**Journal of Research in Medical and Dental Science**
**2021, Volume 9, Issue 11, Page No: 278-283**

Available Online at: www.jrmds.in
eISSN No.2347-2367: pISSN No.2347-2545

# Paramedical Therapies for Parkinson Disease: A Systematic Review

**Fahad Somaa[1*], Andleeb Asghar[2]**

[1]*Faculty of Medical Rehabilitation Sciences, King Abdul Aziz University, Jeddah, Saudi Arabia*

[2]*Faculty of Pharmaceutical & Allied Health Sciences, Institute of Pharmacy, Lahore College for Women University, Pakistan*

## ABSTRACT

*Background: Parkinson disease is associated with multiple disabilities and functional impairment in activities of daily living regarding gait, posture, falls, balance, and cognitive decline. The paramedical therapies have been proposed as an effective adjunctive intervention by exercising physiotherapy, speech and language therapy, occupational therapy, and maximizing independence and motor rehabilitation.*

*Objectives: This systematic review explores the effectiveness of different paramedical therapies for Parkinson disease under variant treatment strategies.*

*Methods: We searched online resources like PubMed, PubMed Central, Cochrane Library, and Google Scholar for randomized controlled trials on all types of paramedical interventions. We included human studies published in peer-reviewed journals in the English language in the last ten years.*

*Results: After reviewing 600 initial studies, we excluded 250 duplicates and all irrelevant articles. We did a quality assessment for the remaining 17 studies using The Physiotherapy Evidence Database (www.pedro.org.au). Multidisciplinary physiotherapy trials and speech and language therapy for dysarthria trials had data supporting the beneficial outcome regarding the risk of fall, postural instability, gait speed, improvement in all motor aspects and quality of life. Due to heterogeneous methodology and outcomes, the data is insufficient regarding superiority of one physiotherapy modalities to the others.*

*Conclusions: Rehabilitation interventions encompass a wide range of benefit to the patients who have Parkinson disease, as well as a wide range of techniques and modalities, which needs to be adjusted, measured in the array of intensity, duration, content, quantitative outcome measures in future large randomized clinical trials to improve specific treatment strategies and cost-effective designed interventions.*

**Key words:** Parkinson's disease, Rehabilitation in Parkinson's, Paramedical therapies, Parkinson's management

**HOW TO CITE THIS ARTICLE:** Fahad Somaa, Andleeb Asghar, Paramedical Therapies for Parkinson Disease: A Systematic Review, J Res Med Dent Sci, 2021, 9(11): 278-283

**Corresponding author:** Fahad Somaa
**e-mail** ✉ : tamimrai18@gmail.com
**Received: 23/10/2021**
**Accepted: 15/11/2021**

## INTRODUCTION

Parkinson's disease is an incremental neurodegenerative disorder distinguished by rigidity, tremors, and trouble with balance, coordination, and walking. As the condition progresses, incapacities increase in talking and walking [1], to involve all activities of daily living (ADL). If we also added behavioural, mental variations, depression, sleep problems, fatigue, and memory complications, this will minimize independence, disability, and social alienation, ultimately reducing the quality of life [2].

Parkinson's disease affects elderly more than sixty years old, but almost 5-10% of individuals with PD are diagnosed before 50 years of age [3]. It is well known for its high expenditure and burden on health services as in the US only; the costs are worth around $14 billion per year and $6.3 billion annually as indirect expenses. With the expectation of increased ages, these rates are planned to increase instantly with anticipation to double the total figure of Parkinson's patients worldwide by 2040 [4].

The primary cause of Parkinsonism is idiopathic Parkinson's disease, which is the most common and defined by the absence of dopaminergic neurons in the substantia nigra [5]. With the accumulation of Lewy bodies, the alpha-synuclein protein in brain cells. Parkinsonian patients have subjected to an almost two-fold risk of falling with subsequent bone fractures compared to average similar age and health, which could be explained by axial motor rigidity, including gait motor disabilities, postural instability in patients with advanced Parkinsonism.

