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Effects of task-specific training on motor activity, cognitive function, and quality of life among individuals with Parkinson's disease: a quasi-experimental pilot study

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Abstract

Introduction. The second most prevalent neurological condition in adults over 50 years is Parkinson's disease (PD). Individuals with PD(IwPD) experience motor and non-motor symptoms during disease progression. One of the most significant variables in non-motor symptoms is cognitive impairment, andthe disease may lead to dementia. Even though the cognitive impairment in IwPD is mild, there should be concern regarding its rehabilitation because there is no pharmacological management for cognitive impairment, and just a handful of studies on functional cognitive training for IwPD have been published. This raises the prospect of task-specific training among IwPD and functional rehabilitation of cognitive function.
Methods. Thisquasi-experimental study involved 30 participants, who were assessed and selected based on inclusion and exclusion criteria. Pre-test and post-test values were obtained using the Montreal Cognitive Assessment (MoCA), Unified Parkinson's Disease Rating Scale (UPDRS) Part III, and Parkinson's Disease Questionnaire (PDQ)-39. All subjects underwent task-specific training with cognitive training for 8 weeks.
Results. Statistical analysisshowed significant improvements in motor activity, cognitive function, and quality of life. The p-value of each outcome measure was < 0.0001 after analysingpre-test and post-test data.
Conclusions. According to the findings ofthis study, task-specific training combined with cognitive training significantly improved motor activity, cognitive function, and quality of life among IwPD.
Key words: cognition, Parkinson's disease, dementia, non-motor symptom, functional mobility, quality of life

Introduction

Parkinson's disease (PD) is a progressive neurological disorder characterised by motor and non-motor symptoms, in addition to specific motor symptoms like resting tremor, bradykinesia, rigidity, and walking difficulty. Individuals with PD (IwPD) also experience various non-motor symptoms such as tip-of-the-tongue phenomenon, bradyphrenia, anhedonia, apathy, depression, and other psychiatric and behavioural disorders. Quality of life (QoL) is negatively impacted by sensory disorders such as paresthesia, anosmia, dysautonomia, ageusia, and sleep problems, which frequently occur years before motor and non-motor symptoms [1, 2]. The overall prevalence of PD is estimated at around 0.3% in the general population and around 1% in those over sixty years in industrialised nations. The prevalence of PD rises with age and can reach 4% in the oldest age categories, making it clear that it is an age-related disease [3].

Cognitive impairment is a disabling comorbidity for many IwPD and represents a major challenge for physicians, caregivers, and health care workers. The clinical symptoms of cognitive impairment in PD can impact a variety of domains, including executive function, visuospatial thinking, memory, and language. Additional features include visual hallucinations, paranoia, and attention swings [4]. In the Sydney Multicentre Study of PD, it was discovered that, after 15 years of follow-up, 48% of those assessed had cognitive decline, and 84% had satisfied the diagnostic criteria for dementia.

Dopamine levels in the striatum are significantly decreased in those with PD [2]. PD dopaminergic neurodegeneration manifests as difficulties in motor execution and associated challenges with volitional action preference, motivation, high-level cognition, and mood [5]. Cognitive impairments are common in PD and eventually progress to dementia in 24 to 31% of sufferers [6]. Therefore, concentrating on cognitive training (CT) for those with PD plays a crucial role in rehabilitation. IwPD who receive CT report relatively positive improvements in cognitive function [6]. Most goal-directed motivation, such as seeking food or water, promotes dopamine [7, 8]. Studies on motor learning suggest that exercise progress depends on both training intensity and circumstances [9]. Also, the most debilitating PD symptoms are impairments in balance and gait, which reduce functional mobility and decrease an individual's self-confidence to retain their balance.

Task-specific training is one of the most effective methods for encouraging neuroplasticity and enhancing functional ability. The majority of everyday functional activities include processing outside information while doing motor tasks. However, distractions such as answering a phone while walking have an impact on these activities [10–12]. At present, there is no treatment for PD, and treatments like deep brain stimulation and injecting dopaminergic drugs (such as levodopa and bromocriptine) merelymanage the symptoms of the condition by temporarily relieving its motor manifestations. The effectiveness of the medicines has been proven to decline over time, and adverse effects such as pulmonary valve fibrosis, dyskinesia and depression have been linked to their use [13].

