulness practices have been associated with increased self-reported mindfulness and interoceptive awareness (9), while yoga interventions have produced improvements in selected physical and psychological outcomes among women with abdominal obesity (10, 11).

Evidence also suggests that mind–body interventions may support metabolic management, although findings are heterogeneous. A systematic review and meta-analysis reported that mind- and body-based interventions, particularly yoga, were associated with improvements in glycemic control among people with type 2 diabetes, but the authors emphasized substantial variability in intervention content and study quality (12). Reviews of mindfulness-oriented approaches similarly indicate possible benefits for diabetes-related distress, self-management, and glycemic outcomes, while noting that not all behavioral domains improve consistently (13-15). These mixed results imply that attention-based practices may strengthen psychological capacities without automatically changing every health behavior or metabolic indicator.

Combining healthy lifestyle education with yoga therapy may address complementary components of behavior change. Lifestyle education supplies explicit criteria for evaluating food intake, physical activity, sleep, stress management, and self-care. Yoga therapy may improve the quality of attention brought to this evaluation by reducing automatic reactivity and increasing awareness of bodily and emotional cues. Together, the two components may promote reflection that is purposeful rather than ruminative and insight that is connected to realistic behavioral choices. However, research has focused more often on body weight, glucose regulation, stress, or quality of life than on the distinct constructs of self-reflection and personal insight. The present study therefore examined whether a 10-session combined program could improve these two capacities in overweight adults at risk of type 2 diabetes. It was hypothesized that participants receiving the intervention would show greater increases in self-reflection, personal insight, and the combined score than participants in the control group, and that the gains would be maintained at follow-up.

2. Methods and Materials

2.1. Study Design and Setting

The study used an applied, quasi-experimental design with pretest, posttest, and follow-up assessments and a parallel control group. Participants were recruited from overweight adults with signs or risk factors for prediabetes who attended or were invited through a counseling and health-related center in Tehran, Iran. Purposive sampling was used to identify eligible volunteers, who were then randomly allocated to the experimental and control groups.

Forty participants were included in the analysis, with 20 assigned to the experimental group and 20 to the control group. Eligibility criteria were an age of 20–40 years, overweight status, physician-confirmed symptoms or risk factors compatible with prediabetes, and at least three months since recognition of the risk condition. Participants also had to be able to read and write Persian, complete the study questionnaires, and provide informed consent. Exclusion criteria included severe psychiatric disorder, psychosis, bipolar I disorder, severe cognitive impairment, concurrent psychological treatment, or a substantial recent change in medication. Participants were also withdrawn if they missed more than two sessions, developed an acute medical problem or worsening physical illness, initiated another psychological or rehabilitation intervention, substantially changed medication type or dose, or requested withdrawal.

2.2. Measure

Self-reflection and personal insight were assessed with the Self-Reflection and Insight Scale developed by Grant et al. (2002) (6). The full instrument contains 20 items and two subscales. The 12-item Self-Reflection subscale assesses engagement in and perceived need for examining one's thoughts, feelings, and behavior. Items are rated on a six-point Likert scale from 1 (strongly disagree) to 6 (strongly

Health Nexus
E-ISSN: 2981-2569

agree), with negatively phrased items reverse scored. Possible self-reflection scores range from 12 to 72, and higher scores indicate a stronger tendency to examine personal experiences and behavior. Grant et al. reported a Cronbach's alpha of .91 and a seven-week test–retest coefficient of .77 for this subscale.

The eight-item Insight subscale assesses the clarity of an individual's understanding of thoughts, emotions, motives, and behavior. Responses use the same six-point scale, and five items are reverse scored. Total insight scores range from 8 to 48, with higher values indicating greater clarity and understanding. The original study reported a Cronbach's alpha of .87 and a seven-week test–retest coefficient of .78 (6). Evidence from the scale-development study indicated that insight was positively associated with cognitive flexibility and self-regulation and negatively associated with anxiety, depression, stress, and alexithymia.

