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Comparing the Effectiveness of Repetitive Transcranial Magnetic Stimulation (rTMS) and Cognitive-Behavioral Therapy (CBT) on Emotion Regulation in Individuals with Major Depression

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Abstract

Aim: Effective emotional regulation is crucial for individuals with major depression. This study compares the impact of two intervention methods—repetitive transcranial magnetic stimulation (rTMS) and cognitive-behavioral therapy—on emotional regulation in this population. **Methods:** As a quasi-experimental, goal-oriented study, we employed a pre-test and post-test design with a one-month follow-up for the control group. The sample comprised 39 men and women with major depression purposefully selected from Delaram Sina Psychiatric Hospital in Tehran in 2022. Participants were randomly assigned to three groups: rTMS (13 participants), cognitive-behavioral therapy (13 participants), and a control group (13 participants). The experimental groups received 12 sessions each of their respective interventions, while the control group received no intervention. Demographic characteristics were recorded, and the research tool used was the Emotion Regulation Questionnaire (ERQ). Data were analyzed using repeated measures analysis of variance in SPSS version 26. **Results:** Both rTMS and cognitive-behavioral therapy demonstrated effectiveness in emotional regulation, including suppression and reappraisal components, among individuals with depression. Importantly, cognitive-behavioral therapy exhibited greater efficacy in emotional regulation and its suppression and reappraisal components compared to rTMS. Specific p-values or effect sizes are available upon request. **Conclusion:** In comparing the two intervention methods, cognitive-behavioral therapy emerged as more effective than rTMS in enhancing emotional regulation in individuals with depression. These findings underscore the significance of considering diverse approaches in the treatment depression and may have practical implications for clinical practice.

Keywords: Repetitive Transcranial Magnetic Stimulation (rTMS), Cognitive-Behavioral Therapy (CBT), Emotional Regulation, Depression.

Introduction

Depression remains a controversial issue in the field of mental health, requiring ongoing attention and numerous efforts to address its multifaceted aspects. Depression, as a normative mood state, is a common experiential occurrence (Bellón,2024). In cases of mild depression, individuals engage in cognitive rumination about negative issues and often experience emotions such as boredom, irritability, and anger, while feeling sorry for themselves and strongly relying on reassurance from others. Those experiencing mild depression usually have mental preoccupations with the past and tend to be pessimistic about the future (Sampogna et al, 2024). An individual in a depressed state lacks the energy and motivation needed for daily activities. Academic and occupational performance and interpersonal relationships are adversely affected in individuals with depression. They are sadder and more hopeless, finding it challenging to find solutions to their problems or make decisions about significant life issues. Sometimes, individuals with severe depression may resort to self-harm or suicidal tendencies(Rim et al, 2024; Strawbridge et al, 2023; Biasi; 2023).

The fifth edition of the Statistical and Diagnostic Manual of Mental Disorders (2013) has identified two general types of mood disorders. These include disorders that solely encompass symptoms of depression and disorders that also involve manic symptoms. Mood disorders in this edition include Major Depressive Disorder, Persistent Depressive Disorder, Premenstrual Dysphoric Disorder, Disruptive Mood Dysregulation Disorder, Bipolar I Disorder, Bipolar II Disorder, and Cyclothymic Disorder. The primary symptoms of depressive disorders are profound sadness and an inability to experience pleasure and joy. Depression symptoms are diverse and are generally categorized into four groups: mood, cognitive, motivational, and physical symptoms. Mood symptoms include sadness, loss of interest, and the absence of joy in life. Additionally, activities that used to bring satisfaction become monotonous. The most significant cognitive symptom of depression is negative thoughts about oneself and the future. Low self-esteem, feelings of guilt, pessimism, and hopelessness are among other cognitive symptoms of depression. Motivational symptoms of depression point to difficulties in decision-making and, in severe cases, psychomotor retardation is observed in individuals. Changes in appetite, weight fluctuations, sleep disturbances, and a decrease in libido are physical symptoms of depression (Jennifer et al, 2024; Nemesure et al, 2024).

Depression is one of the most common mental health problems and psychiatric disorders, characterized by a lack of pleasure, social withdrawal from friends and family, lack of motivation, intolerance of failure, decreased libido, changes in appetite (either decreased or increased), reduced energy, premature fatigue, and sleep disturbances, among other symptoms (Nazai & Asadi, 2011; Xiang, 2018; Zamani, Aziz Mohammadi, 2014). Depression has negative consequences for individuals affected by it, affecting aspects such as emotional regulation.

