Research Paper

Relationship of Executive Functions with Manual Dexterity and Instrumental Activities of Daily Living in Older Adults With and Without Mild Cognitive Impairment

Kosar Ghanbarian[1], Hamid Dalvand[2, 3*], Mahtab AlizadehKhoei[4], Fatemeh Salmani[1], Azar Mehri[5]

1. Department of Aging Health & Geriatric, School of Rehabilitation, Tehran University of Medical Sciences (TUMS), Tehran, Iran.
2. Department of Occupational Therapy, School of Rehabilitation, Tehran University of Medical Sciences (TUMS), Tehran, Iran.
3. Department of Occupational Therapy, School of Rehabilitation, Al-Subtain University, International Branch of TUMS, Karbala, Iraq.
4. Department of Speech Therapy, School of Rehabilitation, Tehran University of Medical Sciences (TUMS), Tehran, Iran.
5. Geriatric Health Research Center, Birjand University of Medical Sciences, Birjand, Iran.

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ABSTRACT

Objectives: This study aimed to compare the relationships between executive functions (EFs), manual dexterity, and instrumental activities of daily livings (IADLs) in older adults with mild cognitive impairment (MCI) and cognitively healthy controls to identify targets for early interventions and slowing cognitive decline.

Methods: This case-control study included 64 adults aged ≥60 years (32 with MCI, 32 controls), without depression (geriatric depression scale [GDS]-15 <9), recruited from a geriatric clinic and a day care center. MCI was diagnosed using the Persian version of the clinical dementia rating (CDR). EFs were assessed using the Tower of London (ToL), Wisconsin card sorting test (WCST), and trail making test (TMT-A&B); manual dexterity with the Purdue Pegboard test (PPT); and IADLs with IADLs-Lawton. Data were analyzed using SPSS software, version 27.

Results: No significant differences in age and sex were observed between the MCI (mean age: 68.88±5.08) and control groups (70.5±5.42) (P>0.05). The MCI group showed poorer performance in the ToL, WCST, and TMT-A&B (P<0.001), and performed worse in the PPT (P<0.001). Additionally, they had lower IADL scores (P<0.001). Better EFs correlated with improved manual dexterity and higher IADL scores (r=0.42 to 0.53, P<0.05) in the MCI group. Longer ToL/TMT times and WCST errors were linked to poorer PPT/IADLs performance (r=-0.35 to -0.69, P<0.05) in the control group.

Discussion: Older adults with MCI demonstrated significant declines in EFs, manual dexterity, and IADLs compared to cognitively healthy controls. These results highlight the importance of assessing cognitive and motor abilities to facilitate early interventions and support independence. Combining cognitive and motor education programs with caregiver training can effectively address these challenges.

*** Corresponding Author:**
Hamid Dalvand, Associate Professor.
Address: *Department of Occupational Therapy, School of Rehabilitation, Tehran University of Medical Sciences (TUMS), Tehran, Iran.*
Tel: *+98 (21) 77533939*
E-mail: *hamiddalvand@gmail.com*

Highlights

- Older adults with MCI exhibited poorer performance in EFs than the control group.
- Older adults with MCI exhibited poorer performance in manual dexterity than the control group.
- Older adults with MCI had a poorer performance in IADLs than the control group.
- A significant relationship was observed between EFs and manual dexterity in both groups.
- A significant relationship was observed between EFs and IADLS in both groups.

Plain Language Summary

As people age, some may begin to experience difficulties with thinking, planning, and memory, a condition known as mild cognitive impairment (MCI). This condition can also affect their ability to use their hands for everyday tasks and live independently. In this study, we compared two groups of older adults: One group with MCI and another group without any cognitive problems. We aimed to investigate the relationship between their thinking skills, hand coordination, and ability to perform daily tasks, such as managing money, using a phone, or cooking. We found that older adults with MCI had more trouble with mental tasks, weaker hand control, and struggled more with daily activities than those without cognitive issues. We also found that better thinking abilities were associated with improved hand use and greater independence in both groups. These findings suggest that changes in thinking and movement can occur simultaneously during the aging process. Recognizing these changes early and providing combined brain and hand training, along with family support, may help older adults remain independent for a longer period and improve their quality of life (QoL).