2.3. *Intervention*

The experimental group received a structured group intervention integrating healthy lifestyle education with yoga therapy. The program consisted of 10 weekly sessions of approximately 60 minutes. Lifestyle topics and yoga-based practices were aligned so that each week combined behavioral knowledge with experiential exercises. Participants also received home-practice assignments to repeat relevant yoga, breathing, relaxation, and self-monitoring activities between sessions. The control group received no intervention during the study period.

The lifestyle component covered assessment of daily habits and health goals; principles of balanced nutrition and energy intake; the importance of physical activity and development of a walking plan; recognition and management of stress; sleep hygiene and regulation of the sleep–wake cycle; self-care and balance between activity and rest; identification of emotions linked to unhealthy behavior; goal setting, self-monitoring, and management of barriers; social support; and planning for long-term maintenance. The yoga component included psychoeducation regarding stress and the nervous system; conscious breathing; body scanning; very gentle movements; lengthened exhalation; restorative postures and slow stretching; nonjudgmental observation of thoughts; fatigue management; alternate-nostril and bhramari breathing; deep relaxation and yoga nidra; self-compassion and emotion acceptance; and individualized relapse-prevention planning.

Table 1

Summary of the 10-session combined intervention

Session	Healthy lifestyle education	Yoga therapy
1	Program introduction, daily-habit assessment, and health goals	Stress–nervous system education and conscious breathing
2	Healthy nutrition and balanced energy intake	Body scan, recognition of physical tension, and very gentle movement
3	Physical activity education and a walking plan	Breath regulation, longer exhalation, and nervous-system calming
4	Stress recognition and coping strategies	Restorative postures and gentle stretching with breathing
5	Sleep hygiene and sleep–wake regulation	Mindfulness and nonjudgmental observation of thoughts
6	Self-care and balance between activity and rest	Fatigue management and prevention of excessive effort
7	Emotions and related unhealthy behaviors	Alternate-nostril breathing and bhramari breathing
8	Goal setting, self-monitoring, and barriers to change	Deep relaxation, yoga nidra, and parasympathetic activation
9	Social relationships and support	Self-compassion, emotional acceptance, and emotion regulation
10	Review and maintenance of a healthy lifestyle plan	Personal practice plan and prevention of return to previous patterns

2.4. *Procedure*

After eligibility assessment and informed consent, participants completed the baseline questionnaire and were allocated to the experimental or control group. The experimental group then attended the 10-week program, whereas the control group did not receive a study intervention. Both groups completed the posttest after the intervention period. A follow-up assessment was subsequently administered to examine maintenance of change.

Health Nexus
E-ISSN: 2981-2569

2.5. *Statistical Analysis*

Means and standard deviations were calculated for self-reflection, personal insight, and the total score at pretest, posttest, and follow-up. Mixed repeated-measures analysis of variance was used to test within-participant effects of time, between-group effects, and time-by-group interactions. The Shapiro–Wilk test was used to examine normality and Levene's test to assess homogeneity of variance. Mauchly's test was used to evaluate sphericity. Because sphericity was violated for self-reflection and the total score, Greenhouse–Geisser corrections were applied to the corresponding within-participant tests; the assumption was satisfied for personal insight. Bonferroni-adjusted pairwise comparisons were used to examine differences between measurement occasions in the experimental group. Analyses were performed in SPSS version 26 with $\alpha = .05$. Partial eta squared (partial η^2) was reported as the effect-size index.

3. Findings and Results

Data from 40 participants were analyzed. At baseline, the two groups had similar mean scores for self-reflection, personal insight, and the total scale. Following the intervention, the experimental group showed marked increases in both outcomes, while the control group remained essentially stable. The experimental group's self-reflection mean increased from 39.65 (SD = 6.12) at pretest to 53.40 (SD = 6.35) at posttest and remained at 52.85 (SD = 6.40) at follow-up. Personal insight increased from 24.80 (SD = 4.35) to 34.60 (SD = 4.55), with a follow-up mean of 34.15 (SD = 4.60). The corresponding total score increased from 64.45 (SD = 8.15) to 88.00 (SD = 8.45) and remained at 87.00 (SD = 8.50) at follow-up. Control-group means changed only minimally across the three assessments (Table 2).

