Revista ARACÊ
ISSN: 2358-2472

EFFECTS OF WHOLE BODY VIBRATION ON THE FUNCTIONAL MOBILITY AND QUALITY OF LIFE OF INDIVIDUALS WITH PARKINSON'S DISEASE

https://doi.org/10.56238/arev7n3-009

Date of submission: 04/02/2025 **Date of publication:** 04/03/2025

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ABSTRACT
Background: Parkinson's disease, with its evolution, leads to progressive disorders that compromise the functional mobility of the affected individuals. The whole body vibration as a rehabilitation tool seems to be a promising alternative in Parkinson's disease. Objective: The aim of this study was to verify the effect of VCT on functional mobility and quality of life in individuals with Parkinson's disease. Methods: Ten individuals (four men and six women) diagnosed with Parkinson's disease were evaluated before and after a protocol of 10 training sessions on a vibrating platform using the Short Physical Performance Battery (SPPB) in the domains: balance, gait, limb strength and Parkinson's Disease Questionnaire -PDQ39. The pre and post-intervention data were compared using the using the ANOVA test for repeated and post-hoc Bonferroni measurements ($p < 0.05$). Results: Those evaluated had an average age of 70.00 ± 9.68 years and an average disease evolution time of 3.38 ± 1.51 years. The whole body vibration increased the SPPB scores in all domains: balance (10%), gait (31%), lower limbs (35%) and total strength (23%), and reduced the total scores of the PDQ- 39 (23%). Conclusions: It was concluded that the suggested vibration protocol was able to improve the functional capacity and quality of life of individuals with Parkinson's disease.

Keywords: Physiotherapy. Whole Body Vibration. Functional Mobility.

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ISSN: 2358-2472

INTRODUCTION

Parkinson's disease (PD) is a neurodegenerative disease whose main symptoms are stiffness, postural instability, bradykinesia, tremor[1] and decreased muscle strength[2].

The progressive disorders caused by PD result in impaired functional mobility, whose definition is related to the ability to move with the greatest possible degree of independence, interfering in the execution of tasks and in the performance of activities of daily living[3]. The marked motor impairments, the progressive physical limitation and the deficiency in functional mobility make the physical aspects one of the main responsible for the worsening of the Quality of Life (QOL) of the individuals[4] , in addition to contributing to disability in advanced stages of the disease[3].

According to Tarazi et al.[5], pharmacological treatment only promotes symptom relief, but does not control or prevent disease progression. According to SOUZA et al.[6] the realization of therapy through exercises can act as an adjunct to pharmacological therapy and promote the maintenance of the individuals' functional capacity and quality of life. According to the literature, treatments aimed at increasing strength[6] and improving proprioception[7], can positively affect the functionality and quality of life of individuals with PD.

Among the new forms of treatment, low-frequency whole body vibration (WBV), applied through vibrating platforms, has been used as a stimulus for the neuromuscular structure, generating acute and chronic improvements in gait, balance, proprioception and muscle strength[8,9]. WBV has been recognized as a modality for increasing muscle strength and power mainly in athletes, the elderly and individuals with neurological diseases[10,11,12].

Vibration is defined as a mechanical stimulus characterized by an oscillatory movement whose intensity varies according to the frequency, amplitude and magnitude of the generated movement; it can be applied to the human body in a localized way or transmitted to the whole body[9,13]. According to the literature, vibration provides proprioceptive information to the Central Nervous System, arising from the muscle spindle[14], and induces reflex muscle activation[15], possibly resulting in benefits in the capacity to generate strength muscle[16].

Some authors suggest that vibration may be beneficial for motor symptoms in healthy elderly people[10] and individuals with different neurological disorders[11,12].

Although the evidence suggests beneficial effects of WBV on balance[17] on gait and on sensory motor performance[16,18] of individuals with PD, there are no studies that

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ISSN: 2358-2472

evaluated the effects of vibration on functional mobility through the Short Physical Performance Battery (SPPB), which is considered, according to Guralnik et al. [19] one of the simplest instruments for assessing functional mobility. And, according to Freire et al. (2012)[20] is an objective measure less influenced by culture, educational level, and language than measures of self-reported function and disability. Thus, the present study aimed to verify the effect of WBV on functional mobility and on the quality of life of individuals with Parkinson's disease.

