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The Mediating Role of Cognitive Flexibility in the Relationship between Cognitive Emotion Regulation Strategies and Mindfulness in Patients with Type 2 Diabetes

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Given the importance of mental health in self-care of patients with type 2 diabetes and the relationship between cognitive flexibility and emotion regulation with mindfulness, the present study aimed to investigate the mediating role of cognitive flexibility in the relationship between cognitive emotion regulation strategies and mindfulness in patients with type 2 diabetes. The present study was conducted using correlation method and structural equation modeling. The statistical population of the study consisted of all men and women with type 2 diabetes referred to Imam Khomeini Hospital in Tehran. 253 participants were selected using convenience sampling. Participants completed the Garnefski & Kraaij (2006) Cognitive Emotion Regulation Questionnaire, the Kentucky Inventory of Mindfulness Skills (Baer, Smith & Allen, 2004), and the Cognitive Flexibility Inventory (Dennis & Vander Wal, 2010). The results showed a positive overall path coefficient between adaptive cognitive emotion regulation strategies and mindfulness ($P = 0.005$, $\beta = 0.243$) and a negative overall path coefficient between maladaptive cognitive emotion regulation strategies and mindfulness ($P = 0.001$, $\beta = -0.453$). The path coefficient between cognitive flexibility and mindfulness was positive and significant ($P = 0.009$, $\beta = 0.273$). The indirect path coefficient between adaptive cognitive emotion regulation strategies and mindfulness was positive ($P = 0.007$, $\beta = 0.094$) and the indirect path coefficient between maladaptive cognitive emotion regulation strategies and mindfulness was negative and significant ($P = 0.009$, $\beta = -0.117$). With an increase in emotion regulation skills,

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cognitive flexibility and mindfulness also increase in patients with type 2 diabetes.

Introduction

Diabetes, as a chronic disease caused by abnormalities in insulin secretion, insulin resistance, and overproduction of hepatic glucose, is on the rise in Iran and the world (Muthiah et al., 2023). More than half a billion people worldwide live with diabetes, meaning that over 10.5% of the adult population is currently affected by this disease. The global prevalence of diabetes in individuals aged 20 to 79 was estimated at 10.5% (536.6 million people) in 2021 and is projected to increase to 12.2% (783.2 million people) in 2045. The highest relative increase in diabetes prevalence between 2021 and 2045 is expected to occur in middle-income countries (21.1%) compared to high-income countries (12.2%) and low-income countries (11.9%). The global health costs associated with diabetes were estimated at around $966 billion in 2021 and are projected to reach $1054 billion by 2045 (Sun et al., 2022). Managing all forms of diabetes requires significant lifestyle changes, such as dietary and exercise modifications, and depending on the type and severity of the disease, the use of oral or injectable medications on a daily basis. Incorporating these lifestyle changes can be disruptive, stressful, and a source of emotional distress and family conflict. The additional stressors associated with managing a chronic disease, in turn, have a negative impact on diabetes self-management, disease outcomes, and quality of life. Therefore, strategies that help improve psychosocial well-being are crucial for managing diabetes (Koerner & Rechenberg, 2022).

Mindfulness emphasizes the presence and awareness of one's emotions, including bodily sensations, thoughts, behaviors, emotions, motivations, attention, and emotional regulation, so that one can better manage and regulate them. Mindfulness is defined as non-judgmental moment-to-moment awareness and acceptance of the individual. Mindfulness can act as an antidote to common forms of psychological distress such as avoidance, suppression, or cognitive and emotional over-involvement (Shahbaz & Parker, 2022). Mindfulness training has been shown to improve social, biological, and psychosocial aspects of diabetes (Koerner & Rechenberg, 2022). In adults with diabetes, mindfulness interventions have been shown to improve psychosocial outcomes, self-management of diabetes, including blood glucose control (DiNardo et al., 2022; Saito & Kumano, 2022; Guo et al., 2022). Mindfulness can also have an impact on the psychological well-being of patients with diabetes and can moderate the effects of depression (Ajele et al., 2021).

