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ORIGINAL ARTICLE

Effects of LSVT-BIG via telerehabilitation on non-motor and motor symptoms and quality of life in Parkinson's disease

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Abstract

Background Parkinson's disease (PD) is a neurodegenerative disease with motor and non-motor symptoms affecting the quality of life. This study aimed to investigate the effects of the Lee Silverman Voice Therapy (LSVT)-BIG rehabilitation program via telerehabilitation on quality of life, motor and non-motor symptoms in people with Parkinson's disease (PwPD), and their correlation with each other.

Methods Fifteen patients with mild-to-moderate PD (Hoehn and Yahr stages 1–3) were included in the LSVT-BIG exercise program with remote access for 16 sessions over four weeks. Motor and non-motor experiences before and after the program were evaluated with MDS-UPDRS parts 1, 2, and 3 and quality of life with PDQ-39. The correlation between MDS-UPDRS parts and PDQ-39 subgroups was examined.

Results Following the application of the LSVT-BIG rehabilitation program with remote access, MDS-UPDRS parts 1, 2, and 3 scores and PDQ-39 summary index (PDQ-39 SI) and subgroup scores (excluding social support) were improved. A moderate–strong correlation was determined between MDS-UPDRS parts 1 and 2 and the PDQ-39 parameters of the patients.

Conclusion Both motor and non-motor symptoms may be associated with the quality of life in PD. We have concluded that LSVT-BIG treatment via telerehabilitation can improve motor and non-motor symptoms along with the quality of life in PwPD.

Keywords Parkinson's disease · LSVT-BIG · Telerehabilitation · Quality of life

Introduction

Parkinson's disease (PD) is the most common neurodegenerative movement disorder. The worldwide prevalence of PD is estimated to be 0.3% in people aged 40 years and older. The incidence of the disease increases rapidly over the age of 60 [1]. In pathogenesis, neurotransmitter imbalances occurring in the basal ganglia due to the progressive loss of substantia nigra neurons that produce dopamine are held responsible. Although the etiology remains unclear, environmental and genetic factors have been defined. The disease is diagnosed clinically through the presence of bradykinesia and is accompanied by either rigidity, resting tremor, or postural instability [2]. Apart from these basic findings, other motor and non-motor symptoms (NMS) may coexist as well. NMS include cognitive dysfunctions, psychosis and hallucinations, mood disorders, autonomic disorders, sleep disorders, olfactory dysfunction, gastrointestinal dysfunction, and sensory disorders, as they may occur in more than 90% of patients and at any stage in the course of the disease [3]. It is known that both motor and non-motor symptoms negatively affect the quality of life in PD patients [4].

Rehabilitation programs are involved in every phase of PD management. Different exercise modalities, music, dance, yoga, occupational therapies, and speech and language therapies are commonly used. Several studies have indicated that these methods improve patients' quality of life and Unified Parkinson's Disease Rating Scale (UPDRS)

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scores [5]. Lee Silverman Voice Therapy (LSVT)-BIG, one of the rehabilitation techniques, is a treatment approach that trains large-amplitude whole-body movements to increase both the speed and amplitude of functional tasks in people with PD. This therapy also requires sustained attention and cognitive engagement by mentally focusing on individual movements. While many studies [6, 7] have demonstrated that the LSVT-BIG program improves motor symptoms, there are fewer studies [8, 9] examining its effect on non-motor symptoms as well.

During the COVID-19 pandemic, telemedicine has been widely used in all areas of medicine, and it seems to have a large place in medical applications from now on. Telerehabilitation includes rehabilitation services through information and communication technologies and enables patients to access rehabilitation services remotely from their homes [10]. The telerehabilitation method emerged in the 2000s and has been used more effectively in more areas as technology develops [11]. Remote access provides benefits regarding distance, time, and cost. It carries the rehabilitation service beyond the hospital process and provides patients with the opportunity to receive treatment in a comfortable and familiar environment. Its efficacy has been demonstrated in studies comparing telerehabilitation with standard physiotherapy [12]. With the pandemic process, we have been in since the beginning of 2020, physical therapy and rehabilitation units have been closed in many centers to prevent close contact and contagion. People with chronic diseases have had reduced access to health institutions. Particularly during the lockdown periods, the telerehabilitation method provided benefits to patients with reduced range of motion at home [13].

The present study aimed to investigate the effects of the LSVT-BIG treatment via telerehabilitation on quality of life, motor and non-motor problems (NMP), and their relationship with each other in individuals with PD.

Methods

The study included 15 PD patients diagnosed according to the UK Parkinson's Disease Association Brain Bank Clinical Diagnostic Criteria [14] admitted to a tertiary referral hospital, Neurology and Physical Medicine and Rehabilitation Clinics.

