

**The effect of aerobic training and its combination
with acceptance and commitment therapy on insulin
sensitivity, C-reactive protein and depressive
symptoms in women with type 2 diabetes**

**Nader Moghaddam Dizaj Herik¹, Naimeh Moheb², Abdol Ali
Banaeifar^{3*}, Nasser Agha Mohammadzadeh⁴**

Received: 20 January 2020 / **Accepted:** 12 March 2020

- (1) PhD student, Department of Psychology, Tabriz Branch, Islamic Azad University, Tabriz, Iran.
- (2) PhD, Department of Psychology, Tabriz Branch, Islamic Azad University, Tabriz, Iran.
- (3)* PhD, Department of Exercise Physiology, South Tehran Branch, Islamic Azad University, Tehran, Iran., PhD in Exercise Physiology. E-mail: alibanaeifar@yahoo.com
- (4) Internal Department, Endocrinologist and Member of Endocrine Research Center, Associate Professor, Tabriz Branch, University of Medical Sciences, Tabriz, Iran.

Abstract

Introduction: The purpose of the present research is to study the effect of aerobic training and its combination with acceptance and commitment therapy interventions (ACT) on insulin sensitivity, C-reactive protein and depressive symptoms in women with type 2 diabetes.

Material & methods: In the present quasi-experimental study, 60 women with type 2 diabetes with the age range of 50.4 ± 1.8 are selected among patients referred to the specialized clinic for health and treatment of the oil industry in the northwest of the country in a purposeful sampling and then divided into 4 groups of 15 for aerobic training (AT), psychological therapy interventions based on acceptance and commitment (ACT), AT+ACT and control group. AT group was performed endurance training corresponding to 50-75% of HR max, 3 times per week for 10 weeks. Psychological intervention plan was done in a form of 90 min therapy workshop based on acceptance and commitment for 13 weeks. Biochemical and depression indicators are collected before and after intervention by using blood sample and Beck test. Data analysis was done through analysis of covariance ($P\text{-value} \leq 0.05$) and by SPSS-27 software.

Results: The results showed that, AT, ACT and AT + ACT resulted in the significant decrease of depressive symptoms ($P\text{-value}=0.001$). However, insulin sensitivity, C-reactive protein in intervention groups didn't show any significant difference than control group.

Conclusion: According to the findings, it seems that psychology and aerobics training can influence important glycemic indicator such as insulin sensitivity besides changes in depression indicators and also results in C-reactive protein clinical recovery in women with type2 diabetes.

Keywords: Acceptance and Commitment Therapy, Aerobics Training, Depression, Insulin sensitivity, C-reactive protein, Type 2 Diabetes.

1. Introduction

Chronic health problems are diseases which are incurable and should be controlled by patient and health specialist. However, humans are disappointed from the treatment and try to find a way for their

recovery. But the treatment of chronic diseases like cerebral stroke, cancer, diabetes, heart diseases have high cost for governments. Furthermore, 60 percent of world mortality rate is due to these diseases (1). Diabetes is a complicated metabolic disease that can have destructive effects on different parts of body. Diabetes is the main cause of kidney disease in final steps and also a main cause of vision, neuropathy and cardiovascular disease. This disease arising from defects in secretion, lack of access to insulin, decrease in sensitivity of cells to it or insulin function or both and is associated with hyperglycemia, disorder in carbohydrate, lipid, protein metabolism and its psychological symptoms (2-4). Evidence has shown that chronic inflammation has a key role in cardiovascular diseases and can be like a stimulant force for insulin sensitivity and type 2 diabetes (5,6). Among different indicators, C-reactive protein with high sensitivity which is an inflammatory stimulant response to the liver and is made from lipid tissue by lipid cells, is a useful, available and low-cost indicator with easy measurement for the prediction and diagnosis of cardiovascular diseases (7,8). Type 2 diabetes is a disease which is highly related to lifestyle and has strong behavioral and emotional components and its side effects significantly affect patients' quality of life (9). Studies have shown that diabetes increases the risk of depression a lot. Living with this disease and dealing with hormonal and biological factors, as well as the need to manage daily conditions with diabetes, may increase the risk of depression (10). The recent studies have shown that depression is a common joint disorder and affects 25 percent of patients with diabetes (11). The clinical studies have pointed out that diabetic patients with depression are the indicators of negligence in controlling anti-diabetic diet, lack of control of blood sugar regularly and exposure to the risk of eye diseases (12) and small and large coronary arteries side effects as well (13). Depression can increase the possibility of diabetic side effects. It can be difficult to do routines for depressed people. Overtime, managing diabetes (regular blood sugar test, using medications, following healthy diet and regular physical activities) can have its effects which can result in negligence of routine diabetes care (14). Cognitive problems related to depression such as memory disorder, decision making problem and losing cognitive flexibility are associated with attention disability and limited

performance recovery (15,16). Depression and diabetes tend to worsen both processes especially through diabetic side effects, deterioration of glucose control and more depression recurrences (17).

