Effect of walking and aerobic exercise on physical performance and depression in cases of type 2 diabetes mellitus

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Aim
Investigate the effect of walking and aerobic exercise on physical performance and depression symptoms in patient with type 2 diabetes mellitus (T2DM).
Patients and methods
Forty patients with T2DM were divided into two groups. Group 1 was treated by walking 30 min three times per week. Group 2 was treated by aerobic exercise for 30 min for 3 months. Physical performance and depression were measured pretreatment and posttreatment.
Results
Walking improved BMI by 4.2%, waist circumference by 1.22%, blood glucose by 6.82%, timed up and go test by 24.34%, static balance by 74.63%, 6 min walk by 14.91%, muscle power by 15.97%, muscle endurance by 71.42%, 2 min stair climbing by 52.63%, squat test by 73.63%, and hospital scale of anxiety and depression by 46.79%.
Aerobic exercise improves by BMI 5.47%, waist circumference by 3.95%, blood glucose by 17.21%, time up and go test by 29.2%, static balance by 118.58%, 6 min walk 8.57%, muscle power by 31.93%, muscle endurance by 81.63%, 2 min stair climbing by 49.19%, squat test by 81.3%, and hospital scale of anxiety and depression by 50%.
Conclusion
Both walking and aerobic exercise improve physical performance and depression scale in T2DM.

Keywords:
aerobic exercise, depression, diabetes mellitus, physical performance

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Introduction

The WHO has reported that about 350 million people have depression, and about one million people with depression worldwide commit suicide every year. There is more than a threefold increase in the prevalence of depression in people with type 1 diabetes mellitus (T1DM), and nearly a twofold increase in people with type 2 diabetes mellitus (T2DM) [1,2].

Decreased muscle strength, lower muscle quality [3], and accelerated loss of muscle mass, especially in the lower extremities, have all been documented in individuals with diabetes mellitus (DM) [4]. Through these mechanisms, older adults with DM may be more likely to develop frailty. Hyperglycemia may activate inflammatory pathways that subsequently cause muscle catabolism and disability as part of the frailty process. On the other hand, physical and cognitive impairment may lead to difficulties in DM self-management and subsequent hyperglycemia [3].

Patients with DM experience significantly higher rates of depression compared with their age-matched and sex-matched counterparts [5]. The prevalence of depression in people with T2DM has been estimated to be ~25%, and depression can occur in as many as 70% of people with DM-related complications [6]. The prevalence of depression in people with DM is higher in women, unmarried people, those with more children, and those with low vitamin B6 [1].

Major depressive disorder is a relatively common condition and a leading cause of years lived with disability across the world. Sedentary behavior assessed as TV viewing time and low physical activity is related to an increased risk of depression [7,8].

DM may worsen the depression symptoms due to increased symptom burden complications causing functional impairment and decreased quality of life, as well as vascular brain changes secondary to DM. Comorbid depression has been found to impair the

ability to perform self-care activities necessary to control diabetes by affecting memory, energy level, and executive function. Overall, comorbid depression in individuals with diabetes is associated with a 1.5-fold increase in mortality risk as compared with those without depression [2–4].

Home-based exercise and group exercise served to reduce depressive symptoms .It is somewhat surprising that exercise was as effective as medical treatment among the subgroup of patients with severe depression [9].

It is documented that exercise is a main part of treatment of T2DM and also exercise is documented to improve depression scale, but no study compares the effect of walking on T2DM and depression as another approach to exercise. Exercise is difficult for many diabetic patients. A meta-analysis done between 1996 and 2007 concluded that pedometer-based walking programs can significantly increase the activity levels, decrease BMI, and improve blood pressures [10].

The aim of this study was to compare the effect of walking versus aerobic exercises on physical performance and depression scale in T2DM.

Patients and methods

Forty patients with T2DM from the Department of Internal Medicine, Cairo University Hospitals were divided into two groups. Group 1 was treated by walking 30 min 3 days per week and group 2 was treated by aerobic exercise on a stationary bicycle (Wingtech, Shanghai, China) for 30 min according to the following stages.

Warming-up phase

Five minutes in the form of pedaling at a speed of 60 revolutions/min without load.

