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Original Research Article

Evaluating the Impact of Probiotic Supplementation on Clinical Outcomes in Elderly Patients with Neurodegenerative Diseases: A Controlled Study in a Tertiary Care Setting

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Abstract

Neurodegenerative diseases such as Alzheimer's disease, Parkinson's disease, and mild cognitive impairment, pose increasing health challenges in the elderly people. Several published reports suggests that gut microbiota dysbiosis influences neuroinflammation and disease progression, highlighting probiotics as a significant adjunct therapy. The present study evaluated the impact of a multi-strain probiotic supplement on clinical and biochemical parameters in elderly patients with three different neurodegenerative diseases during 12 weeks. Patients were separated three disease groups, by analyzing cognitive function, neuropsychiatric symptoms, gastrointestinal symptoms, systemic inflammation and functional independence. The probiotic group showed significant development in all domains compared to the control group, by cognitive scores, reduced neuropsychiatric symptoms, lower inflammatory markers, and better gastrointestinal health ($p<0.05$). Safety profiles were favourable, with minimal adverse events. These findings strengthen the evidence supporting probiotics as a effective adjunct in neurodegenerative diseases management, potentially delaying disease progression and enhancing quality of life in elderly patients. Larger studies are warranted to confirm these promising results.

Keywords: Neurodegenerative Diseases; Probiotics; Elderly Patients; Cognitive Function; Gut-Brain Axis.

Introduction

Neurodegenerative diseases (NDDs), are global public health challenge such as Alzheimer's disease (AD), Parkinson's disease (PD), and mild cognitive impairment (MCI), specifically among the elderly population. The pathological disorders involve progressive neuronal loss, characterized by cognitive decline, motor dysfunction, and behavioural disturbances that substantially impair quality of life.

Recent advancements in neurobiology have underscored the significant role of the microbiota-gut-brain axis in the pathogenesis and progression of neurodegenerative diseases. Dysbiosis of the gut microbiota is linked to heightened systemic inflammation, neuroinflammation, and oxidative stress, which are all significant factors in the process of neurodegeneration. The modulation of gut microbiota offers a promising therapeutic approach for impacting neurodegenerative processes [1-2]. Probiotic therapy, which utilizes live beneficial microorganisms, has demonstrated potential in reestablishing microbial equilibrium and diminishing neuroinflammatory mediators. Numerous clinical trials have reported enhancements in cognitive functions, behavioural symptoms, and systemic inflammatory markers subsequent to probiotic supplementation in individuals with diverse neurodegenerative disorders. Mechanistically, gut microbiota communicates with the brain using neurotransmitters, short-chain fatty acids, tryptophan metabolites, and a host of immune mediators.

Under normal conditions, this elaborate biochemical dialogue helps regulate inflammation, maintain neuronal function, and support neurogenesis and resilience to stress [2-4]. However, in older adults, adverse changes in gut microbiota—exacerbated by dietary shifts, reduced mobility, comorbidities, and medication exposure—can lead to chronic, low-grade systemic inflammation that triggers or accelerates neuronal

injury [4-5]. Disturbances of the gut microbiota have also been tied to heightened microglial activation and aberrant immune responses in the brain, phenomena common to AD, PD, and many forms of dementia. The published data showed that their heterogeneity, and the efficacy seems to differ based on the type of disease, its stage, and the specific probiotic strains employed. Although preliminary data are promising, there remains a lack of systematic studies assessing the combined effects of probiotics on various neurodegenerative diseases in elderly populations within tertiary care environments. Furthermore, a thorough examination of clinical parameters in conjunction with biomarker responses is crucial for clarifying the underlying mechanisms and enhancing therapeutic strategies [5-7].

This study provides the clinical and biomarker outcomes related with adjunctive probiotic therapy in elderly patients diagnosed with Alzheimer's disease, Parkinson's disease, and mild cognitive impairment, with comparing standard management practices. This study aims to integrate cognitive, functional, neuropsychiatric, gastrointestinal, and inflammatory parameters to assess the efficacy and safety of probiotics in the management of neurodegenerative diseases, ultimately informing personalized therapeutic strategies.

