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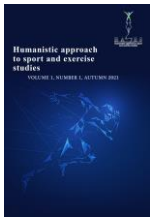

Original article

The effect of intervention based on cranial wall stimulation with direct current and matrix approach on the desire to eat and physical activity in obese people

Seyed Mohammad Hossein Hosseini Ravesh [1*]

[1] Assistant Professor, Department of Physical Education and Sports Science, Zabol Branch, Islamic Azad University,Zabol, Iran;

* **Correspondence:** Hhoseinir@yahoo.co

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Abstract: The aim of the present research was to evaluate the effectiveness of a therapy package for weight control based on Acceptance and Commitment with the Matrix Approach and Transcranial Direct Current Stimulation (tDCS) on Food Craving and Physical Activity in overweight individuals. The research Design was a quasi-experimental with pretest and posttest and An Active Control group. For this purpose, 40 persons were selected via availability sampling and in regard to include and exclude criteria. The instrument of the study were Baecke's Physical Activity Questionnaire (1982) and Food Craving Questionnaire-Trait of CepedaBenito (2000, FCQ-T). The experimental group received the intervention package in 12 online group sessions of 2-hour weekly sessions and 8 individual sessions of tDCS AR/CL stimulation (2Ma for 20 minutes) and the control group received only 8 individual tDCS sessions of AR/CL stimulation (2Ma for 20 minutes). The results of between- within group mixed analysis of variance showed that the combined intervention package of weight control based on Acceptance and Commitment with the Matrix Approach and Transcranial Direct Current Stimulation (tDCS) had a significant effect on physical activity and cravings of overweight people in comparison with tDCS alone. According to the results, it can be concluded that the therapeutic package of the present study can be a good option to increase Physical Activity and reduce Food Craving.

Keywords: Overweight, Obesity Treatment, Matrix, ACT, Food Craving, Physical Activity

1. Introduction

Following industrialization and the trend towards machine life in recent centuries, the prevalence of obesity in the world has reached such a level that it has surpassed the standards of globalization and is considered the most common health problem in most countries. Obesity and overweight puts a person at risk of serious diseases, increasing the risk of disability and early retirement (Silontovanna and Kantin, 2020). Despite many advances in the treatment of many diseases and increased life expectancy, the "obesity epidemic" is responsible for millions of deaths and will be one of the main causes of life expectancy reduction in the next 100 years in developed countries (Preston et al., 2018). . Studies show that the prevalence and occurrence of obesity increases with an unhealthy lifestyle, especially an inappropriate diet and inactivity. Obesity is a major public health concern, yet there are limited effective treatment options for it. Physical activity is essential for long-term weight maintenance (Fletcher, 2019). Research has shown that programs that include diet and exercise have better results at one-year follow-up than programs that only target diet (Dishman, 2021). Despite the positive results of interventions related to physical activity, the dropout rate in these programs is high (Markos et al., 2016).

Several psychological processes prevent engaging and maintaining a high level of physical activity. Among these, three cases of avoiding experience (discomfort), stigma of obesity and self-judgment, and lack of long-term motivation have special empirical support. Experiential avoidance is an attempt to change or prevent unwanted internal experiences by avoiding situations and behaviors that lead to unpleasant thoughts, feelings, or bodily sensations, even if this avoidance has negative effects (Fletcher, 2019). Studies have shown that the ability to tolerate discomfort caused by exercise is related to the duration of adherence to an exercise program (Ansi, 2022). Obesity stigma includes internalized critical thoughts and negative beliefs about one's worth and abilities. When negative thoughts and self-criticism are activated, they can act as barriers to healthy behaviors through depression, isolation, and inactivity. The third factor is lack of long-term motivation. While people can increase their physical activity levels in the short term, maintaining these changes over time is rare (Fletcher, 2021).

Another of the strongest predictors of obesity is food cravings. Craving is a common phenomenon and is not in itself problematic, pathological, or distressing, yet it is often experienced maladaptively or unwillingly, in part due to the difficulty of resisting it (Karkla et al., 2020). Fighting cravings can become chronic. Cravings are associated with problematic eating behaviors, increased caloric intake, increased body mass index, and food addiction (Joyner et al., 2019). Cravings are difficult to resist and can undermine weight management (Karkla et al., 2020). On the other hand, in the treatment of obesity and overweight, contemporary neurological models cannot be ignored, these models consider obesity a brain disorder that leads to persistent consumption of food despite its negative consequences; are considered (Ghanbari et al., 2019). Biological approaches associate the regulation of food cravings with the decision-making process that undergoes changes in the activity of the posterior-lateral prefrontal cortex (Rostami et al., 2022). Food responding and general processes of reward and pleasure are mediated by dopamine release in the mesocorticolimbic system (de Arajo et al., 2020). Therefore, the prefrontal cortex regulates and moderates the craving for food and the decision-making process.

