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Cognitive Function in Midlife and Beyond: Physical and Cognitive Activity Related to Episodic Memory and Executive Functions

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Abstract

This study seeks to examine the relationships between physical activity (PA), cognitive activity, and cognitive function for the purpose of developing future brain-fitness programs. A sample of 2,305 participants (age = 50–84, mean age: 63.1 years) was selected from the Midlife in the United States longitudinal study for analysis. The strength of the associations between the dependent variables (episodic memory and executive functions) and independent variables (three domains of PA and cognitive activity) were determined by hierarchical regression. Episodic memory regressed positively on leisure-time PA (LPA) and cognitive activity. Executive functions regressed positively on LPA and Cognitive activity, but negatively on job-related PA (JPA). The interaction effect (JPA × Cognitive activity) was nonsignificant. Community-dwelling participants are encouraged to engage in more LPA and cognitive activity to increase brain fitness. Further research may explore the distinctive effects of JPA.

Keywords

aging, physical activity, cognitive activity, episodic memory, executive functions

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Introduction

Current knowledge postulates subtle cognitive changes are detectable years before meeting the criteria for mild cognitive impairment. These changes could be used as a predictor to the progression of dementia (Sperling et al., 2011). Some studies propose the need to identify midlife factors associated with cognitive aging (Hughes & Ganguli, 2010; Singh-Manoux & Kivimaki, 2010). Studies have also found amyloid deposition and cognitive memory markers change relatively early in the course of Alzheimer's disease (AD) (Braak & Braak, 1991; Frisoni, Fox, Jack, Scheltens, & Thompson, 2010). Accordingly, researchers have suggested adopting healthy lifestyle to reduce the risk of cognitive deterioration or dementia preferably starting in or before middle age (Grouphealth, 2009; Lee, Hsiao, & Wang, 2013).

Numerous studies argue that episodic memory and executive functions are significantly related to dementia (Buschke, Sliwinski, Kuslansky, & Lipton, 1997; Dubois, Feldman, & Jacova, 2007; Inoue et al., 2012; Lezak, 1983; McGuinness, Barrett, Craig, Lawson, & Passmore, 2010; Pennington, Hodges, & Hornberger, 2011; Petersen, Smith, Ivnik, Kokmen, & Tangalos, 1994; Schroeter et al., 2012; Vogel, Mortensen, Gade, & Waldemar, 2007). Some suggest that episodic memory tests, such as cued recall, may be particularly effective in the diagnosis of early AD (Buschke et al., 1997; Dubois et al., 2007; Petersen et al., 1994; Vogel et al., 2007). Executive functions control the planning, sequencing, and execution of complex goal-directed activities (Lezak, 1983). In early dementia, executive deficits are attributed to the inferior frontal junction area (McGuinness et al., 2010; Schroeter et al., 2012). Another possible cause may be functional disconnection in the central neural network that supports the executive system (Inoue et al., 2012).

Epidemiological studies reveal physical inactivity is related to many psychological and physical health problems including, but not limited to, depression, diabetes, cardiovascular disease, hypertension, colon cancer, osteoarthritis, osteoporosis, and mortality (de Geus & de More, 2008; Haskell et al., 2007; Kilbourne et al., 2009; Lee, 2013; Lee, Lan, & Lee, 2012). The role of physical activity (PA) on cognitive function seems inconclusive. Some researchers suggest that PA serves as protection against memory loss, dementia, and cognitive impairment (Doaga & Lee, 2008; Flöel et al., 2010; Lee et al., 2013). Others assert the protective effects of PA on cognitive impairment or dementia as overly optimistic (Morgan et al., 2012; Plassman, Williams, Burke, Holsinger, & Benjamin, 2010). In a 16-year of follow-up Caerphilly Prospective Study longitudinal data, Morgan et al. compare the effects of leisure-time and work-related PA on dementia and cognitive impairment not dementia. By age-adjusted models, they conclude that PA has no statistical association with dementia, and the increasing risk for cognitive impairment not dementia is attenuated after adjustment for other confounders.

