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Exploring the Association Between Physical Fitness Components and Cognitive Function in Older Korean Adults: The SUPERBRAIN Exploratory Sub-study

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ABSTRACT

Background and Purpose: Tailored physical exercise interventions have the potential to promote cognitive health in older adults and offer significant advantages for those more vulnerable to decline. The specific relationship between physical fitness and cognition among the elderly has not been clearly established. The purpose of this investigation was to assess the relationship between physical fitness and cognitive function in older Korean adults.
Methods: Eighty-four community-dwelling older adults (mean age: 70.7±5.3 years; 81.0% female) completed a standardized physical fitness battery assessing handgrip strength, sit-and-reach, 30-second sit-to-stand, 2-minute stationary march, 3-m sit-walk-and-return, figure-8-walk, and T-wall response time. Cognitive function was evaluated using the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS). Descriptive statistics, partial correlation analyses, and stepwise multiple linear regression were conducted.
Results: Slower T-wall response time was significantly correlated with lower RBANS total index, immediate memory, and delayed memory scores. In regression models, slower T-wall response time was independently associated with lower RBANS total index ($\beta=-0.234$, $p=0.026$) and delayed memory scores ($\beta=-0.295$, $p=0.029$). The regression model for immediate memory was not statistically significant overall; therefore, no predictive conclusion was drawn for this domain. Higher education showed a significant positive association with cognitive performance.
Conclusions: Coordination, as measured by T-wall response time, emerged as the only physical fitness component consistently associated with cognitive performance in older

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Conflict of Interest
The authors have no financial conflicts of interest.

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adults. Coordination-related fitness may be an important correlate of cognitive function in older adults and a promising target for future exercise interventions.

Keywords: Dementia; Cognition; Physical Fitness; Physical Exercise; Aging; Prevention

INTRODUCTION

In South Korea, the proportion of individuals aged 65 and above was 17.5% in 2022, with estimates suggesting an increase to 20.6% by 2025, signaling the nation's transition into a super-aged society.[1] In 2020, among the 8,134,674 individuals in this age group, 837,992 had dementia (10.3%). These demographic changes raise significant concerns regarding the health, medical care, and welfare of older adults. Moreover, the World Health Organization (WHO) has highlighted dementia and Alzheimer's disease as vital global public health priorities.[2] The 2019 "Risk Reduction of Cognitive Decline and Dementia WHO Guidelines" advocate a "comprehensive dementia management" strategy, encompassing lifestyle practices, social involvement, cognitive engagement, and medical considerations. A physically active lifestyle (PAL) is a cornerstone within this approach, and interest is growing in enhancing physical fitness among seniors for healthy and active aging, underscoring the need to explore adaptable approaches for facilitating physical activity engagement.

Research shows that incorporating physical exercise within lifestyle interventions, either independently[3-10] or in conjunction with other risk factor corrections,[11-14] produces favorable effects in terms of dementia risk reduction and cognitive enhancement. The Finnish Geriatric Intervention Study to Prevent Cognitive Impairment and Disability (FINGER), which investigated a 2-year multidomain lifestyle intervention including nutritional counseling, exercise, cognitive training, and monitoring of vascular and metabolic risk factors, administered to older individuals with heightened dementia risk, represents an initial sizable randomized controlled trial that demonstrated favorable cognitive effects.[11] Moreover, the SoUth Korean study to PrEvent cognitive impaiRment and protect BRAIN health through lifestyle intervention in at-risk elderly people (SUPERBRAIN) established the feasibility and potential efficacy of adapting the multidomain intervention from the FINGER study to the cultural and contextual nuances of another nation.[13,14] According to a systematic review, the amount of physical activity is associated with cognitive outcomes in older adults, regardless of cognitive impairment status. The analysis indicated that participating in at least 52 hours of physical exercise was linked to improvements in global cognition, attention, processing speed, and executive functioning.[15] Furthermore, evidence endorses the effectiveness of aerobic and resistance exercises, mind-body exercises, or their combinations as strategies to counteract cognitive aging effects. However, a recent narrative review suggests adopting diverse forms of physical exercise to promote comprehensive physical and cognitive well-being in advanced age, considering the distinct neuroplasticity mechanisms associated with each exercise mode.[16] Tailored physical exercise prescriptions could prove effective in enhancing individual cognition. To achieve this, the connection between cognition and specific physical fitness factors, including cardiorespiratory fitness, muscular strength/endurance, balance, flexibility, or coordination, within a specific population needs to be explored. Although the association between physical fitness and cognitive function is acknowledged,[17-20] the precise links between specific components of physical fitness and cognitive function within specific populations have not been elucidated.

