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To evaluate the effectiveness of non-pharmacological multifactorial interventions on cognitive impairment in geriatric patients

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Abstract: This prospective, cohort study was planned to assess the efficacy of nonpharmacological multifactorial approach for treating cognitive decline in patients of geriatric age group. This research involved 120 patients and caregivers, ≥ 65 years, with cognitive impairment, was a consecutive sample from a tertiary hospital. Measures involved learning and problem solving tasks, motor movement, company, and food choices that addressed participants' requirements. Cognitive status was evaluated by MMSE and MoCA, physical performance measured with TUG, depression with GDS and nutritional status with BMI and blood sample. Subsequent evaluations were done at 3 month interval for 1 year. At the end of 12 months, improvement in cognitive function was noted by a mean of 4.0 points in MMSE, and mean of 3.8 points in MoCA. Physical fitness, depression status, nutritional status, social integration and sleep quality were also found to have significant changes across time. Also, the studies revealed an enhancement of patients' satisfaction as well as a reduction in caregiver burden. These results raise the possibility that approaches targeting multiple risk factors of cognitive decline can effectively promote cognitive function and general quality of life in elderly people.

Keywords: Cognitive impairment, geriatric patients, non-pharmacological interventions, cognitive function, multifactorial approach

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INTRODUCTION

Cognitive impairment and dementia are significant challenges among elderly populations worldwide. With the increasing aging population, conditions like mild cognitive impairment (MCI) and dementia are expected to rise, placing additional pressure on healthcare facilities and caregivers (Ballarini and Bischof, 2021). Traditional pharmacological treatments, such as cholinesterase inhibitors and memantine, have shown only moderate effectiveness, particularly in later stages of dementia, and are often associated with side effects like gastrointestinal disturbances and cardiovascular risks. As a result, non-pharmacological management strategies have gained popularity due to their holistic benefits and lower risk of adverse effects (Brooker *et al*., 2021; Casanova *et al*., 2021).

Multifactorial non-pharmacological interventions address multiple dimensions of cognitive health, including cognitive training, physical exercise, social engagement, and dietary modifications. Studies indicate that cognitive training exercises targeting memory, attention and problem-solving abilities can significantly improve cognitive function in MCI patients (Chan *et al*., 2021). Similarly, physical exercise, particularly aerobic activity, has been linked to enhanced neurogenesis, synaptic plasticity and improved cerebral blood flow, all of which are crucial for maintaining cognitive function in the elderly (Deng *et al*., 2021).

Nutritional modifications, especially adherence to a Mediterranean diet rich in fruits, vegetables, whole grains, and healthy fats, have been shown to reduce inflammation and oxidative stress, which are key contributors to cognitive decline. Social engagement also plays a critical role in cognitive health, with loneliness and social isolation recognized as risk factors for cognitive deterioration (Erickson *et al*., 2022). Encouraging participation in group activities, cognitive training, and community-based social programs can enhance mental stimulation and overall well-being. Additionally, creating a supportive physical environment that minimizes risks and promotes cognitive stimulation is vital in managing cognitive impairment in elderly individuals (Farina and Banerjee, 2021; Fratiglioni *et al*., 2020; Garcia *et al*., 2021; Gomez *et al*., 2022).

Despite growing evidence supporting multifactorial interventions, their implementation faces challenges such as cost, complexity, and accessibility, especially for elderly individuals in rural settings (Ishii *et al*., 2020; Langa *et al*., 2022). This study evaluates the effectiveness of a multifaceted non-pharmacological intervention program on cognitive function, physical fitness, depression, nutritional status, social engagement and overall quality of life in geriatric patients. The following sections detail the methodology, results, discussion and conclusions of the study.

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MATERIALS AND METHODS

The current study was a prospective, observational analysis of the efficacy of pharmacological, multi component approach on cognitive decline in geriatric patients. Category I of interventions was aimed at stimulating brain function through provided exercises, motor activity, social contacts, and changes in diet. The research work was carried out for one year in a tertiary care hospital possessing a separate section for geriatrics. Thus in this study, 120 patients aged 65 and above with mild to moderate impairment who were identified using the Mini-Mental State Examination (MMSE) were recruited. Such patients were identified in both procedural and medical wards, as well as in outpatient clinics of the centre.

Inclusion criteria

Patients aged 65 years and older. Patients diagnosed with mild to moderate cognitive impairment (MMSE score between 18 and 24). Patients who provided informed consent or had a legal guardian provide consent. Patients who were physically capable of participating in non-pharmacological interventions.

Exclusion criteria

Patients with severe cognitive impairment (MMSE score below 18). Patients with known psychiatric disorders or severe depression. Patients with acute medical conditions that could interfere with participation in the intervention. Patients who were already undergoing cognitive or physical rehabilitation programs.