Based on the Liverpool mindfulness model, mindfulness is influenced by skills such as cognitive flexibility and emotion regulation, and attentional skills, behavioral self-regulation, stress management, and others are among the potential mechanisms of the relationship between mindfulness exercises and positive health outcomes. In this model, flexibility is the main and core process of the relationship between motivational factors and mindful outcomes, and flexibility is defined as the ability to adapt emotions, thoughts, and behaviors to situations, regulate emotions, and think and behave when situations and conditions change (Malinowski, 2013).

Emotional regulation is the ability to respond to the continuous demands of experiencing a range of emotions in a socially acceptable and flexible enough manner to delay automatic reactions when necessary. It can also be defined as external and internal processes that are responsible for monitoring, evaluating, and correcting emotional responses (Thompson, 1994). Cognitive emotion regulation includes cognitive strategies for managing emotionally arousing information (Ochsner & Gross, 2008). The role of adaptive emotional regulation has been proposed as one of the pathways for the psychological effects of mindfulness (Hambour et al., 2018; Garofalo et al., 2020). According to researchers, changes in emotional regulation are one of the main underlying mechanisms of the beneficial effects of mindfulness (Guendelman et al., 2017). Webb et al. (2012) have categorized mindfulness as a strategy for reappraising and suggest that mindfulness (and acceptance) involves reappraising an emotional response. Garland et al. (2011) have shown that mindfulness includes reappraising positive contexts. Researchers have found that psychological distress related to diabetes is significantly associated with negative emotions and emotion regulation skills in adults with diabetes. This relationship appears to be stronger than the relationship between psychological distress related to diabetes and perceived psychological stress or diabetes self-care (Coccaro et al., 2021). Payandeh et al. (2020) also found that individuals with type 2 diabetes have lower scores in reappraisal and higher scores in suppression compared to non-diabetic counterparts.

Research findings indicate that mindfulness practice is associated with adaptive emotion regulation, including reducing distress intensity, increasing emotional recovery, decreasing negative self-referential processing, and/or enhancing the ability to engage in goal-directed behaviors (Roemer, Williston & Rollins, 2015). Kaunhoven & Dorjee (2021) confirmed the relationship between mindfulness and emotion regulation, and found that a mindfulness-based stress reduction program not only increases mindfulness skills but also leads to significant improvements in cognitive reappraisal. The results of Ebrahimi et al. (2018) showed a negative correlation between the disengagement component as one of the components of emotion regulation and mindfulness, and a positive correlation between cognitive reappraisal and mindfulness, predicting the emotion regulation strategies of students. Based on the results of Mosavi et al. (2022), mindfulness treatment is effective in reducing emotional regulation difficulties and cognitive fusion in patients with type 2 diabetes.

Cognitive flexibility is a dynamic process that involves positive adaptation to changing environments and helps individuals understand difficult situations, cope with and accept new situations, accept different beliefs, and provide logical responses (Pineda-Alhucema et al., 2018). Cognitive flexibility includes three important features: the ability to learn (acquired through training), the ability to change cognitive processing strategies with the goal of adaptation, and adaptation to new and unexpected environmental situations (Canas, Fajardo & Salmeron, 2006). Cognitive flexibility consists of two important dimensions: knowledge representation and attention control process, and as a result, individuals with low cognitive flexibility do not have the correct orientation towards problem-solving (Braem & Egner, 2018). Individuals who accurately perceive situations and choices have better cognitive flexibility and adaptability in thinking and behavior (Arici-Ozcan et al., 2019). Therefore, it seems that cognitive flexibility can influence diabetes management. Patients who do not have a correct understanding of their illness have weaker self-care skills, which negatively affects their health and quality of life. In addition, cognitive flexibility is influenced by negative emotions and emotion regulation skills (Paschke et al., 2016; Khodapanah et al., 2018). In this regard, studies have shown that individuals with diabetes have cognitive impairments (Verhulst et al., 2022) and cognitive flexibility is related to difficulties in emotion regulation and symptoms of depression in individuals with type 2 diabetes (Vatankhah Amjad et al., 2021).

