



## Research Paper: The Effect of Cognitive-behavior Modification and Feeding Behavior on Serotonin Levels and Depression Symptoms



Motahare Golbarg Khonachah<sup>1\*</sup>, Mahnaz Khosrojavid<sup>1</sup>, Seyed Musa Kafi Masouleh<sup>1</sup>, Ebrahim Mirzajani<sup>2,3</sup>, Marjan Mahdavi Roshan<sup>4,5</sup>

1. Department of Psychology, School of Literature and Humanities, University of Guilan, Rasht, Iran
2. Cellular and Molecular Research Center, School of Medicine, Guilan University of Medical Sciences, Rasht, Iran
3. Department of Biochemistry and Biophysics, School of Medicine, Guilan University of Medical Sciences, Rasht, Iran
4. Cardiovascular Diseases Research Center, Guilan University of Medical Sciences, Rasht, Iran
5. Department of Social Medicine, School of Medicine, Guilan University of Medical Sciences, Rasht, Iran



**Citation** Golbarg Khonachah M, Khosrojavid M, Kafi Masouleh SM, Mirzajani E, Mahdavi Roshan M. The Effect of Cognitive-behavior Modification and Feeding Behavior on Serotonin Levels and Depression Symptoms Caspian J Neurol Sci. 2020; 6(4):222-232. <https://doi.org/10.32598/CJNS.6.23.3>

**Running Title** Educational Program of Cognitive-behavior Modification and Feeding Behavior and Depression

**doi** <https://doi.org/10.32598/CJNS.6.23.3>



© 2018 The Authors. This is an open access article under the CC-BY-NC license.

### ABSTRACT

**Background:** Depression includes negative interpretations of events, dislike of the self, and negative appraisal of the future.

**Objectives:** The present study was conducted to investigate the effect of educational programs of cognitive-behavior modification and feeding behavior on serotonin levels and depression symptoms in university students.

**Materials & Methods:** This quasi-experimental study was conducted with a pretest-posttest and a control group design. The study population included all male and female bachelor degree students in the Faculty of Literature and Humanities of the University of Guilan, Guilan Province, Iran at the time of the research. Among 2854 students, using Morgan's table, the sample size was determined as 340. In the following, 24 students with depression symptoms and other inclusion criteria were selected as the sample and randomly assigned to the experimental and control groups. During the twelve sessions of training, the number of participants decreased from 24 to 16. The study tools included the Beck depression inventory (1996), the food frequency questionnaire (2017), 21 food enjoyment questionnaire, and the blood test. The obtained data were analyzed by 1-way analysis of covariance in SPSS v. 24.

**Results:** The analysis showed that the use of cognitive-behavior modification training reduced students' depression ( $P < 0.01$ ). However, the use of feeding behavior training did not increase serotonin levels in students ( $P > 0.05$ ).

**Conclusion:** Among people with depression symptoms, cognitive-behavior modification by focusing on their negative self-talk can be useful in creating sensible thoughts and positive inner dialogue. But in these people, feeding behavior training for two months did not change serotonin levels.

**Keywords:** Depression; Serotonin; Behavior; Feeding behavior; Students

#### Article info:

**Received:** 28 May 2020

**First Revision:** 10 Jun 2020

**Accepted:** 08 Aug 2020

**Published:** 01 Oct 2020

#### \* Corresponding Author:

**Motahare Golbarg Khonachah**

**Address:** Department of Psychology, School of Literature and Humanities, University of Guilan, Rasht, Iran

**Tel:** +98 (13) 33825485, **Fax:** +98 (13) 33690380

**E-mail:** [img70mm@gmail.com](mailto:img70mm@gmail.com)

## Highlights

- The educational program of cognitive-behavior modification can reduce depression symptoms.
- Training in feeding behavior does not lead to an increase in serotonin.

## Introduction

**D**epression is a mental disorder that has characteristics like depressed mood, decreased interest, and pleasure, changes in appetite or weight, sleep disturbance, movement changes, decreased energy and fatigue, feelings of worthlessness or guilt, impaired thinking and concentration, death thinking, suicide, and unexplained medical conditions [1]. Depression is a major cause of disability among 12 to 44 years old people [2]. According to forecasts, depression will be the main cause of disease severity by 2030 [3]. In Iran, research on non-clinical groups such as students suggests that the prevalence of depression among students is higher than the general population. About 78% of students suffer from some of the symptoms of depression, and 64% of them suffer from severe depression, who need professional help [4]. Students due to their special circumstances are exposed to a lot of stresses, and factors such as entering a new environment, academic problems, competition with other students, and financial pinches increase their stresses [5]. Depression has a variety of problems, including coexistence with many mental and physical disorders, job losses, financial problems, and ultimately affect the next generation. The worst consequence of depression is suicide so that nearly a million people worldwide suffer from depression committing suicide each year [6].

Serotonin levels play a key role in people's depression [7]. So far, the role of 15 serotonin receptors in depression has been identified [8]. For this reason, selective inhibitors of serotonin reuptake are effective drug treatments for major depression. But there is evidence about side effects of serotonin reuptake inhibitors such as decreased overall serotonin metabolism in the brain, decreased bone mass density, as well as changes in sleep patterns, appetite, and sexual desire. These side effects are prevalent [9].

In the meantime, promoting non-pharmaceutical solutions as well as research to help people achieve a healthier lifestyle is necessary. In the past few years, various studies have reported that dietary habits may predict the

onset or signs of depression. Seifert, Heflin, Corcoran, and Williams [10] found a positive relationship between food shortages and depression in women. Because the effect of nutrition on the treatment of depression is not fully understood, and the results of the research on this topic are contradictory [11-16], this is still one of the most interesting areas of research [17]. Nutrition and depression have a complex and possibly mutual relationship. On the one hand, the diet of a person may be a risk factor for starting and continuing depression, and on the other hand, depression may lead to lifestyle changes, including poor eating habits [17-19]. Socioeconomic status is also one of the determinants of nutritional practices [20]. Therefore, if mental health interventions consider the mutual relationship between lifestyle factors and major depression, they will possibly increase the effectiveness of interventions related to this disorder [19]. Besides, given the need to expand non-pharmacological treatment for depression [21], and the presence of convincing evidence showing that nutrition is an important factor in the high prevalence of mental disorders, comprehending nutrition and diet as nutritional drugs in the treatment of mental disorders will help to expand the field of nutritional psychiatry [22].

