Effects of Baduanjin exercise on motor function, balance and gait in Parkinson’s disease: a systematic review and meta-analysis

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ABSTRACT

Objective This study aims to systematically evaluate the effects of Baduanjin on motor function, balance and gait in patients with Parkinson’s disease (PD).

Design Systematic review and meta-analysis.

Study selection All eligible randomised controlled trials (RCTs) published in the English and Chinese languages were included.

Data sources Ten electronic databases were systematically searched, from inception to 17 March 2022: PubMed, Web of Science, Cochrane Library, Embase, EBSCOhost, OVID, SinoMed, China National Knowledge Infrastructure, Wanfang Data and China Science Journal Database (VIP).

Review methods Methodological quality assessment and meta-analysis were performed for the included studies using the Cochrane Review Manager V.5.4 software.

Results Ten RCTs with 804 participants were included. The results revealed the following: (1) Baduanjin significantly improved the motor function of patients with PD, based on the Unified Parkinson’s Disease Rating Scale Part III (mean difference, MD −5.37, 95% CI −8.96 to −1.78, p=0.003) and Fugl-Meyer Assessment of Lower Extremity (MD 5.39, 95% CI 2.71 to 8.07, p<0.0001); (2) Baduanjin significantly improved the ability of balance of patients with PD, based on the Berg Balance Scale (MD 4.40, 95% CI 3.08 to 5.73, p<0.0001); (3) Baduanjin significantly improved the gait of patients with PD, based on the 6 min walk distance (MD 21.62, 95% CI 11.14 to 32.10, p<0.0001). After the further subgroup and sensitivity analyses, the heterogeneity was identified to be potentially due to the different degrees of disease severity in patients with PD and the difference in Baduanjin intervention durations.

Conclusions The analysis of this systematic evaluation indicates that Baduanjin might have a positive effect in improving the motor function, balance and gait of patients with PD. However, due to the quantity and clinical heterogeneity limitations of the included studies, this conclusion still warrants more high-quality and multicentre RCTs for further verification.

INTRODUCTION

Parkinson’s disease (PD) represents as the second most common neurodegenerative disease, which is characterised by the decrease of dopaminergic neurons in the substantia nigra pars compacta (SNpc). According to the global survey of nervous system diseases, the rate of incidence and prevalence of PD have been dramatically increasing. In addition, this has been recognised as the potentially fastest-growing neurological disease in the world. From 1990 to 2015, more than six million people suffered from PD. Considering the increasing ageing population, the number of patients with PD is expected to reach more than 12 million by 2040, which would be almost double the present number. PD cardinal clinical symptoms mainly include resting tremors, postural balance disorder, bradykinesia and rigidity. Furthermore, patients with PD are more prone to falls or fractures due to balance disorder and abnormal gait, limiting their activity ability, seriously affecting their quality of life (QoL) and imposing a heavy burden on families and society. Hence, the timely prevention or treatment of PD with effective strategies is imperative.

At present, levodopa remains as the main and first-line drug for the clinical treatment for patients with PD. Although drug therapy can improve the patient’s symptoms, the effectiveness of pharmacological treatment tends to wear off over time, resulting in severe motor fluctuations and dyskinesia. Furthermore, motor complications of any kind can...
Baduanjin is a traditional mind-body exercise that originated from the Song Dynasty, and has existed for more than one thousand years. This consists of eight simple movements, in which the whole set of activities are gentle, slow and continuous. This is characterised by deep and slow breathing, emphasising static and dynamic posture control, and combining body movement and breathing patterns. Baduanjin exercises can improve the patient’s ability to focus on postural stability, strengthen core muscles, put pressure on weight-bearing joints, increase proprioception and control body posture. In addition, Baduanjin is commonly referred to as a moderate-intensity aerobic exercise that consumes 3–5 metabolic equivalents, and is easy to learn and practice at home. Based on its characteristics, this is very suitable for special populations, including populations with physical disabilities, such as patients with chronic diseases (eg, PD), who have low tolerance to physical activity intensity. In recent years, a number of trials have been conducted to investigate the effects of Baduanjin on PD. However, to date, no systematic evaluation of these research results has been identified. Therefore, in order to determine the effectiveness of Baduanjin in PD, a systematic review and meta-analysis of Baduanjin randomised controlled trials (RCTs) on patients with PD was conducted, particularly in terms of the motor function, balance and gait of patients with PD.

