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Effects of integrated Physical Activity and Cognitive Training on Executive Function in Older Adults

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Abstract

Background: Executive functions encompass a set of cognitive processes, primarily governed by the prefrontal cortex, that are essential for purposeful, goal-directed behavior.

Aim: This study aimed to effects of integrated physical activity and cognitive training on executive function in older adult.

Design: A quasi-experimental design was utilized.

Setting: The study was conducted in Shobera El Nakhla, a randomly selected rural area in Sharkia Governorate, Egypt.

Sample: The sample consisted of 100 older adults, and a multistage random sampling technique was employed.

Tools: Data were collected using four tools: Structured interview questionnaire, The Community Healthy Activities Model Program for Seniors (CHAMPS), the Cognitive and Leisure Activity Scale (CLAS), and The Executive Skills Questionnaire.

Results: The findings revealed statistically significant improvements among participants following the intervention. The proportion of participants with good physical activity levels increased from 10% to 52%, cognitive training ratings improved from 16% to 62%, and executive function scores rose from 15% to 68%. Additionally, a highly significant positive correlation ($p < 0.01$) was observed among physical activity, cognitive training, and executive functions both before and after the intervention.

Conclusion: The combined physical activity and cognitive training intervention was effective in enhancing executive functions among older adults.

Recommendations: The combined intervention should be applied continuously in the current study setting and expanded to similar environments to assess its long-term sustainability and to support evidence-based aging care.

Keywords: Physical Activity, Cognitive Training, Executive Function, Older Adult

Introduction

The ageing of the population is a worldwide phenomenon **(United Nations Department of Economic and Social Affairs, 2020)**. Healthy ageing is described as "the process of establishing and maintaining functional ability that allows for well-being in old age." **(Matsuyama et al., 2022).** The number of people aged 60 and up reached one billion in 2019. By 2030, this number will have risen to 1.4 billion, and by 2050, it will have risen to 2.1 billion. This rise is occurring at an unprecedented rate, and it is expected to intensify in the next decades, particularly in developing countries **(WHO, 2022).**

Executive functions (EFs) refer to a set of mental processes and cognitive skills essential for goal-directed planning, organization, and behavioral regulation **(Stucke & Doebel, 2024).** As an umbrella term, EFs encompass a range of abilities, including planning, working memory, attention, inhibition, self-monitoring, self-regulation, and initiation. These functions rely on a network of cognitive processes that enable individuals to navigate and perform effectively in real-world situations **(Sadozai et al., 2024).** The core components of EFs—updating working memory, shifting between tasks, and inhibiting dominant responses—are highly interrelated, reflecting a unified and integrated cognitive system **(Jansen & Franse, 2024).**

Combining physical activity with cognitive training has shown promise in enhancing executive functions. These interventions incorporate activities that require both physical exertion and cognitive engagement, such as aerobic exercises paired with tasks involving attention, memory, or problem-solving. This approach represents a shift from simple physical movements to "thinking moves," effectively integrating cognitive stimulation with physical exercise **(Mao et al., 2024).**

Physical activity (PA) is essential for health promotion and disease prevention, contributing to physiological well-being and enhancing quality of life across all age groups **(Conger et al., 2024).** It is defined as any bodily movement produced by skeletal muscles that requires energy expenditure, including activities performed during work, play, housework, travel, and recreation **(Longhini et al., 2024).** For older adults, physical activity offers a wide range of benefits in preventing and managing common conditions and diseases associated with aging. Well-known benefits include improvements in cardiovascular health, hypertension control, and weight management, while additional positive effects extend to daily functioning, sleep quality, cognitive health, and even cancer survival **(Sullivan, 2024).** Moreover, regular physical activity has been shown to counteract many of the adverse effects of aging, making exercise a vital component of healthy aging for older adults **(Indrakumar & Silva, 2024).**

Cognitive training is a structured program of guided mental activities designed to maintain or enhance cognitive functions that support daily tasks and independent living. This approach leverages the brain's functional and structural plasticity to build on existing cognitive resources and improve overall functioning. Interest in cognitive training for older adults has grown significantly following evidence that the brain retains substantial plasticity well into advanced age **(Bruno et al., 2024).** Similarly, cognitive training has been shown to improve specific cognitive functions such as memory, cognitive inhibition, and cognitive flexibility **(Baykara et al., 2021).**

