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Comparison of the Effectiveness of Cognitive-Behavioral Group Therapy Combined with Mindful Self-Compassion With and Without Physiotherapy on Executive Functions of Older Adults with Chronic Osteoarthritis-Related Pain

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A B S T R A C T

Purpose: This study aimed to compare the effectiveness of cognitive-behavioral group therapy combined with mindful self-compassion with and without physiotherapy on executive functions in older adults suffering from chronic osteoarthritis-related pain.

Methods and Materials: Using a semi-experimental design with pre-test, post-test, and two-month follow-up, 45 older adults with chronic knee osteoarthritis pain were randomly assigned to one of three groups: (1) CBT combined with mindful self-compassion plus physiotherapy, (2) CBT combined with mindful self-compassion without physiotherapy, and (3) a control group. The intervention protocol consisted of 16 sessions over eight weeks for the psychological components, while the physiotherapy component included eight weekly sessions of ultrasound therapy. Executive functions were assessed using the Barkley Deficits in Executive Functioning Scale. Data were analyzed using ANCOVA and Bonferroni post-hoc tests.

Findings: Results revealed a significant main effect of treatment on reducing executive function deficits after controlling for pre-test scores ($F(2,41)=98.37$, $p<0.001$, $\eta^2=0.62$). Post-hoc comparisons indicated that the group receiving CBT with mindful self-compassion and physiotherapy showed significantly greater reductions in executive dysfunction compared to both the group without physiotherapy ($p=0.001$) and the control group ($p=0.001$). The group receiving only psychological intervention also demonstrated significantly greater improvement compared to the control group ($p=0.03$). These effects remained stable at the two-month follow-up.

Conclusion: Integrating physiotherapy with CBT and mindful self-compassion enhances executive functioning in older adults with chronic osteoarthritis-related pain. Both intervention conditions produced sustained improvements, but combining physical and psychological treatment yielded the strongest outcomes, underscoring the importance of interdisciplinary approaches in this population.

Keywords: *Executive functions; cognitive-behavioral therapy; mindful self-compassion; physiotherapy; chronic pain; osteoarthritis; older adults.*

1. Introduction

Aging is associated with progressive changes in cognitive functioning, particularly in domains related to executive functions such as working memory, inhibitory control, cognitive flexibility, and planning. Among older adults, especially those with chronic physical conditions such as osteoarthritis, these deficits can become more pronounced and detrimental to daily functioning and quality of life. Executive functions are crucial for independent living, adaptive behavior, emotional regulation, and health management; thus, addressing these impairments is vital for the elderly population (Guarino et al., 2020; Kim et al., 2022). Osteoarthritis, one of the most common chronic diseases among the elderly, is not only a source of persistent physical pain but also a contributor to psychological distress and cognitive decline, particularly in domains of executive functioning (Mariappan & Mukhtar, 2024).

Recent evidence has highlighted the promise of integrative therapeutic approaches that target both the psychological and physiological dimensions of chronic conditions. Cognitive Behavioral Therapy (CBT), a widely studied psychological intervention, has shown efficacy in improving cognitive processes such as planning, decision-making, and self-regulation (Afshari et al., 2022; Rahmani et al., 2024). CBT has also demonstrated benefits in reducing anxiety and maladaptive thoughts in chronic illness populations, which are often linked to executive dysfunctions (Gu & Zhu, 2023; Mohseni Nasab et al., 2024). However, executive dysfunction in older adults appears to be multifactorial, necessitating a combination of psychotherapeutic and neurocognitive components for optimal outcomes.

In recent years, mindfulness-based interventions and self-compassion practices have been integrated into CBT to enhance its cognitive and emotional impact. Mindful Self-Compassion (MSC) encourages individuals to develop a non-judgmental awareness of their present-moment experiences, coupled with kindness toward oneself, especially during times of distress (Ritter & Álvarez, 2020; Ullrich-French & Cox, 2019). Research suggests that mindfulness and self-compassion may reduce cognitive rigidity and facilitate emotional regulation, thereby indirectly improving executive functioning (Kodavanji et al., 2015; Wang et al., 2022; Zhou et al., 2020). Mindfulness training has been associated with improved attention control and working memory even in elderly populations, demonstrating the potential to reverse or slow down some age-related cognitive declines (Khatri, 2024; Vatankhah et al., 2021).

