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Original Article

Use of the Tokyo Cognitive Assessment for mild cognitive impairment to characterize elderly people that use day care services in Japan

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Abstract. [Purpose] This study compared the motor skills and cognitive functions of elderly participants who required support with those who did not require support. We aimed to evaluate the characteristics of impairment in sub-items of cognitive function in patients who needed support to predict future clinical issues. [Participants and Methods] We surveyed 31 participants requiring support under the day care service insurance system for which they attended day care service centers in Japan (rehabilitation users) and 10 healthy participants who attended a university for lifelong learning (healthy elders). Data on personal attributes of the participants were collected, and the Cardio-Ankle Vascular Index and motor and cognitive functions were assessed. [Results] Although the participants undergoing rehabilitation were, on average, 6 years older than the healthy elders, we found no significant differences between the two groups in closed-eye, one-legged standing, grip strength, or quadriceps muscle strength. In terms of the Tokyo Cognitive Assessment for mild cognitive impairment, we found no significant differences between those undergoing rehabilitation and healthy elders in clock drawing performance, serial 7 task performance, or orientation; however, there were significant differences in erase character, copy of triangular pyramid, composition, read of digits, go/no-go, word recall, story reproduction, ToCA total score. [Conclusion] We believe that it is imperative for day care service centers to conduct programs that maintain cognitive function in addition to programs for improvement of physical function.

Key words: Tokyo Cognitive Assessment for mild cognitive impairment, Day care services, Rehabilitation

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INTRODUCTION

According to the Japanese Ministry of Health, Labor, and Welfare, there were estimated 5 million users of the long-term care insurance system in Japan in 2020. Of these, about 80% are home-based users, and there are more than 100,000 long-term care-prevention service offices throughout Japan[1)]. Day care service centers account for approximately 40% of all long-term care-prevention establishments.

Mild cognitive impairment (MCI) refers to a condition in which a primary cognitive function (e.g., memory, decision making, reasoning, task execution) is impaired but does not interfere with daily life. The Tokyo Cognitive Assessment for MCI

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(ToCA-MCI) has been validated as having higher sensitivity and specificity than either the Mini Mental State Examination (MMSE) or the Hasegawa Dementia Scale-Revised (HDS-R), and its use is recommended as a clinical neuropsychological test for early detection of MCI in specific medical examinations and the diagnosis of dementia[2]. MCI is said to progress to dementia in 10–30% of patients per year[3, 4], and certain effects of dementia drugs have not yet been clearly demonstrated[5].

On the other hand, it is decline in the capacity of physical activity is believed to precede the onset of dementia, so early detection of physical activity impairment is important in screening for and preventing dementia[6, 7]. We hypothesized that investigating physical function and activity capacity of elderly people with MCI and clarifying their characteristics would help not only in understanding the pathophysiology and early detection of the condition, but also in creating intervention programs to prevent the transition from MCI to dementia.

The purpose of this study was to find an association between the decline in physical functions associated with aging and mild dementia, to characterize early cognitive decline, and to find intervention methods to prevent progression from MCI to dementia. We thus compared physical activity levels and cognitive functions between elderly people requiring support and elderly people not requiring support, with both groups at a day care service center. We detected patterns of impairment in the sub-items of cognitive function in elderly people requiring support, but not in those not requiring support.

PARTICIPANTS AND METHODS

Out of 37 people using day care services in August–September of 2021, this study included 31 people (mean age 81.3 ± 5.6 years, 10 males and 21 females, mean height 154.1 ± 5.6 cm, mean weight 58.7 ± 13.0 kg) who were certified as requiring support (rehabilitation users). For comparison, we incorporated 10 healthy elderly individuals (mean age 75.0 ± 5.9 years, 3 males and 7 females, mean height 157.0 ± 7.1 cm, mean weight 57.0 ± 6.3 kg) among the 13 participants who attended the lifelong learning university (healthy elders) in 2021 and who performed all task items. The establishments surveyed in this study were general care preventative day care facilities, where users attend half-day services providing functional training on a day-to-day basis. The participants of this study included people who were certified as requiring "support 1" or "support 2" under the long-term care insurance system; however, other users were accepted upon request, even if they were not users of long-term care insurance. We defined "needing support" as having a condition in which a person is able to perform the activities of daily life on their own but needs some assistance. The healthy elders attending the Elder College of Lifelong Learning functioned as this study's control group.