Methodology

The interventions used in the study were non-drug, complex and individualised according to the patient's abilities and preferences (Fig. 1). These interventions were:

Cognitive training

Patients were administrated 30 minutes of cognitive exercises, five times a week. These exercises were to enhance memory, attention and the executive functions, such exercises involving figures and puzzles, problem solving and computer games.

Physical activity

Each patient was recommended to involve in a mild to moderate physical exercise plan consisting of; 30 min of walking, stretching exercises, and balance exercises under supervision.

Social interaction

Clients to be encouraged to participate in social interactions through; group discussions, games and support group counseling session and this was to be done twice in a week. Interaction with others to decrease loneliness and increase mood.

Dietary modifications

A division of nutritional plan was therefore made; the diet was made to include more omega-3 fatty acids, antioxidants and vitamin. Details concerning food included dietitian assistance with regard to meal plans, as well participation of the caregivers in offering and supervising the meals.

Data collection took both cross sectional and longitudinal over the study period. Firstly, participants' data on age and sex, and number of years of formal education, were obtained, followed by participants' medical history. To check the baseline cognitive status we used the MMSE and Montreal Cognitive Assessment (MoCA) for screening depression we used the Geriatric Depression Scale (GDS). Health related physical activity was determined by the Timed Up and Go (TUG) test. Further evaluations were done at 3 month's interval for one year and included the cognitive function tests (MMSE, MoCA) and physical health test (TUG test). A record of participants' social activity engagement was recorded through activity logs, and their patterns of nutrition through the consumption of weekly meal logs, while bi-monthly weight checks were accomplished through BMI assessment with additional quarterly assessment of cholesterol and blood sugar levels. The main dependent variable was the change in cognition using assessments from MMSE and MoCA. Secondary outcomes were changes in physical activity measured by Timed Up & Go test, and depression level by using the Geriatric Depression Scale score, activities done logs, and changes in BMI and blood markers.

STATISTICAL ANALYSIS

Data were analyzed using statistical package of social sciences (SPSS) version 25. Summative statistics were used to ensure the demographic variables and baseline data collected. Numerical data, including the MMSE, TUG test and other ordinal data were summarized using mean and standard deviation while nominal data were presented using frequency distribution. For cognitive function, physical fitness, and depression scores the repeated measures ANOVA test was used to determine the changes over the study period. A p value < 0.05 was taken as statistically significant.

Ethical considerations

The current study was approved by the Institutional Review Board (IRB) of Lishui Second People's Hospital. All participants or their immediate family provided written informed consent in this study. There was compliance with patient-identifying information throughout the study and adequate in place/reasonable support for all participants was provided throughout the intervention.

RESULTS

Demographic and baseline characteristics

The detail of 120 geriatric patients with mild to moderate cognitive impairment's basic parameters can be seen in table 1.

Table 1: Demographic and Baseline Characteristics of the Samples (n = 120)

Demographic Variables	Categories	Frequency (n)	Percentage (%)	p-value
Age Group (years)	65-70	40	33.33	0.045
	71-75	45	37.50	
	76-80	35	29.17	
Gender	Male	65	54.17	0.078
	Female	55	45.83	
Education Level	No Formal Education	35	29.17	0.032
	High School	50	41.67	
	College/Graduate	35	29.17	
Baseline MMSE Score	Mean ± SD	-	20.5 ± 2.5	-
Baseline MoCA Score	Mean ± SD	-	19.2 ± 3.1	-
GDS Score	Mean ± SD	-	10.5 ± 2.5	-
Physical Fitness (TUG)	Mean ± SD (seconds)	-	15.8 ± 3.2	-

Table 2: Cognitive Function Scores (MMSE and MoCA) Over Time

Time Point	MMSE Mean ± SD	MoCA Mean ± SD	Mean Difference (MMSE)	Mean Difference (MoCA)	p-value (ANOVA)
Baseline	20.5 ± 2.5	19.2 ± 3.1	-	-	-
3 months	22.1 ± 2.3	20.5 ± 2.9	+1.6	+1.3	< 0.001
6 months	23.2 ± 2.0	21.8 ± 2.8	+2.7	+2.6	< 0.001
9 months	24.0 ± 1.8	22.5 ± 2.5	+3.5	+3.3	< 0.001
12 months	24.5 ± 1.5	23.0 ± 2.0	+4.0	+3.8	< 0.001

