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Effect of Mindfulness Meditation and Aerobic Exercise on Serum Cortisol Levels in Type 2 Diabetic Patients

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Abstract

Background: Diabetes is a fast-growing health problem in Egypt with a significant impact on morbidity, mortality, and health care resources. While increasing physical activity is an essential component of all effective lifestyle-based trials for the prevention of type 2 DM. Psychological stress has been linked to the development of type 2 diabetes. Plenty of studies have shown that meditative movements are effective for glucose control in patients with type 2 diabetes.

Aim of Study: To compare the effect of mindfulness meditation and aerobic exercises on serum cortisol levels in type 2 diabetic patients.

Subjects and Methods: Sixty, types 2 diabetic patients for more than 5 years (29 women and 31 men) were selected from the Faculty of Physical Therapy Outpatient Clinic, Cairo University. Their ages ranged from forty to fifty years. Serum cortisol a.m. and fasting blood glucose tests were done before the start of the study and after 6 weeks. The patients were randomly assigned into two equal groups in number (30 patients for each group). Group A received aerobic exercise in the form of walking on a treadmill and mindfulness meditation for 20mins and group B received continuous aerobic exercise only in the form of walking on a treadmill The exercise program including 45 minutes and consist of the warming up phase of slow walking on the treadmill for 5 minutes, training phase 35 minutes, and cooling down for 5 minutes. And it was done three days per week for 6 weeks.

Results:

- Within-group comparison:

The percent of the decrease in cortisol level and fasting blood glucose of group A was 30.29% and 14.54% respectively and that of group B was 20.37 and 9.83% respectively.

- Between groups comparison:

Comparison between groups post-treatment revealed a significant decrease in cortisol level and fasting blood glucose of group A compared with that of group B (p<0.01).

Conclusion: The combination model between mindfulness meditation and aerobic exercise is more effective in decreasing serum cortisol levels and fasting blood glucose.

Key Words: *Diabetes mellitus – Serum cortisol – Meditation – Mindfulness – Aerobic exercise.*

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Introduction

DIABETES is a complex, chronic illness requiring continuous medical care with multifactorial risk-reduction strategies beyond glycemic control. Ongoing diabetes self-management education and support are critical to preventing acute complications and reducing the risk of long-term complications. Significant evidence exists that supports a range of interventions to improve diabetes outcomes **[1]**.

About 422 million people worldwide have diabetes. Deaths from diabetes increased by 70% globally between 2000 and 2019, with an 80% rise in deaths among males **[2]**.

Most people with T2D know the importance of exercising regularly, eating a healthy diet, and getting plenty of rest. “But stress relief is a crucial and often forgotten component of diabetes management **[3]**.

Cortisol hormone has an effective way to adjust the glucose level in diabetic patients. Cortisol secretion has been observed to be higher in people with diabetes than healthy subjects **[4]**.

Meditation interventions were shown to significantly affect changing cortisol levels assessed from blood samples. meditation interventions are most beneficial for at-risk populations. These interventions might provide people with strategies of stress management that can contribute to well-being **[5]**.

The core components of meditation practice include focused attention, self-regulation of emotions, and self-awareness [6]. Mindfulness meditation refers to the state of awareness that arises through paying attention, on purpose, in the present momentjudgmentally [7].

Physical activity can reduce the risk of T2DM, only 150 minutes of moderate aerobic exercise per week can be observed to reduce the risk, and/or at least 90 minutes of vigorous aerobic exercise per week Aerobic exercise, which means 30 minutes of moderate exercise every day. Help reduce the risk of DM2. Regular exercise can improve blood sugar control in all forms of diabetes. Insulin resistance is the main cause of hyperglycemia in type diabetes, physical exercise is the best way to reduce insulin resistance [8].

Patients and Methods

I- *Patients:*

Sixty, type 2 diabetic patients (29 women and 31 men) were included in this study. They were selected from outpatient clinics at the Faculty of Physical Therapy Cairo University. From April 2021 to August 2021 the study was conducted at outpatient clinics at the Faculty of Physical Therapy, Cairo University.

An informed consent form was taken from every patient.

Ethical consideration: The Ethics Committee of Faculty of Physical Therapy, Cairo University, Egypt n (P.T.REC/012/003210) reviewed and approved this study.

