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Can simple behavioural interventions increase daily physical activity in Parkinson's disease?

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Abstract

Introduction. Physical activity (PA) is a modifiable factor that may influence the course of Parkinson's disease (PD). This study aimed to apply a simple behavioural intervention aimed at encouraging PD sufferers to increase their everyday PA and to assess which parameters of motor functions will be improved.

Methods. The research covered 50 PD patients (28 men and 22 women) aged 40–81 years (65.38 ± 9.23), with a duration of the disease of 2–4 years, in stages 1–3 on the Hoehn and Yahr scale. The patients were randomly divided into two groups: the experimental group with behavioural therapy and the control group without intervention. During 12 weeks, the patients from the experimental group had five phone conversations. Each conversation lasted 15 min and was an interview about the subjects' PA in the last month. The outcome was measured by the Timed Up and Go test (TUG), Unified Parkinson's Disease Rating Scale (UPDRS) – part III, FIR [Functional Index "Repty" – own modification of Functional Independence Measure (FIM)], Functional Ambulation Category (FAC), and International Physical Activity Questionnaire (IPAQ).

Results. The results showed that, after 12 weeks and five phone conversations, in the experimental group spontaneous PA increased and motor functions improved.

Conclusions. PA improvement depended on age, body mass index, and gender.

Key words: Parkinson's disease, physical activity, sedentary lifestyle, walking

Introduction

Parkinson's disease (PD) stands as the second most prevalent neurodegenerative disorder, impacting over 4.5% of individuals aged 80 and above. Predominant symptoms encompass bradykinesia, tremors, rigidity, and postural instability, contributing to challenges in walking, balance, and an elevated risk of falls. Physical inactivity may manifest prior to the disease onset, representing a potential symptom of PD.

The World Health Organization (WHO) has recently intensified its focus on the influence of physical activity (PA) on human well-being. In response, experts have formulated an action plan spanning 2018–2030, aimed at enhancing global health through the Global Action Plan on Physical Activity (GAPPA) [1]. The British Journal of Sports Medicine has dedicated a special edition wherein Bull et al. [2], representing WHO experts, presented guidelines advocating that all adults engage in PA for 150–300 min weekly at moderate intensity or for 75–150 min if the exercise is vigorous, or a combination of moderate and high-intensity aerobic exercise.

The recommendations further underscore the importance of regular muscle-strengthening exercises across all age groups [2]. Additionally, experts emphasise the necessity to curtail sedentary habits. According to Pate et al. [3], sedentary behaviour comprises activities that maintain energy expenditure within the range of 1.0–1.5 metabolic equivalent units (METs) and includes actions such as sleeping, sitting, lying down, and screen-based entertainment. Notably, a sedentary lifestyle, defined as sitting for more than 7–10 hours daily, poses health risks, irrespective of adherence to WHO-recommended PA levels. Silva et al. [4] referred the physical inactivity to people who reported not participating in PA during their free time in the last three months, partaking in intense physical exertion at work, actively commuting to work or school by walking or biking for at least 10 min, or performing intense household cleaning. Lima et al. [5] due to a survey of 53,395 Brazilian adults, stated that older adults with a higher level of education were more active in their leisure time and were more optimistic about their health status; however, the level of PA decreased with age in both sexes.

It is widely acknowledged that individuals with PD exhibit lower levels of PA compared to the general population, a consensus supported by various scientific studies [6, 7]. Despite advancements in pharmacological therapy, deep brain stimulation (DBS), and non-invasive thalamotomy and pallidotomy via focused high-intensity ultrasound monitored by magnetic resonance imaging (MRgFUS), progressive disability remains challenging to control [8]. A recent meta-analysis by Ahmad et al. [9] encompassing 25 eligible articles (n = 1505) emphasised the positive overall impact of therapeutic exercise on PD patients, revealing no qualitative differences between aerobic and non-aerobic forms of exercise.