**Management challenges**

**Pharmacotherapy**

It is imperative to understand that the management of Parkinson disease is based on the pharmacological replacement of striatal dopamine; this goes hand in hand with non-dopaminergic approaches to handle both motor and non-motor symptoms. Despite proper optimal medical pharmacotherapy with or without the inclusion of surgical intervention to the thalamus, subthalamus, and the globus pallidus, these patients still had a decline in the functioning of the body, everyday tasks and communication [6,7].

**Paramedical and other therapies and challenges for clinical management**

There is a growing ample amount of evidence from health professionals and Parkinson's disease Society strongly supporting the compelling argument to use paramedical treatments in the inclusive management of Parkinson's disease on top of optimum surgical and medical therapies [8]. These paramedical therapies comprise physiotherapy, speech, and language therapy, as well as occupational therapy. Despite its support for paramedical rehabilitations, quite a few surveys have concluded that only 3%-29% of Parkinson's patients have met an expert physical medicine physician [8]. This subordinate level of referral represents an unsatisfactory trust and minimal belief in clinicians and evidence to practice such therapies. However, the under-financing of such facilities might be an additional factor [9].

Exercise therapy in PD patients using a diversity of physiotherapy intervention could serve as an essential function in improving balance, flexibility, gait, aerobic capacity, functional independence, and movement initiation [10]. Studies have highlighted the functional improvement in all consequences, but the measured improvement was sometimes minimal in extent, and its effectiveness following discontinuation of the exercise remains a question [9]. Scientists found in a systematic review of 33 random controlled trials including 1518 participants who went through multiple physiotherapy mediations, including general physiotherapy, exercise, treadmill training, martial arts, and dance, remarkable improvements for step length, walking strength, walking speed, balance, and mobility. Instead, there was no proof that a single kind of physiotherapy was superior to others [11]. Neurorehabilitation is arguably essential for treating axial symptoms such as freezing, hypophonia, dysphagia, postural instability, and postural disturbances that respond poorly to drug therapy [12]. The laryngeal complications of PD mostly lead to reduced contribution in the activities of everyday living due to an incapability to communicate efficiently. In severe cases, 45% to 89% of patients found dysarthria problems to be the most incapacitating part of the disorder [13].

Any exercise or therapy is done in a safe and regulated water environment, such as a pool, is referred to as aquatic therapy [14]. Aquatic activity in a pool, typically a heated pool, will, for example, include exercise to increase fitness levels or overall health. Physical therapists use physical therapy protocols in a pool or water environment in aquatic physical therapy [15]. Water has unique properties that allow it to be used for both therapy and exercise, especially for people who cannot move freely on the land, often with Parkinson's patients. When a person with Parkinson's disease can float and travel in a lake, they feel much more liberated than they are on the ground [16]. Tremors are a common symptom of Parkinson's disease, and water can help with this. While the normal resistance of the water relaxes movements, a warmer pool will soothe muscles. Tremors are reduced, giving patients more time to respond and concentrate on movement. Patients with Parkinson's disease can be afraid of falling or moving, which may discourage them from exercising. Because of the hesitation, muscles will weaken even more without exercise, resulting in even narrower ranges of motion [17].

Tai Chi is a type of exercise that focuses on maintaining equilibrium and is focused on the 6000-year-old yin-yang principle of traditional Chinese medicine [18]. Tai Chi is a healthy and powerful technique that benefits both the body and the mind. It consists of 108 intricate exercise steps. Tai Chi is a potentially helpful meditation technique for people with mild to moderate Parkinson's disease (PD), slowing disease progression [19]. According to the findings, Tai Chi and routine exercise, enhanced the timed up-and-go, 50-foot speed walk, and functional reach, but the intensity of Tai Chi for improving these parameters was higher than routine exercise [20].

Additionally, all physical therapies reduced the number of falls; however, the Tai Chi community saw a more significant reduction. Researchers discovered that 9 percent of patients in the Tai Chi community had successfully discontinued levodopa therapy during the follow-up and those who did not have reduced their dose [21]. During the final interview, all participants expressed satisfaction with their exercise program, describing it as easy, healthy, and necessary. Patients also said the exercises helped them with their equilibrium and confidence [22].

