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Effects of treadmill-walking training with additional body load on quality of life in subjects with Parkinson's disease

Efeitos do treino da marcha em esteira com aumento da carga corporal sobre a qualidade de vida de sujeitos com doença de Parkinson

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Abstract

Background: Parkinson's disease (PD) causes motor and non-motor impairments that affect the subject's quality of life. **Objective:** To assess the effects of treadmill-walking training with additional body load on the quality of life and motor function of subjects with PD. **Methods:** Nine subjects with PD, Hoehn and Yahr stages 2-3, not demented and with capability to ambulate independently took part in this study. The training program was divided into three phases (A_1-B-A_2): treadmill training with additional body load (A_1), control condition (conventional physical therapy group; B) and a second period of treadmill training with load (A_2). Each phase lasted six weeks. Quality of life and motor function were assessed by the PDQ-39 and the motor score of the Unified Parkinson's Disease Rating Scale (UPDRS), respectively. The evaluations and the training were performed during the on-phase of the medication cycle. **Results:** There was improvement in the total PDQ-39 score across the training period. The subscores mobility, activities of daily living and cognition subscores significantly improved after the training period. The improvement in the total score was associated with motor and non-motor factors in all of the training phases. The UPDRS motor score also improved, however it did not present any association with the improvement in quality of life. **Conclusions:** The results showed that the treadmill-walking training with additional body load allowed an improvement in motor and non-motor aspects related to quality of life and motor function in subjects with PD.
Article registered in the Clinical Trials.gov under the number NCT 00890669.

Key words: treadmill training; body load; quality of life; Parkinson's disease.

Resumo

Contextualização: A doença de Parkinson (DP) causa prejuízos motores e não-motores que afetam a qualidade de vida dos sujeitos. **Objetivo:** Avaliar os efeitos de um treino de marcha em esteira, com aumento da carga corporal, sobre a qualidade de vida e a função motora de sujeitos com DP. **Métodos:** Nove sujeitos com DP idiopática, estágio 2 a 3 da escala de Hoehn & Yahr, sem demência e com capacidade de andar independentemente participaram do estudo. O programa de treino foi dividido em três fases (A_1-B-A_2) de seis semanas cada: treino da marcha em esteira com aumento da carga corporal (A_1), condição controle (fisioterapia convencional) (B) e treino da marcha em esteira novamente (A_2). A qualidade de vida e a função motora foram avaliadas, respectivamente, pela PDQ-39 e escore motor da UPDRS (Escala Unificada de Avaliação da Doença de Parkinson). As avaliações e os treinos foram realizados na fase *on* do ciclo da medicação. **Resultados:** Houve melhora no escore total da PDQ-39 ao longo do período de treino. Os subitens mobilidade, atividades da vida diária e cognição da PDQ-39 melhoraram significativamente após o treino. A melhora no escore total mostrou correlação com fatores motores e não-motores. O escore motor da UPDRS também melhorou, no entanto, não houve correlação com a melhora na qualidade de vida. **Conclusão:** Os resultados mostraram que o treino em esteira com aumento de carga corporal permitiu uma melhora de aspectos motores e não-motores relacionados à qualidade de vida e à função motora de sujeitos com DP.
Artigo registrado no Clinical Trials.gov sob o número NCT 00890669.

Palavras-chave: treino em esteira; carga corporal; qualidade de vida; doença de Parkinson.

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Introduction

Parkinson's disease (PD) is a chronic degenerative disorder that has an adverse impact on patients' lives[1]. Symptoms such as hypokinesia, rigidity, tremor, postural abnormalities, gait disorders, sleep and communication disorders, pain, difficulty with manual abilities, and depression lead to falls, social embarrassment, isolation, loss of hobbies and leisure activities, and increased dependence[1-3]. Treatments for PD aim to improve motor function[3,4], however non-motor symptoms should be considered because they also affect the quality of life of subjects with PD.

