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The Effect of Levels of Leisure-Time Physical Activity on Cognitive Functions Among Older Adults with Mild Cognitive Impairment: A Longitudinal Analysis

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Abstract

One dementia prevention strategy that is effective for older adults is frequent participation in leisure time physical activity. However, research gaps exist in our understanding of the longitudinal relationship between different levels of leisure time physical activity participation and the cognitive function of older adults with mild cognitive impairment. Thus, we investigated this relationship using Health and Retirement Study data from 2012 to 2020. Results from Repeated Measures Multivariate Analysis of Covariance indicated that both the mid (Mean Difference = −0.45) and high level (Mean Difference = −0.82) leisure time physical activity groups showed higher levels of memory function compared to the low-level leisure time physical activity group. Additionally, the mid (Mean Difference = −0.21) and high level (Mean Difference = −0.37) leisure time physical activity groups reported better working memory function, and the mid (Mean Difference = −0.02) and high level (Mean Difference = −0.02) leisure time physical activity groups showed higher levels of attention and processing speed than the low-level leisure time physical activity group. These findings suggest that older adults with mild cognitive impairment who engage either vigorously or moderately in leisure time physical activity (more than three times a week) experience improvements in cognitive function compared to those who do not. This study provides valuable insights for clinicians on the optimal level of leisure time physical activity required to mitigate cognitive decline in older adults with mild cognitive impairment.

Keywords

aged, cognitive dysfunction, leisure activities, health behavior

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Introduction

More than 7 million people aged 65 and over in the US had dementia in 2020, and it is projected that more than 9 million could be living with dementia by 2030 and nearly 12 million by 2040 (Alzheimer's Association, 2023). Due to an increasing number of people living with dementia (PLwD), a new goal was initiated by the National Plan to Address Alzheimer's Disease (National Plan) to "accelerate action to promote healthy aging and reduce the risk factors for Alzheimer's disease and related dementias" to help reduce the risk of dementia or delay the progression of AD/ADRD (Omura et al., 2022). In 2023, healthcare, long-term care, and hospice care for PLwD will cost the nation $345 billion, costs that are projected to increase to nearly $1 trillion in 2050 (Alzheimer's Association, 2023). Therefore, multiple stakeholders including researchers, policy makers, and governments will be called upon to design and develop practical solutions to delay or prevent cognitive decline among geriatric populations.

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Dementia is developed by an estimated 10% to 20% of people with mild cognitive impairment (MCI) within 1 year (Bruscoli & Lovestone, 2004; Öksüz et al., 2024; Panza et al., 2005; Petersen, 2004), and 80% to 90% after approximately 6 years (Busse et al., 2006). Although MCI tends to progress to dementia within 2 to 5 years (Petersen et al., 2018), it should be noted that people with MCI may not necessarily develop dementia and may even recover from MCI back to normal cognition (Salzman et al., 2022). According to recent empirical studies, people with MCI were able to return to a normal cognitive state after receiving 1 year of intervention (Salzman et al., 2022; Sanz-Blasco et al., 2022; Shimada et al., 2019).

The importance of non-pharmacological interventions, including cognitive, and memory training, as well as physical activity and exercise, has been stressed in several systematic reviews and meta-analyses to prevent or delay the onset of cognitive impairment (Smart et al., 2021; Yao et al., 2020). For example, Katayama et al. (2021) found that community-dwelling older adults with MCI who continued to participate in multidomain lifestyle activities including sports activities were more likely to report reversion from MCI to normal cognition. These studies demonstrated the importance of non-pharmacological approaches to reducing cognitive decline and the risk of developing dementia. Thus, it is critically important to design, develop, and implement these preventative strategies so that MCI progression and cognitive decline can be delayed or prevented in older adults.

One effective dementia prevention strategy for older adults is to frequently participate in leisure time physical activity (LTPA). There is substantial evidence that suggests that participation in LTPA can improve cognitive function in older adults. For example, Hamer and Chida (2009) conducted a systematic review of 16 prospective studies and demonstrated that high intensity physical activity was significantly associated with reducing the risk of dementia. They suggested that participation in regular exercise programs can be effective in improving vascular health, brain function, and cognitive function. In addition, Li et al. (2023) investigated the relationship between the level of LTPA participation and cognitive function and found that cognitive function in older adults increased with increasing levels of LTPA participation. Given the increasing prevalence of physical inactivity and functional limitations in older adults (Boente Antela et al., 2020; Leirós-Rodríguez et al., 2018), there is a need to encourage regular physical activity in this population, as it can mitigate the risk of cognitive decline.