Table 2

Means and standard deviations by group and assessment

Outcome	Group	Pretest	Posttest	Follow-up
Self-reflection	Experimental	39.65 ± 6.12	53.40 ± 6.35	52.85 ± 6.40
Self-reflection	Control	40.10 ± 6.05	40.55 ± 6.18	40.30 ± 6.11
Personal insight	Experimental	24.80 ± 4.35	34.60 ± 4.55	34.15 ± 4.60
Personal insight	Control	25.05 ± 4.20	25.20 ± 4.32	25.10 ± 4.28
Total score	Experimental	64.45 ± 8.15	88.00 ± 8.45	87.00 ± 8.50
Total score	Control	65.15 ± 8.02	65.75 ± 8.25	65.40 ± 8.18

The mixed repeated-measures analyses showed statistically significant time effects, group effects, and time-by-group interactions for all three outcomes (Table 3). For self-reflection, the time-by-group interaction was $F(1.66, 63.08) = 70.85$, partial $\eta^2 = .651$. For personal insight, the interaction was $F(2, 76) = 60.92$, partial $\eta^2 = .616$. For the total score, the interaction was $F(1.64, 62.32) = 92.76$, partial $\eta^2 = .709$. Each interaction represented a large effect and indicated that change over time differed substantially between the intervention and control groups.

Table 3

Mixed repeated-measures analysis of variance

Outcome	Effect	df	F	Partial η^2
Self-reflection	Time	1.66, 63.08	74.23	.661
Self-reflection	Group	1, 38	24.18	.389
Self-reflection	Time × group	1.66, 63.08	70.85	.651
Personal insight	Time	2, 76	63.17	.624
Personal insight	Group	1, 38	21.65	.363
Personal insight	Time × group	2, 76	60.92	.616
Total score	Time	1.64, 62.32	96.41	.717
Total score	Group	1, 38	27.84	.423
Total score	Time × group	1.64, 62.32	92.76	.709

Health Nexus
E-ISSN: 2981-2569

Bonferroni-adjusted comparisons within the experimental group confirmed that self-reflection increased significantly from pretest to posttest (mean difference = 13.75, SE = 1.10, P < .001) and from pretest to follow-up (mean difference = 13.20, SE = 1.15, P < .001). The posttest-to-follow-up difference was not significant (mean difference = 0.55, SE = 0.48, P = .682). Personal insight also improved from pretest to posttest (mean difference = 9.80, SE = 0.85, P < .001) and from pretest to follow-up (mean difference = 9.35, SE = 0.88, P < .001), with no significant difference between posttest and follow-up (mean difference = 0.45, SE = 0.39, P = .731). The total score increased from pretest to posttest (mean difference = 23.55, SE = 1.60, P < .001) and from pretest to follow-up (mean difference = 22.55, SE = 1.65, P < .001); the posttest-to-follow-up difference was nonsignificant (mean difference = 1.00, SE = 0.72, P = .506). No significant differences across the three occasions were reported for the control group.

4. Discussion

The present study found that a 10-session program combining healthy lifestyle education with yoga therapy produced substantial improvements in self-reflection and personal insight among overweight adults at risk of type 2 diabetes. The groups began with similar mean scores, but participants receiving the intervention showed pronounced gains at posttest, whereas control-group scores remained stable. The large time-by-group effect sizes indicate that the observed differences were not merely small statistical changes. The absence of significant differences between posttest and follow-up further indicates that the gains were maintained through the follow-up assessment.