Thus, it seems that manipulation of this region can lead to changes in the control of attention to food. Today, non-invasive methods such as direct stimulation from the skull using electric current are used to regulate and modulate activity (Rostami et al., 2015). However, despite the use of tDCS in the treatment of obesity, the results of the conducted studies are contradictory. (Ray et al., 2017; Beaumont et al., 2021) and limited studies have evaluated the effectiveness of the repeated stimulation protocol using anodic stimulation of the right posterior-lateral prefrontal cortex and cathodal stimulation of the left posterior-lateral prefrontal cortex (two Arajo et al., 2020). New studies have proposed tDCS as a "reinforcement therapy to enhance the effectiveness of other psychotherapies" (Alizadeh Gouradel, 2021; Tehrani et al., 2022). On the other hand, recently a new and growing field of research and theories related to mental health in The National Institute of Mental Health of the United States, under the title of Research Domain Criteria Project, has been initiated, which in its integrative approach to illness and mental health emphasizes the interaction of different psychological-biological systems (McNeil et al., 2021). In such a perspective, the complex interaction of factors It is behavioral, biological, environmental and psychological that leads to disturbances in the regulation of energy balance and as a result overweight (Boment et al., 2021). Therefore, it seems that the combination of interventions based on a neurological approach, including interventions based on psychological approaches to overweight effects It has synergy and can bring more effective results both in prevention and in treatment and prevention of weight return.

Today, the third wave of cognitive-behavioral treatments, including treatment based on acceptance and commitment, are used in the field of obesity and overweight. These treatments increase people's psychological resilience, which is key to motivating health-related behavior change. Therefore, it seems

that the use of ACT matrix productivity can increase addressing effective behaviors in weight loss. Considering the growing trend of obesity and overweight and its complications and the inability of existing standard psychological treatments to reduce and maintain the reduced weight (Bidadian et al., 2019) and also considering the contemporary neurological models of obesity, it seems that the intervention method can be achieved. Non-pharmacology and integration of treatments based on neurological models with contemporary psychological approaches to obesity and overweight can reduce these complications and accelerate recovery and make it more stable. Despite the current studies, no study has investigated the effectiveness of integrating interventions based on acceptance and commitment with the matrix approach and tdcs on people with obesity and overweight. Therefore, the question of the present research is whether the treatment guidelines based on acceptance and commitment with the matrix approach and tDCS are effective in reducing and preventing the return of weight of people suffering from obesity and overweight?.

2. Materials and Methods

Since this research is done with the aim of obtaining the results of the findings to solve existing problems, therefore, the type of research is applied and because in this study the researcher seeks to obtain information about the views and opinions of different people, therefore the nature of the research is to determine the relationship between the variables of the correlation type, which was carried out by the field method. The statistical population of the research, the employees of the Ministry of Sports and Youth, includes 745 people, and by referring to Morgan's table, the sample size was estimated to be 256 people. A questionnaire was used to collect data. Transformational leadership questionnaire contains 20 questions and Organizational culture questionnaire contains 24 questions. In addition the organizational commitment questionnaire has 24 questions. These questionnaires are of the 7-value type and are graded from "completely agree" to "completely disagree", where "completely disagree" is assigned a score of 1 and "completely agree" is assigned a score of 7. After collecting the questionnaires, 230 items could be used in this research. In order to determine the reliability of the transformational leadership questionnaire, 15% of the statistical sample were selected for the study. Table 1 shows Cronbach's alpha coefficient for each dimension and the entire questionnaire.

The current semi-experimental research was conducted as a pre-test-post-test plan and a three-month follow-up with a control group. The statistical population of the research was made up of overweight people living in Mashhad in 2022. 40 people from among the studied population were selected by purposive sampling method through calling in centers and places related to the field of overweight (sports clubs, weight loss clinics, virtual spaces related to weight loss) and were randomly divided into two experimental and control groups of 20 people. were placed The inclusion criteria in the study were: body mass index greater than or equal to 25, the ability to participate in intervention sessions, having sufficient reading and writing literacy, and the exclusion criteria included: suffering from a specific physical disease affecting weight and eating behavior such as diabetes, blood pressure, thyroid and Cancer, taking psychiatric medications and medications that may cause changes in weight or appetite, being pregnant or intending to become pregnant by the end of the study for women, participating in any other weight loss program during the study based on the participants' self-reports, having psychiatric problems Severe (severe period of major depression, bipolar disorder, substance abuse and borderline personality disorder) was based on clinical interview and absence of more than one weekly meeting. Dependent variables included cravings and physical activity.