Emotion regulation is a crucial process in research, therapy, and psychological pathology, encompassing actions aimed at modifying or adjusting emotional experiences, emotional expression, and the intensity or type of emotional experiences (Levenson, Lascoytiz, 2021). Emotion regulation involves a range of conscious and unconscious cognitive and behavioral strategies that work to decrease, maintain, or increase the intensity of emotion

(Domaradzka & Fajkowska, 2015). The cognitive emotion regulation model is one of the most significant models of emotional control, utilizing cognitive strategies and processes. Cognitive processes assist individuals in regulating their emotions (Zlomke, 2010). Cognitive emotion regulation encompasses all cognitive styles that individuals use to increase, decrease, or maintain emotional experiences. Cognitive emotion regulation strategies are generally divided into two categories: positive cognitive emotion regulation strategies and negative cognitive emotion regulation strategies. Positive strategies include acceptance, refocusing on planning, positive refocusing, positive reappraisal, and adopting a perspective. These adaptive coping strategies are employed in dealing with stressful events and contribute to improvements in self-esteem, social competence, etc. On the other hand, negative strategies include self-blame, other-blame, rumination, and catastrophic thinking. These maladaptive coping strategies in dealing with stressors can lead to stress, depression, and other psychological damages (Garnefski, Kraaij, 2006).

Depression is treatable through various methods such as pharmacotherapy, psychotherapy, and electroconvulsive therapy (ECT). However, despite these interventions, approximately half of depressed patients still experience residual symptoms, and at least 20% exhibit minimal or no response to treatment (Fava M., 2003). Despite the effective use of electroconvulsive therapy in treating mood disorders, the focus of mental health professionals has gradually shifted towards other methods that, without inducing generalized seizures and by modulating cortical regions, can generate therapeutic effects in depression (Khomami, 2010).

Among psychotherapies, cognitive-behavioral therapy has demonstrated significant improvement in reducing cognitive rumination in patients with cognitive-affective disorders (Hayley & Littlejohn, 2013). Unlike psychotherapies that mainly focus on managing residual symptoms, especially cognitive rumination, biological treatments (medications and brain stimulation methods) have paid less attention to these symptoms (Watkins et al., 2011). Repetitive Transcranial Magnetic Stimulation (rTMS) is a brain stimulation treatment method that has been utilized over the past decade for treating patients with Major Depressive Disorder (MDD) (Mutz et al., 2018). With the advancement in neuroscience knowledge in recent decades, it has become possible to identify neural correlates, and using brain stimulation methods, these areas can be influenced through such interventions (Bergmann et al., 2016). In a study by Khomami (2010), repetitive transcranial magnetic stimulation significantly led to a reduction in depressive symptoms in patients with major depressive disorder, and these changes persisted up to 1.5 months after treatment. Peirmoradi et al. (2013) investigated the impact of repetitive transcranial magnetic stimulation (rTMS) on reducing symptoms and signs of depression, such as cognitive, and physical symptoms, and pessimism-worthlessness feelings, in patients with recurrent depression. The results indicated that rTMS resulted in a reduction in cognitive, and physical symptoms, and feelings of pessimism-worthlessness in the samples, with a more pronounced decrease in cognitive symptoms compared to the other symptoms. Nguyen et al. (2021), in a meta-analysis study reviewing 14 studies with 274 participants, examined the effect of rTMS on depression. The results indicated a significant impact of rTMS intervention in reducing depression.

Cognitive-behavioral therapy (CBT) is an approach in which the client evaluates their living conditions and psychological pressures, seeking to change their perspectives on themselves, their environment, their future, and beliefs that contribute to increased emotional vulnerability. The primary emphasis of this approach is on the interplay between cognition, emotion, and behaviors. In Cognitive-Behavioral Therapy, irrational thoughts and negative assumptions that play a role in unpleasant emotional states are challenged (Leahy RL, 2017). Essentially, Cognitive-Behavioral Therapy is a method for exploring the meaning we assign to events and problems. The focus includes recognizing faulty thoughts, modifying dysfunctional beliefs, and enhancing the quality of relationships, serving as key aspects of treating depression. Numerous studies indicate that Cognitive-Behavioral Therapy is effective in improving symptoms of depression and anxiety (Deng et al., 2016). Sheibani et al. (2022) demonstrated that Cognitive-Behavioral Therapy led to a significant reduction in negative components of emotional self-regulation, such as blaming others, cognitive rumination, catastrophizing, and an increase in positive components of emotional self-regulation, including positive attention, positive evaluation, refocusing, and acceptance. The results of Kianzad et al.'s (2021) research show that Cognitive-Behavioral Therapy resulted in an increase in adaptive emotion-regulation strategies and a decrease in maladaptive emotion-regulation strategies, suicidal thoughts, and depression at the end of the intervention and follow-up period. Rahmani et al. (2015) demonstrated in their study that both Cognitive-Behavioral Therapy and repetitive transcranial magnetic stimulation were effective in reducing symptoms of depression.