In accordance with the Declaration of Helsinki, we explained the study details to all participants and obtained informed consent that due consideration would be given to the protection of their information, that the data obtained throughout the study would not be used for any purpose other than this research, that the data would be anonymized, and that participation in the study was not compulsory. In addition, we followed the guidelines for medical research in the "Ethical Guidelines for Clinical Research" of the Japanese Ministry of Health, Labor, and Welfare. This study was approved by the Ethical Review Committee of Kurume Rehabilitation Hospital, Kabutoyamakai Medical Corporation (approval no. 21-001).

We collected data on personal attributes, including educational background, level of support required, disease status, and smoking status. Measurements of the Cardio-Ankle Vascular Index (CAVI) and of motor and cognitive functions were also assessed.

The CAVI is an index of vascular stiffness. We measured CAVI using a VaSeraVS-3000E device (Fukuda Denshi; Tokyo, Japan). The participant was asked to rest for 5 min on their back on a bed in a quiet and isolated place. Subsequently, cuffs were placed on both the arms and ankles, and a cardiac microphone was placed on the chest.

As for physical functions, we measured the closed-eyed one-legged stand, knee extension force of the quadriceps, grip strength, and walking speed.

For the closed-eyed one-legged stand, the participants were instructed to stand using one leg, with both eyes closed, on a hard horizontal floor. Measurements of the holding time were taken twice for both the left and right legs, and the maximum value for each was used as the measured value.

The knee extension force of the quadriceps femoris muscle was measured using a handheld dynamometer (OG Wellness; Okayama, Japan). Measurements were performed twice on each side in an upright sitting position with the knee joint flexed at 90°, and the higher of the two measurements was used as the measured value.

Grip strength was measured twice for each hand using a Smedley grip-strength meter (Matsumiya; Tokyo, Japan), and the mean of the highest left- and right-hand values was used as the measured value.

Walking speed was measured by having the participants walk a 5 m path at a normal speed with a 3 m path before and after the measurement section. Measurements were performed twice, and the fastest value (in seconds) was used as the measured value.

The ToCA-MCI was used to assess cognitive function. The ToCA-MCI consists of 11 tasks, including erasing a character, copying a triangular pyramid, drawing a clock, composition, reading digits, the serial 7 test, a go/no-go test, word recall, an orientation task, and story reproduction.

In the story reproduction task, a story was played back immediately after the start of the task, and the content of the story was listened to immediately after and at the end of the task (delayed playback); the task was divided into 25 words and scored

according to the number of words answered. It was scored as follows: 7 points for 10 or more words, 6 points for 8–9 words, 1–5 points for 3–7 words, and 0 points for 1–2 words.

The character erasure task has a time limit of 70 seconds and consists of six rows of 20 randomly chosen hiragana characters, with seven target hiragana characters (two "ta" and "ni") scattered in each row, for a total of 42 characters. The task was scored on a 2-point scale.

The figure-copying task asked participants to copy three-dimensional figures that had been taught to them, and it was graded on a one-point scale. In the clock-drawing task, participants were asked to draw a clock with numbers in the displayed circle to indicate the time 11:10. The task was graded on a 3-point scale.

The number chanting task consisted of sequential chanting of five-digit numbers and reverse chanting of three-digit numbers, and it was scored on a two-point scale. The subtraction task consisted of subtracting 7 from 100, three times, and had a maximum score of 3 points. The go/no-go task consisted of tapping on the desk on a screen and pressing "touch" once when the desk was tapped once and twice when it was tapped twice. The go/no-go task had a maximum score of three points.

The word recall task consisted of answering as many words as possible starting with the letter "ka". Three points were given for ≥10 words, 2 points for 6–9 words, 1 point for 3–5 words, and 0 point for 1–2 words. In the register task, students had to indicate where they were, the current day's date, the current day of the week, and their educational history. The test took approximately 20 min, and the participants listened to the instructions on a bed phone and responded on a touch panel. An assistant was assigned to respond to any questions during each of these tests.

The concept of age-associated cognitive impairment (AACI) is used to describe other than dementia and the prodromal state of dementia. The rehabilitation users did not have Alzheimer's disease, so we focused on mild cognitive impairment and compared the rehabilitation users to the AACI and MCI groups in a survey conducted by Otsuka et al.[2] to determine the degree of dementia.