All the patients performed continuous aerobic exercises in the form of a treadmill exercise program.

Study design: Comparative study. All participants were assigned randomly into two equal groups in numbers.

Patients were chosen under the following criteria: Sixty diabetic patients (31 men and 29 women), their age between 40 and 50 years old they had type 2 diabetes mellitus for more than 5 years. Their HbA1c value from 6.5% to 7.5%. Stress scores on the Perceived stress scale are >13 in the eligibility check assessment. All patients are under full medical supervision. Their physical activity level is less than 30 minutes of aerobic training in the week. Their body mass index ranged from 25 to 34.9. (overweight and obesity class I).

Patients with one of the following criteria were excluded from the study: Unstable medical condition and sleeping disorder. Indication of receiving treatments for depression and anxiety. Musculoskeletal or neurological conditions that might interfere with the execution or the assessment of the exercise.Cushing's disease (hypercortisolism) or Addison's disease (hypocortisolism). Hepatic diseases and dyslipidemia. Patients with renal diseases and arterial stenosis. Severe hypertensive patients (higher than 200/120mmHg). Any acute or chronic inflammatory disorder.

II- *Instrumentations:*

A- *Evaluative equipment:*

- Weight and height scale (ZT-120 Health scale, china) was used to measure the weight and height of each patient to determine their Body Mass Index.
- Lab analysis: All the patients were subjected to complete clinical evaluation (including careful history taking vital signs, and fasting blood glucose and serum cortisol a.m. were measured before starting the program and after 6 weeks (after completing the training program).
- All patients received a complete explanation of the objectives and procedures of the study.

B- *Treatment equipment and tools:* Sponeta treadmill k S 11080801-1 with serial number: 2168 B10 S D.

III- *Treatment:*

Group (A): Consisted of 30 patients who received aerobic exercise in the form of continuous walking on a treadmill with the rate of perceived exertion (13-15) on the Borg Scale. The total duration was about 45 minutes and consisted of the warming up phase of slow walking on the treadmill for 5 minutes, the training phase 35 minutes, and cooling down for 5 minutes. And it was done three days per week for 6 weeks [8]. Then they also received mindfulness meditation for 20 minutes, they were instructed to come on empty stomachs, wearing clean, simple, and loose clothing. They were made to sit comfortably and allowed to relax for about 5min. This was to allay any apprehension associated with the class. To ensure free and fresh ventilation, the temperature was maintained on all days between 16 °C and 20° C. The room was clean, noise-free, and dimly lit. Meditation technique was demonstrated each day for the first few days until they had learned the technique perfectly; Subsequently, they followed the procedure themselves. Special emphasis was

laid on breathing techniques practiced by each patient individually [9].

Mindfulness-based intervention (MBI):

The MBI was an adaptation of the mindfulness-based Stress Release Program. The training approach can be summarized in two modules includes (1) Attention monitoring, and (2) Acceptance. The formal practice of meditation involved activities that required sustained focused attention meditation towards a focus object (i.e., breath, body, sound, or thoughts) [10].

Group (B): Consisted of 30 patients who received aerobic exercise only in the form of walking on a treadmill with the rate of perceived exertion (13-15) on the Borg Scale. The total duration was about 45 minutes and consisted of the warming up phase of slow walking on the treadmill for 5 minutes, training phase 35 minutes, and cooling down for 5 minutes. And it was done three days per week for 6 weeks.

Statistical analysis:

Subject characteristics were compared between groups by unpaired *t*-test for numerical data and by chi-squared test for categorical data. The normal distribution of data was checked using the Shapiro-Wilk test. Levene's test for homogeneity of variances was conducted to test the homogeneity between groups. Unpaired *t*-test was conducted to compare the mean values cortisol level and fasting blood glucose between the group A and B. Paired *t*-test was conducted for comparison between pre and post-treatment in each group. The level of significance for all statistical tests was set at $p<0.05$. All statistical analysis was conducted through the statistical package for social studies (SPSS) version 25 for Windows (IBM SPSS, Chicago, IL, USA).

Results

Subject characteristics:

Table (1) showed the subject characteristics of the group A and B. There was no significant difference between groups in age, BMI, stress score, HbA1C, and sex distribution ($p>0.05$).

