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ORIGINAL ARTICLE

Effect of Exercise on Psychological Well-being in T2DM

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Background: Type 2 diabetic patients (T2DM) experience health problems including psychiatric and psychological complications that influence their general health. Since exercise has an additional effect on psychological improvement, we aimed to establish the role of exercise as improvement of psychological problems. Methods: 80 subjects with T2DM were assigned to take exercise for 90 minutes per session, 3 times a week for a period of 4 months. They answered the GHQ-12 questionnaire before and after the study project.

Results: Questionnaires were scored by Likert model and entered the statistical analysis. Our findings demonstrate a significant decrease in the mean GHQ-12 scores. [13.39 ± 5.89 to 8.52 ± 5.12 ($p < 0.001$)]. Factor analysis by Graetz's three-factor model suggests that factor I (anxiety and depression) associates with more improvement than the other factors.

Conclusion: Exercise improves psychological distress inT2DM and results in improved well-being.

Key words: T2DM, exercise, psychological well-being, GHQ-12, mental health

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Type 2 diabetes Mellitus (T2DM) is a chronic disorder, which is characterized by hyperglycemia and glycosuria. High concentration of blood glucose can cause structural damages including macrovascular events in the heart and blood vessels as well as microvascular complications including retinopathy, nephropathy, and neuropathy, which can finally lead to blindness, kidney failure, foot ulcers, gangrene, and erectile impotence (Albright, 2000; Schram et al, 2009).

Complications of chronic disorders such as diabetes may damage quality of life (Singh & Bradley, 2006). Furthermore, compared to the general population, the prevalence of psychological disorders such as depression and anxiety are higher among diabetic patients. The negative impacts of

emotional problems of the quality of life include poor medical outcomes such as decreased adherence to medication, impaired self-care behaviors or glycemic control, risk of cardiovascular complications, increased rate of mortality, and high costs (Koopmans et al, 2009; Pouwer, 2009, p.670; Egede, 2005).

Several studies have shown that the quality of life in diabetic patients is decreased as compared to healthy persons because their daily life can involve many restrictions, which may affect their mood, mental health, physical, and social function (Schram et al, 2009).

Ali and Barnard (as cited in Schram et al., 2009) expressed that "Individuals with diabetes have a two-fold increased risk for depression, affecting approximately one in every five diabetes patients". Depression is a leading cause of disability, work place absenteeism, lost productivity (Egede, 2005).

Anxiety and diabetes- specific distress (for example not accepting diabetes, worries about complications, concerns about food, feeling of guilt or shame, and distressing social interactions are also common (Pouwer, 2009, p. 666). Self-confidence, family life, and even general perceptions of health, and pain are negatively impacted by diabetes (Nizami et al, 2005; Singh & Bradley, 2006).

Physical inactivity could be a behavioral factor linking depression and poor T2DM outcomes (Pouwer, 2009, p.666).

In order to reduce the risk of late complications of diabetes, permanent changes in lifestyle and lifelong multipharmacological treatment are needed. American Diabetes Association (ADA) has recommendations about the assessment of psychological and social situation as part of the medical management of diabetes. It also offers screening for psychological problems such as depression, anxiety, eating disorders, and cognitive impairment. ADA notes that emotional well-being is part of diabetes management (ADA, 2009). According to US Department of Health and Human Services, regular physical activity as a non-pharmacological intervention leads to multiple physiological and psychological benefits that can improve glycemic control, overall health, and quality of life (Hayes et al, 2007, p. 37)

Salmon (as cited in Zacker, 2004) states the following:

> Exercise has long been recognized as an essential component of diabetes management. It appears to foster psychological well-being through the provision of three main benefits: 1) antidepressant effects, 2) anxiolytic effects, and 3) increased resilience to stress. (p.142)