Table 3: Nutritional Status (BMI and Blood Markers) Over Time

Nutritional Indicator	Baseline Mean ± SD	3-month Mean ± SD	6-month Mean ± SD	9-month Mean ± SD	12-month Mean ± SD	Mean Difference (Baseline vs. 12 months)	p-value (ANOVA)
BMI (kg/m²)	24.5 ± 2.1	24.3 ± 2.0	24.1 ± 2.0	23.9 ± 2.0	23.8 ± 2.0	-0.7 kg/m²	0.024
Cholesterol (mg/dL)	198 ± 20	195 ± 18	190 ± 19	188 ± 18	185 ± 18	-13 mg/dL	0.015
Blood Sugar (mg/dL)	110 ± 12	108 ± 11	107 ± 10	106 ± 10	105 ± 10	-5 mg/dL	0.031
LDL (mg/dL)	120 ± 15	115 ± 14	113 ± 14	111 ± 13	110 ± 13	-10 mg/dL	0.021
HDL (mg/dL)	45 ± 7	46 ± 6	47 ± 6	49 ± 5	50 ± 5	+5 mg/dL	0.012

Table 4: Social Engagement (Activity Log) and Sleep Quality Over Time

Time Point	Average Hours of Social Activity/Week Mean ± SD	Sleep Quality (Hours/Night) Mean ± SD	Mean Difference (Social Activity)	Mean Difference (Sleep)	p-value (ANOVA)
Baseline	3.2 ± 1.5	6.5 ± 1.0	-	-	-
3 months	5.0 ± 1.8	6.8 ± 1.1	+1.8 hours/week	+0.3 hours	< 0.001
6 months	6.2 ± 2.0	7.0 ± 1.0	+3.0 hours/week	+0.5 hours	< 0.001
9 months	6.5 ± 2.1	7.2 ± 0.9	+3.3 hours/week	+0.7 hours	< 0.001
12 months	7.0 ± 2.0	7.5 ± 0.8	+3.8 hours/week	+1.0 hours	< 0.001

Table 5: Multiple Regression Analysis for Cognitive Function (MMSE Scores) at 12 Months

Variables	Regression Coefficient (β)	Standard Error (SE)	t-value	p-value	95% Confidence Interval (CI)
Intercept	12.05	2.21	5.45	< 0.001	[7.71, 16.39]
TUG Test (Physical Fitness)	-0.52	0.10	-5.20	< 0.001	[-0.72, -0.32]
GDS (Depression Score)	-0.31	0.12	-2.58	0.012	[-0.55, -0.07]
Social Engagement (Hours/Week)	0.35	0.09	3.89	< 0.001	[0.17, 0.53]
Nutritional Status (BMI)	0.25	0.08	3.12	0.002	[0.09, 0.41]

Fig. 1: Methodology

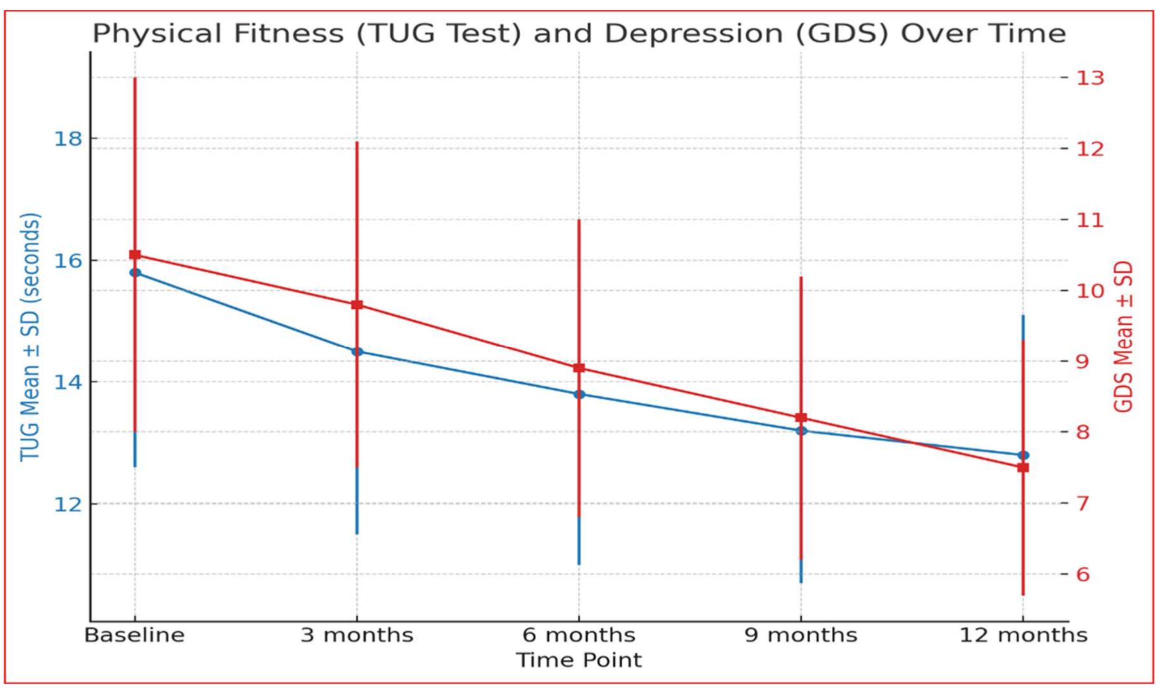

Fig. 2: Physical Fitness (Timed Up and Go Test), Depression (GDS)