METHODS
This study was conducted in accordance with the guidelines of the Cochrane Handbook (PRISMA : for reporting of systematic review and meta-analysis). "16"

Patient and public involvement
No patient was involved in the study design.

Search strategy
An electronic literature search was performed on the following databases for articles published in the English and Chinese language as of March 2022: PubMed, Web of Science, Cochrane Library, Embase, EBSCOhost, OVID, SinoMed, China National Knowledge Infrastructure, Wanfang Data and China Science Journal Database (VIP). The following search terms were used: Baduanjin, Mind-body exercise, Qigong and Parkinson’s disease. All database search strategies are presented in online supplemental appendix 1.

Inclusion and exclusion criteria
The inclusion criteria for this study were as follows: (1) studies that targeted patients with PD; (2) RCTs; (3) the control group received other treatments (eg, drug therapy, balance board training, conventional treatment and conventional physical therapy), while the experimental group received Baduanjin exercises in addition to the interventions used in the control group; (4) for studies with multiple groups, all groups that met the above criteria were included and (5) outcome indicators: types correlated to motor function, balance and gait.

The exclusion criteria for this study were as follows: (1) the experimental group performed Baduanjin exercises combined with another intervention not used in the control group (eg, Baduanjin combined with balance board training); (2) duplicate publications; (3) reviews, animal experiments, experience reports, etc and (4) studies with no relevant results.

Study selection and data extraction
Two researchers independently screened the included studies and extracted the relevant data. The extracted data included the general information (first author and publication year, location, Hoehn and Yahr grade, age and sample size), details of the interventions (interventions measured in the control and Baduanjin groups, frequency of interventions and intervention duration) and outcome indicators. Any disagreement during the process was resolved by discussion with a third researcher for confirmation.

Risk of bias
Two researchers used the bias risk assessment tool, which is applicable for RCTs and recommended by the Cochrane Manual V.5.1.0, in order to independently evaluate the included literature and cross-check the results. If there was any disagreement, a third researcher would arbitrate to reach a consensus. The risk of bias evaluation involved seven aspects: random sequence generation, allocation concealment, blinding of researchers and participants, blinding of evaluators, completeness of outcome indicators, selective reporting and other bias.

Statistical analysis
The Cochrane Review Manager V.5.4 software was used for the data analysis. The count data were presented in OR and 95% CIs, and the measurement data was presented in mean difference (MD). The I² test was applied to estimate the statistical heterogeneity among trials. Studies with I²≤50% were considered to have low heterogeneity, and these were analysed using a fixed effect model. Otherwise, significant heterogeneity was considered among the studies, and the random effects model was adopted. Then, a subgroup analysis (eg, according to the duration of interventions) or sensitivity analysis was performed, and the possible reasons for the high heterogeneity were explored. Funnel plots were used to analyse the
publication bias. The difference was defined to be statistically significant when \( p < 0.05 \).

**RESULTS**

**Search results**

A total of 267 articles were retrieved from the databases. Among these articles, 125 duplicate articles were excluded. Then, the titles and abstracts of the remaining 142 articles were screened, and 125 articles that were not qualified based on the criteria were excluded. After the full-text screening of the remaining 17 articles, a total of 7 articles that did not meet the study criteria were excluded. The reasons for the exclusion were as follows: non RCTs \((n=4)\), clinical case reports \((n=2)\) and duplicate publications \((n=1)\). Finally, a total of 10 studies\(^{18-27}\) were included for the present meta-analysis. The flow chart for the study selection is presented in figure 1.