Several theories have been supposed about the mechanisms of which exercise improve mental health. One theory involves the production of endorphins. These natural opiates are chemically similar to morphine and have "pain-relief" effect. Exercise leads to a β-endorphin surge into the blood stream to provide post-exercise mood elevations. In animal studies, it has been found that exercise increases levels of serotonin, dopamine, and norepinephrine, which are associated with elevated mood. Recently, enhanced activities in the brain lobes and the hippocampus as well as increased levels of "brain-derived neurotrophic factor (BDNF)" have been purposed. BDNF is thought to improve mood (Koehl et al, 2008). On the other hand, exercise ameliorates many of the known vascular risk factors by positive effects on blood pressure, LDL cholesterol, HDL cholesterol, triglycerides, and HbA_{1c} levels. Exercise appears to aid in the loss of weight and visceral fat. The results are the better glycemic control and improved quality of life (Albright, 2000).

According to Greist (as cited in Zacker, 2004), "the first research on the link between exercise and

emotional health was begun in the late 1970s, with an investigation made into running and depression". During the last few years, an increasing interest has been observed towards the impact of diabetes on patient's well-being because they must deal with their disease every day. Therefore, several validated measures have been used to assess the satisfaction of patients with the treatment programming and their quality of life. These measures, which are performed by using different questionnaires, have demonstrated that improved glycemic control could improve the patient's well-being status (Milenkovic et al, 2004).

The General Health Questionnaire-12 (GHQ-12), a self-assessing and screening instrument, and a measure of current mental health is one of the best psychological well-being measures to detect psychiatric disorders in the general population and within community or non-psychiatric clinical settings such as primary care or general medical outpatients. It was developed by Goldberg in 1970s, and was originally developed as a 60-item instrument but altered as versions like GHQ-30, GHQ-28, GHQ-20, and the GHQ-12.

This questionnaire assesses the respondent's current state and asks whether it differs from his or her usual state (Nizami et al, 2005). This self-administered questionnaire focuses on two major areas- the inability to carry out normal functions and the appearance of new and distressing psychological phenomena.

The GHQ-12 questionnaire has been known as a valid instrument in primary care settings beside the other instruments such as GHQ-20, STAI, PSS, CHADS, WHO-QOL… (Nizami et al, 2005; Surwit et al, 2002).

In the present study, we have evaluated the effect of exercise training on psychological well-being and general health in T2DM patients by using the GHQ-12 questionnaire. We found no similar studies in literature, which have previously been performed. However, the GHQ-12 has been used for the assessment of many other conditions in diabetic patients (Nizami et al, 2005).

METHODS

Participants

Our study included 80 patients with type II diabetes by the age of 34-70 years, which were registered through hospitals of Tabriz University of Medical Sciences. They were selected according to certain criteria, such as diagnosed type II diabetes for more than one year; $HbA_{1c} \geq 6.5$, taking oral hypoglycemic agents without insulin therapy, age$\leq$70 years, and having no sever diabetic complication or history of cancer and cerebrovascular incidents. Baseline characteristics and their changes are shown in Table 1.

Instrument

The GHQ-12 that has been adapted to many cultures and languages was used in our study. It has been used over the world and its numerous versions exist in different number of languages (i.e. Persian language). It has been studied within various populations and has been validated in different nations (Makikangas et al, 2006; Montazeri et al, 2003, Discussion section, para.1; Ozdemir & Rezaki, 2007; Sanchez-Lopez & Dresch, 2008; Tait et al, 2003).

Each item of the GHQ-12 is rated on a four-point scale and there are four scoring methods including:

Likert method (a total score ranging from 0 to 36), Modified Likert scoring (that yields a total score from 0 to 24), GHQ method or bimodal method, and C-GHQ method (both methods give a total score 0 to 12) (Montazeri et al, 2003, Background section, para.1; Hankins, 2008, Background section, para. 5). In all methods, higher scores indicate worse conditions (Gao et al, 2004; Hankins, 2008, Discussion section, para.1; Sanchez-Lopez & Dresch, 2008).