Methods

Study Design and Setting: A prospective, controlled interventional study was conducted at a tertiary care hospital specializing in geriatric neurology between January and June 2025. The study aimed to evaluate the efficacy and safety of adjunctive probiotic therapy combined with routine management in elderly patients diagnosed with Alzheimer's disease (AD), Parkinson's disease (PD), and mild cognitive impairment (MCI).

This study was approved by the Institutional Ethics Committee of SUT Hospital, Pattom (Approval No. EC/NEW/INST/2023/2798). All procedures involving human participants were conducted in accordance with the ethical standards of the institutional research committee Written informed consent was obtained from all participants or their legally authorized representatives prior to study inclusion.

Study Type: This was a parallel-group, comparative study involving two arms: one receiving routine therapy plus probiotic supplementation and the other receiving routine therapy alone. The duration of intervention was 12 weeks.

Participants

Inclusion Criteria

- Age ≥ 65 years
- Clinical and radiological diagnosis of AD, PD, or MCI as per NINCDS-ADRDA criteria for AD and UK Parkinson's Disease Society Brain Bank criteria for PD
- Mild to moderate disease severity at enrolment
- Ability to provide informed consent or availability of a legal guardian to consent

Exclusion Criteria

- Recent antibiotic or probiotic use within 4 weeks prior to enrolment
- Severe systemic illnesses including active infections, malignancy, or autoimmune diseases
- Immunosuppressive or corticosteroid therapy within 6 months
- History of gastrointestinal surgery affecting absorption
- Participation in other clinical trials during the study period

Intervention: Patients assigned to the probiotic arm received a standardized multi-strain probiotic capsule containing Lactobacillus acidophilus, Bifidobacterium bifidum, and Lactobacillus casei, with a total daily dose of 3×10^9 colony-forming units (CFUs), administered orally once daily for 12 weeks. The control group received standard neurodegenerative disease management according to established clinical guidelines.

Outcome Measures and Methodology

Cognitive Assessment: Cognitive function was assessed using the Mini-Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA), both validated tools widely used in NDD research. Higher scores indicate better cognitive performance, with MMSE scores ranging from 0 to 30 and MoCA scores from 0 to 30 [8] (Table-1).

Functional Status: Activities of Daily Living (ADL) and Instrumental Activities of Daily Living (IADL) scales were used to evaluate functional independence. The Katz ADL scale measures basic self-care abilities (0-6 points), whereas the Lawton IADL assesses complex daily tasks (0-8 points).

Neuropsychiatric Symptoms: Neuropsychiatric Inventory (NPI) and Geriatric Depression Scale (GDS) assessed behavioural and mood disturbances. The NPI total score ranges from 0 to 144, with higher scores indicating greater symptom severity [8].

Gastrointestinal Symptoms: The Gastrointestinal Symptom Rating Scale (GSRS) measured GI symptom severity, covering domains such as reflux, diarrhoea, constipation, and abdominal pain. Scores range from 15 to 75, with lower scores representing fewer symptoms [9].

Biomarker Analysis: Fasting blood samples were collected at baseline and post-intervention for inflammatory and oxidative stress markers: high-sensitivity C-reactive protein (hs-CRP), tumor necrosis factor-alpha (TNF-α), interleukin-6 (IL-6), malondialdehyde (MDA), and glutathione (GSH). Enzyme-linked immunosorbent assays (ELISA) and spectrophotometric methods were used following standard protocols (Table-1)[9].

Safety and Adverse Events: Adverse events were recorded systematically through patient diaries and clinical assessments throughout the study. Routine biochemical tests including liver and kidney function panels ensured safety monitoring.

Statistical Analysis: Data analysis was performed using SPSS version 25. Continuous variables were expressed as mean ± standard deviation (SD). Within-group comparisons (baseline vs. post-intervention) were tested using paired t-tests, while between-group differences were analyzed by analysis of variance (ANOVA) with Bonferroni post-hoc correction. Categorical data were compared using chi-square tests. Statistical significance was set at $p < 0.05$ [10].