Table (1): Basic characteristics of participants.

	Group A	Group B	*p*-value
Age (years)	45.06±3.19	46.23±2.75	0.13
BMI (kg/m^2)	30±3.06	30.17±2.15	0.79
Stress score	22.7±2.73	22.9±2.27	0.75
HbA1C	6.89±0.34	7±0.3	0.19
Sex, n (%):			
Females	15 (50%)	14 (47%)	0.79
Males	15 (50%)	16 (53%)	

SD: Standard deviation. *p*-value: A probability value.

Effect of treatment on cortisol level and fasting blood glucose:

- Within-group comparison:

There was a significant decrease in cortisol level and fasting blood glucose of group A and B post-treatment compared with that pre-treatment ($p>0.001$). The percent of the decrease in cortisol level and fasting blood glucose of group A was 30.29% and 14.54% respectively and that of group B was 20.37 and 9.83% respectively (Table 2).

- Between groups comparison:

There was no significant difference between groups pre-treatment ($p>0.05$). Comparison between groups post-treatment revealed a significant decrease in cortisol level and fasting blood glucose of group A compared with that of group B ($p<0.01$). (Table 2).

Table (2): Mean cortisol level and fasting blood glucose pre and post-treatment of the group A and B.

	Group A Mean ± SD	Group B Mean ± SD	MD	*t*-value	*p*-value
Cortisol (mcg/dl):					
Pre-treatment	18.09±3.07	17.92±3.32	0.17	0.2	**0.84**
Post-treatment	12.61±2.15	14.27±2.89	–1.66	–2.51	**0.01**
MD	5.48	3.65			
% of change	30.29	20.37			
t-value	10.1	8.24			
	***p*=0.001**	***p*=0.001**			
Fasting blood glucose (mg/dl):					
Pre-treatment	160.3±8.79	158.66±10.41	1.64	0.65	**0.51**
Post-treatment	137±5.36	143.06±7.33	–6.06	–3.65	**0.001**
MD	23.3	15.6			
% of change	14.54	9.83			
t-value	17.67	13.17			
	***p*=0.001**	***p*=0.001**			

SD : Standard deviation.
MD: Mean difference.
p-value: A probability value.

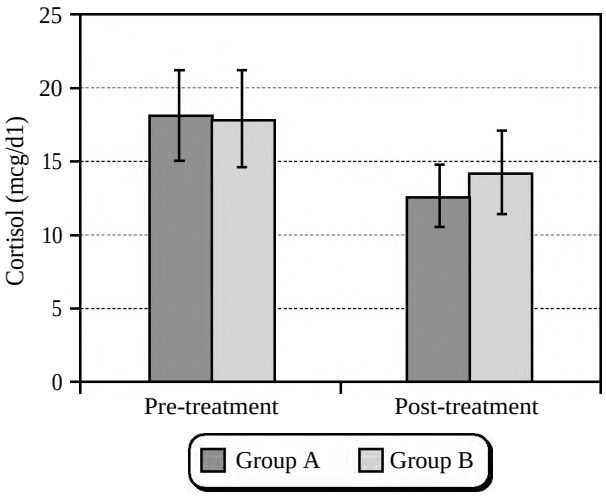

Fig. (1): Mean cortisol level pre and post-treatment of the group A and B.

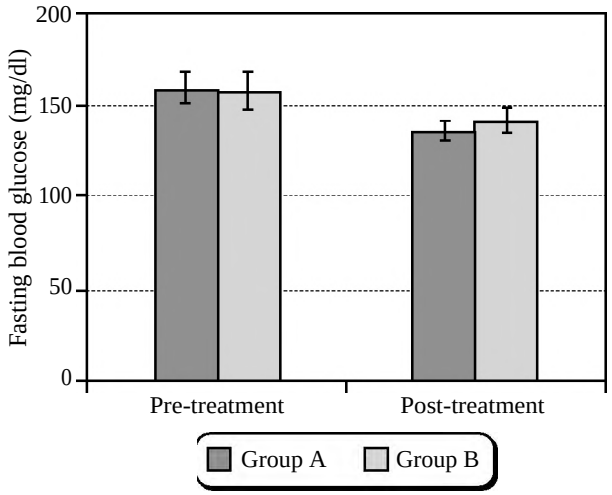

Fig. (2): Mean fasting blood glucose pre and post-treatment of the group A and B.