Table 1. Brief description of treatment sessions based on acceptance and commitment with matrix and dcst approach

Number of sessions	Description of meetings
1	Getting to know the treatment model based on acceptance and commitment with the matrix and TDCS approach, introducing the members and the therapist group, explaining the structure, rules and programs of the group, - investigating how weight stigma works, introducing and identifying valuable actions as a way to experience a quality life - performing a 5-minute exercise Self-compassion and a short mindfulness practice
2	Beginning the session with a short exercise of mindfulness - awareness of the effectiveness of taking action to get away from unwanted internal experiences, including weight stigma and other self-blames - explaining experiential avoidance and the impossibility of fully controlling responses - performing a short self-compassion exercise.
3,4	Begin the session with an awareness practice - self-compassion training - visualization of a compassionate friend - discussion about the experience of acceptance from another person and how to cultivate this acceptance towards yourself - a loving-compassionate self-compassion meditation.
5,6	The beginning of the session with a short exercise of paying attention to awareness - the hooks of the thief's attention and problems with controlling internal events - examining behaviors focused on values - discussing efforts to control and avoid unwanted emotions - examining the experience of emotions based on the loss of valuable behaviors that are Attempts to avoid unwanted internal experiences such as weight stigma have occurred - an exercise focused on compassion by recalling supportive and kind people in life - participants were asked to recall dreams or life goals they had given up because of obesity.
7	Carrying out a short practice of mindfulness-discussing acceptance and mindfulness and how to use them in life and in relation to self-blame and weight stigma Explaining acceptance as a skill to choose a valuable life while experiencing unwanted and unpleasant feelings and thoughts of life using From the polar bear technique - do a self-compassion exercise.
8,9	Conducting a short mindfulness practice - Verbal Aikido - In this session the group learned the basic principle of self as context - Participants practiced visualization techniques that include seeing themselves through the eyes of a significant other in their life or romantic partner or family member, as well as imagining Your future self or your past self.
10,11	Harnessing the force of perspective-taking This session explored the importance of craving (inclination) - providing explanations of traditional coping and how it works when faced with distressing internal experiences - participants ranked the situations they avoided due to the avoidance of distressing internal experiences From relationships and closeness with important people in life to career situations or participation in social situations, they listed - do a short self-compassion exercise.
12	Verbal Aikido practice / the final session was dedicated to the generalization of the acceptance, mindfulness, and compassion exercises that the participants learned during the course. Participants shared their experiences, changes that had occurred over the past 8 weeks, and what exercises they found most helpful and would use more in the future – teaching a self-compassion technique.

2-1. Research tool

1- The food craving questionnaire (FCQ-T) was made by Sepda-Benito et al. (2000). The general form of this questionnaire includes two separate parts (trait and state). The trait questionnaire used in this research measures the craving for food in a person. In this questionnaire, subjects are asked to answer each item using a 6-point Likert scale (never to always). The total score of this questionnaire is in the range of 39-234, and 9 subscales measure the experience of food cravings, which include; They are positive reinforcement, negative reinforcement, dependent eating, mental preoccupation with food, intention to eat, lack of control, negative affect, guilt, and hunger (Vander- Wall et al., 2017). The higher the score of the questionnaire, the more intense the craving. Cronbach's alpha for the questionnaire is reported to be 0.97 (Sepda-Benito et al., 2013).

2- Physical Activity Level Questionnaire: To check the physical activity level, Beck et al.'s (2002) physical activity level questionnaire was used, which has 16 questions with a range of five options (never, rarely, sometimes, often, always), which are respectively Points are scored from 1 to 5. This questionnaire measures the levels of physical activity in the form of three components: work, sports and leisure time. The reliability and validity of this questionnaire has been reported by Beck et al. at

a high level (Beck, Burma, Frijters, 2012). This questionnaire has three parts, the first part contains 8 questions related to different body positions that exist while working and the scores are added together and divided by eight. The second part of the questions, which includes questions 9 to 12 and is related to the people who do the first and second sports, which we divide the total points by four. The third part of the questions, which is related to physical activity in free time, includes questions 13 to 16, and the sum of the points is divided by four, and finally, the points of the three parts are added together, and the scores obtained determine the level of physical activity of the person. The highest score for physical activity level is 15. Beck et al. (2002) reported the reliability of this questionnaire with Cronbach's alpha of 0.73. Sanai et al. (2019) reported the reliability of this questionnaire as 0.78 in their research, and its reliability in the present study was 0.71.