Donald Mickenbaum is the founder of "self-instruction training," which is also called cognitive-behavior modification. This modification is a combination of three approaches: rational-emotional behavior therapy, cognitive therapy, and behavioral therapy. This method emphasizes talking to oneself, in other words, one should tell oneself what to do in different situations [23]. According to Mickenbaum, talking to oneself affects one's behavior just like talking to others [24]. One of the important characteristics of depressed people is the unrealistic negative assessments of the self-value, guilt, and rumination of past minor failures [1]. Because of these characteristics in depressed individuals, teaching cognitive behavior modification by focusing on negative self-talk can help create sensible thoughts and positive inner dialogue [25-30]. Also, since mental health has a significant relationship with negative self-talk, teaching how to reduce negative self-talk can help the psychological adjustment of depressed people [26].

Therefore, considering the prevalence and negative consequences of depression and the need to develop non-pharmacological methods, this study focuses on the characteristics of depression.

## Materials and Methods

### Research type, sample, and sampling method

This is a quasi-experimental study with a pretest-posttest and a control group design. It was performed in the 2018-2019 academic year. The statistical population included 2854 undergraduate students of the Faculty of Literature and Humanities of the University of Guilan. After determining the total number of undergraduate students, using Morgan's sample size chart, 340 individuals were determined as the sample size, and then eligible college students were identified and screened using the Beck depression inventory. When distributing the questionnaire, everyone was explained that they would be contacted if necessary. After reviewing the questionnaires, 140 people who met the inclusion criteria were contacted, and finally, 24 people announced their readiness to participate in this research. However, during the training programs, 8 people withdrew and the number of experimental and control groups decreased to 16. The statistical sample method as well as the assignment of participants in the experimental and control groups were random.

The inclusion criteria included the age range of 18 to 30 years, studying at the Faculty of Literature and Humanities of the University of Guilan, Guilan Province, Iran, in the academic year 2017-18 (undergraduate), not using psychiatric drugs (especially serotonin reuptake inhibitors), not using the other psychological treatments, and receiving a score of 14 or higher on the Beck depression inventory (based on a mild and moderate depression cut score). Also, the use of psychotropic drugs, receiving other psychological therapy, obtaining a score below 14 in the Beck depression inventory, absenteeism for more than two sessions, and cancellation was the criteria for leaving the study.

Before the start of the study, all necessary permits were obtained from the University of Guilan and Guilan University of Medical Sciences. At each step, the participants were assured that their information would be confidential and that questionnaires and blood sera would be coded. Before entering the research process, an informed consent form was presented to the participants and they were asked to introduce two of their trusted individuals in this form so that in case of any emergency

problems during the blood sampling and other stages, we could contact and inform them. Besides, the subjects were assured that they could drop out of the study at any time. Withdrawal of individuals, especially those with a fear of blood feuds, was quickly and unequivocally agreed upon. To comply with the ethical principles, we told the control group that after completing the investigation they could ask the researcher to provide them with all the training program.

### Measuring tools

In the pretest and posttest phases of this research project, the latest version of the Beck-2 depression inventory, published in 1996 by Beck, Stirr, and Brown was used to assess the participants' depression levels. This tool is a 21-item self-report questionnaire to measure the severity of depression in adults and 13 years and older adolescents [31]. The results of the meta-analysis of the Beck depression inventory indicate that its internal consistency coefficients are between 0.73 and 0.93 with an average of 0.86. The validity coefficients obtained from the test-retest are in the range of 0.48 to 0.86 according to the distance between the number of performances and the type of population [32].

In addition, a blood test using the ELISA method was used to measure serotonin levels. For this test, IBL International GmbH RE59121 was used. This kit can be used to determine the amount of serotonin in human serum, plasma, platelets, and urine. Since more than 98% of serotonin is found in platelets and is released into the bloodstream, we measured the amount of serotonin in the blood serum.

A food frequency questionnaire and 21 food enjoyment questionnaire was used to assess the eating habits of the subjects at the beginning and end of the study. The validity and reliability of the food frequency questionnaire in Iran have been evaluated by Hadi et al. [33] as well as Hosseini Esfahani et al. [34]. Using this questionnaire, the status of the recent intake of food groups was examined. This questionnaire can provide information about the frequency and the amount of food consumption. Using it, you can estimate the general mid-term and short-term eating habits of individuals [35]. In this study, according to the information needed for the research, some items of food groups were removed. The participants were asked that based on their food consumption, to check the consumption of each food item in the questionnaire per day and week, and also indicate the amount of consumption per meal. The questionnaire was completed by the researcher. Also, Rabiee et al. as-

sessed the validity and reliability of the 21-item food enjoyment questionnaire in Iran [36].

### Learning programs

In this study, educational programs (Table 1) were presented by the researcher during twelve 90-min sessions. The cognitive behavior modification training program was implemented in eight 90-min sessions once a week for two months in the experimental group. This program was compiled using the information, methods, and assignments provided in Meichenbaum's cognitive-behavior modification approach [24, 37-40]. Also, a feeding behavior program was taught for groups in 2 sessions. This program was compiled by researchers under the supervision of a nutritionist from Guilan University of Medical Sciences based on various sources.