Furthermore, the three types of PA (leisure-time PA [LPA], household PA [HPA], and job-related PA [JPA]) have been individually linked to preventing various diseases, such as, diabetes (Hu, Li, Colditz, Willett, & Manson, 2003), mental disorders (Wiles, Haase, Gallacher, Lawlor, & Lewis, 2007), and cognitive function (Adam, Bonsang, Grotz, & Perelman, 2013; Lee et al., 2013). Few studies have explored the relationship between the three domains of PA and cognitive function (in one model), and researchers (Ku, Stevinson, & Chen, 2012) have suggested future study should investigate how JPA and HPA are related to cognition.

One recent paper categorized PA into the same three types for analyzing relationships to cognitive function such as memory complaints (Lee et al., 2013). Lee et al. suggest that those more frequently engaged in LPA have fewer self-reported memory complaints, whereas those more frequently engaged in HPA have more complaint of memory loss. However, in their study, no link was found between JPA and memory complaints.

The relationship between LPA and cognitive function has been established elsewhere (Lee et al., 2013); however, links between HPA or JPA with cognition are rare. One study, inconsistent with Lee et al., suggests that individuals who continue to work after retirement have better cognitive performance (Adam et al., 2013). In terms of HPA, women who shoulder most of the household chores while holding a job might be stressed out when their jobs are also demanding (Luo, Gilmour, Kao, & Huang, 2006). The effect of stress on memory loss and increased odds of dementia has been suggested (Small, 2004). Accordingly, it can be assumed that if people are conducting HPA under stress, they will not exhibit the same relaxation level while conducting leisure activity.

Many studies contend frequent cognitive activity improves cognitive performance (Hertzog, 2009; Hultsch, Hertzog, Small, & Dixon, 1999; Lachman, Agrigoroaei, Murphy, & Tun, 2010; but see Salthouse, 2006; Small & McEvoy, 2008). A high level of mental stimulation activity during midlife seems to decrease the risk of dementia in later life (Karp et al., 2009). One recent study applying functional magnetic resonance imaging on elderly with early-stage AD found cognitive rehabilitation of memory-related brain activation had some potential in changing memory-related brain activity (van Paasschen et al., 2013). Another study argues memory training in patients with mild cognitive impairment is associated with training-specific increases in activation and connectivity of the central neural system (Hampstead, 2011, 2012).

Sedentary cognitive activity (e.g., reading or computer use) is less studied in relation to cognitive outcomes (Rhodes, Mark, & Temmel, 2012). Furthermore, the relationship between levels of activity engagement and cognitive performance is inconclusive. Some studies report a negative relationship between levels of activity engagement and cognitive decline; while others present no functional links, or less decline (Ghisletta, Bickel, & Lövdén, 2006; Hertzog, Hultsch, & Dixon, 1999). Ghisletta et al. believe the divergence is caused by a number of methodological and analytical considerations.

This study seeks to examine the relationships between PA/cognitive activity and cognitive function for the purpose of developing a successful brain fitness (cognitive health) program. The three goals for this purpose are (a) Find the relationship between the frequency of participants who engage in three types of PA (JPA, HPA, and LPA) to episodic memory and executive functions; (b) Assess the link between elders who frequently engage in sedentary cognitive activities (e.g., reading, using the computer, playing word games, and attending lectures) and cognitive advantages on episodic memory and executive functions; (c) Test the interaction effects between three types of PA and cognitive activity on episodic memory and executive function. The relationship between PA and cognitive function has been addressed previously (e.g., Doaga & Lee, 2008; Flöel et al., 2010). Because no previous study has conducted such analysis, it is reasonable and meaningful to further explore the interaction terms among the variables.