3- Digital scale: Using a digital scale, while the participants were wearing little clothes and no shoes, their weight was measured with an accuracy of 100 grams. Height was measured using a portable stadiometer with an accuracy of 0.1 cm. The height of the participants was measured while their body was completely straight and their head up and also without shoes to calculate the maximum height. Body mass index was obtained from the formula of the square of height divided by weight.

4- Chattanooga two-channel device, direct stimulation from the skull using electric current: (tDCS) is performed using a simple tool that includes sponge electrodes with an area of 35 cm2, which is soaked in saline and placed on the person's head, and the device A battery-powered generator passes a continuous, mild current through the head. In the present study, anodic stimulation of the right posterior-lateral prefrontal cortex (DLFPC) (F4) and cathodic stimulation of the left posterior-lateral prefrontal cortex (F3) were used for both groups. Electrode placement was done using the international 10-20 system (Do Arajo et al., 2020).

The weight control treatment package based on acceptance and commitment with the matrix approach and tDCS: the experimental group under the intervention based on acceptance and commitment with the matrix approach based on the protocols compiled by Polk and Schoendorf (2014); Polk et al. (2016) and Levine et al. (2020) combined with tDCS stimulation. Considering the promising results of the studies conducted on the effects of teaching self-compassion skills in weight management and weight loss, including the studies conducted by Carles et al. (2021) and Brenton-Peters et al. (2021), the current intervention package focusing on compassion skills to It was executed. In the ACT matrix protocol, self-compassion takes one step (one session), while in the present study, the number of self-compassion step sessions for working with overweight and obese people has increased to more than one session. A summary of the goals and a brief description of the treatment sessions based on acceptance and commitment with the matrix approach and tDCS are given in table number (1).

2-2. Implementation method

In order to conduct the research, first, a face-to-face briefing session was held with the presence of all the people who volunteered to participate in the research. After providing a general explanation about the research and how the subjects participated, the weight and height of the subjects were measured and the body mass index of the subjects was calculated, and among them, people with a body mass index of 25 or more who also met the other conditions for entering the study as The studied sample entered the next steps and the consent form was distributed among the participants. In order to guarantee the privacy of the participants, a corresponding code was assigned to each participant. After obtaining the principled consent for conducting the research and selecting the participants, the subjects were randomly assigned to 2 treatment groups based on acceptance and commitment with the matrix approach and tDCS and the active control group that received only tDCS. In the next stage, demographic information questionnaires, physical activity level of Beck et al. (2002) and food craving questionnaire (FCQ-T) were completed by the subjects and their results together with the body mass index that was recorded in the first stage were recorded as a pre-test became. Then the experimental group participants with Google Meet learned how to download, install and use it, and in the next step, the experimental group was subjected to an intervention based on acceptance and commitment with the matrix approach prepared and compiled by the researcher and combined with tDCS stimulation. Participants in the experimental group received weekly 2-hour online tDCS sessions (via Google Meet platform) for 12 weeks and 8 individual sessions of 20-minute face-to-face stimulation, and the control group received only 8 face-to-face individual sessions of tDCS stimulation. From the first week of the intervention, tDCS stimulation was performed every other day for 8 sessions. tDCS sessions were scheduled so as not to coincide with psychotherapy sessions on the same day. In each group, 24 hours after the end of the treatment period, dependent variables were measured again. Then, 3 months after the intervention, both groups were measured in dependent variables.

Data were analyzed with SPSS 23 software. Mbox test to check the default equality of variance covariance matrices of two groups in the research variables, one-way analysis of variance test to

determine the difference between groups in the pre-test, Moheli's sphericity test to check the error covariance matrix and statistical method of inter-group mixed variance analysis to check research hypotheses. became. The significance level of $p < 0.05$ was considered.

