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The Effect of 12 Weeks of Cawthorne-Cooksey Exercises on Balance and Quality of Life in Patients with Parkinson's Disease

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Abstract

Background: Parkinson's disease (PD) is known as the second most destructive central nervous system (CNS) disorder, which leads to movement slowness, tremors, decreased balance, instability, and CNS disorders in affected patients. This study aimed to investigate the effect of 12 weeks of Cawthorne-Cooksey exercises on the balance and the quality of life in patients with PD.

Methods: This was a quasi-experimental study, and the research population consisted of PD patients in Zahedan City who were present at the Zahedan Elderly Center during May, June, and July 2022. Twenty-four individuals who were 53 to 69 years old volunteered to participate in this study and were assigned to the experimental (N = 12) and control (N = 12) groups. In addition to the usual treatment, the experimental group performed Cawthorne-Cooksey exercises (CCE) exercises for 12 weeks, while the control group only received the usual treatment during this period. The CCE exercises were performed for 60-minute sessions, three days a week, for twelve weeks. The Berg Balance Scale (BBS) was used to evaluate balance, and the Parkinson's Disease Quality of Life Questionnaire (PDQL 37) was used to assess the QOL of PD. The data were analyzed using Wilcoxon and Mann-Whitney U tests.

Results: The Mann-Whitney U test results revealed that the experimental group exhibited significantly higher scores in all factors of QOL and balance during the post-test when compared to the control group ($P < 0.05$). Moreover, the outcomes of the Wilcoxon test demonstrated significant improvements in all components of QOL and balance for the experimental group from pre-test to post-test ($P < 0.05$), whereas the control group experienced a notable decline in both balance and QOL during the same period ($P < 0.05$).

Conclusion: The study demonstrates that CCE exercises positively influence the balance and quality of life of Parkinson's disease patients, suggesting their potential as complementary therapy in the treatment of PD.

Keywords: Cawthorne-Cooksey Exercises, Parkinson's disease, Quality of life, Balance, Elderly

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Introduction

Parkinson's disease (PD) is one of the most commonly reported conditions among the elderly (1) and is the second most prevalent neurodegenerative disease after Alzheimer's disease (2). Central nervous system (CNS) damage in the vestibular process is accompanied by visual and proprioceptive impairments (which are responsible for maintaining balance), along with a decrease in the capacity for adaptive reflexes. Symptoms such as dizziness and difficulty maintaining balance are characteristic of these disorders. Dysfunctional features in this disease include dopaminergic impairment resulting from the destruction of the substantia

↑What is "already known" in this topic:
The CCE, also known as vestibular rehabilitation exercises, were initially developed to help patients with vestibular disorders. However, these exercises have shown promising results in improving balance and reducing postural instability in patients with Parkinson's disease as well.

→What this article adds:
It provides further evidence that CCE can be beneficial for patients with Parkinson's disease. It highlights the positive impact of these exercises on both balance and quality of life.

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nigra, although the primary cause of this destruction remains unknown. Due to decreased dopamine levels and the resulting disturbance of acetylcholine balance, other centers that control irregular body movements do not function properly, causing motor dysfunction in these patients (3).

Among the most important movement disorders in PD patients are decreased balance, loss of postural control, and progressive reduction in speed and range of movements (4). Postural stability depends on the integration of the vestibular system(VS) (labyrinth, auditory nerve, central nucleus, pathways, and CNS connections) and sensory receptors located in tendons, muscles, joints, and vision (5). Elderly individuals complain more about dizziness than other symptoms, and changes in postural control are one of the main reasons for increased fall risk in this population (6). Increased fall risk can result in fractures, joint dislocations, serious soft tissue injuries, and even death (7). Since falling can impact the function and independence of individuals with Parkinson's disease, identifying and developing diagnostic and therapeutic methods can improve QOL and reduce healthcare costs (8). QOL is one of the most important contemporary issues in healthcare, and for many older individuals, it is as important as lifespan itself.