Quality of life refers to the patient's perception and self-evaluation regarding the physical, psychosocial and emotional effects of the illness on her or his life. Therefore, the assessment of quality of life is subjective and multidimensional[2], and it varies according to the progression of the disease[5]. The assessment of the impact of the illness on quality of life is an important measure of treatment efficacy[6] because the most common clinical scales do not appropriately assess the non-motor symptoms related to the disease. One of these scales is the Parkinson's Disease Questionnaire (PDQ-39) is a specific instrument for PD, and has been shown to be viable, valid, consistent, reliable, responsive and reproducible[7-9] in the assessment of the functional, emotional and psychosocial aspects of the patient's quality of life.

Physical activity promotes improvement in motor aspects such as strength, gait and, balance of subjects with PD[10]. The quality of life of these subjects also improves with exercise[10,11]. Different studies involving dancing[12], high-intensity eccentric resistance training[13], aerobic conditioning and muscular strengthening[14], and Nordic walking[15] observed improvement in the quality of life and motor function of subjects with PD.

The treadmill has been used as an external cue to walking training of subjects with PD. Studies using the treadmill and body weight support[16] or the treadmill alone[17,18] observed improvements in gait and motor performance in these subjects, as well as improvement in quality of life[18]. However, subjects with PD show impairment in the load receptors that affect proprioceptive function and cause a decrease in leg extensor muscle activity[19]. This impairment reduces propulsion, stride length and gait speed[20,21].

There is evidence that the increase in body load during treadmill walking in healthy subjects improves reflex activity and leg extensor muscle activity[22,23]. Thus, training with additional body load would benefit subjects with PD. However, studies on the effects of treadmill training with additional body load in PD are lacking. Only one study[21] has assessed the effects of this training on the gait, balance, fall risk, and daily function of subjects with PD. Therefore, the purpose of the present study was to assess the effects of treadmill-walking training with additional body load on the different aspects of the quality of life and motor function of subjects with moderate PD.

Methods

Subjects

Nine subjects (7 male, 2 female) with idiopathic PD, previously diagnosed by a specialist physician, took part in this study. Inclusion criteria were: Hoehn and Yahr (H-Y) stages 2-3, absence of dementia (Mini Mental Status Examination – MMSE, defined according to educational level)[24], and capacity to ambulate independently. Exclusion criteria were: change of medication (dopaminergics) during the study period; use of treadmill for at least six months prior to the study; other neurologic problems; musculoskeletal, cardiovascular or respiratory disease; uncorrected visual deficit that could pose a risk and interfere in the accomplishment of the training. All subjects were in a stable drug program and had been adapted to their current medications for at least two weeks. The mean age was 65.88 (±8.13) years, and the mean body mass was 71.51 (±17.27) kg at the beginning of the study. The mean illness duration was 5.44 (±4.06) years, the classification mean in the H-Y scale was 2.8 (±0.45), and the MMSE score was 27.11 (±2.57). The subjects were recruited from the city's health service. This study was approved by the Human Research Ethics Committee of Universidade Federal de São Carlos (UFSCar), São Carlos (SP), Brazil (Approval report number 234/07), and all subjects gave their written informed consent according to the declaration of Helsinki, prior to entering the study.

Experimental setup

The training program was divided into three phases (A_1-B-A_2): treadmill training with additional body load (A_1), control condition (conventional physical therapy group; B) and a second period of treadmill training with additional body load (A_2). Each phase lasted six weeks, totaling 18 weeks. Both evaluations and training were performed during the on-phase of the medication cycle. The choice of the A-B-A design was based on previous clinical studies[25-28]. This design has been used for small sample and large intra- and inter-subjects variability. In this methodology, it is recommended that the intervention be tested in duplicate.