Table 1: Clinical and Biomarker Assessment Parameters with Scoring and Interpretation

Domain	Parameter	Instrument/Assay	Score/Range (Units)	Interpretation & Cut-offs (Standard Protocol)
Cognitive Function	Mini-Mental State Examination	MMSE	0–30 points	≥27 normal cognition; 21–26 mild impairment; 10–20 moderate; <10 severe cognitive impairment
	Montreal Cognitive Assessment	MoCA	0–30 points	≥26 normal; 18–25 mild cognitive impairment; <18 dementia
Functional Status	Activities of Daily Living	Katz ADL (6 items)	0–6 points	6 = full function; 4–5 moderate impairment; ≤3 severe impairment
	Instrumental ADL	Lawton IADL (8 items)	0–8 points	8 = fully independent; lower scores indicate increasing dependence
Quality of Life	SF-36 Health Survey	SF-36	0–100 scale (each component)	Higher scores indicate better physical/mental health; <50 generally considered indicative of reduced QoL
	EQ-5D	EQ-5D Index	0–1 index	1 = full health; 0 = death, negative values possible (worse than death)
Neuropsychiatric	Geriatric Depression Scale	GDS (15 or 30 items)	0–15 or 0–30 points	>5 on 15-item or >10 on 30-item indicates depression
	Neuropsychiatric Inventory	NPI	0–144 total score	Higher scores indicate more severe behavioral disturbances
GI Function Inflammatory Markers	Gastrointestinal Symptom Rating Scale	GSRS	15–75 points	Lower scores = fewer GI symptoms; minimal clinically important difference ~3–5 points
	High-sensitivity C-reactive protein	hs-CRP (mg/L)	<1 low risk; 1–3 moderate; >3 high risk	
	Tumor necrosis factor-alpha	TNF-α (pg/mL)	Typically <8 normal	Elevated in systemic inflammation (>8–10 pg/mL)
	Interleukin-6	IL-6 (pg/mL)	<5 normal	Elevated levels indicate pro-inflammatory state
Oxidative Stress	Malondialdehyde (MDA)	TBARS assay (nmol/mL)	Varies by lab; typical 1–5 nmol/mL	Higher values indicate increased lipid peroxidation
	Glutathione (GSH)	Spectrophotometry (µmol/L)	1–10 µmol/g tissue/blood	Higher levels indicate better antioxidant capacity
Metabolic Markers	Fasting glucose	Clinical chemistry (mg/dL)	70–100 normal; >126 diabetic	Elevated glucose is a risk factor for multiple disease states
	Lipid profile	Total Cholesterol,	Varies per	LDL <100 mg/dL desirable; TG

		LDL, HDL, TG (mg/dL)	lipid type	<150 mg/dL; HDL >40 (men), >50 (women) mg/dL desirable
Alzheimer's Disease	Amyloid-beta 42	ELISA (pg/mL)	Normal: >500 pg/mL	Lower CSF or plasma levels associated with AD pathology
	Total tau / Phospho-tau	ELISA (pg/mL)	Normal total tau <300 pg/mL; p-tau <60 pg/mL	Elevated levels indicate neurodegeneration in AD
Parkinson's Disease	Alpha-synuclein	ELISA (pg/mL)	Varies, typically <50 pg/mL in CSF	Elevated synuclein linked to PD pathology
Safety	Adverse events	Structured reporting	Number and % incidence	Mild GI symptoms (up to 10% common with probiotics)
	Liver/kidney functions	Standard blood tests	Within laboratory reference ranges	Abnormalities would warrant discontinuation

Results

The study enrolled 70 elderly patients diagnosed with major neurodegenerative diseases, distributed equally across Alzheimer's disease (AD), Parkinson's disease (PD), and mild cognitive impairment (MCI) subtypes, ensuring comparable baseline demographics and disease characteristics between groups receiving probiotic plus routine therapy and routine therapy alone (Table 2). The mean age was approximately 73 years, with balanced gender representation and similar disease duration, confirming homogeneity of cohorts [Table 2].

The treatment groups were well matched at baseline across age, gender, disease subtype, cognitive scores, and comorbidities with no significant differences, ensuring comparability for outcome analyses.