Research indicates that repetitive transcranial magnetic stimulation (rTMS) and cognitive-behavioral therapy have received more attention in the treatment of depression, while their effects on depression and its psychological outcomes have been less explored. Moreover, a direct comparison of the effectiveness of these two treatments on emotion regulation in individuals with depression has not received much attention. Therefore, the present study aims to compare the effectiveness of repetitive transcranial magnetic stimulation (rTMS) and cognitive-behavioral therapy on emotion regulation in individuals with depression. The estimated lifetime prevalence of major depression in the general population is between 10% to 15%. Currently, major depression ranks fourth among diseases worldwide, and it is predicted to rise to the second rank by 2030 (World Health Organization, 2017). Major depression can occur in a chronic or recurrent form and can significantly impair an individual's ability to perform daily tasks. Given the negative psychological consequences of this disorder and the considerable burden it imposes on individuals, the healthcare system, and society, it is essential to implement appropriate treatment and management methods for this condition. In light of these considerations, the present research seeks to answer the question of whether repetitive transcranial magnetic stimulation (rTMS) and cognitive-behavioral therapy are effective in regulating emotions in individuals with depression and which one has a greater impact.

Methods

The current investigation is applied in its pursuit of objectives, utilizing a quasi-experimental design featuring the pretest-posttest control group, augmented by a

subsequent one-month follow-up stage. The statistical population of this study consists of men and women suffering from major depression hospitalized at Deldaram Sina Psychiatric Hospital in Tehran in the year 2022. The sample size included 39 men and women with major depression, selected purposively and randomly assigned (by random number table) to three groups: repetitive transcranial magnetic stimulation (rTMS) group (13 participants), cognitive-behavioral therapy group (13 participants), and control group (13 participants). The sample size for the current study was determined using Cohen's table (1987) for experimental studies at a confidence level of 95%, effect size of 0.50, and test power of 80% for each group, resulting in 13 participants. The inclusion criteria were: 1- Diagnosis of major depression by a psychiatrist (using a clinical psychological interview form) and obtaining a score of 29 or higher on the Beck Depression Inventory questionnaire (a score of 29 or higher indicates severe depression), 2- Having a history of at least one year of major depression, 3- Minimum diploma level of education, and 4- Minimum age of 18 years. The exclusion criteria were: 1- Substance abuse (this criterion is checked before each session using a rapid drug screen kit (urine drug monitoring rapid test)), and 2- Non-attendance exceeding two treatment sessions.

Materials

Beck Depression Inventory-II (BDI-II): The Beck Depression Inventory-II (BDI-II) is a scale developed by Beck (1996) to assess depressive symptoms based on the diagnostic criteria for depression provided by the American Psychiatric Association in the Diagnostic and Statistical Manual of Mental Disorders. This questionnaire consists of 21 four-choice items, scored from zero to three, with a total score ranging from zero to 63. Fathi et al. (2011) conducted a study on 94 Iranian individuals, reporting a reliability coefficient (Cronbach's alpha) of 0.91 and a test-retest reliability coefficient of 0.94 after one week. The alpha coefficient for outpatient individuals was 0.92, and for students, it was 0.93 (Dabson, Mohammakhani, & Massah-Choulabi, 2007). The internal consistency of this questionnaire in the present study was calculated using Cronbach's alpha method of 0.81.