Introduction

Cognitive impairment is a major clinical concern, characterized by problems with memory, attention, and problem-solving skills. It significantly reduces the quality of life of older adults and their families [1], underscoring the need to identify contributing factors, such as executive functions (EFs). EFs are higher-level cognitive processes that manage thoughts and actions [2] and include key components such as inhibition in cognition status, planning, flexibility in attention, decision-making, and problem-solving [2].

Early assessment of EFs can help predict the onset of mild cognitive impairment (MCI) [3]. Strong EFs are critical for maintaining independence in daily life and assessing functional levels, particularly in instrumental activities of daily livings (IADLs) [4], even in the presence of cognitive impairments [5]. EF tests are commonly used during routine check-ups to obtain crucial information about cognitive abilities essential for managing daily activities [6].

Another crucial factor in maintaining independence in daily life is manual dexterity, the ability to skillfully manipulate objects using different grip hand patterns [7]. Impairments in either the dominant or non-dominant hand (or both) can severely limit functionality, especially in IADLs [8]. Unlike basic tasks (ADLs), IADLs demand higher cognitive processing, making individuals more vulnerable to cognitive decline. Consequently, older adults with MCI often struggle more than those without cognitive problems, needing extra time and making more errors during daily tasks, such as using public transportation, organizing items, or managing medications [9].

In this context, hand performance in tasks, such as gripping, lifting, and manipulating objects can significantly influence EFs, such as attention, problem-solving, planning, cognitive flexibility, and self-control [10]. Therefore, the ability to use hands effectively is essential for maintaining independence in older adults. Any decline in these abilities can impair the performance of IADLs, ultimately leading to greater dependence and a lower quality of life [4]. However,, understanding the relationship between EFs and IADLs is crucial for identifying individuals with MCI, as early interventions can manage the progression of cognitive decline [11]. Treatments aimed at improving EFs can help maintain independence [12]. Therefore, this study aimed to explore the relationships between EFs with manual dexterity and IADLs in older adults with MCI, and to compare these factors in those without cognitive impairment.

Materials and Methods

Subjects and sampling

In this case-control study, 64 older adults ≥60 years old (32 diagnosed with MCI and the remaining without cognitive impairment), who visited the geriatric clinic of Ziaeian Hospital at Tehran University of Medical Sciences and a day care center, were selected through a random sampling method, for face-to-face interviews from May to September, 2024. First, the assessor screened older adult outpatients for eligibility and willingness to participate in this study. The inclusion criteria included right-handed older adults without obvious physical impairments (e.g. speech disabilities, motor/physical difficulties), with normal or corrected vision and hearing, scoring <9 based on the geriatric depression scale (GDS)-15 tool (indicating no depression), and providing informed consent via signature or fingerprint. Outpatients who were not expected to continue their cooperation were excluded. Participants in the case group were included if they had been diagnosed with MCI using the Persian version of the clinical dementia rating (CDR) tool [13].

Background variables

Demographic data (age and sex) were collected. The Persian version of the GDS-15 [14] was employed to assess depression.

Cognition assessment measurement

The Persian version of the CDR tool was used to screen for cognitive status. This tool is one of the most reliable and effective screening tools for cognitive status, consisting of two main components: Memory and orientation. Memory includes remote, recent, immediate, and highly learned material, while orientation includes time, place, and person. A final score of 0 indicates no cognitive impairment, 0.5 signifies MCI, and 1 indicates dementia [13].

EFs assessment measurement

The Tower of London (ToL), Wisconsin card sorting test (WCST), and trail making test A and B (TMT-A and TMT-B) were used to assess EF of the participants in this study.

The computer version of the ToL was used in this study. The ToL was developed to evaluate at least two aspects of EFs: Strategic planning and problem-solving. The participants were presented with 12 challenges that required them to arrange the sample shape by moving colored plates (green, blue, and red) into the correct positions with the fewest necessary movements. Each challenge can be attempted up to three times. After a successful attempt (and if the challenge remains unsolved after three attempts), the next challenge is presented. The test was graded based on the total test time, total delay time, total number of errors, and total points [15].