Besides medical treatment which is one of the ways to face diabetes, psychological interventions have been able to take effective steps for the recovery of this disease. Therapy approach based on acceptance and commitment is one of the third waves of the cognitive-behavioral therapy and of modern behavioral therapies which is called (ACT). ACT is a therapy approach which uses acceptance, mental awareness (mindfulness), commitment and behavioral changes to create more psychological flexibility (18). A range of research has expressed a global interest toward behavioral change model from the viewpoint of acceptance and commitment therapy (ACT) and more than 30 random clinical trials confirmed this approach. One of the ACT features is its effectiveness in many human issues including anxiety, depression, psychodynamics, eating disorder and self-control recovery at the time of having chronic physical diseases (such as diabetes and epilepsy) (19). Various factors such as genetic background, diets, physical activity reduction are the most important risk factors for type 2 diabetes, therefore, physical activity increases the insulin sensitivity in diabetic and non-diabetic people as a non-pharmaceutical intervention. Regular physical activities increase the oxidative capacity, lipid metabolism, and insulin signaling sensitivity (20). Aerobic training increases the glucose transmitter level in skeletal muscle as well as muscle glycogen synthesis and hexokinase levels and improving glucose uptake recovery in response to insulin stimulation (21). Hence, according to the possible effects of physical activities on blood glucose and insulin secretion, it seems that one of the effective factors on type 2 diabetes is physical activity. According to the studies and investigations in other research, one can express that a lot of studies have done individually in psychological domain and aerobic training with diabetes and other research topics, but what differentiates this research from other research is conducting combination of aerobic training with therapy approach based on acceptance and commitment and due to the fact that there hasn't been any interdisciplinary combination research yet, the present study was done with the purpose of the effect of aerobic training and its

combination with acceptance and commitment therapy interventions on insulin sensitivity, C-reactive protein and depressive symptoms in women with type 2 diabetes.

2. Material & methods

The present study is practical, quasi-experimental, and selection of purposeful statistical community among patients referred to the specialized polyclinic of health and treatment of the oil industry in Tabriz, the criteria to enter the study was women under drug treatment for type 2 diabetes with the average age of 50.4 ± 1.8 years old, with at least having 2 years of type 2 diabetes, with clinical depression symptoms who didn't have regular physical activities during past 6 months. The exclusion criteria were availability to participate in measurements: no unstable chronic condition including kidney diseases, neuromuscular and cardiovascular diseases, hypoglycemia and diabetic foot ulcers. On the other hand, subjects who missed more than 3 sessions of the intervention were excluded from the study.

The statistical sample included 60 patients who were divided randomly into 4 groups of: aerobic training (AT), psychological therapy interventions based on acceptance and commitment (ACT), AT + ACT and control group. 12 participants were excluded from (AT, ACT, AT+ACT and Control) the research for various reasons. The present study used Beck Depression Inventory (22). The Beck Depression Inventory is a 21-item, self-report rating inventory that measures characteristic attitudes and physical, behavior and mental symptoms of depression. Each answers being scored on a scale value of 0 to 3 to obtain minimal to sever grades of depression. Range of score for this test is 0 to 63. Depression symptoms and laboratory blood samples (insulin and C-reactive protein) were collected before and after the intervention. Before doing the research, an explanatory session was held for all the participants and they became aware of the purpose of the study, the process of counselling sessions and exercises, blood samples, time, location, research scheduling program and making a communication channel in one of virtual spaces. Then a consent form for participating in the research was filled by the participants. Psychological intervention

plan was done in a form of therapy workshop based on acceptance and commitment according to the therapy protocol in Table 1. (18,23).

Table 1. explanations related to psychological intervention program

Sessions(90 min)	Workshop content
Sessions 1-2	Physiological-behavioral-intellectual and cognitive symptoms caused by stress and its strategies and management
Sessions 3-4	Awareness about how diabetes occurs, genetic issues, medication therapy, and its strategies to deal with diabetes treatment
Sessions 5-6	An introduction to interpersonal problems/ reasons of interpersonal problems/ how to overcome interpersonal problems
Sessions 7-8	Schemas and their formation/identification of primary incompatible schemas
Sessions 9-10	Consciousness awareness by practicing 5 senses(5-senses)-meditation
Sessions 11-12	The effectiveness of schemas on interpersonal relationship with schemas behaviors- in three behavioral domains
Sessions 13	Identification of mind performance and practicing with metaphors

AT program was done during 10 weeks, 3 sessions every week for 40-50 minutes each session including warm-up, aerobic training, and cooling in one of the equipped gym of the National Gas Company of East Azerbaijan (Tabriz) in an appropriate atmosphere under the supervision of a coach and a general physician. The intensity of the AT was designed based on the Maximum heart rate (HR max) which was done with the intensity of 50-75% of HR max (Table 2).