Instruments and procedures

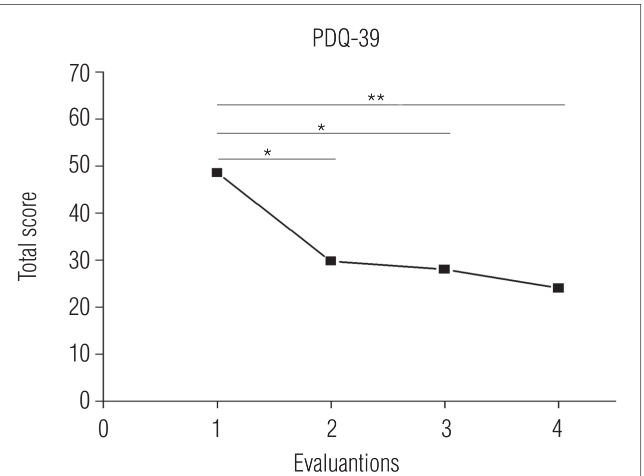
All subjects were submitted to a clinical evaluation that consisted of personal data collection, anamnesis (past and current history, previous treatment, pharmacological treatment and life habits), physical examination and body mass measurement. The subjects' quality of life and disability were assessed in the pretraining condition and after each phase of the training program (four evaluations). The quality of life was measured through the PDQ-39, which comprises 39 questions, each of them with five different answer options (never, occasionally, sometimes, often or always). Eight subscores (mobility, activities of daily living - ADLs, emotional wellbeing, stigma, social support, cognition, communication, and bodily discomfort) and a total score can be calculated. Higher scores indicate a greater problem, according to the subject's perception. To identify the disability, the Unified Parkinson's Disease Rating Scale (UPDRS) was used. It is composed of 42 items divided into four main sections. In this study, only the motor score (part III) was assessed. This section contains 14 questions with scores from 0 (normal) to 4 (unable to perform the task). Higher scores indicate greater impairment.

Training protocol

The training consisted in walking on a treadmill wearing a weighted scuba-diving belt (Seasub), which increased the normal body mass by 10% approximately. The treadmill (Athletic Speedy 3) allows tuning of the speed with increments of 0.1 km/h (minimum speed 0.1 km/h) and it has frontal and adapted lateral bars for hand support. In addition, the subjects walked with a safety harness to prevent falls. The load was positioned around the waist, close to the center of mass, to avoid problems with postural adjustment.

The training was performed 50 minutes per day, three days per week for six weeks in each one of the A phases. Each session consisted of a five-minute warm-up in an unloaded cycle ergometer, 40 minutes of treadmill training with additional body load, followed by five minutes of recovery, with decreased speed. During training, the treadmill speed was gradually increased and the subjects were instructed to walk until the maximum comfortable speed was reached. The speed was recorded in each session. The heart rate was monitored during the entire training session through a frequency meter (Polar A3). If the submaximal value calculated for each subject was exceeded, the training session was interrupted. The blood pressure was measured at the beginning and at the end of each session, and when necessary, during the session, in case the subject felt any sign of indisposition. The treadmill remained horizontal throughout the training period. Before the beginning of the training, the subjects were given time to become familiar with the treadmill, and they were instructed in the sequence of activities to be performed.

In the control condition (phase B), conventional physical therapy sessions were performed one hour per day two days per week. The subjects were treated as a group. This period included stretch exercises of the main muscle groups, strength, coordination, mobility and balance exercises, ADL training, and gait training in different conditions. The subjects were instructed and encouraged to perform the exercises at home.



* indicates significant differences between pretraining evaluation and evaluations after phase A_1 and B ($p \leq 0.05$); ** indicates significant differences between pretraining evaluation and evaluation after phase A_2 ($p \leq 0.01$).

Figure 1. Mean total PDQ-39 score in each evaluation (n=9).

