

The Effects of Cognitive Activity Combined with Active Extremity Exercise on Balance, Walking Activity, Memory Level and Quality of Life of an Older Adult Sample with Dementia

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Abstract. [Purpose] The purpose of this study was to compare the effectiveness of cognitive activity combined with active physical exercise for a sample of older adults with dementia. [Subjects] A convenience sample of 30 patients with dementia (Mini-Mental State Examination score between 16 and 23) was used. Participants were randomly allocated to one of two groups: cognitive activity combined with physical exercise CAE, n=11), and only cognitive activity CA, n=9). [Methods] Both groups participated in a therapeutic exercise program for 30 minutes, three days a week for 12 weeks. The CAE group performed an additional exercise for 30 minutes a day, three days a week for 12 weeks. A Wii Balance Board (WBB, Nintendo, Japan) was used to evaluate postural sway as an assessment of balance. The Berg Balance Scale (BBS) and Modified Falls Efficacy Scale (MFES) were used to assess dynamic balance abilities. The Timed Up-and-Go test (TUG) was used to assess gait, and the Digit Span Test (DST) and 7 Minute Screening Test (7MST) were used to measure memory performance. The Mini-Mental Status Exam-Korean version (MMSE-K), Kenny Self-Care Evaluation (KSCE), and Short Geriatric Depression Scale (GDS) were used to assess quality of life (QOL). [Results] There were significant beneficial effects of the therapeutic program on balance (velocity in EOWB, path length in ECNB, BBS, and MMFE), QOL (MMSE-KC, GDS, KSCE), and memory performance (DSB) in the CAE group compared to CA group, and between pre-test and post-test. [Conclusion] A 12-week CAE program resulted in improvements in balance, memory and QOL. Therefore, some older adults with dementia have the ability to acquire effective skills relevant to daily living.

Key words: Dementia, Elderly, Gait

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INTRODUCTION

Increased rates of dementia are a problem for the aging population around the world. The loss of brain function due to dementia has a variety of causes, and results in emotional and behavioral problems, social and occupational dysfunction, personality changes, and difficulties with intellectually complex issues¹⁾. Patients with dementia associated with aging have problems with memory, thinking, orientation, judgment, and activities of daily living due to neural dysfunction²⁾.

Furthermore, dementia coincides with a decline in physical and cognitive activity³⁾. Changes caused by dementia are often related to difficulties with navigating one's living environment, the ability to assess situations and make

decisions, and environmental adaptation⁴⁾. Dementia is an irreversible syndrome resulting from neural degeneration. Cognitive impairment and behavioral interruption are major symptoms that are associated with negative outcomes. These symptoms are a major target for intervention to improve patients' quality of life⁵⁾. Several studies have shown that exercise has a positive effect on cognitive functioning of both healthy older adults and patients with dementia. Exercise can be specifically helpful for enhancing the independent recovery of cognitive and behavioral functions of patients with dementia⁶⁾.

According to a recent meta-analysis, exercise was useful for improving the cardiovascular and motor functions of normal older adult populations. Exercise also provided a significant increase in cognitive speed, vision, hearing, and concentration. The same study also reported a positive effect on complex movement. Therefore, exercise could lead to some cognitive recovery, as well as prevent further deterioration⁷⁾.

The results of other studies^{5, 8)} have suggested that the integration of a cognition and physical exercise program is helpful for individuals with dementia. A study by Tappen et al.⁹⁾ had older adults with dementia perform three interven-

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tions: “conversation, walking, and conversation and walking”. Their results show that conversation combined with walking was the most effective at improving cognitive and motor functions.

Harlein et al.¹⁰ reported on the importance of combined exercise and cognitive training for the restoration of independence through increased muscle strength, functional ability, and reduction in fall risk, and showed that physical activity is associated with the cardiovascular risk factors of subjects with dementia.

Lee YM and Bak NH¹¹ also observed that an integrated program of exercise and cognitive training is better way of preventing the loss of cognitive abilities than a traditional intervention.

The main benefit of an integrated exercise and cognitive therapy program is to increase activity and participation, as well increase neural plasticity. Improvements in physical activity and cognitive function can also help reduce neural degenerative structures, such as beta-amyloid plaques and tangles. Alleviating cognitive and functional changes, to aid independent living might help individuals with dementia preserve their QOL¹². Thus, the purpose of the present study was to investigate the effects of combined exercise and cognitive training on balance, gait, and memory of patients with dementia to see if such an intervention can help improve their QOL.

SUBJECTS AND METHODS

A total of 30 older adults patients with dementia, living in a long-term care facility were recruited for this study. The patients understood the content of the study and agreed to participate. The subjects provided their informed consent to participation in this study. Approval for the study protocol was received from the Sahmyook University Institutional Review Board. Table 1 lists the general characteristics of the subjects.

This study used a randomized, two-group, pretest-posttest design. After the pretest, patients were randomly assigned to either the cognitive activity with exercise group (CAE, n=15) or the cognitive activity group (CA, n=15). An individual judged unsuitable to assess the impact or progress of the training randomized patients by selecting sealed envelopes one hour prior to the start of the intervention. Fewer than 80% of the patients were available for the final analysis due to poor concentration during the intervention. This left us with 11 participants in the CAE group and 9 participants in the CA group for full analysis.

All groups received conventional physical therapy (5 times a week for 30 min). The CAE group received the same intervention as the CA group, with the addition of a cycling exercise (3 times a week for 20 min), during their cognitive activity session (3 times a week for 20 min). Inclusion criteria were as follows: The ability to communicate and understand the tasks, a Mini-Mental Status Examination score between 16 and 23 points, no visual field deficits, no known musculoskeletal conditions that would have affected patients' ability to walk safely, and the ability to walk independently with or without the use of an assistive device.