Despite many noteworthy findings from existing research, considerable research gaps exist in the understanding of the longitudinal relationship between levels of LTPA participation (i.e., mild, moderate, and vigorous) and the cognitive function of older adults with MCI. Prior studies have focused on a cross-sectional relationship between LTPA participation and the cognitive health of older adults with and without cognitive decline (Kim et al., 2022; Ku et al., 2012), and have provided researchers with results with limited generalizability about the effects of LTPA participation on cognitive health. Clinical trials that investigated the effects of LTPA participation on cognitive health presented evidence on the effects of exercise programs on the cognitive function of people with MCI (Gates et al., 2013). Still, these clinical trials lacked empirical evidence describing which levels of LTPA participation led to the improvement of cognitive function in older adults with MCI and measured only verbal fluency as a cognitive outcome, not executive measures such as memory or information processing.

Thus, the purpose of this study was to investigate the longitudinal relationship between different levels of LTPA participation and the cognitive function of older adults with MCI. Based on previous studies (J. Lee et al., 2023), LTPA included exercise, sports, and leisure walking, and the level of LTPA participation was categorized as either low, middle, or high. This study focused on memory, working memory, and attention and processing speed, the three main cognitive domains that were measured as cognitive outcomes in the findings of previous studies (Amano et al., 2022; Crimmins, Kim, Langa, et al., 2011; Y. Lee et al., 2019; Ofstedal et al., 2005; Williams et al., 1996). This longitudinal study will provide researchers and healthcare providers with valuable information on the most effective LTPA intensity level for cognitive function improvement in older adults with MCI, and add empirical evidence to the literature on the importance of LTPA participation as a dementia prevention strategy.

Methods

Data Source

This longitudinal study employed Health and Retirement Study (HRS) data collected biannually between 2012 and 2020 that has been published by the Institute of Social Research at the University of Michigan since 1992. The HRS collects data on multiple domains including a wide range of information describing the demographic characteristics, physical health, mental health, and socioeconomic status of Americans. The survey forms have maintained a similar structure even as the questions have been updated and modified from the first year of data collection.

The reason we used the data from 2012 to 2020 is that each data set during that time span included similar questions. The data collection was implemented under a specific protocol by the HRS that allows for follow up with the survey respondents continuously from the date they entered the survey pool. HRS data is structured based on households and their family members. The HRS designates a permanent Household Number (HH) and assigns a Person Identification Number (PN) to each family member in each household. Household changes are reflected in the PN such as death, birth, or divorce. For example, if an HH has four family members and a baby is born, the four original family members are designated as PN1, PN2, PN3, and PN4, and the newborn is added to the HH as PN5.

