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Effectiveness of Cognitive Behavioral Therapy in Reducing Anxiety Sensitivity and Negative Meta-Emotion among Patients with Type 2 Diabetes

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ABSTRACT

This study aimed to determine the effectiveness of Cognitive Behavioral Therapy (CBT) in reducing anxiety sensitivity and negative meta-emotion among patients with type 2 diabetes mellitus. This randomized controlled trial used a pretest–posttest design with a three-month follow-up. The study population consisted of adults with type 2 diabetes attending diabetes clinics and medical centers in Gorgan, Iran, in 2025. Of 87 screened patients, 50 eligible participants were recruited and randomly allocated to a CBT group or a control group at a 1:1 ratio. The intervention group received eight weekly 90-minute CBT sessions in addition to routine medical care, while the control group received routine medical care only. Anxiety sensitivity was assessed using the Anxiety Sensitivity Questionnaire, and negative meta-emotion was measured using the Mitmansgruber Meta-Emotion Questionnaire. Outcomes were assessed at pretest, posttest, and three-month follow-up. Data were analyzed in SPSS version 26 using mixed-design repeated-measures multivariate analysis of variance, univariate repeated-measures analyses, and Bonferroni-adjusted pairwise comparisons. The multivariate analysis indicated a significant overall group effect on the combined dependent variables, Wilks' Λ = .006, $F(2, 47) = 68.30$, $p < .001$, partial $\eta^2 = .924$. Repeated-measures analyses showed significant time × group interactions for anxiety sensitivity, $F = 166.50$, $p < .001$, partial $\eta^2 = .822$, and negative meta-emotion, $F = 333.80$, $p < .001$, partial $\eta^2 = .903$. Bonferroni comparisons indicated significant differences between pretest and posttest and between pretest and follow-up for both outcomes ($p < .001$), whereas posttest-to-follow-up differences were nonsignificant ($p > .05$), demonstrating maintenance of treatment effects over three months. CBT was effective in reducing anxiety sensitivity and negative meta-emotion among patients with type 2 diabetes, and the improvements were maintained at three-month follow-up, supporting the incorporation of structured cognitive-behavioral interventions into multidisciplinary diabetes care.

Keywords: Cognitive Behavioral Therapy; Anxiety Sensitivity; Negative Meta-Emotion; Type 2 Diabetes; Psychological Intervention; Randomized Controlled Trial

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Introduction

Type 2 diabetes mellitus is one of the most prevalent chronic metabolic disorders worldwide and represents a major public health concern because of its progressive nature, multiple systemic complications, substantial treatment burden, and long-term effects on quality of life. The condition requires continuous

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self-management involving medication adherence, dietary regulation, physical activity, glucose monitoring, periodic medical evaluation, and sustained behavioral adjustment. In addition to its metabolic consequences, type 2 diabetes is increasingly recognized as a condition with important psychological and emotional dimensions. Patients frequently experience worry about disease progression, fear of acute or chronic complications, frustration associated with lifestyle restrictions, uncertainty regarding glycemic control, and emotional exhaustion related to the ongoing demands of self-care. These challenges can generate persistent psychological distress and interfere with effective disease management. In Iran, the increasing prevalence of type 2 diabetes and related metabolic disorders has heightened the importance of addressing both the biomedical and psychological dimensions of the disease. A systematic review and meta-analysis of studies conducted in Iran documented a substantial burden of type 2 diabetes across different population groups, emphasizing the growing need for comprehensive prevention and treatment strategies (1). Similarly, the high prevalence of metabolic syndrome in Iran further reflects the broader cardiometabolic context within which type 2 diabetes develops and progresses (2). Consequently, contemporary diabetes care increasingly emphasizes integrated interventions that address psychological well-being, health behavior, and medical outcomes simultaneously.

The chronic nature of diabetes creates a psychological context in which emotional difficulties may emerge not merely as secondary reactions but as clinically meaningful factors capable of influencing illness behavior and treatment outcomes. Depression, anxiety, diabetes-related distress, fear of complications, and negative emotional responses are commonly reported among individuals living with diabetes. Recent evidence indicates that depression is highly prevalent among patients with diabetes and is associated with a variety of demographic, clinical, and behavioral risk factors (3). Psychological vulnerability is not limited to adults with long-established disease; depressive comorbidity has also been documented among children and adolescents with type 2 diabetes, suggesting that the emotional burden of the condition can emerge across developmental stages (4). Beyond depressive symptoms, chronic worry and distress may interfere with adherence to medical recommendations and reduce the ability of patients to engage consistently in self-care. This issue is particularly important because effective diabetes management is behaviorally demanding, and psychological variables can either facilitate or undermine treatment adherence. Personality characteristics and coping strategies have been identified as relevant predictors of adherence in chronic non-communicable diseases, illustrating the importance of patients' cognitive and emotional responses to illness in determining health-related behavior (5). Current standards of diabetes care therefore increasingly recognize psychological health and positive health behaviors as integral components of optimal disease management rather than optional adjuncts to biomedical treatment (6).

Negative emotional states can affect diabetes outcomes through several interconnected pathways. Anxiety, sadness, frustration, anger, and distress may reduce motivation for self-care, impair decision-making, increase avoidance, and contribute to inconsistent dietary, medication, or physical activity patterns. Empirical research has demonstrated associations between negative emotions, self-care activities, and glycemic control among adults with type 2 diabetes, indicating that psychological functioning may have direct implications for daily disease management (7). Likewise, negative emotions have been shown to play a mediating role in the relationship between impulsivity and everyday executive functioning among patients with type 2 diabetes, suggesting that emotional dysregulation may compromise cognitive processes that are

important for planning, behavioral control, and adherence (8). Research on neuroticism and self-management behaviors has similarly highlighted the role of stable emotional vulnerability in shaping how individuals respond to the practical demands of diabetes care (9). At the neurobiological level, emotional processing and cognitive functioning may also be closely intertwined in type 2 diabetes. Neuroimaging evidence has identified patterns of functional connectivity related to emotional conflict monitoring that may be associated with subsequent cognitive decline, reinforcing the view that emotional and cognitive processes are clinically relevant to the course of diabetes (10).