Table 2. details of exercises

week	Warm-up (min)	aerobic (min)	Cooling (min)	Total time of training	Intensity of exercises (HRmax)
First-second	5	30	5	40	%50-55
Third-fourth	5	35	5	45	%55-60
Fifth-sixth	5	40	5	50	%60-65
Seventh-eighth	5	25	5	55	%65-70
Ninth-tenth	5	25	5	60	%70-75

The present study was approved by the Organizing Committee on Ethics in Biomedical Research on 21.5.2019 with the ethical code with ID of IR.IAU.TABRIZ.REC.1398.011.

Fasting blood samples were centrifuged after data collection and were kept in the freezer under -70° centigrade for the measurement of blood factors. Serum level of C-reactive protein was less than 0.1 for normal people and the risk of more than 8 mg/dL was the symptom of serious inflammation or infection which was measured by BioSystems kit for Pars Azmoon company in Iran.

Fasting blood sugar (FBS) was measured via photometric method by Pars Azmoon special kit. Insulin serum level was measured through enzymatic method by the application of DiaSorin kit with the sensitivity of 5 micro international units per milliliter and coefficient of variant of 20% with wavelength of (450nm). Insulin sensitivity (QUIKI) used serum glucose and fasting insulin concentration and calculated through the following formula. $FBS \text{ logarithm (mmol/l)} + \text{fasting insulin logarithm (ml}\mu\text{/IU)} / \text{QUIKI} = 1$ (24,25).

All statistical investigations were done by SPSS/Win software V.27. Shapiro-Wilk Test was used to ensure the normal distribution of data. The analysis of ANCOVA was used to compare the changes between groups by controlling the effects of pretest and in case of a significant difference among groups, the Benferoni post hoc test was used at a significance level of 5%.

3. Results

The descriptive information related to mean and standard deviation of research variables after psychological interventions and exercises compared with pretest of 4 groups was presented in table (3).

The result of the present study showed:

- The therapy approach based on acceptance and commitment caused a significant decrease in depression symptoms in women with diabetes ($p\text{-value}=0.001$), but ACT didn't have a significant difference in the C-reactive protein and insulin sensitivity amount ($p\text{-value}>0.05$).

- Aerobic training had a significant decrease in depression symptoms (p-value=0.001) in women with diabetes but it didn't have a significant difference in the C-reactive protein and insulin sensitivity amount (p-value>0.05).
- The effect of the combination of aerobic training with ACT had a significant decrease in depression symptoms (p-value=0.001) and the comparison of values showed that however the changes of this value weren't significant in posttest, but they were significant in ACT+training group and showed a significant increase and that the combination of aerobic training with ACT didn't have a significant difference in the amount of C-reactive protein (p-value>0.05).
- However, the investigation of the results of values mean in pre and posttest hasn't shown a significant difference in C-reactive protein and insulin sensitivity in the interventions but it has shown a positive laboratory and clinical effects in the decrease of CRP and increase of QUIKI.

Table 3. Mean and standard deviation for investigated variable in 4 groups of the study

Variable	ACT		AT		ACT +AT		Control	
	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest	Pretest	Posttest
Depression	7.3±26.6	4.2±20.6	3.8±23.4	3.1±19.6	6.4±28.5	4.1±20.9	2.0±24.3	2.5±25.3
CRP	6.9±4.6	5.0±4.1	5.5±3.5	4.7±3.2	4.9±5.0	5.1±4.5	1.6±1.8	3.3±3.4
Glucose	20.8±118 .8	10.8±113 .1	23.3±115 .4	15.7±109 .1	33.5±125 .0	16.5±113 .2	28.9±110 .8	11.1±112 .1
Insulin	10.2±10. 6	5.0±9.5	5.6±14.6	4.1±11.1	4.9±12.0	4.8±9.5	7.6±13.0	6.8±13.7
QUIKI	0.12±0.6 1	0.05±0.5 8	0.04±0.5 2	0.07±0.5 6	0.1±0.57	0.07±0.6	0.09±0.5 9	0.06±0.5 7