Given the multifaceted nature of PD, adopting multidimensional approaches in the treatment and control of this disease is recommended (9). Nowadays, pharmacological treatment is the standard therapy for PD, but a decrease in its effectiveness over time has been observed, which may be associated with the development of motor problems related to PD (10). Exercise therapy and rehabilitation methods provide numerous benefits for individuals with Parkinson's disease. They can improve motor symptoms, enhance balance and posture, potentially slow disease progression, offer a non-pharmacological approach, improve quality of life, and enhance overall function and independence. Incorporating exercise therapy and rehabilitation methods into the comprehensive management plan for individuals with Parkinson's disease is essential for optimizing their physical, mental, and social well-being (11-13). So, research findings have shown that in addition to pharmacological interventions, the use of exercise and physical therapy as a complementary treatment method has a positive impact on controlling some of the disease-related symptoms and improving daily functioning (14). Studies have demonstrated that exercise therapy brings about greater benefits in improving the performance of PD compared to medication and surgical treatments (3). Therefore, there is a need for implementing combination therapies such as physical exercises that aid in the control of movement and the reduction of PD progression (15). Studies indicate that the mortality of PD is primarily due to motor impairment and physical weakness rather than the nature of the PD itself (16). Therefore, in such circumstances, PD patients require regular and appropriate physical activities alongside medication to reduce their balance impairments, the risk of frequent falls, and related complications, as well as to prevent disease progression, to improve their QOL, balance, and motor function.

Vestibular rehabilitation is an exercise program that utilizes eye, head, and body movements to stimulate the vestibular system, aiding in the restoration of central compensation. Research has demonstrated the efficacy of vestibular rehabilitation for patients with both central and peripheral vestibular disorders (17). The involvement of the vestibular system in Parkinson's disease is multifaceted, incorporating factors such as degeneration of specific brain structures impacts on postural control, the presence of non-motor symptoms, as well as cognitive and spatial deficits. Understanding the role of the vestibular system in Parkinson's disease is crucial as it can significantly enhance the management and treatment of balance impairments, gait disturbances, and other associated symptoms in individuals with Parkinson's disease (18-20). Cawthorne-Cooksey exercises (CCEs) may serve as support for the reorganization of new environmental sensory information and allow for new patterns of vestibular stimulation to become automatic. CCEs are the most common protocol for vestibular rehabilitation programs, which include activities that target balance centers such as visual, proprioceptive, and vestibular activities. Furthermore, CCEs can be used to enhance the formation of new environmental sensory information (16). However, there are limited studies that have investigated the effects of CCEs on the balance of PD patients (16), and it is currently unclear whether CCEs can play a role in improving balance and QOL in PD. Therefore, this study aimed to investigate the effect of 12 weeks of CCEs on balance and QOL in PD patients.

Methods

This semi-experimental study was approved by the Ethics Committee of the University of Zabol (reference number: IR.UOZ.REC.1400.0023). The research population consisted of PD patients in Zahedan City from the Zahedan Elderly Center during May, June, and July 2022. The sample size was calculated utilizing G*Power software. To achieve a statistical power of 0.80, with an alpha level of 0.05 and an effect size (d = 1), a total sample size of 28 participants was determined (21). Twenty-four individuals who were 53 to 69 years old volunteered to participate in this study and were assigned to the experimental (N = 12) and control (N = 12) groups. All the selected samples completed a written informed consent form. In addition to the usual treatment, the experimental group performed CCEs for 12 weeks, while the control group only received the usual treatment during this period. The patients had idiopathic PD, and their disease severity was at stage 3 on the Yahr & Houn (H&Y) scale (bilateral disease and some difficulty in standing but able to perform daily activities). All participants in the study were under the supervision of a neurologist and took the same medications, such as selegiline tablets, amantadine capsules, etc., with appropriate doses during the exercise period. It should be noted that the exercises were performed on the patients one hour after taking the medications. Inclusion criteria included: 1. Participants with a score of 21 or higher on the MMSE questionnaire; 2. Patients aged between 50 and 70 years; 3. Patients with a Yahr & Houn (H&Y) scale between 2-3; 4. Patients who have not undergone deep brain stimulation or any

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other surgical intervention for Parkinson's disease; 5. Patients who can walk independently; 6. Patients who can communicate effectively with the therapist and follow instructions.

Exclusion criteria included:1. Patients with a history of neurological disorders other than Parkinson's disease; 2. Patients with a history of significant musculoskeletal disorders affecting balance and mobility; 3. Patients with a history of significant cardiovascular or respiratory disorders that may limit exercise tolerance; 4. Patients who have undergone any form of physical therapy or rehabilitation within the past six months; 5. Patients who are unable to attend the scheduled exercise sessions.

The CCEs were performed for 60-minute sessions, three days a week, for twelve weeks. The Berg Balance Scale (BBS) was used to evaluate balance, and the Parkinson's Disease Quality of Life Questionnaire (PDQL 37) was used to assess the QOL of PD patients.

Cawthorne–Cooksey Exercises

A. Eye and Head Movements, in a seated position - Start slowly and then increase the speed:

1- Look up and down.