Table 1. Baseline characteristics and after intervention changes.

Changes	Baseline Characteristics	After intervention
Sex (M/F) %	**44.77/55.22**	-
Age (y)	51.56 ± 8.51	-
Duration of diabetes (y)	6.07 ± 2.56	-
Anti diabetes medications:		
● Metformin	**6** *	**9**
● Glibenclamid	**3**	**4**
● Acarbose	**56**	**52**
● Metaformin		
Metformin + Clibenclamid + Acarbose	**2**	**2**
Hemoglobin A1c %	8.16 ± 1.06	7.35 ± 1.07
Fasting Blood glucose (mg/dl)	157.63 ± 36.04	132.45 ± 32.68
Body mass index (kg/m^2)	30.66 ± 4.48	29.68 ± 4.34
Systolic Blood Pressure (mmHg)	130.67 ± 16.28	122.98 ± 14.53
Diabetes blood pressure (mmHg)	79.77 ± 10.39	75.44 ± 8.02

$P< 0.0001$

** The values that are not made bold present M ± SD*

While the longer versions of GHQ are normally considered multidimensional, the GHQ-12 is sometimes regarded as a unidimensional measuring of psychological health. However, several authors have revealed at least two factors (Vanheule & Bogaerts, 2005).

The proposed 3-factor model by Graetz is one of the commonly used methods, which was used in this study. Several studies have found that the Graetz's 3-factor model gives goodness-of-fit than the others (Gao et al, 2008). Its validity and reliability have been found in Persian version by Montazeri et al (2003).

Procedure

After a two-week run-in phase of exercise test, 80 subjects were randomly divided into different types of aerobic, non-aerobic, and combination training groups. Training programs were performed three times a week in 90 minutes per session for a period of 4 months under the supervision of professional trainers. All types of exercise training progressed gradually in intensity and duration at 60 % to 75 % of maximum heart rate and from 15 to 60 minutes respectively.

The aerobic exercise was performed using treadmill, fixed bicycle, and eleptical ergometers and the resistance training was performed by weight machines. Furthermore, the combined exercise training included both the aerobic plus resistance training programs.

Before the interview and doing the trainings, all patients were informed about the study design. They were received a questionnaire both before and after the procedure of this study.

During the study, 13 subjects were dropped out due to adverse events, changing the therapy method

or inadequate number of training sessions, and finally 67 subjects entered the analysis process.

Statistical analysis:

Statistical analysis was done using SPSS. (16.0). The results were evaluated statistically significant by a two-tailed p value< 0.05. Furthermore, the data are shown as mean ± standard deviation.

RESULTS

The participants answered the questionnaire in two times, before and after the program. Due to the short form of the questionnaire, our subjects spent a short time to answer the questions.

Each item has four answer choices and we scored the questionnaire using a 4-point Likert-type scale from 0 to 3 that seems to produce a wider, smoother, and more acceptable distribution of scores for a parametric analysis (Sanchez-Lopez & Dresch, 2008). This method generates a total score ranging from 0 to 36 with high scores show worse health condition and the most negative mood state. Then the statistical analysis was performed using SPSS version 16.0

Descriptive statistics suggests a mean GHQ-12 score of 13.39±5.89 ($p<0.001$) for the pre-intervention state of participants and a mean score of 8.52±5.12 ($p<0.001$) for their post-intervention mood state. The mean difference was -4.86±3.96.

In the present study, it was observed that women had mean scores of 14.05±5.75 and 9.54±5.54 respectively before and after the exercise program. The order of these scores for men was 12.56±6.06 and 7.26±4.31 respectively.

Furthermore, it was revealed that the p-value of the difference between both genders was not statistically meaningful, however both pre-test and post-test scores for the men were less than the women were (Table 2). In this study, the calculated value of Cronbach's alpha coefficient was 0.88.