Active phase

Pedaling at a speed of 60 revolutions/min with an adjusted load to achieve 60% of the predictive maximal heart rate according to the following equation: maximal heart rate=220-age in years. A pulsometer was attached to the patient ear to detect the pulse rate during exercise. The duration of that stage was 20 min.

Cooling-down phase

Five minutes of pedaling at a speed 60 of revolutions/min without load.

BMI, waist circumference, and blood glucose were measured pretreatment and posttreatment for both groups.

Physical performance is measured by the following:

(1) Timed up and go (TUG) test: this test measures the time required for the patient to stand up from a chair, walk a distance of 3 m, turn around, walk back to the chair, and sit down. A time more than or equal to 14 s predicts a risk of fall [11].
(2) Static balance: the patient is asked to stand in balance on one limb of his/her choice, with the other limb raised off the ground. The patient should stand barefoot, with his arms placed across the chest, each touching the opposite shoulder, with open eyes. The time to maintain one leg balanced is measured. Time measurement starts when the patient raised one foot off the floor and ends when either the patient moves his arms, raises the standing foot to maintain the balance, or when 60 s are elapsed. If after 60 s the patient is still standing, the test is interrupted and the result is computed as equal to 60 s. A time less than 5 s predicts a risk of fall [11].
(3) The 6 min walk test: the patient is asked to walk as far as possible in 6 min along a 25 m long stretch in a quiet hospital corridor and the walking distance was recorded [12].
(4) Measure of muscle power: sit to stand (STS) tests, the time taken to complete five sit to stand to sit cycle is a surrogate.
(5) Measure of muscle endurance (STS60): number of sit to stand to sit cycle in 60 s is a surrogate measure.
(6) 2 min stair climbing: the number of steps covered ascending and descending two flight of stairs as many times as possible for 2 min.
(7) Squat test: the time to perform 10 consecutive standardized unsupported squats was required [13].
(8) The presence of depression was evaluated using the hospital anxiety and depression scale. A score from 0 to 7 is normal, from 8 to 10 borderline, and from 11 to 21 is abnormal.

Blood glucose levels were checked before exercise. If the blood glucose was less than 80 mg/dl, the participants were instructed to eat a snack and recheck their glucose 10–15 min later to ensure that it was rising before engaging in the exercise. Participants with blood glucose levels of more than 250 mg/dl were instructed to not exercise until their blood glucose was less than 250 mg/dl [14].

Exclusions included:

(1) Difficulty in walking one-quarter mile or walking up 10 steps without resting.
(2) Use of a cane or other equipment to get around.
(3) Fracture in the lower extremity.

All procedures are done according to the Helsinki Declaration 2000 and its adjustments. All patients signed an informed consent prior to participation in the study and for publication of results.

Statistical analysis

All the data were presented as the mean±SD and analyzed using *t* test and the statistical significance at a confidence of 95% probability ($P<0.001$) as a level of significance pretreatment and posttreatment measures analyzed by Minitab, version 13.1 (LLC headquartered in state college Pennsylvania, USA).

Results

Forty patients with T2DM, 30 (75%) women and 10 (25%) men in the age range from 35 to 60 years and BMI from 34 to 38 were included in this study.

Discussion

Depression is a risk factor for greater morbidity in individuals with T2DM. Up to 30% of individuals with DM have a significant number of depressive symptoms of depression rating scales and 12–18% meet the diagnostic criteria for major depression. Patients with DM experience significantly higher rates of depression compared with their age-matched and sex-matched counterparts [4–15].

Patients with both depression and DM have low adherence to diet and exercise instructions, which may contribute to the worsening of their quality of life and the deterioration of their DM. The worldwide increase in sedentary lifestyle, obesity, and T2DM is also linked to socioeconomic status and constitutes alarming secular trends, even for the future prevalence of cerebrovascular disease (CD). Despite an important genetic component of T2DM, it is obvious that its dramatic increasing prevalence is caused by factors related to lifestyle and environment. Therefore, efforts to promote changes in diet and physical activity do represent the cornerstones of both preventive and therapeutic measures for T2DM today [6–16].

So, walking can be considered a simple, cheap, and easy lifestyle modification and can help patients who have no desire to do exercise.