In this study, a computer version of the WCST was used. In the WCST, the participant is presented with a deck of 64 cards, each featuring a shape with four symbols: a triangle, star, plus, and circle, in four colors: red, green, yellow, and blue. Naturally, no two cards are identical. Four cards, including "A red triangle, two green stars, three yellow pluses, and four blue circles," served as the main cards. The participants' task is to place the other cards under the main cards according to the rules governing them. After each response, participants received feedback indicating whether their answers were correct or incorrect. The desired pattern for the four main cards is color, form, and number, repeated twice (C, F, N, C, F, N). Once the participants provided a sufficient number of consecutive correct answers, the desired pattern changed, but the participants remained unaware of this change and must discover it independently. The test grading is based on the number of categories completed, the number of errors in persistence, the correct and incorrect responses, the duration of the test, and the conceptual level of responses. [16].

The TMT-A requires participants to draw lines that consecutively connect 25 circles on a piece of paper. The task requirements for the TMT-B are similar, except that the individual must alternate between numbers and letters (e.g. 1, A, 2, B, 3, C). The score for Part A reflected the time taken to complete the task, while for Part B, the total number of errors was recorded [17].

Manual dexterity assessment measurement

The Purdue Pegboard test (PPT) was used to assess the manual dexterity of the older adult participants in this study. The PPT consists of a rectangular board featuring two rows of holes (20-25 in number) on each side and three circular cups. The first cup contained pins, the second cup held washers, and the third cup had collars. A movable board covered all three cups. This test measured the speed and accuracy of the participants' hand movements. The participant must remove the pins, washers, and collars one by one with the dominant hand (right), once with the non-dominant hand (left), and once with both hands simultaneously, placing them into the holes. The given time was 30 s, and at the end of this test, the number of pins placed in the holes was counted [18].

IADLs assessment measurement

The IADLs-Lawton tool was used for the IADLs assessment of the participants in this study. It comprises eight items: Telephone use, shopping, food preparation, house cleaning and laundry, transportation, medication management, and money management. Each item is scored as 0 (lower ability) or 1 (higher ability), with a total score of 8 reflecting full independent functioning [19].

Statistical analysis

Data were analyzed utilizing SPSS software, version 27. All analyses were considered statistically significant at P<0.05. Quantitative variables were described using central tendency and dispersion indices, while qualitative variables were represented using counts and percentages. The assumption of normality was assessed using the Shapiro-Wilk test. Spearman's test is employed to examine the relationships between variables. The mean differences between the two groups were analyzed using the Mann-Whitney test.

Results

The mean age of the older adult participants in the MCI group was 68.88±5.08 years, while in the control group, it was 70.5±5.42 years. No significant differences in age were observed between the two groups (t=-1.23; P=0.221). In the MCI group, 71.9% (n=23) were female, and 28.1% (n=9) were male, whereas the control group consisted of 56.2% (n=18) females and 43.8% (n=14) males. No statistically significant differences in sex distribution were observed between the two groups (t=1.69; P=0.193) (Table 1).

EFs in older adults with and without MCI

The results of the independent-samples Mann-Whitney test showed statistically significant differences between the two groups for all components of the ToL test. The MCI group required more time to complete the test (t=5.7; P<0.001), made more errors (t=8.797; P<0.001), and ultimately obtained a lower overall score (t=-6.441; P<0.001) compared to the control group.

For the WCST, all measures showed a significant difference between the two groups, indicating that compared to the control group, the MCI group responded to fewer categories (t=-6.286; P<0.001), had more errors (t=6.822; P<0.001) and incorrect responses (t=6.544; P<0.001), and required more time to complete the test (t=4.014; P<0.001) (Table 2).

The results for the TMT showed a significant difference between the two groups. The MCI group took a longer time to complete the TMT-A (t=8.936; P<0.001) and also made more mistakes in TMT-B (t=5.777; P<0.001) compared to the control group (Table 2).

Manual dexterity in older adults with and without MCI

The results of the independent-samples Mann-Whitney test indicated statistically significant differences between the two groups for all PPT subtasks. This revealed that individuals with MCI placed fewer pins with their dominant (right) hand (t=-4.514; P<0.001), non-dominant (left) hand (t=-4.095; P<0.001) and both hands simultaneously (t=-5.137; P<0.001) in the holes compared to the control group (Table 2).

Table 1. Frequency distribution of demographic variables in the MCI and control groups of older adults

Variables		Mean±SD/No. (%)		t	P
		MCI Group	Control Group		
Age (y)		68.8±5.08	70.5±5.42	-1.23	0.221
Age(median) (IQR)		69(7)	70(9)		
Gender	Female	23(71.9)	18(56.2)	1.69	0.193
	Male	9(28.1)	14(43.8)		

IQR: Interquartile range.