Cognitive function assessment

Cognitive function was evaluated both prior to and following the intervention using the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS).[26] The RBANS is a widely validated and reliable cognitive screening tool consisting of 12 subtests, requires approximately 20–30 minutes to administer, and includes 4 alternate forms (A-D) to minimize learning effects during reevaluation. The 12 subtests are organized into 5 cognitive domains: 1) Attention, assessed by digit span and coding; 2) Language, evaluated through picture naming and semantic fluency; 3) Visuospatial/constructional abilities, measured with figure copy and line orientation tasks; 4) Immediate memory, including list learning and story recall; and 5) Delayed memory, covering list recall, recognition, story recall and figure recall. Domain-specific scores are obtained for each of the 5 cognitive domains, and a total index scale (range, 40–160) is calculated by summing across domains, such that higher values represent improved general cognitive functioning. We chose the RBANS rather than brief screening tools such as the Korean version of Mini-Mental State Examination (K-MMSE) because it provides more sensitive, domain-specific indices for memory, attention, language, and visuospatial/constructional abilities, which was important for exploring relationships with specific physical fitness components in this exploratory sub-study.

Statistical analysis

The sample size was estimated through power analysis, targeting a statistical power of 0.80 for correlation analysis (medium effect size; r=0.30, significance level α=0.05) and regression analysis (large effect size; f^2=0.30, significance level α=0.05), using PASS 11 software (NCSS, Kaysville, UT, USA). With 84 participants, the estimated power was 0.987, confirming that the final sample size was sufficient to detect large effect sizes in the relationship between physical fitness and cognitive function.

All statistical analyses in this sub-study were restricted to baseline (pre-intervention) measurements, as the aim was to examine cross-sectional associations before any intervention exposure.

Data analyses were implemented through R software (version 4.4.2; R Foundation for Statistical Computing, Vienna, Austria) along with RStudio (2021.09.0+351), considering $p<0.05$ as the criterion for significance. Participant demographic and clinical features were presented using descriptive statistics. The distributional assumption of continuous variables was tested using the Shapiro–Wilk method and further verified by Q–Q plots. Partial correlations were calculated to determine the links between physical fitness indices and cognitive function variables. These analyses were adjusted for age, sex, education level, and comorbidities, such as diabetes mellitus, hypertension, dyslipidemia, cardiovascular diseases, stroke, and traumatic brain injury (TBI). Covariates were selected according to their commonly reported associations with cognitive performance in older adults. The variables that showed statistically significant partial correlations were subsequently entered into stepwise multiple linear regression models to identify significant predictors for each RBANS domain score. Model selection was guided by the Akaike Information Criterion (AIC) to achieve a balance between model parsimony and explanatory power. Model assumptions for linear regression—covering linearity, homogeneity of variance, residual distribution, and multicollinearity—were verified using diagnostic plots along with variance inflation factor statistics. Final regression results were reported as unstandardized coefficients (B), standardized beta coefficients (β), standard errors (SE), 95% confidence intervals (CIs), and p-values. Model fit was evaluated using R^2 and adjusted R^2 statistics.

RESULTS

A total of 84 older adults (mean age: 70.7±5.2 years; 81.0% female) were enrolled in the SUPERBRAIN physical fitness sub-study. The key characteristics of participants were as follows: mean years of education, 9.6±5.0 years; mean BMI, 24.3±2.9 kg/m^2; and mean K-MMSE total score, 28.0±1.8. Furthermore, the average baseline MVPA was 2,518.7±3,352.2 metabolic equivalent of task (MET)-minutes/week, and baseline sedentary time was 284.4±192.5 minutes/day. The demographic and baseline clinical characteristics are further detailed in **Table 1. Table 1** summarizes baseline demographic, clinical, and physical fitness characteristics for the total sample and provides a descriptive comparison of participants allocated to the combined intervention group (FMI + HMI) and the control group. All subsequent correlation and regression analyses were conducted on the entire cohort irrespective of group assignment.