While novel methods like music therapy, dance therapy, Tai Chi, and Qigong have enriched comprehensive rehabilitation approaches for PD [10], PA continues to play a pivotal role in the disease's trajectory. Increased PA not only delays the progression of physical disability but also augments the quality of life in affected individuals. A 2017 systematic review by Wu et al. [11], incorporating 11 studies and 342 patients engaged in 17 distinct PA programs, demonstrated that qigong positively influenced UPDRS-III (motor) scores and reduced the occurrence of non-motor symptoms (NMS) and depression. Moreover, balance-training programs like Tai Chi exhibited improvements in postural stability and overall quality of life. The authors concluded that PA holds the potential to mitigate motor skills degeneration, alleviate depression, and

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enhance the quality of life for PD patients, with aerobic training yielding optimal results [11]. PA, exercise, and fitness are occasionally viewed as synonymous and used interchangeably. However, it is essential to recognise that they represent distinct concepts. The WHO relies on the 1985 definition proposed by Caspersen et al. [12], defining PA as "any bodily movement produced by skeletal muscles that results in energy expenditure." Exercise, classified as a subset of PA, is deliberate, structured, and repeatable, aiming to enhance or maintain physical fitness – an amalgamation of attributes related to health and skills [12].

PA can be categorised into various types, including occupational, sports, conditioning, household, and others. Strath et al. [13], as per the American Heart Association, identified four dimensions of PA: mode or type, frequency, engagement time, and intensity. The U.S. Chief Surgeon's report further classified PA into moderate (e.g., walking, gymnastics, dancing) and vigorous (e.g., climbing, swimming, jogging) [14].

Dontje et al. [15] conducted an analysis of accelerometer data from 467 PD patients identifying as sedentary individuals, where over 98% of their day was spent in sedentary to light-intensity activities. Their findings revealed that 82% of participants were physically inactive (0 days/week of 30-minute activity) and 17% were semi-active (1–4 days/week of 30-minute activity). In summary, advanced age, female gender, and reduced physical capacity emerged as pivotal determinants of diminished daily PA [15]. Some authors [16, 17] have suggested that PA may enhance both motor and non-motor functions, as well as the quality of life in PD.

Several methods exist to gauge PA, categorised as objective vs. subjective or quantitative vs. qualitative. Subjective methods encompass questionnaires, diaries, etc., while objective methods involve motion sensors, heart-rate monitors, etc. The International Physical Activity Questionnaire (IPAQ), considered one of the world's premier questionnaires, was developed by an International Consensus Group in 1998. Validated in 2003 across 12 countries, the long version comprises 27 questions measuring PA in metabolic equivalent (MET-minutes/week) units across various life domains [18, 19]. Additionally, Washburn et al. introduced the Physical Activity Scale for Individuals with Physical Disabilities (PASIPD) in 2002, encompassing 13 items related to leisure, household, and occupational activities [20].

The WHO advocates for the Global Physical Activity Questionnaire (GPAQ), designed in 2009 by Bull et al. [21], capturing PA across work, transport, and discretionary domains. The GPAQ aligns with the IPAQ, providing reliable data with a moderate-strong positive correlation. The General Practice Physical Activity Questionnaire (GPPAQ), mandated by the British NHS for general practitioners (GPs), classifies individuals into four levels based on their PA index [22].

Ainsworth et al. [23] emphasised in 2015 that assessing PA aims to discern the frequency, duration, intensity, and types of behaviours over a specific period. Methods encompass self-report measures, including questionnaires and detailed diaries, and direct measures like motion sensors. Selection considerations should include literacy requirements, the assessment's purpose, recall or time period, validity evidence, and generalizability to diverse populations [23]. Skender et al. [24] conducted a comprehensive analysis, encompassing 57 articles featuring a minimum of 100 participants aged 18 or older, in their systematic exploration of PA assessments through both accelerometry and questionnaires. The prescribed wear times across most studies was seven days during waking hours, predominantly fastened on hips using waist belts. The findings from this investigation suggested that accelerometers yield marginally more reliable outcomes concerning self-reported PA, particularly in male subjects. Acknowledging the overall limited consistency, divergent aspects measured by each method, and variations in the dimensions under examination, it is recommended that research endeavours employ both questionnaires and accelerometers to obtain the most comprehensive and accurate information about PA [24]. Similarly, Dowd et al. [25], in alignment with a systematic review, proposed that, although an unequivocally "perfect" tool for scrutinising adult PA remains elusive, researchers should strive to integrate appropriate objective measures tailored to the specific behaviours of interest when scrutinising PA in natural living settings.