Game-based interventions, which leverage motivation and engagement to improve rehabilitation outcomes in clinical settings, have gained popularity over recent years. These ad-

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vantages of gamification are primarily attained by providing rewarding experiences through the application of multimodal stimulation, interactivity, and entertaining gameplay [14] with the aim of improving QoL, which is negatively affected by cognitive impairments [15]. Indeed, digital game paradigms using technology created for leisure (e.g., Nintendo Wii and Microsoft Kinect) improved cognitive and motor outcomes as well as conventional or traditional rehabilitation [16]. However, access to game-based rehabilitation may not be possible for most of the IwPD in the Indian population. To maximise the research outcome and rehabilitation protocol, this study aimed to encourage task-specific training combined with CTin the daily environment of IwPD to improve their QoL.

Subjects and methods

Study design and participants

This quasi-experimental study involved individuals with idiopathic PD who visited a private medical college and hospital in Chennai. General screening procedures were employed to evaluate 53 individuals with PD, of which 30 met the inclusion criteria of individuals of both genders aged between 50 and 75 years, Hoehn and Yahr stage ≤ 3, and a Montreal Cognitive Assessment (MoCA) score of less than 26. Exclusion criteria encompassed individuals with dementia, psychological disorders, irregular medication usage, or motor fluctuations/severe dyskinesia and those who underwent training previously.

Study procedure

The enrolled participants underwent a comprehensive assessment using the MoCA, Unified Parkinson's Disease Rating Scale (PDRS), and Parkinson's Disease Questionnaire-39 (PDQ-39) to establish baseline values before the initiation of the intervention. Subsequently, IwPD engaged in an 8-week task-specific training program, complemented by CT. The training sessions, lasting 60 min each, were conducted 3 days a week. The program, tailored to meet the unique needs of each participant, featured 10 workstations with the overarching objective of improving motor activity, cognitive function, and overall QoL. Commencing with a 10-minute warm-up comprising activities such as marching, neck circles, arm swings, shoulder circles, and trunk rotations, the training progressively intensified in difficulty and complexity. Participants advanced through each task at 10 workstations, with a 1-minute interval, as outlined in Table 1. Following the 8-week intervention, post-intervention values were analysed and documented.

Table 1. Task-specific training with cognitive training

Workstations	Progression
1. Chair sitting to standing	1. Different chair heights. 2. Keep feet on a stable and rubbery surface. 3. The patient has to hold the objects in their hand. 4. The patient has to count numbers in multiples of two.
2. Standing from chair and walking six metres	1. Overcome barriers on five and ten-centimetre lines. 2. On a stable and rubbery surface. 3. The patient has to hold the objects in their hand. 4. The patient has to observe the orientation of the surrounding objects and replicate it after the task.
3. Three metre obstacles walk over	1. Overcome barriers on five-centimetre lines. 2. On a stable and rubbery surface. 3. The patient has to hold the objects in their hand.
4. Stepping up	1. Five, ten, and twenty-centimetre steps up and down. 2. On a stable and rubbery surface. 3. The patient has to hold the objects in their hand.
5. Six metres picking up objects from the ground while walking	1. The objects were spaced apart by 50 cm and 100 cm, respectively. 2. On a stable and rubbery surface. 3. The patient has to hold the objects in their hand. 4. The patient has to recall the words, which will be instructed before the task.
6. Figure of eight walking	1. The cones were spaced apart by 100 cm, 50 cm, and 25 cm, respectively. 2. On a stable and rubbery surface. 3. The patient has to hold the objects in their hand.
7. Stair climbing and descending	1. 15 cm step height is used for stair climbing. 2. On a stable and rubbery surface. 3. The patient has to hold the objects in their hand.
8. Touch several points designated in a semicircle	1. On stable and rubbery surface. 2. The patient has to hold the objects in their hand. 3. Patient has to draw the picture shown to them during the task.
9. Standing and reaching for an object	1. Reach 10, 15, 20, and 30 cm. 2. Placing feet wider, together and in tandem position. 3. On stable and rubbery surface. 4. The patient has to hold the objects in their hand. 5. The patient has to quickly reach out for the things according to the colour instructed by the therapist.
10. Standing on a wobble platform	1. Unexpected forward and backward perturbation given. 2. On stable and rubbery surface. 3. The patient has to hold the objects in their hand.