**Characteristics of the included studies**

The present review included a total of 10 RCTs with 804 participants diagnosed with PD.\(^{18-27}\) For the language used by the included studies, eight\(^{18-25}\) studies were reported in the Chinese language, and two\(^{26, 27}\) studies were reported in the English language. The Hoehn and Yahr grade is a standard clinical measure of PD progression, which globally measures the signs and symptoms of functional impairment. Grades 1–3 represent low-to-moderate incapacity, and grades 4–5 represent serious incapacity.\(^{28}\) For the 10 included RCTs, 5 RCTs\(^{18, 20, 23, 24, 27}\) clearly reported the disease grading of patients with PD using the Hoehn and Yahr grade, while 5 RCTs\(^{19, 21, 22, 25, 26}\) did not clearly report this. The control group received drug therapy, balance board training, conventional physical therapy, etc. The experimental group received any of the interventions in the control group plus Baduanjin. The Baduanjin intervention in the included studies had a frequency that ranged within 4–7 times a week, with a duration that lasted for 1–24 weeks. The main outcome indicators included the following: (1) tests of motor function, including the Unified Parkinson’s Disease Rating Scale Part III (UPDRS-III), Fugl-Meyer Assessment of Lower Extremity (FMA-LE) and Function Independent Measure (FIM); (2) indicators of balance, including the Berg Balance Scale (BBS) and Balance-check balancer test; (3) indicators of gait, including the 6 min walk distance (6MWD), Timed Up and Go Test (TUGT), Intelligent Device for Energy Expenditure and Activity gait (IDEA gait), Tinetti Performance Oriented Mobility Assessment (Tinetti POMA), 10 m Walk Test (10MWT) and Freezing of Gait (FOG). The characteristics of the analysed trials are presented in table 1.

**Methodological quality and risk of bias**

The methodological quality and risk of bias for each included study are presented in figures 2 and 3. Four studies\(^{18, 19, 21, 22}\) reported the random sequence-generation method, while one study\(^{27}\) used the blinded outcome assessors. All these studies were judged to have low risk of bias in the aforementioned domains. In addition, one study\(^{24}\) was grouped according to the way patients voluntarily participated. Hence, this was rated as ‘high risk’. All selective reporting and other bias risks included in the trial were considered as ‘low risk’.

**Meta-analysis**

**Effect of Baduanjin on motor function**

*Unified Parkinson’s Disease Rating Scale Part III*

UPDRS-III is part of the standard clinical test to assess the severity of motor complications in PD, with higher scores indicating more severe motor complications.\(^{29}\) Related studies have shown that a change of >3.25 points before and after the intervention may be clinically important for PD.\(^{29}\) Five studies\(^{19, 20, 23, 24, 27}\) with 418 participants used UPDRS-III to evaluate the motor symptoms. The meta-analysis revealed that the UPDRS-III scores were lower in the Baduanjin group, when compared with the control group (MD \( -5.37, 95\% \) CI \( -8.96 \) to \( -1.78, p=0.003, I^2=94\%\); figure 4A). The heterogeneity sensitivity analysis was performed after excluding the study conducted by Shi et al.\(^{18}\) The subsequent meta-analysis yielded the following results: MD \( -3.40, 95\% \) CI \( -4.15 \) to \( -2.64, p<0.00001, I^2=0\%\); figure 4B). The heterogeneity may be due to the different degrees of PD among participants, and merely the study conducted by Shi et al did not report the stages of the participant’s PD. These above results indicate that Baduanjin can improve the degree of motor function impairment in PD.

Furthermore, subgroup analyses were performed, according to the intervention durations. The meta-analysis of two studies\(^{20, 24}\) with a Baduanjin intervention duration of ≤8 weeks revealed the following: MD \( -2.83, 95\% \) CI \( -3.82 \) to \( -1.83, p<0.00001, I^2=0\%\). The meta-analysis of two studies\(^{23, 27}\) with a Baduanjin intervention duration of >8 weeks revealed the following: MD \( -4.17, ...
Table 1  Basic characteristics of the included studies