Combining CBT with mindfulness and self-compassion may provide a more holistic intervention that addresses both the cognitive distortions and emotional responses associated with chronic pain and executive dysfunction. For instance, the integration of compassionate awareness within CBT protocols may enhance treatment adherence, reduce avoidance behavior, and improve cognitive flexibility, as participants become more willing to face and reappraise their distressing thoughts (Hosseini Dastjerdi et al., 2024; Norouzi Homayoun et al., 2023). Furthermore, empirical findings suggest that MSC-based practices could significantly impact neural correlates of executive control by reducing activity in brain regions associated with negative rumination and increasing activity in those responsible for attention regulation and top-down control (Dado & Emadian, 2024; Gu & Zhu, 2023).

Parallel to psychotherapeutic methods, non-invasive physiotherapy modalities—such as ultrasound therapy—have been shown to alleviate chronic pain symptoms and improve physical function in older adults with osteoarthritis. The reduction in pain may in turn reduce cognitive load and free up mental resources needed for executive tasks (Bagheri Khorasgan, 2024). Chronic pain is known to impair executive function by overactivating the salience network and depleting attentional resources (Zhou et al., 2020). Therefore, by integrating physiotherapy with psychological interventions, a dual-pathway model for improving executive functioning in osteoarthritis patients may be established. However, the additive or synergistic effect of physiotherapy combined with CBT-MSC on executive functions remains underexplored in geriatric pain populations.

The relevance of executive functioning in older adults with chronic health issues extends beyond individual well-being. Impaired executive functioning may lead to reduced adherence to medical treatments, poorer health outcomes, and increased caregiver burden and healthcare costs (Babaei et al., 2024; Najjari Alamooti et al., 2023). As such, interventions that improve executive functioning in this population can have significant societal and economic implications. Moreover, considering the psychological vulnerability and cognitive decline often co-occurring with chronic osteoarthritis, there is a compelling need for multimodal interventions that concurrently target emotional resilience and cognitive control (Baniasadi, 2024; Mohseni Nasab et al., 2024).

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Previous studies have underscored the efficacy of CBT and mindfulness-based interventions in various populations, including individuals with anxiety, ADHD, insomnia, and generalized cognitive impairments. For example, CBT has been linked to enhanced executive functioning in children with learning disorders and attentional issues, as well as in adults with anxiety disorders (Afshari et al., 2022; Rahmani et al., 2024). Similarly, mindfulness-based cognitive therapy (MBCT) has shown efficacy in improving executive functioning in individuals with body dysmorphic disorder and adolescents under academic pressure (Gu & Zhu, 2023; Ullrich-French & Cox, 2019). These studies suggest that CBT and mindfulness work through both cognitive restructuring and attentional retraining, offering a dual mechanism for improving executive control (Ritter & Álvarez, 2020; Zhou et al., 2020).

Despite these promising findings, limited research has been conducted on elderly individuals with chronic pain and physical comorbidities such as osteoarthritis, where both physical and mental health challenges converge. Studies that do exist often isolate psychological or physical interventions without assessing their integrated effects. Given the bidirectional relationship between physical pain and cognitive processing, examining a combined treatment protocol offers a novel and clinically meaningful avenue for intervention. This is especially critical in aging populations, where maintaining executive functioning is closely tied to quality of life, autonomy, and psychological resilience (Guarino et al., 2020; Kodavanji et al., 2015; Mariappan & Mukhtar, 2024).

In addition, cultural and contextual factors play an important role in treatment effectiveness. Studies conducted in Iran, for instance, have highlighted the value of localized CBT protocols adapted for older adults' emotional and cognitive profiles, with demonstrated effectiveness in managing executive function deficits, emotional dysregulation, and anxiety (Bagheri Khorasgan, 2024; Hosseini Dastjerdi et al., 2024; Mohseni Nasab et al., 2024). These culturally attuned interventions further emphasize the necessity of nuanced, multifaceted programs that are not only evidence-based but also sensitive to the unique biopsychosocial conditions of the elderly.