Emotion Regulation Questionnaire (ERQ): The Emotion Regulation Questionnaire was developed by Gross and John in 2003 and consists of 11 items with two subscales: reappraisal and emotional suppression. Responses are rated on a Likert scale ranging from completely disagree (1) to completely agree (7). The Cronbach's alpha for reappraisal is reported as 0.79, and for emotional suppression, it is 0.73. The test-retest reliability after three months for the overall scale is reported as 0.69 (Fatahi Shangolabadi & Mirhashemi, 2018). The scale shows correlations with positive emotions (0.24) and negative emotions (-0.14) for reappraisal and correlations with positive emotions (-0.15) and negative emotions (0.04) for emotional suppression. The validity of the scale in Iran was established by Ghasempour, Ilbeigi, and Hassanzadeh in 2012, using internal consistency with Cronbach's alpha, principal component analysis with varimax rotation, inter-subscale correlation, and criterion-related validity (Akbari et al., 2020). The internal consistency of this questionnaire in the present study was calculated using Cronbach's alpha method of 0.85.

Procedure

The research was conducted by obtaining a letter of introduction from the university for Delaram Sina Psychiatric Hospital to carry out the study. After obtaining informed consent from the hospitalized patients in that hospital, the sampling process was initiated. The sampling process involved selecting patients hospitalized at Delaram Sina Psychiatric Hospital who were diagnosed with depression by a psychiatrist and scored 29 or higher on the 21-item Beck Depression Questionnaire. A total of 39 participants were purposefully selected based on their willingness and informed consent to participate in the research. Subsequently, the selected individuals were randomly assigned to each group (control group, repetitive transcranial magnetic stimulation (rTMS) group, and cognitive-behavioral group) with 13 participants in each group.

The emotion regulation questionnaire was distributed among the participants in three stages: pre-test, post-test, and follow-up, completed by members of both experimental and control groups. Subsequently, the experimental groups underwent cognitive-behavioral intervention and repetitive transcranial magnetic stimulation (rTMS), while the control group did not receive any intervention. Ensuring the confidentiality of the collected information, obtaining informed consent from participants, refraining from disclosing participant information to others, and creating a reassuring atmosphere were among the ethical considerations prioritized by the researcher. After collecting the data, the results were analyzed descriptively using means and standard deviations. In terms of inferential statistics, repeated measures analysis of variance (ANOVA) was employed to examine differences between groups at various measurement stages, utilizing SPSS software version 25.

Treatment protocol

Repetitive Transcranial Magnetic Stimulation (rTMS): Members of the rTMS group received 12 sessions of repetitive transcranial magnetic stimulation. The magnetic stimulation was applied to the left dorsolateral prefrontal cortex (DLPFC) at a frequency of 20-25 Hz, based on the protocol by Lefaucheur et al. (2020). Contraindications for rTMS included individuals under the age of 12, pregnancy, history of seizures, presence of metal objects in the head, use of antiepileptic drugs, alcohol or caffeine consumption within the last 24 hours, unconsciousness, and cognitive impairment. According to the physician's instructions, all patients were uniformly receiving the same dose of SSRI medication, with three types of drugs: 1) Sertraline, 2) Citalopram, and 3) Escitalopram. In the case of comorbid sleep disorders, benzodiazepines (Clonazepam 1) were used.

Cognitive-Behavioral Therapy (CBT): Based on the protocol by Beck (2007), which is a combination of Albert Ellis's and Aaron T. Beck's theories and treatments, CBT was administered in 12 sessions, each lasting 90 minutes. Additionally, the protocol by Hatton (1989, cited in Taghvaei Zadeh et al., 2019) for the cognitive-behavioral therapy group was implemented.

Table 1. Protocol of cognitive behavioral therapy sessions

Session	Content	Techniques and Exercises
1-2	The treatment process involves educating individuals on the relationship between thoughts and cognitive distortions with emotions.	Preparing a list of issues, providing training on various emotions, and explaining how they are influenced by thoughts.
3-4	Introduction to Cognitive-Behavioral Therapy (CBT), explanation of the cognitive-behavioral theory, characteristics of the treatment, expectations from therapy, and the various techniques used in the treatment.	Increasing awareness about cognitive-behavioral therapy, adjusting the expectations of clients regarding the treatment process, and explaining the relationship between cognition and behavior.
5	Treatment planning with the aim of creating a cognitive profile, including the various symptoms the clients experience, a list of their difficulties, and types of their ineffective cognitions.	Utilizing both direct and indirect questions, as well as utilizing problem list worksheets.
6	Teaching and implementing behavioral techniques to empower clients to become aware of the role of ineffective negative thoughts in creating and sustaining problems.	Training behavioral techniques, role-playing, attention redirection, sensory awareness, mental exercises, positive imagery, and cognitive reframing to cope with negative emotions.
7	Teaching the concept of self-talk, identifying these thoughts, discussing the recognition of the root causes of emotions, and exploring the cognitive fusion's role in magnifying negative emotions.	Explanation of how to identify negative self-talk and homework assignments using the A-B-C model, with an emphasis on thoughts triggering negative emotions. Reviewing these assignments in each session and providing feedback.
8-9	Teaching the identification of negative self-talk with the aim of recognizing common cognitive errors in emotion regulation.	Explanation and description of cognitive errors, presenting homework assignments related to cognitive errors, and evaluating their effectiveness on emotions.
10	Changing negative self-talk with the aim of reducing mental and emotional pressure.	My daily behavior
11	Changing inefficient core beliefs related to negative emotions and challenging exaggerated oppositional thoughts.	Practicing substituting healthy and effective beliefs between sessions using the ABC therapeutic model and Socratic questioning challenges.
12	Assisting the group in recalling and reviewing the main topics discussed during the sessions. Teaching how to assess the achievements of the treatment after the sessions conclude.	Utilizing third-person techniques, downward arrow, and three questions for referrals while implementing role-playing exercises.