Therefore, it seems that the cognitive flexibility of patients with diabetes may be influenced by their emotion regulation skills and emotional states, and may be affected by their mindfulness skills. Researchers have confirmed the relationship between cognitive flexibility and mindfulness and identified non-reactivity as one of the influential factors in this relationship (Zou et al., 2020; Sünbül, 2020). It is important to note that mindfulness has been shown to improve a wide range of cognitive functions, including cognitive flexibility, working memory capacity, sustained attention, and problem-solving abilities (Whitfield et al., 2022). However, there has been no research to date on the mediating role of cognitive flexibility in the relationship between emotion regulation strategies and mindfulness in patients with type 2 diabetes. Addressing this issue can play a significant role in identifying the factors that affect mindfulness and its outcomes, and by identifying potential mechanisms for the effectiveness of mindfulness, it can help psychologists design interventions to improve the mental health of patients with diabetes.

The comorbidity of physical and mental disorders is a major challenge for healthcare systems worldwide, and given its increasing prevalence, attention to the mental health of patients with diabetes is essential. Considering the important role of cognitive and emotional factors in self-care, disease management, and mental health of patients with type 2 diabetes, identifying effective cognitive and emotional factors plays a fundamental role in improving the quality of life of these individuals. Therefore, the present study aimed to investigate the mediating role of cognitive flexibility in the relationship between emotion regulation strategies and mindfulness in patients with type 2 diabetes.

Methodology

The present study is a descriptive correlational study. The population included women and men with type 2 diabetes who visited the diabetes clinic of Imam Khomeini Hospital in Tehran. Some researchers consider a minimum sample size of 100 for descriptive studies, while others consider a sample size of 200 or more desirable (Mayer, Gamst, & Guarino, 2006). Therefore, with a potential drop-out rate, a sample size of 253 was selected. Demographic factors such as age, gender, education, time since diagnosis, and marital status of the participants were also examined. Sampling was done using convenience sampling method. The inclusion criteria were: diagnosis of type 2 diabetes by specialists, having a history of type 2 diabetes for at least one year, having at least basic literacy to be able to respond to the scales, and age range of 30 to 65 years. The exclusion criteria were: having other chronic and high-risk diseases such as heart and lung diseases, use of medications for mental disorders or psychotropic drugs. First, the medical records of the patients were extracted, and then their addresses were obtained through telephone calls. The questionnaires were then given to the participants at their residence or workplace. Participants completed the questionnaires in an individual session. Necessary explanations were provided regarding the reasons for conducting the study, confidentiality of information, and voluntary participation in the study, and their consent was obtained. This study was conducted in accordance with ethical principles related to human research and was approved by the ethics committee of the university.

Materials

Cognitive Emotion Regulation Questionnaire (CERQ): is a 36-item tool designed by Garnefski and Kraaij (2006) to measure cognitive emotion regulation strategies in response to threatening events and life stressors on a five-point scale ranging from 1 (never) to 5 (always) across nine subscales: self-blame, other-blame, rumination, catastrophizing, positive refocusing, refocus on planning, positive reappraisal, putting into perspective, and acceptance. A higher score indicates a greater use of the cognitive strategy. The Cronbach's alpha coefficient for the subscales of this questionnaire has been reported by Garnefski and colleagues (2002; cited in Samani & Sadeghi, 2010) to range from 0.71 to 0.81, and the test-retest reliability of these factors has been reported to range from 0.48 to 0.61 over a period of 14 months. In Iran, Samani and Sadeghi (2010) obtained a Cronbach's alpha coefficient of 0.62 to 0.91 for the subscales and a test-retest reliability of 0.75 to 0.88 over a one-week period. The content validity of the Cognitive Emotion Regulation Questionnaire was evaluated by eight psychologists and the Kendall's coefficient of agreement for the subscales ranged from 0.81 to 0.92. In the present study, the Cronbach's alpha coefficients for self-blame, other-blame, rumination, catastrophizing, positive refocusing, refocus on planning, positive reappraisal, putting into perspective, and acceptance were 0.71, 0.66, 0.63, 0.74, 0.67, 0.69, 0.67, 0.54, and 0.73, respectively.

The Kentucky Inventory of Mindfulness Skills (KIMS): was developed by Baer, Smith, and Allen (2004) and consists of 39 items that assess four components: Observing, Describing, Act with Awareness, And Accept Without Judgment. This questionnaire is scored on a five-point Likert scale ranging from rarely to almost always. The results of Baer's (2004) psychometric analysis showed an internal consistency of 0.73 for the questionnaire and Cronbach's alpha coefficients of 0.91, 0.84, 0.83, and 0.87 for the subscales of observing, describing, act with awareness, and accept without judgment, respectively. There is a significant correlation between this questionnaire and other mindfulness measures. Dehghan Manshadi and colleagues (2012) reported a Cronbach's alpha coefficient of 0.82 for the KIMS in Iran and confirmed the presence of four factors: act with awareness, describing, accept without judgment, and observing, with convergent validity ranging from 0.47 to 0.78 for the subscales. In the present study, the cronbach's alpha coefficients for act with awareness, describing, accept without judgment, and observing were 0.83, 0.74, 0.79, and 0.81, respectively.

