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Effectiveness of Compensatory Cognitive Training on Concentration and Self-Regulation Skills in Hyperactive Disorder (ADHD) Students

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Abstract

Introduction: Hyperactivity is a developmental behavioral disorder that causes impulsive reactions, learning disorders and excessive physical activities and is associated with some abnormal behaviors that lead to destructive concentration and self-regulation skills. Therefore, this study aims to investigate the effectiveness of Compensatory cognitive training has been conducted on concentration and self-regulation of students with attention deficit hyperactivity disorder.

Research method: The experimental research method was carried out using a pre-test-post-test design with a control group. The current research population, all male students have hyperactivity symptoms in Chahar Karaj region in the academic year 97-98. Sampling was done by simple random sampling and included 30 hyperactive students of Qalam 1 and 2 schools who were randomly placed in two experimental and control groups. To collect data, subscales of Wechsler's memory test, Conner's behavioral problems rating scale created by the teacher, d2 concentration test and Bouffard's self-regulation were used. The experimental group was administered for 8 sessions under the training program. Compensatory cognition was placed and the research hypothesis was calculated through multivariate and univariate covariance analysis test.

Findings: The results showed that compensatory cognitive training was effective in improving concentration and self-regulation skills of students with attention deficit hyperactivity disorder ($p>0.05$).

Conclusion: According to the obtained results, it is recommended to use compensatory cognitive training to improve concentration and self-regulation skills.

Keywords: Compensatory Cognitive Training, Concentration, Hyperactive Students, Self-Regulation Skill

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Introduction:

The growth of a person as a gradual and continuous process in different dimensions is influenced by the two factors of inheritance and upbringing. However, abnormal growth or occurrence of abnormal behavior in children and adolescents should be properly investigated and the means of prevention and correction should be provided (1). One of the abnormalities discussed in the field of child morbid psychology and child psychiatry is the phenomenon of attention deficit hyperactivity disorder, which includes a significant part of clients to child counseling centers, pediatricians, and child psychiatrists (2). Attention deficit hyperactivity disorder is one of the most common neurobehavioral disorders in school children and has affected many children in the world. This disorder has a prevalence of 5 to 8% in childhood and is the reason why many children are referred to medical centers (3). A longitudinal study conducted on children with this disorder has shown that this disorder in most cases continues until adulthood (4), and this disorder often coexists with other disorders such as learning disorders, anxiety disorders, mood disorders, bipolar disorder, and obsessive-compulsive disorder. Compulsion and oppositional defiant disorder are associated (5). 58% of the cases in which the diagnostic criteria of the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition with parents' reports were used for diagnosis, have also confirmed these results (6).

Attention-deficit hyperactivity disorder is a developmental, neurological disorder affecting scientific, social and emotional adaptations, whose characteristics include inattention, hyperactivity impulsivity or a combination of these three characteristics (7). In the first grades of school, children with attention deficit hyperactivity disorder may be considered unhealthy and immature. All school-based behaviors are difficult for these children: sitting, participating, controlling impulsive behaviors, cooperating, organizing actions, following instructions, sharing, playing well, and interacting with other children. These children are not able to learn effectively due to the lack of concentration and lack of behavior control in the classroom and can lead to disruptions in the classroom and the teacher's teaching. Due to poor social skills, children with this disorder cannot tolerate group activities or are rejected by their peers. Differences with parents compared to peers without attention deficit hyperactivity disorder and free time without structure and plan are other psychological defects of these children. These deficiencies lead to many problems in daily life and learning (8).

One of the characteristics that is almost always seen in a child with attention deficit hyperactivity disorder is distraction and lack of attention. A child with this disorder, compared to other children, does not have the ability to concentrate and follow long and boring tasks and quickly move from one activity to another (9). Attention is a cognitive skill that directs concentration and helps humans to sense and perceive their world by directing attention towards relevant stimuli and ignoring irrelevant stimuli. Attention control processes are complex and different and play an important role in memory, program following and organization (10). The level of students' attention to the subject of the lesson is one of the main factors in teaching and learning. Bandura emphasizes that the initial stage of any learning begins with attention, and if the attention is not enough, the individual's learning will be impaired (11).

