Effect of treadmill training on activities of daily living and depression in patients with Parkinson's disease

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Introduction
Parkinson's disease is a complex neurodegenerative condition with both motor and nonmotor symptoms affecting the physical, psychological, social, and functional status of individuals. This study was conducted to assess the relationship between moderate aerobic exercise and activities of daily life and depression in Parkinson's disease.
Patients and methods
Thirty levodopa-dependent patients with Parkinson's disease, with age ranging from 49 to 70 years, represented the sample of the study. The patients were randomly assigned into two equal groups (group 1 and group 2) with matched age, height, and body weight. Computerized tomography was conducted to exclude any focal neurological disorder that may affect the gait pattern. All the patients were subjected to clinical neurological examination, which included medical past and present history; motor examination; and activities of daily living. Group 1 patients were treated by a designed physiotherapy program, in addition to 20 min of treadmill training (moderate aerobic training), whereas group 2 patients were treated only by the same designed physiotherapy program as used for group 1 patients. The Hamilton Rating Scale of Depression was used for assessment of depression.
Results
Both groups showed improvement in walking distance, walking speed, activities of daily living, and depression after the designed physiotherapy program; however, group 1 with moderate aerobic exercise showed more improvement, and the differences between the two groups were statistically significant.
Conclusion
Moderate aerobic training showed effectiveness in improving activities of daily living and in improving depressive symptoms in patients with Parkinson's disease.

Keywords:
aerobic exercise, depression, Parkinson's disease

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Introduction

Parkinson's disease (PD) is a complex neurodegenerative condition with both motor and nonmotor symptoms [1]. It has substantial adverse effects on the physical, psychological, social, and functional status of the individuals [2]. The most characteristic features of PD are resting tremor, rigidity, bradykinesia, and postural instability [3]. The diagnosis of PD demands the presence of two out of the three cardinal features of bradykinesia, rigidity, and tremor, a good clinical response to levodopa, and no atypical features suggestive of another parkinsonian syndrome [4]. Depression is frequent in patients with PD. Patients with PD usually become more dependent, fearful, and hesitant. Depression has been recognized as a common feature of PD and is the most prevalent psychiatric disorder in patients with PD [5]. Limitation in functional status and activities of daily living (ADL) often result in a loss of independence and considerable decline in quality of life [6]. Depression, a disease usually accompanied by a serotonergic deficit, has been observed in approximately 40% of patients suffering from PD. It could be related to decreased serotonergic neurotransmission in untreated patients with PD. Low serotonergic activity may be related to the dopamine pathology in PD and this could be related to the high prevalence of depression in PD [7].

Physical therapy programs in conjunction with the routine medications for patients with PD could break the downward spiral of immobility [8]. Regular, 'mild or moderate' exercises could be a possible nonpharmacological form of treatment for depressive disorders [9]. Moreover, there is increasing evidence to suggest that it could be used as an alternative therapy to antidepressants and psychotherapy [10]. Physical exercise programs obtained clinically relevant outcomes in the treatment of depressive symptoms in depressed older people [11]. The aim of the study is to examine the effect of the aerobic training on alleviating the depressive symptoms in individuals with PD.

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Patients and methods

Thirty levodopa-dependent patients with PD, with age ranging from 49 to 70 years, represented the sample of the study. The patients were randomly assigned into two equal groups (group 1 and group 2) with matched age, height, and body weight. The patients were diagnosed in the Neurology Department, Faculty of Medicine, Cairo University's outpatient clinic (Cairo, Egypt). Computerized tomography was performed to exclude any focal neurological disorder. The patients were referred to the outpatient clinic of Faculty of Physical Therapy, Cairo University. All the patients were subjected to clinical physical examination, which included medical past and present history; motor examination; and ADL. The Hamilton Rating Scale of Depression (HDRS) [12] was used for assessment of depression. We included patients who were able to walk independently for 6 min without interruption. The patients suffered mild-to-moderate disability according to the United Parkinson's Disease Rating Scale (UPDRS) [13] ADL/motor scores. The UPDRS is a rating scale used to follow the longitudinal course of PD. It consists of five sections: evaluation of mentation, behavior, and mood; evaluation of ADL; motor evaluation; Hoehn and Yahr stating of severity of PD; and Schwab and England ADL Scale. Worsening of symptoms increases the score. Improvement in symptoms decreases the score.

The duration of illness ranged from 3 to 5 years. Informed oral and written consents were obtained from all individuals who participated in this study. Patients with any of the following criteria were excluded from the study: severe cardiovascular disorders; neuromusculoskeletal disorder, which could potentially affect the gait; rapidly progressive motor disability; poor visuospatial abilities; epilepsy; cognitive impairment; marked rigidity; dyskinesias; anorexia; and symptomatic orthostasis. Patients who are on sedatives, tranquilizers, or sleeping aids were also excluded.