An expert professional Paramedical therapist provides proper exercises, education, aids, and guidance to the essential patients [23]. Occupational therapists use relaxing approaches and offer modification readjustment and aid to permit normal work, personal care, and leisure activities to proceed. In speech and language therapy, the patients are managed with particular swallowing and speech training exercises.

It is crucial to review and investigate the role of various physiotherapy techniques, rehabilitation modalities, occupational, speech and language therapeutic interventions offered for PD patients. This systematic review aims to assess the current evidence for the advantages of physiotherapy therapeutics for treating postural instability, balance impairments, and decreasing

the frequency and tendency of falling for subjects with Parkinson's disease and highlighting its effectiveness.

### Outcome measures assessed

Quality of life, improvement in dysarthria, functional improvement in everyday tasks, and subjective and objective enhancement of motor and speech progress.

## METHODOLOGY

Recommendations of the preferred reporting items for systematic reviews and meta-analyses (PRISMA) statements have been accomplished [24]. PubMed, PMC, Wiley Online Library, Cochrane Libraries, Embase, Medline, Google Scholar in conjunction with National Library NIH of Medicine have been explored with proper keywords. Full-length articles have been evaluated to normalize either the enclosure criterion fulfilled in the current review.

### Eligibility criteria

Only randomized controlled trials were included, which evaluated different kinds of paramedical therapies, including physiotherapy, occupational therapy, exercise, treadmill training, dance, martial arts, and speech and language therapy to treat Parkinson's disease. The studies related to pharmacological, surgical management were excluded. Participants in the trials were patients with Parkinson's disease of any disease duration, of all ages, and on any form of mentioned therapies. The patients were not selected during treatment trials and reports in any other language except English.

### Search strategy

### Study design and interventions

Multiple randomized, systematic, and controlled procedures available in English from 2011 to 2020 were included in the research criteria. The strategy to search the studies was followed by the Cochrane Movement Disorders Group that cross-referenced fundamentally as text titles and keywords including Parkinson's disease, rehabilitation, treatment, paramedical therapy, physical therapy, exercise, physiotherapy, voice, speech, language, and occupational therapy.

### Data extraction

Three independent reviewers analyzed entire research papers, and data extracted as stated by defined criteria resolved any inconsistencies by multiple discussions. Research papers were evaluated for methodological quality by estimating definite eligibility criteria, methods of blinding, and randomization disguise of allocation, correspondence of baseline patients in treatment groups, the discrepancy in co-interventions obtained by patients through the trial duration, either a purpose to treat study was conducted, or the total patients missing follow-up.

### Data analysis

### Quality assessment

The Physiotherapy Evidence Database (www.pedro.org.au) was used to assess individual RCTs analytically by PEDro scale scores and explained under decision guidelines. For example, intention-to-treat analysis, concealed allocations, and sufficiency of follow-ups. The trials were individually rated and evaluated the bias risks by three authors. Studies were disqualified if the PEDro scale did not touch the 5 points cut-offs. The extracted data from the selected studies include study designs, patient's information, and explanation of interventions, outcomes, and follow-up duration. According to the Consolidated Standards of Reporting Trials (CONSORT) guidelines, a critical appraisal of the RCTs was performed.

### Types of outcome measures

Gait outcomes, Functional mobility and balance outcomes, number of patients falling, Clinician-rated impairment and disability measures, patient-rated quality of life.

## RESULTS

### Study selection

The overall 600 papers were recognized from electronic and additional searches; however, 250 were duplicates. Subsequently, with screening titles, abstracts, and interventions, 180 studies were again skipped. The full-length texts were obtained for 30 papers, of which 13 papers were removed as they did not run into inclusion criteria. Thus, 17 papers included in the final qualitative research as represented by the PRISMA flow diagram.