Discussion

The present study was conducted to measure the effect of aerobic exercises and mindfulness meditation on serum cortisol levels in type 2 DM.

The present study's findings effectively showed a statistically significant decrease in fasting blood glucose and serum cortisol levels post-treatment in the study group compared with that pre-treatment. (p=0.001) for fasting blood glucose and (p=0.01) for serum cortisol levels.

So this study approved that the combined model between mindfulness meditation and aerobic exercises is more effective in decreasing fasting blood glucose and serum cortisol levels than using aerobic exercises only.

And these findings can decrease possible complications of diabetes.

The results of the current study are consistent with the findings of, Chen et al., **[11]**, who reported that mindfulness-based stress reduction therapy combined with intensive education can improve patient symptoms, reduce their anxiety/depression, improve their coping levels, quality of life, and cortisol levels as well as their satisfaction/awareness rates in diabetic patients with arthritis.

This finding is in line also with the result of Pascoe et al., **[12]**, who aimed to conduct a meta-analysis investigating the neurobiological effects of meditation, including focused attention, open monitoring, and automatic self-transcending subtypes, compared to active control, on markers of stress. They included randomized controlled trials comparing meditation interventions compared to an active control on physiological markers of stress. Studied outcomes include cortisol, blood pressure and heart rate. Forty-five studies were included. All meditation subtypes reduced systolic blood pressure. Focused attention meditations also reduced cortisol and open monitoring meditations also reduced heart rate. When all meditation forms were analyzed together, meditation reduced cortisol, blood pressure and heart rate. Overall, meditation practice leads to decreased physiological markers of stress in a range of populations.

Our results agreed with Koncz et al., **[5]**, who reported that meditation interventions were shown to have a significant medium effect on changing cortisol levels from pre-to post-test compared to the control group, Based on 10 studies using blood samples meditation interventions and they said that longer meditation programs were found to be more effective.

Also, the current study comes in line with the result of a pilot and feasibility study by Prochilo et al., **[13]**, who investigated the Feasibility criteria of Twenty-four participants were allocated to a single-arm pre-post study and subjected to 16 weeks of concurrent mindfulness psychoeducation and aerobic exercise training. Retention rate, response rate, recruitment rate, and sample size analyses indicate a definitive trial is feasible for detecting most effects with precision.

Moreover, Fakhri et al., **[14]**, approved the effectiveness of mindfulness on perceived stress and blood pressure control in diabetic patients. 50 patients with type-2 diabetes are divided into control (n=25) and intervention (n=25) groups. The training program consisted of 10 weekly sessions. Perceived stress was investigated in participants using Cohen's Perceived Stress Scale before and after the intervention. Results: In the experimental group, there was a significant decrease in perceived stress in the posttest (11.60 ± 1.55) compared with that in the pretest (13.96 ± 1.84) (r=0.293, p=0.001). But no significant difference was found in the scores of the control group (p=0.619).

In agreement with our results, Medina et al., **[15]**, supported that Mindfulness-based Interventions (MBIs) can be seen as preventive and complementary interventions in DM, particularly for the relief of symptoms related to depression and anxiety in diabetic patients and also in the management of other factors, including mindful eating, physical exercises and treatment adherence.

Also, Ngan HY et al., **[16]**, found that mindfulness- and acceptance-based approaches may reduce

distress and HbA1c levels and promote self-care in people with type 2 diabetes. Winkley K et al., **[17]**, suggested that psychological treatments offer minimal clinical benefit in improving glycated hemoglobin levels for adults with type 2 diabetes mellitus.

Mindfulness Based Interventions appear to have benefits on HbA1c, depression, stress, and diabetes-related distress in people with diabetes.

In agreement with our results, Priya, G., & Kalra, S. **[18]**, concluded that Mindfulness meditation-based strategies are simple, easy to grasp and practice, and do not incur additional cost. Meditation-based therapies may offer immediate positive benefits in such individuals. It may also help improve self-care behavior, self-reliance, and self-control.