One psychological construct that may be particularly relevant in this context is anxiety sensitivity. Anxiety sensitivity refers to the tendency to fear anxiety-related sensations because of beliefs that these sensations may have harmful physical, cognitive, or social consequences. Individuals with high anxiety sensitivity may interpret ordinary physiological changes, including increased heart rate, dizziness, sweating, trembling, breathlessness, or cognitive confusion, as indications of imminent danger or loss of control. This tendency may be especially problematic in patients with chronic medical conditions such as diabetes, because the disease itself can involve bodily sensations and fluctuations that may be interpreted catastrophically. Concerns regarding hypoglycemia, cardiovascular symptoms, neuropathic sensations, fatigue, or other somatic experiences can potentially become amplified when patients are highly sensitive to anxiety-related bodily cues. Anxiety sensitivity has been associated with health anxiety, and distress tolerance has been proposed as one mechanism through which anxiety sensitivity may contribute to excessive concern about health-related sensations (11). In patients with diabetes, such a pattern may create a self-reinforcing cycle in which bodily sensations trigger threat interpretations, these interpretations intensify anxiety, and heightened anxiety further increases attention to physical sensations.

The relevance of anxiety sensitivity is also reinforced by the fact that type 2 diabetes carries a risk of serious long-term complications. Cardiovascular complications, including heart failure, represent an important but sometimes underrecognized component of diabetes-related morbidity (12). Awareness of these risks may be adaptive when it promotes adherence and preventive behavior, but it may become maladaptive when physical sensations are consistently interpreted through a catastrophic lens. Patients who perceive benign bodily changes as signs of severe complications may experience heightened vigilance and persistent anticipatory anxiety. Such cognitive patterns may contribute to avoidance, excessive reassurance seeking, reduced confidence in disease self-management, and increased emotional distress. This makes anxiety sensitivity a clinically meaningful target because it reflects not only the presence of anxiety but also the manner in which individuals interpret and respond to internal experiences.

A second construct of particular relevance is meta-emotion, which refers to emotional responses directed toward one's own emotions. Individuals do not merely experience primary emotions such as sadness, fear, anger, or frustration; they may also evaluate and react emotionally to those experiences. Negative meta-emotions may include shame about feeling afraid, anger about feeling vulnerable, guilt about emotional distress, fear of anxiety itself, or attempts to suppress and excessively control unwanted emotions. These secondary emotional reactions can intensify psychological distress by transforming a transient emotional experience into a broader cycle of self-criticism, avoidance, and dysregulation. In chronic illnesses such as diabetes, negative meta-emotional responses may develop when patients judge themselves harshly for experiencing fear, frustration, discouragement, or uncertainty. Rather than accepting these experiences as

understandable responses to a demanding chronic condition, patients may interpret them as evidence of weakness or personal failure. This additional layer of negative emotional processing can increase distress and interfere with adaptive coping.

Research on emotional functioning in diabetes supports the importance of emotional self-awareness and emotion regulation. Among adults with diabetes, emotional self-awareness and regulatory capacity have been linked to diabetes-related distress, suggesting that how patients identify, interpret, and manage emotions may influence their psychological adjustment to illness (13). Diabetes distress itself is now regarded as an important clinical phenomenon that differs conceptually from major depressive disorder, although the two may overlap. It reflects emotional burdens specifically associated with living with diabetes, including concerns about disease management, treatment demands, complications, healthcare experiences, and perceived failure to maintain adequate control. Despite growing awareness of diabetes distress, challenges remain in identifying effective, scalable approaches for addressing it within routine primary care (14). Negative meta-emotion may therefore represent an important therapeutic target because it captures a layer of maladaptive emotional processing that can maintain or intensify diabetes-related distress even when the initial emotional response is understandable.

Psychological interventions that directly target maladaptive cognitions and emotional responses may offer a useful complement to routine medical care. Cognitive Behavioral Therapy is among the most extensively studied psychological treatments for anxiety, depression, maladaptive beliefs, behavioral avoidance, and emotional dysregulation. CBT is based on the proposition that emotional and behavioral difficulties are influenced by patterns of interpretation, underlying beliefs, and learned responses. Through techniques such as psychoeducation, self-monitoring, identification of automatic thoughts, cognitive restructuring, behavioral experiments, exposure, coping-skills training, and relapse prevention, patients are taught to identify maladaptive patterns and replace them with more balanced and functional responses. These mechanisms make CBT particularly relevant to anxiety sensitivity because catastrophic interpretations of bodily or emotional sensations can be explicitly identified, evaluated, and modified. CBT may also be useful for negative meta-emotion by helping individuals recognize maladaptive beliefs about emotions, reduce secondary self-criticism and fear, and develop more adaptive strategies for responding to emotional experiences.

Evidence for CBT has expanded across a wide range of psychological and medical contexts. A randomized controlled trial comparing cognitive behavioral and dialectical behavior approaches demonstrated that structured psychological interventions can enhance important psychological resources, including psychological capital, in populations exposed to substantial stress (15). Systematic reviews have also supported the effectiveness of CBT in reducing psychological distress among patients with cardiovascular disease, including survivors of myocardial infarction (16). Similarly, a randomized controlled trial involving individuals with hypertension demonstrated beneficial effects of CBT on psychological distress, illustrating the applicability of cognitive-behavioral strategies to chronic medical populations beyond primary psychiatric disorders (17). Emotion-focused and acceptance-based interventions have likewise shown beneficial effects in chronic pain conditions, reinforcing the broader therapeutic value of targeting maladaptive emotional processing in persistent health problems (18).

Within Iranian research, the effectiveness of CBT for emotional disorders has also received empirical support. A systematic review and meta-analysis of Iranian studies concluded that CBT-based interventions are effective for a range of emotional difficulties, indicating that cognitive-behavioral techniques can be successfully applied within the Iranian sociocultural context (19). More specifically, recent evidence from adults with type 2 diabetes has demonstrated that group-based transdiagnostic CBT can improve depression, anxiety, quality of life, and medication adherence (20). These findings are particularly relevant because they suggest that CBT may influence both psychological symptoms and disease-management behaviors in this population. The broader literature on non-pharmacological interventions in type 2 diabetes also supports the role of psychological treatments. A systematic review and network meta-analysis reported that non-pharmacological therapies can improve depression, anxiety, and glycemic outcomes in patients with type 2 diabetes, indicating that psychosocial interventions may have clinically meaningful effects extending beyond emotional symptoms alone (21).

