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Effect of affect regulation training on positive and negative affects in adolescents with type 1 diabetes

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Abstract

Aim: Diabetes is characterized by high blood glucose levels caused by insulin production defects, insulin resistance, or both. This condition can lead to psychological and physiological impairments. The present study aims to investigate the effect of emotion regulation training on regulating positive and negative emotions in adolescents with type 1 diabetes.

Material and Methods: This study was conducted in 2020 on 40 teenagers with type 1 diabetes, comprising 72.5% girls and 27.5% boys, randomly assigned to experimental and control groups. Only the experimental group received emotion regulation training. Both groups completed the questionnaires before the start of the emotion regulation training sessions (pre-test) and at the end of the training sessions (post-test). For data analysis, paired and independent sample T-tests were utilized. Data were analyzed using univariate analysis of covariance (ANCOVA) in SPSS version 23.

Results: The ANCOVA analyses revealed significant differences between the intervention and control groups. The ART group showed a significant reduction in negative emotions and a significant increase in positive emotions in the post-test compared to the pre-test ($p < 0.05$).

Discussion: Regulating emotions by weakening or strengthening negative and positive feelings influences various brain areas. These areas, through hormonal regulation, are associated with controlling diabetes and emotions and their accompanying symptoms.

Conclusion: The results suggest that ART can be considered an effective treatment for stimulating positive emotions and reducing negative emotions in adolescents with type 1 diabetes.

affect regulation training; positive affects; negative affects; type 1 diabetes; adolescents

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INTRODUCTION

Type 1 diabetes is an autoimmune disease in which defects in insulin secretion occur due to autoimmune destruction of insulin-secreting cells [1]. As a chronic metabolic syndrome, diabetes mellitus is the most prevalent endocrine disorder, particularly among children and

adolescents, although it can occur at any age. The peak incidence is typically during puberty, with most diagnoses made before age 30 [2]. The global prevalence of type 1 diabetes shows considerable geographical variations and is currently increasing at an annual rate of 3.2%. According to the World Health Organization (WHO), approximately 35 million individuals worldwide are affected by type 1 diabetes, with prevalence rates varying based on geographical region and ethnicity, and an incidence of 10-20 cases per 100,000 individuals annually has been reported among Asians [3]. In Iran, the prevalence of individuals with type 1 diabetes is estimated to be between 5% and 10%, with one in every 400-500 children being diagnosed with the disease [4].

Research demonstrates that the rise in type 1 diabetes is linked to factors such as autoimmunity, genetics, and environmental conditions. Over the past decades, significant advancements have been made in understanding the complex immune responses involved in the pathogenesis of type 1 diabetes. However, this disease's leading cause of the underlying autoimmune process remains unknown [5]. Furthermore, diabetes is one of the most common chronic diseases, and the influence of psychological factors on its management has been extensively studied. Both type 1 and type 2 diabetes are highly susceptible to the impact of positive and negative affects. Positive and negative affects are not merely two sides of a coin, with interlinked increase or decrease. Instead, these two are relatively independent structures, showing a spectrum of high or low experiences. Positive affect refers to being energetic and concentrated to do pleasurable activities and experiencing emotions such as joy, pride, and contentment. Conversely, negative affect includes emotions such as despair, worry, anger, and hatred [6]. Individuals who experience higher levels of positive affect tend to adopt varying coping strategies when encountering problems and challenges, maintain a positive outlook on challenges, and solve problems more appropriately, culminating in better psychological well-being and diabetes management [6,7].

Individuals with diabetes who struggle with stress management and emotion regulation often experience negative affections, such as anger, frustration, despair, fear, guilt, shame, resentment, and depression [8]. Research has revealed a significant positive correlation between poor blood sugar control in patients with diabetes and stressful life events as well as potentially negative emotions. Moreover, minor everyday life stressors have been more strongly linked to poor diabetes control than more significant stressors [9]. In recent years, psychological interventions have gained considerable attention, particularly emotion processing and regulation, in improving emotion regulation strategies and self-care in various disorders [10].