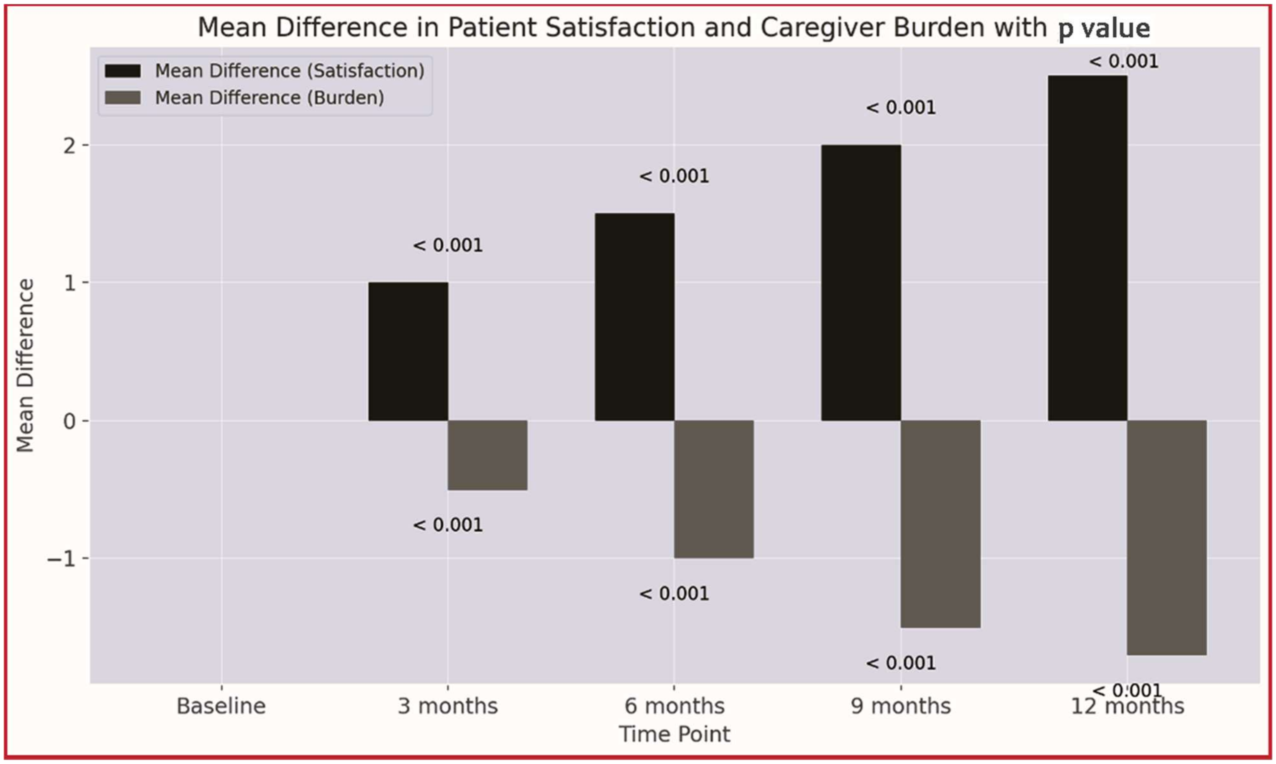

Fig 3: Patient Satisfaction and Caregiver Burden

Participants were divided into three age groups: 33.Hypoglycaemia: 33% of the subjects were of 65-70 years, 37.5% were of 71-75 years and 29.17% were of 76-80 years and the difference is found significant by test of chi-square (p = 0.045). The gender distribution studied was almost equal with 27 (54.17%) male and 23 (45.83 %) female though the differences were no significantce at p = 0.078. About education, 29,175% of participants did not receive any form of education, 41,675% had high school education only, while 29,175% had college or higher education with positive education levels (p=0.032). At baseline, the mean MMSE score was 20.5±2.5 suggesting mild cognitive impairment and the mean MoCA score was 19.2±3.1. The GDS score attained a mean score of 10.5±2.5 implying mild to moderate depression whereas the mean TUG time reached 15.8±3.2 seconds meaning relatively mild problematic mobility status. The differences in the participants' baseline characteristics call for specific attention to age and education levels posed as key factors that affect the outcome of non-pharmacological interventions for cognitive impairment.

