

Research Paper



Effectiveness of Cognitive Behavioral Therapy and Aerobic Exercise in Parkinson Disease Dementia: A Pilot Study

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ABSTRACT

Purpose: Parkinson disease is a prevalent neurodegenerative illness of the central nervous system that causes significant disability. Neurological and memory impairments are hallmarks of dementia, which has significant therapeutic implications for patients with Parkinson disease and is associated with elevated mortality. Non-motor symptoms, in addition to the traditional motor symptoms, were commonly acknowledged components of the clinical picture. Cognitive decline, including problems with memory and attention, was a crucial feature of the disease since it adds a great deal of burden to both the patient and caretakers. So, this study aims to find the effectiveness of cognitive behavioral therapy and aerobic exercise on the attention and memory in Parkinson disease dementia.

Methods: A pilot study was conducted with 30 patients diagnosed with Parkinson disease dementia who had mild to moderate impairments in cognitive functions such as attention and memory. The participants were randomly divided into two groups, and the study was conducted in a private setting. Group A (n=15) received cognitive behavioral therapy, and group B (n=15) received aerobic exercise for 6 weeks daily for 30 minutes. Parkinson disease-cognitive rating scale and mini-mental state examination were used as outcome measures.

Results: Cognitive behavioral therapy demonstrated a significantly greater improvement in cognitive functions than aerobic exercise ($P < 0.001$), evidenced by paired and unpaired t-tests.

Conclusion: The study concluded that cognitive behavioral therapy significantly outperforms aerobic exercise in enhancing attention and memory in dementia associated with Parkinson disease. These findings highlight the effectiveness of cognitive behavioral techniques as a key therapeutic intervention for improving cognitive function in this population.

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Highlights

Parkinson disease is the second most prevalent neurodegenerative ailment, and dementia-associated Parkinson disease often impairs memory and attention, affecting daily life and independence.

Attention and memory performance improved significantly in Group A (CBT) compared to Group B (Aerobic exercise).

Non-drug therapies offer a promising approach to supporting cognitive abilities in individuals with Parkinson-related dementia.

Plain Language Summary

This study investigates the effects of two therapies—cognitive behavioral therapy (CBT) and aerobic exercise—on improving memory and attention in people with dementia related to Parkinson disease. It is widely known for affecting movement, but when dementia is also present, it severely impacts memory, thinking, and daily life, adding strain on both patients and caregivers. We divided participants into two groups: Group A received CBT, designed to help people build positive thought patterns, and Group B participated in aerobic exercise, which has well-known benefits for physical and mental health. The results showed that each therapy had unique benefits: Group A (CBT) improved attention and memory compared to Group B (aerobic exercise). These findings highlight a practical, non-medication approach to supporting memory and attention in individuals with Parkinson disease and dementia. This could mean more independence and confidence in handling daily activities for patients. The study shows that CBT and aerobic exercise are accessible, effective tools that enhance patients' and their caregivers' quality of life, demonstrating a meaningful, everyday impact

Introduction

Parkinson disease (PD) is the second most prevalent neurodegenerative disorder after Alzheimer disease. PD affected people of all races and ethnicities worldwide [1]. Globally, Parkinson disease affects approximately 1.51 individuals per 1000 people across all ages [2]; it is estimated that the prevalence of Parkinson disease dementia (PDD) is around 24%–31% [3].

Motor symptoms such as bradykinesia, stiffness, resting tremors, and irregularities in posture and gait were the first signs of PD [4]. Within the discipline of neuroscience, there was increased convergence in research on non-motor abnormalities like autonomic dysfunction, cognitive impairment, and psychiatric symptoms [5]. The features of cognitive impairment in PD can vary considerably in terms of which cognitive domains were affected, as well as in terms of the time of start and rate of development, much like the characteristics of motor symptoms [6]. The cognitive profile in PD had four problems of cognitive impairment: Attention and frontal executive function, memory, visuospatial skills, and language [7].

The cognitive impairment risk factor in PD was age factor (male>female), age of onset (>65), family history, psychiatric features, medication use (deprenyl, amantadine, agonist, anticholinergics, and cumulative exposure to levodopa), which resulted in increased mortality [8]. The investigation of cognitive decline in PD includes cerebrovascular fluid biomarkers, which showed aggregated α -synuclein, increased CSF tau protein, and reduced amount of β -amyloid 1–42 and neuroimaging techniques such as magnetic resonance imaging and Positron emission tomography to detect brain pathology [9].