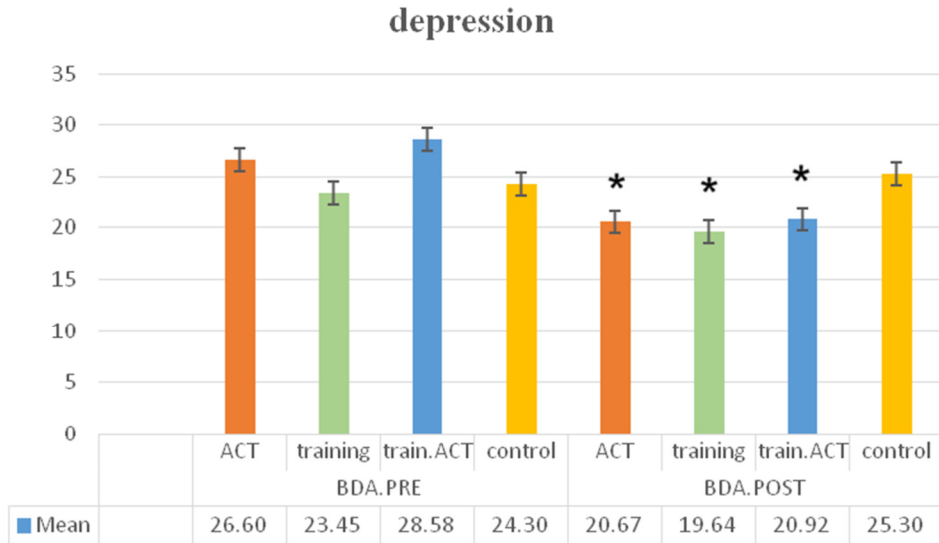


Figure 1: BDI values mean in pre-posttest for ACT, AT and ACT+AT and control.
 * Significant compared to ACT, AT and ACT+AT and control P = 0.05

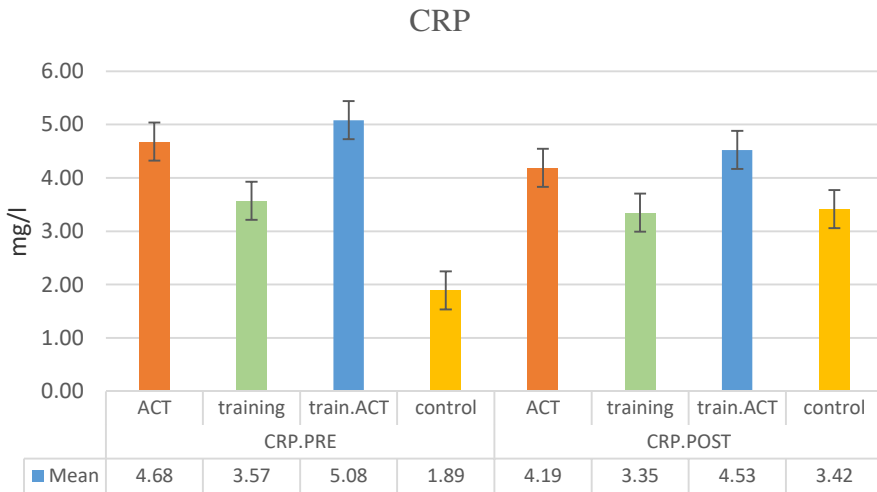


Figure 2: CRP values mean in pre-posttest for ACT, AT and ACT+AT and control.

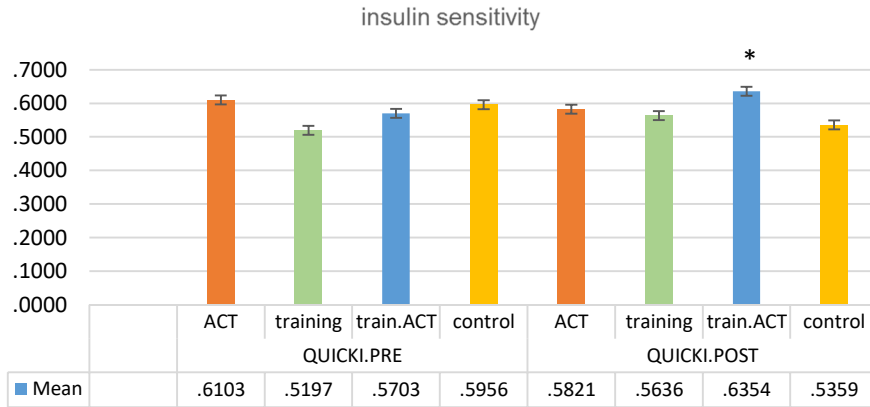


Figure 3: Insulin sensitivity values mean in pre-posttest for ACT, AT and ACT+AT and control.