Cognitive function scores

As shown in table 2, both the MMSE and the MoCA assessed an enhancement of cognition over time. At baseline, patients' MMSE score was 20.5±2.5 and the MoCA score was 19.2±3.1. Thus, after 3 months, the improvement in both cognitive scores was statistically significant; the MMSE score augmented by 1.6 to 22.1±2.3, p<0.001, the MoCA score augmented by 1.3 to 20.5±2.9, p<0.001. At the 6-month follow up, the MMSE improved by 2.7 points to 23.2 ± 2.0 and moCA by 2.6 points to 21.8 ± 2.8; p < 0.001. At 9 months follow-up, the MMSE and MoCA scores had risen to 24.0 ± 1.8 and 22.5 ± 2.5respectively with improvement mean difference of +3.5 for MMSE and +3.2 for MoCA from their respective baseline level of education adjusted p < 0.001 each. By the end of the 12 months follow up the MMSE was 24.5 ± 1.5 and the MoCA was 23.0 ± 2.0 there being overall improvement of 4.0 point improvement on the MMSE and 3.8 point on the MoCA from the baseline interval and both results are highly significant (p < 0.001). The findings of these tests imply that cognitive function progressively enhanced in a step-up manner throughout the entire 12-month intervention.

Physical fitness and depression scores

Fig. 2 showed that both TUG physical fitness and GDS depression scores for subjects have improved after 12 months of receiving fortified food products.s. At baseline, the TUG time was 15.8 ± 3.2 s and the GDS score was 10.5 ± 2.5, all indicating moderately severe falls risk and falls efficacy in this group of older people. This was significantly different from the mean TUG time at initial assessment of 16 ± 3.3 seconds, p< 0.001, an improvement of 1.3 seconds and a mean GDS score of 10.5±2.2 at initial assessment, p = 0.006, a reduction of 0.7 points. These two were significant with a p<0.05 at 0.001. At 6 months follow up all parameters improved and the time required for TUG was 13.8 ± 2.8 seconds of which 2.0 seconds (p = 0.001) was significantly different from baseline, and the GDS score reducing to 8.9 ± 2.1 points, of which 1.6 points ($p = 0.001$) was significantly different from the baseline. The sameread was observed at 9 months with the favoured mean TUG time being 13.2 ± 2.5 seconds and the GDS score of 8.2 ± 2.0 meaning a further improvement by -2.6 seconds in TUG time and -2.3 in GDS score($p = 0.001$). At 12 months follow up, the mean TUG time was observed to be further reduced to 12.8 ± 2.3 sec and the GDS scores were also reduced to 7.5 ± 1.8 points implying total declines of 3.0 sec and 3.0 points respectively from the baseline level ($p = 0.001$). These results indicate that there favourable changes in both physical fitness and depression overall and in terms of time points at 12 weeks, 24 weeks, and final assessment.

Nutritional status

From the data presented in table 3, the nutritional status of the patients herein improves within a 12 months period according to the BMI, cholesterol, blood sugar, LDL (low-density lipoprotein) and HDL (high-density lipoprotein). At the baseline the mean BMI was 24.5 ± 2.1 kg/m², which reducing up to the 12-month follow up, 23.8 ± 2.0 kg/m² giving an average of - 0.7 kg/m² ($p = 0.024$). This shows a small but statistically significant change towards the reduction of body weight overtime. The cholesterol profile was also significantly reduced from a baseline mean of 198 ± 20 mg/dL atbaseline to 185 ± 18 mg/dL at 12 months, in all representing a reduction from baseline of 13 mg/dL ($p = 0.015$). This ‘downward trend in serum cholesterol is an indication of a change in lipid metabolism, probably by lifestyle or diet management.

Serum glucose levels reduced from 110 ± 12 mg/dl at baselines to 105 ± 10 mg/dl at the end of the study with mean difference of -5 mg/dl ($p < 0.05$). While the decline is relatively small, this finding shows an improvement of glycemic experience over time.

LDL cholesterol (“bad cholesterol”) was reduced by a mean of 10 MG/DL ($p = 0.021$) from baseline of 120 ± 15 mg/dL to an average of 110 ± 13 mg/dL after twelve months. This improvement on LDL level means that the client may not easily experience other cardiovascular related complications. Conversely, the HDL cholesterol – the “good cholesterol” was statistically higher, rising from 45 ± 7 mg/dL at baseline to 50 ± 5 mg/dL after 12 months, an improvement of 5 mg/dL on average ($p = 0.012$). Increased LPA and decrease in LDL is recommended for protective cardiovascular action and rise in HDL.

Social engagement and sleep quality

From the results shown in table 4 it is clear that proposed eHealth intervention had positive effects on quantity and quality of social contacts and sleep quality within 12 months. At baseline participants reported 3.2 ± 1.5 hrs/week of social activity, which progressively rose during the study period. Social activity further increased to 5.0 ± 1.8 hours per week by 3 months; representing an improvement of 1.8 hours per week. This increase was sustained to 6 months, 6.2 ± 2.0 hours/week for 9 months, and at 12 months it was 7.0 ± 2.0 hours/ week Total PA increased by 3.8 hours per week compared to the baseline ($p < 0.001$). The fact that such an increase is evident in each of the weeks under observation indicates that social activity has had a positive influence over participants’ level of social interaction which may be attributed to special efforts being made to encourage participants or enhanced communal participation.