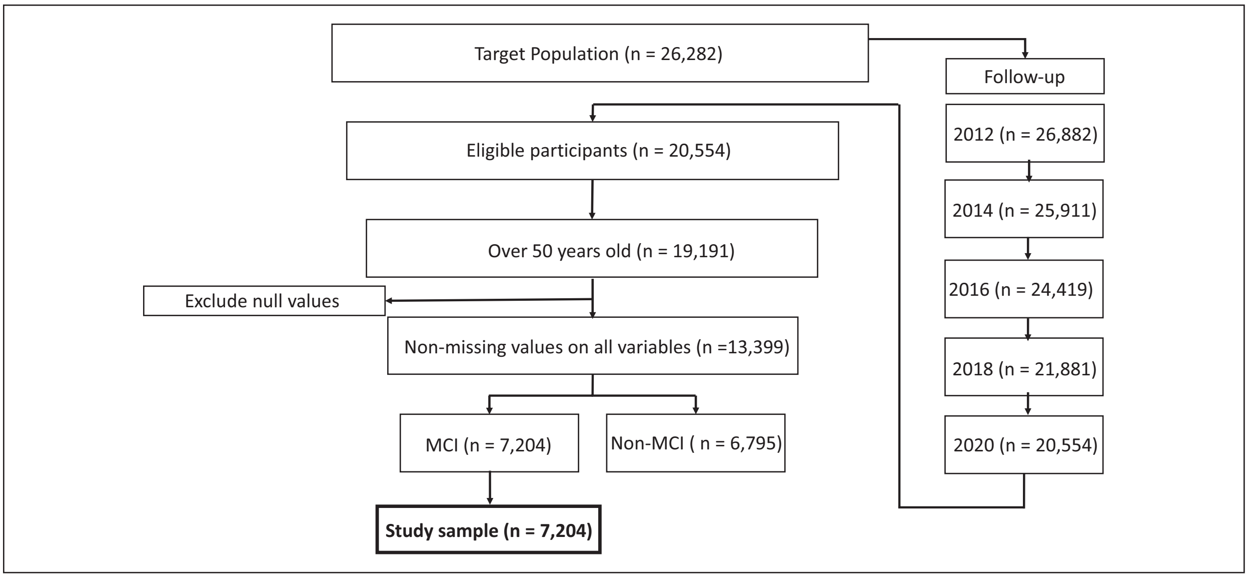

Figure 1. Flow chart of the longitudinal follow-up of study participants.

Data Reliability

The HRS employs two methods, Patient-Reported Outcome (PRO) and Proxy-Measured Outcome (PMO) strategies for data collection, with the choice determined by the interviewer based on the responsiveness of the interviewee. If consistent engagement was observed, PRO was chosen, if not, PMO involving caregiver input was used for unresponsive or unreliable interviewees. Thus, PRO data reflects independent responsiveness in interviewees that enables users to evaluate the reliability of responses. Individuals designated for PRO responses were considered reliable, irrespective of the presence of a dementia diagnosis.

Study Sample

The single inclusion criterion of this study was whether a potential participant had been evaluated to have met the criteria for having MCI. The HRS employed a consistent cognitive assessment approach using the Telephone Interview for Cognitive Status-27 (TICS-27) in both the PRO and PMO approaches (Crimmins, Kim, & Solé-Auró, 2011; Herzog & Wallace, 1997). The TICS-27 consists of cognitive tests that evaluate the three domains of cognitive function: memory, working memory, and attention and processing speed. The total cognitive function score was calculated by summing the three cognitive function test results (range 0–27). The integrated cognitive function scale has been found to satisfy the validity and reliability criteria for assessing cognitive status and screening for MCI in large cohort studies.

A TICS-27 score of 6 or lower indicates the presence of dementia, while a score between 7 and 11 suggests cognitive impairment without meeting the dementia threshold, which is commonly referred to as MCI. Scores ranging from 12 to 27 are considered within the normal cognitive status range as established by previous studies (Crimmins, Kim, Langa, et al., 2011; Herzog & Wallace, 1997). Consequently, this study included participants with scores ranging from 7 to 11 on the TICS-27. Information about the detailed formulation of each cognitive function test is provided in the instrument section as a part of the description of the dependent variables.

Figure 1 illustrates the overview of the longitudinal study sample follow-up. Study participant tracking was implemented using the following steps: (a) a baseline year of 2012, (b) merge 2012 to 2020 data, (c) study participants must be over 50 years of age in 2012, and (d) study participants should have MCI in 2012. Using a cut-off of 50 years old in this study is important because cognitive decline can begin in midlife, and early detection allows for timely intervention (Jung et al., 2017). The exclusion of participants younger than age 50 helps identify the impact of LTPA on cognitive function before significant decline occurs (Kim et al., 2022) and ensures that the study captures the early stages of mild cognitive impairment, which is crucial for developing effective preventative strategies (X. Xu et al., 2022). The total study sample of this study consisted of 7,204 participants.

Instruments

Independent Variables. The HRS provides information about 21 types of leisure activities in the Psycho-Social section (i.e., LB). We used two questions to construct the LTPA variable: “Play sports or exercise” and “Walk 20 minutes or more” (Lee et al., 2022). The items measured activity participation using a seven-point Likert scale ranging from 1 = “Daily” to 7 = “Never relevant.” We reverse-coded the instrument so that a high score indicated a high level of LTPA participation.

We then calculated the total amount of LTPA participation from 2012 to 2020 and categorized study participants into three groups reflecting their level of LTPA participation: low, mid, and high groups. The classification criteria followed the convention used in previous studies based on a seven-point Likert scale: low group = 1 to 2, mid group = 3 to 5, and high group = 6 to 7 (Clarke & Janssen, 2013; J. Lee et al., 2022; Ramadan & Barac-Nieto, 2003).

Dependent Variables. The study assessed three cognitive functions—memory, working memory, and processing speed—annually from 2012 to 2020 using the TICS-27. These assessments were incorporated into the dependent variable based on a time-sequenced, time-variant model.

Memory. The memory domain was measured using both immediate and delayed recall tests. Study participants were asked to recall as many words as they could remember immediately after seeing 10 random words in the immediate recall test (e.g., water, fruit, flower). In the delayed recall test, the same test procedure was conducted, and participants were asked to recall as many words from the list of 10 words as they could after 5 min. Each correct answer earned one point in both tests and resulted in a total memory score that ranged from 0 to 20.