3. Results

De In this research, 40 people (20 people in each of the intervention and control groups) were studied. The mean and standard deviation of the subjects' age in the control group was 38.70 and 7.46 and in the experimental group was 43.05 and 9.58. The results of the one-way analysis of variance test showed that there is no significant difference between the groups in terms of age (F=0.12, P=2.57) and the groups are homogeneous in terms of age. Also, gender distribution was equal in both groups; The number of women in both groups was 12 (60%) and the number of men in both groups was 8 (40%). The two groups were equal in terms of education level (25% of the participants had a diploma, 35% had a bachelor's degree, 25% had a master's degree, and 15% of the participants had a doctorate degree). The results of the one-way analysis of variance test also showed that there is no significant difference between the two experimental and control groups in terms of the pre-test scores of physical activity (P=0.09, F=0.77) and food cravings (P=0.001, F=0.99); Therefore, the homogeneity of the groups was confirmed in terms of dependent variables. Table 2 shows the descriptive indices (mean and standard deviation) of physical activity and craving scores of the participants based on time (pre-test, post-test and follow-up) and group membership (experiment and control).

Table 2. Descriptive indicators of physical activity and cravings in the experimental and control groups of the three stages of the test

Variable	group	Pre-test		Post- **test**		**Follow up**	
		M	**SD**	**M**	**SD**	**M**	**SD**
Physical activity	control group	7.10	1.65	7.00	1.97	6.55	1.70
	examination Group	7.25	1.52	8.35	1.73	9.00	1.81
Craving	control group	219.90	10.75	215	13.09	217.40	11.35
	examination Group	219.95	10.67	192.45	15.11	192.20	14.81

The results listed in table (2) show that the average physical activity scores of the experimental group participants increased compared to the control group and also the average craving scores of the experimental group compared to the control group decreased significantly. Prior to data analysis, the assumptions of repeated measures mixed analysis of variance were checked. The Mbox test was conducted to check the assumption of equality of variance-covariance matrices of two groups in the research variables, and the results indicated that this assumption was established in physical activity scores (p=0.55) and that this assumption was not established in craving scores (p=0.001).) Was. Violation of this assumption in craving scores is not a problem due to the equality of two sample sizes, and also regarding the violation of the homogeneity assumption of the variance-covariance matrix according to Tabachink and Fidell (2021), the Pillai criterion is used to evaluate the significance of craving scores. Also, the assumption of porous sphericity - checking the error covariance matrix - was tested. The results of the Moheli sphericity test for physical activity showed that the assumption of sphericity is valid (p=0.228). Therefore, the results of the Assumed sphericity test were used to perform the physical activity score test. Also, the results of Mauchly's sphericity test at a significant level ($p < 0.001$) establish the condition of sphericity, as multivariate statistics

They do not require sphericity, it was rejected in craving scores, and therefore, by not establishing the default of sphericity, Greenhouse-Geisser test correction was used to test craving scores in 3 measurement times and for intragroup effects. Levin's assumption of homogeneity of variances test was also checked. The F test was not significant for any of the significant within-group factors at the significance level ($p < 0.001$), and this shows that the assumption of homogeneity of variance was maintained; Therefore, according to the establishment of the assumptions of variance analysis of repeated measurements, this test was used to check the hypotheses of the research. The results of multivariate tests are reported in Table 3.

Table 3. The results of multivariate tests of variable scores of physical activity and craving

	Variable	Test	value	F	df	df error	P	η2	Power
Physical activity	Time	Wilks Lambda	0.78	5.25	2	37	0.01	0.22	0.80
	Time*Group	Wilks Lambda	0.56	14.19	2	37	0.001	0.43	0.99
Craving	Time	Pillai effect	0.80	72.34	2	37	0.001	0.80	1
	Time*Group	Pillai effect	0.73	49.48	2	37	0.001	0.73	1

Examining the effect of time in Table 3 shows that there is a significant difference between the scores of the variable of physical activity in the three times of pre-test, post-test and follow-up. There is a significant difference (p=0.001); However, due to the significance of the interaction between time and group, for both variables of physical activity and craving (p=0.001), the changes in scores related to repeated measurements should be investigated for both groups. In other words, there is no same change in the scores of the two experimental and control groups in the research variables at different evaluation stages from the pre-test to the 3-month follow-up. For a more detailed analysis, first, the results of the inter-group test comparing the two experimental and control groups in Table 4 are examined, then the analysis of the intra-group test and the comparison of the post-test and follow-up sizes compared to the pre-test are discussed.

