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Original Article

Unveiling the Impact of Outpatient Physiotherapy on Specific Motor Symptoms in Parkinson's Disease: A Prospective Cohort Study

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HIGHLIGHTS

- This study tested outpatient physiotherapy's impact on specific PD-motor symptoms.
- Improvements were observed only in PD patients with moderate-severe motor symptoms.
- Notably, specific improvements were seen in axial symptoms and bradykinesia.

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Unveiling the Impact of Outpatient Physiotherapy on Specific Motor Symptoms in Parkinson's Disease: A Prospective Cohort Study

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ABSTRACT

Understanding how outpatient physiotherapy impacts on specific motor symptoms in Parkinson's disease (PD) is important for multidisciplinary care, but these points have not been clarified. We investigated the impact of outpatient physiotherapy on individual motor symptoms in PD patients. Fifty-five PD patients participated in the prospective cohort study, which examined the changes in motor symptoms after 90 min of outpatient physiotherapy program (1×/week for 10 weeks) and at 3 months follow-up. Movement Disorder Society-Unified Parkinson's Disease Rating Scale (MDS-UPDRS) motor score and tremor, rigidity, bradykinesia, and axial scores were assessed and compared pre-intervention, post-intervention, and at follow-up. Significant level was set at 0.05. Their MDS-UPDRS motor score and axial score significantly decreased post-intervention and at the follow-up. In the analysis differentiating effects based on the severity of motor symptoms according to the MDS-UPDRS motor score, only the moderate-severe group showed significant decreases in their MDS-UPDRS motor score, bradykinesia, and axial scores post-intervention, as well as in their MDS-UPDRS motor score, rigidity, bradykinesia, and axial scores at the follow-up. These findings suggest the outpatient physiotherapy might provide benefits, particularly in managing axial symptoms and bradykinesia, for community dwelling PD patients with moderate-severe motor symptoms within a multidisciplinary care framework.

Keywords: Physical Therapy; Parkinson Disease; Outpatient

INTRODUCTION

Parkinson's disease (PD) is a common neurodegenerative disease characterized by various motor and non-motor symptoms. The cardinal motor symptoms in PD are resting tremor, bradykinesia, rigidity, and axial symptoms including postural instability, abnormal posture, and gait disorders [1,2]. These motor symptoms are managed by various interventions such as antiparkinsonian medications, surgical treatments, and rehabilitation, mainly physiotherapy [3-7]. The axial symptoms are not sufficiently improved by antiparkinsonian medications or surgical treatments such as deep brain stimulation [4,8-10]. It is important

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Conflict of Interest

The authors have no potential conflicts of interest to disclose.

Author Contributions

Conceptualization: Okada Y, Ikuno K, Terasawa Y; Formal analysis: Terasawa Y, Ikuno K, Fujii S, Nishi Y, Tanizawa E, Nabeshima S, Okada Y; Writing - original draft: Terasawa Y, Okada Y; Writing - review & editing: Ikuno K, Fujii S, Nishi Y, Tanizawa E, Nabeshima S.

for the recommended multidisciplinary care [11,12] of PD patients to clarify how physiotherapy impacts on individual motor symptoms.

Most of the studies of the effects of physiotherapy on motor symptoms used the Unified Parkinson's Disease Rating Scale or the Movement Disorder Society-Unified Parkinson's Disease Rating Scale (MDS-UPDRS) motor score [5-7,13] as a primary outcome. Since the MDS-UPDRS motor score can be divided into tremor, rigidity, bradykinesia, and axial scores [14], it is possible to examine the impact of physiotherapy on each of these cardinal motor symptoms, but our search identified no studies investigating the impact of physiotherapy from this perspective.

Outpatient physiotherapy is important in managing motor symptoms of PD patients living in the community. Outpatient physiotherapy has been shown to be effective for functional gait [15] and falls [16] among individuals with PD. We thus hypothesized that outpatient physiotherapy including standard care with PD-specific exercise to mitigate mobility deficits could improve PD patients' axial symptoms, including postural instability and gait disorders.

Each motor symptom of PD becomes pronounced as the disease progresses, but it has been suggested that axial symptoms including postural instability, abnormal posture, and gait disorders may progress to a greater degree than other motor symptoms [17]. If outpatient physiotherapy can indeed lead to improvements in axial symptoms in PD patients, it is conceivable that the impacts of such therapy might be more pronounced in individuals with more severe motor symptoms. Based on this premise, we formulated a hypothesis that the effectiveness of outpatient physiotherapy on axial symptoms could vary in degree among patients with different severity levels of motor symptoms.