Methods

Study Sample

First-tier data were drawn from the Midlife Development in the United States (MIDUS) wave II surveys of 2005. MIDUS was based on a nationally representative random-digit-dial (RDD) sample of noninstitutionalized, English-speaking adults aged 25 to 74 (wave I) selected from working telephone banks within the coterminous United States in 1995. The second-tier data were gathered by the National Institute on Aging (wave II, 10 years later) for the longitudinal follow-up of the original MIDUS national probability sample ($n = 3{,}487$; Brim, Ryff, & Kessler, 2004). By including only those aged 50 and above, a sample size of 2,305 was analyzed, ranging from 50 to 84 ($M = 63.01$, $SD = 9.06$). The datasets with complete information for episodic memory ($N = 2{,}237$) and executive functions ($N = 2{,}240$) are smaller. The sample was composed of 53.30% women, and 21% of the sample had either suspected or confirmed heart trouble.

Independent and Dependent Variables

Cognitive measures were obtained from telephone interviews, and all other measures were collected with mail questionnaires. Definitions of terms are as follows:

Physical activity. PA was classified into three domains: JPA, HPA, and LPA. Each of these three domains comprised four items (two vigorous and two moderate activities) to assess the frequency of vigorous and moderate PA in both summer and winter seasons. These questions were scored with 1 = *never*, 2 = *less than once a month*, 3 = *once a month*, 4 = *several times a month*, 5 = *once a week*, and

6 = *several times a week*. The four scores (moderate and vigorous level for both seasons) were averaged with the maximum value representing the highest frequency of PA across all intensity levels and domains.

The sample question for probing vigorous PA was: *How often do you engage in vigorous PA that causes your heart to beat so rapidly that you can feel it in your chest and you perform the activity long enough to work up a good sweat and are breathing heavily?* This question is asked twice, once for summer and once for winter, for each domain. The question asked for probing moderate PA was: *How often do you engage in moderate physical activity, that is not physically exhausting, but it causes your heart rate to increase slightly and you typically work up a sweat?*

Frequency of engagement in cognitive activities. The cognitive activity variable was created by averaging the self-reported frequencies on a 6-point scale (1 = *never*, 2 = *once a month*, 3 = *several times a month*, 4 = *once a week*, 5 = *several times a week*, 6 = *daily*) of engaging in four cognitive activities: reading books/magazines/news; using computer, playing word games such as crossword, puzzles, or scrabble; and attending educational lectures or courses.

Cognitive performance (dependent variable). Through factor analysis, seven cognitive measures in the present study yielded two factors (with eigenvalues greater than one) with principal axis extraction and oblique rotation. Both factors account for 59.03% of the total variance. The scree plot of the analysis also shows two cognitive measures, episodic memory and executive functions. The episodic memory test comprises immediate and delayed recall of 15 words. The executive function included measures of Digits Backward (working memory—the highest span achieved in repeating strings of digits in reverse order), Category Fluency (verbal ability and speed—the number of words produced from the category of animals in 60 seconds), Number Series (reasoning: completing the pattern in a series of five numbers), Backward Counting (speed of processing: the number of digits produced by counting backwards from 100 in 30 seconds), and the stop and go switch tasks (attention switching and inhibitory control—reaction times were calculated). The two factor means were standardized to z scores, with a mean of zero and a standard deviation of one. Higher scores corresponded to better cognitive performance.

Covariates

Demographic variables. The variables included age, sex (1 = *men*, 2 = *women*), level of education, and self-rated financial situation.

Mental health. Participant response to the question: *In the past twelve months, have you experienced or been treated for any of the following -anxiety, depression, or some other emotional disorder?* 1 = *Yes*, 2 = *No*.

Head injury. Participant response to the question: *Do you have a history of a serious head injury?* 1 = *Yes*, 2 = *No*.

Diabetes/high blood sugar ever (12 months). Participant response to the question: *In the past twelve months, have you experienced or been treated for diabetes or high blood sugar?* 1 = *Yes*, 2 = *No*.