Psychological interventions may also contribute to biological and physiological outcomes associated with chronic disease. In patients with diabetic nephropathy, multimodal psychological intervention has been associated with improvements in psychological well-being as well as inflammatory profiles, suggesting a potentially meaningful relationship between emotional functioning and physiological processes (22). Case-based evidence has also described improvements in stress-related outcomes among patients with type 2 diabetes following interventions targeting neuro-emotional processes (23). Although such evidence does not establish causal mechanisms on its own, it contributes to the growing recognition that psychological stress and emotional regulation are relevant components of comprehensive diabetes care.

Advances in research methodology have also increased interest in identifying which patients may benefit most from CBT. Recent systematic review evidence indicates that artificial intelligence and predictive modeling are increasingly being used to estimate treatment response among individuals receiving CBT for anxiety disorders (24). Such developments reflect a broader transition toward personalized psychological care in which emotional, cognitive, behavioral, and potentially biological characteristics may help guide treatment selection. However, personalization requires a clearer understanding of specific therapeutic targets. In patients with type 2 diabetes, much of the existing intervention literature has focused on broad outcomes such as depression, generalized anxiety, quality of life, adherence, or diabetes distress. Comparatively less attention has been directed toward transdiagnostic cognitive-affective mechanisms such as anxiety sensitivity and negative meta-emotion, even though these constructs may contribute to persistent distress and maladaptive reactions to disease-related sensations and emotional experiences.

This gap is important because reducing general anxiety does not necessarily imply that patients have become less fearful of internal sensations, and reductions in depressive symptoms do not necessarily indicate healthier responses to one's own emotions. Anxiety sensitivity and negative meta-emotion represent more specific cognitive-affective processes that may maintain distress even when overall symptom severity changes. CBT is theoretically well suited to address both constructs because it challenges catastrophic beliefs about internal experiences, promotes more differentiated awareness of thoughts and emotions, reduces avoidance and suppression, and strengthens adaptive coping. Moreover, because individuals with chronic illnesses are repeatedly exposed to bodily sensations, health uncertainty, and emotionally challenging self-management demands, interventions that alter the interpretation of these experiences may have durable

value. Accordingly, examining these variables may provide a more nuanced understanding of how CBT contributes to psychological adjustment in patients with type 2 diabetes.

The need for such research is further strengthened by contemporary diabetes-care recommendations emphasizing behavioral health, emotional well-being, and sustained engagement in self-management (6). When chronic emotional distress remains untreated, adherence may deteriorate and the capacity to maintain demanding self-care routines may decline. Conversely, strengthening patients' ability to reinterpret bodily sensations, regulate emotional responses, and reduce secondary negative reactions to distress may support both psychological adaptation and everyday disease management. Considering the high burden of type 2 diabetes in Iran, the documented role of negative emotions in diabetes-related functioning, and increasing evidence supporting psychological interventions in chronic medical conditions, evaluating CBT in relation to specific cognitive-emotional mechanisms is clinically and theoretically warranted.

Therefore, the aim of the present study was to determine the effectiveness of Cognitive Behavioral Therapy in reducing anxiety sensitivity and negative meta-emotion among patients with type 2 diabetes.

Methods and Materials

Study Design and Participants

This study employed a randomized controlled trial with a pretest–posttest design and a three-month follow-up to investigate the effectiveness of Cognitive Behavioral Therapy (CBT) in reducing anxiety sensitivity and negative meta-emotion among patients with type 2 diabetes mellitus. The study population consisted of adults with a confirmed diagnosis of type 2 diabetes who attended diabetes clinics and medical centers in Gorgan, Iran, during 2025. Potential participants were initially recruited using convenience sampling from the accessible patient population and subsequently allocated randomly to either the CBT intervention group or the control group at a 1:1 ratio. During the initial recruitment and screening stage, 87 patients were assessed for eligibility according to predefined inclusion and exclusion criteria. The required sample size was estimated using G*Power software, version 3.1.9.7, for a mixed-design analysis involving within-subject and between-subject effects. Assuming an effect size of $f = 0.40$, a significance level of $\alpha = 0.05$, and statistical power of 0.80, the minimum required sample was estimated at 46 participants. To compensate for a possible attrition rate of approximately 10%, 50 eligible participants were ultimately recruited and randomized, with 25 participants assigned to the CBT group and 25 to the control group.

Eligibility criteria included a physician-confirmed diagnosis of type 2 diabetes mellitus, an age range of 20 to 50 years, possession of at least a high school diploma, receipt of ongoing medical treatment for diabetes, and willingness to participate voluntarily as demonstrated by written informed consent. Individuals were excluded if they had a documented history of a severe psychiatric disorder based on available clinical records or professional assessment, were simultaneously participating in another structured psychological or psychotherapeutic intervention, or withdrew their consent at any stage of the study. For participants allocated to the CBT group, absence from more than three treatment sessions was additionally considered a criterion for discontinuation of the intervention. Screening of the 87 potential candidates resulted in the enrollment of 50 eligible participants, while individuals who failed to satisfy the eligibility criteria or declined participation were excluded before randomization. Simple randomization was performed using a computer-generated random sequence prepared by a researcher who was not directly

involved in delivering the intervention. Allocation concealment was maintained through sequentially numbered, sealed, opaque envelopes, which were opened only after completion of the baseline assessment and formal enrollment of each participant.