The improvement in self-reflection is consistent with the structure of the intervention. Lifestyle education repeatedly required participants to examine current habits, compare them with health goals, identify barriers, monitor behavior, and plan corrective action. These activities operationalize reflection as a purposeful self-regulatory process rather than as abstract introspection. The intervention addressed diet, activity, sleep, stress, self-care, emotional triggers, social support, and relapse prevention, thereby providing multiple concrete domains in which participants could observe discrepancies between intentions and behavior. Psychological research on lifestyle programs indicates that behavior change depends partly on self-regulatory processes and the individual's interpretation of progress, control, and capability (5). The current findings extend that logic by suggesting that a structured lifestyle program can increase the measured tendency to examine thoughts, emotions, and actions.

The gain in personal insight is equally important. Reflection alone is not necessarily adaptive; repeatedly thinking about weight, disease risk, or personal shortcomings can become unproductive rumination. Grant et al. (2002) distinguished reflective engagement from insight precisely because frequent self-focus does not guarantee accurate or useful understanding (6). In the current intervention, reflection was paired with practical education and nonjudgmental mind–body exercises. Participants were not only encouraged to notice behavior but also to identify links among stress, emotion, bodily sensations, eating, inactivity, sleep, and self-care. This combination may have helped transform observation into clearer explanations of why unhealthy patterns occurred and how alternative responses could be selected.

Evidence from mindfulness research supports this interpretation. Nyklíček et al. (2020) reported that increased insight, rather than simply greater interest in introspection, played an important role in psychological improvement during mindfulness-based stress reduction. Although that study involved a different population and intervention, it supports the distinction between useful understanding and mere inward attention (16). The current program may have increased insight by directing attention toward specific, behaviorally relevant questions: What triggers eating without physical hunger? How does stress change breathing or muscle tension? When does fatigue reflect a genuine need for recovery, and when does it function as an avoidance cue? How do sleep disruption and negative emotion influence health decisions? Such questions can produce actionable knowledge rather than generalized self-focus.

Yoga therapy may have enhanced these effects through interoceptive and attentional mechanisms. Controlled breathing, body scanning, gentle movement, restorative postures, and relaxation train participants to detect subtle changes in physical arousal. Yoga also encourages sustained

Health Nexus
E-ISSN: 2981-2569

attention to present-moment experience with less immediate judgment or reaction. Gard et al. (2014) proposed that yoga influences psychological health through interacting mechanisms involving attention, emotion regulation, stress regulation, and self-regulation (8). In an integrative exercise program, Mehling et al. (2018) observed improvements in mindfulness and interoceptive awareness (9), and van Aalst et al. (2021) reported increased interoceptive awareness following yoga in sedentary adults (17). These findings make it plausible that participants in the current study became better able to recognize bodily cues connected to tension, hunger, fatigue, or emotional activation.

For adults with excess weight, improved awareness of internal cues may have direct behavioral relevance. Emotional eating often involves responding to distress, boredom, or tension as though these states were hunger. Physical inactivity may also be maintained by automatic interpretations of discomfort, low mood, or anticipated effort. By helping individuals notice bodily sensations and emotional states before reacting, yoga-based practice may create a brief interval in which choices become more deliberate. The lifestyle component then supplies alternative responses, such as planned walking, balanced meals, sleep regulation, stress-management strategies, or seeking social support. The intervention may therefore have worked through a sequence of noticing, understanding, and choosing: attention to internal and external cues, insight into the pattern linking cues with behavior, and selection of a healthier response.

The large increase in the combined score is consistent with a complementary rather than redundant relationship between the two intervention components. Lifestyle education alone can identify what should change, but it may not sufficiently address automatic emotional and physiological processes that interfere with change. Yoga therapy can increase awareness and reduce reactivity, but awareness without explicit behavioral goals may not translate into diabetes-prevention practices. The combined program connected experience to action. Participants learned objective health principles while simultaneously practicing skills for observing thoughts, emotions, and bodily states. This integrated design may explain why improvements occurred in both the tendency to reflect and the clarity of insight.