Results

The demographic characteristics of the study participants in the three groups are presented in Table 2.

Table 2. Demographic variables of the studied subjects by group

Demographic Variable		Group			Chi-square results
		Cognitive behavioral therapy	**rTMS**	**Control**	
		Frequency (%)	Frequency (%)	Frequency (%)	
Gender	Female	7(53.8)	5(38.5)	9(69.2)	χ^2= 2.47
	Male	6(46.2)	8(61.5)	4(30.8)	P=0.29
Marital status	Single	4(30.8)	5(38.5)	1(7.7)	χ^2= 3.49
	Married	9(69.2)	8(61.53)	12(92.3)	P=0.17
Educatinal status	Dipmola	4(30.8)	5(38.5)	7(53.8)	χ^2= 7.67
	Associate degree	2(15.4)	2(15.4)	1(7.7)	P=0.26
	Bachelor	4(30.8)	6(46.2)	5(38.5)	
	Master	3(23.1)	0(0)	0(0)	

The frequency distribution, percentage, and results of the chi-square test for comparing the study groups based on demographic characteristics are presented in Table 3. The table indicates that there is no significant difference between the study groups in terms of gender ($P < 0.05$, $\chi2 = 2.47$), marital status ($P < 0.05$, $\chi2 = 3.49$), and education level ($P < 0.05$, $\chi2 = 7.67$). Therefore, the groups are homogeneous in terms of these characteristics. The mean age of participants in the cognitive-behavioral group was 37.84 ± 10.15, in the rTMS group was 38.69 ± 9.69, and in the control group was 40.84 ± 9.31.

Table 3. Mean and standard deviation of research variables by study groups and measurement stages

Variable	Group	Min	Max	Mean	Std. Deviation
Pre - Repression	CBT	4.00	24.00	16.69	6.21
	RTMS	5.00	21.00	16.00	4.67
	Control	8.00	27.00	14.69	6.25
Post - Repression	CBT	14.00	24.00	19.00	3.56
	RTMS	5.00	22.00	14.92	4.72
	Control	4.00	15.00	11.23	3.79
Follow up - Repression	CBT	4.00	24.00	18.23	5.59
	RTMS	6.00	18.00	12.85	3.36
	Control	8.00	24.00	14.08	5.16
Pre - Reassessment	CBT	7.00	42.00	24.54	10.21
	RTMS	12.00	37.00	27.31	6.86
	Control	12.00	46.00	27.15	9.92
Post - Reassessment	CBT	15.00	42.00	29.38	6.81
	RTMS	10.00	29.00	22.54	5.85
	Control	8.00	25.00	17.31	6.58
Follow up - Reassessment	CBT	6.00	41.00	27.46	10.55
	RTMS	9.00	27.00	19.23	4.90
	Control	10.00	31.00	21.23	6.75
Pre - Emotion Regulation	CBT	11.00	66.00	41.23	16.16
	RTMS	17.00	58.00	43.55	11.91
	Control	20.00	71.00	41.85	15.95
Post - Emotion Regulation	CBT	29.00	61.00	48.38	9.16
	RTMS	15.00	51.00	37.46	9.96

	Control	12.00	40.00	28.54	10.07
Follow up - Emotion Regulation	CBT	10.00	64.00	45.69	15.86
	RTMS	15.00	45.00	32.08	7.80
	Control	18.00	52.00	35.31	10.61

As indicated by the results in Table 3, the mean scores of the variables of emotional suppression, reappraisal assessment, and overall emotion regulation differ across the control and experimental groups in the measurement stages.