### Feeding behavior taught to the experimental group

In the nutrition behavior training program of this study, consuming foods containing tryptophan, carbohydrates, and vitamins B6, B12, B9, and C was recommended to the experimental group. In the forthcoming, the reason is provided. As mentioned, serotonin is made from the amino acid tryptophan [41]. The results of some studies

show that the availability of tryptophan in brain cells is accountable for the composition and decomposition of serotonin, which directly affects the rate at which this amino acid is converted to serotonin. Also, the consumption of this amino acid or nutrition that raises its level in cells, increases the production of this transmitter [42]. The human body is unable to make tryptophan and must receive it from foods [43]. Strasser et al. also believed that a diet rich in tryptophan could have a positive effect on mood and cognition. Table 2 presents food sources containing tryptophan.

Besides, excellent food mixtures were introduced. These mixtures are special food ingredients that, when consumed together, provide all the essential amino acids. These mixtures include cereals and grains, cereals and dairy products, and beans and grains. Eating supplemental amino acids in a meal is not necessary but should be eaten during the same days [43].

Tryptophan absorption by the brain, and thus the breakdown and synthesis of serotonin by the brain, also depends on carbohydrates. Carbohydrates increase the brain tryptophan absorption and thus increase serotonin. This process happens because carbohydrate-rich foods increase the level of glucose that stimulates insulin se-

Table 1. The content of the training sessions

Sessions	Contents
1	Introduction, explaining the research objectives, group rules, responsibilities of group members, general explanations on the perspective of cognitive behavior modification and its application, general explanations on depression disorder, explaining the nutritional relationship and depression
2	Performing the pretest, including Beck depression inventory, food frequency questionnaire, serotonin test, height, and weight calculation
3	Introducing the neurotransmitter serotonin and its role in depression, the process of serotonin formation in the body, the introduction of the amino acid tryptophan, the introduction of carbohydrates and its role in the production of serotonin
4	An introduction to food groups, food subgroups, and foods that play a role in the process of serotonin formation
5	Gaining more awareness of the nature of automatic thoughts and self-talk, familiarity with self-defeating thoughts and their role in the emergence of problems, awareness of one's role in creating stress, paying attention to one's inner conversations, summarizing the content, and present homework
6-7	Introducing different types of cognitive errors and giving examples of each, expressing the relationship between adaptive and maladaptive behaviors and inner conversations, the role of the need for self-talk, acquiring and practicing new self-talk, changing negative self-talk with positive, presenting homework
8-9	Reviewing the homework, providing a variety of behavioral coping techniques to perform in stressful situations, physical relaxation training, breathing control techniques, muscle contraction, and dilation, and other intrusions such as walking, jogging, gardening, knitting, and other physical activities; learning, performing and practicing guided relaxations, providing homework
10	Reviewing homework, self-study training, and discussion about self-reinforcement for positive expression, priority assessment training, building support systems, providing homework
11	Reviewing homework, emphasizing the transfer of change from treatment to the practical world, making behavioral homework more difficult, providing homework
12	Summarizing and reviewing the material with an emphasis on changing self-talk, preparing to say goodbye to the group, performing posttest

**Table 2.** Food sources containing tryptophan

Food groups containing tryptophan	Food subgroups containing tryptophan
Milk and dairy products	Milk [45], cocoa milk, various types of cheese, such as cheddar cheese [12]
Meats	Beef liver, mutton, deer meat, boiled eggs [12], deer, chicken breast [16, 12]
Fruits	Banana [16, 12], avocado, pineapple [12], strawberry, blueberry [11], apple, pear, watermelon, green grape, peach, grapefruit, purple grape [44], kiwi, Portuguese [45]
Cereal	Soybeans [16], beans, peas, lentils [12], lima beans [46]
Nuts	All kinds of nuts such as walnuts [16], peanuts, hazelnuts, sunflower seeds, and pumpkin [12]
Grains	Wheat, corn [16], brown rice, barley, whole wheat bread [12], oats, sorghum, flour, and millet [47]
Fish	Fish [11], such as tuna [16] and king prawns [12]
Vegetables	Asparagus, beetroot [12], tomato, spinach, lettuce, cabbage, eggplant, pepper, broccoli, okra, cauliflower, carrot, potato, sweet potato, onion, ginger [44]
Coffee	Coffee [48]



cretion, and it facilitates receiving most of the large natural amino acids (such as tyrosine, phenylalanine, isoleucine, and valine) except tryptophan to the tissues such as muscle. This condition raises the ratio of tryptophan plasma against large natural amino acids, and as a result, tryptophan outperforms the competition for access to the brain, increasing the breakdown and synthesis of serotonin. A low-carbohydrate, high-protein diet can reduce the amount of tryptophan in the brain. Because in the transport competition, less tryptophan is transferred to the brain [16].

Eating foods containing tryptophan alone does not increase serotonin levels, but tryptophan also requires certain enzyme mediators to be converted into serotonin, which is called mediators. These mediators for the breakdown and synthesis of serotonin are vitamins. Serotonin mediator enzymes are water-soluble vitamins [49], including vitamins B6, B12, C [43], and B9 [50].

## Results

The Kolmogorov-Smirnov test was used to test the normal distribution of variables in the pretest and posttest. Non-significant results indicate that the distribution of variables is normal. Results show that the mean pretest depression score in the experimental group decreased compared to the posttest results and the serotonin level increased from the pretest to the posttest, while these average values increased from the pretest to the posttest in

the control group. The test was not much different. The results also indicate that the Kolmogorov-Smirnov statistic is not significant for all variables. Based on these results, the distribution of variables is normal. The findings show that the statistical F-linearity of the pretest-posttest relationship is significant for all variables at the level of 0.01. Based on these significant findings, the pretest and posttest relationship between depression and serotonin variables is linear.