The findings also fit broader evidence that yoga and mindfulness-oriented interventions can improve selected psychological and metabolic outcomes. Yoga has shown benefits in women with abdominal obesity, although effects differ across outcomes and may be influenced by lifestyle factors and adherence (10, 11). Systematic reviews have reported favorable effects of yoga and other mind–body approaches on glycemic control in adults with type 2 diabetes, but heterogeneity remains high (12). Mindfulness- and acceptance-based interventions may reduce diabetes distress and modestly improve glycemic outcomes (15). The current study did not measure glucose, weight, waist circumference, or physical activity, so its results should not be interpreted as evidence of metabolic improvement. Rather, it identifies two psychological capacities that may support subsequent behavior change.

This distinction is necessary because improved awareness does not guarantee improved self-management. Heo et al. (2023) found that meditation interventions improved some outcomes in adults with type 2 diabetes, but effects across self-management domains were not uniform (14). Hamasaki (2023) similarly concluded that mindfulness may assist glycemic management through attention, emotion regulation, and self-awareness, while emphasizing limitations in the evidence base (13). Health behavior depends on more than individual insight: financial resources, food availability, neighborhood conditions, social support, treatment access, established habits, and competing responsibilities can all constrain action. A participant may understand an unhealthy pattern clearly but still lack the practical resources to change it. The present findings should therefore be interpreted as improvement in psychological readiness and self-understanding, not proof of comprehensive behavioral or clinical change.

The maintenance pattern is encouraging. Posttest and follow-up means were nearly identical, and pairwise comparisons showed no significant decline. The intervention's final sessions explicitly addressed maintenance, personal planning, and prevention of return to previous patterns, while home practice may have supported continued use of breathing, relaxation, and self-monitoring skills. Nevertheless, longer follow-up periods and objective measures of adherence are needed to establish whether these gains persist over time.

Health Nexus
E-ISSN: 2981-2569

Several alternative explanations must also be considered. The control group received no intervention, so the study could not separate the specific effects of lifestyle education and yoga from nonspecific effects such as therapist attention, group membership, social interaction, expectation of benefit, or repeated discussion of health goals. Goldberg et al. (2020) found improvements across different versions of a multicomponent meditation program without clear superiority of the version explicitly emphasizing insight, suggesting that common program factors can contribute meaningfully to outcomes (18). In the present study, an active control involving health education of equal duration, light stretching, or supportive group meetings would provide a stronger test of the intervention's specific mechanisms.

The combined design also prevents determination of the independent contribution of each component. A four-arm trial comparing lifestyle education, yoga therapy, their combination, and an active control would clarify whether the integrated program produces additive or synergistic effects. Mediation analyses could then test whether changes in mindfulness, interoceptive awareness, stress, self-efficacy, or emotion regulation explain gains in self-reflection and insight. Such work is particularly important because increased self-focus can have different consequences depending on how it is experienced. Bucknell et al. (2022) reported that adaptive self-reflection was associated with resilience through insight, but that rumination altered this relationship (19). Yoga's emphasis on acceptance and nonjudgment may reduce the likelihood that reflection becomes self-criticism, but this mechanism was not measured in the present study.

The study has several methodological limitations. The sample was small and purposively recruited from one setting, which limits statistical precision and generalizability to other age groups, regions, cultural contexts, and levels of diabetes risk. The use of a non-intervention control group did not control for therapist attention, group interaction, or expectations of benefit. Reliance on self-report measures may have introduced social-desirability, recall, and expectancy effects. In addition, combining lifestyle education and yoga therapy in a single intervention prevented estimation of the independent contribution of each component. These limitations should be considered when interpreting the findings.

Future research should use larger samples, preregistered protocols, concealed randomization, active controls, and clearly specified follow-up intervals. Objective outcomes should be included alongside psychological measures, such as body weight, waist circumference, step count, sleep parameters, fasting plasma glucose, and glycated hemoglobin. Repeated assessment could determine whether psychological gains precede improvements in health behavior and metabolic status. Ecological momentary assessment or daily diaries could examine whether increased insight is expressed in real-time choices during stress, hunger, fatigue, or social eating. It would also be useful to determine which participants benefit most. Individuals with high baseline rumination, severe stress, low body awareness, or limited social support may require modified or more intensive interventions.