Patients between 40 and 75 years of age, who were at or below stage 3 per Hoehn and Yahr Clinical Staging [15], had the necessary technical competence to provide remote video communication at home, could communicate during the examination and could follow commands, had full cooperation and orientation, had no speech and understanding disorders, and did not undergo the LSVT-BIG technique before were included. Patients with dyskinesia or another disease that would impair mobility, comorbidities affecting exercise abilities, and patients whose medication or dose would need to be changed during the study were excluded.

Thirty consecutively patients with stage 3 and below who had no contradictions to exercise applied to outpatient clinics were informed about the study and were invited to the study. Since they did not have the facility or ability to use remote access, 13 patients could not be included. Seventeen patients agreed to participate, yet two could not complete the study due to remote access problems.

Sociodemographic and clinical information of the patients were recorded in a pre-prepared form. All participants were enrolled in a 4 week training program online under the supervision of a single physiotherapist.

The LSVT-BIG technique was applied according to the standard protocol for four weeks, with 1 h of online exercise plus a predefined home exercise program and four sessions per week (Tuesday–Friday) for a total of 16 sessions (see the therapeutic approach video at ptjournal.apta.org). One hour during the exercises was a one-on-one, supervised training session in which patients were encouraged to state how they felt and learn how to perform the high-amplitude movement, focus on exercise, and exert at least 80% of maximal effort. LSVT-BIG exercises consist of 3 tasks. The first task is called "maximum sustained movements" and includes floor-to-ceiling and side-to-side stretch movements performed in a sitting position. The second task is performed standing up and is called "repetitive/directional movements." At this stage, there are five exercises that include forward, backward, and sideways large steps and forward and sideways movements of the upper extremities that provide coordination between the extremities. The third task consists of movements of large amplitude, such as sitting up and standing, which are a combination of previous movements, and are defined as "functional component movements." Later in the session, more complex tasks, such as buttoning up, are exercised. "Shaping techniques" are used to increase the quality and amplitude of the movement, and the patient is trained through modeling. For instance, visual aid can be provided by saying, "watch me and do what I do" [16].

The Parkinson's Disease Quality of Life Questionnaire-39 (PDQ-39) scale [17] evaluated the quality of life before (week 0) and after (week 4) the LSVT-BIG rehabilitation program. The questionnaire contains 39 items in eight different sections as mobility (10 items), activities of daily living (6 items), emotional well-being (6 items), stigma (4 items), social support (3 items), cognition (4 items), communication (3 items), and bodily discomfort (3 items). Lower scores reflect better quality of life for patients, while higher scores indicate a worsening quality of life [17]. In the Turkish reliability and validity study, Cronbach's alpha coefficient was 0.955, and the correlation coefficients for test–retest reliability ranged from 0.693 to 0.970 [18].

Non-motor and motor experiences of daily living and motor examination were assessed with the Movement Disorder Society (MDS)-sponsored Revision of the Unified Parkinson's Disease Rating Scale (MDS-UPDRS) [19]. In MDS-UPDRS, non-motor experiences of daily living are included in the first part, motor experiences of daily living in the second part, and a motor examination in the third part [19]. Turkish validation was performed by Akbostancı et al., and for all four parts of the Turkish MDS-UPDRS, the comparative fit index (CFI), in comparison with the reference standard factor structure, was 0.94 or greater [20]. The questions in the first and second parts were asked to the participants, and the answers were recorded. Motor examination was evaluated based on an objective neurological examination in the third part. All parts were evaluated face-to-face by the same neurologist before (week 0) and after (week 4) the online exercise program during the "on" period.

Statistically, PDQ-39 subgroups and MDS-UPDRS part 1, 2, and 3 scores before and after exercises were compared, and their correlations with each other were investigated.

The PDQ-39 and MDS-UPDRS assessments were performed for each patient 90 min after the first dose of levodopa during the "on" period. No drug changes were made throughout the four weeks during which the exercises were performed. The tests were performed in the same order for each patient and each evaluation.

Permission was obtained from the licensee, International Parkinson and Movement Disorder Society, to use the Turkish version of MDS-UPDRS in this study. The study was performed as per the Principles of the Declaration of Helsinki, and approval was obtained from the local ethics committee before starting the study.

Some data obtained from the same study and not used in this article will be used in another study.

Statistical analysis

As descriptive statistics, mean and standard deviation or median and 1st–3rd quartile values were presented for continuous data, and frequency and percentages were presented for categorical data. Kolmogorov–Smirnov test was used to assess whether the continuous data were normally distributed or not. Paired samples *t* test was used for normally distributed data for before-after comparisons, and Wilcoxon signed-rank test for data that did not distribute normally. The correlation between the two continuous variables was evaluated with the Spearman rank correlation coefficient. A p value of < 0.05 was considered statistically significant.