We conducted the prospective cohort study to examine the changes in MDS-UPDRS motor scores and scores for individual motor symptoms (tremor, rigidity, bradykinesia, and axial symptoms) after the outpatient physiotherapy program to improve axial symptoms such as postural instability, abnormal postures, and gait disorders, hypokinetic movements in activities of daily living (ADL), secondary impairments in PD patients. Additionally, we aimed to assess the sustainability of these improvements at the follow-up time point. Secondly, we investigated the differences in the effects of outpatient physiotherapy on individual motor symptoms between patient groups with different severity levels of motor symptoms using a cut-off point of 32 on the of MDS-UPDRS motor score, as used in an earlier investigation [18].

MATERIALS AND METHODS

Study population

Participants were recruited from patients who underwent outpatient physiotherapy program at Nishiyamato Rehabilitation Hospital from December 2018 to November 2021. Inclusion criteria comprised: 1) a diagnosis of PD according to the United Kingdom Parkinson's Disease Society Brain Bank [19], 2) absence of concurrent neurological disease, orthopaedic disease, or internal disease affecting motor function, 3) no history of deep brain stimulation, 4) no changes in antiparkinsonian medication(s) from the start of intervention to the follow-up assessment. Exclusion criteria was a diagnosis of atypical Parkinsonism. All participants provided written informed consent, and the study conducted in accordance with the Declaration of Helsinki. Ethical approval was granted by the Ethical Review Committee of Nishiyamato Rehabilitation Hospital (IRB #36).

Study design and procedures

This prospective cohort study aimed to assess changes in individual motor symptoms following a 10-week outpatient physiotherapy program and at 3 months follow-up, in comparison to pre-intervention baseline. Demographic data including age, gender, height, body mass index (BMI), disease duration, Hoehn and Yahr stage, and antiparkinsonian medication dose were collected. Each levodopa-equivalent dose was calculated using established methods [20].

The primary outcome variables encompassed the MDS-UPDRS motor score, tremor (items 15–18), rigidity (item 3), bradykinesia (items 2,4–9,14), and axial scores (items 1,9–13) [14]. All MDS-UPDRS motor scores were assessed in "ON" medication state.

Interventions

All patients received 90 min of outpatient physiotherapy program 1×/week for 10 weeks. The main goals of outpatient physiotherapy program were to improve axial symptoms such as postural instability, abnormal postures, and gait disorders, hypokinetic movements in ADL, secondary impairments such as muscle weakness, inflexibility, and reduced endurance, and inactivity at home. The outpatient physiotherapy consisted of 30 min of stretching, and muscle strengthening using an elastic band (Thera-Band®, Akron, OH, USA) with the loads set according to the patient as a warm-up, followed by 60 minutes of one-on-one interventions by a physiotherapist. These interventions consisted of stretching, progressive resistance training, ≥ 10 minutes of aerobic exercise on a stationary ergometer, balance exercise to improve postural instability, posture-modification exercise, gait training using cueing and/or a treadmill, and training for ADLs. Gait training or ADLs training were conducted with the perspective of preventing the onset or progression of impairments for early PD patients, and with the perspective of alleviating impairments in more advanced patients. The patients also received individualized self-exercise instructions including those for stretching, strengthening using an elastic band, balance exercise, and gait training at home, and they were encouraged to continue this training during their outpatient physiotherapy program and the follow-up.

Statistical analyses

The Shapiro-Wilk test was used to assess the normality of all variables. The results are presented as mean ± standard deviation (SD). The MDS-UPDRS motor score and the summed and mean scores of tremor, rigidity, bradykinesia, and axial symptoms were compared across time (pre-intervention/post-intervention, and pre-intervention/follow-up) using the paired t-test (when normally distributed) or Wilcoxon signed rank test (when not normally distributed). In addition, based on the MDS-UPDRS motor score at pre-intervention, we classified the patients with a score of ≤ 32 point as the Mild group and those with a score of ≥ 33 points as the moderate-severe group [18]. The demographic and clinical characteristics of the patients at pre-intervention were compared by the unpaired t-test, Mann-Whitney U-test, and Fisher's exact test. The change in data across the time points in each group was also examined by the paired t-test or Wilcoxon signed rank test. The software program R4.1.0 was used for all statistical analyses. All statistical tests were two-tailed, and the significance level was set at 0.05.