For the comparison between rehabilitation users and healthy elders, an unpaired t-test was performed; the significance probability of the two population means was determined based on the results of Levene's test for equal variance. A one-sample t-test was used to compare the ToCA-MCI of the rehabilitation users with the AACI (n=22, mean age 79.6 ± 6.9 years) and MCI (n=21, mean age 80.9 ± 4.3 years) groups in a survey conducted by Otsuka et al.[2] of 105 local residents. This one-sample t-test was conducted to determine the degree of cognitive function in the rehabilitation user group. SPSS ver.26 (IBM, Tokyo, Japan) was used to perform the aforementioned statistical analyses. The significance level of all statistical analyses was set at $p<0.05$, and the values are presented as the mean ± standard deviation (SD).

RESULTS

Table 1 presents the attributes of the participants. There were 26 rehabilitation users over 75 years old. The healthy elders were high school graduates (50%) and college graduates (50%), while the rehabilitation users were middle high school graduates (45%), high school graduates (52%) and College graduate (3%). Stroke and spinal diseases (spinal canal stenosis, lumbar herniation, thoracic osteoarthritis, and osteoarthritis of the spine) accounted for about 20% each in the rehabilitation users. The ToCA-MCI cutoff value of ≥18 points[2] included 90% of the healthy elders group and about 45% of the rehabilitation users.

Table 2 shows a comparison of the mean values of physical function between the rehabilitation users and the healthy elders. The rehabilitation users were approximately 6 years older, on average, than the healthy elders. There were no significant differences in height and weight between the groups. Body mass index (BMI) was defined per the Japan Society for the Study of Obesity, with normal weight considered 18.5–25.0 and obese >25.0; the mean BMIs of the participants were within normal ranges. A CAVI value of <8.0 is within the normal range, 8.0–9.0 is in the borderline range, and >9.0 indicates advanced atherosclerosis; the mean value was >9.0 for both the rehabilitation users and the healthy elders, and the difference between them was not significant. There was no significant difference in balance function of the closed-eye one-leg stand, grip strength, or knee extension strength; however, walking speed was significantly slower in the rehabilitation users compared with the healthy elders.

Table 3 shows the relationships between total ToCA-MCI scores and the items listed in Table 2. In the healthy elders, there was a strong positive correlation between ToCA-MCI score and knee extensor strength. There was no correlation between the other items.

Table 4 compares the sub-items of the ToCA-MCI between the rehabilitation users and healthy elders, AACI, and MCI groups. Between the rehabilitation users and healthy elders, there was no significant difference in clock drawing task performance and or on orientation ability; however, there were significant differences in other areas, including in the total score. Between rehabilitation users and the AACI group, there were no significant differences in performance on composition, the serial 7 and go/no-go tasks, word recall, or story reproduction, but significant differences were found in other areas. In comparison with the MCI group, there were no significant differences in performance on the letter erasure task, number reading task, or directionality.

DISCUSSION

Surprisingly, despite the rehabilitation users being about 6 years older than the healthy elders, we found no significant differences between the two groups in three physical function tasks (closed-eye one-leg stand, quadriceps muscle strength, and grip strength), but we did find significant differences in gait speed. We believe that the rehabilitation users walked significantly slower than the independently walking healthy elders because some of the former group used a T-cane daily.

Table 1. Demographics of characteristics of participants

Domographic characteristics	R (n=31) Number (%)	Healthy elders (n=10) Number (%)
Gender (Male/Female)	10/21	3/7
Age		
≤74	5 (16.1)	6 (60.0)
75≥	26 (83.9)	4 (40.0)
Education background		
Middle school	14 (45.2)	-
High school	16 (51.6)	5 (50.0)
College	1 (3.2)	5 (50.0)
Type of disease		
Cerebrovascular disease	6 (19.4)	-
Spine disease	6 (19.4)	-
Low limb surgery	5 (16.1)	-
High blood pressure	3 (9.7)	1 (10.0)
Heart disease	2 (6.5)	-
Diabetes	1 (3.2)	2 (20.0)
Osteoarthritis	1 (3.2)	1 (10.0)
Rheumatoid arthritis	1 (3.2)	1 (10.0)
Cataract	1 (3.2)	1 (10.0)
Others	5 (16.1)	4 (40.0)
Smoking	21 (67.7)	8 (80.0)
ToCA-MCI		
≤17	17 (54.8)	1 (10.0)
18≥	14 (45.2)	9 (90.0)

R: Rehabilitation users; ToCA-MCI: Tokyo Cognitive Assessment for Mild Cognitive Impairment.
Others (R): Low back pain, sleep apnea syndrom, heperlipidaemia, fundus hemorrhage. Others (healthy elders): Cancer, ganglion, hepatitis C, ischemic colitis, respiratory disease.