The present study addresses this gap by comparing the effectiveness of cognitive-behavioral group therapy integrated with mindful self-compassion—with and without physiotherapy—on executive functions in older adults suffering from chronic osteoarthritis-related pain.

2. Methods and Materials

2.1. Study Design and Participants

The present study employed a semi-experimental, pretest–posttest design with a control group and a two-month follow-up, implemented across three arms: a cognitive-behavioral therapy program integrated with mindful self-compassion alongside physiotherapy, the same psychological intervention without physiotherapy, and a non-intervention control group. The sampling frame comprised all individuals aged over 60 who presented with chronic knee osteoarthritis pain at the Elderly Rehabilitation Center of Hamrah Salamat and the Iman Physiotherapy Clinic in Babol between March and May 2023. A priori power analysis for a three-group comparison, targeting 80 percent power, a medium effect size, and an alpha of 0.05 based on Cohen's tables, indicated a minimum of 15 participants per group. To allow for potential attrition, 45 participants were recruited via purposive sampling. Inclusion criteria required absence of neurological or psychiatric disorders (and no history of psychiatric hospitalization), no psychological treatment in the previous six months, no severe incurable conditions (such as cancer), no physiotherapy in the past year, diagnosis of knee osteoarthritis within the last year, absence of substance misuse, willingness to participate, and no current use of psychotropic medication. Exclusion criteria for the intervention arms encompassed withdrawal of consent, missing more than two sessions, development of any physical complications during the psychological intervention, or experiencing a major life crisis (e.g., bereavement or serious accident affecting the participant or a first-degree relative). After obtaining written informed consent, participants were randomly allocated to one of the three study groups using a random-numbers table, and block randomization procedures were applied to ensure comparable group sizes.

2.2. Measure

Data were gathered through a demographic information form and the Barkley Deficits in Executive Functioning Scale (BDEFS), an 89-item self-report inventory developed by Barkley (2012) comprising five subscales that assess domains such as time management, self-organization, problem solving, emotional regulation, and motivational control; respondents rate each item on a four-point Likert scale from "never or rarely" (1) to "very often" (4), with

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eleven specified items reverse-scored to mitigate response bias. Elevated scores on any subscale indicate greater executive function deficits in daily life. Convergent validity of the BDEFS has been demonstrated via its correlations with the Adult ADHD Self-Report Scale and the Metacognitions Questionnaire-30 (MCQ-30), while divergent validity was confirmed against the Cognitive Flexibility Questionnaire. Both exploratory and confirmatory factor analyses have consistently supported the original five-factor structure, with all items exhibiting satisfactory loadings. In Iranian samples, Rabiei (2015) reported a Cronbach's alpha of 0.98 for the full inventory, convergent validity correlations of $r = 0.732$ ($p < 0.001$) with ADHD self-report and $r = 0.531$ ($p < 0.001$) with MCQ-30, divergent correlation of $r = –0.676$ ($p < 0.001$) with cognitive flexibility, and a factor structure explaining 55.37 percent of variance; in this study, the overall internal consistency was excellent, with a Cronbach's alpha of 0.96.

2.3. Interventions

Participants in both experimental conditions engaged in a sixteen-session, eight-week group program integrating Gilbert's mindful self-compassion approach with Wildermuth's cognitive-behavioral therapy. The program commenced with twice-weekly ninety-minute sessions designed to cultivate self-compassion through exercises such as mindful body scans, breath awareness, exploration of self-compassionate versus self-critical mind states, development of warm and kindly attitudes toward self and others, application of compassion-focused metaphors to foster forgiveness and acceptance of emotional distress, and compassion-based imagery practices supported by home-practice assignments. Thereafter, the sessions transitioned to cognitive-behavioral techniques that built on these foundations by introducing daily thought-record worksheets for anxiety-provoking events, training participants to recognize and challenge automatic negative thoughts and common cognitive distortions such as catastrophizing and mental filtering, and teaching behavioral coping strategies including sensory refocusing, adaptive coping cards, diaphragmatic breathing, and group relaxation exercises. Imagery rescripting was employed to modify distressing mental images, and the program concluded with consolidation of skills in emotion regulation, impulse control, adherence to health recommendations, and relapse-prevention planning to ensure sustainable application of both compassion and cognitive-behavioral strategies.