Results

Fifteen PD patients, 9 (60%) males and six females, aged between 45 and 77 years (mean ± SD; 63.13 ± 9.89), were included in the study. Sociodemographic and clinical data of the participants are presented in Table 1.

Table 1 Patient characteristics

	n (%)
Gender	
Male	9 (60)
Female	6 (40
Age (Mean ± SD)	63.13 ± 9.89
Height (Mean ± SD)	165.13 ± 9.98
Weight (Mean ± SD)	77.07 ± 10.23
BMI (Mean ± SD)	28.44 ± 4.24
Marital status	
Married	14 (93.3)
Single	1 (6.7)
Educational status	2 (13.3)
Illiterate	1 (6.7)
Literate	4 (26.7)
Primary school	2 (13.3)
Middle school	3 (20.0)
High School	3 (20.0)
University and higher	
Parkinson's treatment	11 (73.3)
Levodopa (mg/day)	1 (6.6)
250	1 (6.6)
300	5 (33.3)
375	1 (6.6)
500	1 (6.6)
625	1 (6.6)
700	1 (6.6)
1725	8 (53.3)
Dopamine agonists	13 (86.6)
MAO-B inhibitors	3 (20)
Amantadine	
Comorbid disease	
Yes	5 (33.3)
No	10 (67.7)
Other drugs used	
Yes	12 (80.0)
No	3 (20.0)
Years since diagnosis	7 (46.7)
Less than 1 year	3 (20.0)
1–3 years	1 (6.7)
4–5 years	3 (20.0)
6–10 years	1 (6.7)
16–20 years	
Hoehn–Yahr stage	7 (46.7)
1	5 (33.3)
2	3 (20.0)
3	

n number, *Mean* arithmetic mean, *SD* standard deviation

After completing the online LSVT-BIG rehabilitation program, there was a statistically significant improvement in all parameters of the PDQ-39 except the social support section (Table 2).

Following the completion of LSVT-BIG treatment, the MDS-UPDRS evaluation revealed a statistically significant decrease in the scores of non-motor experiences of daily living (part 1), motor experiences of daily living (part 2), and motor examination (part 3) in ($p < 0.001$, $p = 0.001$, $p < 0.001$, respectively) (Table 2).

The correlation between PDQ-39 subgroups and MDS-UPDRS parts before and after the LSTV-BIG program applied with the telerehabilitation method is summarized in Table 3.

Discussion

The study results revealed that the LSVT-BIG rehabilitation program with remote access improved quality of life (excluding social support), non-motor and motor experiences of daily living, and motor examination. To the best of our knowledge, there is no other study in which the LSVT-BIG rehabilitation program with remote access has been performed, and its effects on quality of life and motor and non-motor experiences have been evaluated.

Since the study was performed during the pandemic, the number of outpatient clinic applications was low. The number of patients with facility and ability for "remote access" was even less among the patients who applied. Therefore, the study was completed with a small number of patients at an early stage. Additionally, newly diagnosed people with Parkinson's Disease (PwPD) were more eager to participate in the exercise program. This situation suggested that patients should be informed more about rehabilitation and should be encouraged to exercise programs. Patients with severe dyskinesia or comorbidities that prevent them from exercising were excluded since a remote access exercise program could not be administered to them, and a healthcare professional could not intervene. For these reasons, bias may have occurred. In the literature, patients with severe dyskinesia were excluded from studies using the LSVT-BIG program [21], and the benefit was reported in patients with dyskinesia only on a case-by-case basis [22].

The present study indicated that LSTV-BIG exercise was effective on motor experiences of daily living and motor examination as assessed by MDS-UPDRS parts 2 and 3 in early and middle stage PwPD. This condition may be associated with the protective effects of physical activity on the central nervous system (CNS). This exercise program is a therapy designed to maximize neuroplasticity, including multi-directional movements of maximum amplitude specific to the task [23]. The effectiveness of physiotherapy in motor symptoms is well known in the literature [24, 25]. A systematic review of 84 participants with mild PD demonstrated that LSVT-BIG treatment resulted in more positive UPDRS motor scores than general exercise and Nordic walking [6]. However, a decrease in UPDRS motor section scores was observed in another study after exercise in 9 PD treated with LSVT-BIG [26]. In a recent study in which motor function was measured objectively with the device, 12 PD treated with LSVT-BIG, 8 PD who did not exercise, and 14 healthy controls were included. As a result of the study, improvement in motor functions was observed [7]. There