Univariate covariance analysis was used to investigate the effect of cognitive-behavior modification training on reducing students' depressive symptoms. First, the homogeneity of the regression line slope was investigated. It showed that the interaction between the conditions and the pretest was not significant ( $P=0.026$ ,  $F=1.31$ ), so the data support the homogeneity of the regression line slope. Then, Levene's test was used to evaluate the variance of the dependent variables. The homogeneity assumption of the errors of both groups for the depression score was confirmed ( $P<0.05$ ). Therefore, due to the homogeneity of the regression slope and the similarity of the dependent variable, the single-variable covariance analysis was used to test the first hypothesis of the research. As shown in Table 3, covariance analysis of posttest depression score after pretest adjustment shows that by eliminating the effect of pretest score, the effect of cognitive-behavior modification training on posttest depression is significant ( $F=8.671$ ,  $df=1$ ,  $P<0.01$ ). The effect size of 0.40 means

**Table 3.** Results of univariate covariance analysis of posttest depression in the experimental and control groups

Source	Sum of squares	df	Mean square	F	P	Eta coefficient
Group	150.636	1	150.636	8.671	0.01	0.40
Analysis of covariance by controlling pretest values	159.916	1	159.916	9.205	0.01	0.415
Error	225.834	13	17.372			

**Table 4.** Results of one-way analysis of covariance for serotonin posttest score in the experimental and control groups

Statistics Source of variation	$\chi^2$	df	MS	F	Sig.	Eta coefficient
Group	2.094	1	2.094	0.045	0.836	0.003
Covariance analysis with controlling the pretest scores	445.426	1	445.426	9.471	0.009	0.421
Error	277.754	27	10.287			

that this difference in society is almost average. Pretest F-statistic was also 9.205, which is significant at the level of 0.01. This finding suggests that pretest has a significant effect on posttest depression scores.

The adjusted averages were used to determine which group of subjects was more likely to have a posttest depression. It should be noted that the Bonferroni correction method was used to estimate the means. Accordingly, the mean score of the experimental group in depression is 8.838 and the mean for the control group is 15.162. The mean difference between the two groups (6.324) is significant at the level of 0.01. Therefore, the mean of the depression score in the experimental group is significantly higher than the mean of the control group. Based on this finding, the first hypothesis is confirmed that educational cognitive-behavior modification reduces the symptoms of student depression.

One-way analysis of covariance is used to investigate the effect of feeding behavior program training on increasing serotonin in students. To do so, the assumptions for using this method were examined. First, the homogeneity of the regression line slope was investigated, which showed that the interaction between the conditions and the pretest was not significant ( $P=0.588$ ,  $F=0.31$ ), so the data support the regression slope homogeneity. Then, Levene's test was used to evaluate the variance of the dependent variable. The results showed that the assumption of the homogeneity of the errors of serotonin score was confirmed for both groups ( $P<0.05$ ).

Therefore, due to the homogeneity of the regression slope as well as the similarity of the dependent variable variance, a single variable covariance analysis test was used to investigate the second hypothesis of the research. Based on Table 4, the covariance analysis for posttest serotonin after pretest adjustment proves that the effect of feeding behavior training on serotonin levels in the posttest is not significant ( $F=0.045$ ,  $df=1.14$ ,  $P>0.05$ ). Based on this result, the second hypothesis is not confirmed and the feeding behavior training did not increase serotonin level in students.

## Discussion

Based on the study finding, the effect of cognitive-behavior modification training on depression is significant. According to the findings, the first hypothesis is confirmed, and teaching cognitive-behavior modification reduced students' depression ( $P<0.01$ ). In the literature review, no study was found that investigated the effect of cognitive-behavior modification training on depressive symptoms among students. However, the results of this study agree with the findings of Arian and Dehghani Firoozabadi [29], Lotfi et al. [27], Esmaili [30], Kazemian [28], Sadipoor et al. [25], and Chen et al. [26], confirming that the mental health has a significant relationship with negative self-talk, and teaching how to reduce negative self-talk is very effective in psychological adjustment.

Arian and Dehghani Firoozabadi [29] showed that teaching positive self-talk is effective in increasing women's belief in their general self-efficacy. Lotfi et al. research [27] indicates that Meichenbaum's cognitive-behavior modification treatment method significantly reduces the anxiety of high school girls. Esmaili [30] also reported that this type of treatment leads to the resolution of marital conflicts. Saadipoor et al. [25] believed that teaching positive self-talk and eliminating cognitive errors and familiarity with the techniques of replacing negative self-talk with positive self-talk affect people's self-efficacy and their belief in mastery and success in various fields. Chen et al. [26] observed that students' social anxiety decreased rapidly and significantly after intervention with cognitive-behavior modification strategy.

In explaining this finding, it should be noted that research studies [51] show a significant relationship between mental rumination and components of social evaluation, self-reinforcement, self-regulation, self-criticism, and self-talk with depression. The relationship between mind rumination, self-expression components, and depression symptoms indicates the significance of cognitive components in depression. People who are prone to depression are more likely to have negative cognitive styles, which can lead to depression. In addition, based on the fifth edition of the Statistical and Diagnostic Guide to Mental Disorders [1], one of the critical features of depression is the unrealistic negative assessments of the value, guilt, and offensiveness of past minor failures. Such people often interpret everyday events that are irrelevant to them or insignificant as proof of a personal defect and feel an exaggerated responsibility for unforeseen events. Feelings of helplessness or guilt may be due to one's imaginary thoughts, such as people who are sure that they are responsible for global poverty.