For the first experimental group, a physiotherapy regimen was delivered concurrently with the psychological program, comprising eight weekly sessions of therapeutic ultrasound applied to the affected knee by a specialist physiotherapist at the Elderly Rehabilitation Center. Each session lasted approximately sixty minutes, during which ultrasound parameters were selected according to standard clinical guidelines and adjusted to each participant's tolerance, with the goal of alleviating pain, reducing inflammation, and enhancing joint mobility over the two-month intervention period.

2.4. Data Analysis

All data were analyzed using SPSS version 21. Descriptive statistics—including means, standard deviations, frequencies, and percentages—were computed to characterize the sample and summarize baseline demographic and outcome measures. To examine intervention effects while adjusting for baseline differences, analysis of covariance (ANCOVA) was performed on posttest executive function scores with pretest scores as covariates. Where omnibus tests reached significance, Bonferroni-adjusted post-hoc comparisons identified specific group differences. Follow-up data collected two months after the intervention underwent the same analytical procedures to assess the durability of treatment effects.

3. Findings and Results

Of the total 45 participants, 24 were women (53%) and 21 were men (47%). Regarding marital status, 39 participants (86.6%) were married and 6 (13.4%) were single. In terms of age distribution, 22 participants (48.8%) were between 60 and 65 years old, 14 participants (31.1%) were between 65 and 70 years old, and 9 participants (20%) were between 70 and 75 years old.

Table 1

Means and Standard Deviations of Executive Function Scores Across Groups and Phases of Measurement

Variable	Group	Pre-test Mean	SD	Post-test Mean	SD	Follow-up Mean	SD

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Executive Functions	CBT + Mindful Self-Compassion + Physiotherapy	306.26	11.87	263.26	12.10	259.20	12.00
	CBT + Mindful Self-Compassion without Physiotherapy	307.53	12.48	292.40	13.45	294.38	13.05
	Control	310.66	12.69	305.52	12.66	304.34	12.60

Table 1 presents the descriptive statistics for executive function scores across the three groups at pre-test, post-test, and two-month follow-up phases. In the group that received cognitive-behavioral therapy combined with mindful self-compassion and physiotherapy, the mean score for executive functioning decreased notably from 306.26 (SD = 11.87) at pre-test to 263.26 (SD = 12.10) at post-test and slightly further to 259.20 (SD = 12.00) at follow-up, indicating a sustained improvement. The group that received the same psychological intervention without physiotherapy also showed a reduction from a pre-test mean of 307.53 (SD = 12.48) to 292.40 (SD = 13.45) at post-test and 294.38 (SD = 13.05) at follow-up. In contrast, the control group exhibited minimal change over time, with a pre-test mean of 310.66 (SD = 12.69), post-test mean of 305.52 (SD = 12.66), and follow-up mean of 304.34 (SD = 12.60), suggesting limited natural improvement in executive functions without intervention. These findings indicate greater improvements in both intervention groups, particularly the group that also received physiotherapy.

Before conducting ANCOVA, key statistical assumptions—including normality of residuals, homogeneity of variances, linearity between covariates and dependent variables, and homogeneity of regression slopes—were examined and confirmed. Tests indicated that residuals were approximately normally distributed, Levene's test showed no significant differences in error variances across groups, scatterplots confirmed linear relationships, and the interaction between covariates and the independent variable was not significant, supporting the assumption of homogeneity of regression slopes. Thus, the data met the necessary conditions for valid application of ANCOVA.

Table 2

Summary of ANCOVA for the Effectiveness of Cognitive-Behavioral Group Therapy with Mindful Self-Compassion with and without Physiotherapy on Reducing Executive Function Deficits

Source	SS	df	MS	F	P	η^2
Pre-test Executive Functions	1154.53	1	1154.53	5.57	0.02	0.12
Main Effect (Treatment)	39465.26	2	19732.63	98.37	0.000	0.62
Residual Error	8223.73	41	200.57			

The ANCOVA results in Table 2 show that after controlling for pre-test executive function scores, the main effect of treatment on reducing executive function deficits at post-test was statistically significant ($F(2, 41) = 98.37$, $p < 0.001$), with a large effect size (partial eta squared = 0.62). This indicates that differences in post-test means among the three groups were statistically significant with 95% confidence after adjusting for baseline scores.