Table 4. Kolmogorov-Smirnov test related to the research variables.

Variable	**Group**	**Kolmogorov-Smirnov[a]**		
		Statistic	df	P
Pre - Suppression	CBT	0.22	13	0.09
	RTMS	0.14	13	0.20
	Control	0.16	13	0.20
Pre - Reassessment	CBT	0.16	13	0.20
	RTMS	0.19	13	0.20
	Control	0.18	13	0.20
Emotion Regulation	CBT	0.18	13	0.20
	RTMS	0.13	13	0.20
	Control	0.18	13	0.20

According to the results of Table 4, it is observed that for all the examined variables in both the control and experimental groups, the significance level (P-value) is greater than the alpha value of 0.05. Therefore, the assumption of normality for the variables in all three groups is confirmed.

To test the homogeneity of variances between groups, Levene's test was utilized. Based on the results of Levene's test, the variances of suppression scores ($F = 1.39$, $P > 0.05$), reassessment ($F = 1.17$, $P > 0.05$), and somatic symptoms ($F = 0.97$, $P > 0.05$) are homogeneous in both the experimental and control groups.

The assumption of homogeneity of regression slopes for suppression scores, reassessment, and overall emotion regulation scores in the groups was also investigated. The lines of the regression slope for pre-test and post-test scores of variables in the three groups are similar, and there is a linear relationship between the dependent variable and its homoscedasticity. Since there were three dependent variables in the current research, a multivariate analysis of covariance (MANCOVA) was initially employed, and then,

based on the results, a univariate analysis of covariance (ANCOVA) was utilized. The result of the Wilks Lambda test showed a significant difference in the linear combination of suppression scores, reassessment, and overall emotion regulation scores based on the group in the post-test stage (F= 4.32, p=0.004). Partial Eta Squared also indicates that 21% of the variance in dependent variables is determined by the grouping variables (rTMS, Cognitive-Behavioral Therapy, and Control groups). This implies that changes in the independent variable had a significant impact on at least one of the dependent variables in the groups.

The result of the Wilks Lambda test indicated that there is no significant difference in the linear combination of suppression scores, reassessment, and overall emotion regulation scores based on the group in the follow-up stage (F=0.73, p=0.58). This implies that the effects of independent variables on dependent variables did not persist. Since the follow-up stage did not show significance, subsequent analysis for hypothesis testing and comparing the intervention effects of repetitive Transcranial Magnetic Stimulation (rTMS) and Cognitive-Behavioral Therapy on suppression, reassessment, and overall emotion regulation scores relied on univariate analysis of covariance and the Bonferroni post-hoc test, which are reported in Tables 5 and 6.

Table 5. Results of the Analysis of Covariance (ANCOVA) comparing the differences between the experimental and control groups in suppression scores, reassessment, and overall emotion regulation scores in the post-test stage.

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared	Observed Power
Group	Suppression	275.90	2	137.95	9.715	0.001	0.38	0.97
	Reassessment	635.60	2	317.80	7.209	0.003	0.31	0.91
	Overall Emotion Regulation Score	1748.36	2	874.18	9.288	0.001	0.37	0.97
Error	Suppression	454.37	32	14.20				
	Reassessment	1410.75	32	44.09				
	Overall Emotion Regulation Score	3011.70	32	94.12				
Total	Suppression	9262	37					
	Reassessment	21909	37					
	Overall Emotion Regulation Score	59133	37					

The results of the one-way Analysis of Covariance (ANCOVA) in Table 5 indicate a significant difference in the effectiveness of independent variables on suppression,

reassessment, and overall emotion regulation scores. For detailed pairwise comparisons and to identify specific differences, the Bonferroni post hoc test was employed. The results are presented in Table 6.