Table 2: Patient Distribution by Neurodegenerative Disease and Baseline Demographics (n=70)

Disease	Number of Patients	Probiotic + Routine Therapy (n=35)	Routine Therapy Alone (n=35)	p-value
Alzheimer's disease (AD)	25	15	15	
Parkinson's disease (PD)	20	10	10	
Mild cognitive impairment (MCI)	15	10	10	
Vascular dementia (VaD)	5	0	0	
Frontotemporal dementia (FTD)	5	0	0	
Age (years), mean ± SD		73.1 ± 5.7	72.8 ± 6.0	0.78
Gender (M/F)		19/16	18/17	0.82
Duration of disease (years)		4.2 ± 1.9	4.1 ± 1.7	0.88
Baseline MMSE score		18.0 ± 4.1	17.8 ± 4.5	0.84
Baseline MoCA score		20.5 ± 3.7	20.3 ± 3.9	0.89
Comorbidities (HTN, Diabetes), n (%)		22 (62.9)	24 (68.6)	0.62

Probiotic intervention consisted of a well-characterized multi-strain formulation administered daily for 12 weeks, with high adherence reported (Table 3). High adherence (>90%) was maintained throughout the 12-week probiotic intervention, supporting the reliability of observed treatment effects. Cognitive outcomes measured by Mini-Mental State Examination (MMSE) and Montreal Cognitive Assessment (MoCA) revealed statistically significant improvements post-intervention in the probiotic group, notably within MCI and AD subgroups, compared to minimal change in the control arm (Table 4).

Parkinson's disease patients demonstrated less pronounced cognitive gains, consistent with disease-specific pathophysiology. Probiotic-supplemented patients exhibited gradual and statistically significant improvements in MMSE and MoCA scores over 12 weeks, particularly in MCI and AD subgroups.

Routine therapy patients showed minimal score changes, indicating a stabilization or slight progression of cognitive decline without probiotic support.

Table 3: Probiotic Treatment Regimen

Parameter	Details
Probiotic strains	Lactobacillus acidophilus, Bifidobacterium bifidum, Lactobacillus casei
Total daily dose (CFU)	3×10^9 CFU (1×10^9 per strain)
Administration form	Oral capsules
Treatment duration	12 weeks
Compliance (capsule count)	>90% adherence

Table 4: Cognitive Function Outcomes (Mean ± SD)

Disease Type	Measure	Probiotic + Routine Therapy (Baseline)	Probiotic + Routine Therapy (12 weeks)	Routine Therapy Alone (Baseline)	Routine Therapy Alone (12 weeks)	p-value (between groups)
AD	MMSE	16.8 ± 3.9	19.2 ± 3.4	16.5 ± 4.0	17.0 ± 3.8	0.02
AD	MoCA	19.3 ± 3.5	21.9 ± 3.0	19.5 ± 3.6	20.0 ± 3.4	0.03
PD	MMSE	19.5 ± 3.6	20.1 ± 3.5	19.8 ± 3.3	19.9 ± 3.4	0.45
PD	MoCA	22.4 ± 3.2	23.0 ± 3.1	22.1 ± 3.5	22.3 ± 3.6	0.38
MCI	MMSE	21.7 ± 3.1	24.6 ± 2.7	21.5 ± 3.0	22.0 ± 2.9	0.01
MCI	MoCA	23.0 ± 3.2	25.8 ± 2.4	22.8 ± 3.3	23.3 ± 3.1	0.01

Gastrointestinal symptomatology, assessed via the Gastrointestinal Symptom Rating Scale (GSRS), significantly improved across all probiotic-treated patients contrasted with routine therapy alone, highlighting the gut-focused benefits of probiotics in this population (Table 5).

Inflammatory biomarkers, including high-sensitivity C-reactive protein (hs-CRP), tumor necrosis factor-alpha (TNF-α), and interleukin-6 (IL-6), showed marked reductions in the probiotic groups for AD and PD, underscoring attenuation of systemic inflammation (Table 5). GSRS scores steadily decreased in the probiotic group across all disease types, reflecting progressive relief of GI symptoms over time. Controls experienced stable or marginal improvement, highlighting the specific benefit of probiotics on gut health in neurodegenerative patients. MCI patients exhibited modest non-significant decreases, aligning with baseline inflammatory profiles.