| Study  | Location (language) | Hoehn and Yahr grades | Sample (male/female) | Intervention | Frequency | Duration (weeks) | Intervention sites | Outcomes |
|--------|---------------------|-----------------------|----------------------|--------------|-----------|------------------|--------------------|----------|
| Dong, 2022 | Jiangsu, China (Chinese) | 1–3 | C: 63.07±12.78 E: 65.37±7.47 | Drug therapy | 30 min/session, one session/day, 7 days/week | 3 | Hospital | IDEEA gait, Balance-check balancer test |
| Shi, 2021 | Henan, China (Chinese) | Not reported | 60–75 | Drug therapy+Balance board training | 60 min/session, one session/day, 4 days/week | 8 | Hospital | FMA-LE, 6MWD, UPDRS-III, BBS |
| Song, 2020 | Jiangsu, China (Chinese) | 1–3 | >65 | Drug therapy+Balance board training | 20 min/session, one session/day, 5 days/week | 8 | Hospital | FMA-LE, 6MWD, UPDRS-III, BBS |
| Zhang, 2020 | Fuzhou, China (Chinese) | Not reported | 61–74 | Drug therapy+Balance board training | 30 min/session, one session/day, 7 days/week | 12 | Hospital | 6MWD, FIM |
| Zhou, 2020 | Changsha, China (Chinese) | Not reported | 60–86 | Balance board training | 20 min/session, 1–2 sessions/day, 5 days/week | 4 | Hospital | FMA-LE, 6MWD |
| Zhi, 2020 | Dalian, China (Chinese) | 1–2 | 45–65 | Drug therapy | 60 min/session, one session/day, 6 days/week | 12 | Hospital | UPDRS-III, TUGT, 10MWT |
| Wei, 2019 | Beijing, China (Chinese) | 1–3 | 32–78 | Drug therapy+Health education | 60 min/session, one session/day, 7 days/week | During hospitalisation (1–2 weeks) | Hospital | III |
| Yang, 2019 | Chongqing, China (Chinese) | Not reported | 45–82 | Conventional treatment | Not reported | 8 | Hospital/ Home (after discharge) | BBS, Tinetti POMA |
| Xiao, 2016 | Beijing, China (English) | Not reported | 67.8±9.4 | Conventional physical therapy | 60 min/session, one session/day, 7 days/week | 24 | Not reported | BBS, TUGT, 6MWD, FOG, UPDRS-III |
| Xiao, 2015 | Beijing, China (English) | 1–3 | 55–80 | Walking | 60 min/session, one session/day, 4 days/week | 24 | Home | UPDRS-III, BBS, TUGT, 6MWD |

BBS, Berg Balance Scale; C, control group; E, experiment group (Baduanjin group); FIM, Functional Independence Measurement; FMA-LE, Fugl-Meyer Assessment of Lower Extremity; FOG, Freezing of Gait; IDEEA gait, Intelligent Device for Energy Expenditure and Activity gait; 6MWD, 6 min Walking Distance; 10MWT, 10 m Walk Test; POMA, Performance Oriented Mobility Assessment; Tinetti POMA, Tinetti Performance Oriented Mobility Assessment; TUGT, Timed Up and Go Test; UPDRS-III, Unified Parkinson’s Disease Rating Scale, Part III.
These results indicate that Baduanjin can reduce the degree of motor function impairment in PD, regardless of whether the intervention duration is ≤8 weeks or >8 weeks.

**Fugl-Meyer Assessment of Lower Extremity**

FMA-LE is a frequently used injury-based measure to assess the motor recovery in the lower extremity and predict the functional recovery of individuals with PD, with higher scores indicative of lower levels of impairment. Scoring is done on a three-point ordinal scale ranging from 0 (no performance) to 2 (faultless performance). The total score range from 0 (no motor function) to 34 (good motor recovery). Three studies that involved 313 participants used FMA-LE to assess the lower extremity motor function. The meta-analysis revealed that the FMA-LE scores were higher in the Baduanjin group, when compared with the control group (MD 5.39, 95% CI 2.71 to 8.07, p<0.0001, I²=92%; figure 5A). Furthermore, a heterogeneity sensitivity analysis was performed after excluding the study conducted by Song et al., and the subsequent meta-analysis results were consistent, with the following results: MD 6.64, 95% CI 5.69 to 7.59, p<0.00001, I²=39% (figure 5B). The heterogeneity among these studies may be attributable to the difference in Baduanjin intervention duration. These results indicate that Baduanjin can improve the motor function of the lower limbs in patients with PD.

**Effect of Baduanjin on balance function**

**Berg Balance Scale**

BBS is a test used to assess functional balance, showing high validity and reliability in PD, with higher scores indicating better balance, with scores interpreted in the following manner: 0–20, wheelchair users; 21–40, walking with assistance and 41–56, independent. Three studies that included 318 participants used BBS to evaluate the balance function. The meta-analysis revealed that the BBS scores were higher in the Baduanjin group, when compared with the control group (MD 4.40, 95% CI 3.08 to 5.73, p<0.00001, I²=87%; figure 6A). A heterogeneity sensitivity analysis was performed after excluding the study conducted by Shi et al., and the consistent results were as follows: MD 3.71, 95% CI 2.90 to 4.51, p<0.00001, I²=63% (figure 6B). These results indicate that Baduanjin has a positive effect on balance function in PD.