The aim of our study was to apply a simple behavioural intervention aimed at encouraging PD sufferers to increase their everyday PA and to assess which parameters of motor functions will be improved.

Subjects and methods

Subjects

The study group consisted of 50 non-demented PD patients aged 40–81 years (65.38 ± 9.23 years, 22 women, 28 men). They were treated at the outpatient Neurology Clinic of the Silesian Medical University in Katowice. The research was conducted in 2015–2017 after obtaining approval by the local Bioethics Committee. All participants signed the informed consent form. PD was diagnosed based on the principles of the United Kingdom Parkinson's Disease Society Brain Bank [26]. The inclusion criteria were duration of the disease between 2 and 4 years, stage I–III on the Hoehn and Yahr (H&Y) scale, subjects able to walk independently: UPDRS questionnaire part III = 0–42 points, FIR for walking = 3 or 5 points, Functional Ambulating Category (FAC) = 2–5 points, IPAQ = 0–21 points, and unchanged pharmacological treatment – constant doses of drugs during the study. The H&Y scale consists of four stages of development of the disease [27]. The Unified Parkinson's Disease Rating Scale (UPDRS) was developed in 1987 as a rating tool used to gauge the severity and progression of PD. The UPDRS scale consists of six segments: (1) Mentation, Behavior, and Mood, (2) Activities of Daily Living – ADL, (3) Motor functions, (4) Complications of Therapy (in the past week), (5) Modified H&Y Scale, and (6) Schwab and England ADL scale [28]. Functional Index Repty was developed in 1997 as a motor modification of the Functional Independence Measure (FIM). FIR is an ADL scale which consists of 15 items; the scoring system is 1-3-5-7 points [29]. Functional Ambulating Categories (FAC) was developed by Holden et al. [30] as a 6-point functional walking test that evaluates ambulation ability, determining how much human support the patient requires when walking. The Timed Up and Go (TUG) test was developed in 1991 by Podsiadło and Richardson [31].

Patients were randomised into two groups: experimental (n = 26) and control (n = 24). Characteristics of the study groups are presented in Tables 1–3.

Intervention

During 12 weeks, the patients from the experimental group had five phone conversations. Each conversation lasted 15 min and was an interview about the subject's PA. The questions related to walking in the period preceding the last phone call – approximate time and distance per day. Another member of the research team made the telephone calls and another

Table 1. Characteristics of the experimental group (n = 26)

	Mediana	*SD*
Gender: women/men (n)	9/17	
Age (years)	66.38	8.44
The duration of the disease (years)	6.96	3.30
Hoehn and Yahr scale (degrees)	2.25	0.35
Body mass index (BMI)	27.32	2.69

Table 2. Characteristics of the control group (n = 24)

	Mediana	*SD*
Gender: women/men (n)	13/11	
Age (years)	64.38	10.19
The duration of the disease (years)	7.58	4.10
Hoehn and Yahr scale (degrees)	2.21	0.35
Body mass index (BMI)	25.71	3.16

Table 3. Distribution of features in groups: experimental (n = 26) and control (n = 24)

Feature		Experimental		Control		*p*
		n / mean (*SD*)	% / median (min–max)	*n* / mean (*SD*)	% / median (min–max)	
Gender	women	9	35	13	54	0.791
	men	17	65	11	46	
Age (years)		66 (9)	65.5 (50–80)	64 (11)	(40–81)	0.353
Hoehn and Yahr stage		2.25 (0.35)	2 (1.5–3)	2.21 (0.35)	2 (1.5–3)	0.003
Duration of disease (years)		6.96 (3.30)	7 (2–15)	7.58 (4.10)	7 (2–20)	0.041
Body mass index (BMI) (kg/m^2)		27.32 (2.74)	26.75 (21.88–32.19)	25.71 (3.16)	(18.67–30.10)	0.544

member of the team made the calculations of the test results. The patients from the control group had no telephone calls.