Blaming yourself for being ill, evading from occupational or personal duties as a result of depression is very common [1]. Because depressed individuals have these characteristics, teaching cognitive behavior modification by focusing on negative self-talk can help create sensible thoughts and positive inner dialogue [29]. In addition, talking to oneself leads to desirable changes in behavior, and talking to oneself like talking to others, can affect one's behavior, too [23]. Teaching positive self-talk skills by breaking the cycle of reinforcing negative emotions caused by negative self-talk affects the resulting behaviors [28]. Most people allow the thoughts related to distresses, fears, anger, or sadness to occupy their minds. These people are constantly preoccupying their minds with repetitive words about situations and

negative actions. Such an inner conversation ultimately influences the subconscious mind and forces it to accept these negative thoughts; so one must be careful about unconscious thoughts. With this training program, a person realizes that she or he is under the influence of his unconscious commands and shows behaviors that he has not consciously chosen. Therefore, he not only makes the situation more complicated, but he can also choose better ways to deal with his problems.

Arian and Dehghani Firoozabadi [29], quoting from Merluzzi (1993), stated that positive self-talk was a kind of facilitating self-talk also a form of coping and being able to cope. They introduced negative self-talk as a kind of deterrent self-talk. Confrontational sentences are a form of positive self-talk that immediately counteracts negative self-talk and eliminates its deterrent effect. The habit of negative self-talk lies in our daily habits, but it can be replaced by practice. Therefore, in this way, focusing on the narrators' narratives of their lives helps them to create a healing story in which it creates purpose and gives meaning to their lives [38].

Therefore, it seems that the factor influencing the reduction of depression in the experimental group was their awareness of their negative self-talk and also trying to change it. They realized that they were under the influence of their ignorant orders and tried to identify these negative self-talk. In this study, positive self-talk skills training could reduce depression by breaking the cycle of reinforcing negative emotions caused by negative self-talk. Besides, changing self-talk from negative to positive also affects a person's behavior.

The results of this study show that, by eliminating the effect of pretest score, the effect of feeding behavior training on post-serotonin test scores was not significant. According to this finding, the second hypothesis is not confirmed and the teaching of feeding behavior cannot affect the increase of serotonin in students ( $P < 0.05$ ). Therefore, the simultaneous use of educational programs about cognitive-behavior modification and feeding behavior reduces depression but does not increase the serotonin level.

In the literature review, we could not find a study that directly investigated the effect of feeding behavior training program on increasing serotonin, but the results of this study were in line with the results of Karegar Novin et al. [13], Lindseth et al. [15], Soh and Walter [12] Hulsken et al. [16], Sánchez-Villegas et al. [14], Jacka et al. [18], and Strasser et al. [11]. They supported the effect of feeding programs on reducing depression. In

this study, the feeding training program was effective in reducing depression but was not effective in increasing the serotonin level. This result is similar to the findings of Lindseth et al. [15]. They also found that having a diet rich in tryptophan compared to a low tryptophan diet was effective in reducing depression and anxiety, but its effect was not significant in reducing cortisol.

Based on the findings of Soh and Walter [12], there is no empirical evidence for improving mood through manipulation of the tryptophan diet, and it is difficult to change the level of plasma tryptophan only through the diet. A study of dietary supplements and a reduction in tryptophan levels suggests that changing tryptophan levels may only be beneficial for certain groups of patients, such as those with a history of personal or family depression. Instead of treating depression by changing the tryptophan levels, scientific studies focus on clarifying depressive processes. Although public media articles often recommend programs and foods to raise blood tryptophan levels and increase brain serotonin levels, many researchers believe that such recommendations are not supported by scientific studies.

In addition, Strasser et al. [11] believed that a diet rich in tryptophan could have a positive effect on mood and cognition. However, the absorption of tryptophan as a precursor of serotonin by the brain, and the breakdown and synthesis of serotonin in the brain, depends on other factors, including carbohydrates [16] and water-soluble vitamins [49]. So it is not enough to just eat foods containing tryptophan to increase serotonin. In the feeding behavior training program, all three categories of foods, including foods containing tryptophan, carbohydrates, and water-soluble vitamins, were taught, but to increase serotonin, the participants should have eaten all of the food groups.

One of the important points affecting the test result is the quality of the serotonin kit. Ever since the kit was made available to researchers, many efforts have been made to maintain safety tips such as temperature, light, and no impact on the kit box, but due to the 4-month process of importing this kit from Germany and the duration of clearance, the repository situation of kits is unclear to researchers. The guidebook of this kit emphasizes the effect of light, heat, and severe blows on the box on the diagnostic accuracy of the kit [48]; researchers did not have any control over these parameters. Besides, serotonin kits cannot be reused due to the high sensitivity of enzymes. Therefore, researchers have to freeze blood samples in the pretest and posttest phases in the blood serum form. The freezing process of blood sera will also

affect the test results, according to IBL's Kit Serotonin Guide. In this study, blood serum was isolated in the laboratory of Rasht Hospital and frozen there. The researchers are unaware of the quality of the freezing or occurrence of events such as power outages. If for any reason the freezing of the serum has had a problem, it will affect the amount of serotonin in the blood serum.

However, it should be noted that the results of this study do not mean that nutrition does not affect serotonin, because the serotonin level of the experimental group was higher in the posttest compared to that in the pretest, but it was not significant compared to the control group. So subjects in the research field may have thought that there is no need to follow the tips of feeding behavioral training sessions, and if in real life they decide to follow the feeding recommendations willingly, the increase in serotonin might be greater. It is possible that providing a dietary plan (feed regime) instead of training about feeding behavior significantly increases the serotonin level. Also, feeding behavior training may be effective in the long run and will take effect within two months.

As noted, Soh and Walter [12] argued that tryptophan levels may be beneficial only for certain groups of patients, such as those with a background of personal or family depression. In this study, most participants had mild to moderate depression and people with high levels of depression did not agree to participate. Therefore, it is possible that teaching the feeding behavior on mild to moderate depression does not alter serotonin levels. But for other depressed groups, they may produce some significant results.

Finally, improving depression without significantly increasing serotonin is a promising and valuable outcome. This means that if a person has difficulty absorbing precursors, breaking down and reabsorbing serotonin at different stages, they are not doomed to depression, but psychological help and intervention can greatly reduce the symptoms of depression.