Table 2 PDQ-39 and MDS-UPDRS assessment comparison before and after exercise

	Before Mean ± SD Median (Q_1–Q_3)	After Mean ± SD Median (Q_1–Q_3)	*p*
PDQ-39-Mobility	77.5 (10.0–82.5)	7.5 (0.0–25.0)	0.002[a]
PDQ-39-Activities of daily living	29.2 (8.3–79.8)	8.3 (0.0–33.3)	0.004[a]
PDQ-39-Emotional well-being	29.2 (16.7–70.83)	16.7 (0.0–25.0)	0.002[a]
PDQ-39-Stigma	18.8 (0.0–25.0)	0.0 (0.0–12.5)	0.019[a]
PDQ-39-Social support	0.0 (0.0–33.3)	0.0 (0.0–8.3)	0.058[a]
PDQ-39-Cognition	37.5 (18.8–56.3)	25.0 (12.5–25.0)	0.007[a]
PDQ-39-Communication	0.0 (0.0–25.0)	0.0 (0.0–8.3)	0.017[a]
PDQ-39-Bodily discomfort	50.0 (33.3–83.3)	16.7 (8.3–50.0)	0.001[a]
PDQ-39-Summary index	38.9 (12.2–47.4)	11.4 (5.7–23.4)	0.001[a]
MDS-UPDRS part I	14.73 ± 10.98	5.40 ± 4.39	< 0.001[b]
MDS-UPDRS part II	10.00 (9.00–20.00)	4.00 (1.00–9.00)	0.001[a]
MDS-UPDRS part III	27.47 ± 11.36	7.53 ± 5.04	< 0.00[b]

Avg arithmetic mean, *SD* standard deviation, Q_1 1. quartile, Q_3 3. quartile

[a]Wilcoxon signed-rank test

[b]Paired samples *t* test

Table 3 Correlation between PDQ-39 subgroups and MDS-UPDRS parts

PDQ-39	MDS-UPDRS					
	Part I		Part II		Part III	
	Before	After	Before	After	Before	After
Mobility						
ρ	0.576	0.894	0.742	0.777	0.471	0.791
p	0.025	< 0.001	0.002	0.001	0.077	< 0.001
Activities of daily living						
ρ	0.570	0.581	0.815	0.735	0.458	0.445
p	0.026	0.023	< 0.001	0.002	0.086	0.097
Emotional well-being						
ρ	0.596	0.519	0.384	0.275	0.281	0.487
p	0.019	0.047	0.158	0.321	0.310	0.065
Stigma						
ρ	0.224	0.167	0.316	0.272	0.051	-0.141
p	0.422	0.552	0.252	0.326	0.858	0.617
Social support						
ρ	0.452	0.396	0.444	0.586	0.710	0.357
p	0.091	0.144	0.097	0.022	0.003	0.192
Cognition						
ρ	0.803	0.705	0.388	0.471	0.081	0.591
p	< 0.001	0.003	0.153	0.076	0.775	0.020
Communication						
ρ	0.723	0.603	0.755	0.757	0.570	0.446
p	0.002	0.017	0.001	0.001	0.026	0.096
Bodily discomfort						
ρ	0.532	0.872	0.639	0.668	0.158	0.743
p	0.041	< 0.001	0.010	0.007	0.573	0.001
Summary index						
ρ	0.773	0.891	0.824	0.859	0.461	0.737
p	0.001	< 0.001	< 0.001	< 0.001	0.084	0.002

are few studies in the literature indicating that the functional gains obtained with the LSVT-BIG protocol continue in the long term [27]. Furthermore, it is necessary to emphasize the importance of continuity of physical activity. These studies support the application of this program to improve motor performance and walking speed in mild-to-moderate PwPD. Our study determined that the LSVT-BIG program can also cause similar effectiveness through remote access. However, there is a need for studies comparing this program with remote access conventional physiotherapy methods and those who do not exercise. In addition, prospective studies with larger numbers of patients are required to demonstrate the long-term effectiveness of telerehabilitation programs at all stages.