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Table 2. EFs, manual dexterity, and IADLs scores in MCI and control groups

	Variables	Mean±SD		t	P*
		MCI	Control		
ToL	Total test time	265.9±51.1	174.4±48.7	5.7	<0.001
	Total delay time	53.2±15.4	68.8±30.9	-2.257	0.024
	Total number of errors	30.1±11.5	10.4±5.1	8.797	<0.001
	Total points	20.5±4.4	30.5±3.5	-6.441	<0.001
WCST	Number of categories	2.7±1.5	5.6±0.8	-6.286	<0.001
	Errors in persistence	10.3±5.3	1.3±1.2	6.822	<0.001
	Correct answers	36.1±5.3	41.3±3.6	-4.549	<0.001
	Incorrect answers	23.7±5.6	10.7±3.4	6.544	<0.001
	Duration	174.7±27.7	147±27.5	4.014	<0.001
	Conceptual responses	3.7±2.2	5.9±0.5	-4.92	<0.001
TMT-A		139.3±42.7	66.5±17.1	8.936	<0.001
TMT-B		4.8±1.2	1.8±1.7	5.777	<0.001
PPT	Dominant hand (right)	1.4±0.5	2.4±0.8	-4.514	<0.001
	Non-dominant hand (Left)	0.8±0.6	1.9±1.04	-4.095	<0.001
	Both hands	0.4±0.5	1.4±0.6	-5.137	<0.001
IADLs–Lawton		4.5±1.2	6.3±0.8	-5.204	<0.001

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Abbreviations: ToL: Tower of London; WCST: Wisconsin card sorting test; TMT: Trail making test; PPT: Purdue Pegboard test.

*Significant P<0.05.

IADLs in older adults with and without MCI

The MCI group scored lower than the control group using the IADLs-Lawton tool (t=-5.204; P<0.001), showing that individuals with MCI may struggle with higher-level functional activities, which could impact their independence level and overall quality of life (Table 2).

Relationships between EFs and manual dexterity

Spearman correlation in the MCI group revealed several associations with the third subtask of the PPT; ToL points correlated positively (r=0.529; P=0.002), indicating better PPT performance with higher ToL scores. Errors in persistence in WCST correlated negatively (r=-0.418; P=0.017), indicating that more errors were associated with poorer PPT performance. Correct answers in WCST showed a positive association (r=0.418; P=0.017), while incorrect answers in WCST had a negative correlation (r=-0.37; P=0.037), indicating better PPT performance with higher correct answers and lower incorrect answers. Longer TMT-A completion times were negatively associated with poorer PPT performance (r=-0.454; P=0.009), indicating a link between longer time and worse PPT performance (Table 3).

In the control group, the total test time in ToL negatively correlated with PPT subtasks one (r=-0.451; P=0.01) and three (r=-0.415; P=0.018), indicating slower ToL completion linked to poorer PPT performance. The total errors in the ToL were negatively correlated with PPT subtasks one (r=-0.573; P= 0.001) and two (r=-0.352; P=0.048), indicating that more errors were associated with poorer PPT performance. Higher total points in the ToL are associated with better performance in PPT subtask one (r=0.603; P<0.001). Errors in persistence