2- Look left and right.

3- Bring fingers closer and move them away while looking at them.

4- Rotate the head left and right (start slowly and then faster) with your eyes open.

5- Move the head up and down (start slowly and then faster) with your eyes open.

6- Perform movements 4 and 5 with eyes closed as well.

B. Head and Trunk Movements, in a seated position:

1- Place an object on the ground, pick it up, raise it above the head, and place it back on the ground (keep looking at the object throughout the exercise).

2- Perform rotational movements from the shoulder joint.

3- Bend forward and pick up an object placed in front and between the knees.

C. Standing Exercises:

1- Repeat Exercises A and B.

2- Sit down and stand up repeatedly.

3- Rotate to the right while standing up.

4- Rotate to the left while standing up.

5- Throw a small ball from hand to hand (upwards, at eye level).

6- Throw a small ball lower than the knees from one hand to the other and repeat (16).

Berg Balance Scale (BBS)

The BBS is used to assess balance and consists of 14 items. The BBS was found to have high inter-rater (ICC = 0.98) and intra-rater (ICC = 0.99) reliability and high internal consistency (Cronbach's alpha = 0.96) (22). The movement maneuvers of the BBS include the following:

1. Sitting unsupported
2. Maintaining a standing position with your feet apart
3. Maintaining a standing position with your feet together
4. Maintaining a standing position with your eyes closed
5. Standing with one foot in front of the other
6. Standing on one leg
7. Sitting down from a standing position
8. Standing up from the sitting position
9. Transferring from lying down to a sitting position
10. Turning 90 degrees
11. Turning 360 degrees
12. Picking up an object from the floor
13. Reaching forward with arms and transferring weight forward
14. Weight shifting on alternate legs (16).

The Parkinson's Disease Quality of Life Questionnaire (PDQL 37)

PDQL 37 was used to assess the QOL in PD patients, which was designed by De Boer and colleagues (23). This questionnaire consists of four subscales: Parkinsonian symptoms, systemic symptoms, social function, and emotional function. Each question in this questionnaire has five options, which are scored from one (1) to five (5) based on the type of response options: always (1), most of the time (2), sometimes (3), to some extent (4), and never (5), representing the most natural state to the most abnormal state. The questionnaires were completed by a physiotherapist before the first session and after the last exercise session.

Statistical Analysis

Data were analyzed using SPSS Statistics for Windows (Version 21.0; IBM Corp). Since the data are qualitative, non-parametric tests were used for data analysis at a significance level of α=0.05. The Mann–Whitney U test was used to compare two independent groups (experimental and control groups), while the Wilcoxon test was used to compare two dependent groups (pre- and post-test within groups).

Results

The mean and standard deviation of age were 61.6 ± 4.7 years in the control group and 60.2 ± 5.3 years in the experimental group. The duration of illness was 4.12 ± 1.8 years in the control group and 4.35 ± 1.2 years in the experimental group. Additionally, the disease severity based on the H&Y scale was stage 3 in both groups. Before the intervention, the samples in both the experimental and control groups were similar.

The results of the Wilcoxon test showed that there was a significant difference between the pre-and post-test in the experimental group in all QOL subscales (Parkinsonian symptoms, systemic symptoms, social functioning, and emotional functioning) and balance ($P < 0.001$) (Table 1). In the control group, there was a significant difference in the balance subscale, emotional functioning, and overall QOL score from the pre-test to the post-test ($P < 0.05$), but no significant difference was observed in other subscales between the pre-and the post-test. However, it is worth mentioning that the difference from the pre-test to the post-test in the experimental group was positive, meaning that individuals improved in all factors. In contrast, in the control group, this change was negative, indicating a decline in balance and QOL from the pre-test to the post-test (Table 1).

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Table 1. Comparison of pre-test and post-test quality of life and balance of experimental and control groups after 12 weeks of CCE training

		Subscales of PDQL				PDQL	Balance
		Parkinsonian symptoms	systemic symptoms	social function	emotional function		
Control	Pre- test	12.75	12.85	13.30	13.65	13.50	7.75
Wilcoxon test	Post- test	6.80	7.25	7.15	7.70	6.95	6.30
	Z	-1.91	-1.02	-0.24	-2.49	-2.49	-2.00
	p value	0.056	0.301	0.803	*0.009	*0.012	*0.043
Intervention	Pre- test	8.25	8.15	7.70	7.35	7.50	13.25
Wilcoxon test	Post- test	14.20	13.75	13.85	13.30	14.05	14.70
	Z	-2.80	-2.84	-2.80	-2.80	-2.80	-2.82
	p value	*0.005	*0.004	*0.005	*0.005	*0.005	*0.005

*Significant at the level of ($P < 0.05$).