Partial correlation analyses, adjusted for age, sex, education level, BMI, and comorbidities (diabetes mellitus, hypertension, dyslipidemia, cardiovascular disease, stroke, and TBI),

Table 1. Demographic and clinical characteristics of participants

Characteristics	Total (n=84)	Intervention (n=57)	Control (n=27)	*p*-value
Age (yr)	70.7±5.2	71.0±5.2	70.0±5.4	0.630
Sex, female	68 (81.0)	45 (78.9)	23 (85.2)	0.670
Education (yr)	9.6±5.0	9.2±5.2	10.5±4.6	0.504
BMI (kg/m^2)	24.3±2.9	23.9±2.7	25.0±3.3	0.509
Medical history				
DM	19 (22.6)	8 (14.0)	11 (40.7)	0.004
HTN	39 (46.4)	26 (45.6)	13 (48.1)	0.599
Dyslipidemia	36 (42.9)	21 (36.8)	15 (55.6)	0.032
Cardiovascular diseases	9 (10.7)	6 (10.5)	3 (11.1)	0.383
Stroke	9 (10.7)	6 (10.5)	3 (11.1)	0.778
TBI	1 (1.2)	0 (0.0)	1 (3.7)	0.003
Depression	28 (33.3)	19 (33.3)	9 (33.3)	0.629
Smoking	8 (9.5)	7 (12.3)	1 (3.7)	0.458
Alcohol	20 (23.8)	13 (22.8)	7 (26.0)	0.620
GPAQ				
MVPA time (MET-minutes/week)	2518.7±3352.2	2606.8±3437.2	2332.6±3220.9	0.776
Sedentary time (minutes/day)	284.4±192.5	284.7±194.4	283.7±192.1	0.186
K-MMSE total score	28.0±1.8	28.3±1.8	27.7±1.9	0.336
CDR	0.3±0.2	0.4±0.2	0.3±0.2	0.603
CDR-SOB	0.5±0.4	0.5±0.5	0.4±0.4	0.331
Physical fitness				
Handgrip (kg)	41.7±10.3	42.3±11.3	40.1±9.4	0.202
Sit-and-reach test (cm)	11.9±9.8	12.1±7.8	11.4±9.1	0.739
30-sec sit-to-stand test (times)	19.0±5.9	18.7±4.8	19.8±7.7	0.585
2-min stationary march (times)	104.6±18.2	105.2±12.2	103.4±24.3	0.732
3-m sit-walk-and-return test (sec)	6.4±1.5	6.2±1.6	6.6±1.8	0.440
Figure-8-walk (sec)	28.5±6.6	28.0±4.6	29.3±8.7	0.385
T-wall response time (sec)	99.3±26.8	94.5±26.6	100.9±29.4	0.663
RBANS				
Total index scale	98.6±19.6	97.7±21.3	100.7±16.2	0.598
Immediate memory domain scale	100.6±15.5	99.8±16.0	102.3±13.8	0.202
Delayed memory domain scale	95.8±16.6	93.9±18.0	99.7±13.0	0.304
Language domain scale	108.1±13.9	106.9±15.2	110.7±11.7	0.515
Visuospatial/constructional ability domain scale	84.1±18.0	84.5±17.8	83.4±18.2	0.844
Attention domain scale	102.2±18.1	102.8±19.7	101.3±15.3	0.819

Data are mean ± standard deviation or number (%).
BMI: body mass index, DM: diabetes mellitus, HTN: hypertension, TBI: traumatic brain injury, GPAQ: Global Physical Activity Questionnaire, MVPA: moderate-to-vigorous intensity physical activity, MET: metabolic equivalent of task, K-MMSE: Korean version of Mini-Mental Status Examination, CDR: Clinical Dementia Rating, CDR-SOB: Clinical Dementia Rating-Sum of Boxes, RBANS: Repeatable Battery for the Assessment of Neuropsychological Status.