Sample size determination

The appropriate sample size was determined by Gpower based on the pre- and post-intervention mean values (22.7 and 19.5) and SDs (7.1 and 7.3) of the MDS-UPDRS motor scores obtained from a study conducting outpatient physiotherapy sessions similar to the present

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study [15], either as whole or by severity level comparison. To detect the difference with 80% power and 5% alpha error and, and assuming a correlation of 0.8 between the measurements, a minimum sample size of 18 was calculated. Taking into account a potential drop-out rate up to 15% in each group with different disease severity, we aimed to include 21or more patients.

RESULTS

Of the 97 PD patients enrolled in the outpatient physiotherapy program during the study period, we excluded the six patients who dropped out (unclear reason), the two patients had received deep brain stimulation, 11 patients experienced changes in antiparkinsonian medications, 10 patients had coexisting neurological disease, and 13 patients with musculoskeletal disease affecting motor function. This resulted in the inclusion of 55 patients for the analysis of pre- and post-intervention changes. The demographic and clinical characteristics are summarized in **Table 1**.

Among the included participants, 20 patients did not complete the follow-up evaluation, while 35 patients successfully completed the follow-up evaluation. The pre-intervention characteristics of these two groups of patients did not show significant difference, except for BMI (**Supplementary Table 1**). The BMI of PD patients who completed the follow-up evaluation was significantly lower than that of those who did not.

Changes in motor symptoms for all included PD patients

The analyses of the 55 PD patients revealed a significant decrease in the MDS-UPDRS motor ($Z = -2.099$, $p = 0.036$) and axial scores ($Z = -2.463$, $p = 0.013$) after the 10-week outpatient physiotherapy intervention (**Table 2**). However, the scores for tremor ($Z = -0.358$, $p = 0.724$), rigidity ($Z = -0.910$, $p = 0.129$), and bradykinesia ($Z = -0.910$, $p = 0.363$) were not significantly changed from pre- to post-intervention. In addition, the analyses of the 35 PD patients who completed the 3-month follow-up evaluation showed significant decreases in their MDS-UPDRS motor score ($Z = -2.284$, $p = 0.021$) and axial score ($Z = -2.083$, $p = 0.036$) at the follow-up compared to pre-intervention (**Table 3**). Their scores for tremor ($Z = -1.951$, $p = 0.051$), rigidity ($Z = -1.314$, $p = 0.145$), and bradykinesia ($Z = -1.385$, $p = 0.131$) were not significantly different between pre-intervention and follow-up. Similar results were observed for the changes in the mean score of each motor symptom (**Supplementary Tables 2** and **3**).

Table 1. Demographic and clinical characteristics of the patients

Varibles	Total (n = 55)	Mild (n = 34)	Moderate-severe (n = 21)	p value
Age (yrs)	67.80 ± 7.06	65.97 ± 6.45	70.76 ± 7.15	0.010*,†
Male/female	33/22	17/17	16/5	0.360‡
Height (m)	1.63 ± 0.09	1.62 ± 0.09	1.64 ± 0.08	0.438§
BMI (kg/m^2)	21.44 ± 3.47	21.61 ± 3.79	21.17 ± 2.93	0.635§
Disease duration (mon)	66.06 ± 44.23	63.22 ± 45.44	70.66 ± 42.89	0.377†
Hoehn and Yahr stage (I/II/III/IV)	7/13/34/1	6/10/18/0	1/3/16/1	0.240‡
MDS-UPDRS motor score	30.47 ± 14.61	20.91 ± 7.72	45.95 ± 8.41	< 0.001*,†
Tremor score	3.27 ± 3.54	2.24 ± 2.80	4.95 ± 4.01	0.003*,†
Rigidity score	6.49 ± 3.44	4.91 ± 3.12	9.05 ± 2.20	< 0.001*,†
Bradykinesia score	15.27 ± 9.10	9.56 ± 5.04	24.52 ± 6.03	< 0.001*,§
Axial score	5.44 ± 2.76	4.21 ± 2.13	7.43 ± 2.52	< 0.001*,§
Levodopa equivalent dose (mg/day)	414.71 ± 251.34	432.70 ± 283.15	389.60 ± 191.93	0.828†

The data are shown as mean ± standard deviation.
BMI, body mass index; MDS-UPDRS motor score, Movement Disorder Society-Unified Parkinson's Disease Rating Scale motor score.
*$p < 0.05$; †Mann-Whitney U-test; ‡Fisher's exact test; §Unpaired t-test.