Dementia is a clinical syndrome characterized by acquired loss of emotional and cognitive abilities and increased mortality compared to non-dementia PD severe enough to interfere with daily functioning and quality of life [10]. Dementia affects 10% to 80% of individuals with PD at age 60, according to community-based studies, while the prevalence was only around 30% [11]. Up to 36% of PD sufferers with a recent diagnosis show cognitive impairment. The impact of dementia on the patient, the caregiver, and the wider community was significant [6]. Dementia and cognitive decline have an important clinical impact on PD [9]. Numerous research studies have conclusively shown their adverse impact on patient quality of life and the burden on care receivers

and caregivers, and specialized therapeutic approaches are needed [12].

Attention is the process of filtering information related to external and internal stimuli modulated by the pre-frontal cortex, which can be classified into simple and complex attention [13]. Memory was not a single, cohesive concept. Instead, various memory systems in different forms are supported by multiple neural systems of brain areas that could save data and access it later [14]. It is an essential physiological function that depends on medial temporal structures and is required for survival [13]. Memory is classified into emotional memory, implicit memory, and explicit memory. The amygdala, hippocampus, and other brain regions are necessary for emotional and explicit memory. The basal ganglia, motor cortex, and cerebellum support implicit memory [7].

Cognitive behavioral therapy (CBT) involves a set of clinical interventions designed to improve non-motor cognitive impairment, such as attention flexibility, memory, and behavior changes. CBT is an efficient, time-limited, cost-effective, and brief treatment. CBT has been designed to treat specific symptoms and behavioral patterns of the patient in as few as 10-20 sessions through assisted therapy programs, group format, self-help materials, and bibliography [15]. The program for CBT enhances the training of the brain's prefrontal executive functions, working memory, and attention [16].

Aerobic exercise (AE) increases fitness, helps maintain good cognitive function, and benefits older people [17]. Additionally, physical activity has advantageous impacts on physiological functions, including glucose management and cardiovascular health, which increases the chance of Alzheimer disease and cognitive decline when impaired [18]. Aerobic exercise impacts cognitive functions such as working memory, inhibition, multitasking, planning, and selective attention, and these effects could be more prominent in older women than in older males. AE improves global cognitive functions such as memory and attention in mild cognitive impairment patients [19, 20].

CBT targets cognitive restructuring and emotional regulation, while AE enhances physical health and neuroplasticity. Comparing these interventions is crucial to determine whether one is superior or combining both yields synergistic benefits for mental health and cognitive functioning. This research will tip off clinicians' evidence-based treatment decisions for optimal patient outcomes.

The research aimed to determine the effectiveness of CBT and AE on memory and attention in patients with dementia-related PD.

2. Materials and Methods

Study design and participants

A pilot study was conducted on PD patients with dementia in a private setting. The study was explained to all 30 participants, and their informed consent was obtained. A total of 30 participants were randomly assigned to groups A (n=15) and B (n=15) using a sealed envelope method. Eligible participants completed a pre-test evaluation, and values were recorded. For 6 weeks, group A received 30 minutes of cognitive behavioral therapy every day, while group B engaged in daily aerobic exercise for the same duration. A post-test outcome measure was recorded following the 6-week intervention.

Inclusion criteria

The inclusion criteria included both genders (male and female), above 60 years of age, at least 5 years of having PDD, mild to moderate cognitive impairment such as memory and attention with a mini-mental state examination (MMSE) score of less than 23, and Parkinson disease-cognitive rating scale (PD-CRS) less than 101, and agreement to cooperate with the treatment and follow up.

Exclusion criteria

The exclusion criteria included age below 60, diagnosis of dementia due to causes other than PD, MMSE score below 10, severe psychiatric disorders, participants with severe motor dysfunction, having cardiovascular disease, and not interested in participating in the study. Outcome measures were the PD-CRS and MMSE.

Assessment measures

Parkinson disease-cognitive rating scale (PD-CRS)

The PD-CRS is a reliable screening tool for identifying PD-related cognitive impairment. It consists of 2 cortical items, clock copying (scores 0–10) and confrontation naming (scores 0–20), and 7 frontal-subcortical items: Working memory (scores 0–10), sustained attention, clock drawing, alternating and action verbal fluencies (scores 0–20 and 0–30, respectively), and immediate and delayed free-recall verbal memory (scores 0–12 for both). All item scores are added up to produce a PD-CRS score

(0–134), which is split into cortical (0–30) and frontal-subcortical (0–104) scores. PD-CRS has demonstrated exceptional clinical utility, high test-retest reliability ($ICC > 0.90$), high inter-rater reliability ($ICC > 0.90$), and strong internal consistency ($\alpha = 0.94$) [21].