Table 2. Comparison of physical variables between rehabilitation users and healthy elders

	R (n=31) Mean	Healthy elders (n=10) Mean
Age (years)	81.3 ± 5.6**	75.0 ± 5.9
Height (cm)	154.1 ± 7.1	157.0 ± 7.1
Weight (kg)	58.7 ± 13.0	56.9 ± 6.3
BMI (kg/m2)	24.5 ± 4.1	23.3 ± 2.5
CAVI average	9.8 ± 1.1	9.2 ± 0.9
Closed-eye one-leg stand_right (s)	1.9 ± 1.4	4.8 ± 4.8
Closed-eye one-leg stand_left (s)	2.3 ± 2.2	2.4 ± 1.5
Knee extension (kgf)	23.1 ± 8.4	17.0 ± 6.0
Grip average (kg)	22.9 ± 7.7	23.8 ± 8.1
Gait speed (m/s)	1.1 ± 0.3***	1.8 ± 0.3

BMI: Body mass index; CAVI: Cardio-Ankle Vascular Index. Mean ± SD. **p<0.01, ***p<0.001.

Table 3. Correlation coefficient of physical variables with total ToCA-MCI scores

	R (n=31)	Healthy elders (n=10)
	r value	r value
Age	0.126	−0.330
Height	−0.201	0.011
Weight	0.001	0.171
BMI	0.131	0.227
CAVI average	−0.113	−0.253
Closed-eye one-leg stand_right	−0.037	0.150
Closed-eye one-leg stand_left	−0.211	0.153
Knee extension	0.127	0.852**
Grip average	−0.341	−0.390
Gait speed	0.045	0.540

**p<0.01.

Table 4. Cognitive of cognitive variables between rehabilitation users and elders or age-associated cognitive impairment, mild cognitive impairment

ToCA-MCI	R (n=31)	Healthy elders (n=10)	AACI[a)]	MCI[a)]
	Mean	Mean	Mean	Mean
1. Erase character (2 points)	0.13 ± 0.50	1.40 ± 1.00**	0.73 ± 0.98***	0.29 ± 0.72
2. Copy of triangular pyramid (1 point)	0.42 ± 0.50	1.00 ± 0.00***	0.82 ± 0.39***	0.76 ± 0.44**
3. Clock drawing (3 points)	2.19 ± 0.87	2.7 ± 0.48	2.36 ± 1.05***	1.62 ± 1.20**
4. Composition (1 point)	0.35 ± 0.49	0.80 ± 0.42*	0.18 ± 0.39	0.05 ± 0.22**
5. Read of digits (2 points)	0.68 ± 0.70	1.30 ± 0.82*	1.32 ± 0.84***	0.76 ± 0.89
6. Serial 7 (3 points)	1.94 ± 1.06	2.4 ± 0.84	2.00 ± 0.93	1.19 ± 0.98***
7. Go/no-go (3 points)	2.06 ± 1.06	2.70 ± 0.48*	2.05 ± 1.07	1.14 ± 1.06***
8. Word recall (3 points)	1.97 ± 0.84	2.70 ± 0.48*	2.05 ± 0.65	1.48 ± 0.51**
9. Orientation (5 points)	4.32 ± 1.14	4.7 ± 0.67	4.82 ± 0.73*	4.71 ± 0.85
10. Story reproduction (7 points)	2.52 ± 2.69	5.00 ± 2.40*	2.82 ± 1.89	1.33 ± 1.65*
Add 1 point if ≤9 yr. Education	0.35 ± 0.49	0	0.82 ± 0.39***	0.86 ± 0.36***
ToCA total (30 points)	16.94 ± 5.84	24.70 ± 4.81***	19.60 ± 3.90*	14.0 ± 2.90**

[a)]: Citation from Reference 2). AACI: Age-associated cognitive impairment; MCI: Mild cognitive impairment; ToCA-MCI: Tokyo Cognitive Assessment for Mild Cognitive Impairment.
R vs. Healthy elders: unpaired t-test, R vs. AACI and MCI: one sample t-test. Mean ± SD. *p<0.05, **p<0.01, ***p<0.001.

The rehabilitation users showed significantly lower values in most of the scored items compared to those of the healthy elders, but there were no significant differences in performance on the clock drawing task, serial 7 task, or orientation in the sub-items of the ToCA-MCI; this suggests a relatively preserved cognitive function and slower progression of impairment for these items in particular. Comparison of the rehabilitation users with the AACI and MCI groups for the ToCA-MCI sub-items showed that the items that were not significantly different and were predictive of MCI were character erasure and digit reading.