Working Memory. The working memory domain represents the cognitive function of processing and storing information simultaneously. A seven-subtraction test was used to measure this domain. Study participants were asked to subtract 7 from 100 continuously in 5 trials (e.g., 100 − 7 = 93, 93 − 7 = 86, 86 − 7 = 73). The score ranged from 0 to 5 reflecting the number of correctly completed trials.

Attention and Processing Speed. A counting backward test was used to measure attention and processing speed (Crimmins, Kim, Langa, et al., 2011; Ofstedal et al., 2005). Participants were asked to count backward for 10 continuous numbers from 20 in two trials (e.g., 20, 19, 18, 17). Each trial was worth one point and respondents were able to earn a total of two points in this test.

Covariates

Age and Sex. This study used age and sex as covariates. Covariate analysis increases the precision of estimating a particular coefficient if covariates are predictive of the outcome and not highly correlated with the variable whose coefficient is being estimated (Strawbridge et al., 1999). Thus, age and sex were entered into the analysis as covariates at the baseline (i.e., 2012).

Analysis. We used a Repeated Measures Multivariate Analysis of Covariance to investigate the longitudinal group mean differences of the three cognitive functions following different levels of LTPA participation. First,

Table 1. Demographic Variables.

Characteristics	*n*	%
Age		
50 to 109 years old (mean = 77.19, SD = 11.34)	7,204	100
Sex		
Male	3,078	42.7
Female	4,126	58.3
Marital status		
Married	3,975	55.2
Living with a partner	395	5.5
Separated	892	12.4
Divorced	1,368	19.0
Widowed	553	7.6
Never married	21	0.3
Independent variables		
Leisure-time physical activity low-level participation group	2,877	39.9
Leisure-time physical activity mid-level participation group	2,563	35.6
Leisure-time physical activity high-level participation group	1,764	24.5

Note. Total *n* = 7,204.

Mauchly's Test of Sphericity was used to test the sphericity assumptions in the merged data set from 2012 to 2020. This test evaluates whether the variances in the differences between all within-subjects pairs (i.e., independent variables) are equal. We found Mauchly's test was significant and alternatively used Greenhouse-Geisser epsilon to evaluate the differences in the measures of the three cognitive functions associated with the three levels of LTPA participation. We then displayed the changing trend of the three cognitive functions in the three LTPA groups based on the estimated marginal means from 2012 to 2020. All statistical analyses were conducted using the SPSS 29.0 statistical package.

Results

Table 1 summarizes the demographic characteristics of the older adult participants with MCI. Participant age ranged from 50 to 109 years (M = 77.19, SD = 11.34). The study sample was 42.7% (n = 3,078) male and 58.3% (n = 4,126) female. Approximately half of the study sample was married (55.2%), 12.4% were living with a partner, and 19% were divorced. 39.9% of participants were found to belong to the low LTPA participation group (n = 2,877), 35.6% in the mid LTPA participation group (n = 2,564), and 24.5% in the high LTPA participation group (n = 1,764).

Descriptive statistics of the three cognitive functions measured from 2012 to 2020 are summarized in Table 2. Memory function declined from 2012 (M = 9.55, SD = 3.55) to 2020 (M = 8.49, SD = 3.59). Working memory was not found to increase or decrease consistently during the study period, although it did increase

Table 2. Descriptive Statistics of Cognitive Functions.

Variables	Mean	SD
Dependent variables		
Memory 12	9.55	3.55
Working memory 12	1.58	1.55
Attention and processing speed 12	0.87	0.33
Memory 14	8.22	3.30
Working memory 14	2.69	2.02
Attention and processing speed 14	0.88	0.33
Memory 16	7.88	3.23
Working memory 16	1.95	1.85
Attention and processing speed 16	0.85	0.35
Memory 18	8.43	3.33
Working memory 18	2.00	1.89
Attention and processing speed 18	0.78	0.41
Memory 20	8.49	3.59
Working memory 20	2.06	1.92
Attention and processing speed 20	0.74	0.43

Note. Total $n = 7{,}204$.

overall from 2012 ($M = 1.58$, SD = 1.55) to 2020 ($M = 8.49$, SD = 3.59). Attention and processing speed was found to have a declining slope from 2012 to 2020 ($M = 0.86$, SD = 0.33) to 2020 ($M = 0.74$, SD = 0.43).