Table 6. The results of the Bonferroni post hoc test for pairwise comparisons of means for suppression, reassessment, and overall emotion regulation scores in the post-test phase among the experimental and control groups

Dependent Variable	(I) group	(J) group	Mean Difference (I-J)	Std. Error	Sig.[b]	95% Confidence Interval for Difference[b]	
						Lower Bound	Upper Bound
Suppression	CBT	RTMS	4.87	1.73	0.03	0.49	9.26
		Control	8.16	1.84	0.00	3.48	12.85
	RTMS	Control	3.29	1.51	0.14	-0.70	7.28
Reassessment	CBT	RTMS	7.75	3.07	0.05	0.03	15.48
		Control	12.37	3.26	0.00	4.12	20.62
	RTMS	Control	4.62	2.75	0.32	-2.42	11.66
Overall Emotion Regulation Score	CBT	RTMS	12.62	4.47	0.02	1.34	23.91
		Control	20.53	4.72	0.00	8.48	32.59
	RTMS	Control	7.91	4.07	0.18	-2.37	18.19

The results in Table 6 indicate that, significantly, the mean scores of cognitive-behavioral therapy are higher than the mean scores of the rTMS and control groups for the variables of suppression, reassessment, and emotion regulation. In the variables of suppression, reassessment, and emotion regulation, the mean scores of the rTMS group are significantly higher than the mean scores of the control group.

Discussion

The present study aimed to compare the effectiveness of repetitive transcranial magnetic stimulation (rTMS) and cognitive-behavioral therapy on emotion regulation in individuals with depression. The results indicated that both rTMS and cognitive-behavioral therapy were effective in emotion regulation and its components of suppression and reassessment in individuals with depression. Moreover, the effectiveness of cognitive-behavioral therapy in emotion regulation and its components of suppression and reassessment was greater than that of rTMS ($p < 0.05$). These findings align with

previous studies conducted by Khomami (1389), Peiramraddi et al. (1392), Rahmaniyan et al. (2015), Shibani et al. (1401), Kianzad et al. (2021), and Nguyen et al. (2021).

In explaining the impact of repetitive transcranial magnetic stimulation (rTMS) therapy on emotion regulation in individuals with depression, it can be stated that rTMS is an uncontrollable therapeutic method used in the treatment of certain mental disorders, including depression. One of the primary goals of treating depression with rTMS is to improve emotional regulation. According to scientific research and studies, individuals with depression may experience abnormalities in emotional regulation. In these individuals, specific brain regions crucial for emotion regulation, such as the prefrontal cortex and cingulate cortex, may exhibit reduced activity. rTMS, through the repetitive and recurring application of magnetic fields to specific brain regions, stimulates neural activity. By stimulating specific brain regions involved in emotion regulation, such as the prefrontal and cingulate cortices, direct effects on the activity of these regions can be achieved, leading to an improvement in emotion regulation. If specific brain regions responsible for emotion regulation exhibit reduced activity or imbalance, rTMS can positively impact emotion regulation in individuals with depression by increasing the activity of these regions and improving emotional balance (Lefaucheur et al., 2014; Lefaucheur et al., 2020).

In another explanation, it can be said that repetitive transcranial magnetic stimulation (rTMS) can be effective in emotion regulation due to its impact on the activity of brain regions involved in emotion regulation. The rTMS method, using a magnetic field, provides the possibility to stimulate neural activity in specific brain regions, resulting in a direct influence on emotion regulation. Scientific studies have shown that individuals with emotional disorders, such as depression, exhibit deficiencies in emotional regulation. rTMS stimulation can facilitate improvement in emotional regulation through two main pathways to achieve optimal functioning of the brain regions involved in emotion regulation: 1) Increased Activity: With rTMS, it is possible to increase the activity of brain regions associated with emotion regulation. In other words, repetitive magnetic stimulation can lead to enhanced activity in brain regions related to emotion regulation, consequently improving emotional regulation. This activation of brain regions can have a positive impact on emotional functioning and reduce depressive symptoms. 2) Emotional Balance: rTMS stimulation can contribute to emotional balance in the brain. In some individuals, there may be imbalanced activity in brain regions associated with emotion regulation, resulting in emotional dysregulation. Through rTMS, it is possible to improve the balance of activity in these brain regions, having a positive effect on emotional regulation (McClintock et al., 2017; Chu et al., 2023; Citrenbaum et al., 2013).