One treatment focusing on emotion and its regulation is affect regulation training (ART) [10]. The term "emotion regulation" refers to a set of conscious (top-down) and automatic (bottom-up) mechanisms used by people to manage their emotional responses to threats, responsibilities, and fears [11]. In other words, individuals use techniques and strategies to enhance positive emotions and reduce negative ones. This process represents an active interaction between a person and their emotions. For example, when an individual faces a complication from diabetes, they can react to the situation in two ways. An adaptive response involves utilizing physical and psychological resources, such as engaging in positive activities and striving for improvement. On the other hand, a maladaptive response may include negative states, such as rumination, doubt, avoidance of treatment, or impulsive and irrational behaviors [12]. Moreover, there is an inverse relationship between the experience of emotions and the emotion regulation skill. In other words, individuals who experience more negative emotions generally have difficulty regulating and managing their emotions. If emotion regulation skills do not function optimally, they cannot effectively control or reduce negative emotions; when individuals are weak in managing their emotions, they cannot control negative emotions, which are experienced more strongly [10,13,14].

Various studies have highlighted the role of emotion regulation in the mood of individuals with diabetes. For instance, Fisher et al. utilized emotion regulation to improve diabetes distress in adults. They found that patients with poor emotion regulation had severe depression, and high levels of depression were associated with

poor diabetes management and inadequate glycemic control [10]. Niven et al. investigated the mood of diabetic individuals and demonstrated that self-control practices, such as emotion regulation, led to decreased blood glucose levels [15]. According to Ruiz-Aranda et al., difficulties in emotion regulation result in increased HbA1c levels, whichd is influenced by diabetes-related stress. In other words, stress plays a mediating role in emotion management [16]. Miniksar et al. concluded that children and adolescents with type 1 diabetes face specific challenges in controlling emotions and impulsivity, which can give rise to inefficient eating and worsening diabetes. Thus, the significance of psychological interventions, such as emotion regulation, for improving these individuals' psychological and physical well-being is emphasized [17]. Kafali et al. examined the characteristics of emotional dysregulation and co-morbid psychiatric disorders in children with type 1 diabetes with the risk of eating disorder behavior. They found that individuals with diabetes faced an 8.5 times higher risk of emotional disorders, experienced difficulties in emotion regulation, and were unable to employ emotion-regulation strategies, goal-directed behavior under difficult emotional conditions, and impulse control [18].

Previous research has indicated a limited exploration of the effect of ART, particularly on the emotions of adolescents with type 1 diabetes, both domestically and internationally. Given the increasing number of adolescents with type 1 diabetes and considering that adolescents, due to rapid physical, mental, and social development changes, face the most significant challenges in controlling and managing type 1 diabetes, resulting in a higher incidence of diabetes complications [19-23], there is a pressing need for targeted treatment programs to reduce the complications arising from type 1 diabetes. Therefore, the present study aimed to investigate the impact of emotion regulation on positive and negative affect in adolescents with type 1 diabetes.

Research Hypotheses

This study aimed to investigate the effect of affect regulation training on positive and negative emotions in adolescents with type 1 diabetes. Based on theoretical assumptions and previous empirical studies, emotional regulation training provided would positively impact the increase of positive emotions and the reduction of negative emotions in adolescents with type 1 diabetes, which would be demonstrated the results of a questionnaire.

METHODS

Participants

This research was a quasi-experimental study with a pre-test and post-test design and a control group. The study's statistical population included adolescents aged 16 to 18 with type 1 diabetes who visited the Bou Ali Diabetes Clinic in Shiraz between 2020 and 2021. The first stage of this research was the selection of the subjects. A purposive sampling method was used to calculate the sample size. Initially, in cooperation with the Bou Ali Diabetes Center of Shiraz, a list of adolescents with type 1 diabetes aged 16 to 18 residing in Shiraz was provided to the researcher. These individuals were invited to participate in the study via telephone. Then, the volunteers were screened based on the inclusion criteria and randomly assigned to two groups of twenty: experimental and control. The inclusion criteria for the groups were as follows: All participants were students aged 16 to 18, had a desire for personal growth, had mental health problems, were at risk of having mental health problems, and had a desire for personal growth. The exclusion criteria included having severe mental illnesses (such as severe mood disorders or anxiety disorders), acute poisoning, or substance abuse. In the second stage, before the implementation of the independent variable (ART), the selected subjects in both groups were measured using a pretest (Positive and Negative Affect Schedule [PANAS]). The PANAS questionnaire was administered to both groups of participants. Then, the participants in the experimental group received the ART interventions of Berking and Wheatley (Table 1) over nine 120-minute sessions, while the control group received no intervention. After completing the sessions, the dependent variable (positive and negative affects) was measured in both groups using a post-test.