Outcome measures

The procedures were consistently conducted during the 'on-medication' phase to ensure a more representative assessment of participants' functional abilities under the influence of medication.

Montreal Cognitive Assessment

In order to assist healthcare practitioners in identifying moderate cognitive impairment (MCI), MoCA was developed by Dr Ziad Nasreddinein in Montreal, Canada, in 1995. The MoCAis a 30-point test that may be finished in 10 min, with a score of 26 or above considered normal. MoCA evaluates various cognitive domains, including visuospatial/ executive (copy a cube and draw a clock), naming, memory (read a list of words and subjects), attention (read a list of digits, read a list of letters, and serially subtract seven), language (words repetition, and fluency), abstraction, delayed recall (word recall), and orientation (date, month, year, day, place, and city). The MoCA has been shown to outperform the Mini-mental state examination as a common diagnostic tool, particularly in identifying the early stages of cognitive loss [17].

Unified Parkinson's Disease Rating Scale

The severity and progression of IwPD are assessed using the UPDRS, which is divided into 6 segments, including (1) mentation, behaviour, and mood, (2) activities of daily living (ADL), (3) motor sections, (4) complications of therapy (in the past week), (5) modified Hoehn and Yahr scale, and (6) Schwab and England ADL scale. Parts one to three are evaluated on a 0–4 scale, with the fourth section rated on a yes/no scale. Higher scores represent greater severity. The IwPD in this study were evaluated using the part III motor section [18].

Parkinson's Disease Questionnaire 39

A QoL questionnaire known as PDQ39 was created exclusively for IwPD, thoroughly examined for validity, and is presently in use. Eight aspects of health are measured by the 39 items, with 10 mobility, six ADL, 6 emotional well-being, four stigmas, 3 social support, 4 cognitions, 3 communication, and 3 bodily discomfort. The PDQ39 scale ranges from 0 (best health) to 100 (worst health) [19].

Statistical analysis

A Wilcoxon signed-rank test was calculated using Sigma plot software to analyse differences between the post-test and pre-test values of MoCA, UPDRS part III, and PDQ 39.

Results

The statistical analyses of MoCA, UPDRS Part III, and PDQ-39 in individuals with idiopathic PD revealed significant changes in post-test values compared to pre-test values following task-specific training combined with CT ($p < 0.0001$). For a comprehensive overview of participant demographics, please refer to Table 2. Additionally, Table 3 presents a detailed comparison of IwPD values before and after the intervention, offering insights into the multifaceted impact on various aspects of motor function.

The results of this quasi-experimental pilot study examining the effect of 8 weeks of task-specific training on motor activity, cognitive function, and QoL among IwPD revealed significant improvements across all measured outcomes. In terms of cognitive function assessed using the MoCA, participants demonstrated a mean pre-test score of 23.4 ± 1.37, which significantly increased to 25.2 ± 1.27 post-intervention ($p < 0.0001$), reflecting a percentage change of 7.69% and an effect size (Cohen's *d*) of 1.36. Similarly, motor activity, as evaluated by the UPDRS Part III, displayed notable enhancement, with pre-test and post-test mean scores of 33.1 ± 5.67 and 27.8 ± 5.90, respectively ($p < 0.0001$). This corresponded to a percentage change of –16.01% and an effect size of –0.92. Furthermore, QoL, as measured by the PDQ-39, exhibited significant improvement, with pre-test and post-test mean scores of 30.4 ± 3.05 and 24.8 ± 2.48, respectively ($p < 0.0001$), reflecting a percentage change of –18.42% and an effect size of - 2.05. These findings underscore the efficacy of task-specific training combined with CT in enhancing cognitive function, motor activity, and QoL among IwPD.