* Significant compared to control group $P = 0.05$

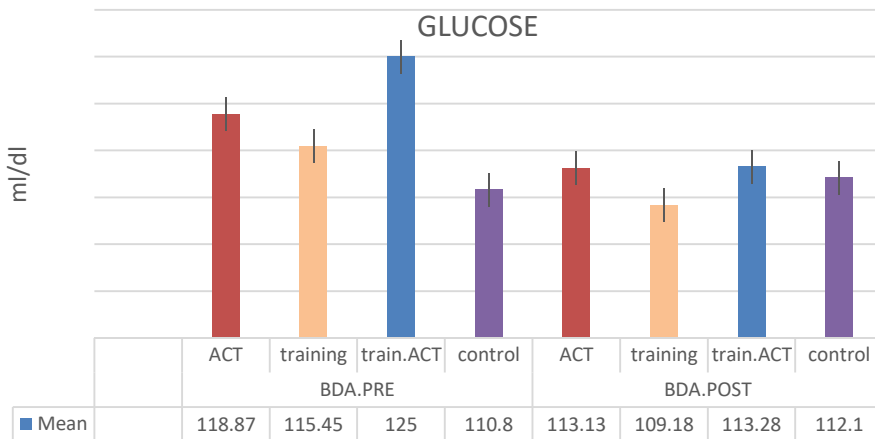


Figure 4: Glucose values mean in pre-posttest for ACT, AT and ACT+AT and control.

4. Discussion:

The programs of changing lifestyle including physical activities and exercise by controlling blood sugar and reduction of depression have a bold role in the increase of people's life quality with type 2 diabetes and on the other hand, the improvement of life quality and physical and mental health indicators of diabetic patient was obvious with therapy

approach based on acceptance and commitment. Therefore, in the present study beside the investigation of the individual effects of both dependent variables on independent variables, the base of research was established on their combination in three domains of medical, sport and psychological for the treatment of diabetic patients (26,28).

Findings of the study about depression variables showed that: therapy based on acceptance and commitment, aerobic training and their combination effect compared to control group, cause a significant decrease in depression. The present study was consistent with the previous studies and separation of ACT approach and aerobic training and inconsistent with some others. In a way that: Sanagoi Moharer et al. (2020) investigated the effect of cognitive therapy based on mindfulness on depression and flexibility in diabetic patients (29). Hor et al. (2013) investigated the therapy based on acceptance and commitment therapy on depression of type 2 diabetic patients and their results indicated the decrease of depression (30) and according to the given findings from Valla et al. (2015) research, depression, anxiety, stress and confidence have relation with HbA1C amount and depression decrease therapy based on mindfulness, some psychological symptoms of type 2 diabetic patients and increase in their confidence was effective in sugar blood control and patients recovery which was consistent with the result of the present study (31). Herder et al. (2017) observed the relation between anti-inflammatory cytokines and depression symptoms in diabetic patients-the possible differences were based on diabetes type and depression grades and there was a significant relation in C-reactive protein and interleukin and depression symptoms which was consistent with the present study in depression symptoms but inconsistent with C-reactive protein (32). Gregg et al, Hayes et al. (2007) assessed the effectiveness and significance of ACT approach about the participants who learned therapy training based on acceptance and commitment and awareness about emotions related to diabetes, personal values related to diabetes and concentration on abilities for valuable actions during the experience of general health and did mental flexibility and mental health increase which was all consistent with the present study (33-35). According to the investigation, one can state that: ACT approach interventions are based on two main purposes of self- awareness and self-

cognition (excitement, thoughts, beliefs, values, five senses, and how mind performs) toward positive changes and adaptability and acceptance of events that cannot be changed (36). This approach can be used as an effective psychological intervention on life quality of type 2 diabetic patients (37) and improve their mental health (38). The effectiveness of ACT interventions was based on active to present, mindfulness, and acceptance in decrease of depression symptoms of diabetic patients and diseases management. Therefore, cognitive therapy combined with mental care has been effective in the recovery of this disease. This therapy method is a short-term and structured intervention and its purpose isn't to teach mental care thinking and change of thought content like traditional cognitive therapy, but also it wants to make an attitude or a relation different to thoughts, emotions, or feeling of change which includes keeping full and moment by moment concentration as well as having an attitude with acceptance and away from judgment (39). Therefore, the role of exercise and aerobic training according to the performed studies is bold as exercise could change attention from depression to hilarity, health, attitude change toward lifestyle and depression is the cause of lack of attention to self and physical activity and inactivity is the main cause of diabetes, exercises cause the recovery of depression and eventually recovery of diabetes.

