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Influence of whole-body vibration and gait training with additional load on functioning, balance, and gait in patients with Parkinson's disease

Influência da vibração de corpo inteiro e do treinamento de marcha com carga adicional na funcionalidade, equilíbrio e marcha em pacientes com doença de Parkinson

Influencia de la vibración de todo el cuerpo y el entrenamiento de la marcha con carga adicional en el funcionamiento, el equilibrio y la marcha en pacientes con enfermedad de Parkinson

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Abstract
Parkinson's disease (PD) is characterized by the selective loss of dopaminergic neurons from the *substantia nigra compacta* and nigrostriatal pathway, which leads to sensory and motor impairments. The aim of the present study was to compare the effect of whole-body vibration and gait training with additional load on functioning, balance and gait in patients with PD. Twenty-two male and female patients (mean age: 61 ± 5.6 years) were randomly allocated to a Control Group (CG), Vibration Group (VG), or Added Weight Group (AWG). The following evaluations were performed before and after the intervention: Unified Parkinson's Disease Rating Scale – subscales "Activities of Daily Living" and "Motor Examination"; Tinetti Test, Timed Up and Go test, Berg Balance Scale, and baropodometry. The ordinal variables were evaluated using the Kruskal-Wallis test ($p \leq 0.05$) and the numerical variables were analyzed using two-way ANOVA followed by the Student-Newman-Keuls *post hoc* test ($p \leq 0.05$). The results demonstrated a significant increase in functioning, balance, and gait quality in the VG and AWG compared to the CG. Vibration training and gait training with additional weight exert a positive influence on functioning, balance, and gait in patients with PD. Other studies can be carried out comparing the effect of the vibratory training with the partial weight support and the addition of body weight using the same variables of the present research.
Keywords: Parkinson disease; Vibration; Gait; Functionality; Postural balance.

Resumo
A doença de Parkinson (DP) é caracterizada pela perda seletiva de neurônios dopaminérgicos da substantia nigra compacta e da via nigrostriatal, levando a deficiências sensoriais e motoras. O objetivo do presente estudo foi comparar o efeito da vibração de corpo inteiro e do treinamento da marcha com carga adicional no funcionamento,

equilíbrio e marcha em pacientes com DP. Vinte e dois pacientes do sexo masculino e feminino (idade média: 61 ± 5,6 anos) foram alocados aleatoriamente para um Grupo de Controle (GC), Grupo de Vibração (GV), ou Grupo de Peso Adicionado (GPA). As seguintes avaliações foram realizadas antes e depois da intervenção: Escala Unificada de Classificação da Doença de Parkinson - assinaturas "Atividades da Vida Diária" e "Exame Motor"; Teste de Tinetti, Teste Timed Up e Go, Escala de Equilíbrio de Berg, e baropodometria. As variáveis ordinais foram avaliadas usando o teste Kruskal-Wallis ($p \leq 0{,}05$) e as variáveis numéricas foram analisadas usando ANOVA bidirecional seguida pelo teste pós-hoc Student-Newman-Keuls ($p \leq 0{,}05$). Os resultados demonstraram um aumento significativo no funcionamento, equilíbrio e qualidade de marcha no GV e GPA em comparação com o GC. O treinamento da vibração e a marcha com peso adicional exercem uma influência positiva no funcionamento, no equilíbrio e na marcha em pacientes com DP. Outros estudos podem ser realizados comparando o efeito do treinamento vibratório com o suporte de peso parcial e a adição de peso corporal utilizando as mesmas variáveis da presente pesquisa.
Palavras-chave: Doença de Parkinson; Vibração; Maneira de andar; Funcionalidade; Equilíbrio postural.

