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Effects of Whole Body Vibration on reaction time in Parkinson's Disease Patients – A pilot study

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1. Abstract

Background: Parkinson's disease is the second most common neurodegenerative disease. The symptoms are treated with medication, physiotherapy, exercise and occupational therapy. The effect of Whole Body Vibration (WBV) as an alternative training method has already been investigated for several symptoms in Parkinson's patients. As the effect on the reaction time has not yet been investigated, the effectiveness of different application frequencies should be tested in this pilot study.

Hypothesis: Different frequencies of WBV have different effects on reaction. Study design: RCT.

Methods: The 43 participating PD patients (22 males, 21 females, age 69.02 ± 11.54 years, mean time past diagnosis 6.60 ± 4.74 years) were randomly assigned to a frequency (6, 12 or 18 Hz) or to the control group. Before and after the treatment of 5 x 60 seconds with a 60 second break each, the measurement of reaction time was performed by the Ruler Drop Test (three runs each, mean value and best of three of pre- and posttest were evaluated).

Results: All groups improved their performance in the Ruler Drop Test. Significant differences were found for the effect *time* for all groups (best of 3: $F(1,38)=18.73$, $p=.00$; mean of 3: $F(1,38)=4.96$, $p=.03$). There was no significant effect for factor *group* and for interaction *time*group*.

Conclusions: WBV can cause an improvement in reaction. Vibration frequency seems to play a subordinate role. There is a placebo effect for Whole Body Vibration that should be eliminated.

2. Introduction

Parkinson's disease is the second most common neurodegenerative disease [1]. The main symptoms of this disease are brady- (slowing of movement), hypo- (reduced amplitude and spontaneous movement) and akinesia (inhibition of movement initiation), rigor (muscle tone disorder, limited mobility), tremor and postural instability (disturbance of postural reflexes) [2,3]. Late motor symptoms include the on-off phenomenon after several years of treatment with dopamine preparations, propulsion (falling forward) and freezing (involuntary movement blockade) [4].

Symptoms are treated by medication, mainly to compensate for the dopaminergic deficit, with L-dopa preparations proving most effective in combination with decarboxylase inhibitors. Since the fluctuation in the effects increases with the duration of treatment, MAO-B inhibitors (monooxidase type B inhibitors) and COMT inhibitors (catechol-O-methyl transferase inhibitors) are prescribed as support. This results in a longer and more uniform duration of action of L-dopa. In addition, physio-, ergo- and speech therapy is usually prescribed for Parkinson's patients [5], which becomes more and more important with increasing duration of the disease, since the drug-refractory symptoms such as freezing, gait and balance problems, speech and swallowing problems occur more frequently [2]. Whole Body Vibration (WBV) is an alternative treatment method in the field of physiotherapy. Here, mechanical vibrations are transmitted to the muscles via a platform on which the patient stands [6]. A distinction is made here between harmonic and stochastic whole-body vibration, whereby this can be induced on vertical or side-alternating plates [7]. The sinusoidal, harmonic whole-body vibration has the advantage that it can be used to test the effect of a certain frequency [8]. So far, only very few side effects are known, such as headaches or dizziness [9]. However, these can be reduced or avoided when standing on a vibration plate by adopting an upright, relaxed posture with slightly bent knees (approx. 26-30°) [8-10]. There are few contraindications, WBV application should be avoided in case of pregnancy, acute thrombosis, serious cardiovascular disease, pacemaker, recent wounds from an accident or surgery, hip and knee implants, acute hernia, discopathy, spondylolysis, severe diabetes, epilepsy, recent infections, severe migraine, tumors, recently placed intrauterine devices, metal pins or plates, kidney stones, organ failure [11,12].

The effect of whole-body vibrations in Parkinson's patients has been researched in recent decades on many aspects of the symptoms. For example, there are many studies on mobility, gait and other motor symptoms such as tremor, but the results are still inconsistent due to different examination methods (different application frequencies, frequencies, sentence numbers and lengths), the effect on reaction has yet not been investigated [13]. In the present study it will be investigated how different application frequencies of WBV affect reaction time in PD patients.

3. Hypothesis

There is a difference in performance between pre- and post-test in reaction time depending on the vibration frequency.