Cognitive flexibility inventory: This inventory was developed by Dennis & Vander Wal (2010) and consists of 20 seven-point items and three components: a) the ability or tendency to perceive difficult situations as controllable; b) the ability to perceive multiple alternative explanations for human behavior and situations in life; and c) the ability to generate multiple alternative solutions to difficult situations. This inventory is scored on a 7-point Likert scale (strongly disagree=1 to strongly agree=7). The highest possible score an individual can obtain on this inventory is 140, and the lowest possible score is 20. A higher score indicates greater cognitive flexibility, while a lower score closer to 20 indicates lower cognitive flexibility. Dennis & Vander Wal (2010) reported concurrent validity of this inventory with the Beck Depression Inventory as 0.39 and convergent validity with the Martin and Rubin Cognitive Flexibility Scale as 0.75, with a Cronbach's alpha of 0.90 for the overall scale and 0.87, 0.89, and 0.55 for the subscales, respectively. Additionally, this inventory has shown good factor validity and concurrent validity in Iran. In the Persian version, unlike the original scale which yielded only two factors, the Cognitive Flexibility Inventory consists of three factors: perception of controllability, perception of alternative options, and perception of justification for behavior (Soltani et al., 2013). In the present study, the Cronbach's alpha coefficients were 0.76 for perception of controllability, 0.59 for perception of alternative options, and 0.84 for perception of justification for behavior.

The data were analyzed using SPSS-21 and Amos software and structural equation modeling (SEM).

Findings

In the present study, 253 patients (105 females and 148 males) with type 2 diabetes participated. The mean age and standard deviation of the participants were 43.39 and 29.8 years, respectively, and the mean and standard deviation of time since diagnosis were 6.85 and 3.83 years. The educational level of the participants was as follows: 76 (30%) had below diploma education, 89 (35.2%) had a diploma, 21 (8.3%) had associate degree, 45 (17.8%) had bachelor's degree, and 22 (8.7%) had master’s degree or higher. It should be noted that 169 (62.8%) of the participants were married and 94 (37.2%) were single. Table 1 shows the mean, standard deviation, and correlation coefficients between the cognitive emotion regulation, cognitive flexibility, and mindfulness components.

Table 1: Mean, standard deviation and correlation matrix between research variables

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1. Maladaptive strategies - self-blame	-															
2. Maladaptive strategies - blaming others	**34.0	-														
3. Maladaptive strategies - rumination	**41.0	**30.0	-													
4. Maladaptive strategies - catastrophizing	**53.0	**46.0	**65.0	-												
5. Adaptive strategies - positive reappraisal	**17.0-	06.0-	**26.0-	**26.0-	-											
6. Adaptive strategies - acceptance	04.0-	*13.0-	02.0-	06.0-	**30.0	-										
7. Adaptive strategies - positive refocusing	08.0-	02.0	**26.0-	10.0-	**36.0	**35.0	-									
8. Adaptive strategies - planning	06.0-	04.0-	*13.0-	01.0-	**41.0	**34.0	**48.0	-								
9. Adaptive strategies - perspective-taking	*13.0	07.0-	01.0-	06.0	*16.0	**33.0	**25.0	**49.0	-							
10. Flexibility - alternatives	*14.0-	**20.0-	**35.0-	**29.0-	**24.0	**24.0	**27.0	**23.0	*13.0	-						
11. Flexibility - control	**24.0-	**18.0-	**29.0-	**29.0-	**28.0	*15.0	**20.0	**16.0	07.0	**62.0	-					
12. Flexibility - alternatives...	**19.0-	**23.0-	**39.0-	**32.0-	**21.0	*16.0	**22.0	**20.0	09.0	**65.0	**55.0	-				
13. Mindfulness - observation	**22.0-	09.0-	**22.0-	**31.0-	11.0	*15.0	11.0	06.0	01.0	**19.0	**23.0	**20.0	-			
14. Mindfulness - description	**29.0-	*15.0-	**30.0-	**31.0-	**22.0	**33.0	**17.0	12.0	06.0	**31.0	**33.0	**30.0	**42.0	-		
15. Mindfulness -	**23.0-	11.0-	**28.0-	**25.0-	**16.0	**26.0	**19.0	10.0	05.0	**27.0	**27.0	**33.0	**33.0	**63.0	-	