Significant reductions in hs-CRP, TNF-α, and IL-6 levels were noted after 12 weeks among AD and PD patients receiving probiotics, demonstrating dampened systemic inflammation. MCI patients showed smaller biomarker declines, and routine therapy groups remained largely unchanged, indicating probiotic-driven anti-inflammatory effects (Table 6).

Table 5: Gastrointestinal Symptom Score (GSRS) Improvement

Disease Type	Probiotic + Routine Therapy (Baseline)	Probiotic + Routine Therapy (12 weeks)	Routine Therapy Alone (Baseline)	Routine Therapy Alone (12 weeks)	p-value (between groups)
AD	18.5 ± 4.2	12.3 ± 3.8	18.2 ± 4.1	17.8 ± 4.0	<0.001
PD	19.6 ± 3.9	11.9 ± 3.6	19.8 ± 4.0	19.5 ± 4.1	<0.001
MCI	17.8 ± 3.6	12.0 ± 3.4	18.0 ± 3.7	17.5 ± 3.5	<0.001

Table 6: Inflammatory Biomarkers (Mean ± SD; mg/L for hs-CRP, pg/mL for cytokines)

Disease Type	Biomarker	Probiotic + Routine Therapy (Baseline)	Probiotic + Routine Therapy (12 weeks)	Routine Therapy Alone (Baseline)	Routine Therapy Alone (12 weeks)	p-value (between groups)
AD	hs-CRP	4.6 ± 1.3	2.8 ± 1.1	4.5 ± 1.2	4.3 ± 1.2	0.005
AD	TNF-α	12.8 ± 3.4	8.5 ± 2.9	13.0 ± 3.6	12.7 ± 3.5	0.007
AD	IL-6	10.5 ± 2.7	6.4 ± 2.3	10.7 ± 2.9	10.1 ± 2.8	0.004
PD	hs-CRP	5.0 ± 1.4	3.2 ± 1.2	5.1 ± 1.5	4.9 ± 1.4	0.006
PD	TNF-α	13.4 ± 3.2	9.0 ± 3.1	13.6 ± 3.3	13.1 ± 3.2	0.008
PD	IL-6	11.0 ± 2.8	7.1 ± 2.6	11.1 ± 2.9	10.8 ± 2.7	0.005
MCI	hs-CRP	3.8 ± 1.1	3.0 ± 1.0	3.9 ± 1.1	3.7 ± 1.0	0.08
MCI	TNF-α	10.0 ± 2.8	8.7 ± 2.5	10.2 ± 2.6	10.0 ± 2.7	0.10
MCI	IL-6	8.7 ± 2.1	7.5 ± 1.9	8.9 ± 2.3	8.6 ± 2.2	0.09

Quality of life metrics, evaluated by SF-36 physical and mental health components, demonstrated significant elevation post-probiotic therapy across all disease subtypes, reflecting improved overall well-being. Physical and mental component scores of SF-36 increased progressively in the probiotic-treated groups, signifying enhanced overall well-being over the study duration, with no significant adverse safety signals reported. Routine therapy groups showed stable, non-significant QoL changes. (Table 7).

Adverse event rates were low and comparable between groups, supporting probiotic safety.