Heart problem. Participant response to the question: *Have you ever had heart trouble suspected or confirmed by a doctor?* 1 = *Yes*, 2 = *No*.

Statistical Analysis

The correlations between the dependent, the independent, and all covariate variables were computed. Hierarchical multiple regression analysis was separately performed for the two cognitive factors (episodic memory, executive function) in order to examine their relationships. The interaction effects for PA and cognitive activity were also examined to test whether inactive individuals would benefit from PA in their cognitive performances (episodic memory and executive functions).

Results

The means, standard deviations, and intercorrelations of all variables are shown in Table 1. The results revealed a higher frequency of PA, especially those who spent more time in LPA, was associated with better episodic memory and executive functions, with r's = .179 and .295, respectively, both $p < .01$. Frequent cognitive activity also revealed significant bivariate relationship with better episodic memory and executive functions, with correlations ranging from .286 to .396.

Multiple regression analysis revealed that both LPA and cognitive activity were significant predictors of episodic memory ($p = .041$ and $p < .001$, respectively) when all covariates are controlled. First, the combination of the three PA measures and cognitive activity accounted for a significant proportion of the episodic memory variance, with adjusted $R^2 = .208$, $p < .001$. Second, JPA, LPA, and cognitive activity were all significant predictors of executive functions, with adjusted $R^2 = .348$, $p < .001$, for all three variables when the covariates were controlled. Lastly, executive function is positively related with LPA, but negatively associated with JPA (see Table 2).

Because JPA negative associated with executive functions, the researcher further conducted a two-way contingency table analysis (2×3) to evaluate the relationship between JPA (high, low) and education levels (high, moderate, low). The results showed that JPA was significantly associated with education level (see Figure 1), with Pearson's $\chi^2(2, N = 2{,}302) = 6.720$, $p = .035$, Cramer's

Table 1. Means, Standard Deviations, and Intercorrelations for All Variables.

	M (%)	SD	Age	Sex	Edu	Fin.	Dps.	Dbt	HdI	JPA	HPA	LPA	CoA	HtP	EpM	ExF
Age	63.01	9.06	1													
Sex	(F[a] = 53.30%)	–	.01	1												
Edu[b]	7.27	2.58	−.13**	−.14	1											
Fin.[c]	6.67	2.09	.10**	−.09	.16**	1										
Dps.	(17.7%)	–	.09**	−.15**	.03	.18**	1									
Dbt[d]	(12.4%)	–	−.11**	.07**	.06**	.09**	.05*	1								
HdI[e]	(2.4%)	–	.03	.06**	.02	.02	.03	.01	1							
JPA[f]	2.10	1.60	−.29**	−.18**	−.04*	−.05*	.02	.03	−.02	1						
HPA[g]	3.32	1.52	−.25**	−.10**	.10**	.03	−.03	.04*	−.01	.44**	1					
LPA[h]	3.43	1.70	−.28**	−.11**	.26**	.13**	.04*	.09**	.00	.31**	.71**	1				
CoA[i]	3.46	.92	−.14**	.13**	.39**	.11**	.03	.05*	.03	−.03	.12**	.21**	1			
HtP[j]	(21.00%)	–	−.20**	.09**	.05*	.02	.02	.14**	.02	.08**	.04*	.07**	.06**	1		
EpM(Z)[k]	0	1	−.30**	.24**	.19**	.05*	−.06**	.11**	.03	.04*	.12**	.18**	.29**	.11**	1	
ExF(Z)[l]	0	1	−.36**	−.12**	.43**	.08**	.05*	.11**	−.02	.04*	.16**	.30**	.40**	.11**	.39**	1

Note. $N = 2{,}305$ (Age = 50–84). All values were rounded off to the second decimal place.

[a]F = Female.

[b]Education level range: 1 (*no school*) to 12 (*PhD, MD, or other professional degree*).

[c]The financial situation ranges from 0 (*worst*) to 10 (*best*).