revealed several significant associations between physical fitness parameters and the RBANS scores (**Table 2**). Notably, the T-wall response time showed significant negative correlations with RBANS total index (r=−0.266, p<0.05), immediate memory (r=−0.242, p<0.05), and delayed memory domain scores (r=−0.262, p<0.05). In contrast, handgrip strength was positively associated with the language domain score (r=0.270, p<0.05), whereas the figure-8-walk time was negatively associated with the same domain score (r=−0.223, p<0.05). Additional partial correlation analyses using MMSE and Clinical Dementia Rating Scale Sum of Boxes as cognitive measures were conducted, and the results are summarized in **Supplementary Table 1**. To further contextualize the findings, we also examined associations of MVPA (MET-min/week) and sedentary time with cognitive outcomes and physical fitness measures; these results are shown in **Supplementary Tables 2** and **3**.

Variables showing significant bivariate associations were entered into stepwise multiple linear regression models (**Table 3**). T-wall response time emerged as a significant predictor of RBANS total index (β=−0.234, p=0.026) and delayed memory domain scores (β=−0.295, p=0.029). Although the coefficient for immediate memory reached nominal significance, the overall regression model for this domain was not statistically significant (F=0.607, p=0.817; adjusted R^2=−0.057); therefore, no predictive conclusion was drawn for immediate memory.

Table 2. Association of physical fitness with RBANS scores

Variables	TI	IM	DM	L	VCA	A
Handgrip test (kg)	0.199	−0.022	0.045	0.270*	0.172	0.215
Sit-and-reach test (cm)	0.005	−0.110	0.015	0.144	0.085	−0.158
30-sec sit-to-stand test (times)	0.089	0.115	0.084	0.198	−0.129	0.053
2-min stationary march (times)	0.190	0.047	0.140	0.169	0.124	0.156
3-m sit-walk-and- return test (sec)	−0.062	−0.011	0.040	−0.181	0.066	−0.161
Figure-8-walk (sec)	−0.080	−0.024	−0.029	−0.223*	0.096	−0.122
T-wall response time (sec)	−0.266*	−0.242*	−0.262*	−0.155	−0.153	−0.049

Values represent partial correlation coefficients adjusted for age, sex, education level, body mass index, and comorbidities (diabetes mellitus, hypertension, dyslipidemia, cardiovascular disease, stroke, and traumatic brain injury).
RBANS: Repeatable Battery for the Assessment of Neuropsychological Status, TI: total index scale, IM: immediate memory domain scale, DM: delayed memory domain scale, L: language domain scale, VCA: visuospatial/constructional ability domain scale, A: attention domain scale.
*p<0.05.

Table 3. Stepwise regression analysis of predictors of RBANS scores

Dependent variable	Predictor	B	SE(B)	β	p-value	VIF
TI	Covariates					
	Age	−0.755	0.362	−0.199	0.041*	1.57
	Education	2.095	0.369	0.536	<0.001†	1.53
	Traumatic brain injury	−32.988	14.764	−1.652	0.029*	1.16
	Physical fitness					
	T-wall, response time	−0.172	0.075	−0.234	0.026*	1.80
	Model summary: R^2=0.600, Adjusted R^2=0.536, F (11, 69)=9.404, p<0.001					
IM	Physical fitness					
	T-wall, response time	−0.141	0.069	−0.317	0.044*	1.80
	Model summary: R^2=0.088, Adjusted R^2=−0.057, F (11, 69)=0.607, p=0.817					
DM	Covariates					
	Education	0.948	0.402	0.288	0.021*	1.50
	Physical fitness					
	T-wall, response time	−0.184	0.082	−0.295	0.029*	1.80
	Model summary: R^2=0.332, Adjusted R^2=0.214, F (11, 69)=3.11, p=0.002					

RBANS: Repeatable Battery for the Assessment of Neuropsychological Status, B: unstandardized regression coefficient, SE: standard error, β: standardized coefficient, VIF: variance inflation factor, TI: total index scale, IM: immediate memory domain scale, DM: delayed memory domain scale.
*p<0.05, †p<0.001.

The final regression model presented in **Table 3** includes only significant predictors. Full regression results, including all covariates and nonsignificant variables for each RBANS domain, can be found in **Supplementary Table 4**. Of note, although handgrip strength and figure-8-walk showed significant correlations with RBANS language domain in the partial analyses, they were not retained in the stepwise regression model owing to lack of statistical significance in the multivariate context.

