Exercise programs improve mobility and balance in people with Parkinson’s disease

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Compromised balance and loss of mobility are among the major consequences of Parkinson’s disease (PD). The literature documents numerous effective interventions for improving balance and mobility. The purpose of this study was to verify the effectiveness of two exercise programs on balance and mobility in people with idiopathic PD. Thirty-four participants, with idiopathic PD that ranged from Stage I to Stage III on the Hoehn & Yahr (H&Y) scale, were assigned to two groups. Group 1 (n=21; 67±9 years old) was engaged in an intensive exercise program (aerobic capacity, flexibility, strength, motor coordination and balance) for 6 months: 72 sessions, 3 times a week, 60 minutes per session; while Group 2 (n=13; 69±8 years old) participated in an adaptive program (flexibility, strength, motor coordination and balance) for 6 months: 24 sessions, once a week, 60 minutes per session. Balance and basic functional mobility were assessed in pre- and post-tests by means of the Berg Balance Scale and the Timed Up and Go Test. Before and after the interventions, groups were similar in clinical conditions (H&Y, UPDRS, and Mini-Mental). A MANOVA 2 (programs) by 2 (moments) revealed that both groups were affected by the exercise intervention. Univariate analyses showed that participants improved their mobility and balance from pre- to post-test. There were no differences between groups in either mobility or balance results. Both the intensive and adaptive exercise programs improved balance and mobility in patients with PD.

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1. Introduction

Functional independence is related to the capacity to perform activities of daily living (ADL) independently. Balance and mobility are crucial to their performance. Motor disturbances related to Parkinson’s disease (PD) can contribute to the decline of balance and mobility [1], which subsequently can lead to a reduction in functional independence. As a consequence, individuals with PD experience an increase both with difficulties in performing daily activities and in the risk of falls [2].

Non-pharmacologic therapies related to PD, such as physical exercises and nutrition, are not known to attenuate the disease’s severity or reduce its progression, but they can contribute to improvements in the patient’s quality of life [3,4]. Systematic participation in physical activity programs can help individuals maintain not only their motor repertoires, but also their ability to perform daily living activities.

Crizzle and Newhouse [5] reviewed the literature and concluded that, through exercise, patients with PD improve their physical performance and the execution of activities of daily living. In addition, they suggested that future studies should include the development of standardized exercise programs specific to problems associated with PD, as well as standardized testing methods for measuring improvements in PD patients.

Physical activity programs for PD patients that focus on improvements in functional capacity and mobility vary according to the type of proposed activity, whether it will be practiced by individuals or in a group, the program’s duration, the duration and frequency of weekly sessions, and type of evaluation. Such programs include intensive sports training [6], treadmill training with body weight support [7], resistance training [8,9], aerobic exercise [10], alternative forms of exercise [11], home-based exercise intervention [12], and the practice of movement strategies [4].

Within this context, the purpose of this study was to verify the effectiveness of two intervention programs on functional balance and mobility in people with idiopathic PD. Two physical
exercise programs, a multi-mode exercise program and an adaptive program – whose features differed relative to duration, intensity and the exercises’ complexity – were applied to PD patients. The effectiveness of the programs was judged relative to the patients’ functional balance and mobility, which were measured by means of Berg’s Functional Balance Scale (FBS) [13] and the Timed Up and Go Test (TUG) [14], respectively.

Berg’s FBS was chosen because it is typically used in older populations [15] as a reliable tool for measuring functional stability [16], and because it has a strong association with well-established measurement instruments for people with PD, such as the motor subscale of the Unified Parkinson’s Disease Rating Scale (UPDRS), and the modified Hoehn and Yahr (H&Y) Staging Scale [17]. The TUG was chosen to assess a series of functionally important tasks related to daily living activities and independent mobility: sitting to standing, gait initiation, walking, turning and sitting [18], to detect changes in mobility in PD patients [19], and to quantify the effects of an intervention program [4].

2. Patients and methods

2.1. Participants

Thirty-four participants, with idiopathic PD that ranged from Stage I to Stage III on the H&Y rating scale, gave their informed consent to participate in the experimental procedure, as required by the Declaration of Helsinki and the Institutional Research Ethics Committee (Protocol #002529/2007). They were assigned to two exercise groups. Group 1 (n = 21; 67±5 years old; 11 females; 10 males) was engaged in a multi-mode exercise program, while Group 2 (n = 13; 69±8 years old; 5 females; 8 males) participated in an adaptive program, both detailed below.