The results of the sphericity test (Mauchly's assumption) for homoscedasticity of variance is shown in Table 3. The homoscedasticity of variance was not satisfied in five sets of data from 2012 to 2020 for memory (Mauchly's = 0.69, $p < .05$), working memory (Mauchly's = 0.56, $p < .05$), or attention and processing speed (Mauchly's = 0.97, $p < .05$). We then used the Greenhouse-Geisser univariate test that resulted in a value of 0.81 in memory, 0.73 in working memory, and 0.98 in attention and processing speed.

The Greenhouse-Geisser univariate test (Table 4) was used to investigate the group mean differences in the three cognitive functions measured. The test assessed the interaction between covariates (age and sex) and LTPA participation. The interaction between time and age was significant but the interaction between time and sex was not significant except for memory function. The interaction between time and LTPA participation level was found to be significantly different in memory ($F = 5.77$, $df = 6.52$, $p < .05$) and working memory ($F = 6.26$, $df = 5.87$, $p < .05$), but not in attention and processing speed ($F = 1.31$, $df = 7.87$, $p > .05$).

Table 5 summarizes the result of the Bonferroni post-hoc test that was used to investigate group the mean differences in the three LTPA participation groups (low, mid, and high levels). First, the mid (MD = −0.45, $p < .05$) and high level (MD = −0.82, $p < .05$) LTPA participation groups were found to have higher levels of memory function than the low level LTPA participation group, and the high-level LTPA participation group (MD = −0.37, $p < .05$) was found to have a higher level of memory function than mid-level LTPA participation group. Second, the mid (MD = −0.21, $p < .05$) and high level (MD = −0.37, $p < .05$) LTPA participation groups showed higher levels of working memory function than the low level LTPA participation group, and the high-level LTPA participation group (MD = −0.16, $p < .05$) was found to have a higher level of working memory function than mid-LTPA group. Third, the mid (MD = −0.02 $p < .05$) and high level (MD = −0.02, $p < .05$) LTPA participation groups were found to have higher levels of attention and processing speed functioning than did the low level LTPA participation group. However, no group difference in attention and processing speed function was found between the mid and high level LTPA participation groups.

Figure 2 illustrates the trend of memory function based on the estimated marginal mean scores for the three LTPA participation groups from 2012 to 2020. The high level LTPA participation group consistently showed a higher level of memory function compared to the mid and low level LTPA participation groups throughout the observed period. Specifically, the low level LTPA participation group exhibited a steep decline in memory function between 2012 and 2016, indicating a significant deterioration. In contrast, the high level LTPA participation group showed a smaller decline, demonstrating the protective effect of high levels of LTPA participation on memory function. Notably, between 2016 and 2018, the high level LTPA participation group experienced a rebound in memory function as evidenced by the highest positive slope coefficient among the three groups, evidence that suggests a recovery or improvement phase.

Table 3. Model Fit Test.

Within Subjects Effect	Mauchly's	*df*	Sig.	Epsilon: Greenhouse-Geisser	Epsilon: Huynh-Feldt
Memory	0.69	9	.00	0.81	0.81
Working memory	0.56	9	.00	0.73	0.74
Attention and processing speed	0.97	9	.00	0.98	0.98

Note. Design: Intercept + Age + Sex + Leisure-Time Physical Activity. Epsilon was used to adjust the degrees of freedom for the averaged tests of significance.

Table 4. Adjusted Univariate Test (Greenhouse-Geisser Correction).

Source	Dependent variable	Type III sum of squares	*df*	Mean square	*F*	η^2_p	Observed power	Sig.
Time	Memory	1,401.88	3.26	429.88	46.79	0.02	0.99	.00*
	Working memory	222.42	2.93	75.78	22.87	0.02	0.95	.00*
	Attention	0.78	3.94	0.19	2.63	0.01	0.65	.03*
Time*age	Memory	2,049.55	3.26	628.64	66.95	0.03	0.99	.00*
	Working memory	108.96	2.94	37.13	11.21	0.01	0.85	.00*
	Attention	0.85	3.93	0.22	2.89	0.01	0.70	.02*
Time*sex	Memory	326.02	3.26	99.99	10.65	0.01	0.80	.00*
	Working memory	5.32	2.94	1.81	0.54	0.01	0.20	.65
	Attention	0.16	3.94	0.04	0.55	0.01	0.20	.69
Time*LTPA	Memory	353.49	6.52	54.21	5.77	0.02	0.90	.00*
	Working memory	121.87	5.87	20.76	6.26	0.01	0.90	.00*
	Attention	0.78	7.87	0.09	1.31	0.01	0.70	23
Error (time)	Memory	6,9306.00	7,381.29	9.39				
	Working memory	22,015.09	6,633.57	3.31				
	Attention	669.63	8,916.73	0.07				

*$p < .05$.