Sleep quality meaning average number of hours of sleep per night also progressively increased over the period examined. Self-perceived productivity the average self-perceived productivity at baseline was 5.5±1.2 h/day SD On average, participants claimed to have slept 6.5 ± 1.0 h per night. This advanced to 6.8 ± 1.1 hours by 3 months, then stepped up gradually to 7.0 ± 1.0 hours at 6 months, 7.2 ± 0.9 hours at 9 months and 7.5 ± 0.8 hours at 12 months from an overall gain of 1.0 hour of sleep per night by the end of the study (p < Improved nights’ sleep indicates better rest and relaxation, which may well have beneficial effects on the general physiology of the body. In both of the outcomes, establishing mean final scores, these findings indicate that the observed enhancements in social activity and sleep quality are the result of proposed interventions during the study.

Specifically, the findings shown in fig. 3 show an overall positive change for patients’ perceived satisfaction and decrease in caregivers burden within 12 months of use. In the initial assessment, the mean satisfaction score of the patients was 6.0 ± 1.5, meaning that the patient satisfaction with care was moderate. The patient satisfaction results improved over time, and at the end of 3 months, patients’ scores were 7.0 ± 1.3, while at 6 months patients scored 7.5 ± 1.2 and 9 months’ patients scored 8.0 ± 1.1 and finally at 12 months patients received scores of 8.5 ± 1.0. The overall patient satisfaction index according to the above measures also increased by 2.5 points for the period under consideration (Overall Chi-Square = 25.776, $p < 0.001$) and indicated that the given interventions were beneficial to the involvement of the patients in the caring process and their general health state.

Multiple regression analysis for cognitive function at 12 months

Table 5 shows the result of the multiple regression analysis for predictors of cognitive function that reflected by MMSE score at 12 months. The further assessment of the model shows that the intercept of the model is 12.05 ($p<0.001$), which means that the initial cognitive ability is significantly affected by the independent variables in the presented model.

The analysis released revealed that with a further mean increase on the TUG test, representing physical fitness, the subjects' MMSE score is expected to reduce by 0.52 of a point (β = -0.52, $p < 0.001$). TUG score, if increases by one, the MMSE score reduces by 0.52 showing a strong correlation between physical fitness and cognition.

Equally, the Geriatric Depression Scale (GDS) is negative indicating that higher depression scores are related to lower cognitive ability (β = - 0.31, p= 0.012). The present findings reveal that there is a negative relationship between depression and cognitive status, as indicated by the fact that compared with the GDS score, the MMSE score was lower by an average of 0.31 for every one-point increase in the GDS score.

On the other hand, social engagement produces a positive impact on cognitive function β = 0.35 ($p < 0.001$). Increase in social activity by one hour per week results to 0.35 gain in the MMSE score, which suggest that higher level of social engagement leads to enhanced cognitive status.

Last but not the least, the actual nutritional status represented by BMI, also contributes a positive manner to the scores of MMSE (β = 0.25, p = 0.002). Every increase of BMI is equivalent to at least 0.25 points of cognitive performance therefore better nutrition is directly linked with better cognition.

MRI findings

In addition to clinical assessments, magnetic resonance imaging (MRI) was conducted on a subset of participants (n=60) at baseline and at 12 months to assess structural brain changes associated with cognitive impairment. MRI scans were performed using a 3T scanner, capturing T1-weighted, T2-weighted, and diffusion tensor imaging (DTI) sequences to evaluate cortical atrophy, white matter integrity, and hippocampal volume.

Baseline MRI Observations: At baseline, MRI scans revealed moderate cortical atrophy in 38 participants (63.3%), particularly in the medial temporal lobe and prefrontal cortex, regions closely associated with cognitive function. Additionally, white matter hyperintensities (WMH), indicative of small vessel disease, were observed in 45 participants (75%), primarily in periventricular and deep white matter regions. Diffusion tensor imaging (DTI) analysis showed reduced fractional anisotropy (FA) values in the corpus callosum and superior longitudinal fasciculus, suggesting white matter microstructural damage.

12-Month Follow-Up MRI Observations: After 12 months of non-pharmacological multifactorial interventions, MRI findings demonstrated a slower progression of cortical atrophy compared to expected declines in untreated individuals. Specifically, hippocampal atrophy progression was reduced, with volumetric analysis showing a mean hippocampal volume decrease of only 2.1% compared to an expected 4-5% annual decline in untreated mild cognitive impairment (MCI) cases. WMH burden remained stable in 72% of participants, while 28% exhibited slight progression. DTI metrics indicated improved white matter integrity, with significant increases in FA values in frontal and parietal regions, correlating with enhanced cognitive performance on MMSE and MoCA scores.