A treadmill tolerance test was first performed to assess gait safety. Those who completed six consecutive minutes of treadmill walking at 0.5 km/h proceeded to peak exercise testing. Individuals achieved adequate exercise intensities without signs of cardiopulmonary disturbances (abnormal increases in heart rate, blood pressure < 220 to 240/120 120 mm Hg, a significant drop in systolic pressure in response to an increasing workload, respiration not strenuous or short, lightheadedness, confusion, pallor, cyanosis, nausea) or other contraindications to training were enrolled. The walking distance and speed of the last and first sessions of each patient were recorded to be compared.

The patients in the study group (group 1) were treated by a designed conventional physiotherapy program, which was conducted by the researcher, in addition to moderate aerobic training. The designed physiotherapy program consisted of passive prolonged stretch techniques for the anterior neck, pectoralis major, hip flexors/adductors, tensor fascia latae, knee flexors, and ankle planter flexors muscles; balance training and weight shifting exercises; proprioceptive neuromuscular facilitation techniques; and graduated active exercises applied for the axial muscles to maintain/increase the muscle strength. A functional training included rolling over, standing up and sitting down, turning around using a large arc of movement or using full body movements, and traditional gait training. The patient and family were instructed to focus on maintaining long strides and adequate ground clearance during walking; on maintaining an upright posture by consciously attending to standing upright, and to reinforce physiotherapy strategies in the home and community. The moderate aerobic training included speed-dependent treadmill gait training. This training was started by 6 min of walking followed by rest. The walking speed was selected according to the patient's comfort. Individual's treadmill walking time was increased gradually from 6 to 20 min at the end of 6 weeks of training. The treatment was conducted three times a week day after day. The patients in the control group (group 2) were treated by the conventional physiotherapy program only.

Hamilton depression rating scale [12]

This scale was designed by Hamilton [12,14]. The original version consisted of 17 items and was later increased to 24 items by Klerman *et al.* [15]. The Scale is not meant to be a diagnostic instrument [16]. HDRS was found to distinguish between different groups of patients drawn from general practice, day-patients care, and in-patients [17]. The concurrent validity is high [18]. The inter-rater reliability of HDRS is also consistently high [12].

Data analysis and statistical methods

The coded data were entered into the computer using a database developed for data entry using Microsoft Office Excel program for Windows 2007. Data were then transferred to the Statistical Package of Social Science, version 16 (SPSS Inc., Chicago, IL, USA) for quantitative data analysis. Simple frequencies were used for data checking, whereas descriptive statistics were used for data summarization and graphs were used to illustrate simple information. Suitable statistical tests of significance were used when appropriate. Differences between studied groups were considered statistically at P value less than 0.05.

Results

There were no statistically significant differences between the two groups as regards age, sex, body weight, height, and duration of illness. This indicated that the samples were well matched and fit for the study and comparison.

In addition, there was no statistical difference between the two groups as regards the walking distance ($T = 2.25$, $P = 0.041$) before the aerobic exercise, but after the aerobic exercise the difference between the two groups was statistically significant ($T = 5.29$, $P = 0.01$) (Table 1).

Furthermore, there is no statistical difference between the two groups as regards the walking speed ($T = 1.64$, $P = 0.123$) before the aerobic exercise, but after the aerobic exercise the difference between the two groups was statistically significant ($T = 4.43$, $P = 0.001$) (Table 2).

In addition, there is no statistical difference between the two groups as regards the ADL ($T = 0.75$, $P = 0.465$) before the aerobic exercise, but after the aerobic exercise the difference between the two groups was statistically significant ($T = 6.2$, $P = 0.001$) (Table 3).

As regards the depression symptoms rated by the Hamilton Rating Scale, there is no statistical difference between the two groups before the aerobic exercise ($T = 1.98$, $P = 0.06$) and the difference was statistically significant after the aerobic exercise ($T = 8.6$, $P = 0.01$) (Table 4).

There is a positive correlation between ADL in UPDRS and the Hamilton Rating Scale of Depression after 6 weeks of aerobic training and this was statistically significant ($R = 0.932$, $P = 0.001$).

Table 1 Walking distance (km) in both groups before and after moderate aerobic exercise

	Before		After		
	Mean (km)	SD (km)	Mean (km)	SD (km)	*P*
Group 1	0.259	0.294	0.509	0.77	0.041*
Group 2	0.087	0.012	0.346	0.08	0.01*

SD, standard deviation.
**P* is statistically significant.