Furthermore, Sholi et al., **[19]**, Supported that, the intensity of training as an independent variable influencing the changes in the levels of testosterone and cortisol has been recommended; so highly sport-affected hormonal changes during the combined exercise should be considered more than that in one exercise.

Under these results, Gashi et al., **[20]**, showed that by inducing physical stress for 1-7d on the rats, their cortisol levels decreased. The results showed that regular aerobic activity for 7d (i.e. swimming) had a positive impact on lowering the levels of the stress hormone cortisol.

Following these results, Goyal et al., **[21]** found that meditation programs can result in small to moderate reductions of multiple negative dimensions of psychological stress.

Inconsistent with our results Turakitwanakan et al., **[22]**, found that Mindfulness meditation lowers the cortisol levels in the blood suggesting that it can lower stress and may decrease the risk of diseases that arise from stress, such as psychiatric disorder, peptic ulcer, and migrainous headache. Then, meditation should be used in combination with standard treatment.

On the other hand, Gerber et al., **[23]**, showed that six weeks of exercise training did not result in an altered pattern of cortisol secretion in response to an acute psychosocial stressor among inpatients with MDD.

Moreover, Koc **[24]**, investigated the effect of post-challenge acute values of serum cortisol levels in elite and sedentary athletes and found that cortisol levels were the same in both groups and were not affected by aerobic exercise.

In contrast to our results, the results of this study contradicted the study of Alghadir et al., **[25]**, who evaluated the effect of 4 weeks of moderate aerobic exercise on outcome measure of saliva stress hormones and lactate levels on sixteen healthy students volunteers performed an exercise test of moderate intensity for 4 weeks, three times per week. The exercise was treadmill walking. After 4 weeks of exercise, there was a significant increase in cortisol.

Conclusion:

The combination model between aerobic exercise and mindfulness meditation as group A seems to be more effective in decreasing serum cortisol levels and fasting blood glucose than aerobic exercise only as group B.

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تأثير التأمل الواعى والتمرينات الهوائية على مستوى الكورتيزول لدى مرضى السكرى من النوع الثانى

الهدف من البحث: الغرض من هذه الدراسة معرفة تأثير التأمل الواعى والتمرينات الهوائية على مستوى الكورتيزول لدى مرضى السكرى من النوع الثانى ومن تقلل مستوى السكر فى الدم وتقليل المشاكل الناتجة عن مرض السكرى.

مواد وأساليب البحث: أجريت هذه الدراسة على ستين مريضاً (رجال ونساء) يعانون من مرض السكرى من النوع الثانى، تراوحت أعمارهم بين أربعين وخمسين عاماً، تم اختيارهم من العيادة الخارجية بكلية العلاج الطبيعى جامعة القاهرة وتم أخذ عينة دم وريدى منهم قبل البدء بالتمارين لقياس مستوى السكر الصائم ومستوى الكورتيزول الصباحى. وقد تم تقسيمهم إلى مجموعتين مجموعة (أ) ضمت ٣٠ مريض وقامت بعمل التمرينات الهوائية لمدة ٤٥ دقيقة وتمرينات التأمل الواعى لمدة ٢٠ دقيقة بمعدل ٣ مرات فى الاسبوع لمدة ستة أسابيع ومجموعة (ب) وتكونت من ٣٠ مريض، قامت بعمل التمرينات الهوائية فقط لمدة ٤٥ دقيقة بمعدل ٣ مرات فى الاسبوع لمدة ست أسابيع.

بعد انتهاء مدة التدريبات تم عمل تحليل السكر الصائم ومستوى الكورتيزول الصباحى مرة أخرى وقد تبين انخفاض كلا من مستوى السكر الصائم والكورتيزول الصباحى فى المجموعتين (أ و ب) ولكن فى مجموعة (أ) قد انخفضت بشكل ملحوظ، وهذا يرشدنا إلى فائدة هذه التمرينات إلى الحد من مشاكل مرض السكرى.

نتائج البحث: بعد إجراء التحليل الإحصائى أوضحت النتائج أن هناك انخفاض ذات دلالة إحصائية فى المجموعة (أ) عن المجموعة (ب) وقد استخلصت هذه الدراسة بأفضلية دمج التمرينات الهوائية والتأمل الواعى معاً للحد من مشاكل مرض السكرى من النوع الثانى.