Table 5. Post-hoc Test for LTPA.

Dependent variable	LTPA (I) (adjusted mean)	LTPA (J) (adjusted mean)	Mean difference (I–J)	Sig.	Bonferroni
Memory	Low (8.20)	Mid (8.66)	−0.45	.00*	Mid > Low
		High (9.03)	−0.82	.00*	High > Low
	Mid	High	−0.37	.00*	High > Mid
Working memory	Low (1.84)	Mid (2.04)	−0.21	.00*	Mid > Low
		High (2.21)	−0.37	.00*	High > Low
	Mid	High	−0.16	.01*	High > Mid
Attention and Processing speed	Low (0.88)	Mid (0.91)	−0.02	.03*	Mid > Low
		High (0.91)	−0.02	.04*	High > Low
	Mid	High	0.00	1.00	High = Mid

Note. Bonferroni post-hoc test.
*$p < .05$.

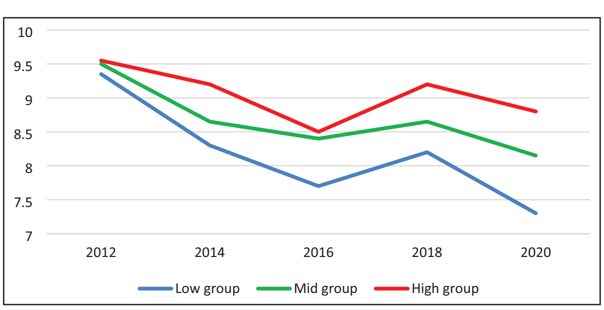

Figure 2. Estimated marginal means memory.

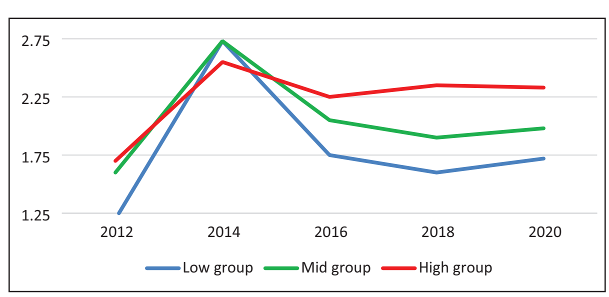

Figure 3. Estimated marginal means working memory.

This pattern highlights the beneficial impact of sustained high levels of LTPA participation on maintaining and enhancing memory function over time.

Figure 3 summarizes the changes in working memory function. The low level LTPA participation group exhibited a sharp decline in working memory after 2014,

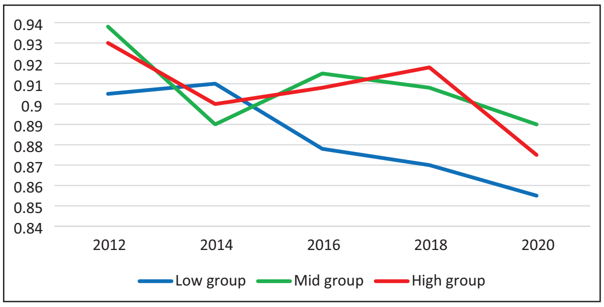

Figure 4. Estimated marginal means attention and processing speed.

with the lowest values observed in 2016, followed by a slight improvement by 2020. The mid and high level LTPA participation groups both peaked in 2014, but the high-level participation group maintained relatively stable working memory levels from 2014 to 2020, while the mid-level participation group experienced a decline after 2014 that stabilized at a lower level than the high-level LTPA participation group but higher than the low level LTPA participation group.

Figure 4 summarizes the estimated attention and processing speed marginal means for the three LTPA participation groups from 2012 to 2020. The low level LTPA participation group consistently showed a decline in attention and processing speed over the study period, while the mid and high level LTPA participation groups initially had fluctuations but also declined overall over the study period. The mid-level LTPA participation group showed higher numbers in 2012 and 2020 than the high-level participation group, while the high-level participation group performed better in attention and processing speed in 2014 and 2018 than did the mid-level LTPA participation group. This result is aligned with the findings in Table 5 in that there were no differences in the mean scores of the mid and the high-level LTPA participation groups in attention and processing speed.