Participants in both groups continued to receive their routine diabetes-related medical care throughout the study. Routine care included scheduled clinical follow-ups, prescribed pharmacological treatment, monitoring of diabetes-related health indicators, and standard recommendations concerning diet, physical activity, medication adherence, and general disease management provided by healthcare professionals. Participants assigned to the intervention group additionally received the CBT program, whereas the control group received no organized psychological intervention during the study period. Because of the nature of psychotherapy, neither participants nor the therapist could be blinded to treatment allocation; however, all outcome measures were administered using identical instructions and assessment procedures in the two groups to reduce the potential for differential measurement bias. Data were collected at three assessment points: immediately before the intervention as the pretest, immediately after completion of the eight-session intervention as the posttest, and three months after treatment completion as the follow-up assessment. All 50 randomized participants completed the posttest and three-month follow-up assessments, and no attrition occurred during the study period. To enhance intervention fidelity, all CBT sessions were conducted by a PhD candidate in Clinical Psychology who had received specialized training in CBT. With participants' consent, a senior clinical psychologist reviewed approximately 20% of recorded treatment sessions, and a protocol-based adherence checklist was used to assess consistency between treatment delivery and the therapeutic manual. Before enrollment, participants were informed of the study objectives, procedures, voluntary nature of participation, confidentiality safeguards, and their right to discontinue participation at any time without consequences for their medical treatment. Written informed consent was obtained before data collection, and research data were anonymized and used exclusively for scientific purposes.

Data Collection Tools

Anxiety sensitivity was assessed using the Anxiety Sensitivity Questionnaire (ASQ), a 16-item self-report measure developed to assess fear of anxiety-related sensations and beliefs concerning the potentially harmful physical, psychological, or social consequences of anxiety symptoms. Each item is rated on a five-point Likert scale ranging from 0 ("very little") to 4 ("very much"), producing a total score ranging from 0 to 64, with higher scores indicating greater anxiety sensitivity. The instrument encompasses three major dimensions: fear of physical concerns, assessed through eight items; fear of cognitive dyscontrol, assessed through four items; and fear of publicly observable anxiety reactions, assessed through four items. Previous psychometric studies have provided evidence for satisfactory reliability and validity of the instrument, with Cronbach's alpha coefficients generally ranging between 0.80 and 0.90. Test–retest reliability coefficients of approximately 0.75 across a two-week interval and 0.71 across a substantially longer interval have also been reported. Evidence for construct validity has been established through exploratory and confirmatory factor analyses, with theoretically meaningful factor structures and item loadings generally exceeding 0.40. Psychometric investigations conducted in Iranian populations have similarly demonstrated strong reliability, including internal consistency, test–retest reliability, and split-half reliability coefficients of 0.93, 0.95, and 0.97, respectively. Concurrent validity has also been supported through significant associations

with general psychological symptom measures, including a reported correlation of 0.56 with the SCL-90, while item–total correlations ranging from 0.74 to 0.88 have provided additional evidence for internal consistency. In the present study, the questionnaire demonstrated acceptable internal consistency, with a Cronbach's alpha coefficient of 0.79. The questionnaire was administered at the pretest, posttest, and three-month follow-up assessments under standardized conditions.

Negative meta-emotion was measured using the Mitmansgruber Meta-Emotion Questionnaire (MMEQ), a 28-item self-report instrument developed to assess individuals' emotional responses to their own emotional experiences. Items are rated on a six-point Likert-type scale ranging from 1 ("does not apply at all") to 6 ("completely applies"). The questionnaire assesses six meta-emotional dimensions that are organized into broader positive and negative meta-emotion factors. The dimensions of anger, emotional suppression, shame or humiliation, and excessive control constitute the negative meta-emotion factor, whereas compassion and interest represent the positive meta-emotion factor. Because the primary outcome of the present study was negative meta-emotion, scores corresponding to the negative dimensions were used to represent participants' maladaptive emotional reactions toward their own emotional states, with higher scores reflecting greater negative meta-emotional responding. Previous factor-analytic studies have supported the construct validity of the instrument, identifying an interpretable two-factor structure representing positive and negative meta-emotional orientations, with acceptable model-fit indices, including a chi-square-to-degrees-of-freedom ratio below 3 and item factor loadings generally greater than 0.40. Previous research using the questionnaire in Iranian samples reported a Cronbach's alpha coefficient of approximately 0.78, supporting its acceptable internal consistency. In the present study, the negative meta-emotion measure demonstrated satisfactory reliability, with a Cronbach's alpha coefficient of 0.832. As with the anxiety sensitivity measure, the MMEQ was administered at baseline, immediately following treatment, and at the three-month follow-up under equivalent assessment conditions for participants in both study groups.

Intervention

Participants assigned to the intervention group received a structured Cognitive Behavioral Therapy program consisting of eight weekly sessions, each lasting approximately 90 minutes, while continuing their routine medical treatment for diabetes. The intervention was based on established cognitive-behavioral principles and was adapted to address psychological difficulties commonly experienced by individuals living with chronic medical conditions. The principal therapeutic objectives were to assist participants in recognizing maladaptive patterns of thinking, reducing catastrophic interpretations of physical and emotional sensations, modifying dysfunctional cognitive responses, strengthening emotion-regulation abilities, developing effective coping strategies, and improving psychological adjustment to the continuing demands associated with diabetes management. The first session introduced the treatment process, therapeutic goals, session structure, general participation rules, and the cognitive-behavioral model, with particular attention to the interaction among thoughts, emotions, physiological sensations, and behavior. During the second session, participants' major psychological difficulties were assessed and conceptualized, and the therapist introduced cognitive-behavioral case formulation by identifying associations among triggering situations, automatic thoughts, emotional reactions, bodily sensations, and behavioral responses.

The third session focused on collaborative goal setting and the development of specific and achievable therapeutic objectives; participants were introduced to a therapy notebook for recording thoughts, emotions, daily experiences, behavioral patterns, and homework assignments, and basic activity planning and self-monitoring were initiated. The fourth session concentrated on identifying automatic negative thoughts and maladaptive cognitive patterns associated with distressing emotional and physical experiences, and participants practiced structured thought-recording techniques. The fifth session emphasized cognitive restructuring, including evaluating the accuracy and usefulness of maladaptive thoughts, identifying cognitive errors, examining alternative interpretations, and generating more balanced and adaptive cognitions. The sixth session expanded cognitive restructuring through systematic identification of cognitive distortions, evaluation of evidence supporting and contradicting distress-related beliefs, development of coping statements, and preparation of coping cards that could be used when participants encountered stressful or anxiety-provoking situations. During the seventh session, graded task assignment and behavioral practice were introduced, and participants were encouraged to approach difficult situations progressively while applying the cognitive and behavioral strategies developed during treatment; guided imagery exercises were additionally used to rehearse adaptive responses to distressing circumstances. The eighth and final session focused on reviewing and consolidating the therapeutic skills acquired throughout treatment, discussing homework and therapy notebooks, addressing unresolved difficulties, reinforcing effective coping responses, and developing relapse-prevention strategies to facilitate continued use of CBT techniques after treatment termination. Homework assignments were provided throughout the intervention to strengthen skill acquisition and promote generalization of therapeutic strategies to everyday circumstances. Participants in the control group continued routine medical care but received no structured psychological intervention during the corresponding study period.