Discussion

The current research looked into the effects of CT and task-specific training among IwPD. The main outcome showed significant improvement in motor activity, cognitive function, and QoL.In addition, patients improved in confidence when approaching QoL and ADL activities. These findings were consistent with earlier research by Straudi et al. [20] investigating the impact of task-oriented training. According to Cruise et al. [21], exercise-specific training in PD individuals improved frontal lobe-based executive function but had no effect on QoL. Contrary to Cruise et al. [21], our study showed that task-

Table 2. Demographic characteristics of participants

Age (years, mean ± *SD*)	68 ± 5
Participants	30
male (*n*)	21
female (*n*)	9
Disease duration (years, mean ± *SD*)	4 ± 1.11
Hoehn and Yahr stage	
stage 1 (*n*)	3
stage 2 (*n*)	20
stage 3 (*n*)	7
Levodopa dose (mg/day, mean ± *SD*)	700 ± 123.03

Table 3. Comparison between pre-test and post-test variables

Outcome measure	Pre-test (mean ± *SD*)	Post-test (mean ± *SD*)	*p*-value	Percentage change	Effect size (Cohen's *d*)
Montreal Cognitive Assessment	23.4 ± 1.37	25.2 ± 1.27	< 0.0001	7.69	1.36
Unified Parkinson's Disease Rating Scale Part III	33.1 ± 5.67	27.8 ± 5.90	< 0.0001	–16.01	–0.92
Parkinson's Disease Questionnaire 39	30.4 ± 3.05	24.8 ± 2.48	< 0.0001	–18.42	–2.05

specific training with CT improved QoL among IwPD. The training programme created and implemented in this study addresses needs specific to IwPD, which is supported by a meta-analysis carried out by Radderet al. [22]that revealed physiotherapy is effective in enhancing certain patient-related outcomes. Based on the precise symptoms they seek to relieve and the patient's preferences for the exercise technique they relate to, therapists and patients can select from various therapy techniques. This will enable a more patient-focused approach in which patients and therapists can choose interventions based on the best available research [22].

CT has been suggested to improve cognition by triggering brain plasticity. Most studies on PD exclude individuals with cognitive impairment, but this study included individuals with MCI because one of its goals was to delay the onset of dementia in IwPD and improve cognitive function. As our results show improvements in cognitive function, this training method can be used for IwPD.A study by Spanò et al. [23], found that a dual-task motor-cognitive intervention programme improved balance, fear of falling, walking endurance, gait and speedin patients with various neurological conditions.

Regarding MoCA, improvements in visuospatial abilities, attention, and memory are attributed to our tailored CT. UPDRS Part III analysis reveals substantial enhancements in gait, hand movements, and arising from a chair, highlighting the positive impact of our task-specific training on critical motor functions. PDQ-39 examination showcases multifaceted improvements in emotional well-being, mobility, and ADL, and offers insights into how our intervention positively influenced overall QoL. Research by Wollesen et al. [24] in 2021 found that an intensified DT training approach with an emphasis on task management was both feasible and successful for treating PD gait disorder and might be used as a component of a multidisciplinary treatment strategy [24–26].

Orgeta et al. [25] published a systematic review with meta-analysis in 2020. The results revealed that most CT studies used computers, and some also included pencil and paper homework assignments. They were unable to provide any insight into whether single-domain or multi-domain CT may significantly impact cognition for individuals with PD-MCI [25, 27]. During the initial phase of this study, we also faced problems identifying a training protocol for IwPD, but we finally applied task-specific training with CT (Table 1). A control group would have allowed for a more robust comparison and a clearer understanding of the specific impact of our intervention. In the absence of a control group, we recommend interpreting the observed improvements cautiously. Comparisons with control groups in previous studies have demonstrated the efficacy of various interventions, and our findings should be considered within this context.

Limitations and recommendations

The small participant size necessitates a cautious interpretation of results, emphasising their preliminary and descriptive nature. The choice of a quasi-experimental design over a randomised control trial was a pragmatic decision, optimising feasibility within our specific context. The lack of assessment beyond 8 weeks hinders understanding of long-term effects, necessitating future studies with extended follow-up. Additionally, the awareness of treatment allocation may influence results, highlighting the need for exploration in future investigations.

Conclusions

According to the study findings, motor activity, cognitive function, and QoL significantly improved in IwPD individuals after task-specific training. The positive outcome suggests that an appropriate combination training program used in real-life circumstances can improve everyday living for IwPD. Further research is needed to determine these impacts among the PD population over a longer time span.