In a multicenter study from Italy, the presence of NMS was reported in 98.6% of patients [3]. Some symptoms, such as sleep disorder, olfactory disorder, and constipation, are known to occur before motor symptoms [28]. Although the effects of exercise programs on motor symptoms have been known for a long time, data showing that they would also affect NMS have come to the fore recently [29, 30]. The present study revealed that the LSTV-BIG rehabilitation program was as effective on NMS as on motor symptoms. The improvement in NMS may also be correlated to the milder PD phenotype of our patients and the low incidence of NMS. Several studies in the literature have determined that LSTV-BIG and other exercise modalities can be efficient on NMS. Some studies have reported improvement in MDS-UPDRS part 1 scores with tango sessions and treadmill training [31–33]. LSVT-BIG and two different exercise programs were evaluated in a study that included 44 patients in mild and moderate stages, and it was indicated that 3 exercise programs were effective on both motor and non-motor symptoms [8]. Moreover, in another study evaluating LSVT-BIG and general exercise in 11 patients, significant improvement in motor and non-motor scores was reported in both groups after six months [9]. Factors such as beliefs that exercise would not be beneficial, lack of time, and fear of falling are drawbacks against exercise in PD [34]. PwPD and their caregivers should be provided awareness for exercises, they should be informed that there are programs that can be performed in the home environment, and exercise should be encouraged at every stage of the disease without waiting for the motor problems to increase.

After the 4 week LSVT-BIG program, our study observed a decrease in the subgroup scores of the PDQ-39 scale, except for the social support section, suggesting that the program effectively improved quality of life on short notice. This result may be associated with physical recovery providing well-being in other parameters, or the hormonal effects of exercise. A meta-analysis (20 studies, 2707 PwPD) published in 2020 concluded that people with PD have a worse quality of life than healthy controls [4]. Studies have reported that exercise programs have different effects on quality of life [35–37]. There are some researches in the literature demonstrating that LSVT-BIG treatment improves the quality of life [26, 38], while some studies have reported no changes [23, 39]. After all, physical exercise plays a crucial role in improving health and quality of life.

Although our study concluded that quality of life was associated with both motor and non-motor experiences, the number of quality of life parameters with moderate-to-strong correlations with NMS was higher than those correlated to motor problems. This result can be explained by the fact that most of our participants were at an early stage of the disease. We determined a strong correlation between PDQ-39 subsection scores of mobility, activities of daily living, and communication with MDS-UPDRS part 2, which may be because motor problems are more related to them. There are also studies in the literature stating that motor symptoms and NMS are associated with quality of life [28, 40–42]. MDS-UPDRS, which we used, has been reported to be a useful tool for determining the correlation with the quality of life [40]. In a study in the literature, a correlation was observed between MDS-UPDRS parts 1, 2, and 4 and PDQ-39, but there was no correlation with part 3 [43]. In another study, after a 2 year follow-up of 108 patients, baseline MDS-UPDRS parts 1 and 2 scores were significant predictors of PDQ-39-SI scores at 2-year follow-up, while part 3 scores were not predictive of future quality of life [44]. Our finding of correlations between motor examination and fewer parameters was consistent with other studies [45, 46]. The fact that the correlations between MDS-UPDRS parts 1 and 2 and QoL parameters are more than that of part 3 might be since the motor examination is performed in the “ON” period of the patient, and the other parts are evaluated in the patient’s daily life.

The fact that we applied LSVT-BIG treatment via telerehabilitation and achieved results similar to the face-to-face method suggested that it could be a viable method with remote access. In recent years, especially with the COVID-19 pandemic, the use of telemedicine and telerehabilitation has increased in many countries [10, 47, 48]. In crisis situations such as a pandemic, telerehabilitation may be an option. Telerehabilitation is considered a promising healthcare tool [10, 48, 49]. Telerehabilitation provides equitable access to rehabilitation services for people living in remote areas or unable to access care centers due to physical disabilities. However, there is inequality for patients living in poor areas with low socioeconomic status and limited access to the internet or online e-health resources. The main problem we encountered in our Parkinson’s patient population was the lack of ability to use remote access methods, especially in elderly patients. The majority of the patients participating in the study received help from their younger relatives during the connection process. It appears that telerehabilitation studies have been performed with a small number of patient populations [12]. We hope that data will be obtained from larger samples as this method becomes more applicable in daily practice with the developing technology. In addition, we think that there is a need for studies that evaluate the satisfaction and compliance of patients with these applications.

Regarding the negative impact of poor quality of life on daily living and functional outcomes, effective measures should be developed to improve the quality of life in people with PD. Reaching patients who have difficulties accessing rehabilitation centers via telerehabilitation may be an option to increase their quality of life. Besides, telerehabilitation applications may have the ability to use personnel and time more efficiently and reduce costs. In recent years, rehabilitation methods have been applied with software programs/game technology [50]. These applications may be possible in the future to increase the accessibility of LSVT-BIG. Since the exercises applied in the LSVT-BIG program are easy to understand and can be applied independently, we think that they may be suitable for remote access or application implementations. With the development of an application, there will be ease of access to patients without time limit and whenever they want.