The present study, like other studies, has some limitations. One of the limitations of this research is the quality of the kit used. Ever since the kit was made available to researchers, all efforts have been made to maintain safety features such as temperature, light, and avoiding shock to the kit box, but given the 4-month process of importing the kit from Germany, the quality of the kit is unknown for the researchers. The kit manual highlighted the impact of light, heat, and shock on the box on the kit's diagnostic accuracy [48].



Another limitation is related to the preservation of blood chemicals. In such sensitive tests, it is important to maintain blood chemicals. Maintaining blood chemicals from the moment of blood sampling until the time of measurement with a serotonin kit is effective in the test results. If for any reason the chemical balance is disturbed, we will have different results. Numerous blood serum transfers and freezing in places out of reach of researchers reduce their control of blood samples. Besides, the study provided feeding behavior training but did not provide an accurate diet with clear amounts of calories. Therefore, it is recommended that future studies try to follow a strict diet. This study had a cross-sectional type. Other researchers are advised to use longitudinal research projects as well. To increase the accuracy of the results, it is recommended that similar studies be done in more cities with larger samples.

## Conclusion

The cognitive-behavior modification program affects reducing the symptoms of students' depression. Because this modification by focusing on their negative self-talk can create sensible thoughts and positive inner dialogue. But, feeding behavior training does not affect increasing serotonin in students. This result may have been due to a decrease in the quality of the serotonin kit, a short training period, or educational feeding behavior instead of a diet.

## Ethical Considerations

### Compliance with ethical guidelines

The Ethics Committee of Guilan University of Medical Sciences approved the study protocol (No.: IR.GUMS.REC.1396.528).

### Funding

This article was extracted from the Master's thesis of the first author and was supported by the University of Guilan (grant no.: 2192).

### Authors' contributions

Conceptualization, and Writing the original draft: Motahare Golbarg Khonachah; Methodology: Motahare Golbarg Khonachah, Mahnaz Khosrojauid, and Seyed Musa Kafi Masouleh; Investigation: Motahare Golbarg Khonachah, Mahnaz Khosrojauid, and Marjan Mahdavi Roshan; Funding acquisition: Motahare Golbarg Khonachah and Mahnaz Khosrojauid; Writing, review

and editing the manuscript, Resources, and Supervision: Motahare Golbarg Khonachah, Mahnaz Khosrojauid, Seyed Musa Kafi Masouleh, Ebrahim Mirzajani, and Marjan Mahdavi Roshan.

### Conflict of interest

The authors declared no conflict of interest.

### Acknowledgments

This study was conducted in collaboration with the University of Guilan and Guilan University of Medical Sciences. We thank both universities for their cooperation and financial support.

## References

- [1] American Psychiatric Association (APA). Diagnostic and Statistical Manual of Mental Disorders (DSM-5®). 5<sup>th</sup> edition. American Psychiatric Publishing; 2013. [DOI:10.1176/appi.books.9780890425596]
- [2] Liu CS, Adibfar A, Herrmann N, Lanctôt KL. Evidence for Inflammation-associated depression. *Curr Top Behav Neurosci*. 2017; 31:3-30. [DOI:10.1007/7854\_2016\_2] [PMID]
- [3] Halaris A. Inflammation-associated co-morbidity between depression and cardiovascular disease. *Curr Top Behav Neurosci*. 2017; 31:45-70. [DOI:10.1007/7854\_2016\_28] [PMID]
- [4] Namjoo M, Kafi M, Hakim Javadi M, Gholam Ali Lavasani m, Atashkar SR. [The relationship among perfectionism defense styles, and depression symptoms in students (Persian)]. *Res Clin Psychol Counsel*. 2012; 2(1):53-76. <https://tpccp.um.ac.ir/article/view/8162>
- [5] Esalati P, Arab A, Mehdi Nejad V. [Effectiveness of Frankl's Logotherapy on Health (Decreasing Addiction Potential and Increasing Psychological Well-being) of Students with Depression (Persian)]. *Iran Health Educ Prom Asso*. 2019; 7(1):84-92. [DOI:10.30699/ijhehp.7.1.84]
- [6] Waclawiková B, El Aidy S. Role of microbiota and tryptophan metabolites in the remote effect of intestinal inflammation on brain and depression. *Pharmaceuticals (Basel)*. 2018; 11(3):63-80. [DOI:10.3390/ph11030063] [PMID] [PMCID]
- [7] Golbarg Khonachah M, Khosrojauid M, Kafi Masouleh M, Mirzajani E, Mahdavi Roshan M. [Research on neuro-biological hypotheses, social and psychological factors of depression (Persian)]. *J Rec Adv Psychol Educ Sci Educ*. 2020; 3(25):149-63. <https://www.jonapte.ir/fa/showart-c9d573fa2eb275d-a641b2d4ba68685ee>
- [8] Nautiyal KM, Hen R. Serotonin receptors in depression: From A to B [version 1; peer review: 3 approved]. *F1000Research*. 2017, 6(F1000):123. [DOI:10.12688/f1000research.9736.1]