Table 2. Comparison of pre-tests and post-tests of quality of life and balance of two control and experimental groups after 12 weeks of CCE training

		Subscales of PDQL				PDQL	Balance
		Parkinsonian symptoms	systemic symptoms	social function	emotional function		
Pre	Control	12.75	12.85	13.30	13.65	13.50	7.75
	Intervention	8.25	8.15	7.70	7.35	7.50	13.25
	Mann-Whitney U	27.50	26.50	22.00	18.50	20.00	22.50
	Z	-1.70	-1.79	-2.13	-2.39	-2.27	-2.09
	p value	0.08	0.07	*0.033	*0.017	*0.023	*0.037
Post	Control	6.80	7.25	7.15	7.70	6.95	6.30
	Intervention	14.20	13.75	13.85	13.30	14.05	14.70
	Mann-Whitney U	13.00	17.50	16.50	22.00	14.50	8.00
	Z	-2.82	-2.47	-2.54	-2.13	-2.68	-3.19
	p value	*0.005	*0.013	*0.011	*0.033	*0.007	*0.001

*Significant at the 0.05 level ($P < 0.05$).

The results of the Mann–Whitney U test showed that there was a significant difference between the post-test of the two groups in all subscales of QOL (Parkinsonian symptoms, systemic symptoms, social functioning, and emotional functioning) and balance ($P < 0.05$). The experimental group consistently scored higher in all aspects (Table 2). There was a significant difference between the post-test of the two groups in balance ($P = 0.001$), meaning that the experimental group had a better balance. The results also indicate a significant difference between the pre-test of the two groups in social functioning, emotional functioning, and QOL subscales. In all cases, the control group significantly performed better ($P < 0.05$) (Table 2). Additionally, there was a significant difference between the pre-test of the two groups in balance, indicating that the experimental group had significantly better balance ($P <0 .05$) (Table 2).

Discussion

The present study revealed that CCE had a positive and significant impact on Parkinsonian symptoms, systemic symptoms, social function, and emotional function as components of QOL. These exercises also improved balance, which is one of the main symptoms of PD.

The study findings revealed significant improvements in the balance of individuals with PD following CCE, which aligns with the findings of Abarghuei et al. (2018). Their research similarly demonstrated notable enhancements in the balance of patients with PD following CCE (16). Furthermore, our results are consistent with studies by Taherzadeh et al. (2011), Kargarfard et al. (2012), and Akbarpour et al. (2012) that have demonstrated exercise therapy has a positive impact on the balance of PD patients (22, 24-25). The results of the study by Balochi et al. in 2014 showed that CCE can be considered a non-invasive therapeutic approach and an effective factor in improving the ability to perform daily activities, reducing fatigue, and enhancing balance in multiple sclerosis (MS) patients. It is recommended to combine these exercises with medication for multiple sclerosis patients (26). Zahedi and Shafiei (2017) found significant differences in static and dynamic balance in individuals with MS after a period of CCE program. Therefore, the use of this type of exercise program is recommended for improving balance in individuals with MS (27). Afrazsabifar et al. (2018) concluded that compared to Franklin exercises and the control group, CCEs are more effective in improving the balance of MS patients (28). Ghiyami et al. (2016) conducted a study assessing the effect of CCE on the balance of children with spastic cerebral palsy and found that CCE exercises have a positive effect on the balance of children with cerebral palsy. Therefore, CCEs are recommended as a useful method for improving balance in these children (29). The results of this study are consistent with the mentioned studies, but the duration of exercises varied in the different studies, which can affect the intensity of the impact of CCE on balance.

The results of this study demonstrate that CCE had a positive and significant impact on Parkinson's symptoms, systemic symptoms, social function, and emotional function as measured by QOL subscales. The improved indicators of Parkinson's symptoms and systemic symptoms in this study are characterized by signs such as rigidity and stiffness of movements, shuffling gait, difficulties in rising with stability in a sitting position (as PD symptoms), and feelings of fatigue, excessive tiredness, difficulties in walking, and general discomfort (as systemic symptoms) (30). Previous findings emphasizing the negative effects of these symptoms on the QOL of PD patients point to the improvement

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of these symptoms through motor intervention exercises (31). Abarghouei et al. (2018) conducted a study evaluating the effect of CCE on balance and QOL in older adults and found that CCE improved the QOL and balance in individuals aged 60 to 80. Khalaji et al. (2014) have investigated the impact of therapeutic and physical exercises on the QOL in PD. The results of this study have shown that therapeutic and physical exercises, in conjunction with medication, have positive effects on the QOL of PD patients (32). Therefore, the findings of this research are consistent with the results of the studies conducted by Abrooqi et al. (2018) and Khalaji et al. (2014), both of which indicated that exercise therapy improves the QOL in PD and can be considered as a suitable intervention for PD patient (16, 32).