Discussion

The purpose of this study was to investigate the longitudinal relationship between different levels of LTPA participation and three cognitive functions (memory, working memory, and attention and processing speed) in older adults with MCI. Our results indicate that the high-level LTPA participation group was found to have higher levels of memory, working memory, and attention and processing speed than did the mid and low-level LTPA participation groups, and the mid-level LTPA participation group was found to have higher levels of cognitive functioning than the low-level LTPA participation group. These results show that older adults with MCI who have either vigorously or moderately engaged in LTPA, (more than three times a week) were found to exhibit higher levels of cognitive function than those who did not with the exception of attention and processing speed. These results contribute to filling existing gaps in previous studies by: (a) investigating how different levels of LTPA participation benefit cognitive function in older adults experiencing MCI symptoms, (b) investigating specific cognitive functions rather than universal cognition, and (c) tracking the changes in each cognitive function from 2012 to 2020 in members of the three LTPA participation group levels. Overall, this study provides evidence supporting the encouragement of leisure-time physical activity (LTPA) participation by older adults with MCI as an intervention that improves cognitive functioning.

Previous studies have highlighted the positive relationship between LTPA engagement, cognitive function, and brain health in older adults with MCI by demonstrating its capacity to enhance brain metabolism (i.e., blood flow, hormone levels) and cognitive functioning (Kempermann et al., 2010; Li et al., 2023; Sala et al., 2019; Wang et al., 2012). The findings of our study are aligned with these prior findings in that they provide evidence that LTPA participation can significantly improve cognitive function in older adults with MCI. However, previous research provided limited information about the optimal frequency of LTPA participation necessary for cognitive improvement. Our study expands on the existing literature and addresses this gap by comparing the cognitive benefits associated with different levels of LTPA participation. We found that older adults with MCI who engaged in LTPA more than three times a week demonstrated higher levels of cognitive function than those who participated less frequently. Considering the growing prevalence of physical inactivity among older adults, which contributes to the risk of cognitive decline (Boente Antela et al., 2020; Leirós-Rodríguez et al., 2018), these findings are valuable for the creation of clinical interventions that are designed to enhance specific cognitive function domains for older adults with MCI. Our study also provides a clinical reference that health professionals can use to design a physical activity intervention that will strengthen cognitive function by delaying cognitive decline in older adults with MCI.

Compared to previous clinical and cross-sectional studies, the results of this longitudinal study, based on an updated dataset, significantly contributes to enhancing the reliability of the data describing the cognitive health benefits associated with LTPA participation. Prior investigations in this field have often relied on quasi experimental and cross-sectional approaches that limited the generalizability of their findings (Geda et al., 2012; Hsu et al., 2018; W. Xu et al., 2017). Our study addressed this gap by establishing a longitudinal relationship between different levels of LTPA participation and cognitive function. Further, we provided visualized results that tracked changes in the cognitive function of respondents with MCI who engaged in LTPA at three different levels from 2012 to 2020 (see Figures 2–4). These figures offer a comprehensive overview of changes in cognitive function that have significant potential to be of value to clinical practitioners as they provide a deeper understanding of the necessity of LTPA for older clients with MCI.

Despite the well-documented health benefits associated with engaging in LTPA, older adults diagnosed with MCI encounter barriers that impede their participation that include limited resources, accessibility challenges, and financial constraints that are compounded by psychological factors including motivational deficits, negative mood, and depression (P. Hobson et al., 2016; N. Hobson et al., 2020). Further, independent engagement in any form of activity is particularly challenging for older adults with MCI who lack the support of a caregiver (Domingues et al., 2018; Spitzer et al., 2019). Caregivers not only assist with daily living tasks but also play an important role in motivating individuals with MCI to maintain their LTPA engagement levels. Unfortunately, caregiving services come at a substantial financial cost that in many cases prevents older adults with MCI from participating in LTPA (Zhu et al., 2017). To address this issue, the establishment of public healthcare services and related financial or voucher support is imperative (Domingues et al., 2018; Spitzer et al., 2019). These subsidies are crucial not only to the provision of caregiving support but also to encouraging and enabling older adults with MCI to participate in LTPA. Healthcare providers and caregivers working with older adults living with MCI should actively promote regular engagement in LTPA as an integral component of complementary treatment, while also recognizing and working to mitigate the barriers that can hinder participation.