4. Methods

The study was approved by the ethics committee of Saarland University, application number 16-12.

Trial registration was performed at Deutsches Register Klinischer Studien, registration number DRKS00012265.

The recommendations of the reporting guidelines by Wuestefeld et al. [14] are followed.

4.1 Sample of persons

The test persons were recruited via medical practices, clinics, rehabilitation facilities, self-help groups and residential homes in Saarland and Rhineland-Palatinate. Persons with the contraindications already described (e.g. fresh bone fracture/joint replacement, severe coronary heart disease, untreated high blood pressure, etc.) were not included according to the recommendations [11,12]. The study was conducted in the gymnasiums of the respective facilities. The sample consists of 43 persons, of whom 22 male and 21 female persons. The average age is 69.02 ± 11.54 years, the average stage of the PD disease according to Hoehn and Yahr is 2.23 ± .76, the time past since diagnosis for an average of 6.60 ± 4.74 years, the average hip width is 32.97 ± 1.59 cm. Table 1 shows the characteristics of the sample sorted by test groups.

When comparing the groups, only a significant difference in age for group 3 to groups 1, 2 and 4 can be observed.

4.2 Study design

PD patients were each randomly assigned to an application frequency (6, 12 or 18 Hz) or to the control group. The allocation was randomized by drawing lots.

Table 1: Characteristics of the sample of persons.

	Group 1	Group 2	Group 3	Group 4	Total sample
Male/female	7/8	5/5	5/4	5/4	22/21
Age in years (M ± SD)	69.00 ± 9.70	70.70 ± 10.68	58.89 ± 10.11	77.33 ± 10.37	69.02 ± 11.54
Hoehn & Yahr stage (M ± SD)	2.30 ± .76	2.11 ± .70	2.33 ± .90	2.11 ± .74	2.23 ± .76
Time past since diagnosis in years (M ± SD)	6.23 ± 5.27	8.50 ± 5.32	6.00 ± 4.82	6.00 ± 2.65	6.60 ± 4.74
Hip width in cm (M ± SD)	32.38 ± 1.80	32.33 ± 1.21	34.67 ± 1.16	33.17 ± 1.60	32.97 ± 1.59

4.3 Outcome measurement

To measure reaction time, the Ruler Drop Test was conducted. In the Ruler Drop Test, the subject sits on a chair with the arm bent 90° at the elbow joint and the forearm resting on the armrest. The palm of the hand is open and ready to grip. The experimenter holds the ruler (scale in cm) over the open hand and releases it. The test subject must quickly close the hand and catch the ruler. The value at which the thumb and index finger enclose the ruler is used for statistical analysis [15]. There are three runs each in the pretest and posttest. The mean value from each of the three trials and the best of the three trials is used for statistical analysis. The examiner was blinded.

4.4 Intervention protocol

A side-alternating vibration platform (Galileo med Advanced) from Novotec Medical was used as treatment. Three different constant, immediately full vibration frequencies (6, 12, and 18 Hz) with an amplitude of 3 mm were used and a placebo condition (control group, standing on the switched off vibration plate) was created. The test persons were instructed to stand barefoot as upright and relaxed as possible with slightly bent knees (26 to 30°) on the markers on the platform (distance between feet 31.9 cm) without holding on to the platform, as recommended [8-10]. The test persons were not informed which group they belonged to. For this reason, the display was covered. The examiner was blinded. Five sets of 60 seconds each with a 60 seconds pause between the sets with the corresponding frequency or with the placebo condition were applied, so there were 5 minutes of WBV in total for each participant. There was no muscle warmup before WBV. Figure 1 shows the course of the study.

4.5 Data analysis

SPSS Version 26 software was used. A univariate ANOVA was calculated to compare group characteristics (age, Hoehn & Yahr stage, time past since diagnosis and hip width) and reaction time in the pretest. An ANOVA with measurement repetition was calculated. The effects *time* (within, pre- to post-test), *group* (between, different application frequencies and control condition) and the interaction *time*group* were determined. For this purpose, best of three and mean of three trials in pre- and posttest of the Ruler Drop Test were evaluated. The significance level was defined as $p<.05$.