There are several limitations in our study. The lack of a control group that we can compare with conventional physiotherapy in the clinic is due to the small number of patients and pandemic conditions. Whether the efficacy continued could be assessed by following the patients up for a longer period and performing re-evaluations. It is critical to follow up on telerehabilitation approaches regarding long-term effectiveness in chronic diseases such as PD. Moreover, our patients were mild to moderate; therefore, it cannot be determined whether the results of this study apply to patients with severe Parkinson’s.

Both motor and non-motor problems affect the quality of life in PD. This pilot study concluded that LSVT-BIG treatment with the telerehabilitation method has beneficial effects on motor and non-motor problems and quality of life in PD. However, it is not possible to generalize because patients of a small sample and early stages were included in the study. Researching with scales in which NMSs are evaluated in more detail may also yield different results. Patients and their caregivers should be encouraged to exercise programs. We think that telerehabilitation programs can be more effective in terms of time and cost if their effectiveness is demonstrated as a result of the studies to be done by comparing them with face-to-face rehabilitation programs.

Author contributions All authors contributed to the study's conception and design.

Declarations

Conflict of interest No conflict of interest was declared by the authors.. The authors declared that this study received no financial support.

Ethical approval All procedures performed in this study involving human participants were in accordance with the ethical standards of the institutional and national research committee and with the 1964 Helsinki declaration. Approval was obtained from the SANKO University Clinical Studies Ethics Committee (date: 18/03/2021, session number: 2021/08, decision number: 02).

Informed consent Informed consent was obtained from all individual participants included in this study.

References

1. Pringsheim T, Jette N, Frolkis A, Steeves TDL (2014) The prevalence of Parkinson's disease: a systematic review and meta-analysis. Mov Disord 29:1583–1590. https://doi.org/10.1002/mds.25945
2. Postuma RB, Berg D, Stern M et al (2015) MDS clinical diagnostic criteria for Parkinson's disease. Mov Disord 30:1591–1601. https://doi.org/10.1002/mds.26424
3. Barone P, Antonini A, Colosimo C et al (2009) The PRIAMO study: a multicenter assessment of nonmotor symptoms and their impact on quality of life in Parkinson's disease. Mov Disord 24:1641–1649. https://doi.org/10.1002/mds.22643
4. Zhao N, Yang Y, Zhang L et al (2021) Quality of life in Parkinson's disease: a systematic review and meta-analysis of comparative studies. CNS Neurosci Ther 27:270–279. https://doi.org/10.1111/cns.13549
5. Garg D, Dhamija R (2020) Rehabilitation in Parkinson's disease: current status and future directions. Ann Mov Disord 3:79–85. https://doi.org/10.4103/AOMD.AOMD_1_20
6. McDonnell MN, Rischbieth B, Schammer TT, Seaforth C, Shaw AJPA (2018) Lee Silverman voice treatment (LSVT)-BIG to improve motor function in people with Parkinson's disease: a systematic review and meta-analysis. Clin Rehabil 32:607–618
7. Flood MW, O'Callaghan BPF, Diamond P et al (2020) Quantitative clinical assessment of motor function during and following LSVT-BIG® therapy. J Neuroeng Rehabil 17:1–19. https://doi.org/10.1186/s12984-020-00729-8
8. Schaible F, Maier F, Buchwitz TM et al (2021) Effects of Lee Silverman voice treatment BIG and conventional physiotherapy on non-motor and motor symptoms in Parkinson's disease: a randomized controlled study comparing three exercise models. Ther Adv Neurol Disord 14:1–18. https://doi.org/10.1177/1756286420986744