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Self-regulation arose for the first time from Bandura's social cognitive theory, and after that, outstanding theoretical models were presented in the field of self-regulation of learning. These models, which emerged after the 1980s in an attempt to describe what successful learners do, propose different structures and mechanisms for self-regulation of learning (12). Self-regulation means the development of knowledge and skills. An individual in all fields, through one's own efforts and experience of various situations and cases. In other words, self-regulation is the ability to agree to a request, the ability to start and stop activities according to the situational requirements, the ability to adjust the activity, repetition, continuation of verbal-motor activities in social and educational situations, the ability to postpone working on the subject or the desired goal is defined (13). According to previous researches, these issues have a destructive effect on the level of self-confidence and personality of these students. One of the ways to overcome the disabilities of these students is to use and teach them self-regulation strategies, so that as a result, their level of attention to affairs and details increases, and we see a decrease in listening deficits, an increase in the level of compliance with the teacher's instructions, and in gaining the ability to organize homework and activities is empowered and to reduce distraction and forgetfulness in them (14).

Rehabilitation in a compensatory way, using strategies and skills, provides conditions for a person with a disorder to have a higher level of performance in everyday life despite the presence of defects; In other words, by using these strategies and skills, compensate for this defect (15). Compensatory interventions rely on several key principles: 1- Teaching new and optimal information processing strategies; 2- facilitating the transfer of cognitive achievements to the real world; 3- Peripheral modification of references to strengthen the possibility of completing daily life activities. Levels of this program may target specific cognitive skills: such as cognitive flexibility, memory, and planning, and are graded to minimize task-oriented error and promote error-free learning (16).

Compensatory training programs use strategies to improve information processing, including verbalization (repeating important mental or physical information), information reduction (focusing only on key aspects of information), breaking down and simplifying the task into smaller steps, dividing, Self-monitoring, classification, organization, and planning (17) Compensatory cognitive training is educational and targets memory, attention, learning, and executive function. This intervention focuses on compensatory strategies such as the use of calendar, self-talk, note-taking and six-step problem solving method and does not require a computer. Compensatory cognitive training is an approach that combines the training of compensatory strategies with environmental modifications specific to clients; the goal is an intervention that is brief, simple, low-cost, portable, practical and generalizable to countless situations in the real world. The goal of the intervention is to help clients learn and develop cognitive strategies to form long-term habits that are meaningful in the real world (18).

Tuamli et al. (19) showed that the rehabilitation and cognitive symptom management program has the potential to improve symptoms, cognitive function and quality of life of people with mild to moderate brain injuries. Najian and Nejati (20) showed that computer training of working memory and attention can strengthen language skills in children with attention deficit hyperactivity disorder. This finding confirms the role of attention and memory in language skills.

Shahmohammadi, Intisarfoni, Hijazi and Asadzadeh (21) showed that the cognitive rehabilitation training program using exercise programs has been able to improve the desired parts of the brain of students with learning disabilities in the fields of attention and concentration, academic performance and stimulate and strengthen non-verbal intelligence and improve their mental performance and academic efficiency. Considering the point that cognitive rehabilitation has been effective in improving the executive functions of adults with attention deficit and hyperactivity disorder (22), also in the following studies, cognitive rehabilitation training is used to reduce or eliminate children's deficits. Compensation was used. At the pre-school level, there have been interventions through compensatory rehabilitation, but at the school level, we are faced with the lack of research that examines compensatory cognitive training on students, so far various techniques have been used to improve hyperactivity. But in the meantime, compensatory cognitive training has not been used to improve children's mental state, and no research has been done on newer theories that include compensatory patterns. Compensatory research has started in developed countries in recent years and is still ongoing. It is appropriate that we, too, are on the same path as the developed societies and strive to improve the mental quality of the children and future makers of the country and provide a suitable and safe platform for their growth and prosperity. The research question is whether compensatory cognitive training will be effective in improving concentration and self-regulation of students with hyperactivity.