Table 2: Gender Differences in Mean Scores

	N	*M*	SD	Mean Difference *M*	Mean Difference SD	*t*
Pre-test Total	67	13.38	5.89	- 4.86	3.96	10.05
Post-test Total	67	8.52	5.12			
Pre-test Women	37	14.05	5.75	- 4.51	3.33	8.24
Post-test Women	37	9.54	5.54			
Pre-test Men	30	12.56	6.06	-5.30	4.05	6.23
Post-test Men	30	7.26	4.31			

P< 0/001

For factor analysis, we used the current 3-factor model proposed by Graetz that includes:

- Anxiety and depression (factor I, 4 items),
- Social dysfunction (factor II, 6 items) and;
- Loss of confidence (factor III, 2 items).

We evaluated the mean scores of each factorial dimension before and after the correlation of paired samples. Of total 36 scores, related scores of the three factors are 12, 18, and 6 respectively. In this way, the generated data in the present study is shown in Table 3.

Table 3: Data Based on Graetz 3-Factor Model of Factor Analysis

Dimension	Related Scores	Pre-test		Post-test		Mean of Difference		t
		M	SD	*M*	SD	*M*	SD	
Factor I	12	4.95	2.39	3.04	2.32	- 1.91	1.60	9.75
Factor II	18	7.14	2.72	4.65	2.75	- 2.49	2.18	9.34
Factor III	6	1.47	1.37	0.85	0.97	-1.64	1.06	4.91

P< 0/001

Comparing the other two dimensions, factor I points were more affected by this intervention and its average score was significantly decreased at the second questionnaire. However, we observed the lowest change in the mean score to the third factor. The gender-related differential data in these factors revealed a similar order of reductions in mean scores for women, whereas the men showed the highest difference in factor III and the second factor demonstrated the lowest change in mean score.

DISCUSSION

Depression in T2DM is associated with impaired diabetes self-care behaviors (Pouwer, 2009, p.670). Even depression may be a barrier to exercise initiation (Vickers et al, 2006). Physical activity affords significant acute and chronic benefits for patients with type 2 diabetes. The chronic benefits are more numerous than acute effects, emphasizing the need for regular exercise for these patients. (Albright, 2000, p.1354).

Regular physical exercise as an alternative treatment for stress motivates people to adopt better lifestyle habits (Antunes et al, 2005).

Exercise as different types (aerobic, resistance, or combined form) acts as a therapeutic tool to ameliorate the emotional problems of diabetic through physiological and psychological mechanisms. Regular physical activity improves glycemic control through increased insulin sensitivity and improved glucose tolerance, changed lipid profile, and improved cardiovascular risk factors. Psychological alterations include adherence better to medication or diet regimens as well as changed lifestyle. These alterations will cause a reduction in the long-term complications of diabetes, delayed progression of existing problems, finally elevated mood, and enhanced quality of life (Albright, 2000; Hayes et al, 2007).

The main question of our study was the effectiveness of exercise on the improved quality of life among T2DM patients that their meaningful reduced mean scores after the intervention confirmed this opinion. Therefore, we used the Persian version of the GHQ-12, for the assessment of exercise effects on quality of life in these patients.

Although other questionnaires have been used to evaluate the effect of exercise on type 2 diabetic patients' well-being, using literature search we found no previously published studies that have used the 12-item GHQ for this aim. Our results confirm the findings of researches that have used other questionnaires as instruments for assessing. For example, Kucukurslan et al (2009) obtained improvement in the SF-36 mental component scores after an exercise program including resistance training and home-based walking in diabetic

patients. In another study that SF-36 and WBQ-12 questionnaires were used for measuring mental health, it was shown that the aerobic, resistance exercise or both have significant effect on well-being status, while, resistance exercise was better than aerobic or no exercise for improving physical health status (Reid et al, 2010).