Statistical analysis

Quantitative variables of the analysed parameters were described using mean value, standard deviation (SD), median, maximum and minimum values, and quartiles (Q1, Q2). In the statistical analyses, a significance level of $p < 0.05$ was adopted. The normality of the distribution of the analysed parameters was checked using the Shapiro–Wilk test. To determine the degree of relationship between the analysed quantitative variables, Spearman's rank test was used due to the lack of normality in the distribution of data parameters.

To check whether the results obtained on particular days of the week differed statistically significantly for given parameters, a non-parametric Friedman's ANOVA test for dependent samples was performed. To compare the differences in the analysed quantitative variables between two groups of patients, the Student's t-test or the Mann–Whitney U-test were used, respectively, for parameters with a normal distribution and variables without a normal distribution.

To determine whether there are statistical differences between the results obtained in the initial examination and the examination conducted after the end of therapy, the Wilcoxon test for dependent samples was used due to the lack of normality of the distribution in the analysed variables. Statistica 12 by Statsoft was used for statistical calculations.

Results

The results are presented in Tables 4 and 5. In the experimental group the parameters of gait, ADL, motor functions (UPDRS part III), and PA (in IPAQ) after 12 weeks improved statistically significantly (Table 4). In the control group, the parameters of gait, ADL, and PA (in IPAQ) improved statistically significantly, but motor functions as a whole (UPDRS part III) did not improve (Table 5). PA in the control group did not depend on the stage of PD, duration of disease, BMI, ability to walk, or mobility. The improvement of PA in the experimental group depended on gender (better in males), age (> 66), and BMI (< 26).

Table 4. Results of clinical tests in the experimental group (n = 26)

Test	Experimental group				*p*
	day 1		day 84		
	mean ± *SD*	median (min–max)	mean ± *SD*	median (min–max)	
Gait in Functional Index Repty	4.4 ± 0.91	4.5 (3.0–5.0)	4.88 ± 0.83	5.0 (3.0–7.0)	0.018
Functional Ambulation Category	4.12 ± 0.88	4.0 (2.0–5.0)	4.52 ± 0.71	4.5 (3.0–5.0)	0.023
Timed Up and Go Test (s)	14.68 ± 3.44	14 (11–26)	12.08 ± 2.86	11 (10–19)	0.0002
UPDRS part III (motor examination)	11.28 ± 6.83	11 (2–25)	13.76 ± 9.23	12 (4–30)	0.045
Functional Index Repty total	96.6 ± 7.42	98 (75–105)	101.44 ± 3.47	102 (89–105)	0.00006
International Physical Activity Questionnaire	13.76 ± 6.91	14 (2–27)	17.36 ± 4.47	18 (4–26)	0.005

UPDRS – Unified Parkinson's Disease Rating Scale

Table 5. Results of clinical tests in the control group (n = 24)

Test	Control group				p
	day 1		day 84		
	mean ± *SD*	median (min–max)	mean ± *SD*	median (min–max)	
Gait in Functional Index Repty	4.05 ± 1.2	4.0 (3.0–7.0)	5.19 ± 0.87	5.0 (3.0–7.0)	0.002
Functional Ambulation Category	4.19 ± 0.87	4.0 (3.0–5.0)	4.81 ± 0.4	5.0 (4.0–5.0)	0.007
Timed Up and Go Test (s)	14.52 ± 4.35	15 (10–26)	11.24 ± 1.55	11 (9–15)	0.0005
UPDRS part III (motor examination)	11.62 ± 9.36	10 (1–33)	11.95 ± 9.52	7 (2–30)	0.587
Functional Index Repty total	96.33 ± 8.66	97 (41–105)	101.48 ± 3.31	95 (77–105)	0.0008
International Physical Activity Questionnaire	14.76 ± 4.16	15 (6–23)	19 ± 3.39	19 (12–24)	0.0001