DISCUSSION

This exploratory analysis investigated the association between specific elements of physical fitness and cognitive function among older adults. Our observational findings confirmed that, among the fitness variables tested, coordination as measured by T-wall response time was most consistently related to cognitive performance. Partial correlation analyses demonstrated significant associations between slower T-wall response time—reflecting poorer coordination—and lower RBANS total index as well as both immediate and delayed memory domain scores. However, although the coefficient for immediate memory reached nominal significance, the overall regression model for this domain was not statistically significant; therefore, the predictive relevance of T-wall response time for immediate memory should be interpreted with caution. In contrast, stepwise regression analysis indicated that T-wall response time remained a significant negative predictor of the RBANS total index and delayed memory scores, suggesting that coordination may play a meaningful role in cognitive aging. The T-wall test captures visual stimulus processing, attentional control, reaction speed, and sensorimotor integration, all of which rely on distributed neural networks involving frontal and parietal regions. Prior research indicates that eye-hand coordination, largely mediated by prefrontal and motor cortical systems, declines with age and cognitive impairment, affecting motor planning and execution.[27,28] Moreover, age-related decline in proprioception and optic nerve integrity may further impair coordination, resulting in impairments in daily functioning and a reduced quality of life.[29-32] Consistent with the present findings, previous cognitive–motor intervention studies have demonstrated that rapid visuomotor response training can improve memory, attention, and coordination in older adults, and that these benefits can be sustained over time.[33,34] Given that the T-wall task integrates visual processing, attentional shifting, rapid motor responses, and working memory, it may serve as a more proximal marker of cognitive processing demands than simpler field tests of strength or aerobic capacity. Taken together, these findings suggest that coordination-based tasks may confer multidomain cognitive benefits and may hold clinical relevance for exercise-based dementia prevention strategies.

It is also noteworthy that, unlike coordination as assessed by the T-wall test, cardiorespiratory fitness indexed by the 2-minute stationary march did not show significant associations with cognitive performance, despite extensive prior evidence linking aerobic fitness to cognition in older adults. One likely explanation is that the 2-minute stationary march may have been too easy for this relatively high-functioning cohort, resulting in restricted variability and possible ceiling effects that reduce its ability to discriminate subtle cognitive differences. Moreover, the modest sample size and shared variance among fitness domains may have limited statistical power to detect independent effects of cardiorespiratory fitness once demographic and clinical covariates were taken into account. Thus, the lack of significant associations for the 2-minute stationary march in this study should not be interpreted as contradicting previous work; rather, it underscores the need for larger studies

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using more sensitive and specific assessments of aerobic fitness (e.g., 6-minute walk test or direct cardiopulmonary measures) to better capture its relationship with cognitive function.

Additionally, handgrip strength showed a significantly positive association with the RBANS language domain score in the partial correlation; however, it was not retained in the final multivariate model. Nevertheless, this finding supports previous findings where muscle strength was an important predictor of cognitive aging.[35,36] Handgrip strength, a robust indicator of biological aging and frailty, has been linked to cognitive decline and functional dependence.[20,37] In particular, reduced strength has been associated with attention deficit and poor executive function.[19,38] While handgrip strength did not remain a significant predictor in multivariate analysis, its bivariate association with cognition suggests it may still serve as a practical screening tool or target for intervention.

In contrast to the robust associations observed for T-wall performance, other fitness measures, including handgrip strength, sit-to-stand performance, and figure-8-walk, showed only modest and domain-specific correlations with RBANS scores and were not retained as significant predictors in the multivariate models. This pattern likely reflects the limited sample size and shared variance among fitness domains, which may have reduced power to detect independent effects of strength, balance, or mobility on cognition. Accordingly, the lack of significant associations for these measures in our analysis should be interpreted with caution and not as evidence that they are unrelated to cognitive health; rather, our findings suggest that coordination-related tasks may be particularly sensitive markers of cognitive status in this cohort.