- [9] Golbarg Khonachah M, Khosrojauid M, Kafi Masouleh M, Mirzajani E, Mahdavi Roshan M. Rereading the Psychological, Biological and Social Treatments for Depression (Persian). *J Rec Adv Psychol Educ Sci Educ*. 2020; 3(26):111-32. <https://www.jonapte.ir/fa/showart-892a9dc-a6b3c8203d4e14af47671842d9>
- [10] Siefert K, Heflin CM, Corcoran ME, Williams DR. Food insufficiency and physical and mental health in a longitudinal survey of welfare recipients. *J Health Soc Behav*. 2004; 45(2):171-86. [DOI:10.1177/002214650404500204]
- [11] Strasser B, Gostner GM, Fuchs D. Mood, food, and cognition role of tryptophan and serotonin. *Curr Opin Clin Nutr Metab Care*. 2016; 19(1):55-61. [DOI:10.1097/MCO.0000000000000237] [PMID]
- [12] Soh NL, Walter G. Tryptophan and depression: Can diet alone be the answer? *Acta Neuropsychiatr*. 2011; 23(1):3-11. [DOI:10.1111/j.1601-5215.2010.00508.x]
- [13] Kargarnovin Z, Pourghasem Gargari B, Ranjbar F, Rashidkhani B, Zareiy S, Hoseinpour S, et al. [The association of food groups with major depression in adult women resident in Tabriz (Persian)]. *Stud Med Sci*. 2014; 24(11):872-82. <http://umj.umsu.ac.ir/article-1-2016-en.html>
- [14] Sánchez-Villegas A, Martínez-González MA, Estruch R, Salas-Salvadó J, Corella D, Covas MI, et al. Mediterranean dietary pattern and depression: The PREDIMED randomized trial. *BMC Med*. 2013; 11:208. [DOI:10.1186/1741-7015-11-208] [PMID] [PMCID]
- [15] Lindseth G, Helland B, Caspers J. The effects of dietary tryptophan on affective disorders. *Arch Psychiatr Nurs*. 2015; 29(2):102-7. [DOI:10.1016/j.apnu.2014.11.008] [PMID] [PMCID]
- [16] Hulsken S, Martin A, Mohajeri MH, Homberg JR. Food-derived serotonergic modulators: Effects on mood and cognition. *Nutr Res Rev*. 2013; 26(2):223-34. [DOI:10.1017/S0954422413000164] [PMID]
- [17] Rahe C, Berger K. Nutrition and depression: Current evidence on the association of dietary patterns with depression and its subtypes. *Cardiovas Dis Depr*. 2016; 279-304. [DOI:10.1007/978-3-319-32480-7\_17]
- [18] Jacka FN, Cherbuin N, Anstey KJ, Butterworth P. Does reverse causality explain the relationship between diet and depression? *J Affect Disord*. 2015; 175:248-50. [DOI:10.1016/j.jad.2015.01.007] [PMID]
- [19] Lopresti AL, Hood SD, Drummond PD. A review of lifestyle factors that contribute to important pathways associated with major depression: Diet, sleep and exercise. *J Affect Disord*. 2013; 148(1):12-27. [DOI:10.1016/j.jad.2013.01.014] [PMID]
- [20] Ihensekhien I, Busari O, Adedeji CE, Imuetinyan Salami L. Socio-economic status and gender as determinant of dietary practices of secondary school students' by exposure to pictorial nutrition education for sustainability. *J Health Sci*. 2019; 7(1):29-36. [DOI:10.17265/2328-7136/2019.01.006]
- [21] Sadeghi K, Ahmadi M, Rezaei M, Salehi M. [The effect of eight weeks of aerobic exercises on depression and its cognitive components (Persian)]. *J Kermanshah Univ Med Sci*. 2013; 17(6):343-50. <https://sites.kowsarpub.com/jkums/articles/77047.html>
- [22] Sarris J, Logan AC, Akbaraly TN, Amminger GP, Balanzá-Martínez V, Freeman MP, et al. Nutritional medicine as mainstream in psychiatry. *Lancet Psychiatry*. 2015; 2(3):271-4. [DOI:10.1016/S2215-0366(14)00051-0] [PMID]
- [23] Seif A. Behavior change and behavior therapy: Theories and methods. Tehran: Doran Publication; 2019. <https://www.gisoom.com/book/1137902/%DA%A9%D8%AA%>
- [24] Corey J. Theory and application of counseling and psychotherapy: Cognitive-behavioral therapy. 20<sup>th</sup> edition. [SY. Mohammadi, Persian trans.] Tehran: Arasbaran Publication; 2018.
- [25] Sadipour A, Ghalami Z, Asadzadeh H. Comparison the effectiveness of positive self-talk training and self-control training methods on self-efficacy beliefs of high school girl students. *Iran J Health Educ Health Prom*. 2019; 7(2):172-81. [DOI:10.30699/ijhehp.7.2.172]
- [26] Chen I-J, Du C, Wang X, Zhang H. Effect of cognitive behavior modification on social anxiety for high school students. *Creat Educ*. 2017; 8(12):1803-20. [DOI:10.4236/ce.2017.812124]
- [27] Lotfi S, Eizadi-fard R, Ayazi M, Agheli-Nejad MA. The effect of meichenbaum's cognitive behaviour modification therapy on reduction of test anxiety symptoms in high school girls. *Procedia - Soc Behav Sci*. 2011; 30:835-8. [DOI:10.1016/j.sbspro.2011.10.162]
- [28] Kazemian S. [Effectiveness of self-talking and social phobia (Persian)]. *Counsel Cult Psychother*. 2011; 1(4):43-56. [DOI:10.22054/QCCPC.2011.5894]
- [29] Dehghani FiroozAbadi T, Aryan S. [Investigating the effectiveness of positive self-talk on increasing the women's general self-efficacy beliefs (Persian)]. *Educ Psychol*. 2009; 5(15):127-44. [http://jep.atu.ac.ir/article\\_2228.html](http://jep.atu.ac.ir/article_2228.html)
- [30] Esmaili M. [Effectiveness of training of self-talking technique based on reality in marital conflicts resolution (Persian)]. *Educ Psychol*. 2006; 2(5):21-36. [DOI:10.22054/JEP.2006.5986]
- [31] Rahimi C. Application of Beck-2 Application of the Beck Depression Inventory-II in Iranian University Students (Persian). *Clin Psychol Person*. 2014; 12(1):173-88. [http://cpap.shahed.ac.ir/article\\_2711.html](http://cpap.shahed.ac.ir/article_2711.html)
- [32] Fathi Ashtiani A. Psychological tests: Assessment of personality and mental health: Beck Depression Inventory. 33<sup>rd</sup> edition. Tehran: Besat Publications; 2013.
- [33] Hadi F, Somi M, Ghavamzadeh S. [Validity and reliability of a 40-items food frequency questionnaire to measure the consumption of Gluten in patients with ulcerative colitis. Iran J Nutr Sci Food Tech. (Persian)]. 2017; 12(1):1-9. [http://nsft.sbmu.ac.ir/browse.php?a\\_id=2180&sid=1&slc\\_lang=en](http://nsft.sbmu.ac.ir/browse.php?a_id=2180&sid=1&slc_lang=en)
- [34] Hosseini-Isfahani F, Asghari G, Mirmiran p, et al. Reproducibility and relative validity of food group intake in a food frequency questionnaire developed for the Tehran lipid and glucose study. *Razi J Med Sci*. 2010; 17(71):41-55. [http://rjms.iums.ac.ir/browse.php?a\\_id=1458&sid=1&slc\\_lang=en](http://rjms.iums.ac.ir/browse.php?a_id=1458&sid=1&slc_lang=en)
- [35] Haftenberger M, Heuer T, Heidemann C, Kube F, Kreams C, Mensink GB. Relative validation of a food frequency questionnaire for national health and nutrition monitoring. *Nutr J*. 2010; 9:36. [DOI:10.1186/1475-2891-9-36] [PMID] [PMCID]
- [36] Rabiee S, Honesty F, Righteousness R. [The comparison of dietary patterns and hedonic score in obese and non-obese