Resumen
La enfermedad de Parkinson (EP) se caracteriza por la pérdida selectiva de neuronas dopaminérgicas de la sustancia negra compacta y la vía nigroestriatal, lo que conduce a alteraciones sensoriales y motoras. El objetivo del presente estudio fue comparar el efecto de la vibración de todo el cuerpo y el entrenamiento de la marcha con carga adicional sobre el funcionamiento, el equilibrio y la marcha en pacientes con EP. Veintidós pacientes masculinos y femeninos (edad media: 61 ± 5,6 años) fueron asignados aleatoriamente a un Grupo de Control (GC), Grupo de Vibración (GV) o Grupo de Peso Agregado (GPA). Se realizaron las siguientes evaluaciones antes y después de la intervención: Escala Unificada de Calificación de la Enfermedad de Parkinson – subescalas “Actividades de la Vida Diaria” y “Examen Motor”; Test Tinetti, Timed Up and Go test, Berg Balance Scale y baropodometría. Las variables ordinales se evaluaron mediante la prueba de Kruskal-Wallis ($p \leq 0{,}05$) y las variables numéricas se analizaron mediante ANOVA de dos vías seguido de la prueba post hoc de Student-Newman-Keuls ($p \leq 0{,}05$). Los resultados demostraron un aumento significativo en el funcionamiento, el equilibrio y la calidad de la marcha en el GV y GPA en comparación con el GC. El entrenamiento vibratorio y el entrenamiento de la marcha con peso adicional ejercen una influencia positiva en el funcionamiento, el equilibrio y la marcha en pacientes con EP. Se pueden realizar otros estudios comparando el efecto del entrenamiento vibratorio con el apoyo de peso parcial y la adición de peso corporal utilizando las mismas variables de la presente investigación.
Palabras clave: Enfermedad de Parkinson; Vibración; Paso; funcionalidad; Equilibrio postural.

1. Introduction

Parkinson’s disease (PD) is characterized by the selective loss of dopaminergic neurons from the *substantia nigra compacta* and nigrostriatal pathway, which leads to sensory and motor impairments (Shin et al., 2017). The main motor disorders in PD are muscle stiffness, bradykinesia, tremors, and postural instability; emotional and cognitive deficits are also common (King et al., 2015; Opara et al., 2017; Tarakad & Jankovic, 2018).

Bradykinesia is characterized by difficulties initiating, maintaining, and performing motor activities quickly and easily. When combined with muscle stiffness, this condition causes postural disorders that compromise the musculature of the trunk. Due to balance deficiencies, individuals with PD have postural instability, gait disorders, an inability to maintain an erect posture and greater body sway (Leavy et al., 2017).

Gait disorders are characteristic of the advance stage of PD (Arcolin et al., 2016). Moreover, the central nervous system has difficulties processing the vestibular, visual and proprioceptive signals necessary for the maintenance of balance, resulting in a diminished capacity regarding adaptive reflexes, which predisposes such individuals to falls (Filippin et al., 2010; Takakusaki, 2017).

Due to the sensory and motor impairments, physiotherapeutic resources play an important role in the rehabilitation of individuals with PD in an effort to maximize functioning, balance and gait (Feng et al., 2020). Among the different intervention strategies, a vibration plate (Lau et al., 2011) and treadmill training with additional load are used to promote functional gains (Filippin et al., 2010).

According to Lau et al. (2011), whole-body vibration (WBV) stimulates muscle spindles, which induce the activation of the tonic vibration reflex. WBV applied to the muscle-tendon system causes reflex muscle contractions that lead to improvements in sensory processing, muscle function, postural balance and gait. However, although WBV is considered effective at promoting functional gains and improving motor performance, there is no consensus regarding its effect on functional recovery, balance and gait in patients with PD (Sharififar et al., 2014).

Studies report that treadmill training with additional load leads to improvements in motor function and gait (Filippin et al., 2010; Trigueiro et al., 2017). According to Shin, proprioceptive deficit can contribute to the aggravation of progressive postural responses in individuals with PD. Thus, repetitive treadmill training with an additional load stimulates muscle and joint receptors, which are essential for maintaining balance in the standing position and during gait (Dietz et al., 1992; Filippin et al., 2010).

Despite the evidence, few comparative studies have been conducted on the effect of WBV and gait training with added weight on the rehabilitation of this population. Therefore, the aim of the present study was to compare the effects of WBV and gait training with added weight on the functioning, balance, and gait performance in individuals with PD.