UPDRS – Unified Parkinson's Disease Rating Scale

Discussion

PA is increasingly recommended as an additional intervention for individuals diagnosed with PD. Nevertheless, the specific advantages of PA for the diverse range of impairments observed in PD patients have yet to be conclusively determined. The existing evidence suggests that PA could emerge as a crucial non-pharmacological strategy in PD. In 2018, Stuart et al. [32] asserted that cortical activity tends to rise with PA, such as walking and balance tasks, in both older individuals and PD patients when compared to baseline conditions (sitting/standing) or control groups. Monteiro-Junior et al. [33] highlighted that the positive effects of exercise in PD might be linked to various factors, including neurotrophic elements, particularly the cerebral nerve growth factor, and associated neuroplasticity.

Hidalgo-Agudo et al. [34] conducted a systematic review and meta-analysis of randomised controlled trials (RCTs) investigating the effectiveness of physical interventions in addition to conventional physical therapy in PD. This review included a total of 11 RCTs, with five contributing to the meta-analysis. The statistical analysis revealed favourable outcomes for dance-based therapy in motor balance, assessed by TUG and the Berg Balance Scale. Aquatic interventions demonstrated positive results in balance confidence. The findings from this review underscore the potential advantages of incorporating dance-based therapy into clinical practice for enhancing functional balance in individuals with PD. Nevertheless, numerous aspects necessitate clarification through further research and high-quality studies in this domain [33].

Lauzé et al. [35] identified health parameters likely to improve due to PA interventions in PD patients. They synthesised results from studies examining PA interventions in PD patients, providing statistical analyses from 106 papers published between 1981 and 2015. This synthesis indicated that PA appears most effective in enhancing physical capacities and physical and cognitive functional capabilities, particularly related to gait, mobility, posture, and balance. PA seems to have highly positive effects on gait-related motor symptoms as assessed by the UPDRS Part III – motor examination. Conversely, PA appears less effective at improving clinical symptoms of PD and psychosocial aspects of life, with only 50% or less of results reporting positive effects. However, the impact of PA on disease symptoms and psychosocial aspects of life is moderate and exhibits more variability. This review also underscores the necessity for further investigations into the impact of PA on cognitive functions, depression, and specific manifestations of PD [35].

In 2020, Gorzkowska et al. [36] disseminated findings of a study seeking to identify potential determinants of spontaneous PA in 134 PD patients, averaging 65.2 ± 9.2 years, with a H&Y scale score ≤ 4. In the comprehensive explanatory model, more than 13% of the variance in time spent sitting (R^2 = 0.135; F(16.130) = 2.267; p < 0.01) was accounted for, with significant predictors being secondary education and UPDRS results. Individuals with secondary and vocational education, those starting dopamine antagonist treatment, and those with milder Parkinson's symptoms (UPDRS) exhibited reduced daily sitting time. The researchers concluded that the identification of determinants of spontaneous PA is feasible, potentially shedding light on the repercussions concerning modifiable PA conditions and the appropriate approach to patients with immutable PA factors [36].

In 2018, Mantri et al. [7] scrutinised self-reported PA scores and their correlations with clinical characteristics in 383 subjects with early-stage PD and 175 healthy controls. Activity scores were 8% lower in PD subjects than controls, with higher scores linked to younger age and male gender. Only 47% of PD subjects and 44% of controls reported activity consistent with standard recommendations for adults. The authors' inference from these findings underscores the imperative to promote exercise, even in the early stages of PD [7]. Ellis et al. [37] found in their report that exercise can diminish disability and enhance the quality of life in individuals with PD. Sustaining PA is presently regarded as a factor enabling the maintenance or improvement of cognitive functions and the function of the frontal cortex in elderly individuals [37].