Gerontological nurses play a vital role in addressing the complex and unique healthcare needs of the aging population. As the population ages, healthcare systems face increasing demands, and these nurses are essential in providing specialized care tailored to older adults. They implement evidence-based practices that focus not only on managing existing health conditions but also on promoting health and protection, preventing disease, and supporting recovery and rehabilitation. In addition to direct patient care, gerontological nurses collaborate with families and other healthcare professionals to develop comprehensive care plans that enhance the quality of life and functional independence of older adults **(Ferretti-Rebustini et al., 2021).**

Method:

Study Design

A quasi-experimental research design with a pre-test–post-test intervention was employed to achieve the aim of the study

Setting:

This study was conducted in **Shobera El Nakhla**, a rural area randomly selected from Sharkia Governorate. Shobera El Nakhla is a large village located in the Belbeis district and comprises 20 smaller sub-villages. It has an elderly population of approximately 1,696 and is situated about 24.5 kilometers from Zagazig City. Multigenerational households are the predominant family structure among the residents. Agriculture serves as the primary source of income. The village includes approximately 7,875 houses and is served by five schools, and several pharmacies. Additionally, it has one hospital and a kidney dialysis unit.

Sample

The initial sample consisted of 110 older adults, including 10 participants for the pilot study. After excluding the pilot participants, the final study sample comprised 100 older adults from the aforementioned setting who met the following inclusion criteria: Aged between 60 and 75 years, of either gender, able to read and write, free from any uncontrolled chronic diseases or conditions affecting executive function, and willing and able to cooperate and provide informed consent to participate in the study.

Sampling technique

A multistage random sampling technique was employed to select participants for the study. In the first stage, Sharkia Governorate—comprising 17 districts—was considered, and one district, Belbeis, was selected using simple random sampling. In the second stage, one village, Shobra El Nakhla, was randomly chosen from the 50 villages within the Belbeis district. In the third stage, the selected village was divided into 20 clusters, each containing approximately 85 older adults. Four clusters were then randomly selected, and all older adults within these clusters who met the inclusion criteria were invited to participate in the study until the required sample size of 100 participants was reached.

Sample size calculation

The sample size was calculated using the Epi Info software with a 95% confidence level, a 5% margin of error, and 80% power. It was assumed that 71.2% of older adults had low physical activity based on a sample of 1,696 elderly individuals in the community **(Farrag et al., 2019).** Anticipating a minimum improvement of 10% following the intervention program, the required sample size was determined to be 100 older adults.

Tool of data collection

Four tools were used to collect the study data.

Tool I: Structured Interview Questionnaire

It was developed by the researchers to collect relevant data from older adults. The questionnaire consisted of two main parts, each designed to capture different aspects of the participants' background and lifestyle.

- **Part 1: Demographic Characteristics of the Older Adults**

This section included ten closed-ended questions aimed at gathering key demographic information. The variables covered were age, gender, marital status, educational level, current occupation, crowding index, monthly income, source of income, and living arrangements.

- **Part 2: Health History and Daily Habits of the Older Adults**

This section focused on the participants' health status and lifestyle behaviors. It included questions on the presence of chronic illnesses (e.g., hypertension, diabetes mellitus, respiratory conditions), current medication use, and the number of medications taken regularly. Additionally, it assessed lifestyle habits such as smoking and caffeine consumption.

Tool II: The Community Healthy Activities Model Program for Seniors (CHAMPS):

The CHAMPS questionnaire is a self-report tool designed to assess the weekly frequency and duration of various lifestyle physical activities that are meaningful and appropriate for older adults. Originally developed as a 40-item scale, it was adapted by **Hekler et al. (2012)**. In the present study, the researcher modified the questionnaire to include 27 items by omitting activities deemed unsuitable for the study sample. The adapted version includes activities of varying intensities, ranging from light to vigorous, such as walking, running, bicycling, aerobics, yoga/tai chi, gardening, and housework. **Each item was scored** using a binary response format, with "Yes" assigned 1 point and "No" assigned 0, resulting in a maximum total score of 27. The overall score was then converted into a percentage and used to categorize participants into three levels of physical activity: **Good** (>75%, 21–27 points), **Fair** (50–75%, 14–20 points), and **Poor (**<50%, 0–13 points).