Research method:

This research was of experimental type with a pre-test-post-test design with a control group. The statistical population of the research includes all elementary school boys in district 4 of Karaj city who have symptoms of attention deficit and hyperactivity disorder in the academic year of 1997-1998. Sampling was simple random and the number of samples was considered to be 20 people for each group due to the possibility of dropout of subjects. First, all the students of the fourth to sixth grades of the school were examined based on the Connors test of the teacher's version and neuropsychological tests (execution of some subscales of Wechsler's memory). 74 people were diagnosed with symptoms of hyperactivity and attention deficit, and 58 of them scored lower than the average in the concentration and self-regulation test. Finally, 40 people were randomly selected and assigned to two groups of 20 people, test and control. In the next step, the compensatory cognitive training protocol was implemented for the experimental group in 8 sessions of 60 minutes two days a week, and no training was given to the control group. In the next step, the subjects of the experimental and control groups were examined again and the results were analyzed in order to evaluate the effectiveness of the training. Among the admission criteria for students with attention deficit hyperactivity disorder between the ages of 9 and 12 based on the Conners Behavioral Problems Rating Scale Teacher's Edition, the equivalent score of low self-regulation in the Bouffard questionnaire for elementary school children, the equivalent score of mild to moderate concentration in The standard questionnaire was selective attention, concentration and effort d2, literacy, absence of any psychiatric disorder, absence of hyperactivity medication use and absence of physical defects. Research tools:

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(1) **Connors Behavioral Problems Rating Scale (Teacher's Form):** Construction of Connors Multiple Scales was started in 1960 by Keith Connors. These scales were first created to evaluate the effect of stimulant drugs on hyperactive children and to separate hyperactive children from normal children. Connors' long scale form (special for teachers) which has 38 items measures verbal behavior, participation in the group and attitude towards authority. This questionnaire has 3 dimensions of the child's behavior in the class, cooperation and group participation, the client's attitude towards power. For evaluation in this test, it can be said that obtaining an average score of 1.5 or higher indicates the existence of attention deficit disorder and hyperactivity disorder. In order to determine the construct validity of the scale, due to the large number of items, factor analysis with principal components was used. In order to obtain reliability, Cronbach's alpha coefficients of this scale are as follows: for the total score of 0.86 and for the subscales of behavior problems, inattention-dreaming, hyperactivity, anxiety-shyness and passivity respectively, 0.88. 0.89, 0.74, 0.81, 0.80, which are in the optimal level (23). Shahim, Yousefi and Shahaian (24) standardized this questionnaire in Iran and adapted it to Iranian culture, and the reliability of the scale with the retest method was 0.76 for the whole scale and for the subscales from 0.68 for passivity to 0.82 for problems. Behavior was variable. Cronbach's alpha coefficient for the whole questionnaire was 0.86.

(2) **d2 test (a tool for measuring selective attention, concentration and effort):** In the fifth decade of the 20th century, the institute affiliated with the Technology Supervision Organization produced the d2 test to measure the ability and competence of driving skills. The test used in this research is the 9th edition, which has confirmed huge changes in terms of psychometric indicators, and among the range of general functions, it measures the level of concentration (selective attention and effort level). The word effort is placed in front of procrastination, which can also be measured by this test. During the test, a person shows a certain level of attention efficiency, which is affected by coordination and control. For the Tehrani norm society, the results (all coefficients in the studies are above 90%) showed that due to the high internal consistency of the scales of the d2 test, this test has a very high reliability (25).

(3) **Bouffard self-regulation questionnaire:** the 14-question questionnaire of Bouffard et al. (1995) is a tool to measure self-regulation, which is designed based on Bandura's social-cognitive theory. The questions of this questionnaire are on a Likert scale and measure the two factors of cognitive strategies and metacognitive strategies of self-regulation. The overall reliability coefficient of the questionnaire is 0.71 based on Cronbach's alpha, the reliability of the cognitive strategies subscale is 0.70 and the metacognitive subscale is 0.68. The factor results showed that the correlation coefficient between the questions is appropriate and the value load related to the factors is acceptable and its validity is also at the desired level (26). Khademi and Noshadi (27) also studied the validity and reliability of the questionnaire of Boufard et al. The construct validity of this questionnaire has been reported by using correlation coefficients and factor analysis of the discriminant correlation coefficients between the questionnaire questions and the Cronbach's alpha coefficient for measuring internal consistency was 0.08. Based on this, it can be said that this questionnaire is capable of predicting the scores and actual scores of the subjects.