Mini-mental state examination (MMSE)

The MMSE consists of 11 items that assess orientation, registration, attention or calculation (spelling or serial sevens), recall, naming, repetition, comprehension (written and verbal), writing, and construction. The total score ranges from 0 to 30, with a 25 or higher representing normal cognitive status. The scores are categorized as follows: Severe (0–17), mild (18–23), and normal (24–30).

The MMSE-I (modified MMSE) has demonstrated exceptional diagnostic accuracy, with a sensitivity of 99.0%–100.0%, specificity of 98.5%–97.0%, and area under the curve of 1.0/1.0. The internal consistency reliability of the MMSE-I was high (the Cronbach $\alpha = 0.70$) [22].

Study procedure

Eligible participants completed a pre-test evaluation, and values were recorded. Group A underwent 30 minutes a day of cognitive behavioral therapy for 6 weeks, and Group B underwent daily aerobic exercise for 6 weeks. A post-test treatment outcome measure was recorded following a 6-week intervention.

Memory and attention adaptation training

Memory and attention adaptation training (MAAT) was a brief CBT aimed at improving cognitive failure, such as memory and attention in daily living, and enhancing the overall quality of life of the patient. MAAT was given through offline mode in the private setting daily for 6 weeks with a session of 30 minutes. MAAT consists of four steps: Education, self-awareness and monitoring, self-regulation, and compensatory strategies.

The first step, education, begins by educating patients about common memory and attention challenges associated with PD and dementia. It highlights how negative thought patterns can impact daily life. It provides an interactive session where patients share specific examples of challenging tasks, such as misplacing items or forgetting appointments. Then, it introduces the concept of cognitive lapses and emphasizes how external distractions or internal stress can interfere with performance.

The education step guides setting small, manageable daily goals, like remembering to take medications on time. It creates a weekly planner for tracking simple tasks and engages patients in cognitive activities such as crossword puzzles and word association exercises. The session is concluded by reflecting on the progress made in recognizing cognitive challenges.

The second step is self-awareness and monitoring. It involves practical exercises and guides patients in identifying internal and external distractions using mock scenarios, such as multitasking while organizing tasks. It teaches the importance of monitoring eating habits and documenting emotions or distractions that affect attention. In this step, templates are provided for tracking meal timings and emotional states, encouraging patients to observe their impact on focus. It assigns a take-home task where patients record two to three memory lapses or attention drifts. Finally, more challenging cognitive activities such as Sudoku or chess are introduced to enhance concentration and engagement.

The third step is self-regulation by teaching relaxation techniques, such as diaphragmatic breathing, to calm the mind encouraging patients to practice slow, deep breathing for 10 minutes daily while focusing on their breath. Then, progressive muscle relaxation is introduced. It targets specific muscle groups to reduce physical and emotional tension. The role of relaxation is discussed in alleviating stress and improving concentration. Patients will practice these techniques and reflect on their effects on emotional regulation and focus during the sessions.

The fourth step is compensatory strategies, comprising memory and attention management. Compensatory techniques are introduced to help patients manage memory and attention challenges better. Then, verbal rehearsal is taught, such as repeating steps aloud while completing tasks like preparing tea. The patients are trained using organizational tools like day planners or calendars to simplify daily routines. It works with patients to plan a mock weekly schedule, incorporating designated time slots for meals, exercise, and relaxation. Training is also provided on digital reminders, alarms, and visual cues to improve task management. Patients will practice setting up these aids on their devices during the session.

Finally, there are integration and goal achievement, consolidation, and reflection. The strategies learned over the past five weeks are reviewed and integrated in this step. Then, patients' most effective techniques are discussed, and personalized adaptations are encouraged for future use. Group-based problem-solving activities

such as collaborative puzzles or memory games are conducted to foster engagement and reinforce learned skills. Ultimately, individual and group achievements are celebrated, and patients are encouraged to maintain these practices in their daily routines.

PD-CRS and MMSE are suitable outcome measures for MAAT due to their specificity, comprehensiveness, and sensitivity to cognitive decline, standardization, brief administration, and vast establishment [23, 24].