Tool III: Cognitive and Leisure Activity Scale (CLAS):

The Cognitive and Leisure Activity Scale (CLAS), adapted by **Galvin et al. (2021)**, is designed to assess the frequency of cognitively stimulating and leisure activities among older adults to evaluate their potential impact on cognitive health and well-being. Originally composed of **16 statements**, the CLAS was modified in the current study to include **8 domains**: Memory Activities, Problem Solving, Learning, Social Engagement, Reading, Creative Activities, Physical Activity, and Use of Technology. **The tool employs a 3-point Likert scale** to measure activity frequency, with scores assigned as "Often" = 2, "Sometimes" = 1, and "Never" = 0, yielding a maximum total score of 16. This score is then converted into a percentage to classify cognitive activity levels into three categories: **Good** (≥75%, 12–16 points), **Fair** (50% to <75%, 8–11 points), and **Poor** (<50%, 0–7 points)

Tool IV: Executive Skills Questionnaire (ESQ)

The aim of the Executive Skills Questionnaire (ESQ) in older adults is to assess the level of executive functioning across various cognitive domains to identify strengths and weaknesses that may impact daily living, independence, and overall cognitive health. The ESQ, adopted from **Dawson and Guare (2018),** consists of 36 items grouped into 12 executive skill domains: response inhibition, working memory, emotional control, sustained attention, task initiation, planning and prioritization, organization, time management, goal-directed persistence, flexibility, metacognition, and stress tolerance—each domain containing three items. Responses are rated on a 3-point Likert scale: "Agree" = 3, "Neutral" = 2, and "Disagree" = 1, with a total possible score of 108. These scores are summed and converted into a percentage to categorize participants into three levels of executive functioning: **High** (>75%, 82–108 points), **Moderate** (50–75%, 49–81 points), **and Low** (<50%, 36–48 points)**.**

Statistical analysis

Statistical analysis was conducted using Microsoft Excel and SPSS version 25. Descriptive statistics were used to present the data: frequencies and percentages for categorical variables, and means ($\bar{X}$) with standard deviations (SD) for quantitative variables. The Chi-square test (χ^2) was used to compare qualitative variables, and the Wilcoxon test was applied for comparing quantitative variables. Pearson's correlation coefficient (r) was used to examine the relationships between studied variables, while a linear regression model was employed to analyze the impact of community healthy activities, cognitive and leisure activities, and executive skills on the quality of life of older adults. The reliability of the study tools was assessed using Cronbach's alpha. Statistical significance was considered at P-value ≥ 0.05 (not significant), P-value < 0.05 (significant), and P-value < 0.01 (highly significant).

Results

Table (1) shows that 44.0% of the older adults were aged between 65 and <70 years, with a mean age of 67.64 ± 5.13 years. Additionally, 52.0% were male, and 71.0% were married. Regarding education, 39.0% had completed secondary education. Moreover 64.0% of the participants were not working. In terms of the crowding index, 60.0% had a score between 1 and 2. Furthermore, 51.0% of older adults reported having insufficient income, and for 59.0%, the primary source of income was a pension. Finally, 71.0% of the older adults lived with their spouse.

Table (2): describes that, 54.0% of the studied older adults had chronic diseases with 42.6% of them diagnosed with HTN disease. Additionally, 54.0% were on regular treatment and among of them 96.3% of were taking 3 or more medications. Furthermore, 27.0% of the older adults were smokers, with 59.3% of them smoked 5-<10 cigarettes per day. Moreover, 79.0% reported drinking caffeinated beverages caffeine and 50.6% of them consumed <3 cups per day.

The results in the **Figure (1)** illustrates that, 10.0% of the older adults had good physical activity at pre intervention phase changed to 52.0% after intervention.

Figure (2) illustrates that, prior to the intervention, only 16% of older adults demonstrated a "Good" level of activity, while 32% were rated as "Fair" and 52% as "Poor." Post-intervention, the proportion of participants with "Good" activity levels increased to 62%, while those in the "Fair" and "Poor" categories declined to 25% and 18%, respectively.

Table (3) reveals that significant improvements across all twelve executive function domains. Before the intervention, the majority of participants were classified within the "low" performance category for each domain, 76% for metacognition, 78% for time management, and 76% for goal-directed persistence. Post-intervention, there was a marked shift toward the "high" category, with substantial increases in high-functioning scores, 73% in organization, 72% in task initiation, and 70% in goal-directed persistence. These improvements were statistically significant across all domains (**$p < 0.01$**).

Figure (3) illustrates that, 15% of the older adults have a high level of total executive function at pre intervention phase changed to 68% at post intervention.

Table (4) demonstrates strong and highly significant correlations ($p < 0.01$) among total physical activity, cognitive training, and executive function scores before and after the intervention. At the post-intervention stage, total physical activity showed a very strong correlation with cognitive training ($r = 0.817$), and executive functions ($r = 0.547$). Similarly, cognitive training exhibited strong associations with executive functions ($r = 0.895$).