Despite these limitations, the study contributes to the prevention literature by focusing on two metacognitive outcomes that are often assumed but rarely measured directly. Diabetes-prevention programs typically evaluate weight, activity, diet, or glucose, yet sustained change also depends on whether individuals can accurately observe and understand their own patterns. The present results suggest that a relatively brief, integrated group program can strengthen both reflective engagement and personal insight. This may provide a psychological foundation for more deliberate self-care, particularly when health education is paired with embodied practices that cultivate attention and emotional regulation.

5. Conclusion

A 10-session program integrating healthy lifestyle education with yoga therapy was associated with large improvements in self-reflection, personal insight, and the combined score among overweight adults at risk of type 2 diabetes. The improvements were maintained at follow-up, while the control group showed little change. The findings support the potential value of combining explicit behavior-change education with mind–body practices that strengthen body awareness, emotion regulation, and nonjudgmental attention. Larger controlled trials with longer follow-up and objective behavioral and metabolic outcomes are needed to confirm these findings and determine their clinical significance.

Health Nexus
E-ISSN: 2981-2569

Authors' Contributions

All authors contributed substantially to the study and to manuscript development, and all approved the final version.

Declaration

The authors declare that artificial intelligence tools were used only to assist with language editing, translation, and improvement of the manuscript's readability. All conceptualization, study design, data collection, data analysis, interpretation of findings, and final approval of the manuscript were performed by the authors. The authors take full responsibility for the accuracy, integrity, and originality of the content.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

Acknowledgments

The authors thank the participating centers, clinicians, adolescents, and guardians who made the study possible.

Declaration of Interest

The authors report no conflict of interest.

Funding

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Ethics Considerations

The study was conducted in accordance with the ethical principles applicable to research involving human participants and the Declaration of Helsinki. Before enrollment, participants were informed about the study objectives and procedures, the voluntary nature of participation, and their right to discontinue participation. Informed consent was obtained from all participants. Participants could withdraw from the study at any stage without penalty. Personal information was treated confidentially, and the findings were reported in aggregate form without identifying individual participants.