Table 3

Bonferroni Post-Hoc Test Results for Executive Function Scores

Variable	Group 1	Group 2	Mean Difference	Std. Error	P
Executive Functions	CBT + MSC + Physiotherapy	CBT + MSC without Physiotherapy	-56.59	5.17	0.001
	CBT + MSC + Physiotherapy	Control	-68.39	5.23	0.001
	CBT + MSC without Physiotherapy	CBT + MSC + Physiotherapy	56.59	5.17	0.001
	CBT + MSC without Physiotherapy	Control	-11.80	5.20	0.03

As shown in Table 3, post-hoc comparisons using the Bonferroni correction revealed significant differences in executive function scores between the group that received cognitive-behavioral therapy combined with mindful self-compassion and physiotherapy and both the group without physiotherapy ($p < 0.001$) and the control group ($p < 0.001$).

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Moreover, there was also a significant difference between the group without physiotherapy and the control group ($p = 0.03$). These findings confirm that the combination of psychological intervention with physiotherapy had the strongest impact on reducing executive function deficits, followed by the psychological intervention alone, compared to the control condition.

4. Discussion and Conclusion

The findings of this study indicate that cognitive-behavioral group therapy combined with mindful self-compassion (CBT-MSC), both with and without physiotherapy, significantly reduced executive function deficits in older adults with chronic osteoarthritis-related pain compared to the control group. Furthermore, the group receiving physiotherapy alongside CBT-MSC demonstrated the greatest improvement. This suggests that combining a psychological intervention focused on cognitive restructuring and emotional regulation with physical therapy targeting pain reduction may produce synergistic effects on cognitive performance.

One explanation for the observed improvement in executive functions in the intervention groups relates to the well-established association between chronic pain, cognitive resources, and attentional control. Chronic pain often depletes cognitive resources, reducing working memory and executive capacity as attentional focus becomes dominated by pain signals (Guarino et al., 2020). Reducing pain through physiotherapy, therefore, likely released attentional capacity, facilitating engagement in cognitive tasks and allowing participants to more effectively integrate the skills learned through CBT-MSC. This aligns with previous research suggesting that pain reduction alone can lead to improvements in executive function in chronic pain populations (Bagheri Khorasgan, 2024).

The superior outcomes of the group receiving CBT-MSC with physiotherapy are also consistent with studies showing the impact of mindfulness and self-compassion practices on enhancing cognitive flexibility and working memory. Mindfulness training helps individuals shift attention away from intrusive or ruminative thought patterns and toward the present moment, promoting adaptive cognitive responses and emotional regulation (Kodavanji et al., 2015; Zhou et al., 2020). In the context of older adults with osteoarthritis, this capacity to reorient attention may have been especially critical in mitigating the impact of pain on cognitive processing, thereby enhancing the effectiveness of cognitive restructuring techniques inherent in CBT (Afshari et al., 2022).

The results also support the hypothesis that fostering self-compassion improves treatment adherence, emotional resilience, and motivation to engage in therapeutic practices. Self-compassion has been linked to reduced shame, self-criticism, and avoidance behaviors, which can undermine participation in and benefit from cognitive-behavioral interventions (Ullrich-French & Cox, 2019). Previous research has demonstrated that combining mindfulness and self-compassion with CBT protocols not only amplifies emotional benefits but also enhances cognitive flexibility and attentional control (Gu & Zhu, 2023; Ritter & Álvarez, 2020). The current findings further validate these conclusions in an elderly population with chronic pain.

Importantly, the observed sustained improvements at the two-month follow-up suggest that both CBT-MSC interventions provided participants with durable skills in cognitive control and emotion regulation. This is consistent with prior studies on older adults showing that mindfulness-based cognitive interventions can result in long-term neuroplastic changes supporting executive functions (Kim et al., 2022; Vatankhah et al., 2021). The use of home-practice exercises in both the mindfulness and CBT components may have also contributed to these lasting effects, allowing participants to consolidate therapeutic gains in their everyday routines.