Discussion

Objective 1: Identify Physical Activity patterns in Older Adults Pre- and Post- Intervention

The findings of the current study revealed that prior to the intervention, the majority of older adults exhibited low levels of physical activity. Several factors may explain this result. ***First,*** age-related physiological changes—including declines in strength, endurance, and balance—make physical activity more challenging for older adults. Second, multiple demographic factors influence activity levels, such as gender, education, and marital status. ***Notably,*** physical activity tends to be lower among individuals with limited educational backgrounds. ***Furthermore,*** social determinants play a critical role: older adults with active spouses or strong social support systems are more likely to remain physically active. Access to appropriate facilities, motivation, self-efficacy, and self- regulation skills (e.g., goal-setting and activity tracking) also substantially affect participation. ***Additionally,*** central barriers such as chronic pain, fear of falling, and poor awareness about the benefits of physical activity were commonly reported. These findings aligned with a study by ***Farrag et al. (2019)*** in ***Mansoura***, ***Egypt,*** which found that three-quarters of older adults had low physical activity levels. Similarly, research by ***Shi et al. (2025)*** *in* ***Southern China*** reported that older adults had insufficient physical activity.

After the implementation of the intervention, the study showed ***a statistically significant improvement in the physical activity scores among participants.*** This improvement can be attributed to the content and delivery of the intervention, which emphasized the importance of physical activity for healthy aging, encouraged open communication about health conditions, and promoted access to reliable health information. The intervention empowered participants to take initiative in improving their physical activity habits. These findings were in line with previous international research. ***Chen et al. (2025)*** *in* ***China*** found that more than half of older adults met physical activity recommendations post-intervention. Similarly, ***Kim et al. (2024)*** in ***Korea, Ho et al. (2024)*** in ***Taiwan,*** and ***Alley et al.*** **(2024)** in **Australia** demonstrated that structured interventions significantly improved physical activity levels among older adults. ***Li et al. (2023)*** further showed that physical activity promotion remained effective even after 24 months of follow-up in a Chinese population.

Objective 2: Describe Cognitive Training methods for Older Adults in Older Adults Pre- and Post- Intervention

The present study revealed that prior to the intervention, ***older adults demonstrated a poor level of engagement in cognitive training.*** Several factors may account for this finding. ***Firstly,*** individual variability in response to cognitive training (CT) can be influenced by aspects such as fluid intelligence, baseline mental status, verbal ability, and adherence to CT strategies. ***Secondly,*** older adults residing in rural areas often face unique challenges, including limited access to healthcare resources, reduced social interactions that could stimulate cognitive functioning, lower income levels, and suboptimal health behaviors. These barriers are compounded by limited awareness regarding the benefits and importance of cognitive training. In line with these findings, a study conducted in ***the United States*** by ***Steinberg et al. (2023)*** reported that rural older adults performed worse across all baseline cognitive measures—including memory, reasoning, and processing speed—compared to their urban counterparts ($p < 0.01$).

Following the implementation of the intervention, the study recorded a ***statistically significant improvement in cognitive training practices among participants.*** This improvement can be attributed to several factors: increased educational awareness about the value of cognitive stimulation, the provision of diverse and engaging cognitive activities (e.g., reading, writing, puzzles, yoga, and learning new skills), and effective monitoring and encouragement during the intervention sessions. Daily application of cognitive exercises further reinforced these practices. These outcomes are consistent with a study by ***Kunrit et al. (2025)*** in ***Pathum Thani Province, Thailand,*** which showed that a 6-week game-based brain training program led to improvements in executive and overall cognitive function, with benefits sustained during a 3-month follow-up. Similarly, ***Tsiakiri* et *al. (2025)*** in ***Greece*** supported the use of CT as a non-pharmacological strategy to enhance cognitive resilience in aging populations. Additional international studies echo these findings: ***Paggetti et al. (2025)*** in ***Italy*** reported improvements in global cognitive function through both individual and group CT programs; ***Sung et al. (2023) in Taiwan*** found that multi-domain CT enhanced executive functions (p = 0.001), working memory (p = 0.016), and selective attention (p = 0.026); and ***Moradi et al. (2024) in Iran*** observed that cognitive stimulation interventions significantly enhanced memory (p = 0.047), reduced distractibility (p = 0.035), and improved information processing speed.

Objective 3: Assess the executive function of older adults before and after the intervention.