2. Methodology

A longitudinal randomized, double-blind, clinical trial was conducted, involving evaluations before and immediately after two interventions. Twenty-two male and female individuals (mean age: 61 ± 5.6 years) with PD diagnosed based on the International Code of Diseases and with a median of 2.5 on the modified Hoehn & Yahr staging scale participated in this study. The sample size was calculated considering $\mu^2 = 0.2$, an 80% statistical power and $\alpha = 0.05$ with non-directional distribution, three study groups and five measurements per group. A minimum of seven participants was determined for each group. In the present study, seven individuals participated in each of the two treatment groups and eight participated in the control group. This is in line with Filippin et al. (2017).

The inclusion criteria for the study were a clinical diagnosis of PD in stages 2.5 to 4 on the modified Hoehn & Yahr scale, maximum score of 30 on the Mini Mental State Examination (MMSE), ability to walk independently, regular use of anti-Parkinson's medications and an absence of dementia. Individuals with signs of severe orthostatic hypotension, uncorrected visual impairment, associated neurological disease, cognitive disorder, orthopedic or cardiologic problem, changes in anti-Parkinson's medication and participation in a motor intervention in the previous six months were excluded from the study.

This study was developed at the Physical and Motor Rehabilitation Service linked to *Universidade Federal de Sergipe* (UFS), located on Bahia Street in the neighborhood of Siqueira Campos, city of Aracaju, State of Sergipe, Brazil. The study received approval from the Human Research Ethics Committee of the university (certificate number: 176.386). All participants received clarifications regarding the objectives and procedures of the study and agreed to participate by signing a statement of informed consent.

After the recruitment of the participants based on the eligibility criteria, the pre-intervention evaluation was performed with standardized assessment tools and baropodometry (plantar pressure measurement). At the end of the ten treatment sessions, the post-intervention evaluation was performed by the same examiner using the same instruments. The examiner had undergone training exercises for the use of the instruments and was blinded to the allocation of the participants to the different groups.

The participants were randomly allocated to three different groups: Vibration Group (VG) submitted to whole-body vibration training (n = 7); Added Weight Group (AWG) submitted to gait training on a treadmill with additional load (n = 7); and Control Group (CG) submitted to conventional physical therapy (n = 8).

Before and after training, the participants in both treatment groups were submitted to the stretching of muscle groups for five minutes. Blood pressure was measured before and after each session. Heart and respiratory rates were measured during the entire session using a heart monitor.

The VG was submitted to three five-minute sets of WBV training while barefoot in the standing position, with a one-minute rest period between sets. The vibration plate (*Turbosonic Ovation* - 670 x 905 x 1395 mm) was adjustable (3 to 60 Hz), with a maximum range of 27 millimeters. In the present study, the frequency was set to 6 Hz, with a range of 3 millimeters. The intervention consisted of 10 sessions over a five-week period.

The AWG was submitted to treadmill training with the addition of 10% of the body weight of the individual. The intervention consisted of 10 sessions over a five-week period. Each session lasted 50 minutes: five minutes of warm-up on a stationary bike without load; 40 minutes on the treadmill with weight added to the lower limbs (2.5% of body weight on each leg) and waist (5% of body weight); and five minutes of stretching of the femoral quadriceps, hamstrings and hip adductors. The initial velocity was 0.5 km/h, with increments of 0.1 km/h until reaching the maximum comfortable velocity for the patient. The body mass of the participants was measured periodically to adjust the weight load during training. A safety vest was also worn to impede the possible loss of balance and falls. The treadmill (*Athletic Speedy 3*) had a control for increasing the velocity in increments of 0.1 m/s and lateral hand rails. Belts with pockets were used for the addition of lead weights for the legs and waist.

The CG was submitted to conventional physical therapy in 50-minute sessions held twice a week for five weeks. The training program involved three 15-second sets of static stretching and three sets of 15 repetitions of strengthening with 60% maximum resistance for the muscle groups of the upper and lower limbs, balance training, training activities of daily living (putting on and taking off a shirt, buttoning, reaching for and using flatware) and gait training (five sets on a 10-meter track with an obstacle). The participants were also instructed to perform the exercises at home with monitoring.