### Effect of physiotherapeutic interventions on study outcomes, qualitative analysis

### Study characteristics

We identified 17 randomized controlled trials, and 806 patients were included. They compared different techniques of rehabilitation. Eight studies evaluated the strength and balance training exercises, walking, dancing, occupational therapy, treadmill, and they reported a significant functional improvement in these multidisciplinary therapy rehabilitation trials. Three studies evaluated home-based physiotherapy training, occupational therapy, and treadmill walking and identified independent mobility with decreased incidence of falls. Four studies implemented speech and language therapy, exergaming exercises, incentive spirometer, breathing mounding techniques, aerobic interval training (AIT) for dysarthria cases, and small to moderate benefit in some trials and excellent acoustic and perceptual results in others. Three studies provide Cognitive training programs for mild to moderate patients with cognitive decline, resulting in an enhancement in memory, visuospatial domains, quality of

life, and psychomotor behaviour. All training programs were feasible. Physician-rated disability and patient-rated quality of life outcome measures have been analyzed using Parkinson's disease quality of life questionnaire [PDQL]) measured at 4, 6, and 8 months and revealed a difference of 3·0 points (0·4 to 5·6) in addition to Academic Medical Centre linear disability score [ALDS]. The assessment period ranged from 4 weeks to 12 months. All characteristics of included randomized controlled trials are presented. The results showed a tendency towards a decrease in falling and improved quality of life, enhancing all motor functions. However, there was no demarcating difference between beneficial therapeutic effects of various physiotherapy interventions used in the included studies. Heterogeneous rehabilitation therapeutic methods, different outcome measures, and an indefinite follow-up period were reported, necessitating proper quantitative head-to-head trials of physiotherapy.

## DISCUSSION

The inclusive outcome of this systematic review of RCTs specifies that multi-complex physiotherapy interventions including muscle strengthening, balance training, walking, exercises, ranges of movement, dancing, speech, and language therapy were found to have a beneficial impact among Parkinson's patients. However, the direct influence of the training session's duration, modality, and intensity is inconsistent and variable.

In a current systematic review, a wide range of paramedical techniques was effective in enlightening balance. They were managed in the form of dynamic, functional, and static exercises. Workouts intended at improving both feedback and feed-forward postural reactions gait and stance tasks that need postural control and supported balance exercises. These findings are supported by multiple studies and found that motor training and exercises can progress paramedic-related events in patients with PD.

Scientists confirmed that it might improve balance, flexibility, gait, aerobic capacity, functional independence, and movement initiation [10]. Another systematic review assessed several physiotherapy mediations, including exercise, general physiotherapy, treadmill training, dance, martial arts, and cueing. The effectiveness of these modalities after the discontinuation of the sessions remains questionable [9].

Goodwin, in his study, investigated the PD patients with two or more falls' history in the previous year, and capable of mobilizing self-sufficiently, they underwent ten weeks of physiotherapy, home exercises, and balance or strength training showed that the reduction in the incidence rate ratio for falls was 0.68 (95% CI 0.43 to 1.07, p=0.10) during the therapy, that is evident for the effectiveness of physiotherapy and exercise [25]. Pompeu et al. studied thirty-two patients with PD who underwent 30 minutes of stretching, axial mobility, strengthening exercises and balance training [26]. The patients showed improved activities performance and daily living after 14 balance training sessions. This agrees with McGinley et al., who studied 210 ambulant patients who performed physical therapy and movement strategy training. Both interventions were feasible regarding safety, adherence, retention, and compliance estimates which proved high efficiency [27]. Canning and his colleagues (2012) studied twenty cognitively intact patients with mild PD and gait disturbances who underwent treadmill walking at home for 20 to 40 minutes, for six weeks, four times a week [28].