The findings of the current study revealed that before the intervention, ***older adults demonstrated low levels of executive functioning.*** This outcome is consistent with the known trajectory of normal aging, which typically includes cognitive decline, particularly in executive functions (EFs). EFs—comprising functions such as planning, decision-making, problem-solving, inhibition, and cognitive flexibility—are essential for managing daily life activities and maintaining independence in older adulthood. The decline in these functions can be attributed to various interrelated factors including aging-related changes in brain structure (e.g., volume reduction in the prefrontal cortex), reduced neuroplasticity, and external determinants such as diet, physical health, education level, and emotional well-being. ***Corbo et al. (2024)*** *in* ***Rome, Italy,*** similarly found notable impairments in global cognitive functioning and EF performance among older adults, supporting the assertion that age-associated cognitive decline is a global phenomenon.

Following the intervention, this study found ***statistically significant improvements in executive function scores among participants.*** This improvement may be attributed to the nature of the intervention, which was designed to increase awareness of the importance of executive functions and enhance these capabilities through structured cognitive and behavioral training. These results aligned with findings from ***Chan et al. (2025)*** *in* ***Hong Kong,*** where participants also demonstrated improved EFs following a targeted intervention. ***Kinsella et al. (2020)*** in ***Australia*** similarly observed significant EF improvement after a six-week memory group intervention. Furthermore, ***Muñoz-Perete et al. (2025)*** *in* ***Spain and Bruno et al. (2024)*** *in the* ***USA*** confirmed the efficacy of multifaceted cognitive interventions in enhancing memory and executive functions among older adults.

The current study also demonstrated ***a statistically significant positive correlation between executive functions and physical activity.*** This supports the growing body of evidence that physical exercise is a vital non- pharmacological strategy for enhancing cognitive health in older age. Physical activity is believed to facilitate neuroplasticity, increase cerebral blood flow, upregulate neurotrophic factors (such as BDNF and IGF-1), and support neurotransmitter function—all of which are essential to maintaining or improving EFs. Moreover, physical activity often involves social interaction, which can further support cognitive engagement and executive functioning.

Supporting this, studies conducted by ***Rodriguez-Rodríguez et al. (2024)*** *in* ***Spain, Zeng et al. (2023)*** in ***China, and Chen et al. (2020)*** in ***Taiwan*** reported that physical activity was a significant positive predictor of EF improvement. Additionally, ***Zheng et al. (2022)*** demonstrated that a structured 12-week physical activity program enhanced EF by affecting neural activation patterns. ***Iso-Markku et al. (2024)*** in ***Finland*** also observed a significant association between physical activity and improved EF performance.

Passarello et al. (2025) in ***Italy,*** and cross-sectional studies by ***Chen et al. (2024) in Taiwan and Peng et al. (2025) in China,*** found that higher levels of physical activity—especially involving planning and problem-solving—were linked to improved EF. ***Liu et al. (2025)*** further emphasized that engaging in moderate to vigorous physical activity for at least 150 minutes per week significantly reduced cognitive impairment rates among older adults.

Objective 4: Evaluate the effect of the combined intervention on executive functions in older adults.

The findings from the current study demonstrate that combined physical activity and cognitive training interventions have a ***statistically significant positive effect on executive functions among older adults.*** A substantial proportion of participants exhibited high levels of executive function after the intervention, affirming the hypothesis that this multifaceted approach can generate notable cognitive and functional benefits. The ***improvement in executive functions*** can be attributed to the synergistic effects of physical and cognitive engagement. Interventions incorporating walking, stretching, and resistance training alongside memory, attention, and problem-solving tasks have been shown to stimulate neuroplasticity and enhance cerebral blood flow. These physiological changes support the maintenance and even improvement of cognitive abilities in aging individuals. Moreover, physical activity is known to increase the levels of ***brain-derived neurotrophic factor (BDNF)***—a protein associated with cognitive protection and delayed decline.

In addition to these biological mechanisms, the structured routine of combined training contributes to improvements in ***mobility, strength, balance,*** and ***mental alertness***, which are essential for preserving independence and reducing the risk of falls. The cognitive component may also boost ***dopaminergic activity,*** improving memory and decision-making processes. These findings aligned with previous research. ***Muñoz-Perete et al. (2025)*** in ***Spain, Chan et al. (2024)*** in ***Taiwan, and Guo et al. (2020)*** in ***China*** all reported that combined interventions significantly enhanced executive functions, including memory, attention, and processing speed. Similar improvements were confirmed in studies by ***Teng et al. (2025), Meng et al. (2022), Gui et al. (2024), Silveira-Rodrigues et al. (2023), and Esmaeili et al. (2023),*** further validating the current study's outcomes.