Aerobic exercise

Aerobic exercise consists of a 6-week daily session for 30 minutes in a private setting. Aerobic exercise involves the first 5 min for warm-up and gentle stretching targeting specific muscle groups of the upper and lower extremities and 20 min of continuous cycling on a stationary bicycle with maximum speed, which refers to the highest achievable speed by an individual, typically measured in revolutions per minute (RPM) with the initial target of 50% maximum heart rate during the first week (60%-70% RPM) and then increased gradually to 75% by the sixth week (90% RPM). The maximum heart rate is calculated using the formula $220 - \text{Age}$, and the last 5 min is a cool-down period. If the participant has a target heart rate of $<50\%$, alternative strategies like brisk walking and resistance exercises can be considered. The protocol's effectiveness will be assessed through maximum oxygen uptake ($\text{VO}_2 \text{ max}$), muscle strength and endurance, and quality of life (evaluated using the 36-item short-form survey questionnaire).

Results

A sample of 30 was analyzed, data were collected from the participants using PD-CRS and MMSE, and pre-test

and post-test values were noted after CBT and AE intervention. The result showed a $P < 0.001$ and was considered more statistically significant with CBT than AE.

Group A pre-test and post-test values of MMSE (paired t-test)

CBT intervention significantly improved memory and attention in participants, as measured by MMSE (pre-test: 17.8 ± 2.90 , post-test: 27.2 ± 2.64 , $P < 0.001$) (Table 1).

Group B pre-test and post-test values of MMSE (paired t-test)

AE intervention significantly improved memory and attention in participants, as measured by MMSE (pre-test: 17.8 ± 2.90 , post-test: 27.2 ± 2.64 , $P < 0.001$) (Table 2).

Group A and Group B post-test of MMSE (independent t-test)

Both groups showed significant improvements from the pre-test to the post-test. However, group A (CBT) had significantly greater improvements compared to group B (AE) where $P < 0.001$. The effect size calculated is 1.72, indicating a substantial difference between groups A and B (Table 3).

Group A pre-test and post-test values of PD-CRS (paired t-test)

CBT intervention significantly improved memory and attention in participants, as measured by PD-CRS (pre-test: 88.07 ± 4.55 , post-test: 92.07 ± 4.95 , $P < 0.001$) (Table 4).

Table 1. Group A pre-test and post-test values of MMSE

Test	Mean \pm SD	Median	P
Pre-test	18.47 \pm 2.29	18	<0.001
Post-test	27.13 \pm 2.60	27	

MMSE: Mini-mental state examination.

PHYSICAL TREATMENTS

Table 2. Group B pre-test and post-test values of MMSE

Test	Mean \pm SD	Median	P
Pre-test	18.14 \pm 2.77	18	<0.001
Post-test	23.00 \pm 2.52	23	

MMSE: Mini-mental state examination.

PHYSICAL TREATMENTS

Table 3. Group A and Group B post-test values of MMSE

Post-test	Mean±SD	Median	P
Group A	27.13±2.29	18	<0.001
Group B	23.00±2.52	23	

MMSE: Mini-mental state examination.

PHYSICAL TREATMENTS

Table 4. Group A pre-test and post-test values of PD-CRS

Test	Mean±SD	Median	P
Pre-test	86.47±3.96	86	<0.001
Post-test	97.00±4.97	97	

PD-CRS: Parkinson disease-cognitive rating scale.

PHYSICAL TREATMENTS

Group B pre-test and post-test values of PD-CRS (paired t-test)

AE intervention did not significantly improve memory and attention in participants, as measured by PD-CRS (pre-test: 86.47±3.83, post-test: 91.00±22.70, $P=0.47$) (Table 5).

Group A and Group B post-test values of PD-CRS (independent t-test)

Group A significantly improved from pre-test to post-test, while group B did not. There was no significant difference between the groups in post-test scores, indicating that both interventions had similar effects on PD-CRS outcomes where $P=0.93$. The calculated effect size is 0.98, indicating a large effect size and a strong difference between groups A and B (Table 6).

Discussion

The present study assessed the effectiveness of cognitive behavioral therapy and aerobic exercise in memory and attention in dementia-associated PD. Generally, PD is associated with dementia, and patients have impaired cognitive function. The present study also showed improved cognitive function, and CBT was more effective and beneficial than aerobic exercise.