Data analysis

The total score as well as the subscores of the PDQ-39 were calculated according to Peto, Jenkinson and Fitzpatrick[29]. The UPDRS motor score was calculated as the sum of scores in each question. Before statistical analysis, data normality and variance were tested using the Kolmogorov-Smirnov and Levene tests, respectively. The Friedman test was used to compare the results of the four evaluations. This analysis was followed by a post-hoc Dunn test. Spearman's correlation coefficient was used to investigate the relationship between the total PDQ-39 score, the PDQ-39 subscores and the UPDRS motor score in each evaluation. A p-value ≤0.05 was considered statistically significant.

Results

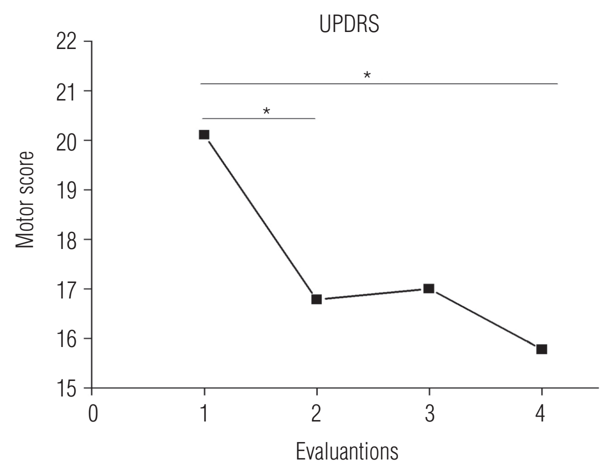
The subjects presented a significant decrease in the total PDQ-39 score ($p=0.002$) across the evaluations compared to the pretraining evaluation ($p<0.05$ for the evaluation after phase A_1 and after phase B, and $p<0.01$ for the evaluation after phase A_2). Although the score continued to decrease after phase A_1, no significant differences were observed between the second evaluation and the following evaluations (Figure 1).

Regarding the PDQ-39 subscores (Table 1), significant differences were observed in mobility (p=0.035), ADL (p=0.006), and cognition (p=0.001) subscores. For the mobility and ADLs subscores, the differences were observed between the pretraining evaluation and the final evaluation ($p<0.05$ and $p<0.01$, respectively). For the cognition subscore, differences were observed between pretraining and all other evaluations ($p<0.05$ for the evaluation after phase A_1 and after phase B, and $p<0.01$ for the evaluation after phase A_2; Table 1). The UPDRS motor score also decreased across the evaluations (p=0.001) and significant differences were observed between the pretraining evaluation and the evaluation after phase A_1 ($p<0.05$) and after phase A_2 ($p<0.01$; Figure 2).

The correlations between the total PDQ-39 score and the subscores are shown in Table 2. In the pretraining evaluations, the total score showed a significant correlation with the subscores emotional wellbeing and social support (p=0.02 and p=0.00, respectively). In the evaluation after phase A_1, the subscores mobility, ADLs, emotional wellbeing and communication were significantly correlated with the total score (p=0.02, p=0.00, p=0.01 and p=0.02, respectively). In the evaluation after phase B, the correlations were observed between the total score and the subscores mobility (p=0.00), ADLs (p=0.00), stigma (p=0.03) and communication (p=0.00). Finally, the evaluation after phase A_2 showed significant correlation between the total score and mobility (p=0.00), ADLs (p=0.00) and communication (p=0.01). The total PDQ-39 score was not significantly correlated ($p>0.05$) with the UPDRS motor score in any of the evaluations (Table 2).

Discussion

The present study assessed the effects of treadmill-walking training with additional body load on the quality of life and



* indicates significant differences between pretraining evaluation and evaluations after phase A_1 and A_2 ($p\leq0.05$).

Figure 2. Mean UPDRS motor score in each evaluation (n=9).

Table 1. PDQ-39 subscores in each phase.