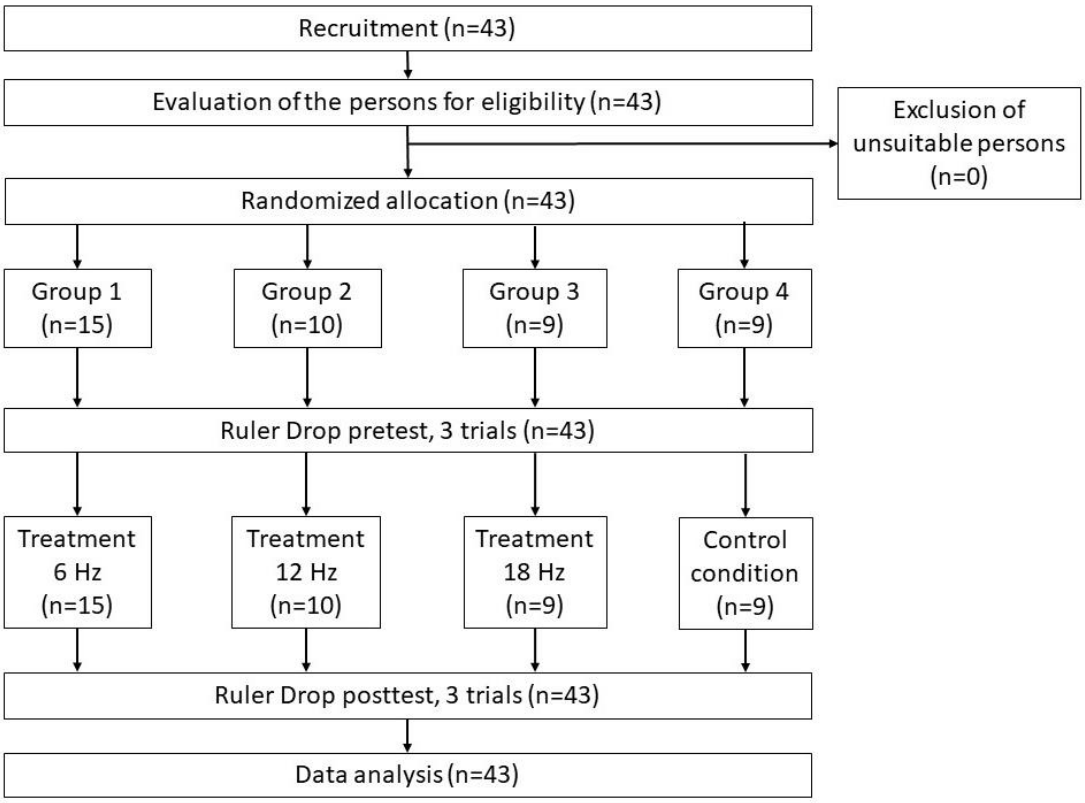

Figure 1: Flow diagram of the study process.

5. Results

Best of three pretest: Levene test shows a heterogeneity between groups in reaction time (F=4.25, p=.01). Univariate ANOVA shows no significant differences (F=1.63, p=.20).

Mean of three pretest: Levene test shows a heterogeneity between groups in reaction time (F=4.01, p=.01). Univariate ANOVA shows no significant differences (F=2.17, p=.11).

Table 2 gives an overview of the results of the pre- and posttest for the Ruler Drop Test to compare the performance in all groups.

There is only a significant effect for factor *time*. Post hoc test LSD shows significant differences from group 3 to groups 2 and 4 in the posttest. The factor *group* and the interaction *time*group* are not significant. This all concerns both measurement conditions, best of three and mean of three. Figures 2 and 3 show these results.

6. Discussion

The aim of this pilot study was to investigate the effect of WBV on reaction time in PD patients. There was only an effect found for factor *time*. At first, none of the participants reported a side effect or any other negative subjective experience like dizziness or pain.

A meta-analysis has shown that good effects on bradykinesis can be achieved [13]. Here, the studies by Gaßner et al. [16], Kaut et al. [17,18] and Spieß [19] were considered, whereby these studies had applied several training sessions of five times 60 seconds each with a frequency of 6 to 7 Hz. However, the experimental groups differed significantly from the respective control groups in the posttest, which is not the case in the present study. However, group 3 (18 Hz) performed best in both the pretest and posttest. This could be related to age, as this group differs significantly from the others here. A difference between the experimental groups and the control group is only evident in group 3. In addition, the entire sample was very small.