Remarkably, Van der Marck et al. studied patients with PD, 20- to 80-year-old, without acute cognitive injury who undergone occupational therapy, physiotherapy, speech and language therapy, Parkinson's disease quality of life questionnaire [PDQL]) measured at 4, 6, and 8 months and revealed a difference of 3·0 points (0·4 to 5·6) in addition to Academic Medical Centre linear disability score [ALDS]. The average ALDS score from months 4, 6, and 8 was more significant in the intervention group than in the control group (difference 1·3 points, 95% CI (-2·1 to 2·8). In a study by Sale (2013), he examined twenty participants with mild PD who underwent robot-assisted gait training and treadmill training five times a week for 40 minutes within a four-week duration. The training was safe and sound, and the patients completed prescribed sessions [29]. Even dance therapy was studied in fifty patients by Ashburn and his co-workers (2014) who had mild-to-moderate PD and showed a positive outcome [30].

Home-based occupational training therapy was examined by Sturkenboom et al., who studied 191 patients with PD from multiple Dutch clinics and hospitals who experienced home-based occupational therapy for three months. The intervention led to an improvement of 94% in self-perceived daily performance [9]. Ricciardi et al. (2015) studied 28 patients with PD undergoing cognitive physiotherapy for three months and confirmed the efficiency of physical therapy as the PD treatment and suggests that intervention is personalized on individual features [31]. Tager-Flusberg et al. studied 31 patients with dysarthria related to PD who underwent speech and language therapy by voice and face-to-face treatment. Ideal outcomes were measured for significant improvements for a perceptual, acoustic, and good standard of life [32].

Paramedical intervention by physiotherapy exercising was studied in twenty parkinsonian patients by Gemin et al. for 12 weeks, which proved to be effective in reducing fatigue and enhancing balance in PD patients [33]. Silva et al. studied 32 patients who undergo Kinect games for seven weeks. The intervention led to an improvement in self-alleged everyday activities [34]. Ribeiro et al. studied 14 patients with mild-moderate PD; underwent Breathing-Stacking (BS) and incentive spirometer (IS) techniques. Interventions were effective for immediately improving volume [35].

In a similar study by Ellis, he confirmed Gemin et al. positive results of exercise programs and walking on improving the severity of the disease. However, Ellis et al.

examined fifty-one patients (2019), walking for a longer duration of the program (12 months in Ellis versus 12 weeks in Gemin study [36].

Supportive emerging evidence is gradually beginning to highlight the positive effect of cognitive training programs in mild to moderate PD; Barboza et al. studied 58 patients and verified improved cognition (visuospatial and memory function domains); this goes with the results of Terra et al. investigated 29 patients and came up with same positive outcome [37,38].

Marusiak et al. studied 20 patients who underwent cycle ergometer aerobic interval training (AIT) for eight weeks and verified improved psychomotor behaviours, bimanual motor control, executive function, and neurological signs [39].

### Limitations of the review

Heterogeneity of different studies, incomplete analysis of the frequency, duration, and intensity of the training interventions, inconsistency in quantitatively and qualitatively measurement of the outcome and poorly documented maintenance long term effect among different studies were the most significant limitations.

## CONCLUSION

This review established the effectiveness of diverse paramedical techniques to maintain physical, mental, and psychological balance and to manage oneself with the help of dynamic, functional, and static exercises. With the absence of any supportive evidence for a specific approach of physiotherapy over another in PD. Large, well designed randomized trials with improved specific treatment strategies and proper follow-up period are warranted for cost-effective designed interventions.

## CONFLICT OF INTEREST

There is no conflict of interest declared by the authors.

## AUTHOR'S CONTRIBUTION

Dr Fahad Somaa and Dr Andleeb Asghar analyzed and conceived the outcomes; both collected the data and wrote the overall paper. Dr Fahad proofread and finalized the paper for final editing and revision.