**Effect of Baduanjin on gait**

**Six min walk distance**

The 6MWD is a validated and widely used test to assess gait by instructing patients to walk for 6 min, and recording the longest distance the subject could walk, generally suggesting that a change of 14.0–30.5 m before and after the intervention may be clinically important for PD. Five studies that involved 485 participants used the 6MWD to evaluate the walking ability. The results revealed that the 6MWD scores were higher in the 95% CI −5.32 to −3.01, p<0.0001, I²=0% (figure 4C). These results indicate that Baduanjin can reduce the degree of motor function impairment in PD, regardless of whether the intervention duration is ≤8 weeks or >8 weeks.

Figure 2 Risk of bias graph.

Figure 3 Risk of bias summary.
Baduanjin group, when compared with the control group (MD 21.62, 95% CI 11.14 to 32.10, p<0.0001, I²=80%; figure 7A). After removing the studies conducted by Zhou and Xiao et al., the heterogeneity sensitivity analysis and subsequent meta-analysis revealed similar results: MD 18.86, 95% CI 13.69 to 24.02, p<0.0001, I²=0% (figure 7B). The heterogeneity may have been attributed to the differences in duration of the Baduanjin interventions between the two studies and other studies. These results indicate that Baduanjin can improve the gait of patients with PD.

Figure 4 (A) Total UPDRS-III scores after the Baduanjin exercise. (B) Total UPDRS-III scores after the Baduanjin exercise (sensitivity analysis). (C) Subgroup analysis of the UPDRS-III scores after the Baduanjin exercise, according to intervention duration. UPDRS-III, Unified Parkinson’s Disease Rating Scale Part III.

Descriptive analysis
One study presented the data in median (range). Hence, no combined analysis was conducted. The results of this study revealed that Baduanjin can improve the balance and lower limb strength of patients with PD. Furthermore, two studies used TUGT to evaluate the gait. However, due to the high heterogeneity and small number of pooled studies, the source of heterogeneity could not be identified. Hence, a meta-analysis was not conducted. One study used IDEEA gait and

Figure 5 (A) Total FMA-LE scores after the Baduanjin exercise. (B) Total FMA-LE scores after the Baduanjin exercise (sensitivity analysis). FMA-LE, Fugl-Meyer Assessment of Lower Extremity.
other study used Tinetti POMA. In addition, one study used FOG, and another one study used the 10MWT. All these methods were used to assess the gait function, and the results suggest that Baduanjin can improve the gait function of patients with PD. In addition, the study conducted by Zhang et al. used FIM to assess the functional independence, and the results indicated that Baduanjin has a positive effect in improving the functional exercise capacity of patients with PD. The study conducted by Dong et al. used the Balance-check balancer test to assess the balance, and the results revealed that Baduanjin can significantly improve the balance of patients with PD.

Among the 10 included studies, no adverse events were reported, indicating that Baduanjin is a relatively safe exercise for patients with PD. In order to ensure that patients adhered to the intervention programme, except for one study that did not mention the specific measures, the remaining studies conducted centralised training through coaches during hospitalisation or the supervision of family members at home after discharge, and the completion status was reported daily to ensure patient completion of the original protocol.

**Publication bias**

According to the indicators of UPDRS-III, FMA-LE, BBS and 6MWD, the funnel chart was drawn, and the publication bias test was carried out. The results revealed that the figure for each indicator was not completely symmetrical between the left and right, suggesting that the studies may have a certain degree of publication bias (figure 8).

**DISCUSSION**

This study revealed that Baduanjin can reduce the UPDRS-III score, and increase the FMA-LE, BBS and 6MWD scores, indicating that Baduanjin might have a positive effect in improving the motor function, balance function and gait of patients with PD. In addition, the subgroup analysis for UPDRS-III revealed an improvement in motor function for patients with PD, regardless of whether the duration of intervention was ≤8 weeks or >8 weeks.

**Gaps in previous reviews**

The present findings are contrary to Hao’s review, which explored the effects of 10 different exercise interventions on motor function in PD, and revealed that Baduanjin has...
no benefit for patients with PD. This may be correlated to the limited number of studies included in that study (merely three studies). In addition, the conclusions of the present review were similar to those reported by another review, in which Baduanjin practice is beneficial for balance and trunk flexibility. However, that study included a population of healthy or people with different types of diseases.