This study was conducted to study the effect of walking and aerobic exercise on physical performance and depression in patients with T2DM. In this study patients with T2DM are all nonathletic and not physically active at any period of their life. The BMI of group 1 was 34.5 and of group 2 was 34.8. Waist circumference was 142.95 and 146.75, respectively (Tables 1 and 2).

Older adults with DM have significantly greater difficulty walking one-quarter mile, climbing stairs, or doing housework and perform worse on measures of physical performance such as walking speed, muscle strength, chair stands, and tandem stand compared with their counterparts. The higher prevalence of functional disability in older adults with DM may be a result of DM-related comorbidities such as CD, vision loss, obesity, and arthritis or poor glycemic control [3]. This agrees with the present study; both groups have decreased in TUG; for group 1 it was 58.95 and for group 2 it was 58.90, static balance were 6.900 and 7.8, 6 min walk distance test were 208.55 and 224.50, 2 min climbing stairs were 6.200 and

Table 1 Group 1 (walking group) pretreatment and posttreatment

Items	Pre	Post	*t* value	*P* value
BMI	34.5±2.328	33.050±1.932	2.02	0.057
Waist circumference (cm)	142.95±8.36	141.20±6.67	0.68	0.508
Fasting glucose (mg/dl)	170.65±20.24	159.00± 19.57	2.58	0.018*
Time up and go (s)	58.95±3.83	44.60±6.14	8.86	0.000**
Static balance (s)	6.900±1.518	12.050±1.605	−10.32	0.000**
Six minutes' walk (m/6 min)	208.55±14.22	239.65±11.52	−6.56	0.000**
Measure of muscle power (s)	32.55±9.70	27.35±1.69	2.36	0.029*
Measure of endurance (no/min)	7.350±0.988	12.600±1.818	−11.92	0.000**
2 min stair climbing (no/2 min)	6.200±1.322	9.250±0.716	−10.36	0.000**
Squat test (no/min)	5.500±1.235	9.550±1.468	−9.00	0.000**
Hospital scale of depression	15.600±2.088	8.300±1.218	16.75	0.000**

*Significant difference at *P* value less than 0.05. **Highly significant difference at *P* value less than 0.001.

Table 2 Group 2 (aerobic exercise group) pretreatment and posttreatment

Items	Pre	Post	*t* value	*P* value
BMI	34.8±1.963	32.8±1.196	4.02	0.001**
Waist circumference (cm)	146.75±7.63	140.95±3.69	3.16	0.005*
Fasting glucose (mg/dl)	166.70±19.41	138.00±10.86	4.96	0.000**
Time up and go (s)	58.90±5.69	41.70±4.39	16.57	0.000**
Static balance (s)	7.800±0.768	17.050±2.212	–17.06	0.000**
Six minutes' walk (m/6 min)	224.50±3.07	243.75±8.98	–9.69	0.000**
Measure of muscle power (s)	36.950±1.731	25.150±1.137	26.53	0.000**
Measure of endurance (no/min)	7.350±1.348	13.350±1.040	–15.92	0.000**
2 min stair climbing (no/2 min)	6.650±1.089	10.150±1.137	–10.66	0.000**
Squat test (no/min)	5.350±1.089	9.700±0.733	–14.43	0.000**
Hospital scale of depression	17.900±1.553	8.950±1.432	15.61	0.000**

*Significant difference at *P* value less than 0.05. **Highly significant difference at *P* value less than 0.001.

6.650, and squat test were 5.50 and 5.350 (Tables 1 and 2).

The recently updated American Diabetes Association exercise guidelines state that exercise should be performed at least three times a week. Exercising regularly for a long period of time is critical for promoting metabolism, improving insulin sensitivity and decreasing blood sugar. In addition, exercise is also critical for stimulating blood circulation in the lower limbs and for preventing foot ulcers [17].