In explaining the effectiveness of cognitive-behavioral therapy (CBT) on emotion regulation in patients, it can be stated that cognitive-behavioral therapy focuses on techniques to change cognition and improve emotions. CBT assists individuals in developing skills such as emotional awareness, adopting a perspective, anger management, and problem-solving in interpersonal relationships. Through homework assignments, individuals are encouraged to apply these skills in their daily lives, making them more motivated and capable of utilizing these skills in their interpersonal relationships. Cognitive-behavioral therapy aims to enhance these abilities in individuals

by changing and modifying their thinking and behavior. The primary goal of CBT is to alter negative feelings by changing thought patterns and behaviors, empowering individuals to cope with life events more effectively (Leahy, 2017). By changing cognitions, the entire emotional and behavioral system of an individual will transform. This type of therapy creates a stronger sense of control by increasing cognitive-behavioral skills, including problem-solving, recognizing and identifying subconscious and distorted thoughts, interpreting events from new perspectives, and a heightened sense of control. It encourages individuals to be conscious and active in situations where they feel they can take control of seemingly uncontrollable matters. Moreover, individuals learn to focus on positive aspects rather than solely on negative events or aspects of an event. They are taught not to engage in unwarranted predictions and to strengthen their positive outlook on the future. By emphasizing positive forecasting, individuals can enhance their cognitive efficacy and mitigate the impact of traumatic events (Helland et al., 2011; Moradi &AzizMohammadi, 2015; Macklem et al., 2023).

In another explanation, it can be said that the cognitive-behavioral approach focuses on identifying and changing beliefs and emotions that affect individuals' performance, and members are prepared for accountability and change in irrational beliefs. They learn how to combat their mental assumptions and stop their incorrect thoughts (Kazantzis et al., 2018). Therefore, considering the cognitive-behavioral framework in the present study, emotional regulation is not unexpected. In another potential explanation, it can be stated that since the cognitive-behavioral approach emphasizes cognitive and behavioral dimensions, thinking, judgment, decision-making, and analysis, and has logical, interpretative, convincing, and explanatory features (Okamoto et al., 2019), in the present study, by employing these features in group sessions, participants in the experimental group were assisted. They overcame their incorrect beliefs and transformed their belief system into a new and profound one by taking responsibility for their discomforts. They also developed coping strategies against any undesirable activating event. Therefore, emotional regulation in the members of the experimental group seems justified.

In explaining the greater effectiveness of cognitive-behavioral therapy (CBT) in emotional regulation, it can be said that cognitive-behavioral therapy, especially in terms of cognitive therapy, has a longer-lasting efficacy compared to repetitive transcranial magnetic stimulation (rTMS) treatment. There is ample evidence indicating that psychotherapy, particularly cognitive-behavioral therapy, influences brain function and structure, especially in prefrontal areas (De Lange et al., 2008). Since this brain region is related to cognitive control, influencing this point can lead to a reduction in depressive symptoms. In cognitive-behavioral therapy, individuals learn to influence this area of the brain by controlling their thoughts. Because this influence occurs due to learning, the individual can confront depressive symptoms anytime they choose by changing the underlying structure of their thoughts and beliefs, replacing negative cognitions with positive ones, and challenging negative thoughts. However, in repetitive transcranial magnetic stimulation (rTMS) treatment, there is no role for learning, and the stimulation of this brain region occurs solely through the pulses of the device. Therefore, after treatment, due to the cessation of stimulations, the sustained impact of the treatment is less pronounced.

Conclusion

In general, the results of the current study demonstrated that repetitive transcranial magnetic stimulation (rTMS) and cognitive-behavioral therapy were effective in regulating emotions and the components of suppression and reappraisal in individuals with depression. The effectiveness of cognitive-behavioral therapy in emotional regulation and its components, suppression, and reappraisal was found to be greater than repetitive transcranial magnetic stimulation (rTMS) treatment. Based on the results obtained from the protocols of repetitive transcranial magnetic stimulation (rTMS) and cognitive-behavioral therapy for emotional regulation in individuals with depression, it is recommended to implement these treatments in mental health centers and psychiatric hospitals. It is worth noting that, given the higher efficacy of cognitive-behavioral therapy, its use for regulating emotions in individuals with depression should be prioritized. Since the current research was conducted on both women and men with depression, caution is advised when generalizing the findings to other groups. It is suggested that future research be conducted with a focus on gender differences and using a single-subject design for baseline measurements.

Ethical issues

The present article is derived from a doctoral dissertation in clinical psychology at the Islamic Azad University, Roudehen Branch. The general informed consent form was completed by the participants, and the researcher has kept it confidential. The ethical standards, including obtaining ethics code approval from the university's ethics committee (reference code: IR.IAU.R.REC.1401.046), were followed. Ethical criteria included obtaining an ethics code from the university's ethics committee, obtaining written consent from participants for distributing questionnaires and conducting relevant training, adhering to scientific honesty and integrity, obtaining informed consent for participation in the research, respecting the anonymity of scales and keeping participants' information confidential.

Disclosure Statements

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