concentration																
16. Mindfulness - acceptance	**21.0-	**23.0-	*13.0-	**22.0-	**17.0	**22.0	10.0	09.0	10.0	**25.0	**31.0	**28.0	**25.0	**39.0	**35.0	-
Mean	22.13	09.14	33.11	03.13	16.12	75.10	11.13	63.13	41.12	59.48	07.37	56.8	92.40	66.26	63.28	02.26
Standard deviation	73.4	59.4	40.4	81.4	47.4	20.3	32.4	43.4	12.3	42.11	17.8	51.3	36.9	23.7	01.6	60.6
Skewness	38.0-	58.0-	02.0-	43.0-	02.0	34.0	23.0-	26.0-	13.0-	13.0-	14.0	28.0-	47.0-	05.0	29.0-	11.0-
Kurtosis	92.0-	80.0-	95.0-	02.1-	95.0-	82.0-	86.0-	89.0-	82.0-	08.1-	85.0-	14.1-	11.0-	77.0-	51.0-	53.0-
Tolerance	66.0	73.0	57.0	50.0	70.0	73.0	65.0	55.0	71.0	45.0	55.0	51.0	-	-	-	-
VIF	53.1	38.1	76.1	99.1	42.1	37.1	53.1	82.1	42.1	23.2	82.1	97.1	-	-	-	-
*p<0.01; **p<0.05																

Table 1 displays the correlation coefficients between the variables, which indicate that the direction of correlation between the variables is in line with expectations and consistent with theories in the research field. Furthermore, to assess the normality of the distribution of univariate data, skewness and kurtosis of each variable were examined, and to evaluate the assumption of collinearity, the values of variance inflation factor (VIF) and tolerance coefficient were investigated, which are considerable in Table 1. Table 1 shows that the skewness and kurtosis values of all components are within the range of ±2. This finding indicates that the assumption of normality of univariate data distribution is met among the data (Kline, 2016). Moreover, based on the results in Table 1, it can be concluded that the assumption of collinearity is also met among the data in the present study, as the tolerance coefficients of the predictors were greater than 0.1 and the inflation factor values were less than 10. Consistent with Mirz and colleagues (2006), a tolerance coefficient less than 0.1 and an inflation factor value greater than 10 indicate a violation of the collinearity assumption. Therefore, it can be said that in this study, the assumption of collinearity among variables was met, and the research data were normally distributed.

In this study, to evaluate the assumption of normality of the distribution of multiple variables, Mahalanobis distance (D) analysis was used. The skewness and kurtosis values for Mahalanobis distance were 0.62 and 0.03, respectively, indicating that the values are within the range of ±2. This finding suggests that the assumption of normality of distribution is met among the data. As mentioned earlier, structural equation modeling was used to analyze the research data. In the research model, it was assumed that in patients with type 2 diabetes, both adaptive and maladaptive cognitive emotion regulation strategies have a direct and indirect relationship with mindfulness through cognitive flexibility. The model fit was evaluated using the structural equation modeling method, AMOS 26.0 software, and Maximum Likelihood (ML) estimation. Table 2 shows the fit indices of the research model.

Table 2: Fit indices

Index	Value	Cutoff point
Chi-square	175.90	-
Df	98	-
df^{2}/χ	1.79	< 3
GFI	0.921	> 0.90
AGFI	0.890	> 0.850
CFI	0.934	> 0.90
RMSEA	0.056	< 0.080

Table 2 shows that all fit indices support the acceptable fit of the model with the collected data. Furthermore, Table 3 presents the path coefficients in the structural model.