Individualized LTPA programs are necessary to meet the unique needs and preferences of participants. Our research underscores the varied impacts of different levels of LTPA participation on cognitive functioning and highlight the necessity for an individualized approach that considers the cognitive abilities and preferences of participants (Shryock & Meeks, 2022). A wide range of activity options such as gate ball, pickleball, Tai Chi, and mindfulness based LTPA should be accessible to those with lower levels of cognitive function. Additionally, more challenging activities should be made available for participants pursuing active cognitive function management (Arthanat et al., 2016; Han et al., 2016). A diverse LTPA program offered at different intensities not only optimizes the benefits of engagement, but it will also enhance the overall experience for older adults living with MCI (Tamminen et al., 2020). LTPA participation fosters a sense of autonomy and empowerment and enables participants to choose activities that align with their abilities and interests that promotes cognitive growth and skill development without causing frustration that can affect motivation to participate (Kim et al., 2017; Siefken et al., 2019; Tamminen et al., 2020). By adopting this individualized strategy, LTPA programs can effectively address the cognitive decline experienced by older adults with MCI.

The results of our study are subject to several limitations that must be mentioned. Our study used objective MCI criteria measured by the MoCA test (Herzog et al., 1997; Y. Lee et al., 2019). However, different types of MCI were not considered when the study screened older adult participants for MCI. Four types of MCI (e.g., amnestic, non-amnestic, single domain, and multiple domain) manifest different behavioral and psychological symptoms of dementia (BPSD) and a different progression of MCI to dementia (Petersen et al., 2018; Şahin Cankurtaran, 2014). Investigating older adults with a specific type of MCI may present different outcomes compared to focusing on older adults with undifferentiated MCI. Second, this study exclusively focused on older adults with MCI without comparing them to older adults with typical cognitive function. While our findings demonstrate the positive impact of LTPA participation on the cognitive function of older adults with MCI, a comparative analysis between older adults with and without MCI would allow researchers to discern the specific benefits of LTPA for the MCI population. Such a comparison is critical to achieving a more nuanced understanding of the unique advantages that LTPA participation can offer to older adults living with MCI and provides invaluable insights for future research and intervention design.

Third, this study did not consider all possible confounding factors that may affect the impact of LTPA participation on cognitive function in older adults with MCI. It is important to note that cognitive function decline is also influenced by lifestyle, health conditions, and health behaviors such as participation in LTPA programs. For example, the cognitive decline of respondents during the study period might have created individual variations in individual motivation to participate in LTPA programs that could have influenced our study results (Davis & Calamia, 2023; Eshkoor et al., 2015). Additionally, unexpected life events, including accidents, disease, and family member changes from 2012 to 2020, were not entered into the analysis (Brooks et al., 2007; Teixeira et al., 2012). Environmental factors, such as socioeconomic status and access to healthcare services were also not considered, which may also have potentially affected study outcomes (Galvan et al., 2021). Lastly, various forms of leisure activities such as recreational sports, outdoor pursuits, and walking, may have different effects on cognitive functioning in older adults (Sala et al., 2019). However, our study did not explore the specific impacts of different types of LTPA on cognitive function. Therefore, future research should examine which types of LTPA are more or less effective in preserving or enhancing cognitive function in older adults.

Conclusion

We investigated the longitudinal relationship between different levels of LTPA participation and the cognitive functioning of older adults with MCI. Our findings contribute to filling the gaps in previous research regarding the benefits of different levels of LTPA participation and the effect of different levels of LTPA on three distinct cognitive functions.

Moreover, this study provides clinical guidance regarding the optimal level of LTPA participation that can be used to address the cognitive decline experienced by older adults with MCI. LTPA participation has been found to be highly associated with the promotion of improved cognitive functioning, and engaging in LTPA over three times a week was identified as the optimal frequency that can be used to enhance each cognitive function domain. Health professionals and practitioners can use this guideline to design behavioral intervention programs that will improve specific cognitive functions in their clients. Additionally, efforts to overcome barriers related to LTPA participation through referrals to public healthcare services and individualized programs, will contribute to enhancing the wellbeing and life satisfaction of older adults with MCI.

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Ethical Approval

The Institutional Review Board of the sponsoring institution reviewed and approved the research protocols used to create and conduct the ongoing Health and Retirement Study. Additional IRB approval to conduct the secondary data analysis used in this study was not required as human subjects research was not involved.

Informed Consent

Informed consent was collected from respondents when data collection was originally conducted precluding the need for the collection of an additional informed consent form for this study.

Data Availability Statement

The datasets generated and analyzed during the current study are available at: https://hrs.isr.umich.edu/

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