Questionnaires

The PANAS: This scale was developed by Watson et al. in 1988 to measure the two dimensions of positive and negative affects, consisting of 20 items. To measure each affective dimension, a 10-item subscale is considered. Items are rated by the subjects on a five-point Likert scale ranging from 1 = very low to 5 = very high. The score range for each subscale is between 10 and 50. A higher score on each of these two subscales denotes more intense positive and negative affects. In Watson et al.'s research, the reliability using Cronbach's alpha was 0.88 for the positive affect sub-scale and 0.87 for the negative affect subscale, and its test-retest reliability was 0.68 for the positive affect subscale and 0.71 for the negative affect subscale [24]. The reliability of the PANAS in Iran was obtained by Azizi et al. using Cronbach's alpha coefficient of 0.69 for the positive affect and 0.78 for the negative affect [25]. In this research, the reliability using Cronbach's alpha was 0.66 for the positive affect and 0.67 for the negative affect.

Data Analysis

SPSS 2022 software was used to analyze the data. The comparison of pre-intervention and post-intervention scores on the PANAS was conducted using analysis of covariance (ANCOVA), a general method more appropriate for examining pre-test to post-test between-group differences. However, before performing the analysis, the assumptions of ANCOVA were examined. Levene's test was conducted to assess the equality of variances between the two groups, while the Kolmogorov-Smirnov test was applied to check for normality of distribution. A p-value less than 0.05 was considered statistically significant.

Table 1. The structure and general content of sessions

Session	Content
First session	Introduction and psychological training: introducing the affect regulation training and general explanation about the skills they would learn throughout the training; explanations about negative affects, experimental and theoretical areas, affect regulation training skills
Second session	Training muscular and respiratory relaxation: training muscular relaxation skills through advanced relaxation method for muscles as well as long exhalation in order to prevent psychological excitation
Third session	Importance of doing the exercises regularly: explanations about the importance of the exercise or practice and how regular exercise would affect the brain so that it could help in establishing positive changes in life
Fourth session	Judgment-free awareness: training awareness about affects and background of affects (emotions, cognitions, motivational impulses), as well as labeling the affects in a nonjudgmental way
Fifth session	Acceptance and tolerance: five steps for establishing acceptance and tolerance are: 1-setting acceptance as a goal, 2 – presenting a reason for this goal, 3 – considering affects as a friend which gives important messages and shows proper reactions, 4-the individual awareness about their capacity for tolerating affects, 5 – understanding the fact that affects are not permanent
Sixth session	Sympathetic self-support: imagining oneself in stressful situations, activating sympathetic thoughts with oneself, approaching, encouraging, and alleviating oneself in the imagined scene.
Seventh session	Analyzing affects: understanding the signs of the present affect using the worksheets delivered to the participants. It includes objective situation, the present expectations, goals, and needs, cognitive assessment, primary affects, secondary affects, practical tendencies, etc.
Eighth session	Alteration of affects: changing the quality or quantity of affective reaction with five steps of the plan for changing affects based on the general problem-solving model including 1 – setting a special and realistic goal about what you want to feel, 2 – brainstorming of the possible solutions for altering the affects, 3 – selecting a strategy, 4 – creating a roadmap, 5 – assessing the progress including encouragement of successful attempts or modification of the plan or goal if necessary
Ninth session	Conclusion: concluding remarks and further exercises for coping with emotional states.

Bioethics Committee

The present research was approved by the Ethics Committee of Tabriz University of Medical Sciences (IR.TBZMED.REC.1398.289). To ensure research ethics, informed consent was obtained from the students to participate in the intervention program, and all stages of the intervention were explained. The parents also provided their consent for their child's participation in the present study and were informed of all stages of the intervention. Moreover, the students in the control group were assured that they would receive these interventions after completing the research process if they wished. Both groups of students were assured that their information would be kept confidential, and no names were requested during the research. To motivate participation in the study, the therapeutic and educational aspects of the interventions were explained to the participants before the intervention, and the entire intervention process was provided to them free of charge.