Table 3: Total, direct and indirect path coefficients between the research variables in the structural model

Path	b	S.E	β	p
Maladaptive cognitive regulation strategies -> Cognitive flexibility	378.1-	281.0	430.0-	001.0
Adaptive cognitive regulation strategies -> Cognitive flexibility	383.1	359.0	346.0	001.0
Cognitive flexibility -> Mindfulness	132.0	056.0	273.0	009.0
Direct path coefficient of maladaptive cognitive regulation strategies -> Mindfulness	520.0-	154.0	335.0-	001.0
Direct path coefficient of adaptive cognitive regulation strategies -> Mindfulness	288.0	198.0	149.0	110.0
Indirect path coefficient of maladaptive cognitive regulation strategies -> Mindfulness	182.0-	084.0	117.0-	009.0
Indirect path coefficient of adaptive cognitive regulation strategies -> Mindfulness	179.0	080.0	094.0	007.0
Total path coefficient of maladaptive cognitive regulation strategies -> Mindfulness	702.0-	167.0	453.0-	001.0
Total path coefficient of adaptive cognitive regulation strategies -> Mindfulness	467.0	196.0	243.0	005.0

Table 3 shows that the total path coefficient between adaptive cognitive emotion regulation strategies and mindfulness (P=0.005, β=0.243) is positive and significant, while the total path coefficient between maladaptive cognitive emotion regulation strategies and mindfulness (P=0.001, β=-0.453) is negative and significant. The path coefficient between cognitive flexibility and mindfulness (P=0.009, β=0.273) is also positive and significant. Table 3 also shows that the indirect path coefficient between adaptive cognitive emotion regulation strategies and mindfulness (P=0.007, β=0.094) is positive and the indirect path coefficient between maladaptive cognitive emotion regulation strategies and mindfulness (P=0.009, β=-0.117) is negative and significant. Therefore, it can be said that cognitive flexibility mediates the relationship between maladaptive cognitive emotion regulation strategies and mindfulness in patients with type 2 diabetes, while it positively, significantly mediates the relationship between adaptive cognitive emotion regulation strategies and mindfulness.

Figure 1 shows the structural model of the research explaining the relationship between cognitive emotion regulation, cognitive flexibility, and mindfulness in patients with type 2 diabetes.

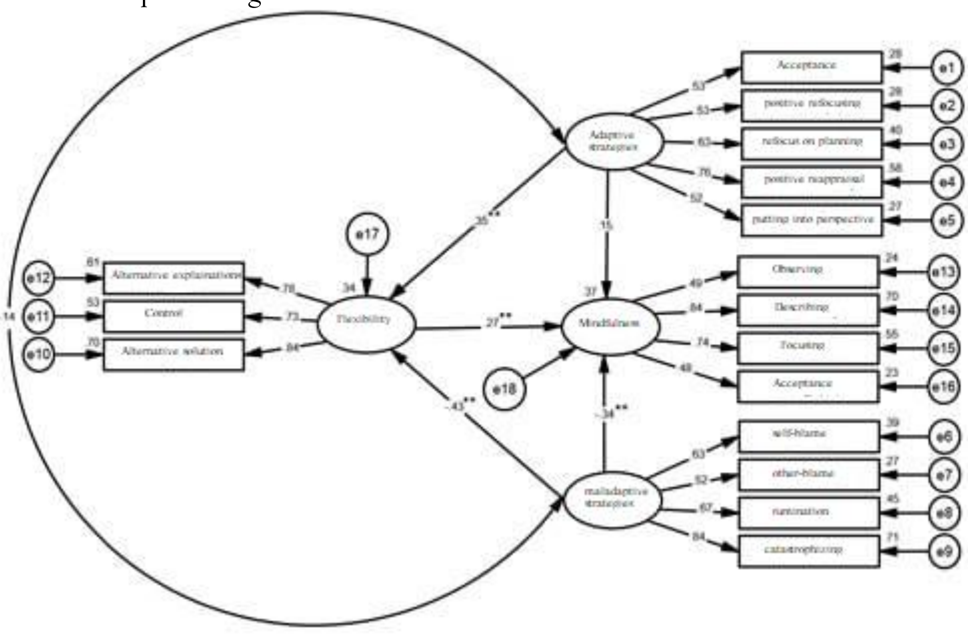

Figure 1: Standard parameters in the research structural model

Figure 1 shows that the total multiple correlation squared (R^2) for the mindfulness variable is 0.37, indicating that adaptive and maladaptive cognitive emotion regulation strategies and cognitive flexibility explain 37% of the variance in mindfulness among patients with diabetes. Furthermore, the total multiple correlation squared (R2) for the cognitive flexibility variable is 0.33, indicating that cognitive emotion regulation strategies explain 33% of the variance in cognitive flexibility among patients with diabetes.