This study is constrained by its modest sample size and the lack of extended follow-up, which may reduce the extent to which the findings can be generalized. Also, the sample comprised a high proportion of women (81%), which may limit the generalizability of our findings to older men and to more gender-balanced populations. In addition, although we controlled several covariates, unmeasured factors, such as depression or sleep quality, may have confounded the results. Moreover, because only 1 of the 7 fitness components showed a consistent association with cognitive outcomes, our results should be interpreted cautiously and not generalized to all aspects of physical fitness or exercise interventions.

In conclusion, this exploratory study identified coordination, quantified by T-wall response time, as the only physical fitness component that consistently predicted cognitive performance among the seven variables examined. While muscle strength also demonstrated relevance, coordination measures may offer enhanced sensitivity in detecting incipient cognitive changes. Rather than indicating that exercise interventions in general maintain cognitive health, these findings tentatively suggest that coordination-oriented elements within exercise programs may be particularly relevant for supporting cognitive function in older adults.

Future studies should aim to replicate these results in larger and more heterogeneous populations, adopt longitudinal and interventional designs to determine whether targeting coordination through specific training can causally influence cognitive trajectories and dementia risk, and clarify how coordination interacts with other fitness domains. Tailored physical exercise prescriptions, meticulously considering individual cognitive and physical profiles, may significantly augment the efficacy of dementia prevention strategies.

SUPPLEMENTARY MATERIALS

Supplementary Table 1
Associations of physical fitness with cognitive measures (RBANS total, K-MMSE, and CDR-SOB)

Supplementary Table 2
Associations of MVPA time and sedentary time with cognitive outcomes

Supplementary Table 3
Associations of MVPA time and sedentary time with physical fitness measures

Supplementary Table 4
Full regression results for RBANS domain scores

REFERENCES

1. Statistics Korea. *Statistics on the Aged*. Daejeon: Statistics Korea, 2022;1-5.
2. World Health Organization. *Adopting a Healthy Lifestyle Helps Reduce the Risk of Dementia*. Geneva: World Health Organization, 2019.
3. Best JR, Chiu BK, Liang Hsu C, Nagamatsu LS, Liu-Ambrose T. Long-term effects of resistance exercise training on cognition and brain volume in older women: results from a randomized controlled trial. J Int Neuropsychol Soc 2015;21:745-756. PUBMED | CROSSREF
4. Christie BR, Eadie BD, Kannangara TS, Robillard JM, Shin J, Titterness AK. Exercising our brains: how physical activity impacts synaptic plasticity in the dentate gyrus. Neuromolecular Med 2008;10:47-58. PUBMED | CROSSREF
5. Erickson KI, Voss MW, Prakash RS, Basak C, Szabo A, Chaddock L, et al. Exercise training increases size of hippocampus and improves memory. Proc Natl Acad Sci U S A 2011;108:3017-3022. PUBMED | CROSSREF
6. Burns JM, Cronk BB, Anderson HS, Donnelly JE, Thomas GP, Harsha A, et al. Cardiorespiratory fitness and brain atrophy in early Alzheimer disease. Neurology 2008;71:210-216. PUBMED | CROSSREF
7. Jia RX, Liang JH, Xu Y, Wang YQ. Effects of physical activity and exercise on the cognitive function of patients with Alzheimer disease: a meta-analysis. BMC Geriatr 2019;19:181. PUBMED | CROSSREF
8. Stephen R, Hongisto K, Solomon A, Lönnroos E. Physical activity and Alzheimer's disease: a systematic review. J Gerontol A Biol Sci Med Sci 2017;72:733-739. PUBMED | CROSSREF
9. Lee SM, Song HS, Chun BO, Choi M, Sun K, Kim KS, et al. Feasibility of a 12 week physical intervention to prevent cognitive decline and disability in the at-risk elderly population in Korea. J Clin Med 2020;9:3135. PUBMED | CROSSREF
10. Lee SM, Choi M, Chun BO, Sun K, Kim KS, Kang SW, et al. Effects of a high-intensity interval physical exercise program on cognition, physical performance, and electroencephalogram patterns in Korean elderly people: a pilot study. Dement Neurocogn Disord 2022;21:93-102. PUBMED | CROSSREF
11. Ngandu T, Lehtisalo J, Solomon A, Levälahti E, Ahtiluoto S, Antikainen R, et al. A 2 year multidomain intervention of diet, exercise, cognitive training, and vascular risk monitoring versus control to prevent cognitive decline in at-risk elderly people (FINGER): a randomised controlled trial. Lancet 2015;385:2255-2263. PUBMED | CROSSREF
12. Chhetri JK, de Souto Barreto P, Cantet C, Pothier K, Cesari M, Andrieu S, et al. Effects of a 3-year multi-domain intervention with or without omega-3 supplementation on cognitive functions in older subjects with increased CAIDE dementia scores. J Alzheimers Dis 2018;64:71-78. PUBMED | CROSSREF
13. Park HK, Jeong JH, Moon SY, Park YK, Hong CH, Na HR, et al. South Korean study to prevent cognitive impairment and protect brain health through lifestyle intervention in at-risk elderly people: protocol of a multicenter, randomized controlled feasibility trial. J Clin Neurol 2020;16:292-303. PUBMED | CROSSREF
14. Moon SY, Hong CH, Jeong JH, Park YK, Na HR, Song HS, et al. Facility-based and home-based multidomain interventions including cognitive training, exercise, diet, vascular risk management, and motivation for older adults: a randomized controlled feasibility trial. Aging (Albany NY) 2021;13:15898-15916. PUBMED | CROSSREF