9. Dashtipour K, Johnson E, Kani C et al (2015) (2015) Effect of exercise on motor and nonmotor symptoms of Parkinson's disease. Parkinsons Dis 58637:1–5. https://doi.org/10.1155/2015/586378
10. Maresca G, Maggio MG, De Luca R et al (2020) Tele-neuro-rehabilitation in Italy: state of the art and future perspectives. Front Neurol 11:1–12. https://doi.org/10.3389/fneur.2020.563375
11. Winters JM (2002) Telerehabilitation research: emerging opportunities. Annu Rev Biomed Eng 4:287–320. https://doi.org/10.1146/annurev.bioeng.4.112801.121923
12. Seron P, Oliveros MJ, Gutierrez-Arias R et al (2021) Effectiveness of telerehabilitation in physical therapy: a rapid overview. Phys Ther 101:1–18. https://doi.org/10.1093/ptj/pzab053
13. Werneke MW, Deutscher D, Grigsby D et al (2021) Telerehabilitation during the COVID-19 pandemic in outpatient rehabilitation settings: a descriptive study. Phys Ther 101:1–11. https://doi.org/10.1093/ptj/pzab110
14. Hughes AJ, Daniel SE, Kilford L, Lees AJ (1992) Accuracy of clinical diagnosis of idiopathic Parkinson's disease: a clinico-pathological study of 100 cases. J Neurol Neurosurg Psychiatry 55:181–184. https://doi.org/10.1136/jnnp.55.3.181
15. Hoehn MM, Yahr MD (1967) Parkinsonism : onset, progression, and mortality. Neurology 17:427–442
16. Fox C, Ebersbach G, Ramig L (2012) Sapir S (2012) LSVT LOUD and LSVT BIG: behavioral treatment programs for speech and body movement in Parkinson disease. Parkinsons Dis 39194:1–12. https://doi.org/10.1155/2012/391946
17. Peto V, Jenkinson C, Fitzpatrick R, Greenhall R (1995) The development and validation of a short measure of functioning and Well Being for Individuals with Parkinson ' s Disease Linked references are available on JSTOR for this article : the development and validation of a short measure of functioning and wel. Qual Life Res 4:241–248
18. Kayapinar T (2018) Parkinson Hastalığı Yaşam Kalitesi Anketi (Pdq-39) Güvenirlik Ve Geçerlik Çalışması. masterThesis 10204801:1–106
19. Goetz CG, Tilley BC, Shaftman SR et al (2008) Movement disorder society-sponsored revision of the unified Parkinson's Disease rating scale (MDS-UPDRS): scale presentation and clinimetric testing results. Mov Disord 23:2129–2170. https://doi.org/10.1002/mds.22340
20. Akbostanci MC, Bayram E, Yilmaz V et al (2018) Turkish standardization of movement disorders society unified Parkinson's disease rating scale and unified dyskinesia rating scale. Mov Disord Clin Pract 5:54–59. https://doi.org/10.1002/mdc3.12556
21. Ebersbach G, Grust U, Ebersbach A et al (2015) Amplitude-oriented exercise in Parkinson's disease: a randomized study comparing LSVT-BIG and a short training protocol. J Neural Transm 122:253–256. https://doi.org/10.1007/s00702-014-1245-8
22. Iwai M, Koyama S, Takeda K et al (2021) Effect of LSVT® BIG on standing balance in a Parkinson's patient: a case report. Physiother Res Int 26:1–8. https://doi.org/10.1002/pri.1921
23. Fishel SC, Hotchkiss ME, Brown SA (2020) The impact of LSVT BIG therapy on postural control for individuals with Parkinson disease: a case series. Physiother Theory Pract 36:834–843. https://doi.org/10.1080/09593985.2018.1508260
24. Tomlinson CL, Herd CP, Clarke CE, Meek C, Patel S, Stowe R, Deane KHO, Shah L, Sackley CM, Wheatley KIN (2007) Physiotherapy for Parkinson ' s disease : a comparison of techniques (Review). Cochrane Collab. https://doi.org/10.1002/14651858.CD002815.pub2.www.cochranelibrary.com
25. Fox SH, Katzenschlager R, Lim SY et al (2018) International Parkinson and movement disorder society evidence-based medicine review: update on treatments for the motor symptoms of Parkinson's disease. Mov Disord 33:1248–1266. https://doi.org/10.1002/mds.27372