Table 4. The results of the intergroup effects test of physical activity scores and cravings in the groups

Variable		Source	Ss	Df	MS	F	P	η2	Power
Physical activity	between groups	group	52.01	1	52.01	6.90	0.01	0.15	0.73
		Error	286.45	38	7.54				
Craving	between groups	group	7584.30	1	7584.30	17.26	0.001	0.31	0.98
		Error	16703	38	439.56				

It should be noted that due to the significance of the interaction effect of the group and the evaluation stage, the changes in the therapeutic effects in the three stages of pre-test, post-test and 3-month follow-up, the intra-group results have also been shown in the form of a diagram (Chart No. 1 and 2). The results related to the difference between the experimental and control groups show that the weight control treatment package based on acceptance and commitment with the matrix approach and stimulation of the cranial wall with direct current on physical activity (P=6.90, F=0.05) and cravings (P=0.001) 17.26 F=) and the intervention has been able to have a significant effect on the experimental group. Comparison of the averages of the two groups in Table 2 shows that in the post-test, the average physical activity of the experimental group is higher and the average craving of the experimental group is lower than the control group, this finding shows that the weight control intervention is based on acceptance and commitment with the matrix approach and cranial wall stimulation. With direct flow, it has led to an increase in physical activity and a decrease in cravings of the experimental group in the post-test stage, while the average scores of physical activity and cravings of the two experimental and control groups were not significantly different from each other in the pre-test.

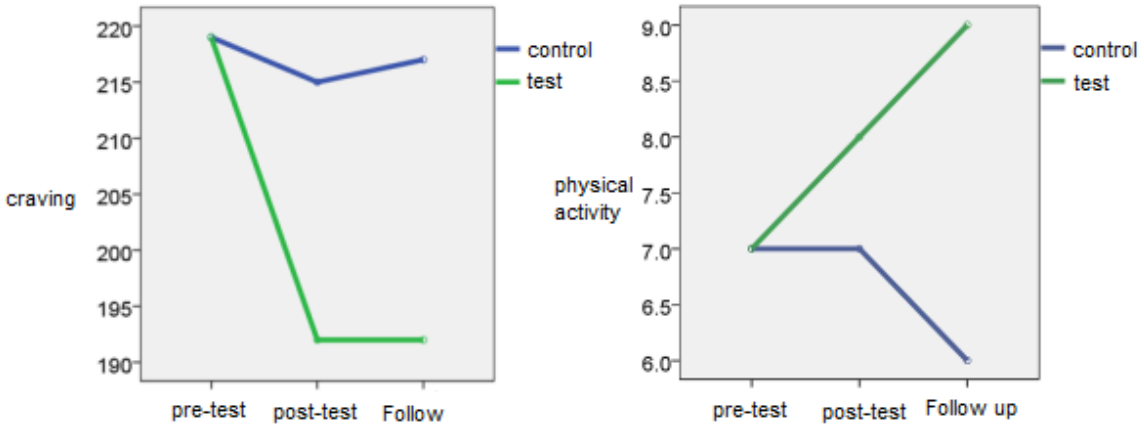

Figure 1. The graphs of changes in the effects of the intervention on cravings and physical activity in the three times of pre-test, post-test and 3-month follow-up

Based on the results related to the average of the two experimental and control groups, in the follow-up phase, it can be stated that after three months of the intervention, the average of the experimental group was still higher in physical activity and the average of the experimental group was lower in cravings of the experimental group than the control group. The results of the ETA test show that the weight control intervention based on acceptance and commitment with the matrix approach and stimulation of the cranial wall with direct current can explain 15% of the variance of physical activity (Partial η2 = 0.15) and 31% of the variance of cravings (Partial η2 = 0.31). According to the significance of the intragroup test of physical activity related to different stages of measurement (η2 = 0.13); p<0.001 (F=55.5), the results of comparing the post-test scores and the 3-month follow-up of the two experimental and control groups are also shown in graph No. 1.

The graph related to the changes in the effects of the intervention on physical activity in the three periods of pre-test, post-test and follow-up, in the continuation of the findings of the analysis of variance with repeated measurements, shows that the level of physical activity in the control group did not change in the post-test, while in the follow-up, contrary to expectations, physical activity decreased by A significant difference is observed in the control group. This is while the level of pre-test scores of the experimental group is similar to the control group and is at a low level, but after applying the weight control intervention based on acceptance and commitment with the matrix approach and stimulation of the cranial wall with direct current, the level of activity scores Body has increased significantly in the post-exam section. In the follow-up, it is observed that the physical activity of the experimental group continues to increase, and the scores of this group are higher than the control group. These findings show the high effectiveness of weight control based on acceptance and commitment with the matrix approach and cranial wall stimulation with direct current on physical activity.