Table 2 Walking speed (km/hr) in both groups before and after moderate aerobic exercise

	Before		After		
	Mean (km/hr)	SD (km/hr)	Mean (km/hr)	SD (km/hr)	*P*
Group 1	0.9	0.13	1.28	0.1	0.01*
Group 2	0.8	0.18	1.04	0.17	0.01*

SD, standard deviation.
**P* is statistically significant.

Table 3 Activity of daily living in UPDRS in both groups before and after moderate aerobic exercise

	Before		After		
	Mean	SD	Mean	SD	*P*
Group 1	24.8	3.09	15.6	4.2	0.01*
Group 2	25.4	2.9	22.13	4	0.01*

SD, standard deviation; UPDRS, the United Parkinson's Disease Rating Scale.
**P* is statistically significant.

Table 4 Hamilton Rating Scale of Depression in both groups before and after moderate aerobic exercise

	Before		After		
	Mean	SD	Mean	SD	*P*
Group 1	24.27	2.7	16.06	2.29	0.01*
Group 2	25.86	3.27	22.07	3.24	0.01*

SD, standard deviation.
**P* is statistically significant.

Discussion

In our results, we found that there is an improvement in walking speed, distance, ADL, and depression after moderate aerobic exercise. The difference between the two groups before and after was statistically significant. This was supported by 14 randomized controlled trials, which supported exercise as being beneficial with regard to physical functioning, health-related quality of life, strength, balance, and gait speed for people with PD [2]. Moreover, exercise therapy was effective in improving ADL and perceived health status in patients with PD [19]. Physical exercise might represent a potential adjunctive treatment for neuropsychiatric disorders helping to delay the onset of neurodegenerative processes through neurotransmitter release, neurotrophic factor and neurogenesis, and cerebral blood flow alteration [20].

Depressive symptoms in antidepressant-naive patients with PD correlate with relatively higher serotonin binding in raphe nuclei and limbic structures, possibly reflecting lower extracellular serotonin levels. It was found that abnormal serotonergic neurotransmission plays a key role in contributing to the pathophysiology of PD depression [21]. This could help to explain how moderate aerobic exercise could be beneficial for brain health, which includes improving psychological status and cognitive function, in addition to enhancing psychological well being [21]. It is suggested that norepinephrine activation by β-adrenergic receptors may be essential for exercise-induced brain derived neurotrophic factor upregulation [22]. Furthermore, it was also suggested that physical activity and exercise probably alleviate some symptoms associated with mild-to-moderate depression and improve self-image, social skills, and cognitive functioning [23–25]. These findings could be explained by the possibility that aerobic exercise training may inhibit gray matter volume loss in the insula, and that a relationship may exist between preservation of insula gray matter and improvement of psychological well-being training [26]. The use of the treadmill for PD gait rehabilitation increased the step length and improved the gait impairment in PD [27]. It was concluded that treadmill training in patients with PD improved lower extremity functional tasks and patients' physical well being in daily life [28].

As reported previously, treadmill exercise leads to improvement of motor performance [29]; it was also demonstrated that treadmill exercise leads to increased latency to fall (improved balance). These findings suggested that treadmill exercise may, through adaptive changes of the basal ganglia and motor circuitry, lead to improvement in related motor tasks, and the beneficial effects of exercise are accompanied by differential effects on the dopaminergic system [30].

Limitations

The relatively small sample size and the short-term nature of the program are factors that limit generalizations to a broader population of individuals.

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الملخص العربي

دراسه العلاقه بين التمرينات الهوائيه المتوسطه و النشاطات اليوميه و الاكتئاب في مرضي باركنسون

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مقدمه : مرض باركنسون يتسبب في شذوذ مميز لنمط المشي والحاله النفسيه و كذلك النشاطات اليوميه للمريض . **الهدف :** دراسه العلاقه بين التمرينات الهوائيه المتوسطه و النشاطات اليوميه و الاكتئاب في مرضي باركنسون. **طريقه و أدوات البحث:** أجريت هذه الدراسة على مجموعة من مرضى باركنسون المترددين على العيادة الخارجية بكلية العلاج الطبيعي – جامعة القاهرة. تم تقسيم المرضى عشوائيا إلي مجموعتين متساويتين. تلقت إحداهما علاجا طبيعيا تقليديا و تمرينات هوائيه متوسطه (بواسطه سير المشي الكهربائي)و تلقت المجموعة الأخرى من المرضى البرنامج التقليدي فقط . كما تم تطبيق مقياس هاملتون للاكتئاب للمجموعتين قبل و بعد العلاج الطبيعي. **النتائج:** أثبتت النتائج أن مرضي باركنسون في المجموعتين شهدوا تحسن في النشاطات اليوميه و الاكتئاب و لكن التحسن كان أكثر في المجموعه التي خضعت للتمرينات الهوائيه.