26. Millage B, Vesey E, Finkelstein M, Anheluk M (2017) Effect on gait speed, balance, motor symptom rating, and quality of life in those with stage I Parkinson's disease utilizing LSVT BIG®. Rehabil Res Pract 2017:1–8. https://doi.org/10.1155/2017/9871070
27. Fleming Walsh S, Balster C, Chandler A et al (2022) LSVT BIG® and long-term retention of functional gains in individuals with Parkinson's disease. Physiother Theory Pract 38:629–636. https://doi.org/10.1080/09593985.2020.1780655
28. Pappala K, Garuda B, Seepana G et al (2019) Non-motor symptoms of Parkinson's disease: Its prevalence across various stages and its correlation with the severity of the disease and quality of life. Ann Mov Disord 2:102–108. https://doi.org/10.4103/AOMD.AOMD_9_19
29. Barboza NM, Terra MB, Bueno MEB et al (2019) Physiotherapy versus physiotherapy plus cognitive training on cognition and quality of life in parkinson disease: randomized clinical trial. Am J Phys Med Rehabil 98:460–468. https://doi.org/10.1097/PHM.0000000000001128
30. Cusso ME, Donald KJ, Khoo TK (2016) The impact of physical activity on non-motor symptoms in Parkinson's disease: a systematic review. Front Med 3:1–9. https://doi.org/10.3389/fmed.2016.00035
31. Nadeau A, Pourcher E, Corbeil P (2014) Effects of 24 wk of treadmill training on gait performance in parkinson's disease. Med Sci Sports Exerc 46:645–655. https://doi.org/10.1249/MSS.0000000000000144
32. Duncan RP, Earhart GM (2012) Randomized controlled trial of community-based dancing to modify disease progression in Parkinson disease. Neurorehabil Neural Repair 26:132–143. https://doi.org/10.1177/1545968311421614
33. McNeely ME, Duncan RP, Earhart GM (2015) Impacts of dance on non-motor symptoms, participation, and quality of life in Parkinson disease and healthy older adults. Maturitas 82:336–341. https://doi.org/10.1016/j.maturitas.2015.08.002
34. Ellis T, Boudreau JK, Deangelis TR et al (2013) Barriers to exercise in people with Parkinson disease. Phys Ther 93:628–636
35. Villegas IL, Israel V (2014) Effect of the ai-chi method on functional activity, quality of life, and posture in patients with parkinson disease. Top Geriatr Rehabil 30:282–289. https://doi.org/10.1097/TGR.0000000000000039
36. Terrens AF, Soh SE, Morgan P (2021) Perceptions of aquatic physiotherapy and health-related quality of life among people with Parkinson's disease. Heal Expect. https://doi.org/10.1111/hex.13202
37. Herman T, Giladi N, Gruendlinger LHJ (2007) Six weeks of intensive treadmill training improves gait and quality of life in patients with Parkinson's disease: a pilot study. Arch Phys Med Rehabil 88:1154–1158
38. Peterka M, Odorfer T, Schwab M et al (2020) LSVT-BIG therapy in Parkinson's disease: physiological evidence for proprioceptive recalibration. BMC Neurol 20:1–8. https://doi.org/10.1186/s12883-020-01858-2
39. Ebersbach G, Ebersbach A, Edler D et al (2010) Comparing exercise in Parkinson's disease - The Berlin LSVT®BIG study. Mov Disord 25:1902–1908. https://doi.org/10.1002/mds.23212
40. Martínez-Martín P, Rodríguez-Blázquez C, Forjaz MJ et al (2014) Relationship between the MDS-UPDRS domains and the health-related quality of life of Parkinson's disease patients. Eur J Neurol 21:519–524. https://doi.org/10.1111/ene.12349
41. Ellis T, Cavanaugh JT, Earhart GM et al (2011) Which measures of physical function and motor impairment best predict quality of life in Parkinson's disease? Park Relat Disord 17:693–697. https://doi.org/10.1016/j.parkreldis.2011.07.004
42. Kadastik-Eerme L, Rosenthal M, Paju T et al (2015) Health-related quality of life in Parkinson's disease: a cross-sectional study focusing on non-motor symptoms. Health Qual Life Outcomes 13:1–8. https://doi.org/10.1186/s12955-015-0281-x
43. Skorvanek M, Rosenberger J, Minar M et al (2015) Relationship between the non-motor items of the MDS-UPDRS and quality of life in patients with Parkinson's disease. J Neurol Sci 353:87–91. https://doi.org/10.1016/j.jns.2015.04.013
44. Ueno T, Kon T, Haga R et al (2020) Assessing the relationship between non-motor symptoms and health-related quality of life in Parkinson's disease: a retrospective observational cohort study. Neurol Sci 41:2867–2873. https://doi.org/10.1007/s10072-020-04406-5
45. Erro R, Picillo M, Vitale C et al (2016) The non-motor side of the honeymoon period of Parkinson ' s disease and its relationship with quality of life : a 4-year longitudinal study. Eur J Neurol. https://doi.org/10.1111/ene.13106
46. Prakash KM, Nadkarni NV, Lye W et al (2016) The impact of non-motor symptoms on the quality of life of Parkinson ' s disease patients : a longitudinal study. Eur J Neurol. https://doi.org/10.1111/ene.12950
47. Ogawa M, Oyama G, Sekimoto S et al (2022) Current status of telemedicine for Parkinson's disease in Japan: a single-center cross-sectional questionnaire survey. J Mov Disord 15:58–61. https://doi.org/10.14802/jmd.21096
48. Garg D, Majumdar R, Chauhan S et al (2021) Teleneurorehabilitation among person with parkinson's disease in India: the initial experience and barriers to implementation. Ann Indian Acad Neurol 24:536–541. https://doi.org/10.4103/aian.AIAN_127_21
49. Lei C, Sunzi K, Dai F et al (2019) Effects of virtual reality rehabilitation training on gait and balance in patients with Parkinson's disease: a systematic review. PLoS One 14:1–17. https://doi.org/10.1371/journal.pone.0224819
50. Canning CG, Allen NE (2020) Virtual reality in research and rehabilitation of gait and balance in Parkinson disease. Nat Rev Neurol 16:409–425. https://doi.org/10.1038/s41582-020-0370-2