The volunteers were first submitted to a clinical evaluation, which included the recording of personal data, patient history and a physical examination. The modified Hoehn & Yahr scale and MMSE were used to determine eligibility for the study. The evaluation of the eligible participants involved the Activities of Daily Living (ADL) and Motor Examination subscales of the Unified Parkinson's Disease Rating Scale (UPDRS), Tinetti Test, Timed Up and Go (TUG) test, Berg Balance Scale (BBS) and baropodometry. All assessment tools are standardized and reliable and have been validated for use in Brazil.

The Hoehn and Yahr Degree of Disability Scale is a specific staging scale to assess the severity and progression of PD (Schenkman et al., 2001). The modified form addresses seven stages for the classification of the degree of disability. Individuals classified in stages 1 and 3 have mild to moderate disability and those classified in stages 4 and 5 have severe disability (Goetz et al., 2004; Opara et al., 2017).

The Mini Mental State Examination (MMSE) was used for the evaluation of cognitive function. The MMSE is composed of seven categories and was used to ensure that the participants were capable of understanding the instructions for performing the tasks. The score ranges from 0 to 30 points, with lower scores denoting possible cognitive impairment (Brucki et al., 2003).

Motor function and ADLs were evaluating using the respective subscales of the UPDRS, which is composed of four parts: 1) Mentation, Behavior, and Mood; 2) Activities of Daily Living; 3) Motor Examination; and 4) Complications of Therapy. Each item is scored from 0 to 4 points, with higher scores denoting greater impairment due to the disease (Goetz et al., 2008).

The Tinetti test was used for the evaluation of balance and gait. This test is used to predict the risk of falls, with a score of higher than 24 points indicative of low risk, a score 19 to 23 points indicative of moderate risk and a score lower than 18 points indicatives of high risk (Creaby & Cole, 2018; Rivolta et al., 2019).

Basic functional mobility was evaluated using the Timed Up and Go (TUG) test. Each participant was instructed to stand up from a chair, walk three meters in a straight line, turn around, walk back to the chair and sit down again. The time in seconds required to complete the test was recorded (Cuevas-Trisan, 2017).

The Berg Balance Scale (BBS) was used to evaluate static balance, dynamic balance and postural control. The scale is used for the quantitative and qualitative evaluation of balance during motor activities commonly used in ADLs and to predict the probability of the occurrence of falls. The maximum score corresponds to the best performance (Berg et al., 1992; Winser et al., 2019).

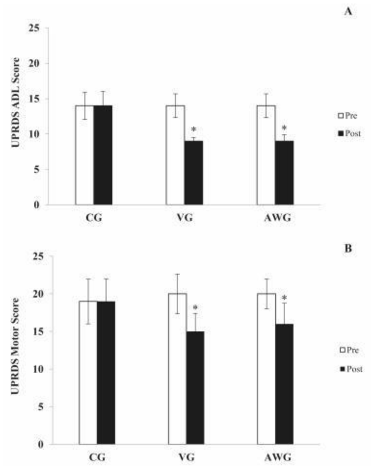
Body stability was measured using a 2544-sensor foot pressure plate (*Buratto Advanced Technology*) measuring 700 x 600 mm with. The participants were asked to remain in two-legged and one-legged stances on the platform in the anatomic position with the eyes open for ten seconds. During the evaluation in the one-legged position, the volunteer was instructed to flex the knee of the contralateral limb at 90°. Three trials were performed in each position, with a one-minute period between trials. The mean was used for the data analysis. Bipedal contact area (BCA), unipedal contact area (UCA), bilateral peak pressure (BPP), and unilateral peak pressure (UPP) were calculated.

Statistical analysis was performed using the Kruskal-Wallis test for the variables from the Tinetti test, BBS and ADL and Motor Examination subscales of the UPDRS. Variables from the TUG test and baropodometry were analyzed using two-way analysis of variance (ANOVA) followed by the Student-Newman-Keuls *post hoc* test. The level of significance was set at 5% ($p \leq 0.05$).