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Table 2. MDS-UPDRS motor score and subscores pre- and post-intervention

Variables	Total (n = 55)				Mild group (n = 34)				Moderate-severe group (n = 21)			
	Pre-intervention	Post-intervention	p value	Change from pre- to post-intervention	Pre-intervention	Post-intervention	p value	Change from pre- to post-intervention	Pre-intervention	Post-intervention	p value	Change from pre- to post-intervention
MDS-UPDRS motor score	30.47 ± 14.61	27.82 ± 13.51	0.036*,†	−2.65 ± 8.91	20.91 ± 7.72	20.68 ± 9.64	0.905†	−0.24 ± 8.60	45.95 ± 8.14	39.38 ± 10.61	0.001*,†	−6.57 ± 8.15
Tremor score	3.27 ± 3.54	2.87 ± 3.23	0.724†	−0.40 ± 2.73	2.24 ± 2.80	1.97 ± 2.46	0.768†	−0.26 ± 2.12	4.95 ± 4.01	4.33 ± 3.83	0.788†	−0.62 ± 3.54
Rigidity score	6.49 ± 3.44	5.75 ± 3.78	0.129†	−0.75 ± 2.88	4.91 ± 3.12	3.97 ± 3.42	0.144†	−0.94 ± 3.25	9.05 ± 2.20	8.62 ± 2.29	0.383‡	−0.43 ± 2.2
Bradykinesia score	15.27 ± 9.10	14.51 ± 7.79	0.363†	−0.76 ± 7.12	9.56 ± 5.04	11.06 ± 6.62	0.286†	1.50 ± 6.21	24.52 ± 6.03	20.10 ± 6.20	0.010*,‡	−4.43 ± 7.10
Axial score	5.44 ± 2.76	4.69 ± 2.86	0.013*,†	−0.75 ± 2.06	4.21 ± 2.13	3.68 ± 2.36	0.155†	−0.53 ± 1.83	7.43 ± 2.52	6.33 ± 2.89	0.048*,‡	−1.10 ± 2.39

The data are shown as mean ± standard deviation.
MDS-UPDRS, Movement Disorder Society-Unified Parkinson's Disease Rating Scale.
*p < 0.05; †Wilcoxon signed rank test; ‡Paired t-test.

Table 3. MDS-UPDRS motor score and subscores pre-intervention and follow-up (3 months post-intervention)

Variables	Total (n = 35)				Mild group (n = 22)				Moderate-severe group (n = 13)			
	Pre-intervention	Follow-up	p value	Change from pre-intervention to follow-up	Pre-intervention	Follow-up	p value	Change from pre-intervention to follow-up	Pre-intervention	Follow-up	p value	Change from pre-intervention to follow-up
MDS-UPDRS motor score	28.63 ± 14.58	23.74 ± 12.24	0.021*,†	−4.89 ± 11.28	19.32 ± 6.96	18.73 ± 10.23	0.844†	−0.59 ± 9.93	44.38 ± 9.46	32.23 ± 10.81	0.002*,†	−12.15 ± 9.86
Tremor score	2.77 ± 3.05	1.89 ± 2.25	0.051†	−0.89 ± 2.51	2.27 ± 2.90	1.45 ± 1.99	0.152†	−0.82 ± 2.48	3.62 ± 3.23	2.62 ± 2.53	0.245†	−1.00 ± 2.65
Rigidity score	6.34 ± 3.74	5.49 ± 3.29	0.145‡	−0.85 ± 3.40	4.50 ± 3.67	4.41 ± 2.89	0.902‡	−0.09 ± 3.44	9.46 ± 2.54	7.31 ± 3.22	0.025*,‡	−2.15 ± 3.02
Bradykinesia score	14.51 ± 9.40	12.29 ± 7.74	0.131†	−2.23 ± 38.51	8.82 ± 5.32	9.45 ± 7.15	0.654†	0.64 ± 6.90	24.15 ± 6.36	17.08 ± 6.37	0.015*,‡	−7.08 ± 9.03
Axial score	5.00 ± 2.93	4.09 ± 2.78	0.036*,†	−0.91 ± 2.42	3.73 ± 2.03	3.41 ± 2.28	0.405‡	−0.32 ± 1.76	7.15 ± 3.02	5.23 ± 3.24	0.043*,‡	−1.92 ± 3.07

The data are shown as mean ± standard deviation.
MDS-UPDRS, Movement Disorder Society-Unified Parkinson's Disease Rating Scale.
*p < 0.05; †Wilcoxon signed rank test; ‡Paired t-test.