 https://doi.org/10.12779/dnd.2026.25.1.13

15. Gomes-Osman J, Cabral DF, Morris TP, McInerney K, Cahalin LP, Rundek T, et al. Exercise for cognitive brain health in aging: a systematic review for an evaluation of dose. Neurol Clin Pract 2018;8:257-265. PUBMED | CROSSREF

16. Netz Y. Is there a preferred mode of exercise for cognition enhancement in older age?—a narrative review. Front Med (Lausanne) 2019;6:57. PUBMED | CROSSREF

17. Pérez-Sousa MÁ, Del Pozo-Cruz J, Olivares PR, Cano-Gutiérrez CA, Izquierdo M, Ramírez-Vélez R. Role for physical fitness in the association between age and cognitive function in older adults: a mediation analysis of the SABE Colombia study. Int J Environ Res Public Health 2021;18:751. PUBMED | CROSSREF

18. Kang SJ, Kim BH, Lee H, Wang J. The beneficial effects of cognitive walking program on improving cognitive function and physical fitness in older adults. Healthcare (Basel) 2021;9:419. PUBMED | CROSSREF

19. Narazaki K, Matsuo E, Honda T, Nofuji Y, Yonemoto K, Kumagai S. Physical fitness measures as potential markers of low cognitive function in Japanese community-dwelling older adults without apparent cognitive problems. J Sports Sci Med 2014;13:590-596. PUBMED

20. Chang M, Geirsdottir OG, Eymundsdottir H, Thorsdottir I, Jonsson PV, Ramel A. Association between baseline handgrip strength and cognitive function assessed before and after a 12-week resistance exercise intervention among community-living older adults. Aging Health Res 2022;2:100092. CROSSREF

21. Han C, Jo SA, Jo I, Kim E, Park MH, Kang Y. An adaptation of the Korean Mini-Mental State Examination (K-MMSE) in elderly Koreans: demographic influence and population-based norms (the AGE study). Arch Gerontol Geriatr 2008;47:302-310. PUBMED | CROSSREF

22. Bull FC, Maslin TS, Armstrong T. Global physical activity questionnaire (GPAQ): nine country reliability and validity study. J Phys Act Health 2009;6:790-804. PUBMED | CROSSREF

23. Jeong GW, Kim YJ, Park S, Kim H, Kwon O. Associations of recommended food score and physical performance in Korean elderly. BMC Public Health 2019;19:128. PUBMED | CROSSREF

24. Park H, Park W, Lee M, Ko N, Kim E, Ishikawa-Takata K, et al. The association of locomotive and non-locomotive physical activity measured by an accelerometer with functional fitness in healthy elderly men: a pilot study. J Exerc Nutrition Biochem 2018;22:41-48. PUBMED | CROSSREF

25. Shin JY, Lee KH, Song HS, Chun BO. Relationship between Eyes-Hands Coordination Test and Reaction time Test: agreement of evaluation standards. Korean J Meas Eval Phys Educ Sport Sci 2019;21:47-58. CROSSREF