During the pre-intervention evaluations, no statistically significant differences were found regarding the UPDRS, BBS, Tinetti test or TUG test ($p \geq 0.05$), indicating similar degrees of impairment.

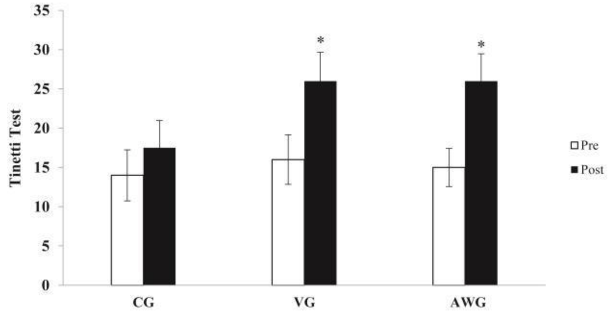
A significant reduction in the ADL subscale of the UPDRS between the pre-intervention and post-intervention evaluations was found in the VG ($p \leq 0.05$). Moreover, significant reductions in both the ADL ($p \leq 0.01$) and Motor Examination ($p \leq 0.01$) subscales of the UPDRS were found in the AWG (Figure 1). Significant differences on the Tinetti test were found between the pre-intervention and post-intervention evaluations in both the VG ($p \leq 0.05$) and AWG ($p \leq 0.01$) (Figure 2). A significant reduction in the time required to complete the TUG test was found between the pre-intervention and post-intervention evaluations in the AWG ($p \leq 0.05$) (Figure 3). Significant differences in both static and dynamic balance (evaluated using the BBS) were found between the pre-intervention and post-intervention in the AWG (Figure 4).

Figure 1. ADL and Motor Examination with UPDRS in the AWG. The asterisk denotes a statistically significant difference.



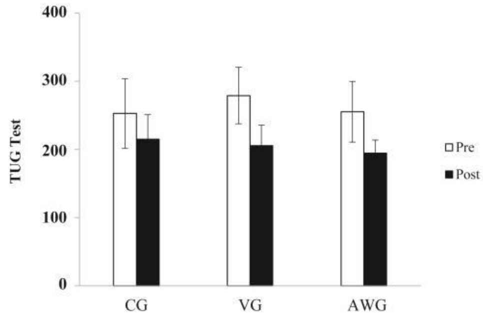
Source: Authors.

Figure 2. Differences on Tinetti test for pre-and post-intervention evaluations in both VG and AWG. The asterisk denotes a statistically significant difference.



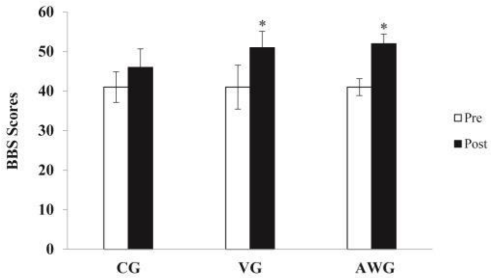
Source: Authors.

Figure 3. Significant reduction in the time required to complete TUG test between the pre-and post-intervention evaluations in the AWG.



Source: Authors.

Figure 4. Significant differences in both static and dynamic balance (evaluated using the BBS) between the pre-and post-intervention in the AWG. The asterisk denotes a statistically significant difference.



Source: Authors.

Regarding baropodometry, significant increases in the BCA and UCA were found in both the VG and AWG ($p \leq 0.05$). Moreover, significant reductions in BPP and UPP were found in the VG ($p \leq 0.01$), and a significant reduction in UPP was found in the AWG ($p \leq 0.01$). In the inter-group comparisons of the post-intervention evaluations, the VG had significantly better results regarding the BCA and BPP compared to the AWG ($p \leq 0.01$) and the AWG had significantly better results regarding the UCA and UPP compared to the VG ($p \leq 0.01$) (Table 1).

3. Results

During the pre-intervention evaluations, no statistically significant differences were found regarding the UPDRS, BBS, Tinetti test or TUG test ($p \geq 0.05$), indicating similar degrees of impairment.