Table 3. Correlation of EFs with manual dexterity in MCI and control groups

	Variables	Right Hand (r)	P	Left Hand (r)	P	Both Hands (r)	P
ToL	Total test time (MCI group)	-0.248	0.172	0.166	0.362	-0.147	0.423
	Total test time (control group)	-0.451	0.01*	-0.334	0.062	-0.415	0.018*
	Total delay time (MCI group)	0.054	0.768	0.092	0.616	-0.075	0.683
	Total delay time (control group)	-0.125	0.494	0.188	0.302	-0.096	0.596
	Total number of errors (MCI group)	-0.309	0.085	0.06	0.746	-0.345	0.053
	Total number of errors (control group)	-0.573	0.001*	-0.352	0.048*	-0.279	0.122
	Total points (MCI group)	0.307	0.087	0.176	0.336	0.529	0.002*
	Total points (control group)	0.603	<0.001*	0.348	0.051	0.304	0.088
WCST	Errors in persistence (MCI group)	-0.014	0.941	-0.06	0.744	-0.418	0.017*
	Errors in persistence (control group)	-0.29	0.107	0.031	0.868	-0.35	0.049*
	Correct answers (MCI group)	0.082	0.657	-0.019	0.919	0.418	0.017*
	Correct answers (control group)	-0.495	0.004*	-0.417	0.017*	-0.21	0.249
	Incorrect answers (MCI group)	-0.051	0.781	0.073	0.692	-0.37	0.037*
	Incorrect answers (control group)	-0.435	0.013*	-0.162	0.377	-0.283	0.117
TMT	A-(MCI group)	-0.21	0.248	-0.048	0.793	-0.454	0.009*
	A-(control group)	-0.592	<0.001*	-0.494	0.004*	-0.575	0.001*
	B-(MCI group)	-0.049	0.791	0.062	0.734	-0.229	0.207
	B-(control group)	-0.658	<0.001*	-0.51	0.003*	-0.692	<0.001*

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Abbreviations: ToL: Tower of London; WCST: Wisconsin card sorting test; TMT: Trail making test; PPT: Purdue Pegboard test.

*Significant P<0.05.

in WCST negatively correlated with PPT subtask three (r=-0.35; P=0.049), and incorrect answers in WCST negatively correlated with PPT subtask one (r=-0.435; P=0.013), indicating more errors and incorrect answers linked to poorer PPT performance. TMT-A completion time negatively correlated with all PPT subtasks (subtask one: r=-0.592; P<0.001; subtask two: r=-0.494; P=0.004; subtask three: r=-0.575; P=0.001), and TMT-B errors negatively correlated with all PPT subtasks (subtask one: r=-0.658; P<0.001; subtask two: r=-0.51; P=0.003; subtask three: r=-0.692; P<0.001), showing higher completion time and errors in TMT associated with poorer PPT performance (Table 3).

Relationships between EFs and IADLs-Lawton

By performing Spearman correlation, it was shown that in the MCI group, total points were positively associated with the IADLs-Lawton score (r=0.425; P=0.015), indicating that the higher the total points participants had in the ToL, the higher their score in the IADLs. Persistence errors were negatively linked with the IADLs score (r=-0.538; P=0.002), indicating that the more individuals made perseveration errors in the WCST, the lower their score was in the IADLs. Correct answers were positively associated with the IADLs score (r=0.52; P=0.002), indicating that the more correct answers older adults had in the WCST, the higher their score in the IADLs. Incorrect answers were negatively correlated with the IADLs score (r=-0.454; P=0.009), indicating that the more individuals had incorrect answers in the WCST, the lower their score

Table 4. Correlation of EFs With IADLs

	Variables	IADLs-Lawton (r)	P
ToL	Total test time (MCI group)	-0.244	0.178
	Total test time (control group)	-0.116	0.526
	Total delay time (MCI group)	0.099	0.589
	Total delay time (control group)	-0.093	0.614
	Total number of errors (MCI group)	-0.325	0.071
	Total number of errors (control group)	-0.155	0.397
	Total points (MCI group)	0.425	0.015*
	Total points (control group)	0.029	0.874
WCST	Errors in persistence (MCI group)	-0.538	0.002*
	Errors in persistence (control group)	0.018	0.921
	Correct answers (MCI group)	0.52	0.002*
	Correct answers (control group)	-0.371	0.037*
	Incorrect answers (MCI group)	-0.454	0.009*
	Incorrect answers (control group)	-0.198	0.278
TMT	A-(MCI group)	-0.397	0.025*
	A-(control group)	-0.316	0.078
	B-(MCI group)	-0.049	0.791
	B-(control group)	-0.284	0.115

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Abbreviations: MCI: Mild cognitive impairment; ToL: Tower of London; WCST: Wisconsin card sorting test; TMT: Trail making test.

*Significant P<0.05.

was in the IADLs. TMT-A performance was negatively associated with the IADLs score (r=-0.397; P=0.025), indicating that the more time participants spent completing the TMT-A, the lower their score was on the IADLs (Table 4).

In the control group, correct answers were negatively associated with the IADLs score (r=-0.371; P=0.037), indicating that the more correct answers older adults had in the WCST, the lower their score was in the IADLs (Table 4).