Measures	Pretraining score	Score after A_1	Score after B	Score after A_2
Mobility	58.9 (±21.9)	33.9 (±16.4)	31.7 (±19.9)	25.6 (±16.1)[d]
ADLs	73.1 (±13.9)	48.6 (±22.5)	51.4 (±26.1)	43.9 (±27.6)[c]
Emotional wellbeing	42.6 (±27.1)	25.0 (±20.4)	26.8 (±15.9)	18.5 (±18.3)
Stigma	26.4 (±25.5)	23.6 (±17.3)	9.7 (±13.7)	9.0 (±12.5)
Social support	14.8 (±18.0)	5.6 (±9.3)	7.4 (±14.7)	6.5 (±10.8)
Cognition	47.9 (±18.7)	22.9 (±13.3)[a]	20.1 (±10.7)[b]	18.7 (±10.4)[c]
Communication	42.6 (±17.9)	26.9 (±19.9)	25.9 (±21.0)	25.0 (±23.9)
Bodily discomfort	41.7 (±25.0)	32.4 (±21.4)	28.7 (±20.0)	29.6 (±18.2)

Values are means (±SD). ADLs (activities of daily living); [a] Differences between the pretraining and phase A_1 measures were significant at $p\leq0.05$; [b] Differences between the pretraining and phase B measures were significant at $p\leq0.05$; [c] Differences between the pretraining and phase A_2 measures were significant at $p\leq0.01$; [d] Differences between the pretraining and phase A_2 measures were significant at $p\leq0.05$.

Table 2. Correlations between total PDQ-39 score, PDQ-39 subscores and UPDRS motor score.

Correlations	Pretraining score	Score after A_1	Score after B	Score after A_2
Mobility x total	0.6	0.7*	0.9**	0.9**
ADLs x total	0.7	0.9**	0.9**	0.9**
Emotional wellbeing x total	0.7*	0.8*	0.6	0.4
Stigma x total	0.3	0.2	0.7*	0.0
Social support x total	0.8**	0.3	0.6	0.1
Cognition x total	-0.5	-0.1	0.5	0.3
Communication x total	0.4	0.7*	0.9**	0.8**
Bodily discomfort x total	0.4	0.4	0.4	0.0
UPDRS x total	-0.1	0.5	0.4	0.6

Values are correlation coefficients. ADLs=activities of daily living; * Significant at $p\leq0.05$; ** Significant at $p\leq0.01$.

motor function of subjects with PD. The key findings were improved quality of life and decreased motor disability related to the disease after the treadmill training.

The total PDQ-39 score showed a decrease across the training period, meaning that there was a perceived improvement in quality of life after treadmill training. This improvement was maintained after the control condition and after the second phase of the treadmill training with additional body load. The PDQ-39 subscores showed significant improvement in mobility, ADLs and cognition, i.e. the motor training had positive effects on motor and non-motor aspects of quality of life in the subjects with PD. Cognition was the item most sensitive to changes related to training because it showed improvement after all phases of the program. Gait disturbances and difficulty accomplishing self-care activities often lead to functional dependence and marked impairments in quality of life[4,18,30]. Carod-Artal et al.[31] observed that, in Brazilian patients, the decrease in quality of life was related to mobility and ADL. Physical activity promotes functional motor gains, musculoskeletal conditioning, aerobic fitness and may prevent or delay secondary complications[15,32-34], therefore exercise may improve the quality of life of subjects with PD.

Schrag, Jahanshahi and Quinn[4] highlight the importance of cognitive aspects to determine the quality of life of subjects with PD. Physical activity not only improves the motor aspects but is also associated with improvement in cognition. One of the potential mechanisms that could explain this is the increase in hippocampal neurogenesis that results from moderate aerobic activity[35]. The literature also describes that moderate exercise leads to an increase in the level of dopamine that would be beneficial to subjects with PD[36]. Furthermore, the improvement in quality of life after a physical activity can be also attributed to social interaction and motivation[12]. In our study, motivation and enthusiasm were greater in phase A_1 compared to phase A_2, possibly due to the long duration of the training program.