Regular exercise provides essential protection against many of the diseases that plague us, including CD, hypertension, DM, obesity, osteoporosis, depression, breast cancer, and dementia (memory loss). Given these extensive potential health benefits, it is clear that regular moderate exercise such as walking or swimming is one of the best emotional and physical health enhancers that we can recommend and prescribe [5] and this agrees with the present study. Walking groups of patients have improved TUG (24.34%), static balance (74.63%), 6 min walk distance (14.91%), 2 min stair climbing (52.63%) and squat test (73.63%), muscle power (15.97%), and muscle endurance (71.42%), which constitute physical performance for group 1 and TUG (29.2%), static balance (118.58%), 6 min walk distance (8.57%), 2 min stair climbing (49.19%), and squat test (81.3%), muscle power (31.93%), and muscle endurance (81.63%), which constitute physical performance for group 2 (Table 3).

A randomized trial of telephone counseling plus walking for depressed diabetics patients by Piette *et al.* [18] found that walking program significantly decreased patients' blood pressure, increased physical activity, and decreased depressive symptoms among patients with both diabetes and depression.

Table 3 Percent of improvement

Items	Percent of improvement group 1	Percent of improvement group 2
BMI	4.2	5.74
Waist circumference (cm)	1.22	3.95
Fasting glucose (mg/dl)	6.82	17.21
Time up and go (s)	24.34	29.2
Static balance (s)	74.63	118.58
Six minutes' walk (m/6 min)	14.91	8.57
Measure of muscle power (s)	15.97	31.93
Measure of endurance (no/min)	71.42	81.63
2 min stair climbing (no/2 min)	52.63	49.19
Squat test (no/min)	73.63	81.3
Hospital scale of depression	46.79	50

Exercise interventions have been shown to improve glycemic control in patients with T2DM and to reduce upper-body visceral adiposity, improve insulin sensitivity, increase high-density lipoprotein (HDL) cholesterol, reduce triglyceride levels, increase low-density lipoprotein cholesterol particle size, reduce hypertension, and decrease total cholesterol where there are reductions in adiposity [14]. In this study, BMI improved by 4.2%, waist circumference by 1.22%, and blood glucose by 6.82% in patients of group 1. BMI improved by 5.74%, waist circumference by 3.95%, and blood glucose by 17.21% in group 2 of patients (Table 3).

Poorer glycemic control is associated with protein catabolism in the skeletal muscle that may lead to sarcopenia and thus loss of functional capacity. Improvements in glycemic control also affect the

quality of life with fewer physical symptoms, including pain and fatigue, as reported [4] and this agrees with the present study as there is improvement of physical function in both groups.

Obese individuals had a 55% increased risk for developing depression, and individuals with depression had a 58% increased risk for developing obesity. The relationship is present between depression and overweight as well but the association is not as strong. Mechanistically, individuals with depression may gain weight due to changes in appetite and because they engage more frequently in unhealthy behaviors such as decreased physical activity. Metabolic syndrome is another risk factor for the development of T2DM and consists of a combination of any three of the following: abdominal obesity, elevated triglycerides, low (HDL) cholesterol, hypertension, and elevated fasting glucose [19]. In this study, all patients have a sedentary lifestyle. BMI was 34.5 and 34.8, waist circumference 142.95 and 146.75, respectively, and hospital score of depression 15.6 and 17.9 for both groups, respectively (Tables 1 and 2).

Any activity causes a shift from predominant reliance on free fatty acids (FFA) at rest to a blend of fat, glucose, and muscle glycogen, with a small contribution from amino acids. With increasing exercise intensity, there is a greater reliance on carbohydrate as long as sufficient amounts are available in the muscle or blood. Early in exercise, glycogen provides the bulk of the fuel for working muscles. As glycogen stores become depleted, muscles increase their uptake and use of circulating blood glucose, along with FFA released from the adipose tissue. Intramuscular lipid stores are more readily used during longer-duration activities and recovery. Glucose production also shifts from hepatic glycogen lysis to enhanced gluconeogenesis as the duration increases. Physical activity causes increased glucose uptake into active muscles balanced by hepatic glucose production, with a greater reliance on carbohydrate to fuel muscular activity as intensity increases [20].