Data Analysis

Data were analyzed using IBM SPSS Statistics version 26. Descriptive statistics, including means and standard deviations, were calculated for anxiety sensitivity and negative meta-emotion at the pretest, posttest, and three-month follow-up assessments. Before inferential analyses were conducted, the relevant statistical assumptions were evaluated, including the normality of score distributions, homogeneity of variances, and the sphericity assumption for repeated measurements. A mixed-design repeated-measures multivariate analysis of variance (MANOVA) was used as the principal inferential procedure to examine changes in anxiety sensitivity and negative meta-emotion over time and to determine whether patterns of change differed between the CBT and control groups. Treatment condition, comprising the CBT and control groups, was specified as the between-subjects factor, whereas time, comprising pretest, posttest, and three-month follow-up measurements, was specified as the within-subjects factor. Anxiety sensitivity and negative meta-emotion were entered simultaneously as dependent variables. The analysis therefore examined the multivariate main effect of time, the between-group effect, and, most importantly, the group × time interaction representing differential changes in outcomes across the three assessment occasions according to treatment condition. Statistically significant multivariate effects were followed by univariate repeated-measures analyses for each dependent variable. Bonferroni-adjusted pairwise comparisons were subsequently used to determine the specific assessment occasions between which statistically significant

differences occurred while controlling for inflation of the Type I error rate resulting from multiple comparisons. Mauchly's test was used to assess the assumption of sphericity, and when this assumption was violated, the Greenhouse–Geisser correction was applied to adjust the relevant degrees of freedom. Statistical significance was established at an alpha level of 0.05, and all statistical tests were conducted using two-tailed criteria.

Findings and Results

The final analysis included 50 patients with type 2 diabetes, comprising 25 participants in the Cognitive Behavioral Therapy (CBT) group and 25 participants in the control group. Examination of baseline demographic characteristics indicated that the two groups were comparable before initiation of the intervention. No statistically significant between-group differences were observed in age, gender, educational attainment, or marital status ($p > .05$). Accordingly, the randomization procedure produced groups with relatively similar demographic profiles, reducing the likelihood that differences in these background characteristics accounted for subsequent changes in anxiety sensitivity or negative meta-emotion.

Table 1. Descriptive Statistics for Anxiety Sensitivity and Negative Meta-Emotion by Group and Assessment Time

Variable	Assessment Time	CBT Group, M (SD)	Control Group, M (SD)
Anxiety Sensitivity	Pretest	42.60 (3.02)	42.80 (3.18)
	Posttest	26.70 (4.78)	40.10 (3.13)
	Three-month follow-up	27.40 (5.06)	40.80 (2.29)
Negative Meta-Emotion	Pretest	61.70 (2.10)	61.20 (2.33)
	Posttest	37.20 (2.81)	55.30 (2.47)
	Three-month follow-up	37.40 (2.90)	53.40 (2.51)

As shown in Table 1, the two groups had highly similar mean scores at pretest for both outcome variables. For anxiety sensitivity, the CBT group had a baseline mean of 42.60 (SD = 3.02), compared with 42.80 (SD = 3.18) in the control group. Following the intervention, anxiety sensitivity in the CBT group decreased markedly to 26.70 (SD = 4.78), whereas the control group showed only a modest reduction to 40.10 (SD = 3.13). At the three-month follow-up, the mean anxiety sensitivity score in the CBT group remained low at 27.40 (SD = 5.06), suggesting maintenance of the improvement observed immediately after treatment, while the control-group mean remained relatively high at 40.80 (SD = 2.29). A similar pattern was observed for negative meta-emotion. The pretest means were 61.70 (SD = 2.10) in the CBT group and 61.20 (SD = 2.33) in the control group. At posttest, the CBT-group mean declined substantially to 37.20 (SD = 2.81), whereas the control-group mean decreased more modestly to 55.30 (SD = 2.47). At follow-up, the CBT group maintained a mean of 37.40 (SD = 2.90), while the corresponding control-group mean was 53.40 (SD = 2.51). Overall, the descriptive findings demonstrated considerably greater reductions in both anxiety sensitivity and negative meta-emotion among participants receiving CBT, with the observed improvements largely sustained during the three-month follow-up period.

Prior to conducting the inferential analyses, the statistical assumptions underlying the repeated-measures model were evaluated. The Shapiro–Wilk test indicated no significant departures from normality for the study variables across the assessment occasions ($p > .05$). Levene's test also supported the assumption of

homogeneity of variance between the two groups for anxiety sensitivity, F = 1.12, p = .29, and negative meta-emotion, F = 0.84, p = .36. In addition, Box's M test was nonsignificant (p = .15), indicating that the variance–covariance matrices could be regarded as homogeneous across groups. Sphericity was also examined using Mauchly's test. Where the sphericity assumption was not adequately satisfied, the Greenhouse–Geisser correction was applied to the within-subject effects, resulting in the adjusted fractional degrees of freedom reported in the repeated-measures analyses. Collectively, these diagnostic findings indicated that the data were suitable for the planned multivariate and repeated-measures analyses.

The multivariate analysis demonstrated a statistically significant overall effect of treatment condition on the combined dependent variables. Specifically, Wilks' Lambda indicated a significant multivariate difference between the CBT and control groups, Wilks' $\Lambda = .006$, $F(2, 47) = 68.30$, $p < .001$, partial $\eta^2 = .924$. This effect size indicated that a substantial proportion of multivariate variance in anxiety sensitivity and negative meta-emotion was associated with group membership. The conclusion was further supported by the alternative multivariate criteria, including Pillai's Trace = .62, F = 24.40, p < .001, partial $\eta^2 = .810$; Hotelling's Trace = 63.40, F = 176.00, p < .001, partial $\eta^2 = .969$; and Roy's Largest Root = 61.70, F = 353.50, p < .001, partial $\eta^2 = .984$. Thus, when anxiety sensitivity and negative meta-emotion were considered simultaneously, the pattern of outcomes differed significantly between participants receiving CBT and those receiving routine medical care alone.