[d]Dbt = Diabetes (1 = *Yes*, 2 = *No*).

[e]HdI = Head injury (1 = *Yes*, 2 = *No*).

[f]JPA = Job-related physical activity (1 = *never*, 2 = *less than once a month*... 5 = *once a week*, and 6 = *several times a week.*).

[g]HPA = Home chores activity.

[h]LPA = Leisure-time physical activity.

[i]CoA = Cognitive activity.

[j]HtP = Heart trouble confirmed by doctor (1 = *Yes*, 2 = *No*).

[k]EpM(Z) = Episodic memory z score.

[l]ExF(Z) = Executive function z score.

$*p \leq .05$; $**p \leq .01$

Table 2. Multiple Regressions with Episodic Memory (Model 1) and Executive Function (Model 2) as Dependent Variables, After Adjusting for Covariates (Age, Sex, Education, Financial Situation, Anxiety/Depression, Head Injury, Diabetes, and Heart Problem).

Predictors	*B*	β	*t*	*p* value
Model 1	DV = Episodic memory($N = 2{,}237$)			
JPA	.000	.000	.011	.991
HPA	.001	.006	.196	.845
LPA	.008	.058	2.040	.041
CoA	.042	.156	7.140	.000
JPA × CoA	.000	.002	−.077	.939
HPA × CoA	.001	.020	.643	.520
LPA × CoA	−.000	−.008	−.260	.556
Model 2	DV = Executive functioning($N = 2{,}240$)			
JPA	−.011	−.077	−3.845	.000
HPA	−.005	−.031	−1.203	.229
LPA	.017	.122	4.746	.000
CoA	.064	.251	13.031	.000
JPA × CoA	−.000	.008	.432	.666
HPA × CoA	.000	−.006	−.201	.841
LPA × CoA	.000	.013	.479	.632

Note. Model 1 with episodic memory as dependent variable: adjusted $R^2 = .208$, $F(15, 2221) = 40.104$, $p < .001$. Model 2 with executive functioning as dependent variable: adjusted $R^2 = .348$, $F(15, 2224) = 80.645$, $p < .001$. Models control for age, sex, education, financial situation, anxiety/depression, head injury, diabetes, and heart problem. DV = dependent variable; B = unstandardized multiple regression coefficient; β = standardized multiple regression coefficient; $t = t$ test; JPA = job physical activity; HPA = home chores physical activity; LPA = leisure physical activity; CoA = cognitive physical activity.

V = .054. The analysis suggested that participants with lower education level tend to engage in higher frequency of JPA (for both high and low groups). The results provided a clearer picture for understanding the possible reasons why JPA negative related to executive functions.

This study found that educational level, age, sex, and financial situation were significant predictors for episodic memory. Additionally, it confirmed that sex, level of education, and anxiety/depression were significant predictors for executive functions. However, when these covariates were controlled, no significant relationships were found between various types of PA and cognitive activity (Table 2).