26. Randolph C, Tierney MC, Mohr E, Chase TN. The Repeatable Battery for the Assessment of Neuropsychological Status (RBANS): preliminary clinical validity. J Clin Exp Neuropsychol 1998;20:310-319. PUBMED | CROSSREF

27. Boisseau E, Scherzer P, Cohen H. Eye-hand coordination in aging and in Parkinson's disease. Neuropsychol Dev Cogn B Aging Neuropsychol Cogn 2002;9:266-275. CROSSREF

28. Guan J, Wade MG. The effect of aging on adaptive eye-hand coordination. J Gerontol B Psychol Sci Soc Sci 2000;55:151-162. PUBMED | CROSSREF

29. Van Halewyck F, Lavrysen A, Levin O, Boisgontier MP, Elliott D, Helsen WF. Both age and physical activity level impact on eye-hand coordination. Hum Mov Sci 2014;36:80-96. PUBMED | CROSSREF

30. Albert MS, DeKosky ST, Dickson D, Dubois B, Feldman HH, Fox NC, et al. The diagnosis of mild cognitive impairment due to Alzheimer's disease: recommendations from the National Institute on Aging-Alzheimer's Association workgroups on diagnostic guidelines for Alzheimer's disease. Alzheimers Dement 2011;7:270-279. PUBMED | CROSSREF

31. Kim EH, Suh SR. Effects of a memory and visual-motor integration program for older adults based on self-efficacy theory. J Korean Acad Nurs 2017;47:431-444. PUBMED | CROSSREF

32. Inzelberg R, Schechtman E, Hocherman S. Visuo-motor coordination deficits and motor impairments in Parkinson's disease. PLoS One 2008;3:e3663. PUBMED | CROSSREF

33. Chan PT, Chang WC, Chiu HL, Kao CC, Liu D, Chu H, et al. Effect of interactive cognitive-motor training on eye-hand coordination and cognitive function in older adults. BMC Geriatr 2019;19:27. PUBMED | CROSSREF

34. Sung CM, Lee TY, Chu H, Liu D, Lin HC, Pien LC, et al. Efficacy of multi-domain cognitive function training on cognitive function, working memory, attention, and coordination in older adults with mild cognitive impairment and mild dementia: a one-year prospective randomised controlled trial. J Glob Health 2023;13:04069. PUBMED | CROSSREF

35. MacDonald SW, Dixon RA, Cohen AL, Hazlitt JE. Biological age and 12-year cognitive change in older adults: findings from the Victoria Longitudinal Study. Gerontology 2004;50:64-81. PUBMED | CROSSREF

36. Cooper R, Kuh D, Hardy R; Mortality Review GroupFALCon and HALCyon Study Teams. Objectively measured physical capability levels and mortality: systematic review and meta-analysis. BMJ 2010;341:c4467. PUBMED | CROSSREF

37. Clouston SA, Brewster P, Kuh D, Richards M, Cooper R, Hardy R, et al. The dynamic relationship between physical function and cognition in longitudinal aging cohorts. Epidemiol Rev 2013;35:33-50. PUBMED | CROSSREF

38. Kunutsor SK, Isiozor NM, Voutilainen A, Laukkanen JA. Handgrip strength and risk of cognitive outcomes: new prospective study and meta-analysis of 16 observational cohort studies. Geroscience 2022;44:2007-2024. PUBMED | CROSSREF

39. Lee I, Kang H. Association of health physical fitness and serum vitamin d with global cognitive performance in older persons. J Korean Soc Living Environ Syst 2016;23:217-224. CROSSREF

40. Lee JO, Byun YH, Kim CY. Relationship between functional physical fitness and cognitive function in elderly women. J Sport for All 2021;85:455-464. CROSSREF

41. Yoon BK. The Correlation between cognitive function and health-related fitness according to the gender in Korean elderly. J Sport Dance Sci 2024;4:95-104. CROSSREF

42. Jeong BJ. A study on the relationship between physical fitness and cognitive function in elderly women. J Kor Assoc Phys Educ Sport Girls Women 2015;29:19-29. CROSSREF

https://doi.org/10.12779/dnd.2026.25.1.13