RESULTS

In the present study, 40 patients were assigned to the intervention and control groups. The demographic characteristics of the participants in both groups are compared in Table 2 (P≤0.05). The comparisons of the mean values of the Positive and Negative Affect Schedule components between the intervention and control groups of patients in the pretest and posttest are demonstrated in Table 3. The comparisons of the mean and P values of the intervention and control groups in the pretest showed no significant differences. In other words, the mean values of the two groups in all the components were almost equal. As shown in Table 3, the mean of positive affect in patients receiving ART was significantly higher, and the mean of negative affect was significantly lower than the control group (P≤0.05).

Table 2. Demographic characteristics of the participants in the intervention group and the control group

Variables		Intervention Group (n, %) (n=20)	Control Group (n, %) (n=20)	P value
Sex	Male	4 (20.0%)	7 (35.0%)	0.30
	Female	16 (80.0%)	13 (65.0%)	
Age	16	7 (0.35%)	10 (50.0%)	0.50
	17	4 (0.20%)	2 (10.0%)	
	18	9 (0.45%)	8 (40.0%)	

Table 3. Descriptive indicators of Positive affects and Negative affects in the intervention and control groups

Variables	Pretest			Posttest		
	ART Mean±SD	Control Mean±SD	P value	ART Mean±SD	Control Mean±SD	P value
Positive affects	33.20±6.59	35.35±6.20	0.29	43.90±6.19	35.90±6.95	0.00
Negative affects	23.70±8.52	22.10±6.89	0.51	12.50±4.29	20.55±7.22	0.00

P values were calculated for the unpaired t test (P≤0.05). Unpaired t test were applied and P values of less than 0.05 were considered significant.

ART: Affect Regulation Training; P values were calculated for the t test (P≤0.05). Unpaired t test were applied and P values of less than 0.05 were considered significant.

As stated above, conducting ANCOVA requires some assumptions. First, the variables' measurement scales should be either ratios or ordinals, and their distribution should be normal.

The other important assumption is related to the equality of variances, which means that the population variance for one thing is the same as for another. The homogeneity of variances was determined using the Levene test. This test is used to assess the equality of the variances of

a variable in two or more groups and is a prerequisite for performing some statistical analyses. If the P value of the Levene test is less than the significance level (in this research, 0.05), the null hypothesis of equal variances is rejected. When the P value is more than 0.05, the variances are equal. The results of the Levene test showed no significant differences between the two groups in the scores of positive affects (p=0.684) and negative affects (p=0.870). Based on these results, all the P values were more than 0.05. Hence, the homogeneity of the variances in the above variables was confirmed in the intervention and control groups.

This test's results showed that the parametric test assumptions were fulfilled. The data distribution was also considered normal after implementing the Kolmogorov–Smirnov test and the P values obtained for all the variables exceeded 0.05, justifying parametric tests. Therefore, it could be acknowledged confidently that the homogeneity of the regression slope assumption was appropriate for performing the covariance analysis because the interactions between the variables were not significant (P≥0.05).

Table 4. Summary of the analysis of covariance of the Positive and Negative Affect Schedule

Source	Dependent Variables	SS	df	MS	F	P	Eta
Positive and Negative Affect Schedule	Positive affects	887.296	1	887.296	39.497	0.000	0.516
	Negative affects	781.783	1	781.783	40.710	0.000	0.524

SS: Sum of the square; df: Degrees of freedom; MS: Mean square; F: Fisher; P: Probability; Eta: Euskadi Ta Askatasuna; The ANCOVA test was used to compare the variables between the experimental and control groups

Table 4 presents the results of the univariate analysis of covariance. This table shows that the ART and control groups were significantly different regarding the positive and negative effects scores in the post-test (P≤0.05). Simply put, the intervention group's positive and negative affects scores significantly differed from those without intervention. The partial Eta-squared value indicated that the effect size should be compared with the Cohen guidelines (0.2: small effect; 0.5: moderate effect; and 0.8: large effect). As can be seen, the effect size for positive effects (0.516) and negative effects (0.524) was moderate.