A significant reduction in the ADL subscale of the UPDRS between the pre-intervention and post-intervention evaluations was found in the VG ($p \leq 0.05$). Moreover, significant reductions in both the ADL ($p \leq 0.01$) and Motor Examination ($p \leq 0.01$) subscales of the UPDRS were found in the AWG (Figure 1). Significant differences on the Tinetti test were found between the pre-intervention and post-intervention evaluations in both the VG ($p \leq 0.05$) and AWG ($p \leq 0.01$) (Figure 2). A significant reduction in the time required to complete the TUG test was found between the pre-intervention and post-intervention evaluations in the AWG ($p \leq 0.05$) (Figure 3). Significant differences in both static and dynamic balance (evaluated using the BBS) were found between the pre-intervention and post-intervention in the AWG (Figure 4).

Regarding baropodometry, significant increases in the BCA and UCA were found in both the VG and AWG ($p \leq 0.05$). Moreover, significant reductions in BPP and UPP were found in the VG ($p \leq 0.01$), and a significant reduction in UPP was found in the AWG ($p \leq 0.01$). In the inter-group comparisons of the post-intervention evaluations, the VG had significantly better results regarding the BCA and BPP compared to the AWG ($p \leq 0.01$) and the AWG had significantly better results regarding the UCA and UPP compared to the VG ($p \leq 0.01$) (Table 1).

Table 1. Mean and standard deviation (± SD) of BCA (cm^2), UCA (cm^2), BPP (Kg/cm^2), and UPP (Kg/cm^2) during the pre-intervention and post-intervention evaluations of the Control Group (CG), Vibration Group (VG), and Added Weight Group (AWG).

GROUPS	BCA		UCA		BPP		UPP	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
CG	224,13	229	109,25	112	1,34	1,21	1,43	1,2
VG	232,39	280,57*+	108,43	130,86*	1,36	0,90 *+	1,14	0,96 *
AWG	221,57	253,00 *	112,29	150,86*-	1,39	0,96	1,39	0,70 * -

(*) Indicates significant difference compared to the control group ($p < 0.05$). (+) Indicates significant difference relative to the AWG ($p \leq 0.01$). (-) Indicates significant difference compared to the VG ($p \leq 0.01$). *Legend: BCA: Bipedal Contact Areas, UCA: Unipedal Contact Areas, BPP: Bilateral Peak Pressure (contact), and UPP: Unilateral Peak Pressure (contact). Source: Authors.

4. Discussion

PD is a neurodegenerative disease that causes motor disorders, such as muscle stiffness, bradykinesia, tremors and postural instability. The present study investigated the influence of vibratory stimulation and treadmill training with added weight on functioning, balance and gait in individuals with PD. The results revealed a significant reduction in the ADL subscale score of the UPDRS in the VG as well as increases in the score on the Tinetti test in both the VG and AWG, indicating that whole-body vibration leads to improvements in balance and gait in this population.

With regard to baropodometry, vibration training led to greater improvements in postural stability in the two-legged stance compared to treadmill training with added weight, demonstrating the greater efficacy of the proprioceptive stimulus. This finding suggests that treatment programs that employ proprioceptive stimulation with generalized distribution may be effective at promoting the recovery of postural stability. As the loss of muscle strength, especially in the lower limbs, in individuals with PD leads to reductions in locomotion and the ability to maintain an erect posture, the functional gains demonstrated by the UPDRS (Skinner et al., 2019) and Tinetti test may be related to the continual activation of muscle and joint proprioceptors triggered by the stimulus of the vibration plate (Sharififar et al., 2014).

Several studies have demonstrated benefits of vibratory training in motor behavior in individuals with neurological disorders (Aboutorabi et al., 2018; Sharififar et al., 2014). However, other studies such as this systematic review, including PD, have shown weak evidence through WBV long-term training on mobility gain (Alashram et al., 2019).