Conclusion

The present study aimed to investigate the mediating role of cognitive flexibility in the relationship between cognitive emotion regulation strategies and mindfulness in patients with type 2 diabetes. The findings showed that the total path coefficient between adaptive cognitive emotion regulation strategies and mindfulness was positive, while the total path coefficient between maladaptive cognitive emotion regulation strategies and mindfulness was negative and significant. The present study's findings are consistent with the findings of other studies on the relationship between cognitive emotion regulation and mindfulness (Kaunhoven & Dorjee, 2021; Garofalo, Gillespie & Velotti, 2020; Roemer, Williston & Rollins, 2015; Musavi et al., 2022; Ebrahimi, Jafari, & Ranjbar, 2018). Kaunhoven & Dorjee (2021) showed that a stress reduction program based on mindfulness, in addition to increasing mindfulness skills, is accompanied by a significant improvement in cognitive reappraisal. The findings of Roemer, Williston & Rollins (2015) indicate that mindfulness practice is related to adaptive emotion regulation. Musavi et al. (2022) found that mindfulness treatment is effective in reducing emotional regulation difficulties and cognitive fusion in patients with type 2 diabetes. Ebrahimi et al. (2018) also showed that emotion regulation strategies predict students' mindfulness. Although the conceptual overlap between these two constructs complicates the interpretation of correlation findings, a set of emerging laboratory, experimental, and therapeutic studies provides initial support for proposed conceptual models (Roemer, Williston & Rollins, 2015). It seems that the use of adaptive emotion regulation strategies such as acceptance, positive refocusing, and so on, increases acceptance, description, and concentration. While maladaptive emotion regulation strategies such as self-blame are associated with reduced mindfulness. Adaptive emotion regulation strategies may improve individuals' ability to attend to specific aspects of a situation and increase mindfulness and present moment awareness. Modulating emotional responses as a result of using adaptive emotion regulation strategies can reduce the intensity of emotional responses while affecting concentration or acceptance. Increasing positive reappraisal of situations and reducing automatic self-referential processing (such as worry, rumination, self-criticism) that often leads to emotional distress can increase mindfulness components such as present moment awareness and acceptance. On the other hand, neuroscientific studies have shown that mindfulness changes the descending emotion regulation systems (emotion generation and emotion regulation systems) (Guendelman, Medeiros & Rampes, 2017); expanding and modifying attention, focus, monitoring capacity, and labeling emotional states facilitate achieving the desired effects of mindfulness meditation. On the other hand, reducing maladaptive emotion regulation strategies such as rumination facilitates non-judgmental acceptance of emotions and helps individuals engage in non-judgmental acceptance of their experiences rather than suppression, avoidance, or drowning in negative emotions, resulting in less neural reactivity to emotional stimuli.

The findings of the present study are consistent with previous research on the relationship between cognitive flexibility and mindfulness (Zou et al., 2020; Sünbül, 2020; Whitfield et al., 2022). For example, Whitfield and colleagues (2022) confirmed a positive relationship between mindfulness and cognitive flexibility, increased working memory capacity, sustained attention, and problem-solving abilities. Zou and colleagues (2020) also demonstrated that mindfulness practices can have a positive relationship with increasing cognitive flexibility. In explaining the relationship between cognitive flexibility and mindfulness, it can be argued that training attention skills forms the basis for emotional and cognitive flexibility and the ability to maintain non-judgmental awareness of one's thoughts and emotions, which is associated with increased mindfulness skills. According to the mindfulness model of Liverpool (Malinowski, 2013), emphasis on focus leads to increased attention processes and provides space for practicing emotional and cognitive flexibility; increased flexibility is also associated with higher levels of mindfulness. Higher levels of mindfulness also allow individuals to separate from automatic thought patterns and perceptual filters caused by past emotions and schemas, and have greater cognitive flexibility in response to thoughts. Additionally, it appears that cognitive flexibility can help individuals with diabetes find positive alternative solutions in difficult situations and cope adaptively with emotional arousal; reducing emotional arousal can also have an impact on mindfulness skills. A broader attention to new information that allows for re-evaluation of life circumstances can increase mindfulness and non-judgmental acceptance. In other words, cognitive flexibility can have a relationship with higher levels of mindfulness through increased focus, attention, control, etc.