MATERIALS AND METHODS

Ten individuals with a medical diagnosis of PD were selected after approval by the Research Ethics Committee (opinion 0704/2013) and all participants signed an informed consent form. Participants in the study were individuals over the age of 18, classified in stages between 1 to 3 on the Hoehn & Yahr Scale[21], who were able to understand verbal instructions, to remain in an orthostatic position and to walk independently. All participants scored ≥24 on the Mini Mental State Examination (MMSE).

Individuals who had another neurological disease or musculoskeletal problems that compromised the performance of the tests were not included. In total, 14 patients were recruited, but only 11 met the inclusion criteria and agreed to participate in the study. Of the 11 participants, one was excluded because he presented another neurological disease during the treatment, preventing him from continuing the training.

All procedures (evaluations and treatment) were performed during the medication period. Before starting the training protocol, the participants were evaluated using the Parkinson's Disease Questionnaire -PDQ39[22] and by the Short Physical Performance Battery (SPPB)[23].

The PDQ39 is a specific questionnaire developed for this population validated for English - United Kingdom, German, Spanish, Chinese, Greek and French[24,25] and adapted for Brazilian Portuguese in Health Services Research Unit, in 2005 and validated for the Brazilian population in 2007[22]. The PDQ-39 questionnaire comprises 39 items divided into eight categories: mobility (10 items); activities of daily living (6 items); emotional well-being (6 items); stigma, which assesses various social difficulties around PD (4 items); social support, which assesses the perception of support received in social relationships (3 items); cognition (4 items); communication (3 items) and body discomfort (3 items). The total score on the PDQ-39 ranges from zero (no problem) to 100 (maximum level of problem), that is, the higher the score obtained, the worse is the person's perception of their quality of life[22].

Short Physical Performance Battery (SPPB) is a test battery validated in Brazil[26] that assesses physical performance through tests of static balance, gait speed and strength of lower limbs. Short Physical Performance Battery (SPPB) tests were performed. Functional mobility was assessed by means of static balance tests assessed in three positions: standing with feet together, standing with one foot partially in front, standing with one foot in front; gait speed over a 4 meter course; and lower limb strength assessed using the test USING THE TEST to get up from the chair five times in a row as quickly as possible. The total SPPB score, obtained by adding the scores of each test allows values between zero and 12 points and represents the physical performance classified through the following graduation: incapable or with very poor physical performance (zero to 3 points), low physical performance (4 to 6 points), moderate physical performance (7 to 9 points) and good physical performance (10 to 12 points)[23].

Immediately after the first training session, individuals were reevaluated using the SPPB. The same procedures as the initial assessment were performed at the end of the training.

The treatment consisted of five weeks of training on the vibrating platform, twice a week, being performed in two positions: a) feet apart in a stable and comfortable position with knees extended, with the aim of obtaining greater activation of postural muscles; b) feet apart and semi-flexed knees. In each of the positions, the vibration was performed in five series of 1 minute duration, with an interval of 1 minute between each series, based on protocols previously performed[27,28,29]. An interval of five minutes was given between the first and the second position. The training was performed on a KIKOS® model P201 lateral vibrating platform with a width of 3 mm[27,28,29] and an average frequency of 30Hz, considering that according to Hallal et al.[13], the optimal training frequency is in the range of 26 to 40Hz. In the following session after the end of the training, the individuals were reevaluated.

Comparisons were made between groups and the possible effect of post-intervention vibration was analyzed. The pre and post-intervention data were compared using the SPSS® software using the ANOVA One Way Test for repeated and post-hoc Bonferroni measurements ($p < 0.05$).

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ISSN: 2358-2472

RESULTS

The study concluded ten individuals, four men and six women. The sample characterization is shown in Table 1 with the data expressed as mean and standard deviation.

Table 1: Characterization of the sample under study.

	Mean	Standard Deviation
Age (years)	70	±9,68
Disease Evolution Time (years)	3,38	±1,51
Levodopa dose (mg/day)	343,75	±187.5

The individuals showed improvement in the quality of life expressed by the total score of the PDQ-39 after the training program. Table 2 reports the maximum, minimum and average scores obtained on the PDQ-39 before and after training with the vibrating platform.

Table 2: Comparison of PDQ-39 scores before and after training.