Limitations of the Study

There is one limitation in this study that could be addressed in future studies. The limitation is that our sample was only rural older adults, so the study results are only generalizable in older population in rural settings.

Conclusion

Based on the findings of the present study and the tested research hypotheses, the results strongly support the effects of integrated physical activity and cognitive training on executive function in older adults. Before the intervention, participants exhibited low levels of physical activity, cognitive functioning, and executive functions. Following the intervention, significant improvements were observed across all measured domains. Furthermore, the positive correlations among physical activity, cognitive training, and executive functions underscore the synergistic impact of an integrated intervention approach in promoting healthy aging.

Recommendations

Based on the results of this study, the combined intervention should be applied continuously in the current study setting and expanded to similar environments to assess its long-term sustainability and to support evidence-based aging care. **Also,** further research should explore the underlying neurological mechanisms associated with cognitive and physical improvements to better understand how the intervention influences brain function and structure.

Declaration of Conflicting Interests

The Author(s) declare(s) that there is no conflict of interest.

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Table (1): Frequency Distribution of the Older Adults According to Their Demographic Characteristics (n=100).

Demographic *Characteristics*	**No.**	**%**
Age (years)		
60-<65	24	24.0
65-<70	**44**	**44.0**
70-75	32	32.0
Mean ± SD **67.64±5.13**		
Gender		
Male	**52**	**52.0**
Female	48	48.0
Marital status		
Married	**71**	**71.0**
Divorced	4	4.0
Widowed	25	25.0
Educational level		
Read and write	29	29.0
Basic education	19	19.0
Secondary education	39	39.0
University education	13	13.0
Current occupation		
Working	36	36.0
Not working	**64**	**64.0**
Crowding index		
<1	37	37.0
1-2	**60**	**60.0**
>2	3	3.0
Monthly income		
Sufficient	40	40.0
Insufficient	**51**	**51.0**
Sufficient and spared	9	9.0
Source of income		
Pension	**59**	**59.0**
Family	32	32.0
Still working	5	5.0
Property income	4	4.0
Living Condition		
Alone	12	12.0
Spouse	**71**	**71.0**
Sons	14	14.0
Relatives	3	3.0

Table (2): Frequency distribution of the studied older adults according to their heath history and daily habits **(n=100).**

Items	**No.**	**%**
Chronic diseases		

Yes	**54**	**54.0**
No	46	46.0
***If yes, what is the disease? (n=54)**		
HTN	**23**	**42.6**
Respiratory diseases	3	5.6
DM	18	33.3
Neurological diseases	9	16.7
GIT diseases	15	27.8
Heart diseases	17	31.5
Liver diseases	9	16.7
Thyroid diseases	6	11.1
Renal diseases	6	11.1
Osteoporosis	12	22.2
Arthritis	13	24.1
Regular treatments		
Yes	**54**	**54.0**
No	46	46.0
If yes, how many treatments are being used? (n=54)		
<3	2	3.7
≥ 3	**52**	**96.3**
Smoking		
Yes	**27**	**27.0**
No	73	73.0
If yes, how often do you smoke per day? (n=27)		
5-<10	**16**	**59.3**
≥ 10	11	40.7
Drink caffeine		
Yes	**79**	**79.0**
No	21	21.0
If yes, what quantity per day? (n=79)		
<3	**40**	**50.6**
≥ 3	39	49.3