The research findings about insulin sensitivity and C-reactive protein have shown that: ACT approach and AT couldn't show a significant effect alone compared to control group but the effect of combination of ACT with AT was significant in insulin sensitivity and from the view of laboratory results, clinical and intergroup observations had sensible and positive changes in the process of type 2 diabetic patients' recovery compared to control group. The reports of Banaei *et al.* (2014) study showed that C-reactive protein in both groups of training reduced and resistance to insulin increased but these changes weren't significant and the control group of any groups didn't have any significant differences which were consistent with this study (40). Nasiri *et al.* (2017) concluded that the amount of blood glucose and insulin resistance had a significant decrease after 8 weeks of combined training but the insulin amount didn't have a significant change. Explaining that this training was effective in prevention and regulation of blood glucose, and lipid profile

in type 2 diabetes (41). The study of Rahbar et al. (2020) pointed out that the combined aerobic and resistance training (AT with external load) for 8 weeks (24 sessions) could increase the satisfaction of diabetic therapy condition, diabetic care, insulin sensitivity increase and improvement of life quality compared to control group (42). Yousefipoor et al (2013) investigated the effects of 8-week sport activities on insulin indicator level, insulin resistance in their study and stated that sport training caused significant decrease in insulin indicator and fasting blood glucose in aerobic and combined group compared to control group (43). A study was done by Zamanpour et al. (2016) and its findings showed that there isn't a significant difference between the effect of sprint and combined training in insulin and CRP (44) which was consistent with the present study and this matter should be pointed out that exercise has a key role in insulin prevention and control, pre-diabetic conditions, gestational conditions, type 2 diabetes and health problems related to diabetes. AT improves insulin action and is effective in the management of blood glucose, blood fat, blood pressure and life quality. However, it has to be noted that to have all these benefits, exercise should be done regularly and continually. We can say in a general conclusion that: each of the mentioned methods in the study seems effective in the reduction of mental and physical symptoms in a positive way. But it seems that, the combined effect of both methods can have more effects in terms of statistics, laboratory and clinical observations in the process of diabetes reductions and its side effects, in a way that the participants of combined group have more motivation for therapy and changes in lifestyle and this is the distinctiveness of the combined effect.

It should be noted in the continuation of the discussion that, the present study had some limitations that we can mention some, for example this study was specific to type2 diabetic women and one should be careful about the generalization of findings to diabetic men and type 1 diabetes and the present study was for diabetic patients covered by the health centers of Tabriz Oil Company and it is necessary to be careful about the generalization of findings to other cities. And finally, the present study was for diabetic patients with the age range of 30-60 years old, therefore one should be careful in generalization of findings to patients out of this age range. At the end, suggestions for further studies are

proposed and it seems that: such study is also done in men statistic community and reach to other conclusions by comparing genders (in terms of the way of behavioral changes in mentioned approach in gender, the way of exercises in genders, motivation of following diabetes in gender). In the following studies, combination of other approaches (schema therapy, dialogue therapy) is also used. Such research in teenager range by identifying type 1 diabetes patients in lower age can improve the life of teenagers with type 1 diabetes as diabetes adverse effects can remain for many years, and in most cases they have to inject insulin and such therapy causes severe mental disorders. Such research is proposed and performed in the national and provincial diabetes association. The time of exercises is increased from 10 weeks to 12 or 15 weeks. The sample size should be selected more that won't have much effects if it falls.

5. Acknowledgement

We appreciate Northwest Health Organization of Oil Industry and Oil Company of East Azarbaijan province as well as all type 2 diabetic women who cooperated us in conducting the research.

Conflict of interest. The authors declare that there is no conflict of interest regarding this article.

References

1. Prevedini A B, Presti G, Rabitti E, Miselli G, Moderato P. Acceptance and Commitment Therapy (ACT): the foundation of the therapeutic model and an overview of its contribution to the treatment of patients with chronic physical diseases. *Giornale Italiano di Medicina del Lavoro ed Ergonomia Supplemento A, Psicologia* 2011; 33, 1: A53-A63.
2. Fondjo LA, Sakyi SA, Owiredu WKBA, Laing EF, Owiredu EW, Awusi EK, et al. Evaluating vitamin D status in pre-and postmenopausal type 2 diabetics and its association with glucose homeostasis. *Biomed Res Int* 2018; 2018: 1-12.
3. Li WP, Neradilek MB, Gu FS, Isquith DA, Sun ZJ, Wu X, et al. Pregnancy-associated plasma protein-A is a stronger predictor for