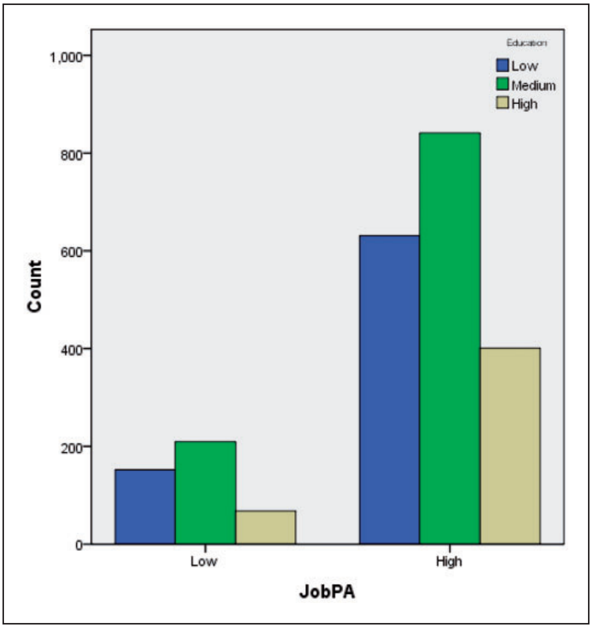

Figure 1. A clustered bar chart of education level within the job physical activity (JobPA) categories. Education level categorized by low: no school to graduate from high school; medium: college but no degree yet to bachelor's degree; high: some graduate school to doctor's degree. JobPA (combination scores range 4–24) categorized by low: 4–13; high: 14–24. JobPA = job physical activity; Count = numbers of individuals.

Discussion

Key Finding of This Study

This study includes a broad range of cognitive measures that are sensitive to aging. The community-dwelling participants who engaged in higher frequency of LPA and cognitive activities showed better executive functions, while those who engaged in JPA displayed worse executive functions. Only LPA and cognitive activity were positively related to episodic memory, and none of the three types of PA were significantly associated with cognitive activity (PA × cognitive activity).

Contribution of This Study to the Existing Literature

Though many studies have found associations between cognitive function and PA, few specifically differentiated the type of physical activities (job, home, and leisure) to cognitive function within one study. No previous studies have explored the links between the three types of PA and cognitive activity (reading books/magazines/news; using computers; playing word games; and attending educational lectures) with episodic memory and executive functions. The importance of dividing PA to into three types has been discussed above. In addition, the exclusive variance of both types of cognitive activity (episodic memory and executive functions) has rarely been examined in previous studies (Lachman et al., 2010). The present study fills the knowledge gap by examining the associations among these variables.

In addition, the study analyzed interaction terms for three domains of PA and cognitive activity. This approach allows testing for possible moderator between these variables. These interaction effects have not yet been fully explored in other studies.

Goal 1: Examine the relationship between the elders who frequently engage in three types of PA (JPA, HPA, and LPA) and the cognitive advantages on episodic memory and executive functions tasks.

Previous studies suggested that PA exerts beneficial effects on memory functions in older individuals (Doaga & Lee, 2008; Flöel et al., 2010; Lee et al., 2013). The present study indicates that those active in LPA performed better in both executive functions and episodic memory. As stated by Flöel et al. (2010), the possible mechanism might be that higher levels of PA is associated with increased cerebral gray matter volume in the prefrontal and cingulated cortices, which leads to a strong association between LPA and better memory encoding.

Of the three evaluated PAs, JPA was negatively associated with cognitive performance (executive functioning), consistent with one previous study (Lensegrav-Benson, 2006). The results in Lensegrav-Benson's 7-year follow-up study showed that occupational PA was inversely associated with cognitive status at baseline with those in the most active occupations evidencing the lowest cognitive performance. The secondary analysis in the present study further provided evidence that those with lower education tend to engage in more JPA. Other researchers (Rydwik, Welmer, Angleman, Fratiglioni, & Wang, 2013) have also suggested that people with moderate or heavy JPA were more likely to have lower education. Given that low education was a strong predictor to poor executive functions and episodic memory (Lachman et al., 2010), it is possible that the negative effects of JPA on cognitive performance was due to those with higher JPA belong to the lower education group in the present study. However, more research is needed to test the relationship between JPA and cognitive health, specifically the characteristics of occupations and subject lifestyles. For example, the characteristic of low complexity occupations has been suggested as a risk factor for age-related cognitive decline (Capurso et al., 2000). Social isolation seems to accelerate this decline. In addition, the measure of

JPA might also need to be refined because research has found imprecise reporting of occupational and household PA (Hallal et al., 2010).

The third type of PA, HPA, in the study was not found to be significantly related to cognitive function. Home chores such as gardening activity or cooking have been found to reduce the risk of dementia (Buchman et al., 2012; Simons, Simons, McCallum, & Friedlander, 2006). On the other hand, people who shoulder most of the household chores while holding a job might be stressed out which may contribute to caused memory loss and increased odds of dementia later in life (Luo et al., 2006). Accordingly, it seems logical no significant relationship existed between the HPA and cognitive function in the study.