Despite the controversies related to time-dependent responses, most research has shown that vibration training has a satisfactory effect on functional recovery. According to a previous study (Ebersbach et al., 2008), the increase in balance and gait performance in individuals with PD undergoing vibratory training suggests that functional recovery is due to an increase in proprioceptive responses. The gain in motor performance, maintained for four weeks, demonstrates a time-dependent therapeutic response. Other author (Kaut et al., 2016) in a study that included short-term WBV training (five or less sessions) and long-term PD training (nine or more sessions) to assess balance and postural control showed a significant improvement in Tinetti score in the short-term WBV training group that had a small Tinetti score (0.23–0.40). Aboutorabi et al. (2018) found improvements in muscle endurance, balance, and flexibility in PD patients undergoing vibratory training, and Arias and colleagues found improvements in stiffness, gait and postural stability when patients with PD underwent a single session of full body vibration (Arias et al., 2009).

The results of these studies and the present investigation show that the proprioceptive stimulus provided by the vibrating plate is a fundamental mechanism for the recovery of function. In addition, the proprioceptive response can be seen through muscle contractions (demonstrated by means of electromyography) in response to the vibratory stimulus (Rehn et al., 2007).

Regarding gait training with added weight, increases occurred in functional performance as well as static and dynamic balance, as demonstrated by the results of the TUG test and BBS. These findings agree with data described by Trigueiro et al. (2017), who also report significant improvements in motor function and postural stability following gait training with added weight. Toole et al. (2005) found that gait training with additional load for patients with PD led to improvements in balance and spatiotemporal gait variables, demonstrated by the motor score of the UPDRS. Shin et al. (2017) found that exercise on a stationary bike was effective at improving balance and motor coordination as well as promoting the preservation of neurons and nigrostriatal dopaminergic fibers. Filippin et al. (2010) found significant increases in mobility, activities of daily living, cognition and gait among individuals in the moderate stage of PD following treadmill training with the addition of 10% of body weight, demonstrating that this treatment modality leads to an increase in motor function.

The present investigation offers similar findings to those described in the studies cited above, as significant post-intervention differences were found in comparison to the control group, with a reduction in the ADL subscale score, increase in the Tinetti test score and reduction in the time required to complete the TUG test. The results also show a significant increase in the Motor Examination subscale score of the UPDRS and an increase in the BBS score. In terms of baropodometry, treadmill training with added weight led to an improvement in body stability during the one-legged stance, suggesting greater efficacy in comparison to vibration training. Therefore, the results show that treadmill training with added weight exerts a positive effect on balance and gait in individuals with PD.

Regarding balance, a significant improvement in the Tinetti score was found in both the VG and AWG, indicating that both vibration training and treadmill training with additional load exert an influence on balance and gait in individuals with PD. These findings are extremely important, as the ability of the central nervous system to process vestibular and proprioceptive signals is compromised in PD, leading to deficits in proprioception and the interaction of the vestibular and visual systems, which are responsible for balance (Zirek et al., 2018). As a result, individuals with PD tend to displace the center of gravity of the body forward and are unable to perform compensatory movements to reestablish the stability of the body, which increases the risk of falls (Flores et al., 2011).

Based on the present findings, task-specific, repetitive training on a treadmill leads to acquisitions regarding locomotor behavior in individuals with PD. These results agree with inferences described by previous studies (Capecci et al., 2019; van Hedel et al., 2006), who state that the treadmill serves as an external track that can compensate for the deficit in basal ganglia by generating an internal rhythm and providing visual and vestibular cues that have beneficial effects on locomotor behavior. Moreover, the additional load may have contributed to improvements in proprioceptive function and balance, as it stimulates joint proprioceptors, which are essential to the maintenance of balance in the stance and swing phases of the gait cycle (Dietz et al., 1992).

5. Conclusion

Vibration training and gait training with additional load lead to improvements in functioning, balance and gait in individuals with mild to moderate PD. In the present findings, treadmill training with additional load was more effective than vibration training. Therefore, both types of training are suggested for physiotherapeutic intervention protocols. Further studies can be carried out comparing the effect of the vibratory training with the partial weight support and the addition of body weight using the same variables of the current research.

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