Table 2. Repeated-Measures Analysis of Variance for Anxiety Sensitivity and Negative Meta-Emotion

Dependent Variable	Source of Variation	SS	df	MS	F	p	Partial η^2
Anxiety Sensitivity	Time	7285.60	1.49	4882.30	996.10	< .001	.933
	Group	4689.90	1.00	4689.90	79.60	< .001	.689
	Time × Group	2436.30	2.98	816.30	166.50	< .001	.822
Negative Meta-Emotion	Time	14580.50	1.46	9972.70	3407.20	< .001	.979
	Group	5012.50	1.00	5012.50	143.70	< .001	.800
	Time × Group	2857.30	2.92	977.10	333.80	< .001	.903

As presented in Table 2, the repeated-measures analyses revealed significant effects of time, group, and the interaction between time and group for both outcome variables. For anxiety sensitivity, the main effect of time was statistically significant, F = 996.10, p < .001, partial $\eta^2 = .933$, indicating a substantial change in anxiety sensitivity across the three measurement occasions. The main effect of group was also significant, F = 79.60, p < .001, partial $\eta^2 = .689$, demonstrating an overall difference between the CBT and control groups. More importantly, the time × group interaction was statistically significant, F = 166.50, p < .001, partial $\eta^2 = .822$, indicating that changes in anxiety sensitivity over time differed substantially according to treatment condition. Comparable findings were obtained for negative meta-emotion. The main effect of time was significant, F = 3407.20, p < .001, partial $\eta^2 = .979$, as was the main effect of group, F = 143.70, p < .001, partial $\eta^2 = .800$. The time × group interaction was also statistically significant, F = 333.80, p < .001, partial $\eta^2 = .903$. The particularly large interaction effect indicated that the temporal reduction in negative meta-emotion was considerably greater among participants receiving CBT than among those in the control condition. Taken together with the descriptive statistics, these findings support a substantial intervention-related reduction in both anxiety sensitivity and negative meta-emotion.

Table 3. Bonferroni-Adjusted Pairwise Comparisons Across Assessment Times

Dependent Variable	Comparison	Mean Difference	p
Anxiety Sensitivity	Pretest – Posttest	12.30*	< .001
	Pretest – Follow-up	11.70*	< .001
	Posttest – Follow-up	−0.60	.333
Negative Meta-Emotion	Pretest – Posttest	16.80*	< .001
	Pretest – Follow-up	17.20*	< .001
	Posttest – Follow-up	0.39	.344

The Bonferroni-adjusted pairwise comparisons presented in Table 3 further clarified the pattern of change across the three assessment occasions. For anxiety sensitivity, the difference between pretest and posttest was statistically significant, with a mean difference of 12.30 ($p < .001$), and the difference between pretest and three-month follow-up was likewise significant, with a mean difference of 11.70 ($p < .001$). In contrast, the difference between posttest and follow-up was not statistically significant, mean difference = −0.60, $p = .333$. A comparable pattern emerged for negative meta-emotion: the mean difference between pretest and posttest was 16.80 ($p < .001$), and the difference between pretest and follow-up was 17.20 ($p < .001$), whereas the posttest-to-follow-up difference was nonsignificant, mean difference = 0.39, $p = .344$. These results indicate that the reductions observed following the intervention were maintained over the three-month follow-up interval, with no evidence of a statistically significant deterioration from posttest to follow-up for either outcome.

Discussion and Conclusion

The present study examined the effectiveness of Cognitive Behavioral Therapy (CBT) in reducing anxiety sensitivity and negative meta-emotion among patients with type 2 diabetes. The findings showed that participants who received CBT experienced substantial reductions in both anxiety sensitivity and negative meta-emotion from pretest to posttest, whereas the control group demonstrated only limited change across the same period. These improvements remained largely stable at the three-month follow-up. The repeated-measures analyses further demonstrated significant effects of time, group, and the time × group interaction for both dependent variables, indicating that the pattern of change differed meaningfully between the CBT and control conditions. Bonferroni-adjusted comparisons showed significant differences between pretest and posttest and between pretest and follow-up for both outcomes, while the differences between posttest and follow-up were nonsignificant. Taken together, these results suggest that CBT produced clinically meaningful psychological improvements and that the therapeutic gains were sustained for at least three months after completion of treatment.

The reduction in anxiety sensitivity observed in the intervention group can be interpreted within the cognitive-behavioral framework. Anxiety sensitivity is maintained largely through catastrophic interpretations of physiological and emotional sensations. Patients who believe that bodily arousal, dizziness, increased heart rate, fatigue, cognitive difficulty, or other internal sensations indicate imminent harm may become increasingly vigilant toward bodily changes, thereby intensifying anxiety and reinforcing maladaptive interpretations. In type 2 diabetes, this process may be particularly pronounced because patients routinely encounter fluctuations in physical sensations associated with glycemic variation, medication effects, fatigue, dietary changes, and concerns about possible complications. CBT directly targets

this interpretive process by teaching individuals to identify automatic thoughts, examine the evidence supporting threatening interpretations, and generate more realistic explanations for internal experiences. The substantial decline in anxiety sensitivity observed in the present study is therefore consistent with the mechanisms through which CBT is expected to operate.

This finding is also compatible with research demonstrating the relationship between anxiety sensitivity, health anxiety, and reduced tolerance of distress. Majidazar et al. showed that anxiety sensitivity is related to health anxiety and that distress tolerance may play an important mediating role in this relationship (11). This is particularly relevant to patients with diabetes because physical symptoms may readily become the focus of excessive concern. By increasing participants' ability to reinterpret bodily sensations and tolerate emotional discomfort, CBT may have weakened the link between internal sensations and catastrophic appraisal. The intervention used in the present study included cognitive restructuring, recognition of cognitive distortions, development of coping statements, graded behavioral practice, and guided imagery, all of which may reduce catastrophic beliefs and increase confidence in managing anxiety-provoking experiences. In this way, the decrease in anxiety sensitivity was likely not merely a general reduction in anxiety but a more specific change in beliefs about the meaning and consequences of anxiety-related sensations.