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Changes in motor symptoms of the PD patients with different motor symptom severity

Of the 55 PD patients included, 34 were classified as the Mild group and 21 were classified as the moderate-severe group. The Mild group showed no significant change in any of the outcomes after the 10-week intervention (MDS-UPDRS motor score: Z = −0.125, p = 0.905, tremor score: Z = −0.327, p = 0.768, rigidity score: Z = −1.746, p = 0.144, bradykinesia: Z = −1.093, p = 0.286, axial score: Z = −1.446, p = 0.155) (**Table 2**). In contrast, the moderate-severe group showed significant decreases in their MDS-UPDRS motor score (Z = −2.991, p = 0.001) and bradykinesia (Z = −2.418, p = 0.010) and axial scores (Z = −1.973, p = 0.048) after the intervention, but not in their tremor (Z = −0.285, p = 0.788) or rigidity (Z = −0.724, p = 0.383) scores.

Twenty-two of the patients in the Mild group (64.7%) and 13 of the patients in the moderate-severe group (61.9%) were evaluated at the 3-month follow-up. The Mild group showed no significant difference in any of the outcomes between the pre-intervention and follow-up evaluations (MDS-UPDRS motor score: Z = −0.209, p = 0.844, tremor score: Z = −1.528, p = 0.152, rigidity score: Z = −0.019, p = 0.902, bradykinesia score: Z = −0.467, p = 0.654, axial score: Z = −0.815, p = 0.405) (**Table 3**). However, the moderate-severe group showed significant decreases at the follow-up compared to pre-intervention: MDS-UPDRS motor score (Z = −2.867, p = 0.002), rigidity (Z = −2.327, p = 0.025), bradykinesia (Z = −2.238, p = 0.015), and axial scores (Z = −2.057, p = 0.043). The moderate-severe group's tremor score did not change significantly from pre-intervention to the follow-up (Z = −1.227, p = 0.245). Similar results were observed for the changes in the mean score of each motor symptom (**Supplementary Tables 2** and **3**).

DISCUSSION

This study is the first to examine how outpatient physiotherapy impacts on individual motor symptoms in PD patients, while also considering the variation in motor symptom severity. The primary findings of this prospective cohort study are twofold: 1) outpatient physiotherapy can lead to improvement in motor symptoms, especially among PD patients with moderate-severe motor symptoms, and 2) this improvement was particularly evident in axial symptoms and bradykinesia among the cardinal motor symptoms.

Our results underscore that outpatient physiotherapy can effectively enhance the MDS-UPDRS motor score of PD patients with moderate-severe motor symptoms, yet fails to manifest a similar effect in those with mild motor symptoms. A recent study comparing PD patients' MDS-UPDRS motor scores obtained before and at 6 months after undergoing outpatient physiotherapy (12 sessions over 6 months) at two distinct frequencies (2 sessions per week and 1 session every 2 weeks) found no noticeable improvement with either intervention [15]. Our study adopted a regimen of 1session per week for 10 weeks and 3 months follow-up, which is relatively comparable to the aforementioned study [15]. The pre-intervention MDS-UPDRS motor scores for the two groups in the earlier study [15] were 22.7 ± 7.1 and 20.5 ± 10.2, suggesting that most of the patients in both groups had mild motor symptoms, based on the criteria of motor symptom severity [18]. These past and present findings suggest that the efficacy of outpatient physiotherapy might be contingent on the severity of motor symptoms, and that individuals with more severe motor symptoms tend to achieve greater improvement in motor symptoms through this intervention.

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We further scrutinized the effects of outpatient physiotherapy on the subscores associated with individual motor symptoms, revealing a significant enhancement in axial score among PD patients with moderate-severe motor symptoms, whereas such an effect was not observed in those with mild motor symptoms. Prior studies have demonstrated the efficacy of physiotherapy on postural stability, gait, and ADLs [5-7,15,16,21,22]. The outpatient physiotherapy program employed in this study encompassed exercises to ameliorate postural instability, posture-modification exercise, gait training and interventions to enhance ADLs, such as arising from a chair depending on the individual needs. Given that PD patients with moderate-severe motor symptoms exhibited higher axial scores, indicative of the focus of the outpatient physiotherapy program, it is reasonable to infer that such intervention contributed to the enhancement of axial symptoms within this subgroup. The limited improvement observed in the patients with mild motor symptoms may be attributed to the ceiling effect of the MDS-UPDRS motor score. Notably, a study on outpatient physiotherapy for PD patients with relatively mild motor symptoms indicated that MDS-UPDRS motor scores remained unchanged, improvements were evident in the timed up and go (TUG) test [15]. Thus, functional measures like the TUG test might be better suited for assessing the benefits of outpatient physiotherapy in individuals with mild motor symptoms.