(4) **Treatment protocol:** The compensatory cognitive intervention training protocol was developed and implemented by Dr. Tovamli. The main form of this protocol is a 12-session compensatory cognitive intervention designed to target four cognitive domains: 1) prospective memory, 2) attention and vigilance, 3) learning and memory, 4) executive function. The Farsi version of this educational package was presented to four professors and was translated and localized with their approval, taking into account the cultural and age level of these students Paying attention to its strengths and weaknesses were summarized and presented in 8 sessions. Before implementing the package on the target community, it was tested on 4 elementary school students, and after the results were obtained and its effectiveness confirmed, it was implemented on the students of the experimental group.

Table 1- Scopes and strategies available in cognitive-compensatory training and summary of sessions

Titles of meetings	The content of the meetings
The first session Prospective memory	use of the calendar; preparing a list of completed tasks; prioritizing tasks; automatic locations; link tasks using programmed cues and automatic locations; Use specific routines for automated tasks
The second and third session Attention and care	ability to pay attention in a conversation; eye contact, translating and interpreting, asking questions during conversation; self - as if during tasks; Refocus
Session four and five Learning and memory	note taking; participation; classifying to recall information; segmenting; categorizing information; use of abbreviations; visual images; improving the way to remember information; Cognitive flexibility
Session six and seven executive performance	6-step problem solving method; self-talk and self-monitoring during problem solving; Hypothesis testing using positive and negative evidence; Training skills such as attention, effort, working memory, organizing tasks and tasks, time management
Session eight	Integrating skills, topics and strategies to review key concepts and skills

Findings:

The findings of the study show that the mean and standard deviation of concentration efficiency in the experimental group increased to 38.7 and 3.97 in the pre-test and 49.33 and 7.89 in the post-test. The mean and standard deviation of the total concentration efficiency increased to 26.13 and 2.56 in the pre-test and 4.12 and 27 in the post-test. In calculating the error score in the pre-test, the mean and standard deviation of 61.67 and 10.67 decreased to 53.40 and 14.08, which indicates the reduction of the error level in the post-test. The changes made show that the experimental group has improved in the concentration variable and its 2 components after the implementation of the intervention, while this improvement is not seen in the control group. The mean and standard deviation of the self-regulation variable of the experimental group in the pre-test are 30.53 and

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5.68, while in the post-test these scores have increased to 43.13 and 9.85. The mean and standard deviation of the cognitive components in the pre-test increased from 15.33 and 3.83 to 21.60 and 5.43, and the metacognitive components increased from 15.2 and 2.78 to 21.53 and 5.39. has had, which shows that the experimental group improved in the total score of self-regulation and components after the implementation of the intervention. In order to analyze the data, multivariate covariance test was used. First, to use multivariate analysis of variance, the necessary presuppositions were examined. The Kolmogorov-Smirnov test was used for the normality of the data, and according to the obtained significance level, all the variables follow the assumption of normality (P<0.05). Plotting the regression slope for each variable showed that the regression slope is not linear. Homogeneity of variances was investigated using Levine's test, the results of which are shown in the following table:

Table 2- The results of Levine's test to measure the assumption of homogeneity of the variance of self-regulation and concentration variables

	Fisher's statistics	df1	df2	sig
Self-regulation before intervention	13.12	1	28	0.02
Pre-intervention focus	5.8	1	28	0.023

The results obtained from the above table show that according to sig values greater than 0.05, as a result, the assumption of equal variance of the two populations is rejected and the assumption of homogeneity of the regression slope is not met.

Table 3- The results of Levine's test to measure the assumption of homogeneity of variance and covariance of research variables

	Fisher's statistics	df1	df2	sig
Cognitive component	3.9	1	28	0.06
Metacognitive component	3.4	1	28	0.05
Total Efficiency (GZ)	7.8	1	28	0.01
Concentration Efficiency (KL)	13.3	1	28	0.01
Error score (F)	7.4	1	28	0.02

The results obtained from Table 3; it shows that the significance level for concentration, self-regulation and its components is less than 0.05, therefore, the assumption of homogeneity of variances is not established for these components and the assumption of homogeneity of the regression slope is not met, for this reason. The results of M. Box's test are presented (P < 0.05, Box's M = 3.8), which confirms the equality of the observed covariance matrices of the dependent variables. In the following, the results of covariance analysis regarding the main hypothesis of the research were presented as follows: "cognitive compensatory training has a positive and significant effect on concentration (total efficiency of concentration) and self-regulation skills of hyperactive primary school students". To answer these assumptions, the covariance analysis method has been used as described in the following table:

Table 4- Multivariate covariance analysis of post-test scores in two experimental and control groups

test	value	F	df hypothesis	df Error	sig	Eta squared
Pillai effect	0.40	9.2	2	25	0.001	0.424
Wilkes Lambda	0.60	9.2	2	25	0.001	0.424
Hotelling's work	0.74	9.2	2	25	0.001	0.424
The largest zinc root	0.74	9.2	2	25	0.001	0.424

The results show that after removing the effect of the pre-test with multivariate covariance analysis, there is a significant effect for the compensatory cognitive training factor (independent variable). This effect shows that there is a significant difference between at least one of the dependent variables in the experimental group and the control group ($P<0.05$) and to determine the effect of the independent variable on the dependent variables, the results of the one-way analysis of covariance test in the text Multivariate covariance analysis in Table 5; has been:

Table 5- The results of the one-way analysis of covariance test in the text of the multivariate covariance analysis

Variables	sum of squares	df	level of F	Sig	Eta squared
self-regulation	875.8	1	13.04	0.001	0.33
Total efficiency of concentration	32.3	1	3.9	0.05	0.13

The results indicate that by removing the effect of the pre-test variable, the first hypothesis of the research that there is a significant difference in concentration and self-regulation of hyperactive students in the experimental group compared to the control group is confirmed and shows that the difference between the estimated means has ($P<0.05$) and therefore the main hypothesis of the research based on the effectiveness of compensatory cognitive training on concentration and self-regulation of hyperactive students is confirmed (self-regulation: $F=13.04$ and $P<0.05$) and (concentration : $F=3.9$ and $P>0.05$). Also, according to the amount of effect obtained in the table, it should be stated that the compensatory cognitive program can improve students' concentration and self-regulation, and the percentage of these changes based on eta squared (effect amount) is 13 and 33 percent, respectively.

Discussion and Conclusion:

This study investigated the effectiveness of compensatory cognitive training on concentration and self-regulation of students with attention deficit hyperactivity disorder. In order to explain the effectiveness of compensatory interventions on students with signs and symptoms of attention deficit and hyperactivity disorder, this issue can be addressed from two perspectives of the brain and behavior. The capacity of executive functions (concentration) and brain activity levels are not constant and can be changed through practice and training. At a younger age, the brain is highly prepared for change. The developing brain changes in response to various environmental stimuli

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such as stress, childhood experiences, and practicing and repeating a skill. Repeated practice of a skill leads to long-term changes in the neuronal structure, such as changes in the volume of white or gray matter of the brain, especially if it is practiced over a longer period of time and with more repetitions (13).

Also, the research of Narimani, Soleimani and Tabrizchi (28) confirms the effectiveness of cognitive rehabilitation on improving attention maintenance of students with attention deficit hyperactivity disorder. Participants in compensatory research consider the strategies of using a calendar, reviewing, self-talk and taking notes to be more effective in the applicability of compensatory cognitive training in their personal lives (16). In the behavioral explanation of the effectiveness of compensatory interventions on children, the characteristics of psychological compensation can be mentioned. In compensatory strategies, despite the fact that the defects caused by the disorder may remain, it helps to improve the individual's performance (18).

Compensatory rehabilitation deals with creating a balance between cognitive deficits and environmental expectations. Defects in the performance of a child with attention deficit and hyperactivity disorder can only be seen when these two components are combined. This is why these children perform well in some situations, and in others, the defects in their performance are clearly visible. By designing strategies to use the skills that the child had and did not use before, teaching new skills, receiving support from the parents, and finally by using frequent practice of skills, it is possible to achieve a balance between these two components create Based on the results obtained from the statistical analysis, it was found that compensatory cognitive training was effective on the efficiency of students' concentration, which may be the result of the effect of compensatory cognitive training on verbal memory and the effect of verbal memory on concentration (11). In the examination of the second component of the d2 test, that is, the error score, which indicates the level of accuracy and attention of students, and Brackencamp (29), has introduced it as an indicator of hard work, which is opposite to procrastination, despite the increase in average growth, in studies A slight growth has been observed in this component, in fact, it can be said that if the number of training sessions is more, it is possible to confirm the effectiveness of this training on the component of error rate (level of accuracy). Despite the difference in the test used in different studies, all of them confirm the effect of cognitive training on attention and concentration. This finding is in line with previous researches (28).