The present study analyzed three specific domains of PA (LPA, HPA, and JPA), which are seldom examined in a holistic manner, to determine the relative relationships with the subject's health (Center for Disease Control and Prevention, 2012) and cognitive performance.

Goal 2: Assess how the elders who frequently engage in a combination of sedentary cognitive activities (e.g., reading, using computers, playing word games, and attending lectures) related to episodic memory and executive functions.

This study found an association between cognitive activity and cognitive performance. This research assessed the combination of four common daily activities of older adults. The significance of the link showed even sedentary cognitive activities, for example, reading a newspaper or playing word games, had a positive effect on cognitive function.

Maintaining an enriching lifestyle is one of the keys to effective cognitive function for older people. The adult hippocampal neurogenesis of mice living in an enriched environment from the age of 10 to 20 months was fivefold higher than those of the control group (Kempermann, Gast, & Gage, 2002). Epp, Spritzer, and Galea (2007) believed that adult neurogenesis in the hippocampus continues throughout life and is an important link to learning and memory. The current study also indicated that frequent engagement in a variety of cognitive activities allows the elderly to enjoy some degree of personal control over successful cognitive performance.

Goal 3: Test the interaction effects between three types of PA and cognitive activity on episodic memory and executive functions.

No interaction effects were found for the three domains of PA and cognitive activity (PA $\times$ cognitive activity) on cognitive performance. The design of the analysis was to test if low levels of PA could be compensated by more cognitive activities. These results indicate that cognitive activity had no modifying effect for low LPA, HPA, and JPA on episodic memory and executive functions tasks, which is not consistent with previous study (Belleville, 2008).

One possible explanation for the nonsignificant interaction results is that the types of cognitive activities are evenly involved, in terms of frequency, in people with either higher or lower PA, especially for the age 50 and above. For dementia prevention programs and brain-fitness advocates, these nonsignificant results imply that cognitive activity is equally important for every domain and for the older adults who engaged all levels of PA.

Because the study disclosed a positive link between LPA and cognitive activity in cognitive performance, future research may investigate programs of cognitive training. For example, one recent study suggested that age-related deficits in neural signatures of cognitive control, as measured with electroencephalography, were remediated through multitasking training (Anguera et al., 2013). Anguera et al. found a way to reverse some of the negative effects of aging on the brain by using 3-D video game training to improve cognitive performance in healthy older adults. Along the same lines, the implication of the current study findings would be to encourage middle-age adults and elderly to engage more cognitive activity (e.g., playing word games, reading books, using computers) or participating in interesting brain-stimulating programs or other types of intellectual activity that might be important to cognitive health.

The intensity, duration, and even the type of LPA needs to be further assessed and explored for linking with multiple cognitive test batteries. This would allow examination of the relationships between these variables. Cognitive performance in the current study only measures episodic memory and executive functions. However, engaging in LPA and cognitive activity might also benefit additional cognitive functions (e.g., attention, language, reasoning), which also need to be investigated. Further, LPA and cognitive activity benefit participant cognitive functions in the study, so developing a two-factor training program might have potential to improve brain health even more or to preserve additional cognitive function (as mentioned above) for the elderly.

Further study may also seek to alter research design to look into the negative relationship between JPA and executive function. All the independent variables in this research are subjectively perceived and frequency measures, which limit precision compared with objective measures. The data are cross-sectional and so cannot provide conclusive evidence about directionality.

Conclusions

Both LPA and cognitive activity possess characteristic of easy-access and can positively contribute to the cognitive function of older adults. It is encouraging to see the older population engage in these easy-to-access and low-effort daily activities more often to maintain a healthy life. The negative effects of JPA found in this study are noteworthy to invite further investigation into its connection with cognitive function.

Declaration of Conflicting Interests

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