Our study also demonstrates the capacity of outpatient physiotherapy to alleviate bradykinesia in PD patients with moderate-severe motor symptoms. Notably, one main goal of our outpatient physiotherapy program for all subjects was to mitigate hypokinetic movements in ADLs. It is possible that our exercise regimen, which emphasized movement magnitude, significantly contributed to the improvement in bradykinesia among patients with moderate-severe motor symptoms. Previous investigations have shown that progressive resistance training using weight machines twice a week for these studies, participants engaged in progressive resistance training with weight machines as part of a weekly outpatient physiotherapy session, supplemented with individualized self-exercise involving resistance training using elastic bands, over a ten-week period. The efficacy of such strengthening exercise might be more pronounced in PD patients with moderate-severe motor symptoms, while the impact on those with mild motor symptoms might be less discernible due to insufficient exercise intensity.

Our findings from the 3-month follow-up demonstrated the continued amelioration of axial symptoms and bradykinesia in PD patients with moderate-severe motor symptoms. These sustained improvements suggest that the benefits of outpatient physiotherapy endure even after the intervention period, possibly due to the integration of individualized self-exercise following physiotherapy sessions. This continuity in exercise likely contributes to the stabilization of symptom enhancement.

Nonetheless, the reasons behind the improvement in rigidity observed during the follow-up evaluation among PD patients with moderate-severe motor symptoms, which was absent in the initial intervention, remain unclear. Given that the rigidity score were not significantly different between patients who completed the follow-up evaluation and those who did not, it is unlikely that the pre-intervention value influenced this result. One plausible explanation is that patients who experienced in rigidity were more likely to participate in the follow-up assessment. Additionally, our study did not yield improvements in tremor among PD patients with mild and moderate-severe motor symptoms. This outcome can be attributed to the absence of interventions targeting tremor in our outpatient physiotherapy program. While few studies have reported improvements in rigidity and tremor through physiotherapy, high intensity forced exercise three times a week for eight weeks was found to alleviate these

motor symptoms [25]. The limited efficacy observed in our study could be attributed to the insufficient exercise intensity to address rigidity and tremor.

A recent review highlight the significance of considering the implementation status encompassing frequency and duration, when evaluating the efficacy of physiotherapy [26]. Within this context, the manners in which interventions are executed is crucial. Notably, a strength of our study lies in the consistent implementation status including duration, frequency, and span of outpatient physiotherapy, providing invaluable insights into the employed intervention methodology.

Several study limitations should be acknowledgment. The absence of a control group leaves room for the possibility that observed improvements may stem not only from the intervention itself, but also from placebo and Hawthorne effects, or other factors. Additionally, the lack of assessment in the OFF medication state leaves the effects in a state minimally influenced by antiparkinsonian medication uncertain. To address these limitations, future studies should investigate the effects of outpatient physiotherapy on individual motor symptoms in both ON and OFF medication states, employing large-scale randomized controlled trials. Lastly, this study did not incorporate data regarding the frequency of patients' engagement in self-exercise at home in the analysis, potentially leading to varying implementation statuses across participants. Future research could explore the application of telerehabilitation to verify and enhance adherence to instructed-self exercise.

In conclusion, our results suggest the effectiveness of outpatient physiotherapy to improve axial symptoms and bradykinesia in PD patients with moderate-severe motor symptoms. Especially since axial symptoms often do not respond to antiparkinsonian medications or surgical treatments such as deep brain stimulation [4,8-10], the significance of the demonstrated potential for improvement of axial symptoms through outpatient physiotherapy is particularly notable. Outpatient physiotherapy might provide benefits, particularly in managing axial symptoms and bradykinesia, for community dwelling PD patients with moderate-severe motor symptoms within a multidisciplinary care framework.

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SUPPLEMENTARY MATERIALS

Supplementary Table 1
Demographic and clinical characteristics of the patients

Click here to view

Supplementary Table 2
Mean score of each motor symptom pre- and post-intervention

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Supplementary Table 3

Mean score of each motor symptom in pre-intervention and follow-up (3 months post-intervention)

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