Acutely, aerobic exercise increases muscle glucose uptake by up to fivefold through insulin-independent mechanisms. After exercise, glucose uptake remains elevated by insulin-independent mechanism for 2 h and insulin-dependent (up to 48 h) mechanism if exercise is prolonged, which is linked with muscle glycogen repletion. Improvements in insulin action may last for 24 h, following shorter duration activities (20 min) if the intensity is elevated to near-maximal effort intermittently. Even low-intensity aerobic exercise lasting 60 min and walking enhances insulin action in obese, insulin-resistant adults for at least 24 h. If enhanced insulin action is a primary goal, then daily moderate-intensity or high-intensity exercise is likely optimal. Regular training increases muscle capillary density, oxidative capacity, lipid metabolism, and insulin signaling proteins, which are all reversible with detraining. Both aerobic and resistance training promote adaptations in the skeletal muscle, adipose tissue, and liver associated with enhanced insulin action, even without weight loss [21].

From the physiologic perspective, animal studies demonstrated a loss of local contractile stimulation (which typically occurs during sitting or lying down) leads to the suppression of skeletal muscle lipoprotein lipase (LPL) activity. LPL is the rate-limiting enzyme involved in the uptake of triglycerides and FFA into the skeletal muscle and HDL cholesterol production. Importantly, the suppression of LPL activity is not observed when experimental animals engage in incidental, light-intensity activity such as standing or walking. Loss of local muscle contraction may also reduce glucose uptake through blunted translocation of GLUT-4 glucose transporters to the skeletal muscle cell surface. Elevated levels of glucose, triglycerides, and FFA in the circulation can generate excess free radicals and trigger a biochemical cascade of inflammation, endothelial dysfunction, hypercoagulability, and increased sympathetic activity [22]. So, walking can be used safely to treat those types of patients.

In a randomized, controlled study the investigators divided 101 patients with various degrees of depression into three treatment groups (medical treatment): sertraline (50–200 mg), group exercise three times per week, or placebo. Baseline depressive symptoms were assessed both by the Hamilton Rating Scale for Depression and by a structured interview. Approximately one-half of the patients had major depression. At the 4-month follow-up, there were comparable reductions in depressive symptoms among the patients who received sertraline and those who underwent exercise, and both groups had greater reductions in depressive symptoms compared with the placebo [9].

Sixteen-week randomized, controlled trial to evaluate the efficacy of aerobic exercise compared with sertraline and combination therapy as a treatment for major depression among older adults. At posttreatment, exercise and combination therapy were as efficacious

as antidepressant medication in ameliorating depression (remission rates range from 60 to 69%). At the 6-month follow-up, 26 (8%) participants in the exercise condition showed the lowest rates of depression relapse compared with those in the other two treatment conditions (38% for medication and 31% for combination therapy) [14]. Piette *et al.* [18] found that walking program significantly decreased patients' blood pressure, increased physical activity, and decreased depressive symptoms among patients with both diabetes and depression. And this agrees with the present study; group 1 improved hospital scale of anxiety and depression by 46.79% and group 2 improved by 50%.Depression symptoms reduced total life expectancy significantly but controlling for chronic diseases eliminated the effect of depression symptoms on mortality across age and sex groups. Having depression increased the overall mortality by almost twofold. However, their results did not control for lifestyle factors or the presence of chronic conditions [4].

According to Cochrane reviews, exercise interventions have a small to moderate effect in reducing depression compared with a placebo or a control group and can be equally effective as pharmacotherapy or psychotherapy, although other reviews have suggested that this effect is even larger [8].

A review by Lustman and Clouse [23] found that improvements in depression were linked to improvements in glycemic control and overall perceptions of well-being. Contradicting these findings, however, are results of a meta-analysis (11 studies in adults and 10 studies in children and adolescents) showing that although both cognitive behavioral therapy and antidepressant medications were associated with an improvement in blood glucose readings in some studies; overall, there was no significant effect of either of these treatments on glycemic control in adults and only weak evidence of an effect in children and adolescents [24] so aerobic exercises and walking, if exercise is difficult for patients, can help improve depression scale.

Conclusion

Walking is a simple, easy, and a cheap way of exercise. Walking for 30 min, three time/week is considered as moderate exercise effect and can be used as a method of treatment of T2DM and depression. So, walking can be used in patients who has difficulty to do exercises such as obese persons. Thirty minutes of aerobic exercise three times/week also improve physical performance and depression scale in patients with T2DM.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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