Table 2: ANOVA Results for Ruler Drop Test for intervention groups 1 to 4 (6, 12 and 18 Hz and control)

	Group 1 6 Hz (M ± SD)	Group 2 12 Hz (M ± SD)	Group 3 18 Hz (M ± SD)	Group 4 Control (M ± SD)	F(1,38) Time	F(3,38) Group	F(3,38) Time* group
Best of 3							
Pretest	29.71 ± 9.19	29.80 ± 13.12	20.44 ± 4.77	31.67 ± 16.61	18.73*** (p=.00)	2.16 n.s. (p=.11)	.21 n.s. (p=.89)
Posttest	22.86 ± 8.39	25.10 ± 13.26	15.44 ± 5.77	24.56 ± 10.49			
Mean of 3							
Pretest	36.17 ± 10.59	35.27 ± 12.01	24.85 ± 5.19	38.26 ± 16.94	4.96* (p=.03)	2.74 n.s. (p=.06)	.37 n.s. (p=.78)
Posttest	30.48 ± 8.76	34.13 ± 18.81	21.11 ± 5.84	34.07 ± 13.71			

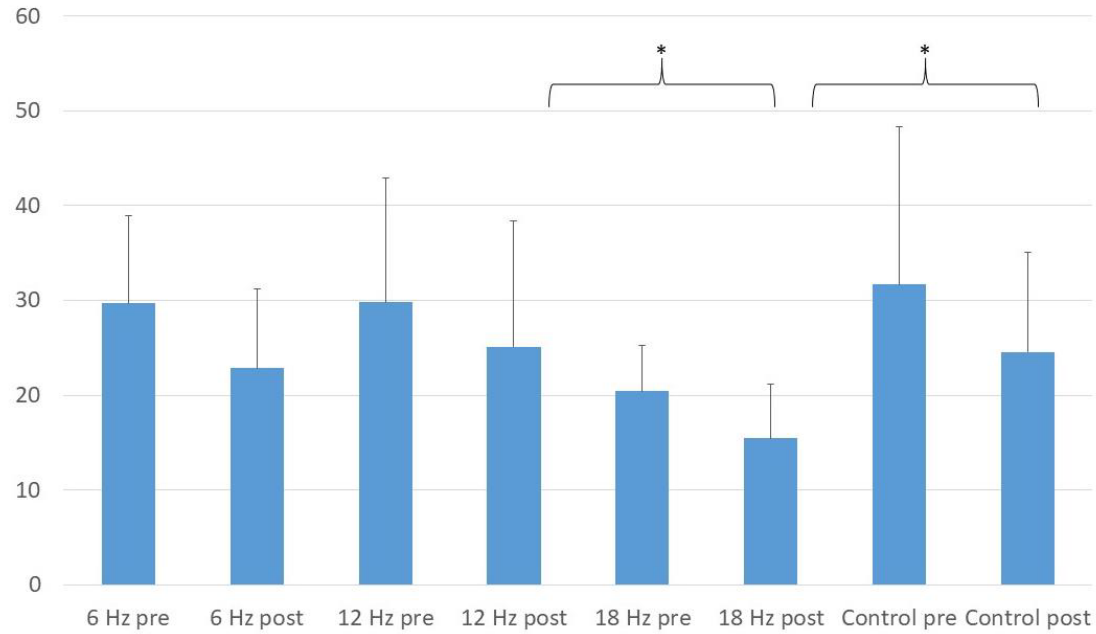

Figure 2: Comparison between groups in Ruler Drop pre- and posttest for best of 3 condition (*: p<.05)