**Effects of Baduanjin on motor function, balance function and gait**

As a chronic disease, PD has a long course, and is prone to recurrence, which is mainly caused by the progressive degeneration of dopaminergic neurons in the SNpc, the decrease in striatal dopamine and the presence of Lewy bodies. Multiple abnormal neural circuits can lead to balance and gait problems in patients with PD. Gait problems are strongly dependent on impaired balance control, and the poor control of both can cause movement disorders. Levodopa is the main drug for relieving motor symptoms of PD. However, approximately 50% of patients who receive levodopa for long durations would develop levodopa-induced dyskinesia (LID). Speck et al suggested through a mice model that exercise can partially prevent the development of LID, and attenuate the side effects of levodopa through the normalisation of striatopallidal dopaminergic signalling, without affecting the antiparkinsonian effect of levodopa. Hence, this indicates that Baduanjin may induce an effect that enhances the medication efficiency and ameliorates the side effects of levodopa, making this a good CAM for the treatment of PD.

Several large controlled clinical studies have revealed that continuous exercise can improve the performance of daily activities in the early stage of PD, such as balance, gait and movement function, which is consistent with the present findings. The exercise guidelines for PD recommends 20–60 min of moderate-intensity aerobic exercise for 3–5 days a week. Baduanjin, as a moderate intensity aerobic exercise, mainly comprises eight simple left-right symmetrical movements, such as arm raising, shaking of the head, waist rotation and foot flipping. Practicing Baduanjin can fully stretch the joints of the upper and lower limbs, and the movement of the trunk can improve the ability of patients with PD to control their centre of gravity. At the same time, Baduanjin can also improve the proprioception, strengthen the coordination and sensitivity of limbs, and promote the recovery of balance function. Ye et al reported that the upper limb exercise of Baduanjin can enhance the patient’s coordination, and the knee flexion and squat movement can enhance the lower limb flexor and extensor muscle strength and lower limb weight-bearing capacity, further improving the gait ability. This explains the findings reported in the present review.

The muscle tension caused by the uncoordinated contraction of active and antagonistic muscles influence a series of motor symptoms in patients with PD. There is evidence that mind-body exercises, including Tai Chi, Yoga and Qigong, can reduce the contraction of antagonistic muscles. As a kind of mind-body exercise, the long-term practice of Baduanjin can promote blood circulation in the upper and lower limbs, and lower back, strengthened the muscle metabolism and stress function, improve the synergistic contraction of active muscles and antagonist muscles, and promote the recovery of motor function. The α-syn protein is the main pathogenic protein of PD, and its accumulation is the main reason of neuronal loss. Existing studies have revealed that aerobic exercise can reduce the loss of dopaminergic neurons, increase synaptic connections and upregulate neurotrophic factor levels to improve PD dyskinesia. Furthermore, this can downregulate the α-Syn protein levels and neuronal apoptosis, which in turn, can reduce inflammation and mitochondrial dysfunction to restore motor function in patients with PD. Al-Jarrah et al proposed that aerobic exercise can decrease the level of proinflammatory proteins in the striatum in a PD experimental model by reducing the activity of microglia, thereby alleviating PD symptoms. These might be the possible mechanisms for the effect of Baduanjin in improving motor function.

**Limitations and future prospects**

The present systematic review has several limitations. First, this study included patients with PD with Hoehn and Yahr grades of below grade 3 or no reported grade. Hence, the results cannot be extended to patients with PD with Hoehn and Yahr grades 4–5. Second, this study had a relatively high heterogeneity among the literatures, such as different study intervention durations, which might have been the cause for the clinical heterogeneity. Third, merely databases in the English and Chinese language were searched. Hence, it is possible that some researches may have been missed during the database search.
CONCLUSIONS

The present review revealed the potential benefits of Baduanjin in improving the motor function, balance function and gait ability of patients with PD. Therefore, Baduanjin exercise may be taken as a valuable aerobic exercise in clinical rehabilitation for the application of CAM. However, all findings must be interpreted with caution due to limitations in both the quantity and quality of available evidence. Furthermore, additional large, rigorous trials are warranted to better characterise the effects of Baduanjin in PD.

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