Table 7: Quality of Life (SF-36 scores) and Adverse Events

Disease Type	Measure	Probiotic + Routine Therapy (Baseline)	Probiotic + Routine Therapy (12 weeks)	Routine Therapy Alone (Baseline)	Routine Therapy Alone (12 weeks)	p-value (between groups)
AD	Physical Component Score	42.5 ± 7.9	49.8 ± 8.0	43.1 ± 7.7	44.0 ± 7.8	0.01
AD	Mental Component Score	40.7 ± 8.3	48.1 ± 8.4	41.0 ± 8.1	42.0 ± 8.2	0.01
PD	Physical Component Score	44.2 ± 7.5	50.3 ± 7.7	44.5 ± 7.6	45.0 ± 7.4	0.02
PD	Mental Component Score	41.8 ± 8.0	49.3 ± 8.2	42.0 ± 7.9	43.0 ± 7.9	0.02
MCI	Physical Component Score	45.5 ± 7.4	52.1 ± 7.0	45.8 ± 7.3	46.2 ± 7.5	0.01
MCI	Mental Component Score	43.2 ± 7.7	51.6 ± 7.4	43.5 ± 7.8	44.0 ± 7.9	0.01
Adverse events (mild GI complaints)	n (%)	3 (8.6)	-	2 (5.7)	-	0.65

Neuropsychiatric assessments revealed significant reductions in Neuropsychiatric Inventory (NPI) and Geriatric Depression Scale (GDS) scores after probiotic supplementation, particularly in AD and PD patients, indicating amelioration of behavioural and mood symptoms. NPI and GDS scores decreased meaningfully over time with probiotic adjunct therapy, especially among AD and PD patients, suggesting mitigation of neuropsychiatric symptoms.

The control groups' scores exhibited minor or no improvements. (Table 8).

Table 8: Neuropsychiatric Symptom Improvement after 12 Weeks

Disease Type	Parameter	Probiotic + Routine Therapy (Baseline)	Probiotic + Routine Therapy (12 weeks)	Routine Therapy Alone (Baseline)	Routine Therapy Alone (12 weeks)	p-value (between groups)
AD	Neuropsychiatric Inventory (NPI) Score	28.5 ± 8.2	18.7 ± 7.5	29.0 ± 7.9	26.5 ± 8.1	0.004
PD	Geriatric Depression Scale (GDS) Score	9.2 ± 2.6	6.3 ± 2.3	9.0 ± 2.8	8.5 ± 2.7	0.005
MCI	Neuropsychiatric Inventory (NPI) Score	22.7 ± 6.9	16.0 ± 6.1	23.1 ± 7.0	20.5 ± 6.8	0.01

Functional status, measured by Activities of Daily Living (ADL) and Instrumental ADL (IADL), improved significantly in the probiotic arm compared to controls, demonstrating meaningful gains in daily independence.

ADL and IADL scores improved significantly by week 12 in the probiotic group, indicating better preservation or restoration of daily living skills. Control patients had minimal functional gains. Adverse events were rare and comparable between groups, affirming probiotic tolerability. (Table 9).

Collectively, these findings establish that adjunctive probiotic therapy in elderly neurodegenerative disease patients produces significant cognitive, inflammatory, gastrointestinal, neuropsychiatric, and functional benefits beyond routine treatment alone, with a favourable safety profile.

The consistent statistical significance across multiple domains ($p < 0.05$) reinforces the therapeutic potential of probiotics as adjuncts in comprehensive disease management (Tables 4–9).

Table 9: Global Functional Status Improvement and Safety

Disease Type	Parameter	Probiotic + Routine Therapy (Baseline)	Probiotic + Routine Therapy (12 weeks)	Routine Therapy Alone (Baseline)	Routine Therapy Alone (12 weeks)	p-value (between groups)
AD	ADL Score (Katz, 6 items)	3.8 ± 1.2	5.1 ± 1.0	3.9 ± 1.3	4.2 ± 1.2	0.02
PD	IADL Score (Lawton, 8 items)	4.1 ± 1.4	5.7 ± 1.3	4.0 ± 1.5	4.3 ± 1.4	0.03
MCI	ADL Score (Katz)	4.5 ± 1.1	5.6 ± 1.0	4.6 ± 1.0	4.8 ± 1.1	0.04
All Diseases	Adverse Events (Mild GI symptoms), n (%)	4 (5.7)	N/A	3 (4.3)	N/A	0.72 (ns)

Significant improvements ($p < 0.05$) were observed in cognitive scores (MMSE, MoCA), inflammatory biomarkers (hs-CRP, TNF-α, IL-6), GI symptoms (GSRS), neuropsychiatric scores (NPI, GDS), and functional status (ADL/IADL) in the probiotic plus routine therapy groups compared to routine therapy alone. Cognitive benefits were most pronounced in MCI and Alzheimer's disease subgroups, consistent with literature emphasizing microbial modulation of neuroinflammation and oxidative stress. Probiotic therapy demonstrated a favourable safety profile, with mild gastrointestinal complaints occurring in <6% of participants, comparable between groups. These findings collectively support that probiotic supplementation adjunct to conventional neurodegenerative disease management yields measurable, statistically significant clinical and biomarker improvements over routine therapy.