(*) Responses not mutually exclusive

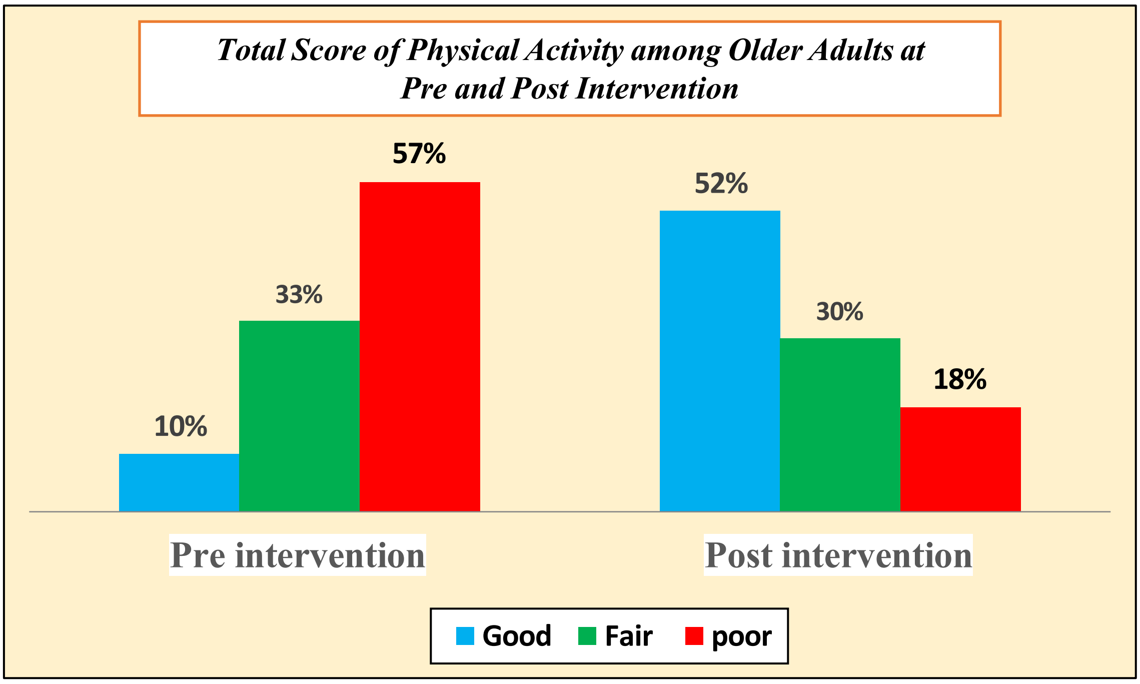

Figure (1): Total Score of Physical Activity Among Older Adults at Pre and Post Intervention

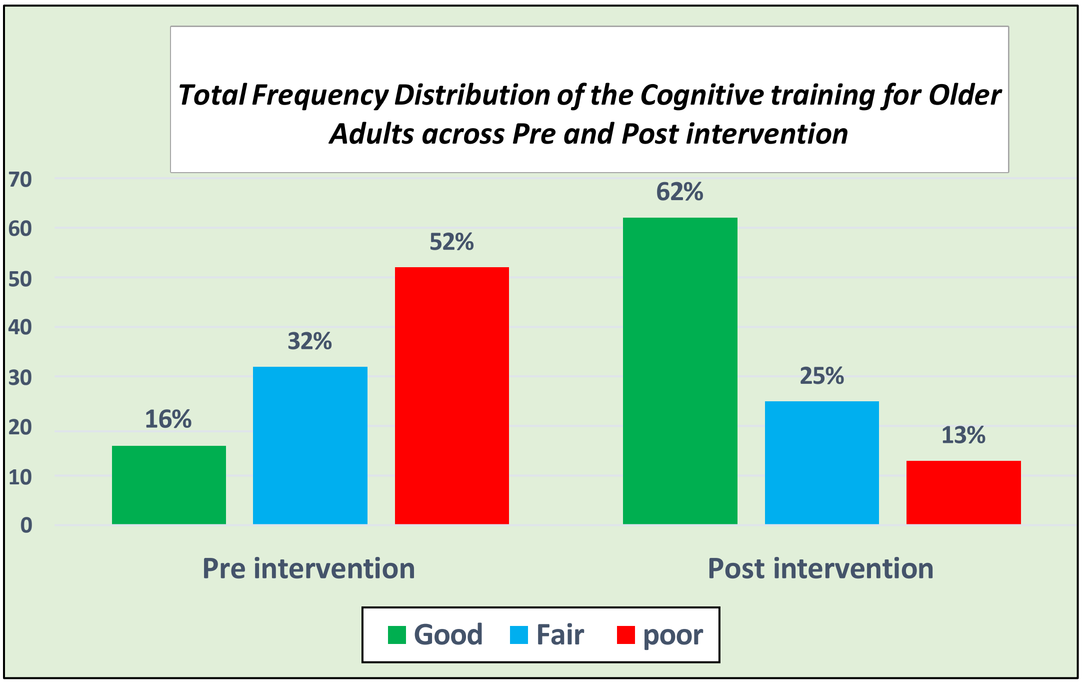

Figure (2): Total Frequency Distribution of the Cognitive Training for Older Adults across Pre- and Post-Intervention (n=100).

Table 3: Executive Functions Domain Scores Among Older Adults Pre- and Post- Intervention (n=100).