The present findings are also consistent with a broader body of evidence showing that CBT can reduce psychological distress in individuals with chronic medical conditions. A systematic review of CBT among myocardial infarction survivors reported beneficial effects on psychological distress, supporting the applicability of cognitive-behavioral interventions in populations managing serious physical illnesses (16). Similarly, CBT has been shown to reduce psychological distress in individuals with hypertension, demonstrating that cognitive and behavioral techniques can be effectively integrated into the management of chronic medical conditions in which fear, uncertainty, and ongoing self-monitoring are prominent (17). Although these studies focused on different medical populations, their findings converge with the present results by indicating that modifying maladaptive cognitions and strengthening coping processes can reduce distress associated with chronic disease.

The significant reduction in negative meta-emotion represents another important finding. Negative meta-emotion involves maladaptive emotional reactions to one's own emotional experiences, such as becoming ashamed of feeling anxious, angry about feeling vulnerable, distressed about sadness, or excessively attempting to suppress and control unwanted emotions. In chronic illness, these secondary emotional reactions may intensify the original emotional experience and contribute to a self-perpetuating cycle of dysregulation. Patients with type 2 diabetes may experience frustration, uncertainty, fear, or discouragement in response to disease-management demands and may then evaluate those emotions negatively. The present intervention likely reduced negative meta-emotion by helping participants differentiate thoughts from emotions, identify dysfunctional appraisals of emotional experiences, and replace rigid or self-critical responses with more adaptive interpretations and coping strategies.

This interpretation is consistent with evidence highlighting the importance of emotional awareness and emotion regulation in diabetes-related distress. Bassi et al. found that emotional self-awareness and emotion regulation were meaningfully associated with diabetes distress, indicating that the manner in which individuals recognize and manage their emotional states is central to psychological adaptation to diabetes

(13). The present findings extend this line of research by suggesting that CBT may not only reduce primary distress but also alter patients' secondary emotional responses to their own emotions. Through repeated identification of automatic thoughts, cognitive restructuring, self-monitoring, and practice of coping responses, participants may have learned to interpret emotional reactions as manageable experiences rather than as signs of weakness, danger, or failure.

The results are likewise consistent with research demonstrating that negative emotions can influence self-care and cognitive functioning in patients with type 2 diabetes. Song et al. reported that negative emotions were associated with self-care activities and glycemic control, underscoring the practical significance of psychological functioning in diabetes management (7). Liu et al. further showed that negative emotions mediated the relationship between trait impulsivity and everyday executive functions in patients with type 2 diabetes, suggesting that emotional dysregulation may compromise cognitive processes needed for planning and self-management (8). From this perspective, reducing negative meta-emotion may have implications beyond subjective emotional relief. When patients respond less negatively to their own distress, they may be better able to maintain problem-solving, planning, medication adherence, and other self-management behaviors under stressful conditions.

The findings also align with research emphasizing the broader relevance of personality and emotional vulnerability to diabetes self-management. Sun et al. identified patterns linking neuroticism with self-management behaviors in type 2 diabetes, indicating that heightened emotional reactivity can influence the way individuals engage with disease-management tasks (9). Because anxiety sensitivity and negative meta-emotion both reflect forms of heightened reactivity to internal experience, the observed reductions may represent meaningful changes in the psychological processes that interfere with adaptive self-regulation. CBT may have reduced this reactivity by providing participants with a structured framework for observing thoughts and emotions, challenging exaggerated interpretations, and responding more flexibly to distress.

The present results are especially consistent with recent evidence concerning CBT in individuals with type 2 diabetes. Nateghi et al. reported that group-based transdiagnostic CBT improved depression, anxiety, quality of life, and medication adherence among adults with type 2 diabetes (20). Although the outcome variables in that trial differed from those examined in the present study, the direction of findings is similar and supports the use of CBT as a psychological adjunct to routine diabetes care. The present study adds to this evidence by demonstrating that CBT may also influence more specific cognitive-affective mechanisms, namely anxiety sensitivity and negative meta-emotion. These constructs may be particularly important because they concern how patients interpret bodily and emotional experiences, rather than merely the overall intensity of anxiety or depression.

The findings also correspond with evidence from Iranian studies indicating that CBT is effective in reducing emotional disorders. A systematic review and meta-analysis of Iranian research found that CBT interventions produced favorable effects across a range of emotional outcomes (19). This is relevant because cultural context may influence emotional expression, coping patterns, attitudes toward psychological treatment, and the interpretation of chronic illness. The present findings therefore contribute additional evidence that CBT can be effectively applied in Iranian clinical populations, including patients with type 2 diabetes, and can produce changes in specific emotional and cognitive processes.

The present results are also supported by broader evidence concerning non-pharmacological interventions for psychological problems in type 2 diabetes. Zheng et al. reported that non-pharmacological therapies can improve depression, anxiety, and glycemic control in patients with type 2 diabetes (21). Although the present study did not evaluate glycemic outcomes, the significant reductions in anxiety sensitivity and negative meta-emotion are consistent with the conclusion that psychological intervention can produce meaningful improvements in emotional functioning among patients with diabetes. These findings are also in line with emerging recommendations that diabetes care should extend beyond biomedical management and incorporate interventions targeting psychological well-being and positive health behaviors (6).

The durability of treatment effects represents another notable finding. The absence of significant differences between posttest and three-month follow-up suggests that the improvements achieved through CBT were maintained after the structured sessions ended. This pattern may be attributable to several characteristics of the intervention. Participants were not only exposed to therapeutic discussion but were trained in skills that could continue to be used independently, including thought monitoring, cognitive restructuring, coping statements, activity planning, graded behavioral practice, and relapse-prevention strategies. Homework assignments and therapy notebooks may have further supported internalization of these skills. Consequently, participants may have continued to apply cognitive-behavioral techniques when confronted with anxiety-provoking physical sensations or difficult emotional experiences after treatment termination.