The difference in effectiveness between the two experimental groups, with the physiotherapy group showing greater reductions in executive dysfunction scores, is in line with findings suggesting that physical health improvements often lead to indirect cognitive benefits by reducing stress, depressive symptoms, and pain interference with cognitive performance (Baniasadi, 2024; Guarino et al., 2020). Moreover, combining a physical treatment with a psychologically oriented intervention likely addressed both the physiological and cognitive-emotional dimensions of chronic osteoarthritis, which are often deeply intertwined in elderly patients (Khatri, 2024; Mariappan & Mukhtar, 2024).

These findings are also supported by literature demonstrating the effects of dual-task interventions in older adults, particularly those involving a combination of physical and cognitive challenges. Such interventions have been associated with improved executive function, suggesting that concurrent training of physical and cognitive domains may yield stronger effects than either component alone (Kim et al., 2022). Similarly, previous research has

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found that reducing pain through non-invasive physiotherapy techniques can enhance readiness to participate in cognitive interventions, further supporting the additive value of physiotherapy in the current study (Bagheri Khorasgan, 2024).

Another factor potentially explaining the findings is the role of emotion regulation in executive functioning. Studies have shown that enhancing emotion regulation skills through mindfulness and self-compassion practices results in greater inhibitory control and working memory performance (Ritter & Álvarez, 2020; Wang et al., 2022). Given that chronic pain often co-occurs with negative affective states, the ability to regulate emotion may be a key mediator in the observed improvements in executive function (Dado & Emadian, 2024; Norouzi Homayoun et al., 2023).

Interestingly, while both intervention groups demonstrated improvements, the group that did not receive physiotherapy still showed significant reductions in executive dysfunction compared to the control group. This highlights the potency of the CBT-MSC approach in addressing executive deficits in older adults, even in the absence of concurrent physical treatment. Previous studies have similarly shown that CBT combined with mindfulness can independently enhance cognitive performance in elderly populations by restructuring maladaptive thoughts, reducing distress, and building attentional flexibility (Afshari et al., 2022; Mohseni Nasab et al., 2024).

The current findings extend this body of work by showing that combining physiotherapy with CBT-MSC further augments these benefits. They also underscore the importance of interdisciplinary approaches to treatment in older adults with chronic conditions. Given that executive function deficits can undermine treatment adherence and self-care in elderly populations, integrative models such as the one tested here may offer promising pathways to improving both cognitive health and overall well-being (Hosseini Dastjerdi et al., 2024; Rahmani et al., 2024).

Despite its contributions, this study has several limitations. First, the relatively small sample size and single geographic location may limit the generalizability of the findings. Second, reliance on self-report measures of executive function introduces the potential for reporting biases. Third, although participants were randomly assigned, complete blinding was not feasible due to the nature of the interventions, which may have introduced expectancy effects. Finally, the study focused exclusively on older adults with chronic osteoarthritis-related pain, limiting the applicability of the results to other clinical or age groups.

Future research should replicate this study with larger and more diverse samples, including older adults with different chronic conditions and across multiple settings. Longitudinal studies with longer follow-up periods are recommended to examine the persistence of treatment effects over time. Additionally, incorporating objective neuropsychological tests and neuroimaging data would provide more robust evidence of intervention-related changes in executive functioning and underlying neural mechanisms.

Practitioners working with older adults suffering from chronic osteoarthritis-related pain may consider integrating physiotherapy with cognitive-behavioral and mindfulness-based interventions to maximize improvements in executive functions and emotional well-being. Emphasizing self-compassion and providing structured home-practice assignments can further enhance treatment adherence and maintenance of gains. Finally, developing interdisciplinary treatment plans that address both physical pain and cognitive-emotional challenges may yield the most effective outcomes in this population.

Authors' Contributions

All authors significantly contributed to this study.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

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

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

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In this study, to observe ethical considerations, participants were informed about the goals and importance of the research before the start of the study and participated in the research with informed consent.

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