Domain	Min.value (before)	Max. value (before)	Average (before)	Min. Value (after)	Max. Value (after)	Average (after)
Mobility	7,5	100	57,99	0	97,5	44,91
Daily living activity	12,5	100	59,29	0	91,6	45,02
Emotional well-being	12,5	75	45,52	0	70,8	36,94
Stigma	0	62,5	24,58	0	62,5	20,12
Social support	0	75	57,99	0	100	26,58
Cognition	12,5	81,3	44,57	12,5	75	34,73
Communication	0	91,6	39,97	0	91,6	33,16
Body discomfort	0	100	55,23	0	100	49,92
Total	13,46	74,35	43,28	9,25	68,6	33,14*

*p<0,01

Table 3 presents the results in the SPPB before and after ten training sessions on the vibrating platform in mean and standard deviation.

Tabela 3: Comparison of performance evaluation in SPPB before and after training.

SPPB	Before	After	p
Balance	3,36±0,93	3,73±0,47	p<0,05
March	2,18±1,33	3,18±1,10	p<0,01
Lower limb strength	1,18±0,41	1,82±0,98	p<0,05
Total	6,73±2,15	8,73±2,05	p<0,01

SPPB (Short Physical Performance Battery).

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ISSN: 2358-2472

Table 4 presents the results in SPPB before, after a single session and after 10 training sessions on the vibrating platform in mean and standard deviation.

Tabela 4: Comparison of performance evaluation in SPPB before, after the 1st session and after training.

SPPB	Before	After 1st session	After
Balance	3,36±0,93	3,67±0,49	3,73±0,47
March	2,18±1,33	2,67±1,16	3,18±1,10
Lower limb strength	1,18±0,41	1,67±1,23	1,82±0,98
Total	6,73±2,15	8,00±2,05	8,73±2,05

SPPB (Short Physical Performance Battery).

In the study, it is possible to observe that after a single WBV session, the subjects showed a significant improvement in the total SPPB score, going from the low classification (6.73 ± 2.15 - 4 to 6 points) to moderate physical performance (8.00 ± 2.05 - 7 to 9 points) according to the classification of Guralnik and collaborators[23]. After the 10 training sessions, the subjects showed significant improvement in all SPPB scores.

DISCUSSION

The study sample was characterized by being composed mostly of women with an average age of 70 years. According to the literature, PD typically develops after the age of 65 and men are more prone to the disease, although they seek health services less than women[30].

After five weeks of training with WBV, the participants showed improvement in the balance, gait and strength of the lower limbs, in addition to an improvement in the quality of life. Individuals showed an increase in the total SPPB score, going from low to moderate physical performance.

A possible justification for the improvements in functional mobility and quality of life presented in our study may be the increase in strength. The improvement in functional mobility may have been caused by the reflex muscle activation resulting from the proprioceptive information to the Central Nervous System. Vibration causes repeated changes in the length of muscle fibers, which increases the rate of firing of type Ia afferent fibers, with consequent excitation of α motor neurons, possibly resulting in benefits in proprioceptive capacity and muscle strength generation, even after a single training session on a vibrating platform[14,15,16,31].

Previous studies have already linked increased strength with improved physical performance[32], balance[33], gait[34] and quality of life[33] in individuals with PD[35]. The improvement in muscle strength can result in better performance in performing tasks, reducing its execution time, characterizing better functional mobility. With the gain in strength, the vibration resulted in improved functional mobility and balance, which may have led the participants to perform their activities of daily living with greater ease, allowing for improved self-perception of quality of life.

The training performed may have been able to increase strength due to neural adaptations that are responsible for the initial increase in muscle strength[36]. According to Moritani[37] and Carroll et al[38], neural adaptations are related to the improvement in strength resulting from motor learning, since they are responsible for the increase in recruitment and synchronization of motor units and decrease in co-contraction of the antagonistic musculature.

According to the literature, an increase in muscle performance, strength and power is suggested after a single session of vibration[39]. Although no evidence of increased muscle strength after chronic treatment with WBV in individuals with PD was found in the literature, increased strength was found, after chronic treatment, in children with Down syndrome[40], in hemiparetic individuals[41] and in institutionalized elderly[42].

Another possible responsible for the improvement in the functional mobility and the quality of life of the individuals may have been the reduction of bradykinesia. Bradykinesia can play an important role in functional mobility, as it compromises the speed of movement execution[43]. As in SPPB tasks are evaluated by the time of accomplishment, the reduction in bradykinesia leads the individual to perform the sit and stand test more quickly five times in a row and walk faster at a distance of four meters. This improvement in performance to perform everyday tasks may have improved the participants' self-perception of quality of life. Kaut and colleagues[44] found an improvement in bradykinesia after the WBV protocol.