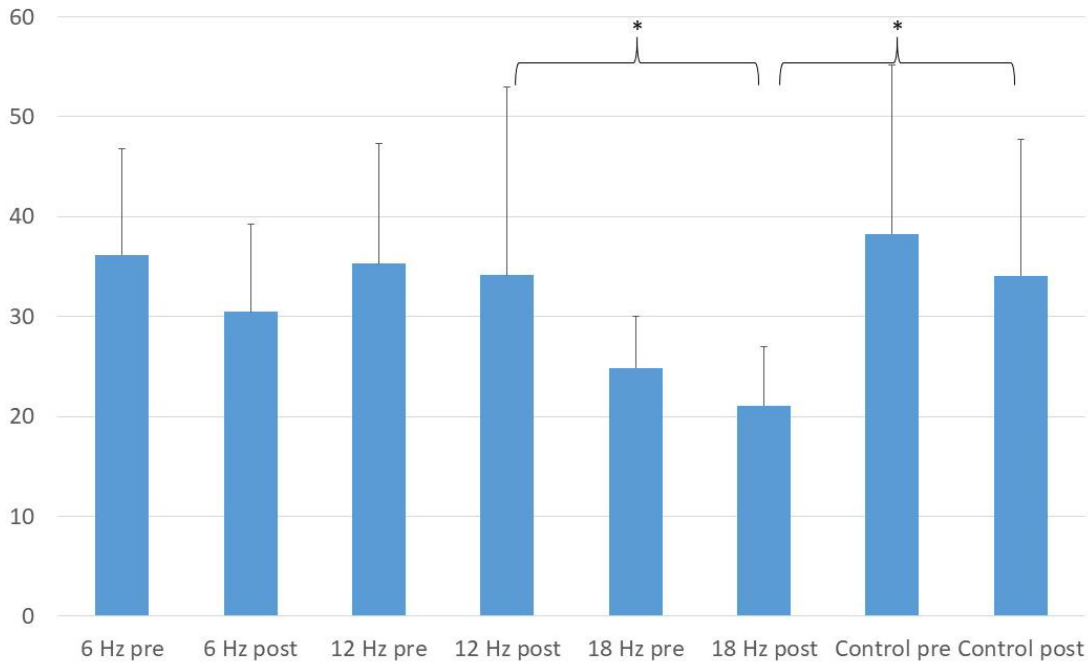

Figure 3: Comparison between groups in Ruler Drop pre- and posttest for mean of 3 condition (*: p<.05)

It seems that even lower frequencies could have lead to a positive effect. This also contradicts the assumption that low application frequencies below 20 Hz are not effective [21], since the internal organs vibrate at a similar frequency [22] and muscles and bones must constantly compensate for these vibrations [23]. There was no significant difference between the application frequencies so it seems that it plays no role which frequency is applied.

Another problem could be that the control group was not blinded. All subjects in the control group had noticed that the plate was not vibrating. Such a placebo effect for WBV that could have led to these results was described by Arias et al. [20]. However, Kaut et al. [17,18] assumed that the placebo effect is eliminated in the bradykinesia subscore of the UPDRS. Gaßner et al. [16] described that there is a stronger placebo effect on bradykinesia than on other main symptoms.

Furthermore, the test procedure (Ruler Drop Test) might not have been meaningful enough.

7. Conclusions and future prospects

The present study was designed to investigate the efficacy of WBV on reaction time in PD patients. However, no clear effect could be obtained compared to the control group. There are no differences between the application frequencies and a placebo effect has been found. Age of the participants could have influenced the results. Therefore, further studies should follow with a larger sample and a different control condition as well as a different test procedure to examine reaction time.

8. Conflicts of interest

There are no conflicts of interest.

9. Acknowledgment

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10. References

1. Ascherio A, Schwarzschild MA. The epidemiology of Parkinson's disease: Risk factors and prevention. *The Lancet Neurology. 2016; 15*: 1257-1272.

2. Ceballos-Baumann AO. Idiopathisches Parkinson-Syndrom: Grundlagen, Medikamente, Therapieanleitung. Editors. In: Ceballos-Baumann AO, Conrad B. *Bewegungsstörungen,* Stuttgart: Thieme. 2005: 33-70.

3. Ludwig E. *Der große TRIAS-Ratgeber Parkinson-Krankheit: Alles über Ursachen und Behandlung; aktiv bleiben im Alltag; mit vielen Sprech- und Bewegungsübungen für zu Hause;* [empfohlen von der Deutschen Parkinson Vereinigung eV]. Georg Thieme Verlag. 2007.

4. Leplow B. *Parkinson*. Göttingen: Hogrefe. 2007.

5. Handschu R, Schuh A, Lunkenheimer J. Morbus Parkinson-Therapie im fortgeschrittenen Stadium. *Geriatrie-Report. 2018; 13*: 40-48.