The positive impact of CCE on components of QOL and balance can be explained by the fact that these exercises target the vestibular system. CCEs are part of vestibular rehabilitation exercises that involve the visual control center, proprioception, and the vestibular system (16). This plays a crucial role in maintaining balance and spatial orientation, and dysfunction of this system is commonly observed in individuals with PD. By stimulating the vestibular system through exercises that involve head movements and changes in body position, CCE may help to improve balance and reduce symptoms associated with PD. Additionally, the improvement in QOL components may be due to the overall improvement in physical functioning and reduction in symptoms.

The available medications for treating PD only temporarily improve the symptoms of the disease, and the therapeutic methods that can halt disease progression are still weak (33). Furthermore, because the remaining dopaminergic neurons compensate for the reduction in dopamine levels in the early stages of the disease, the symptoms of the disease often become apparent when approximately 60% of the substantia nigra neurons are lost, and therapeutic methods are employed after this stage. However, due to the severity of the disease, the improvement in conditions is often slow and challenging. Additionally, the emergence of drug resistance leads to further disease progression and limits the outcomes of treatment (34). On the other hand, physical activity leads to increased endogenous antioxidant systems and reduced levels of oxidative damage in the brain. The effects of exercise on PD depend on various factors, including the type, intensity, and duration of the exercise program (35). Intense exercise can increase oxidative stress in the brain, but low-intensity exercise may protect the brain against oxidative damage (36). Therefore, striving to achieve optimal exercise intensity is of particular importance (37). Since this disease can be considered a multidimensional disorder that affects various aspects of patients' lives, efforts to control its associated complications rely on multidimensional approaches to treatment and management. These approaches encompass not only conventional pharmacological and medical treatments but also complementary methods based on rehabilitation, physiotherapy, occupational therapy, speech therapy, and movement therapy (38).

The experts have always emphasized the need for further research on the effect of movement therapy on the control and improvement of PD by showing that movement therapy can be considered as part of therapeutic approaches (39). Therefore, it is recommended to conduct studies to investigate the effect of CCE on the QOL and balance of PD patients and to generalize the results to the Parkinson's community with a larger and separate sample size in terms of gender and different disease severity and to compare with other types of exercises that affect the balance and QOL. In general, considering the results of the present research, CCE can be effective in improving the balance and QOL of patients. Further research regarding the effectiveness and implementation of CCE for PD includes: investigating the long-term effects of CCE on balance and QOL; investigating the impact of CCE on the risk of falls; investigating the potential benefits of combining CCE with other non-pharmacological interventions; comparing the effectiveness of CCE with other exercise interventions in different stages of PD; explore the impact of CCE on other motor symptoms of PD; examine the feasibility and safety of implementing CCE in a group setting for PD; explore the potential benefits of incorporating virtual reality technology into CCE for PD.

Conclusion

This study provides compelling evidence that CCE has a positive and significant impact on the symptoms of PD. The findings demonstrate improvements in balance, which is a major concern for PD patients, as well as various systemic symptoms, social functioning, and emotional well-being as measured by QOL scales. The specific intervention focus, combined with the extended 12-week duration of the exercise program, strengthens the study's ability to provide meaningful insights into the benefits of CCE for individuals with PD. The innovations and strengths of this article, including its patient-centered approach and potential practical application, underscore the importance of incorporating CCE as a valuable complementary therapy in the management of PD. Given the positive outcomes observed, it is highly recommended to integrate these exercises into the daily routine of PD patients to support their rehabilitation and maximize their QOL. Continued research and exploration of exercise therapies, such as CCE, are essential for enhancing our understanding of their effects and implications in the management of PD. By embracing the comprehensive approach presented in this study, healthcare professionals can offer tailored interventions that address not only physical symptoms but also the holistic well-being of individuals with Parkinson's disease.

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Author Contributions

All authors contributed to the idea and initial design, data collection, analysis and interpretation, and manuscript writ-

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ing. All authors have approved the final version of the present article and accept responsibility for the accuracy of the content.

Conflict of Interests
The authors declare that they have no competing interests.

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