Before and after the interventions, the PD severity and evolution status when they were submitted to the experimental protocol. All of the PD patients were on what is considered “on medication” treatment; UPDRS: total score in Unified Parkinson’s Disease Rating Scale; UPDRS-I: UPDRS mentionation; UPDRS-II: UPDRS functional; UPDRS-III: UPDRS motor.

2.2. Assessments

All of the PD patients were on what is considered “on medication” status when they were submitted to the experimental protocol. Patients were instructed to take their anti-Parkinson’s medication as usual, and the data collection began after their signs/symptoms were under control (at least 1.0 hour after their first morning dose of PD medication was administered). Functional balance and basic functional mobility were assessed in pre- and post-tests by means of the Berg Balance Scale and the Timed Up and Go Test. Participants were asked to perform the following tests:

a. Modified Timed “Up and Go” test (TUG) [14]: The task consisted of the participant standing up from a sitting position in an armless chair with a seat height of 46.5 cm, walking a distance of 3 m, then passing around a cone, returning, and sitting back down in the chair. Each participant was instructed to perform the task as quickly as possible, but without running. At least one practice trial was offered to the participants at the beginning of the procedure so that they could become familiar with it. Three trials were performed for testing purposes, and the time to perform the task was measured in seconds. Time was recorded from the instant the person’s buttocks left the chair until the next contact with the chair. The mean value of the three trials was considered for statistical analysis.

b. Berg’s Functional Balance Scale (FBS) [13]: This assessed the individual’s ability to maintain balance during the performance of 14 tasks common in daily life, such as sitting down and standing up from a chair, and standing on one leg. The performance of each task was evaluated on a 5-point ordinal scale, ranging from zero to four, according to either movement quality or time taken to complete the task. The zero point represents the necessity for maximum assistance, and four points indicates that the individual is functionally independent in the performance of the task. A total score (maximum of 56 points) was calculated by the summation of each item. Higher scores reveal the ability to maintain good balance.

2.3. Intervention programs

Patients were assigned to one of the two exercise programs: the multi-mode exercise and the adaptive program.

a. Multi-Mode Exercise Program: The aim of the program was to develop the patients’ functional capacity (aerobic capacity, flexibility, upper and lower limb strength, motor coordination, and balance). Rhythmic activities, callisthenic gymnastics, stretching exercises, and recreational activities were included in the program. Participants were instructed to focus their attention on the performance of each exercise. Each session had five parts: warming up, initial stretching, main activities, cool-down, and final stretching. The functional capacity components were introduced mainly during the practice of the main activities. The program took place over a six-month period (72 sessions, 3 times per week, at 60 minutes per session). Every 12 sessions, load progressively increased.

b. Adaptive Program: The purpose of this program was to alter the effects of inactivity through exercises related to flexibility, strength, motor coordination, and balance. Low-complexity exercises were applied for six months (24 sessions, once per week, at 60 minutes per session). Incremental load changes were not applied.

2.4. Statistical analyses

Participants in both intervention groups were required to have completed at least 70% of the sessions in order to be included in the data analyses. The dependent variables were defined as (A) score on Berg’s FBS; and, (B) time taken to complete the TUG.

In order to compare the dependent variables between groups at the two times of intervention (pre- and post-test), one MANOVA was used, with the time of intervention considered as a repeated measure. Univariate analyses were employed whenever a MANOVA
revealed a main effect for group or intervention time. A significance level of 0.05 was defined for statistical analyses, which employed SPSS 10.0 (SPSS, Inc.) software.

3. Results

There were no significant differences between intervention programs for both of the dependent variables at baseline (Berg's FBS: $t = 1.79$, $P > 0.05$; TUG: $t = -0.94$, $P > 0.05$). Figure 1 illustrates the descriptive results (means and standard deviations) of the dependent variables (score on Berg's FBS and time taken to complete the TUG).