- adverse cardiovascular outcomes after acute coronary syndrome in type-2 diabetes mellitus. *Cardiovascul Diabetol* 2017; 16: 45.
4. Innes KE, Selfe TK. Yoga for adults with type 2 diabetes: A systematic review of controlled trials. *J Diabetes Res*; 2016; 8: 201-209.
 5. Mora S, Musunuru K, Blumenthal R S. The clinical utility of high-sensitivity C-reactive protein in cardiovascular disease and the potential implication of JUPITER on current practice guidelines. *Clin Chem* 2009; 55: 219-228.
 6. Pfoetzner A, Schondorf T, Hanefeld M, Forst T. High-sensitivity C-reactive protein predicts cardiovascular risk in diabetic and nondiabetic patients: Effects of insulin-sensitizing treatment with pioglitazone. *J Diabetes Sci Technol* 2010; 4: 706-716.
 7. Lee S, Park H, Kim Y, Kim H. High-sensitivity C-reactive protein can predict major adverse cardiovascular events in Korean patients with type 2 diabetes. *J Korean Med Sci* 2011; 26: 1322-1327.
 8. Vepsalainen T, Soinio M, Marniemi J, Lehto S, Juutilainen A, Laakso M & et al. Physical Activity, High-Sensitivity C-Reactive Protein, and Total and Cardiovascular Disease Mortality in Type 2 Diabetes. *Diabetes Care*. 2011 Jul;34(7):1492-6.
 9. Snoek FJ, Skinner TC. Psychological aspects of diabetes management. *Medicine*.2006, 34: 61-62.
 10. Pouwer F. Depression: a common and burdensome complication of diabetes that warrants the continued attention of clinicians, researchers and healthcare policy makers. *Diabetologia*. 2017.Jan 1;60(1):30-4.
 11. Gaynes BN, O'Donnell J, Nelson E, Heine A, Zinski A, Edwards M, McGuinness T, Riddhi MA, Montgomery C, Pence BW. Psychiatric comorbidity in depressed HIV-infected individuals: common and clinically consequential. *General hospital psychiatry*. 2015;37(4):277-82.
 12. Moulton CD, Pickup JC, Ismail K. The link between depression and diabetes: the search for shared mechanisms. *The Lancet Diabetes & Endocrinology*. 2015;3(6):461-71.

13. Semenkovich K, Brown ME, Svrakic DM, Lustman PJ. Depression in type 2 diabetes mellitus: prevalence, impact, and treatment. *Drugs*. 2015;75(6):577-87.
14. Schmitt A, Reimer A, Hermanns N, Kulzer B, Ehrmann D, Krichbaum M, Huber J, Haak T. Depression is linked to hyperglycaemia via suboptimal diabetes self-management: a cross-sectional mediation analysis. *Journal of psychosomatic research*. 2017;94:17-23.
15. Jaeger J, Tatsuoka C, Berns S, Varadi F, Czobor P, Uzelac S. Associating functional recovery with neurocognitive profiles identified using partially ordered classification models. *Schizophrenia research*. 2006 ;85(1-3):40-8.
16. Naismith SL, Redoblado-Hodge MA, Lewis SJ, Scott EM, Hickie IB. Cognitive training in affective disorders improves memory: a preliminary study using the NEAR approach. *Journal of Affective Disorders*. 2010; 121(3):258-62.
17. Blazer DG, Moody-Ayers S, Craft-Morgan J, Burchett B. Depression in diabetes and obesity: racial/ethnic/gender issues in older adults. *Journal of psychosomatic research*. 2002 ;53(4):913-6.
18. Steven C. Hayes & Kirk D. Stroahl. *A practical Guide to Acceptance and Commitment Therapy* .Translaed by: A.Khamseh. 2017 . Published, Arjomand.
19. Paul E. Flaxman, J.T. Blackledge, Frank W. Bond. *Acceptance and Commitment Therapy : distinctive features*. Translated by : M. Mirzaie, S. Nonahal.2011.
20. Roberts CK, Hevener AL, Barnard RJ. Metabolic syndrome and insulin resistance: underlying causes and modification by exercise training. *Comprehensive Physiology*. 2013;3(1):1-58.
21. Mottola MF, Ruchat S-M. Exercise guidelines for women with gestational diabetes. *Gestational Diabetes: IntechOpen*; 2011: pp. 339–62.
22. Beck AT, Ward CH, Mendelson M, Mock J, Erbaugh J. An inventory for measuring depression. *Arch General Psychiatr* 1961; 4: 561-571.