Also, according to the significance of the intra-group craving test related to the different stages of measurement,; (F=12/136, p<0/001, Partial η2 = 0.78) the results of the comparison of the pre-test, post-test and 3-month follow-up scores of the two experimental and control groups are also shown in graph no. 2. As graph no. 2 related to the changes in the effects of the intervention on cravings In the three periods of pre-test, post-test and follow-up, the results of the analysis of variance with repeated measurements show that the level of craving scores in the control group for all three time periods had slight and insignificant changes, while the level of the scores The pre-test of the experimental group was similar to the control group and was at a high level, but after applying the weight control intervention based on acceptance and commitment with the matrix approach and stimulation of the cranial wall with direct current, the level of craving scores in the post-test was significantly higher. has decreased. In the 3-month follow-up, the observed changes in the reduction of the craving scores of the experimental group are still observed, and the level of the scores of this group is lower than the control group. These findings indicate the high effectiveness of the weight control intervention based on acceptance and commitment with the matrix and stimulation approach. The cranial wall is a direct current on the grades of craving.

4. Discussion

The present study was conducted with the aim of evaluating the effectiveness of the intervention package based on acceptance and commitment with the matrix approach and stimulation of the cranial wall with direct current on the level of physical

activity and cravings of overweight people. The results showed that the current intervention package led to a significant increase in physical activity scores in the post-test and three-month follow-up, as well as a significant decrease in craving scores in the post-test and follow-up compared to the control group. Although there is at least one published clinical trial evaluating the effectiveness of a matrix-based ACT mobile app (Levin et al., 2017), no studies were found evaluating a matrix-based ACT intervention combined with tDCS in overweight individuals. The findings of the present research are somewhat consistent with the study conducted by Levin et al. (2017). The findings of Levin et al.'s study (2017) indicate that the mobile application based on the ACT matrix is effective in increasing physical activity. The results of the present study can be considered in line with the findings of de Arajo et al. (2020), who showed that 20 20-minute sessions of tDCS with the AR/CL stimulation protocol can lead to a reduction in cravings in participants. These findings confirm the opinion of researchers (Graham et al., 2016; Ghanbari et al., 2019; Rostami et al., 2015; Hale et al., 2020; Valin et al., 2018; Trainor et al., 2019; Rostami et al., 2015). which emphasize the importance of the role of increasing skills based on acceptance, awareness, compassion and valuable action and the effect of tDCS in people with obesity and overweight in improving health-related behaviors and cravings. Although Fletcher (2019) did not report a significant increase in the physical activity of the experimental group compared to the control group, despite the aforementioned results, through his one-day workshop based on acceptance and commitment therapy, his findings do not mean that longer interventions based on the ACT matrix approach cannot also Successfully increase the level of physical activity. In theory, the ACT Matrix is a simple way to help people adopt a perspective that increases psychological flexibility. Psychological resilience can improve adherence to weight loss programs, including engaging in physical activity, and prevent treatment dropout (Lilis and Kendra, 2014). Therefore, the increase in flexibility and adherence to the program can be considered as one of the factors of maintaining the positive results of the current intervention package in the long term (three months follow-up). The matrix is an applied product of functional contextualism (Hayes, 1993). In functional contextualism, the main concern is to find out which actions are effective to achieve specific goals, not how things are or to find out what is true (Hayes, 1993).