The rehabilitation users were transported to the day care service by car at a fixed time. Because all measurements were conducted at the day care service, it was assumed that the dates and orientation were easy to understand. Since there was only one person with higher brain dysfunction who showed hemispheric cognitive impairment, it is presumed that they spent their daily life checking the date and time. Among the ToCA-MCI sub-items, the rehabilitation users showed no significant differences in the composition, go/no-go, word recall, and story reproduction tasks in comparison with the AACI group, and in the character erasure and digit reading tasks in comparison with the MCI group. The character erasure task in the ToCA-MCI corresponds to the “trail making” task in the Montreal Cognitive Assessment (MoCA). In the character erasure task, the temporoparietal junction plays a central role in integrating functions related to attention, memory, sociality, and language[2, 8)]. The ability to process complex functions quickly declines with age, which is consistent with the results of this study. The digit-reading task showed that participants often forgot numbers between listening to and touching the numbers on the screen; this item also seemed to be related to deficits in processing abilities.

Petersen et al.[9] proposed classifying MCI into four subtypes: amnestic MCI, non-amnestic MCI, and single-domain and multiple-domain stages of MCI leading to Alzheimer's disease. The global standardization of the natural progression of MCI and its evaluation methods are still under study[10, 11]. In the present study, none of the rehabilitation users were diagnosed with Alzheimer's disease. Although 17 rehabilitation users had a total score of ≤17 on the ToCA-MCI, suggesting the presence of MCI, only three sub-items (character erasure, digit reading and orientation) actually predicted MCI. These results suggest that the overall ToCA-MCI score is only a guide, and that its sub-items need to be considered as well.

Rehabilitation users were provided with an array of exercises, including gymnastics, bicycle ergometers, treadmills, quadriceps muscle strengthening tools, one-legged standing exercises, standing and sitting exercises, and stair climbing exercises. These were performed twice a week in the morning or afternoon for a half-day at the day care services center. A report by the Japanese Ministry of Health, Labor, and Welfare indicated that there was a difference in grip strength and closed-eyed one-legged standing in the people aged 75–80 years[12], suggesting a decline in muscle strength due to aging; however, rehabilitation users were able to maintain their physical functions. Previous studies reported both a relationship between physical exercise and neural plasticity[13] and that aerobic—but not anaerobic—exercise correlates with activity in the prefrontal and parietal cortical regions[14]. Previous studies examining the relationship between physical and cognitive function have generally found that older adults with high physical activity levels have superior cognitive function to those with lower physical activity levels[15]. As cognitive performance declines, walking speed decreases, and the ability to perform dual tasks while walking declines[16, 17]. The risk of dual-task performance attenuation is also four times higher in the presence of hypertension[17]. In the present study, rehabilitation users with a CAVI average above the borderline of <9.0 and suspected associated arterial stiffness were slower than the healthy elders in terms of walking speed, but we found no correlation between cognitive and physical function scores. In terms of the relationship between physical functions other than walking and cognition, the amount of central nervous system activity during grip strength measurement is proportional to the magnitude of grip strength, and especially in the elderly, that activity may correlate with a wide range of scores[18]. Coordinated cognition and movement of the limbs have also shown a positive correlation[19]. We suspect that the reason behind the lack of a positive correlation between physical function and cognition is that the rehabilitation users had a level of physical function similar to that of the elderly group, as declines in physical function were reduced due to the aerobic exercise being conducted at the office. The schedule of the day-care center consisted of only one and a half hours per half day, with a focus on exercises and individual training as a whole, with no direct intervention for cognitive function; this issue must be addressed in the future.

In the healthy elder group, we observed an association between the ToCA-MCI score and quadriceps muscle strength. The healthy elder group included elderly people regularly attending a specialized college for lifelong learning. However, the healthy elder group had only a small number of students enrolled in a lifelong learning university, in part due to the COVID-19 pandemic, and the group's sample size was not sufficient for a robust analysis. In the future, it will be necessary to increase that sample size and add prior and current exercise habits to the study questionnaire.

This study analyzed the characteristics of people requiring support who attended a day care service center by evaluating their cognitive functioning using the ToCA-MCI and their physical functioning using other metrics. Based on our findings, we recommend that day care services centers should conduct programs to improve both cognitive and physical function.