AE's cognitive benefits are less consistent and generalized than CBT, and PDD patients may struggle with AE due to motor symptoms, fatigue, and balance issues. Due to this reason, CBT is considered superior to AE [25, 26].

Our findings are supported by another study indicating that CBT effectively sustains attention among children with specific learning disorders. However, this intervention does not affect working and sustained memory in children with specific learning disorders.

Table 5. Group B pre-test and post-test values of PD-CRS

Test	Mean±SD	Median	P
Pre-test	88.07±4.71	88	=0.034
Post-test	92.07±5.12	93	

PD-CRS: Parkinson disease-cognitive rating scale.

PHYSICAL TREATMENTS

Table 6. Group A and Group B post-test values of PD-CRS

Post-test	Mean±SD	Median	P
Group A	97.00±4.97	97	<0.001
Group B	92.07±5.12	93	

PD-CRS: Parkinson disease-cognitive rating scale.

PHYSICAL TREATMENTS

Previous research reveals that those with long-term breast cancer who had undergone a brief program of CBT to manage the cognitive side effects of chemotherapy report better quality of life, improved daily cognitive function, and performance on neuropsychological tests. Participants reported high levels of treatment satisfaction and assessed MAAT as beneficial for learning and implementing cognitive compensatory methods to enhance abilities to make up for memory issues [27].

According to our research, individuals with mild cognitive impairment (MCI) who engaged in AE show improvement in their overall cognitive function and memory [19]. According to recent studies, AE was used as a practice that was both cost-effective and linked to a variety of physical advantages. According to the study's findings, some people with MCI might also improve cognitively from exercise. For executive control tasks, AE has the strongest cognitive-improving effects in women. The at-risk group's cognitive function could be enhanced with just 6 months of behavioral therapy using periodic increases in heart rate without the expense or side effects of most pharmaceutical treatments [20].

Recent studies show that AE could help older MCI patients with general cognitive performance. Due to the different types, frequencies, and lengths of AE employed in earlier studies, it was still unclear how AE affects MCI patient's general cognition. Large-scale, rigorous, randomized control trials are required to investigate specific effect regions and mechanisms of action to identify the most suitable intervention strategies [28].

The current study found that the PD-CRS is a valid and reliable measure with a high level of specificity and sensitivity for diagnosing MCI and dementia in individuals with PD [21]. We also found that the MMSE cut-off rating 17 has 100% specificity and 81% sensitivity when evaluating cognitive impairment in adults [29].

Negative outcomes may be attributed to insufficient CBT dosage or duration, poor therapist-patient rapport or CBT adherence, and advanced dementia stage, limiting CBT effectiveness.

Conclusion

The study concluded that CBT is more effective than AE in improving attention and memory in individuals with dementia associated with PD. With its structured approach to addressing cognitive and emotional challenges, CBT offers superior benefits in enhancing cognitive functions compared to AE. These results underscore

the importance of integrating therapeutic interventions that focus on cognitive and psychological aspects for managing cognitive impairments associated with dementia in PD. While AE has benefits, CBT should be considered a primary component of therapeutic strategies to improve this population's cognitive function. Future research should explore the mechanisms underlying CBT's effectiveness and investigate potential combined interventions that incorporate both CBT and AE for a more comprehensive approach to managing cognitive symptoms in dementia associated with PD. Cognitive behavioral therapy in PDD improves cognitive function, mood stabilization, and coping mechanisms. Potential negative consequences include emotional distress, therapist-patient mismatch, and insufficient progress.

The study's strengths were that CBT techniques were non-invasive, simple and cost-effective, evidence-based approach, and easily administrated. The limitation of the study was that there was no objective assessment to evaluate cognitive impairment. Further research with larger sample sizes and longer intervention durations is warranted to confirm these findings because the smaller population may impact generalizability, including reduced statistical power to detect significant effects and limited representation of diverse population characteristics.

Ethical Considerations

Compliance with ethical guidelines

The study was done in accordance with the Ethics Committee on Human Experimentation of Institution ISRB No. 01/022/2023/ ISRB/PGSR/SCPT and with the 1975 Declaration of Helsinki, as revised in 2000.

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Authors' contributions

Conceptualization, Methodology, Writing - original draft: Dhanusia. S and Shareen Akbar. A; Investigation, writing, Review, and Editing: Dhanusia. S, Priyadharshani Kumar, and Vanitha Jayaraj; Supervision: Prathap Suganthirababu and Vignesh Srinivasan.

Conflict of interest

The authors declared no conflict of interest.

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