Cusso et al. [16] explored the influence of PA on NMS in PD. Through a systematic review, the researchers identified 20 papers meeting inclusion criteria. The participant numbers ranged from 18 to 191, with most studies displaying a higher male-to-female ratio, except for two with equal proportions and three with a greater proportion of females. Participants' ages ranged from 40 to 89 years, and the intervention characteristics varied widely. The studies encompassed diverse, active interventions, such as aerobic training, treadmill training, walking, resistance training, balance training, Tai Chi, and Qigong, as well as customised programs like physiotherapy, occupational therapy, physiotherapist-supervised exercise, self-supervised exercise, group exercise, active theatre training, Argentine tango, early and delayed start exercises modified for PD [16].

The Feldenkrais physical therapy program, Nordic Walking, adapted fitness counts, gym-based exercise program, and the Ronnie Gardiner Rhythm and Music Method were implemented as diverse intervention approaches. However, comparing these methods proved challenging due to demographic variations and methodological distinctions. Nonetheless, PA has the potential to positively influence the overall burden of NMS, encompassing depression, apathy, fatigue, daytime sleepiness, sleep, and cognition. The authors emphasised the need for further adequately powered studies to evaluate the therapeutic impact of PA on both motor and non-motor facets of PD. These studies should be meticulously designed to appraise non-motor aspects of the disease using instruments validated specifically for PD [16].

Cucusi assessed the effects of a customised PA (APA) program on motor and NMS, functional capabilities, and quality of life in a cohort of nine consecutive PD patients (5 men, 4 women, 64.4 ± 6.8 years). The patients engaged in an APA program, attending three sessions per week for a duration of 9 weeks. The exercises targeted balance, walking, strength, and functional activities. Results indicated a significant reduction in resting heart rate, an increase in walking distances, and notable muscle strength impairments. The Berg Balance Scale revealed a significant enhancement in balance abilities, and safety with mobility (TUG, $p < 0.005$) was improved. Ultimately, a significant amelioration in both motor and NMS was observed. The authors concluded that a tailored exercise program in PD patients could serve as an effective complement to conventional therapy, enhancing daily activities, motor, NMS, and the overall quality of life in PD [17].

Our study drew inspiration from Dlugonski et al. [38], who reported on a behavioural intervention applied to 23 individuals with Multiple Sclerosis versus 22 controls. This intervention led to increased PA, sustained for at least three months post-intervention. Participants underwent seven one-on-one 5–10 min video coaching sessions with a health behaviour coach as part of the 12-week intervention: four in the first month, two in the second month, and one in the third month.

In our study, improvements in spontaneous PA were observed in both groups. This could be explained by the absence of phone calls for the control group, but the anticipation of the controlled assessment may have motivated and prompted them to be more active. Limitations of our study include the potential for a pedometer to provide a more objective evaluation of PA, and it would be prudent to conduct follow-ups, such as after 12 weeks. Feenne et al. [39] sought to address whether measuring PA alone could increase self-reported PA behaviour in primary care. Through a systematic review and meta-analysis, the authors concluded that no significant enhancements in objectively measured PA were found within control groups in primary care. Further exploration of noteworthy increases in PA levels within control groups, particularly in specific sub-groups, is warranted, as it may impact PA research and interventions in these populations [39].

Conclusions

The results obtained in this study indicate that a simple behavioural intervention may help increase spontaneous PA in PD. Behavioural intervention may also improve motor functions in PD. Improvement of PA depends on age, body mass index, and gender.

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Bioethics Committee of the Jerzy Kukuczka Academy of Physical Education in Katowice (approval No. 12/2014).

Informed consent

Informed consent has been obtained from all individuals included in this study.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflicts of interest

The authors state no conflicts of interest.

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