The increase in speed in performing the tasks may also have occurred due to the decrease in muscle stiffness. In PD, stiffness is one of the cardinal factors for diagnosis in conjunction with tremor, bradykinesia and postural instability[2]. Vibration can decrease stiffness due to the influence of the myotactic reflex, which is more activated by the increase in excitation of motor neurons α[27]. That is, the reflex muscle activation resulting from the proprioceptive information, originating from the vibratory stimulus, results from the reciprocal inhibition mechanism that occurs in the muscle spindle and in the Golgi tendon organ, which promotes the active contraction of the agonist muscle concomitant to the antagonist inhibition, causing its relaxation[31]. This contraction and relaxation mechanism occurs repeatedly in the muscles during vibration, which can lead to greater activation of the agonist muscles and relaxation of the antagonist, resulting in benefits for motor aspects related to functional mobility.

Although the mechanisms responsible for rigidity in PD are still not well understood, several studies have already reported improved rigidity after the whole body vibration protocol. In the study carried out by Hass and collaborators[27], a decrease in stiffness and tremor was found in a group of patients, after a single session on a vibrating platform. King et al.[45], evaluated the influence of vibration on motor symptoms and functional measures in PD, after a single training session, improvement in functional performance, reduction in stiffness and tremor and significant increase in step length and improvement in speed were observed of the march.

According to Baradaran et al.[46], stiffness is associated with functional limitation in PD patients. For Berardelli et al.[47], stiffness can potentially contribute to a decrease in movement speed (bradykinesia) if it is elicited in an antagonist muscle during isotonic contraction of the agonist. Allen et al.[43] suggested that bradykinesia may be responsible for the lower muscle power required to perform different tasks of daily life present in individuals with PD when compared to individuals without the disease. Thus, the best performance in the SPPB tests found in our study, may have been caused by the decrease in bradykinesia, leading the individual to perform the sit and stand test more quickly five times in a row and walk faster at a distance of four meters .

Several studies have shown promising effects of VCT on variables related to physical performance. In a study carried out by Ebersbach et al.,[34], the treatment performed with WBV showed results as efficient as with conventional balance therapy, a 10-meter gait speed test, a sit-and-stand test and the UPDRS scale. Kaut, 2011[44], performed a training consisting of 15 sessions of five sets of one minute of vibration and found significant improvement in the mobility and balance of individuals with PD, however they found no difference when comparing the results of the control group.

When comparing the performance evaluation in the SPPB before, after the 1st session and after the five weeks of training, it was observed that after a single session of WBV the subjects showed significant improvement only in the total score of the SPPB and after the 10 training sessions the subjects showed significant improvement in all test battery scores.

These results suggest that after the first session there was an improvement in the total SPPB score, and there was no improvement in the specific domains of the test battery: balance, sit-and-stand test and gait speed; this suggests that none of the evaluated components had a greater impact on the final score, however the three domains may have contributed equally to the significant difference found in the final score.

It was also possible to observe that the longer training time was not relevant in the results in the study sample, since no significant difference was found between the results obtained after the 1st session and after the five weeks of training.

Based on the results and suggestions raised, we can suggest that further studies be carried out in order to verify the acute effect of vibration on the strength, stiffness and bradykinesia of patients with PD. And, for that, specific equipment and tests are used, such as an accelerometer in the case of bradykinesia, a load cell for measuring muscle strength and part III of the Unified Parkinson's Disease Rating Scale (UPDRS) to assess stiffness. We also suggest further studies, with larger samples, to assess how long the acute effect persists.

Due to the fact that the protocol used in our study was not able to verify the strength gain resulting from the morphological adaptations, we suggest that further studies be carried out with a longer protocol, longer than 6 weeks, in order to verify these adaptations. And, we also suggest that studies be carried out to evaluate, by means of electromyographic activity, characteristics of the alterations resulting from neural adaptations, such as the decrease in the co-contraction of the antagonistic musculature.

Vibration as a rehabilitation tool seems to be a promising alternative to assist in the rehabilitation of individuals with PD[48,49]. Studies suggest that this type of therapy can be used as an auxiliary method in the treatment of PD, in order to contribute to patient compliance with therapy and not replace conventional physical therapy.

As a limitation of the study, we point out the fact that a direct measure of analysis of muscle strength and bradykinesia was not performed.

CONCLUSIONS

Considering the data presented here, it can be concluded that vibration was able to improve the physical performance of individuals with Parkinson's disease after a single

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ISSN: 2358-2472

treatment session. And that the suggested vibration protocol lasting five weeks was able to improve the functional capacity and quality of life of individuals with PD.

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