Discussion

EFs in older adults with and without MCI

The findings of this study indicated that older adults with MCI exhibit significantly poorer EFs than cognitively healthy older adults. This is consistent with research indicating that individuals with MCI struggle with response inhibition, task switching, cognitive flexibility, and abstract reasoning—all key components of executive functioning. Additionally, studies have shown that individuals with MCI exhibited notable deficits in EFs, as measured by the Stroop test and the modified WCST (in terms of number of errors and perseverations), suggesting that these impairments reflect broader executive dysfunction in MCI [20, 21]. Another study demonstrated that patients with MCI show impairments in planning, problem-solving, and cognitive flexibility, as evidenced by their performance on the ToL and WCST [22]. This exhibition of poorer EFs in individuals with MCI results from structural brain atrophy, neurotransmitter deficits, disrupted neural networks, vascular damage, and failing compensatory mechanisms, which make it harder for MCI patients to perform tasks requiring planning, skill, working memory, and cognitive flexibility compared to cognitively healthy older adults [2, 23].

However, the results of a study revealed that older adults with amnestic MCI showed no significant differences from controls in performing certain executive tasks, such as the TMT-B. This may be attributed to the fact that amnestic MCI primarily affects memory-related brain regions (e.g. hippocampus and medial temporal lobes). At the same time, frontal lobe-dependent EFs may initially remain relatively unaffected [24]. Another study showed that individuals in the early stages of MCI performed normally on EFs tests. As the disease progresses, impairments in their EFs become apparent, which may be due to the early stages of MCI involving localized pathology (e.g. medial temporal atrophy), sparing frontal networks. However, as neurodegeneration spreads (e.g. extension to the prefrontal cortex), EFs decline [25].

Manual dexterity in older adults with and without MCI

The findings of this study showed that the MCI group performed worse in manual dexterity skills compared to the control group. A study indicated that patients with MCI exhibit deficits in fine motor control, as observed in their performance using the PPT in tasks involving picking up and inserting pins, which require precise finger and hand movements. The presence of these deficits was confirmed by a higher number of errors in the MCI group compared to the control group. Furthermore, errors such as dropping pins or incorrect pin selection were related to incorrect finger movements during task performance [26]. In another study [27], a decline in manual dexterity was observed in the MCI group using the PPT, which could indicate deterioration in the interactions between cognitive and motor functions. According to Rattanawan, this is due to neurodegeneration in individuals with MCI, which disrupts the integrative networks needed for skilled hand movements, particularly those involving executive-motor coordination [28].

However, the results of one study showed that performance based on manual dexterity tests (such as the Purdue Pegboard or grooved Pegboard) was similar in the MCI group and healthy older adults, especially in cases of amnestic MCI, which primarily affects memory and does not impact other cognitive domains. This may be due to the preservation of primary motor networks in the early stages of MCI; while motor impairments usually become apparent in more advanced stages [29].

IADLs in older adults with and without MCI

Based on the results of this study, the group with MCI performed worse on IADL activities compared to the control group, according to the IADLs-Lawton tool. Although studies confirm that patients with MCI have less ability to perform IADL activities compared to cognitively healthy individuals, the extent of this impairment may be too subtle for some measurement tools. For example, when assessing IADLs, the Lawton and Brody tools may lack sufficient sensitivity to detect minor but clinically significant changes [30]. Researchers [31] found that IADLs requiring greater cognitive resources are affected in individuals with MCI, and that MCI has a significant impact on IADLs, particularly in items related to financial management, use of transportation, and tasks related to household chores. This is because these complex activities require higher-level cognitive abilities such as planning, executive decision-making, and task switching, which are often impaired in patients with MCI. The findings of a decreased ability to perform IADLs highlight the need for early diagnosis and targeted interventions to maintain functional independence and optimize well-being in individuals with MCI [32].

Meanwhile, the results of the study [33] showed that compared to healthy older adult individuals, the group with amnestic MCI (those who only have memory impairment) did not exhibit a significant difference in IADLs performance. A significant decline in the ability to perform IADLs was observed only when MCI progressed to dementia.

Relationship between EFs and manual dexterity in older adults with and without MCI

In this study, a significant relationship was found between EFs and manual dexterity in both groups. A previous study [34] identified associations between hand function (measured by grip strength, finger tapping, and the Grooved Pegboard test) and cognitive abilities (EFs, attention, visuospatial skills, and processing speed) in older adults with MCI or dementia.