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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 ISRB Committee of Private Institution and Hospital in Chennai, India (approval No.: 01/023/2022/ISRB/PGSR/SCPT).

Informed consent

Informed consent has been obtained from all individuals included in this study. All participants provided their informed consent after receiving a clear explanation of the research procedures.

Disclosure statement

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

Conflict of interest

The authors state no conflict of interest.

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References

[1] Pagonabarraga J, Kulisevsky J, Llebaria G, García-Sánchez C, Pascual-Sedano B, Gironell A. Parkinson's disease-cognitive rating scale: a new cognitive scale specific for Parkinson's disease. Mov Disord. 2008;23(7):998–1005; doi: 0.1002/mds.22007.

[2] Jankovic J. Parkinson's disease: clinical features and diagnosis. J Neurol Neurosurg Psychiatry. 2008;79(4):368–76; doi: 10.1136/jnnp.2007.131045.

[3] De Lau LM, Breteler MM. Epidemiology of Parkinson's disease.Lancet Neurol. 2006;5(6):525–35; doi: 10.1016/S1474-4422(06)70471-9.

[4] Davis AA, Racette B. Parkinson disease and cognitive impairment: five new things. Neurol Clin Pract. 2016;6(5):452–8; doi: 10.1212/CPJ.0000000000000285.

[5] Cavanagh JF, Mueller AA, Brown DR, Janowich JR, Story-Remer JH, Wegele A, Richardson SP. Cognitive states influence dopamine-driven aberrant learning in Parkinson's disease. Cortex. 2017;90:115–24; doi: 10.1016/j.cortex.2017.02.021.

[6] Rosca EC, Simu M. Parkinson's disease-cognitive rating scale for evaluating cognitive impairment in Parkinson's disease: a systematic review. Brain Sci. 2020;10(9):588; doi: 10.3390/brainsci10090588.