## REFERENCES

1. Pfeiffer HCV, Løkkegaard A, Zoetmulder M, et al. Cognitive impairment in early-stage non-demented Parkinson's disease patients. Acta Neurol Scand 2014; 129:307–318.
2. Keus SHJ, Bloem BR, Hendriks EJM, et al. Evidence-based analysis of physical therapy in Parkinson's disease with recommendations for practice and research. Mov Disord Off J Mov Disord Soc 2007; 22:451–460.
3. Horvath S, Ritz BR. Increased epigenetic age and granulocyte counts in the blood of Parkinson's disease patients. Aging 2015; 7:1130–1142.
4. Meissner WG, Frasier M, Gasser T, et al. Priorities in Parkinson's disease research. Nat Rev Drug Discov 2011; 10:377–393.
5. Dickson DW. Parkinson's disease and parkinsonism: Neuropathology. Cold Spring Harb Perspect Med 2012; 2.
6. Nijkrake MJ, Keus SHJ, Kalf JG, et al. Allied health care interventions and complementary therapies in Parkinson's disease. Parkinsonism Relat Disord 2007; 13:S488-494.
7. Martinez-Martin P, Rodriguez-Blazquez C, Kurtis MM, et al. The impact of non-motor symptoms on health-related quality of life of patients with Parkinson's disease. Mov Disord Off J Mov Disord Soc 2011; 26:399–406.
8. Miller N, Noble E, Jones D, et al. Survey of speech and language therapy provision for people with Parkinson's disease in the United Kingdom: patients' and carers' perspectives. Int J Lang Commun Disord 2011; 46:179–188.
9. Sturkenboom IHWM, Graff MJL, Hendriks JCM, et al. Efficacy of occupational therapy for patients with Parkinson's disease: A randomised controlled trial. Lancet Neurol 2014; 13:557–566.
10. Qamar MA, Harington G, Trump S, et al. Multidisciplinary care in parkinson's disease. Int Rev Neurobiol 2017; 132:511–523.
11. Skelly R, Lindop F, Johnson C. Multidisciplinary care of patients with Parkinson's disease. Prog Neurol Psychiatry 2012; 16:10–14.
12. Möller JC, Menig A, Oechsner M. Neurorehabilitation in Parkinson's disease. Praxis. 2016; 105:377–382.
13. Bloem BR, de Vries NM, Ebersbach G. Nonpharmacological treatments for patients with Parkinson's disease. Mov Disord Off J Mov Disord Soc 2015; 30:1504–1520.
14. Vivas J, Arias P, Cudeiro J. Aquatic therapy versus conventional land-based therapy for parkinson's disease: An open-label pilot study. Arch Phys Med Rehabil 2011; 92:1202–1210.
15. Palamara G, Gotti F, Maestri R, et al. Land plus aquatic therapy versus land-based rehabilitation alone for the treatment of balance dysfunction in parkinson disease: A randomized controlled study with 6-month follow-up. Arch Phys Med Rehabil 2017; 98:1077–1085.
16. Pérez de la Cruz S. Effectiveness of aquatic therapy for the control of pain and increased functionality in people with Parkinson's disease: a randomized clinical trial. Eur J Phys Rehabil Med 2017; 53:825–832.
17. Carroll LM, Volpe D, Morris ME, et al. Aquatic exercise therapy for people with parkinson disease: A randomized controlled trial. Arch Phys Med Rehabil 2017; 98:631–638.
18. Zhang TY, Hu Y, Nie Z-Y, et al. Effects of tai chi and multimodal exercise training on movement and

balance function in mild to moderate idiopathic parkinson disease. Am J Phys Med Rehabil Assoc Acad Physiatr 2015; 94.