References

1. World Health O. Diabetes 2024 [Available from: https://www.who.int/news-room/fact-sheets/detail/diabetes
2. World Health O. Obesity and overweight 2025 [Available from: https://www.who.int/news-room/fact-sheets/detail/obesity-and-overweight
3. American Diabetes Association Professional Practice Committee For Diabetes. 3. Prevention OR Delay Of Diabetes And Associated Comorbidities: Standards Of Care In Diabetes-2026. Diabetes Care. 2026;49(Suppl. 1):S50-S60. [PMID: 41358891] [PMCID: PMC12690170] [DOI]
4. Knowler WC, Barrett-Connor E, Fowler SE, Hamman RF, Lachin JM, Walker EA, et al. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. The New England Journal of Medicine. 2002;346(6):393-403. [DOI]
5. Critchley CR, Hardie EA, Moore SM. Examining The Psychological Pathways To Behavior Change In A Group-Based Lifestyle Program To Prevent Type 2 Diabetes. Diabetes Care. 2012;35(4):699-705. [PMID: 22338102] [PMCID: PMC3308314] [DOI]
6. Grant AM, Franklin J, Langford P. The Self-Reflection And Insight Scale: A New Measure Of Private Self-Consciousness. Social Behavior and Personality: An International Journal. 2002;30(8):821-36. [PMCID: PMC11868675] [DOI]
7. Roberts C, Stark P. Readiness For Self-Directed Change In Professional Behaviours: Factorial Validation Of The Self-Reflection And Insight Scale. Medical Education. 2008;42(11):1054-63. [PMID: 19141007] [DOI]
8. Gard T, Noggle JJ, Park CL, Vago DR, Wilson A. Potential Self-Regulatory Mechanisms Of Yoga For Psychological Health. Frontiers in Human Neuroscience. 2014;8:770. [PMID: 25368562] [PMCID: PMC4179745] [DOI]
9. Mehling WE, Chesney MA, Metzler TJ, Goldstein LA, Maguen S, Geronimo C, et al. A 12-Week Integrative Exercise Program Improves Self-Reported Mindfulness And Interoceptive Awareness In War Veterans With Posttraumatic Stress Symptoms. Journal of Clinical Psychology. 2018;74(4):554-65. [PMID: 29076530] [PMCID: PMC8730470] [DOI]
10. Anheyer D, Koch AK, Thoms MS, Dobos G, Cramer H. Yoga In Women With Abdominal Obesity: Do Lifestyle Factors Mediate The Effect? Secondary Analysis Of A Randomized Controlled Trial. Complementary Therapies in Medicine. 2021;60:102741. [PMID: 34144145] [DOI]
11. Cramer H, Thoms MS, Anheyer D, Lauche R, Dobos G. Yoga In Women With Abdominal Obesity: A Randomized Controlled Trial. Deutsches Ärzteblatt International. 2016;113(39):645-52. [DOI]
12. Sanogo F, Xu K, Cortessis VK, Weigensberg MJ, Watanabe RM. Mind- And Body-Based Interventions Improve Glycemic Control In Patients With Type 2 Diabetes: A Systematic Review And Meta-Analysis. Journal of Integrative and Complementary Medicine. 2023;29(2):69-79. [PMID: 36070591] [PMCID: PMC13134557] [DOI]
13. Hamasaki H. The Effects Of Mindfulness On Glycemic Control In People With Diabetes: An Overview Of Systematic Reviews And Meta-Analyses. Medicines. 2023;10(9):53. [PMID: 37755243] [PMCID: PMC10534311] [DOI]
14. Heo S, Kang JH, Umeakunne E, Lee S, Bertulfo TF, Barbé T, et al. Effects Of Meditation Intervention On Self-Management In Adult Patients With Type 2 Diabetes: A Systematic Literature Review And Meta-Analysis. Journal of Cardiovascular Nursing. 2023;38(6):581-92. [PMID: 37816085] [DOI]
15. Ngan HY, Chong YY, Chien WT. Effects Of Mindfulness- And Acceptance-Based Interventions On Diabetes Distress And Glycaemic Level In People With Type 2 Diabetes: A

Health Nexus
E-ISSN: 2981-2569

Systematic Review And Meta-Analysis. Diabetic Medicine. 2021;38(4):e14525. [PMID: 33438251] [DOI]
16. Nyklíček I, Zonneveld R, Denollet J. Introspective Interest And Insight In The Context Of Mindfulness-Based Stress Reduction: A Randomized Trial. Mindfulness. 2020;11:2176-88. [DOI]
17. Van Aalst J, Jennen L, Demyttenaere K, Sunaert S, Koole M, Ceccarini J, et al. Twelve-Week Yoga Versus Aerobic Cycling Initiation In Sedentary Healthy Subjects: A Behavioral And Multiparametric Interventional PET/Mr Study. Frontiers in Psychiatry. 2021;12:739356. [PMID: 34733191] [PMCID: PMC8558251] [DOI]
18. Goldberg SB, Imhoff-Smith T, Bolt DM, Wilson-Mendenhall CD, Dahl CJ, Davidson RJ, et al. Testing The Efficacy Of A Multicomponent, Self-Guided, Smartphone-Based Meditation App: Three-Armed Randomized Controlled Trial. JMIR Mental Health. 2020;7(11):e23825. [PMID: 33245288] [PMCID: PMC7732708] [DOI]
19. Bucknell KJ, Kangas M, Crane MF. Adaptive Self-Reflection And Resilience: The Moderating Effects Of Rumination On Insight As A Mediator. Personality and Individual Differences. 2022;185:111234. [DOI]

Health Nexus
E-ISSN: 2981-2569