The results of the present study indicate that cognitive flexibility mediates the relationship between adaptive and maladaptive cognitive emotion regulation strategies and mindfulness in patients with type 2 diabetes. A study that examines the mediating role of cognitive flexibility in the relationship between cognitive emotion regulation and mindfulness was not found, so it is not possible to compare the results of the present study with those of other researchers. It can be argued that the biological conditions resulting from diabetes can reduce individuals' cognitive abilities (Verhulst et al., 2022). However, the use of adaptive cognitive emotion regulation strategies can improve attention, cognitive evaluation, response modulation, and cognitive flexibility. Emotion regulation and effective management of positive and negative emotional states can improve individuals' understanding of situations, control of situations, and identification of alternatives for human behavior. The mediating role of cognitive flexibility in the relationship between cognitive emotion regulation and mindfulness can be explained based on cognitive theories related to limited capacity and resource depletion. Researchers believe that negative emotions and their maladaptive regulation strategies can reduce cognitive flexibility by reducing self-control resources and disrupting self-regulatory processes (Paschke et al., 2016). The effect of emotion regulation on cognitive flexibility has also been confirmed through neuropsychological studies by placing self-regulatory resources under influence. Researchers have shown that compared to reappraisal, emotion suppression increases activity in the anterior cingulate cortex and the dorsolateral prefrontal cortex. On the other hand, adaptive emotion regulation strategies (such as cognitive acceptance and reappraisal strategies) are associated with cognitive flexibility by improving attention processes, increasing control over limited brain resources, increasing cognitive control, experiencing emotions without reducing memory capacity, and reflecting reduced reactivity due to improved downward control (Siep et al., 2011; cited in Khodapanah et al., 2018). As mentioned, increasing the efficiency of downward emotion regulation systems is related to increasing mindfulness skills (Guendelman, Medeiros & Rampes, 2017). Therefore, adaptive cognitive emotion regulation strategies facilitate achieving the desired effects of mindfulness meditation by increasing cognitive flexibility.

In summary, diabetes management creates stressful conditions for individuals, which can be a source of emotional distress and family conflict. Mindfulness is one of the strategies that can help manage diabetes by improving mental health. Adaptive emotion regulation strategies, through increasing self-regulation resources and reducing negative emotions, can improve cognitive flexibility and increase mindfulness skills in patients with diabetes. On the other hand, maladaptive emotion regulation strategies disrupt self-regulation and cognitive processes, and are associated with reduced cognitive flexibility and mindfulness. Mindfulness training involves a series of self-awareness tasks and exercises that can improve information processing capacity and ability. Mindfulness training requires learning new metacognitive and behavioral strategies to focus attention, prevent rumination and avoid worrying responses, as well as expanding new thoughts and reducing unpleasant emotions, thereby improving individuals' cognitive skills. Therefore, in improving and promoting the mental health of patients with diabetes, the interactive role of emotional, cognitive, and behavioral factors (such as emotion regulation skills, cognitive flexibility, and mindfulness) should be considered by therapists and psychologists.

Interpretation of the results of this study is essential due to some limitations. This study is cross-sectional, so the presentation of the results of this study without considering the effect of time on variables and their relationships is one of the important limitations of this study. The results of this study refer to a sample of patients with diabetes in Tehran province, so the generalization of the results of this study to different research groups and communities should be interpreted with caution. Given the reciprocal effects of cognitive flexibility with cognitive emotion regulation and mindfulness, it is recommended that cognitive rehabilitation and improvement of cognitive flexibility be considered in interventions related to improving the mental health of individuals with diabetes. Providing education on cognitive flexibility and emotion regulation for individuals with diabetes helps them perceive and control the stressful conditions caused by the disease in a positive way and seek more effective solutions to cognitive and emotional challenges. Therefore, designing and implementing training courses to increase cognitive flexibility, cognitive emotion regulation, and mindfulness is recommended.

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