6. Marín PJ, Rhea MR. Effects of vibration training on muscle power: A meta-analysis. *J Strength Cond Res. 2010; 24:* 871-878.

7. Cochrane DJ. Vibration exercise: The potential benefits. *Int J Spo Med. 2011; 32:* 75-99.

8. Griffin MJ. *Handbook of Human Vibration.* London: Elsevier. 1990.

9. Kaeding TS. *Vibrationstraining. Ein praxisorientiertes Handbuch.* Schorndorf: Hofmann. 2016.

10. Abercromby AF, Amonette WE, Layne CS, McFarlin BK, Hinman MR, et al. Vibration exposure and biodynamic responses during whole-body vibration training. *Med Sci Spo Ex. 2007; 39*: 1794-1800.

11. Albasini A, Krause M: Indications and contraindications in the clinical application of WBV. Immediate and long-term effects and their influence on the selection of dosage. In: Albasini A, Krause M, Rembitzki I (eds) *Using Whole Body Vibration in Physical Therapy and Sport. Clinical practice and treatment exercises.* London: Churchill Livingstone; 2009. pp. 65-92.

12. Runge M. Die Vibrationsbehandlung-neue Wege in Therapie und Training von Muskelfunktionen. *B&G. 2006; 2:* 70-74.

13. Dincher A, Schwarz M, Wydra G. Analysis of the Effects of Whole-Body Vibration in Parkinson Disease-Systematic Review and Meta-Analysis. *Pm&r. 2019; 11:* 640-653.

14. Wuestefeld A, Fuermaier AB, Bernardo-Filho M, da Cunha de Sá-Caputo D, Rittweger J, Schoenau E, Stark C, Marin PJ, Seixas A, Judex S, Taiar R, Nyakas C, van der Zee EA, van Heuvelen MJG, Tucha O: Towards reporting guidelines of research using whole-body vibration as training or treatment regimen in human subjects - A Delphi consensus study. *PloS one 2020;15(7):* e0235905. Doi: 10.1371/journal.pone.0235905.

15. van Schooten KS, Duran L, Visschedijk M, Pijnappels M, Lord SR, Richardson J, Delbaere K. Catch the ruler: concurrent validity and test-retest reliability of the ReacStick measures of reaction time and inhibitory executive function in older people. *Aging Clin Exp Res. 2019; 31*: 1147-1154. DOI: 10.1007/s40520-018-1050-6.

16. Gaßner H, Janzen A, Schwirtz A, Jansen P. Random whole body vibration over 5 weeks leads to effects similar to placebo: a con-trolled study in Parkinson's disease. *Parkinsons Dis. 2014*; 2014:1-9

17. Kaut O, Allert N, Coch C, et al. Stochastic resonance therapy in Parkinson's disease. *NeuroRehabilitation. 2011; 28*: 1-6

18. Kaut O, Brenig D, Marek M, Allert N, Wüllner U. Postural stability in Parkinson's disease patients is improved after stochastic resonance therapy. *Parkinsons Dis. 2016; 4:* 1-7

19. Spieß AE. *Validierung der Therapieeffekte einer repetitiven Stochastischen Resonanz-Therapie bei Symptomen des idiopathischen Parkinson-Syndroms* [dissertation]. Bonn: Medizinische Fakultät der Universität Bonn; 2014

20. Arias P, Chouza M, Vivas J, Cudeiro J. Effect of whole body vibration in Parkinson's disease: a controlled study. *Mov Disord. 2009; 24*(6): 891-898

21. Cardinale M, Pope MH. The effects of whole body vibration on humans: Dangerous or advantageous? *Acta Physiol Hung. 2003; 90:* 195-206.

22. Dupuis H, Jansen G. Immediate effects of vibration transmitted to the hand. Editors. In: Bianchi G, Frolov KV, Oledzki A. *Man under vibration. Suffering and protection.* Amsterdam: Elsevier. 1981.

23. Wakeling JM, Nigg BM, Rozitis AI. Muscle activity damps the soft tissue resonance that occurs in response to pulsed and continuus vibrations. *J Appl Physiol. 2002; 93:* 1093-1103.