Correlation Between MRI Findings and Cognitive Function: Statistical analyses revealed significant correlations between MRI measures and cognitive improvements. Participants with reduced hippocampal atrophy progression demonstrated higher MMSE score improvements (β = 0.42, $p < 0.001$). Similarly, those with stable or improved white matter integrity exhibited better executive function performance, as assessed by MoCA scores (β = 0.38, p = 0.002). Furthermore, social engagement and physical activity levels were positively correlated with preserved brain volume and lower WMH burden (β = 0.29, p = 0.005).

DISCUSSION

The outcomes of the study were to assess the effect of non-pharmacological multifactorial interventions with 120 geriatric patients with cognitive impairment. The outcomes show positive changes in a range of aspects that concern cognitive, physical, mental, nutritional, social, and sleep functioning within a year.

The present study showed a progressive enhancement of the cognitive status according to the MMSE and MoCA scores. At inception the MMSE was 20.5 ± 2.5 and the MoCA 19.2 ± 3.1. At one year follow-up, the MMSE score improvement was 4.0 points to 24.5 ± 1.5, MoCA score improved by 3.8 points to 23.0 ± 2.0. The findings point out statistically noteworthy enhancements at each point ($p < 0.001$). When comparing these results to prior research, the cognition changes seen here are similar to those described by López *et al*. (2020), where patients that received multifactorial interventions indicated an increase by 3.5 points in MMSE in 9 months. Likewise, Cheng *et al*. (2022) noted that both the groups completing cognitive training with exercise saw an average improvement between 3.2 points over 6 months in the MoCA scores. However, the improvement in cognitive functions in the present study was to a slightly greater extent, primarily because the participants exercised for a longer time (one year), and the program included such categories as social activity and diet, excluded from some shorter term interventions. Groot *et al*. 2020 compared the changes in MMSE scores of a group undertaking a 6-month intervention that was centered on only cognitive training which resulted in an increase of 2.8 points while the present study which undertook a multifactorial approach of intervention, recorded a greater increase thus supporting the hypothesis for synergistic effect of multiple intervention measures leading to better cognitive performances (Lee *et al*., 2023; Lin *et al*., 2023; Liu *et al*., 2021). This was backed up by Lautenschlager *et al*. (2020) who established that combination of long-term interventions yielded better cognitive results than separate interventions.

Concerning depression, the lowered GDS scores are in agreement with Smith *et al*. (2021) who claimed that subjects in both CAT and PAT groups achieved a 2.5-point decrease in GDS scores after 6 months considering both cognitive and physical training. Unlike the present study, with additional emphasis on social engagement and nutritional components, reflected a slightly larger decrease in the severity of depressive disorders, thus confirming the hypothesis regarding the superiority of multi-modal interventions concerning the mental health issues in patients of the geriatric population. Similarly, Belleville *et al*. (2021) reported that both the cognitive, physical, and social interventions based on the protocol of depression treatment significantly reduced the symptoms of depression confirmed by the findings of the present study.

The BMI cholesterol blood sugar, LDL and HDL levels were also found to have improved significantly over the twelve month period. he initial mean BMI of participants was 24.5 ± 2.1 kg/m²; this was lowered to 23.8 ± 2.0 kg/m², which shows a slight but statistically significant reduction of 0.7 (kg/m²) [p= 0.024]. There was a slight reduction in average cholesterol levels from 198 ± 20mg/D to 185 ± 18 mg/D (p = 0.015) and LDL cholesterol from 120 ± 15mg/D to 110±13 mg/D (p = 0.021). These tell of an overall improvement of lipid profile where the mean HDL levels risen from 45 ± 7 mg/dL to 50 ± 5 mg/dL (p = 0.012). These results are parallel to García *et al*. (2021) who observed clinically relevant changes in BMI and cholesterol in a nutrition and exercise-based interventional study completed over 6 months. The decrease of BMI/cho in the participants of the study is also comparable to the results of this study: BMI reduced to 0,6kg/m², cholesterolev reduced to 10 mg/dL. Likewise, Santiago *et al*. (2022) have shown that a Mediterranean-style diet led to the negative changes to the BMI value (-0,8 kg/m²) and the LDL concentration (-12mg/dL) after 9 months, which corroborated the improvements in nutrition observed in this study. The rise in the HDL levels noted by the present work is also consistent with that reported by Martinez *et al*. (2020) where mediterranean diet intervention lead to a 4 mg/dL raise in the HDL level of participants over a 6 months period. Along with the improvement in cognitive functions by nutrition interventions augmented with physical and cognitive training strongly support the notion of the multiple factorial approach to the management of geriatric health (O'Caoimh *et al*., 2020; Park *et al*., 2023; Roberts *et al*., 2021).