A significant difference was found in three subscores, however all of the other subscores (emotional wellbeing, stigma, social support, communication and bodily discomfort) showed a decrease at the end of the training period, indicating attenuated symptoms in all of the items included in the questionnaire. Thus, the treadmill training with additional body load played a major role in improving the quality of life of the subjects with PD. Herman et al.[18] also identified positive effects of treadmill-walking training, without loading or unloading, on the quality of life and general wellbeing of subjects with PD, however the authors highlight its effects on gait.

The use of loading in treadmill walking to train subjects with PD is promising. The treadmill acts as an external cue, imposes a rhythm and is a task-specific repetitive training that promotes improvement in locomotor behavior[37]. Additionally, the increase in body load may improve proprioceptive function, which is essential for the maintenance of body equilibrium during stance and gait but is impaired in subjects with PD[38]. Therefore, this training promotes motor gains that lead to improved gait and quality of life in these subjects. The emotional factor may not have improved as much as the cognitive factor due to the involvement of the amygdala and basal ganglia in emotional and mood modulation[39]. Therefore, the treadmill training may have promoted a qualitative improvement in the emotional aspect. A hypothesis would be that emotional alterations are an intrinsic symptom of PD.

Regarding the correlations between the total PDQ-39 score and the subscores, it was observed that, at the beginning of the study, the quality of life of the subjects with PD was more related to social and emotional aspects. PD affects the patient's life not only with the typical motor symptoms but also in a multi-dimensional way, including aspects related to mood, cognition, social function, psychological status, communication, occupation and sleep disorders[40-42]. The improvement in quality of life observed after the intervention in the present study was mainly related to motor aspects and communication. The communication capability may have improved due to the interaction with the therapist and other people at the therapeutic environment and, therefore, influenced the total PDQ-39 score. However, this subscore did not present significant differences across the training period. The sum of the subscores may have influenced the total score, however a cause-effect relationship could not be established.

The treadmill training with additional body load was also able to improve the UPDRS motor score. Studies on the effects of treadmill-walking training on PD[16,18] also observed an improvement in the UPDRS score. The UPDRS shows changes after specific interventions and is becoming the gold standard reference scale in PD[43]. However, in the present study, the improvement in the motor score was not associated with the improvement in quality of life in any of the evaluations. This result corroborates previous studies[1,4,7,44], in which the authors affirm that the PDQ-39 and the clinical scales are designed to assess different aspects of PD. The clinical scales used to assess the physical impairment and the results of treatment do not assess the psychosocial factors that are important components of wellbeing and perhaps the most important outcome in treatments[43]. The UPDRS and the H-Y scales may not be sensitive measures to evaluate the impact of disease severity on daily life[1]. In contrast, other studies[9,45,46] found an association between UPDRS scores and quality of life measures. According to Havlikova et al.[9], disease severity evaluated through the UPDRS was a significant predictor of all subscores, except for social support and cognition.

In conclusion, therapy for chronic degenerative diseases such as PD should aim to improve the physical conditions of the subjects and treat a number of other factors related to quality of life. Health care professionals should not only focus on caring of disease or increasing survival but also enhancing the patients' quality of life[2]. The treadmill training with additional body load applied in the present study allowed the improvement of motor function and quality of life in subjects with PD. However, a limiting factor was the small number of subjects evaluated. Despite the large number of individuals with PD, most of them did not fulfill the established inclusion criteria. Another limitation was the possibility of a carryover effect from one phase to the next. However, the A_1-B-A_2 design allowed the evaluation of the same subject in different phases of the training, i.e. the subjects acted as their own controls. Other factors that may have interfered in the results were the heterogeneity of PD and the natural progression of the disease. Based on the results, we suggest combining the treadmill training and additional body load with conventional physical therapy to maximize results. We also suggest that other studies investigating the effects of intervention in PD include the assessment of quality of life. Furthermore, it would be interesting to evaluate how depression and disease duration/progression are related to quality of life and how these factors can interfere in a successful intervention.

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