This value was used to estimate the proportion of variance in the positive affects and negative affects was explained by the intervention (ART). This means that the group explained 51% of the variance of positive and 52% of the variance of negative affects. In other words, most of the changes in the scores were because of the therapeutic effects of the intervention. *[Use precise academic phrasing.]*

DISCUSSION

The present study demonstrated that ART can influence certain hormones and brain regions by using specific strategies, thereby regulating both negative and positive affects. From a neurobiological perspective, ART is employed to modulate emotions. Different brain regions can be affected depending on which emotion regulation is used to weaken or strengthen specific emotions. For instance, increased activity in the amygdala, which is sensitive to both positive and negative emotions, can culminate in an increase in positive or negative emotions. However, other brain regions may be linked to specific emotional experiences. For example, activity in reward-related brain regions, such as the nucleus accumbens, is connected to positive emotions but not negative ones [26]. We utilized ART due to its role in modulating and controlling negative and positive emotions.

The findings demonstrated that ART influenced both positive and negative affects in patients with type 1 diabetes. These findings align with the results of research conducted by Fisher et al. [11], Niven et al. [15], Berking et al. [27], Berking and Lucas [28], Barrack et al. [29], Stecewicz et al. [30], and Yang et al. [31].

While the neurotransmitter of the positive affect system is dopamine, which activates the anticipation of pleasurable events, the negative affect system also has a neural basis. In the hormonal-nervous system or hypothalamic-pitu-

itary-adrenal (HPA) axis, psychological stress stimulates the paraventricular nuclei of the hypothalamus, releasing corticotropin-releasing factor. The corticotropin-releasing factor in the anterior pituitary synthesizes adrenocorticotropin, ultimately stimulating the adrenal glands and the secretion of glucocorticoid hormones (such as cortisol) [32,33]. Individuals with high negative affects are more likely to have a negative perception of their health and report more physical complaints. Hence, focusing on increasing emotion regulation is a key feature of treatment for many mental and physical illnesses [34,35]. Emotion regulation can alter hormone levels, such as cortisol (a stress hormone) and endorphins (happiness hormones). These changes can impact positive and negative emotions. For example, increased cortisol can increase stress and anxiety, while increased endorphins can enhance joy and happiness. Increased experience of positive affect following increased emotional self-regulation leads to effective coping with stressful situations, promoting appropriate behaviors and activities, and improving the quality of life [36] in individuals with diabetes.

Individuals who experience predominantly positive affects have a greater ability to adapt to various circumstances; they have greater self-confidence, employ coping mechanisms better, and, consequently, demonstrate higher levels of satisfaction compared to those who experience more negative affects. With increased flexibility, they exhibit greater resilience in facing challenges and difficulties, ultimately leading to a higher quality of life. Diabetic individuals who experience high levels of positive affect respond to situations and events more positively and adaptively and are more successful in dealing with daily life's ups and downs and coping with stressful and threatening life events. They have higher positive expectations and are more optimistic. In contrast, adolescents who experience negative affect, such as hopelessness, distress, sadness, and grief, have less control over their circumstances, are less efficient, and are less competent in coping with life's challenges. Emotion dysregulation is linked to low resilience, emotional inflexibility, self-denial, and reality denial [37,38]. Positive and negative emotions can significantly predict and modify health outcomes and act according to mood states. However, emotion regulation is vital in initiating and reinforcing positive emotions and organizing adaptive behaviors; it also prevents high levels of negative emotions and maladaptive behaviors [39,40].

CONCLUSION

The present study's findings demonstrate that ART can influence positive and negative affects in individuals with type 1 diabetes by inducing positive changes in brain structure. To address the limitations of the present study, we suggest that future similar research be conducted in other cities and investigate the psychological, social, familial, economic, and academic conditions of parents of adolescent students with type 1 diabetes. They are also advised to employ a random sampling method to increase the generalizability of the results. Given the results of this study, it is recommended that for participants who wish to process their individual problems more deeply, supplementary ART sessions should be combined with individual therapy, and the effect of this treatment should be evaluated in follow-up periods. Moreover, investigating the impact of this program in groups with other chronic diseases seems beneficial. It is also suggested that the effect of this program be evaluated on groups older than 18 years with diabetes and its results be compared. It is recommended that ART be employed as a preventive strategy for the general population.

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