In the current treatment package, it is tried to help people to use this style of functional contextualism in their lives through the matrix model (Hayes, 1993). In the study, it was assumed that distinguishing between the person's experiences and the function of the behavior in relation to the four quadrants of the matrix, simply over time, can significantly reduce the avoidance of the experience and increase the valuable actions. When clients learn to constantly notice how their behavior works in relation to the matrix, they naturally change their behavior to move toward their values (Polk & Schoendorf, 2014). The more people realize the function of their actions, the more their behavior changes from experiential avoidance to values (Polk & Schoendolf, 2014). In relation to therapy, weight loss could be widely present in various value-based life domains (e.g., relationships, health, work, and recreation) (Lilis, Kendra, 2014) and thereby increase physical activity and decrease cravings. You are overweight. One of the psychological factors that prevent engaging in physical activity and maintaining it in the long term and managing cravings is shame and negative self-judgment (Pila et al., 2015). On the other hand, the ability to establish a warm, compassionate, accepting and relaxing relationship with oneself is effective in reducing shame and self-criticism and psychological well-being, especially in people who struggle with eating and overweight problems (Palmyra et al., 2019); Therefore, the current treatment package, in line with recent research, emphasized the role of integrating self-compassion into weight loss interventions. Through compassion, the brain's unique soothing system that regulates emotions and shifts attention to feelings of tenderness and kindness; be stimulated (Mantzius and Wilson, 2015). On the other hand, from a biological point of view, the prefrontal cortex regulates and moderates cravings and the decision-making process, so manipulation of this area can lead to changes in attention control. To regulate and modulate DLPFC activity, direct stimulation from the skull using electric current was used. It was assumed that increasing DLPFC activity; The important area involved in cognitive control Food intake may enhance inhibitory control, thus suppressing reward-related activity in neurocognitive reward circuits that drive food cravings and binge eating. According to this assumption, in the present study, consistent with the findings of previous studies, a significant effect of tDCS on craving was observed in the short term.

5. Conclusions

The findings of the present study also showed that tDCS does not have a significant effect on cravings in the long term (3-month follow-up) and no study was found to evaluate the long-term effectiveness (at least 3 months) of tDCS in overweight people. It seems that the combination of tDCS with acceptance and commitment therapy with the matrix approach has been able to intensify the effect of craving reduction and maintain it in the long term. In other words, the present intervention package has both biological and psychological aspects.

Conflicts of Interest: The authors declare no conflict of interest.

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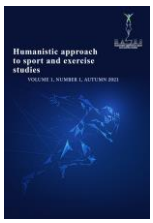

تأثیر مداخله بر اساس تحریک دیواره جمجمه با جریان مستقیم و رویکرد ماتریس بر تمایل به خوردن و فعالیت فیزیکی در افراد چاق

سید محمد حسین حسینی راوش[۱*]

۱. دانشکده تربیت بدنی و علوم ورزشی، دانشگاه آزاد اسلامی واحد زابل، زابل، ایران؛

* نویسنده مسئول: hhoseinir@yahoo.com

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چکیده: هدف از پژوهش حاضر، ارزیابی اثربخشی بسته‌ی درمانی کنترل وزن بر اساس رویکرد پذیرش و تعهد با رویکرد ماتریس و تحریک مستقیم جریان الکتریکی مغزی در کنترل تمایل به خوردن و فعالیت فیزیکی در افراد چاق است. این پژوهش به صورت شبه‌آزمایشی با پیش‌آزمون و پس‌آزمون و گروه کنترل فعال طراحی شده است. برای این منظور، ٤۰ نفر از افراد چاق با توجه به معیارهای از پیش تعیین شده با استفاده از نمونه‌گیری در دسترس انتخاب شدند. ابزارهای این پژوهش، پرسشنامه فعالیت‌های فیزیکی بیک (۱۹۸۲) و پرسشنامه تمایل به خوردن-صفت سپدا بنیتو (۲۰۰۰، FCQ-T) بودند. گروه تجربی بسته‌ی مداخله را در ۱۲ جلسه گروهی آنلاین هفتگی به مدت ۲ ساعت و ۸ جلسه فردی تحریک الکتریکی مغزی با جریان مستقیم AR/CL (Ma۲ برای ۲۰ دقیقه) دریافت کردند. گروه کنترل تنها ۸ جلسه فردی تحریک الکتریکی مغزی با جریان مستقیم AR/CL (Ma۲ برای ۲۰ دقیقه) دریافت کردند. نتایج تحلیل تفاوت مخلوط بین داخل گروه نشان داد که بسته‌ی مداخله ترکیبی کنترل وزن بر اساس رویکرد پذیرش و تعهد با رویکرد ماتریس و تحریک مستقیم جریان الکتریکی مغزی با جریان مستقیم (tDCS)، تأثیر معناداری بر فعالیت فیزیکی و تمایل به خوردن افراد چاق نسبت به تحریک الکتریکی مغزی با جریان مستقیم (tDCS) تنها داشت. با توجه به نتایج، می‌توان نتیجه گرفت که بسته‌ی درمانی این مطالعه می‌تواند یک گزینه خوب برای افزایش فعالیت فیزیکی و کاهش تمایل به خوردن باشد.

واژه‌های کلیدی: اضافه وزن، درمان چاقی، ماتریس، ACT، تمایل به خوردن، فعالیت فیزیکی