Our results confirm the findings of previous researchers such as Surwit et al (2002) indicating that "stress management can improve glycemic control", they also support the data obtained by Albright (2000) found that "exercise can play a role in reducing stress". Furthermore, the results of the present study are in line with the data suggested by Zacker (2004), Arora, Shenoy, and Sandhu (2009), who used the questionnaire of Bradley & Lewis and showed that general well-being was improved in type 2 diabetes after 8-week supervised exercise training. In addition, they are the same as the study of Praet and van Loon (2007) that have focused on the benefits of various types of exercise to improve the psychological problems and general well-being in diabetes or Martyn-Nemeth, Vitale, and Cowger (2010), who demonstrated an improvement in psychological parameters by a culturally focused exercise program in these patients.

Besides, our study is consistent with the study of El-Rufaie with coauthors who revealed the presence of psychiatric disorders among type 2 diabetic patients by using the GHQ-12; however, their aim was not examining the link between psychological morbidity and exercise (El-Rafaie et al, 1999).

In the present study, Cronbach's alpha coefficient was 0.88, similar to the obtained result by Montazeri with coauthors (0.87), which was the first confirmatory study of general population in Iran.

We observed no difference between genders in the p-value of mean scores; however, male patients obtained lower scores in both times of answering the questionnaire. This suggests that compared to the women, men have lower problems and this pattern is similar to the general population; that is women are more likely than men to have a high GHQ-12 score (Ozdemir & Rezaki, 2007; Purdon & Eren, 1995, Chapter 12).

However it is noteworthy that based on the available evidence different models of GHQ-12 dimensional analysis may show several factors across various samples or among different versions and since our aim was not the evaluation of confirmatory factor analysis, so we chose the current model of Graetz for the interpretation of our findings.

Factor analysis in this research revealed that the highest improvement was obtained in the anxiety-depression factor that has been recognized as a common co-occurrence diabetic complication. All of the patients showed less improvement in the confidence factor. After adjustment of the triple factors, they were compared with each other and meaningful mean differences were observed between "FI-FIII" and "FII-FIII". Where as the difference of the mean changes between "FI-FII" was statistically meaningless. Therefore, it suggests that comparing with the other factors; the confidence dimension has shown the least changes.

The order of changes in women was similar to overall changes (i.e. FI > FII > FIII), whereas the changes of those factors in the male group had another trend (i.e. FIII > FI> FII). In other words, the confidence factor showed much more improvement in men.

In the present study, although we did not focus on social, education, and economic classes, we observed the high prevalence of the first factor (anxiety-depression) in women. This could be contributed to their occupational state, because most of them were housekeeper. This parameter plus illiteracy or low grade of education level in this group not only can result in worse psychological symptoms of diabetes, but also lead to their unawareness about the disease, denial reactions, and the most limited social communication.

As expected, after the study design, the exercise-adherence was significantly increased in women and considerable number of them as well as the men continued their exercise programs. Furthermore, there was not a mean score of the GHQ-12 for the identification of depression and the other aspects of well-being through Likert scoring in Iranian population that could be compared with diabetic population in our study; however, significant improvement was found in these individuals as compared with their pre-test states.

The other issue was that we did not include the effects of various types of exercise such as aerobic, anaerobic, and combined trainings on the GHQ-12 scores separately.

CONCLUSION

The effect of various types of exercise activity on reduced glucose levels in T2DM patients is well known, but limited studies have been carried out on the psychological aspects of diabetes and its relation with exercise trainings in these patients especially using GHQ versions. Our results suggest that the GHQ-12 scores are significantly reduced after a 4-month exercise program indicating an improvement in mental health disorders.

In conclusion, our findings demonstrate that exercise program improves psychological distress including anxiety and depression in type 2 diabetic patients and results in the improved quality of life, well-being, and finally better glycemic control in these patients. Thus, exercise could be considered as a justifiable public-health approach and interventions such as life style changes using exercise and diet will have important roles in long-lasting management of disease. However, it is better to begin exercise training just now!

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