To check self-regulation, Bouffard's questionnaire was used, which examines the cognitive and metacognitive components of learning. According to the data obtained from the descriptive statistics, the post-test average of the experimental group compared to the pre-test has increased in the components of self-regulation, and in the analyzes of the inferential statistics, compensatory cognitive training has been able to increase the range of attention, increase the power of self-regulation and Students' motivation affects the improvement of executive actions and performance of students and improves the cognitive and metacognitive components of self-regulation (30).

Halperin and Haley (31) used a neurobehavioral approach in the form of games and exercises to develop self-regulation in preschool children, and the effects of this training on the level of self-regulation of these children were confirmed. Among the trainings given in this package was working memory and how to use and benefit from it, working memory training can improve the

ability to regulate emotions, and the performance of orientation in the attention network may also play a role in this improvement. Working memory is responsible for the allocation of attentional resources during the monitoring of problem solving and is also responsible for cognitive processing that is involved in a wide range of monitoring functions including the retrieval of long-term memory information. Working memory keeps us updated on what's happening so we can focus on what's important. Decreased ability to monitor the problem-solving process may lead to procedural errors and miscommunications in long-term memory and disrupt self-regulation metacognitive skills (32).

Also, interventions including the use of a computer-based program to improve attention and working memory, aerobic exercises or mindfulness activities such as tai chi, yoga, and teaching different thinking strategies can improve cognitive self-regulation (33). These studies provide new evidence that cognitive self-regulatory processes are affected by cognitive performance and executive functions of the brain and are continuously subject to improvement (34).

Another strategy taught in this research is event memory, research shows that the lack of event memory may lead to the absence of metacognitive self-monitoring skills. The work of the mind in a systematic way is to organize experiences related to the results of experiences and situations that have occurred before. In case of problems in the executive function of the brain, these organizational processes may not take place. In compensatory rehabilitation, trainings are provided at the level of behavior change, but these changes are not only limited to behavior, and the change in behavior is associated with a change in performance, and progress has occurred in the cognitive abilities of these children. Studies have shown that the effectiveness of the compensatory method and its effects can also be considered at the level of neuronal communication, and it is not limited to cognitive functions, because the brain is highly prepared for change at a young age and at the elementary level. Another new behavior leads to the reconstruction or reorganization of the damaged neural circuit. The goal of compensatory cognitive education is that despite the presence of defects, the student can perform properly in everyday life. By using compensatory education strategies, students were able to show better performance in daily life despite the fact that signs of attention deficit and hyperactivity are still present, and also in this study, trainings are sent to parents so that they can follow the process be trained and encourage them to do exercises. When a person with a disorder finds a supportive and flexible environment, the negative effects of attention deficit and hyperactivity disorder are reduced and this strengthens his strengths and it compensates for the weaknesses caused by the disorder (13, 16, 19).

Finally, it can be said that compensatory cognitive training focusing on executive functions has been effective in improving concentration and self-regulation, so it can be said that compensatory rehabilitation training helps students with attention deficit and hyperactivity disorder to improve their concentration and self-regulation and have a higher mental health and quality of life. Considering the large number of hyperactive and disordered children in schools and their related social and academic harms, any intervention that leads to their mental, social and academic health will help improve the health of society. As a result, the effort towards training that helps to increase attention, concentration and self-regulation of students with attention deficit and hyperactivity disorder is very important and it is suggested to be included in the agenda of the relevant centers.

Limitations of the research: considering that one of the limitations of this research was that it was conducted on male students, it is suggested that this research be conducted on female students as well.

Application of Research: In order to investigate the effectiveness of this approach more accurately, it is suggested to use designs with control and random replacement in future researches and to consider subgroups of patients. The effectiveness of this approach should be compared with other approaches. A longer follow-up period should be considered, and the effectiveness of this approach should be studied in different diseases.

Ethical Considerations: The researchers of this study consider it necessary to thank all the participants who helped us in this research and made it possible to conduct the study.

Conflict of Interest: There is no conflict of interest in this research and the contribution of the authors is mentioned in the order of their names in the article.

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