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The authors have no conflicts of interest to disclose.

REFERENCES

1) Ministry of Health, Labour and Welfare. Overview of the survey of long-term care service facilities and establishments. https://www.mhlw.go.jp/toukei/saikin/hw/kaigo/service16/dl/tyosa.pdf (Accessed Feb. 12, 2022)
2) Otsuka K, Kubo Y, Yamanaka G, et al.: Tokyo cognitive assessment for mild cognitive impairment, ToCA-MCI: validity and utility in elderly Japanese. Integr Biol Physiol, 2017, 38: 579–621.
3) Bruscoli M, Lovestone S: Is MCI really just early dementia? A systematic review of conversion studies. Int Psychogeriatr, 2004, 16: 129–140. [Medline] [CrossRef]
4) Iwatsubo T, Iwata A, Suzuki K, et al. Japanese Alzheimer's Disease Neuroimaging Initiative Alzheimer's Disease Neuroimaging Initiative: Japanese and North American Alzheimer's Disease Neuroimaging Initiative studies: harmonization for international trials. Alzheimers Dement, 2018, 14: 1077–1087. [Medline] [CrossRef]
5) Birks J: Cholinesterase inhibitors for Alzheimer's disease. Cochrane Database Syst Rev, 2006, (1): CD005593. [Medline]
6) Kikuchi T, Okajima K, Cornelissen G, et al.: Community-based comprehensive geriatric assessment of short- and long-term predictors of cognitive decline in elderly adults. J Am Geriatr Soc, 2015, 63: 1031–1033. [Medline] [CrossRef]
7) Ho RT, Cheung JK, Chan WC, et al.: A 3-arm randomized controlled trial on the effects of dance movement intervention and exercises on elderly with early dementia. BMC Geriatr, 2015, 15: 127. [Medline] [CrossRef]
8) Geng JJ, Vossel S: Re-evaluating the role of TPJ in attentional control: contextual updating? Neurosci Biobehav Rev, 2013, 37: 2608–2620. [Medline] [CrossRef]
9) Petersen RC: Mild cognitive impairment as a diagnostic entity. J Intern Med, 2004, 256: 183–194. [Medline] [CrossRef]

10) Petersen RC, Aisen PS, Beckett LA, et al.: Alzheimer's Disease Neuroimaging Initiative (ADNI): clinical characterization. Neurology, 2010, 74: 201–209. [Medline] [CrossRef]
11) Chandra A, Valkimadi PE, Pagano G, et al. Alzheimer's Disease Neuroimaging Initiative: Applications of amyloid, tau, and neuroinflammation PET imaging to Alzheimer's disease and mild cognitive impairment. Hum Brain Mapp, 2019, 40: 5424–5442. [Medline] [CrossRef]
12) Ministry of Health, Labour and Welfare. Current status of physical functions, etc. of the elderly. https://www.mhlw.go.jp/content/11200000/jinsei100_2_3.pdf (Accessed Feb. 12, 2022)
13) Hötting K, Röder B: Beneficial effects of physical exercise on neuroplasticity and cognition. Neurosci Biobehav Rev, 2013, 37: 2243–2257. [Medline] [CrossRef]
14) Colcombe SJ, Kramer AF, Erickson KI, et al.: Cardiovascular fitness, cortical plasticity, and aging. Proc Natl Acad Sci USA, 2004, 101: 3316–3321. [Medline] [CrossRef]
15) Weuve J, Kang JH, Manson JE, et al.: Physical activity, including walking, and cognitive function in older women. JAMA, 2004, 292: 1454–1461. [Medline] [CrossRef]
16) Cohen JA, Verghese J: Gait and dementia. Handb Clin Neurol, 2019, 167: 419–427. [Medline] [CrossRef]
17) Montero-Odasso M, Speechley M, Muir-Hunter SW, et al. Canadian Gait and Cognition Network: Dual decline in gait speed and cognition is associated with future dementia: evidence for a phenotype. Age Ageing, 2020, 49: 995–1002. [Medline] [CrossRef]
18) Noble JW, Eng JJ, Kokotilo KJ, et al.: Aging effects on the control of grip force magnitude: an fMRI study. Exp Gerontol, 2011, 46: 453–461. [Medline] [CrossRef]
19) Heuninckx S, Wenderoth N, Swinnen SP: Systems neuroplasticity in the aging brain: recruiting additional neural resources for successful motor performance in elderly persons. J Neurosci, 2008, 28: 91–99. [Medline] [CrossRef]