Maintenance of treatment effects is particularly important in type 2 diabetes because the psychological demands of the disease are continuous rather than time-limited. Patients remain exposed to medical appointments, dietary restrictions, medication demands, fears of complications, and fluctuations in symptoms long after a short-term psychological intervention ends. If CBT merely produced temporary symptom relief, its clinical value would be limited. The sustained reductions observed in the current study suggest that participants may have developed transferable coping skills rather than relying solely on therapist-guided regulation. This interpretation is compatible with evidence showing that psychological interventions can improve adaptive coping in chronic medical conditions and that personality-related coping strategies influence treatment adherence in non-communicable diseases (5).

The observed effects may also be understood in light of the cognitive and emotional burden associated with diabetes complications. Patients with diabetes are at increased risk for serious cardiovascular outcomes, including heart failure, which can intensify concern about bodily symptoms and health deterioration (12). Fear of complications may make individuals particularly vulnerable to catastrophic interpretations of benign bodily sensations. By teaching participants to evaluate these interpretations more systematically, CBT may have helped separate realistic health monitoring from excessive threat appraisal. This distinction is clinically important because patients must remain attentive to genuine medical symptoms without becoming overwhelmed by maladaptive anxiety.

Recent research has also suggested that emotional processing may be connected to cognitive functioning in type 2 diabetes. Cheng et al. identified a functional connectivity signature related to emotional conflict monitoring that was associated with cognitive decline in patients with type 2 diabetes (10). Although the present study did not examine neurocognitive outcomes, such findings reinforce the broader significance of

emotional regulation and conflict processing in this population. Reducing maladaptive emotional responses may therefore have implications for psychological functioning beyond the immediate outcomes measured here.

The present findings are further compatible with research suggesting that psychological interventions may influence both emotional and physiological processes in diabetes-related conditions. Tang et al. reported that multimodal psychological intervention improved psychological well-being and inflammatory profiles in patients with diabetic nephropathy (22). Likewise, Bablis et al. described improvements in stress-related outcomes following a neuro-emotional intervention in an individual with type 2 diabetes (23). Although these findings should not be interpreted as evidence that CBT directly alters biological processes in the present study, they support a broader biopsychosocial model in which psychological functioning is intertwined with the experience and management of chronic metabolic disease.

The results are also consistent with evidence from psychological interventions outside diabetes showing that cognitive and emotion-focused therapies can alter maladaptive emotional functioning. Dong et al. demonstrated that both cognitive behavioral therapy and dialectical behavior therapy improved psychological capital in a randomized controlled trial, indicating that structured psychotherapy can strengthen adaptive psychological resources (15). Similarly, emotion-based and acceptance-oriented interventions have shown effectiveness in reducing distress associated with chronic pain conditions (18). These findings reinforce the idea that interventions targeting cognition and emotion can modify entrenched patterns of response to chronic health-related stress.

Finally, current developments in CBT research increasingly emphasize individual differences in treatment response. A systematic review and meta-analysis of artificial intelligence approaches for predicting treatment response in anxiety disorders indicated growing interest in identifying which patients are most likely to benefit from CBT (24). The relatively strong effects observed in the present study suggest that anxiety sensitivity and negative meta-emotion may themselves be useful targets for future precision-oriented intervention research in diabetes. Rather than focusing only on broad diagnostic outcomes such as anxiety or depression, future work may benefit from examining specific transdiagnostic mechanisms that can be modified through treatment and that may explain differences in long-term adaptation.

The present study had several limitations that should be considered when interpreting the findings. First, participants were recruited through convenience sampling from diabetes clinics and medical centers in one city, which may restrict the generalizability of the results to patients in other geographical regions, healthcare settings, or sociocultural contexts. Second, the total sample size was relatively modest, despite being adequately powered for the planned analysis, and larger samples may provide more stable estimates of intervention effects. Third, the outcomes were assessed using self-report measures, which may be influenced by response bias, social desirability, or participants' subjective interpretation of questionnaire items. Fourth, the follow-up period was limited to three months, and it is therefore unclear whether the observed treatment effects would persist over longer periods. Fifth, blinding of participants and the therapist was not possible because of the nature of the psychological intervention, which may have introduced expectancy-related influences. Finally, the study focused on psychological outcomes and did not simultaneously evaluate clinical indicators such as glycated hemoglobin, fasting blood glucose, medication adherence, or objectively measured self-management behaviors.

Future research should replicate the present study using larger and more diverse samples recruited from multiple clinical centers and regions. Longer follow-up periods of six months, one year, or more would provide stronger evidence regarding the durability of CBT effects. Future investigations should also incorporate physiological and behavioral outcomes alongside psychological variables in order to determine whether reductions in anxiety sensitivity and negative meta-emotion are associated with improved glycemic control, adherence, physical activity, or healthcare utilization. Comparative trials could examine CBT against other evidence-based approaches, including acceptance-based, emotion-focused, mindfulness-based, or transdiagnostic interventions. Research may also benefit from testing mediation models to determine whether changes in catastrophic interpretation, distress tolerance, emotion regulation, or coping account for treatment effects. In addition, subgroup analyses could investigate whether age, disease duration, complication status, baseline psychological severity, or personality characteristics influence response to treatment.

From a practical perspective, the findings support the integration of structured CBT-based services into routine diabetes care, particularly for patients who display heightened fear of bodily sensations, persistent emotional distress, or maladaptive reactions to their own emotional experiences. Diabetes clinics could incorporate brief psychological screening procedures to identify patients with elevated anxiety sensitivity or negative meta-emotion and refer them for targeted intervention. Training clinical psychologists and other qualified mental health professionals to deliver standardized CBT protocols within multidisciplinary diabetes teams may improve the accessibility of psychological care. The use of structured homework, self-monitoring diaries, coping cards, and relapse-prevention plans may also facilitate the transfer of therapeutic skills into daily disease management. Where resources are limited, group-based CBT formats may offer a feasible approach for delivering psychological support to larger numbers of patients while maintaining treatment structure and continuity.

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Authors' Contributions

All authors equally contributed to this study.

Declaration of Interest

The authors of this article declared no conflict of interest.

Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants. This article was derived from the first author's doctoral dissertation in psychology at the Central Tehran Branch of Islamic Azad University. The study received ethical approval under code IR.IAU.CTB.REC.1404.191.

Transparency of Data

In accordance with the principles of transparency and open research, we declare that all data and materials used in this study are available upon request.

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