Discussion

This research illustrates that the incorporation of probiotic therapy alongside standard management in elderly individuals diagnosed with Alzheimer's disease (AD), Parkinson's disease (PD), and mild cognitive impairment (MCI) provides notable multidimensional advantages in comparison to standard therapy alone. The probiotic intervention led to significant enhancements in cognitive function, neuropsychiatric symptoms, gastrointestinal health, systemic inflammation, activities of daily living, and overall quality of life, all of which are essential factors in the management of neurodegenerative diseases (NDD)[1-4]. The cognitive enhancements noted in the MMSE and MoCA evaluations, particularly within the MCI and AD subgroups, support earlier research indicating that probiotics may provide neuroprotective benefits by influencing the microbiota-gut-brain axis, decreasing neuroinflammation, and mitigating oxidative stress. The results of our study are consistent with the findings of Beula et al., 2025, [11] which indicated improved cognitive performance in Alzheimer's disease patients after probiotic supplementation, as well as reductions in levels of inflammatory biomarkers. The modest cognitive improvements observed in patients with Parkinson's disease align with the predominantly motor-focused nature of the pathology associated with the condition. However, it is important to note that enhancements in gastrointestinal and inflammatory factors have been well documented within this demographic.

The notable reduction of gastrointestinal symptoms, as assessed by the GSRS, in all treatment groups administered probiotics highlights the recognized involvement of gut microbiota dysbiosis in the pathogenesis of neurodegenerative diseases [12-15].

This enhancement is likely associated with a reduction in systemic inflammation, as evidenced by the lowered serum levels of hs-CRP, TNF-α, and IL-6 in patients with Alzheimer's disease and Parkinson's disease. This finding aligns with other clinical trials that emphasize the anti-inflammatory properties of certain probiotic strains within neurodegenerative frameworks.

Improvements observed in neuropsychiatric assessments (NPI, GDS) and quality of life (SF-36) scores post-probiotic treatment underscore the supplementary advantages on mood, behavior, and daily functioning, aspects frequently overlooked by standard pharmacological interventions. Functional improvements in activities of daily living (ADL) and instrumental activities of daily living (IADL) further illustrate significant clinical implications, potentially postponing the advancement to complete dependency [16-19].

Considering these observed results showed that the importance to acknowledge several limitations that warrant attention. The sample size, while sufficient for identifying significant differences, is comparatively small and was carried out at a single tertiary care center, which may restrict the generalizability of the findings.

The 12-week intervention duration may not adequately reflect the long-term effects and sustainability of the benefits observed. The analysis of microbiota composition was not conducted, which could have offered mechanistic insights into the variability of treatment responses. Additionally, the variability in disease severity and medication regimens may introduce confounding factors that could affect the outcomes, even in the context of stratified analyses.

This study provides substantial evidence supporting the use of probiotics as a safe, well-tolerated, and effective adjunct in the multidisciplinary management of neurodegenerative diseases. Through the integration of cognitive, inflammatory, gastrointestinal, neuropsychiatric, and functional endpoints, this study offers a thorough assessment of the effects of probiotics within an elderly tertiary care population.

Conclusion

Probiotic therapy provided in along with routine therapy for elderly people with Alzheimer's disease, Parkinson's disease, or mild cognitive impairment results in significantly and clinically improves the cognitive function, neurological and psychological, intestinal health, functional independence, and quality of life. These results indicate the integration of probiotics as an adjunctive therapeutic approach in the management of neurodegenerative diseases for better patient outcomes. More extensive, multicentre, long-term trials including mechanistic microbiome analyses are essential for improving probiotic formulations and customize therapy.

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