Executive Functions	Pre intervention						Post intervention						X^2	P-value
	High		Moderate		Low		High		Moderate		Low			
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%		
1.Response inhibition	15	15.0	23	23.0	62	62.0	68	68.0	22	22.0	10	10.0	71.42	0.000**
2.Working memory	6	6.0	53	53.0	41	41.0	67	67.0	23	23.0	10	10.0	81.65	0.000**
3.Emotional control	16	16.0	15	15.0	69	69.0	68	68.0	24	24.0	8	8.0	77.57	0.000**
4.Task initiation	6	6.0	24	24.0	70	70.0	**72**	**72.0**	18	18.0	10	10.0	101.7	0.000**
5.Sustained attention	9	9.0	22	22.0	69	69.0	64	64.0	22	22.0	14	14.0	77.88	0.000**
6.Planning / Prioritization	9	9.0	29	29.0	62	62.0	64	64.0	28	28.0	8	8.0	79.15	0.000**
7.Organization	0	0.0	36	36.0	64	64.0	73	73.0	17	17.0	10	10.0	119.2	0.000**
8.Time Management	3	3.0	19	19.0	78	78.0	68	68.0	22	22.2	10	10.0	112.2	0.000**
9.Flexibility	0	0.0	28	28.0	72	72.0	61	61.0	29	29.0	10	10.0	107.8	0.000**
10.Metacognition	3	3.0	21	21.0	76	76.0	60	60.0	30	30.0	10	10.0	103.8	0.000**
11.Goal-directed persistence	0	0.0	24	24.0	76	76.0	70	70.0	20	20.0	10	10.0	121.01	0.000**
12.Stress tolerance	3	3.0	24	24.0	73	73.0	68	68.0	22	22.0	10	10.0	107.4	0.000**

X^2: Chi Square Test. **(**)** highly Statistically significant at $p < 0.01$.

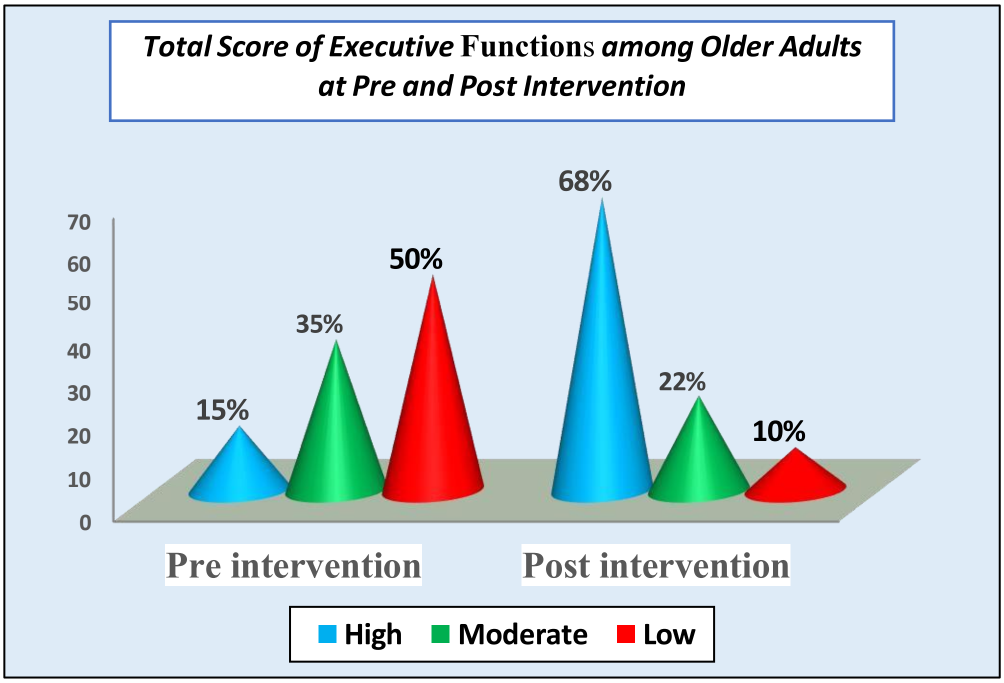

Figure (3): Total Score of Executive Functions Among Older Adults at Pre- and Post-Intervention (n=100).

Table (4): Correlation Between Total Physical Activity, Cognitive Training, and Executive Functions, Among Older Adults at Pre- and Post-Intervention (n=100):

Variables		Total physical activity score		Total cognitive training score		Total executive functions score	
		Pre	Post	Pre	Post	Pre	Post
Total cognitive training score	r p	0.860 0.000**	0.817 0.000**				
Total executive functions score	r p	0.770 0.000**	0.547 0.000**	0.895 0.000**	0.684 0.000**		

R= correlation coefficient test. P= p-value **highly significant at p ‹ 0.01.

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