Moreover, studies have shown that weaker grip strength is associated with poorer cognitive performance, especially in processing speed and EFs [35, 36]. EFs are essential for manual skills, particularly for performing tasks that require fine motor control and coordination of both hands. The strong correlation between assessments of EFs and manual dexterity tests emphasizes the close relationship between cognitive and motor abilities in older adults. Impairments in EF (higher error rates, slower processing speed, and reduced cognitive flexibility) can lead to decreased movement accuracy and motor performance [37].

Although most studies confirm the relationship between EFs and manual dexterity in older adults with MCI, research [38] has reported that this relationship is weak or insignificant. Specifically, after controlling for diseases such as diabetes and arthritis, the association between EFs and manual dexterity in older adults with MCI decreased and became statistically insignificant, indicating that confounding variables, such as comorbid underlying diseases, influenced this relationship.

Relationship between EFs and IADLs in older adults with and without MCI

A significant relationship was observed between EFs and performing IADLs in both groups. The results of a study [33] showed that impairment in EFs is significantly associated with a reduced ability to perform IADLs, and this association is independent of disease diagnosis, cognitive impairment, memory function, and depression. Additionally, executive dysfunction was linearly related to a decline in IADL performance across each diagnostic group (healthy individuals, MCI, and mild Alzheimer's), highlighting the crucial role of EFs in maintaining independence in daily life. Additionally, the researchers noted that [2] difficulties in problem-solving, cognitive flexibility, and processing speed can lead to challenges in managing complex daily activities, such as handling finances and performing household tasks.

In contrast, some studies have not reported a significant relationship between EFs and IADLs in healthy older adults or individuals with MCI. A study [39] found that in cognitively normal older adults, the relationship between EFs (such as planning and response inhibition) and IADL performance became weak and non-significant after controlling for age and education level. This could be attributed to greater cognitive reserve in older adults with higher education levels. Healthy older adults with higher education levels or those who engage in regular mental activities may utilize compensatory mechanisms that help maintain their ability to perform IADLs, even in the presence of mild decline in EF.

Another study found that in the early stages of MCI, the decline in IADL performance is more strongly associated with impairments in memory and processing speed rather than EFs, as many IADLs (such as medication management) rely more on episodic memory (remembering timing and details) and processing speed (responding quickly to changes) rather than complex planning (EFs) [2].

The first limitation of this study was that, due to its cross-sectional design, it could not predict the long-term outcomes of cognitive impairment on motor function in older adults. The second limitation was the use of numerous tools to assess EFs, which could introduce bias into the results by causing fatigue in the participants, particularly in the MCI group. Third, since part of the sample was collected from a geriatric clinic, older adults often attended with their caregivers, and as a result, caregivers sometimes answered the questions on behalf of the older adults during the interviews.

Conclusion

This study demonstrated that older adults with MCI, compared to cognitively healthy peers, performed worse on EFs and manual dexterity tests and scored lower on the IADLs-Lawton tool. The significant correlation between EFs and manual dexterity indicated that, in general, the more time individuals spent completing EF tests and the more errors they made, the poorer their performance was on the manual dexterity test. Additionally, the significant correlation between EFs and IADLs showed that having a higher number of incorrect responses and lower scores on EF tests was associated with lower scores on the IADLs-Lawton tool. These results highlight the importance of assessing cognitive and motor abilities to facilitate early interventions and support to achieve independence. Combining cognitive and motor education programs with caregiver training can effectively address these challenges.

Ethical Considerations

Compliance with ethical guidelines

This study was approved by the Ethics Committee of Tehran University of Medical Sciences, Tehran, Iran (Code: IR.TUMS.MEDICINE.REC.1403.058). Regarding ethical considerations, eligible older adult participants who agreed to contribute to the study signed or fingerprinted an informed consent form. To further protect participants, interviews were conducted privately, and their rights and confidentiality were respected.

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Authors' contributions

Conceptualization, supervision and methodology: Hamid Dalvand and Mahtab Alizadeh-Khoei; Investigation: Fatemeh Salmani; Writing the original draft: Kosar Ghanbarian; Review and editing: All authors.

Conflict of interest

The authors declared no conflict of interest.

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