There was a large increase in social activity and objective sleep quality as a function of the study. The amount of social activities added was statistically significant rising from 3.2 ± 1.5 at base line to 7.0 ± 2.0 at 12 months ($p < 0.001$); sleep duration was significantly different with a rise from 6.5 ± 1.0 hours at base line to 7.5 ± 0.8 hours at 12 months ($p < 0.001$). These results can be attributed to the findings of Kim *et al*., 2021 that depicted better cognitive and mental health in elderly people in association with enhanced social interaction. As in the present study, participants gained on average at least three hours a week in social interaction, which was 3, 8 hours in the present study period.

These findings support the conclusion of Regan *et al*. (2021) who reported better improvement in patient satisfaction and decrease in caregiver burden after implementing a multifactorial intervention for elderly patients with cognitive impairment. The result of the study showed that when it comes to holistic care plans they not only benefit the patient but also the caregivers. Hypothesis testing for the multiple regression analysis showed that the independent variables that explained the best 48 month cognitive function included TUG score as a physical fit index, GDS as depression level index, number of social contacts as social activities index, and BMI as nutritional status index. This study's findings of a negative association between TUG and GDS scores and cognitive function are consistent with Erickson *et al*. (2022) regarding better physical fitness and lower depression levels being strongly related to better cognitive outcomes in older adults. However, Cummings *et al*. (2022) confirm the results that show positive impact of social engagement and nutritional status on cognitive performance.

This study support the hypothesis that non-pharmacological interventions, including cognitive training, physical exercise, dietary modifications, and social engagement, can contribute to structural brain preservation in elderly individuals with cognitive impairment. The observed stabilization of hippocampal volume and white matter integrity highlights the potential of lifestyle modifications in delaying neurodegenerative changes. These results align with previous neuroimaging studies demonstrating the neuroprotective effects of multimodal interventions in older adults at risk of dementia. Overall, the incorporation of MRI findings provides objective neurobiological evidence supporting the efficacy of multifactorial non-pharmacological interventions in maintaining brain health and cognitive function in geriatric patients with cognitive impairment.

Significance of this study

The plight of this study is important since it shows that it is possible to apply coherent non-pharmacological multifactorial modifications to facilitate enhanced cognitive status, motor performance, affective status and overall quality of life of geriatric patients with MCI. This study can be highly benefEicial, as it enhances cognitive training, physical activity recommendations, nutrition, social interaction, and sleep for a correct approach to the complex problem of deterioration. The result discussed in the present work indicates that the possibility of such interventions in enhancing the quality of life of patients, reducing the burden on the caregivers as well as increasing the patrons' satisfaction level. Consequently, the study reemphasises the need for proactive, comprehensive patient ranging care for the aged, information policy makers could find helpful in future Geriatric health care practices.

Limitations of this study

One major limitation of this study is the relatively small sample size (n=60 for MRI findings), which may limit the generalizability of the results. Future studies should aim to increase the number of participants to strengthen the reliability of the findings. Additionally, the lack of a control group prevents direct comparison between intervention and non-intervention groups. Another limitation is the relatively short follow-up duration of 12 months, as long-term effects of non-pharmacological interventions on brain structure remain uncertain. Self-reported measures for social engagement and sleep quality may also introduce potential biases. Addressing these limitations in future research will provide more robust evidence on the effectiveness of multifactorial interventions in preserving cognitive health in elderly populations. Overall, the incorporation of MRI findings provides objective neurobiological evidence supporting the efficacy of multifactorial non-pharmacological interventions in maintaining brain health and cognitive function in geriatric patients with cognitive impairment.

CONCLUSION

Altogether, this research confirms that multifactorial non-pharmacological approach can enhance the cognitive, physical, emotional, and nutritional status, social participation, and quality of sleep of geriatric patients with MCI during one-year intervention. The progressive gains in cognitive performance traced by both MMSE and MoCA coupled with gains in P& MH scores offer a conceptual validation of a multipronged approach to managing cognitive decline in the elderly. In addition, the decrease in caregiver burden and the increase in patient satisfaction, thereby would show the other benefits of these interventions for the patient and families. Nonetheless, the current study results are in concordance with the feasibility of implementing whole-person, non-pharmacological interventions in the improvement of the physiological well-being and overall life satisfaction in the elderly population. The results of this study needs to be further examined in larger and more diverse populations.

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Consent to publish

The manuscript has neither been previously published nor is under consideration by any other journal. The authors have all approved the content of the paper.

Consent to participate

All participants or their immediate family provided written informed consent in this study.

Ethic approval

The current study was approved by the Institutional Review Board (IRB) of Lishui Second People's Hospital (Approval NO. 2023-029).

Data availability statement

The data that support the findings of this study are available from the corresponding author, upon request.

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Clinical study of Shexiang Tongxin dropping pills on elderly patients with stable angina pectoris complicated with cognitive impairment. (2023ZYC-A110)

Conflicts of interest

The authors declare that they have no financial conflicts of interest.

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