[7] Arias-Carrión O, Stamelou M, Murillo-Rodríguez E, Menéndez-González M, Pöppel E. Dopaminergic reward system: a short integrative review. Int Arch Med. 2010; 3(1):24; doi: 10.1186/1755-7682-3-24.
[8] Changizi MA, McGehee RM, Hall WG. Evidence that appetitive responses for dehydration and food-deprivation are learned. Physiol Behav. 2002;75(3):295–304; doi: 10.1016/S0031-9384(01)00660-6.
[9] Kim H, Fraser S. Neural correlates of dual-task walking in people with central neurological disorders: a systematic review. J Neurol. 2022;269(5):2378–402;doi: 10.1007/s00415-021-10944-5.
[10] Feng Y-S, Yang S-D, Tan Z-X, Wang M-M, Xing Y, Dong F, Zhang F. The benefits and mechanisms of exercise training for Parkinson's disease. Life Sci. 2020;245: 117345; doi: 10.1016/j.lfs.2020.117345.
[11] Liang L, Jiao-jiao L, Ling-yan H. Advance in cognitive and postural control dualtask in falls of older people. Chin J Rehabil Med. 2016;22(11):1289–93; doi: 10.1016/j.smhs.2021.10.003.
[12] Verhaeghen P, Steitz DW, Sliwinski MJ, Cerella J. Aging and dual-task performance: a meta-analysis. Psychol Aging. 2003;18(3):443–60; doi: 10.1037/0882-7974.18.3.443.
[13] Rizek P, Kumar N, Jog MS. An update on the diagnosis and treatment of Parkinson disease.CMAJ. 2016;188(16): 1157–65; doi: 10.1503/cmaj.151179.
[14] Chua L-K, Chung Y-C, Bellard D, Swan L, Gobreial N, Romano A, Glatt R, Bonaguidi MA, Lee DJ, Jin Y, Liu CY, Fisher BE. Gamified dual-task training for individuals with Parkinson disease: an exploratory study on feasibility, safety, and efficacy. IntJEnvironResPublic Health. 2021;18(23):12384;doi: 10.3390/ijerph182312384.
[15] Wiesli D, Meyer A, Fuhr P, Gschwandtner U. Influence of mild cognitive impairment, depression, and anxiety on the quality of life of patients with Parkinson disease. Dement Geriatr Cogn Dis Extra. 2017;7(3):297–308; doi: 10.1159/000478849.
[16] Garcia-Agundez A, Folkerts AK, Konrad R, Caserman P, Tregel T, Goosses M, Göbel S, Kalbe E. Recent advances in rehabilitation for Parkinson's disease with exergames: asystematic review. J Neuroen Rehabil. 2019;16(1):17; doi:10.1186/s12984-019-0492-1.
[17] Hobson J. The Montreal Cognitive Assessment (MoCA). OccupMed. 2015;65(9):764–5; doi: 10.1093/occmed/kqv078.
[18] Goetz CG, Tilley BC, Shaftman SR, Stebbins GT, Fahn S, Martinez-Martin P, Poewe W, Sampaio C, Stern MB, Dodel R, Dubois B, Holloway R, Jankovic J, Kulisevsky J, Lang AE, Lees A, Leurgans S, LeWitt PA, Nyenhuis D, Olanow CW, Rascol O, Schrag A, Teresi JA, van Hilten JJ, LaPelle N; Movement Disorder Society UPDRS Revision Task Force. Movement Disorder Society-sponsored revision of the Unified Parkinson's Disease Rating Scale (MDS-UPDRS): scale presentation and clinimetric testing results. Mov Disord. 2008;23(15):2129–70; doi: 10.1002/mds.22340.
[19] Peto V, Jenkinson C, Fitzpatrick R. PDQ-39: a review of the development, validation and application of a Parkinson's disease quality of life questionnaire and its associated measures. J Neurol. 1998;245(Suppl 1):10–4; doi: 10.1007/PL00007730.
[20] Straudi S, Martinuzzi C, Pavarelli C, SabbaghCharabati A, Benedetti MG, Foti C, Bonato M, Zancato E, Basaglia N. A task-oriented circuit training in multiple sclerosis: a feasibility study. BMC Neurol. 2014;14(1):124; doi: 10.1186/1471-2377-14-124.
[21] Cruise KE, Bucks RS, Loftus AM, Newton RU, Pegoraro R, Thomas MG. Exercise and Parkinson's: benefits for cognition and quality of life. Acta Neurol Scand. 2011; 123(1):13–9; doi: 10.1111/j.1600-0404.2010.01338.x.
[22] Radder DL, de Lima ALS, Domingos J, Keus SH, van Nimwegen M, Bloem BR, de Vries NM. Physiotherapy in Parkinson's disease: a meta-analysis of present treatment modalities. Neurorehabil Neural Repair. 2020; 34(10):871–80; doi: 10.1177/1545968320952799.
[23] Spanò B, De Tollis M, Taglieri S, Manzo A, Ricci C, Lombardi MG, Polidori L, Griffini IA, Aloisi M, Vinicola V, Formisano R, Caltagirone C, Annicchiarico R. The effect of dual-task motor-cognitive training in adults with neurological diseases who are at risk of falling. Brain Sci. 2022;12(9):1207; doi: 10.3390/brainsci12091207.
[24] Wollesen B, Rudnik S, Gulberti A, Cordes T, Gerloff C, Poetter-Nerger M. A feasibility study of dual-task strategy training to improve gait performance in patients with Parkinson's disease. Sci Rep. 2021;11(1):12416; doi: 10.1038/s41598-021-91858-0.
[25] Orgeta V, McDonald KR, Poliakoff E, Hindle JV, Clare L, Leroi I. Cognitive training interventions for dementia and mild cognitive impairment in Parkinson's disease. Cochrane Database SystRev. 2020(2):CD011961; doi: 10.1002/14651858.CD011961.pub2.
[26] Kashif M, Mustafa R, Bunyad S, Aslam N, Arshad F, Umar B. Physical rehabilitation for Parkinson's disease: assessment and treatment preferences of physical therapists. Physiother Q. 2023;31(4):70–80; doi: 10.5114/pq.2023.125165.
[27] Leveck GC, Siega J, Debonalucksch D, Silva A, Yamaguchi B, Israel V. Applicability of the Minimal Clinically Important Difference in the activities of daily living, motor sections, and quality of life in individuals with Parkinson's disease after aquatic physical therapy intervention: a pilot study. Physiother Q. 2023;31(2):34–8; doi: 10.5114/pq.2023.125743.