- women (Persian)]. *J Ardabil Univ Med Sci.* 2013; 13(1):48-58. <http://jarums.arums.ac.ir/article-1-126-en.html>
- [37] Meichenbaum D. Cognitive-behavior modification: An integrative approach. Boston, MA: Springer US; 1977. [DOI:10.1007/978-1-4757-9739-8]
- [38] Meichenbaum D. Ways to bolster resilience in traumatized clients: Implications for psychotherapists. *J Construct Psychol.* 2014; 27(4):329-36. [DOI:10.1080/10720537.2013.833064]
- [39] Meichenbaum D, Cameron R. Training schizophrenics to talk to themselves: A means of developing attentional controls. *Behav Ther.* 1973; 4(4):515-34. [DOI:10.1016/S0005-7894(73)80003-6]
- [40] Prochaska J, Norcross J. Psychotherapy theories (psychotherapy systems) [SY. Mohammadi, Persian trans.]. Tehran: Ravan Publication; 2014.
- [41] Barrett KE, Brooks H, Boitano S, Barman SM. Ganong's review of medical physiology. 23<sup>rd</sup> edition. New York: McGraw-Hill; 2009. <https://megapaper.ir/search/view/ebook/596251>
- [42] Le Floc'h N, Otten W, Merlot E. Tryptophan metabolism, from nutrition to potential therapeutic applications. *Amino Acids.* 2010; 41(5):1195-205. [DOI:10.1007/s00726-010-0752-7] [PMID]
- [43] Mahan K, Stump A, Raymond J. General Principles of Krause Nutrition (based on the topics of the course resources of medical sciences). Nutrient intake and metabolism. 4<sup>th</sup> edition [F. Sheidfar and N. Kholdi, Persian trans.]. Tehran: Jame-Negar Publication; 2015.
- [44] Islam J, Shirakawa H, Nguyen TK, Asob H, Komaia M. Simultaneous analysis of serotonin, tryptophan and tryptamine levels in common fresh fruits and vegetables in Japan using fluorescence HPLC. *Food Biosci.* 2016; 13:56-9. [DOI:10.1016/j.fbio.2015.12.006]
- [45] Tohmola N, Johansson A, Sane T, Renkonen R, Hämäläinen E, Ikonen O. Transient elevation of serum 5-HIAA by dietary serotonin and distribution of 5-HIAA in serum protein fractions. *Ann Clin Biochem.* 2015; 52(Pt 4):428-33. [DOI:10.1177/0004563214554842] [PMID]
- [46] Cuq J-L. Effect of heat on tryptophan in food: Chemistry, toxicology, and nutritional consequences. In: Friedman M, editor. *Absorption and Utilization of Amino Acids: Vol. III.* Boca Raton: CRC Press; 2018; 103-28. [DOI:10.1201/9781351069441-7]
- [47] Comai S, Bertazzo A, Bailoni L, Zancatoa M, Costa CVL, Alegria G. The content of proteic and nonproteic (free and protein-bound) tryptophan in quinoa and cereal flours. *Food Chem.* 2007; 100(4):1350-5. [DOI:10.1016/j.foodchem.2005.10.072]
- [48] Instructions for Use Serotonin ELISA. IBL International GmbH. 2018; RE59121. <https://www.ibl-international.com/en/serotonin-elisa>
- [49] Sami R, Li Y, Qi B, Wang S, Zhang Q, Han F, et al. HPLC analysis of water-soluble vitamins (B2, B3, B6, B12, and C) and fat-soluble vitamins (E, K, D, A, and  $\beta$ -Carotene) of Okra (*Abelmoschus esculentus*). *J Chem.* 2014; ID:831357:1-6. [DOI:10.1155/2014/831357]
- [50] Haeri Rouhani A. [Physiology of nerves and endocrine glands. Synapse and transmission of messages between neurons (Persian)]. 17<sup>th</sup> edition. Tehran: Samat Publication; 2016.
- [51] Zeinali S, Ashrafian P, Beyrami M. [The prediction of depression symptoms on the basis of reviewing rumination and self talk in depressed women (Persian)]. *J Woman Stud Family.* 2014; 7(25):57-67. [http://jwsf.iaut.ac.ir/article\\_519969.html](http://jwsf.iaut.ac.ir/article_519969.html)