A 2 (groups) by 2 (times of intervention) MANOVA revealed that both groups were affected by the intervention programs (Wilks' Lambda = 0.755, $F_{30} = 3.242$, $p = 0.036$). Univariate analyses revealed that participants of both groups improved their mobility ($F_{12} = 4.775$; $p = 0.036$) and balance ($F_{12} = 69.884$; $p = 0.004$) from pre- to post-test. Both the multi-mode and adaptive programs were able to improve balance and mobility in the patients with PD. There were no significant differences of groups or interaction between factors in results for either mobility or balance ($p > 0.05$).

![Fig. 1. Means and standard deviations of (A) the score on Berg's FBS and (B) time taken to complete the TUG by the intervention programs.](image)

4. Discussion

The purpose of this study was to investigate the effects of two intervention programs, a multi-mode exercise program and an adaptive program, on the mobility and functional balance in people with PD. The results revealed positive effects for both intervention programs. Berg's FBS and the TUG test provided useful measures to changes in aspects that are related to functional balance and mobility, following interventions based on physical exercises.

The TUG time values indicate individuals' levels of mobility. The mean values of the time taken to perform the TUG in pre- and post-tests for both groups were below 20 s, which indicate good performance and which classified the patients as independent individuals [14,23]. Our mean values for both groups for TUG time values were similar to those reported by Christofoletti et al. [1], but quite a bit higher than those reported by Schilling et al. [24] for PD patients $(7.4 \pm 2.3)$. Older adults that perform the TUG in less than 20 s are considered totally independent in tasks that involve direction change, which also transfers to their ability to perform activities of daily living. Consequently, they have higher scores on Berg's FBS and sufficient walking velocity for locomotion within a community [23].

The TUG combines sequential motor actions. These motor actions require components of functional capacity such as strength, flexibility, and agility. Schilling et al. [24] observed a positive relationship between strength and TUG time. These components are very important to the performance of ADL tasks such as standing up and sitting down [25], and walking and turning. Therefore, the decreases in time required to perform the TUG test for both groups can be a consequence of improvements in these components. Higher levels of strength, flexibility, and agility can contribute to better performance both in ADL and in quality of life [26].

Functional balance, also, is crucial in ADL performance. Our mean values for Berg's FBS in pre- and post-interventions were close to 50 points. While our groups improved in functional balance after the intervention, Christofoletti et al. [1] observed similar mean values for people with PD and healthy matched controls. However, these authors attributed this similarity to patients' physical activity levels. Participation in physical activities can promote gains in functional balance that are related to fall prevention not only in older adults [27], but also in people with PD [28].

It is well documented that physical activity should be a component of healthy everyday life for everyone, and there is a consensus amongst researchers about the short-term benefits of exercise interventions for people with PD [4,12]. However, in order to prolong the benefits provided by these interventions, people with PD should practice exercises on an everyday basis. PD patients enrolled in exercise interventions with durations longer than six months, regardless of exercise intensity, have shown significant gains in functional balance and mobility as compared to programs of only two-week [4] or ten-week [12] durations.

Inactivity has been responsible for the increment in ADL performance lost while exercise can stimulate dopamine synthesis in remaining dopaminergic cells [29]. The association among the disease progression, the undesired effects of the anti-parkinsonian medication and the inactivity can reduce the patients' quality of life in a cyclic reaction way, which some authors called accelerated aging [30]. The benefits observed in the low intensity intervention (adaptive program) proved that breaking down the physical inactivity revealed to be an important factor to stop that cyclic reaction. It is also can be confirmed by the maintenance of the patients' clinical status during our long duration programs.

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In summary, both exercise interventions were effective in improving functional balance and mobility in people with PD. Therefore, people with PD can benefit from such exercises, since they can help facilitate and prolong the performance of ADL, and, consequently, quality of life.

This suggests that exercise interventions should be a necessary ongoing adjunct to PD medication. The optimum form that such exercise practices should take is not yet clear, and a variety of activities has been suggested. For example, Falvo et al. [26]...
recommended resistive exercises, while Hackney and Earhart [11] recommended Tango dance. However, the patient's interest and pleasure should be considered, as well as the inclusion of outpatient settings for people with PD [11,12]. That is, exercise practice should be promoted not only as a therapy, but also as an activity of a healthy patient lifestyle.

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Conflict of interests
The authors have no conflicts of interest to disclose.

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