23. Matthew M, Patrick F, Avigail L & Michelle S. The Interprtsional Problems Workbook. Translaed by: H. Hamidpour , A minas Mirzabeig.2017 .Publications: Arjmand. second edition.
24. Matthews DR, Hosker JP, Rudenski AS, Naylor BA, Treacher DF, Turner RC.Homeostasis model assessment: insulin resistance and B-cell function from fasting plasma glucose and insulin concentrations in man. *Diabetologia*. 2004; 30: 412-9.
25. Katz A, Nambi SS, Mather K, et al. Quantitative insulin sensitivity check index: A simple, accurate method for assessing insulin sensitivity in humans. *J Clin Endocrinol Metab*. 2000; 85: 2402-10.
26. Ghaedrahmati A, Jabalameli S. Effect of Acceptance and Commitment Therapy on the Quality of Life and Physical Indices of Patients with Diabetes. *J Diabetes Nurs*. 2019; 7 (4) :915-928.
27. Gilani SR,Feizabad AK.The effects of aerobic exercise training on mental health and self-esteem of type 2 diabetes mellitus patients. *Health Psychol Res* 2019; 7.
28. Bridle C, Spanjers K, Patel S, Atherton NM, Lamb SE. Effect of exercise on depression severity in older people: systematicreview and meta-analysis of randomised controlled trials. *Br J Psychiatry* 2012; 201: 180-185.
29. Sanagoye Moharer GH, Mirshekari H R, Saberian L Mir Sharafodin A. The Effect of Mindfulness-Based Cognitive Therapy (MBCT) on Depression, Cognitive flexibility among in Diabetic Patients .*Medical Jornal of Mashhad University of Medical Sciences Vol.62, Special Issue, P: 699-711. Jan-Feb 2020.*
30. Hor M, Aghaei A, Abedi A, Attari A. The effectiveness of acceptance and commitment therapy on depression in patients with type 2 diabetes. *J Res Behav Sci* 2013; 11(2): 121-8.
31. Vala M, Razmandeh R, Rambod K, Nasli Esfahani E, Ghodsi Ghasemabadi R. Mindfulness-based Stress Reduction Group Training Depression, Anxiety, Stress, Self-confidence and Hemoglobin A1c in Young Women with Type 2 Diabetes. *Iranian Journal of Endocrinology and Metabolism*. Vol 17 No.5 December- Jaunary 2015.

32. Herder C, Schmitt A, Budden F, Reimer A, Kulzer B, Haak T, et al. Association between pro- and anti-inflammatory cytokines and depressive symptoms in patients with diabetes—potential differences by diabetes type and depression scores. *Translational Psychiatry*. 2017, 7:1. DOI 10.1038/s41398-017-0009-2.
33. Gregg J, Callaghan G & Hayes S. Improving Diabetes Self-Management Through Acceptance, Mindfulness, and Values: A Randomized Controlled Trial, *Journal of Consulting and Clinical Psychology*. 2007; 75(2): 336–343.
34. Hayes SC, Gregg J & Callaghan G. Acceptance and Commitment Therapy for Diabetes Self-management Therapist Manual. *Journal of consulting Clinical Psychology*. 2007; 75(2):357-68.
35. Hayes SC, Luoma JB, Bond FW, Masuda A & Lillis J. Acceptance and commitment therapy: Model, processes and outcomes. *Behavior Research and Therapy*. 2006; 44: 1–25.
36. Matthew M, Patrick F, Avigail L & Michelle S. *The Interprtsional Problems Workbook*. Translaed by: H. Hamidpour, A minas Mirzabeig. 2017 .Publications: Arjmand. second edition.
37. Fathiahmadsaraei N, Neshat Doost T, Manshaee G.R & Nadi M.A. The Effectiveness of Acceptance and Commitment Therapy on Quality of Life among Patients with Type 2 Diabetes. *Iran J Health Educe Health Promote*. 2016;4(1):31-39. In Persian.
38. Hor M & Manshaee GR. Effective of Acceptance and Commitment Therapy on mental health of the patients with Typ2 Diabetes in the city of Isfahan. *Iranian Journal of Diabetes and Metabolism*. 2017; Vol.16, No 6.
39. Zettle R. Acceptance and commitment therapy vs. systematic desensitization in treatment of mathematics anxiety. *The Psychological Record* 2003; 53(2): 197-215.
40. Banaei P, Tadibi V, Rahimi M . Comparing the effect of two protocols concurrent training (strength-aerobic) on fasting blood glucose, glycosylated hemoglobin, high-sensitivity C - reactive protein and insulin resistance in women with type 2 diabetes. Vol.25, Special Issue, P:99-108. 2014. In Persian.

41. Nasiri S, Banitalebi E , Faramarzi M & Rabiei V. Study of blood sugar and lipid profile changes after eight weeks of combined training in women with type 2 diabetes. *Journal of Jiroft University of Medical Sciences*. 2017; 3(2): 114-24. In Persian.
42. Rahbar S ,Sadat Naimi S,Radinmehr H. Improving the quality of life after 8 weeks aerobic exercise with external load in patients with type 2 diabetes. *Volume 22, Issue 4 (Autumn 2020)*, 696 – 703. In Persian.
43. Yousefipoor P, Tadibi V, Behpoor N, Parnow A, Delbari M & Rashidi S. The Effect of 8-week Aerobic and Concurrent (aerobic-resistance) Exercise Training on Serum IL-6 Levels and Insulin Resistance in Type 2 Diabetic Patients. *J Shahid Sadoughi Univ Med Sci* .2013; 21(5): 619-31. In Persian.
44. Zamanpour L, Banitalebi E, Amirhosseini S E. The effect of sprint training and combined aerobic and strength training on some inflammatory markers and insulin resistance in women with diabetes mellitus (T2dm). *IJDLD* 2016; 15: 300-311.