19. Li F, Harmer P, Fitzgerald K, et al. Tai chi and postural stability in patients with parkinson's disease. N Engl J Med 2012; 366:511–519.
20. Poier D, Rodrigues Recchia D, Ostermann T, et al. A randomized controlled trial to investigate the impact of tango argentino versus tai chi on quality of life in patients with parkinson disease: A short report. Complement Med Res 2019; 26:398–403.
21. Choi HJ. Effects of therapeutic Tai chi on functional fitness and activities of daily living in patients with Parkinson disease. J Exerc Rehabil 2016; 12:499–503.
22. Zhu M, Zhang Y, Pan J, et al. Effect of simplified Tai Chi exercise on relieving symptoms of patients with mild to moderate Parkinson's disease. J Sports Med Phys Fitness 2020; 60:282–288.
23. Allen NE, Sherrington C, Suriyarachchi GD, et al. Exercise and motor training in people with Parkinson's disease: a systematic review of participant characteristics, intervention delivery, retention rates, adherence, and adverse events in clinical trials. Park Dis 2012; 2012:854328.
24. Liberati A, Altman DG, Tetzlaff J, et al. The PRISMA statement for reporting systematic reviews and meta-analyses of studies that evaluate health care interventions: Explanation and elaboration. PLOS Med 2009; 6:e1000100.
25. Goodwin VA, Richards SH, Henley W, et al. An exercise intervention to prevent falls in people with Parkinson's disease: a pragmatic randomised controlled trial. J Neurol Neurosurg Psychiatr 2011; 82:1232–1238.
26. Pompeu JE, Mendes FADS, Silva KG da, et al. Effect of Nintendo WiiTM-based motor and cognitive training on activities of daily living in patients with Parkinson's disease: A randomised clinical trial. Physiotherapy 2012; 98:196–204.
27. McGinley JL, Martin C, Huxham FE, et al. Feasibility, safety, and compliance in a randomized controlled trial of physical therapy for Parkinson's disease. Park Dis 2012; 2012:795294.
28. Canning CG, Allen NE, Dean CM, et al. Home-based treadmill training for individuals with Parkinson's disease: A randomized controlled pilot trial. Clin Rehabil 2012; 26:817-826.
29. Sale P, De Pandis MF, Le Pera D, et al. Robot-assisted walking training for individuals with Parkinson's disease: A pilot randomized controlled trial. BMC Neurol 2013; 13:50.
30. Ashburn A, Roberts L, Pickering R, et al. A design to investigate the feasibility and effects of partnered ballroom dancing on people with parkinson disease: Randomized controlled trial protocol. JMIR Res Protoc 2014; 3:e34.
31. Bevilacqua R, Maranesi E, Di Rosa M, et al. Rehabilitation of older people with Parkinson's disease: an innovative protocol for RCT study to evaluate the potential of robotic-based technologies. BMC Neurol 2020; 20.
32. Cp H, Cl T, Kh D, et al. Comparison of speech and language therapy techniques for speech problems in Parkinson's disease. Cochrane Database Syst Rev 2012; CD002814–CD002814.
33. Ribas CG, Alves da Silva L, Corrêa MR, et al. Effectiveness of exergaming in improving functional balance, fatigue and quality of life in Parkinson's disease: A pilot randomized controlled trial. Parkinsonism Relat Disord 2017; 38:13–18.
34. Silva KG, De Freitas TB, Doná F, et al. Effects of virtual rehabilitation versus conventional physical therapy on postural control, gait, and cognition of patients with Parkinson's disease: Study protocol for a randomized controlled feasibility trial. Pilot Feasibility Stud 2017; 3:68.
35. Ribeiro R, Brandão D, Noronha J, et al. Breath-stacking and incentive spirometry in Parkinson's disease: Randomized crossover clinical trial. Respir Physiol Neurobiol 2018; 255:11–16.
36. Ellis T, Latham NK, DeAngelis TR, et al. Feasibility of a virtual exercise coach to promote walking in community-dwelling persons with Parkinson disease. Am J Phys Med Rehabil 2013; 92:472–481.
37. Terra MB, Barboza NM, Almeida IA de, et al. Does physiotherapy plus cognitive training improve balance in Parkinson's disease? Randomized clinical trial. Mot Rev Educ Física 2020; 26.
38. Barboza NM, Terra MB, Bueno MEB, et al. Physiotherapy versus physiotherapy plus cognitive training on cognition and quality of life in parkinson disease: Randomized clinical trial. Am J Phys Med Rehabil 2019; 98:460–468.
39. Marusiak J, Fisher BE, Jaskólska A, et al. Eight weeks of aerobic interval training improves psychomotor function in patients with parkinson's disease—randomized controlled trial. Int J Environ Res Public Health 2019; 16.