Table 1. General characteristics of the subjects (n=20)

Parameters	CAE Group (n=11)	CA Group (n=9)
	MD±SD	MD±SD
Age (yrs)	77.9±7.5	70.1±12.2
Height (cm)	159.1±7.3	157.3±7.2
Weight (kg)	54.6±7.1	49.4±7.3
MMSE-K (score)	18.0±1.5	18.7±1.2
BBS (score)	35.3±1.8	34.9±4.6
MFES (score)	39.9±6.8	37.4±6.8
TUG (score)	27.7±6.1	28.8±5.7
DSF (score)	6.6±1.2	6.9±2.0
DSB (score)	0.9±7.0	1.1±0.8
7MS (score)	50.6±34.6	43.9±36.1
GDS (score)	12.1±0.9	11.2±1.1*

*, significance difference between the groups, p<0.05

MFES: Modified Falls Efficacy Scale, DSF: Digit Span Forward, DSB: Digit Span Backward, 7MS: 7-Minute Screening, MMSE-K: Korean version of the Mini Mental State Examination, BBS: Berg Balance Scale, TUG: Timed Up and Go, GDS: Geriatric Depression Scale

Exclusion criteria included having an unregulated cardiac disorder, or structural or functional limb impairments.

To complete the complex cognitive training and exercise at the same time, the training group patients rhythmically repeated simple actions to build up reactionary movement. Based on their level of dementia patients simply continued to repeat the training at low intensity for 30 minutes, three times a week for 12 weeks. Cognitive training included sequential memory recall tasks used in previous studies¹³.

The cognitive training group performed the same tasks at the same time using a “Three-back verbal working memory”. The measure used in the current study were the Berg Balance Scale (BBS), the Modified Falls Efficacy Scale (MFES), the Timed Up and Go (TUG), the Digit Span Forward (DSF), the Digit Span Backward (DSB), the Mini-Mental Status Exam-Korean version (MMSE-K), the Kenney Self-Care Evaluation (KSCE), the Short Geriatric Depression Scale (GDS). Patients performed memory, balance, gait, and QOL tasks before and after the intervention. A Wii Balance Board (Nintendo, Japan) with Balancia software, and the Berg Balance Scale were used to assess each static and dynamic balance, respectively. The Modified Falls Efficacy Scale (MFES) was used as an additional evaluation tool.

On the Wii Balance Board, balance was assessed under four conditions feet apart with eyes open (EOWB), feet together with eyes open (EONB), feet apart with eyes closed (ECWB), feet together with eyes closed (ECNB). Each position was measured three times¹⁴. For the current study, the sampling for data collection was 50 Hz and 12 HZ (using a low pass filter). Measurements were taken for 15 and 30 seconds with a 60-second rest between each position. The reliability had an ICC ranging from 0.66–0.94, and the pressure points on the center of pressure validity had an ICC ranging from 0.77–0.89^{14, 15}. The TUG was used to assess dynamic balance ability^{13, 15}.

Table 2. Comparison of path length and velocity within groups (n=20)

ECWB		CAE (n=11)	CA (n=9)
		MD±SD	MD±SD
COP	Pre	4.8±1.4	3.5±1.7
Velocity	Post	3.6±1.2	3.2±1.3
(cm/s)	Post-pre	1.2±1.0*,**	0.8±1.8**
ECNB		CAE (n=11)	CA(n=9)
		MD±SD	MD±SD
COP	Pre	146.4±64.5	104.7±46.6
Path Length	Post	93.9±38.9	95.4±37.5
(cm/s)	Post-pre	52.5±59.7*,**	9.3±14.1**

*, Significant post-pre difference (p<0.05)

** , Significant difference between the groups (p<0.05)

ECWB: Eyes Closed Wide Base, ECNB: Eyes Closed Narrow Base

Table 4. Comparison of GDS, KSCE within groups (n=20)

Parameters		CAE (n=11)	CA (n=9)
		MD±SD	MD±SD
GDS (score)	Pre	12.2±0.9	11.2±1.1
	Post	10.6±1.0	10.9±1.3
	Post-pre	1.6±0.5*,**	0.3±0.7**
KSCE (score)	Pre	31.3±9.6	15.0±1.7
	Post	30.9±12.6	16.3±1.5
	Post-pre	-2.9±0.1*,**	-1.3±1.5*,**

*, Significant post-pre difference (p<0.05)

** , Significant difference between the groups (p<0.05)

GDS: Geriatric Depression Scale

KSCE: Kenny Self Care Evaluation

The Korean-Wechsler Adult Intelligence Test (Korean Wechsler Adult Intelligence Scale, KWA) was used to measure cognitive ability, specifically working memory performance assessed with the DSF and DSB. Furthermore, orientation checks, memory check, visuospatial assessment, and verbal fluency were examined with the 7-Minute Screening Test (7MST). The short version of the Geriatric Depression Scale (GDS) was used to assess depressive symptoms. Kenny's activities of daily living scale (KSCE; a QOL measure) was used to examine patient's ability to perform physical activities at home.

SPSS version 12.0 software was used for statistical analyses. We confirmed the normality of the data using non-parametric assays (between-groups: Mann-Whitney test; within groups: Wilcoxon's signed-rank test) between the groups. The level of significance was $p < 0.05$ in all the analyses.

RESULTS

The general characteristics of the 20 patients who fulfilled the inclusion criteria are summarized in Table 1. There were no significant differences in the pre- and post-intervention measures between the CAE and CA groups.

Table 3. Comparison of BBS and NFES within groups (n=20)

Parameters		CAE (n=11)	CA (n=9)
		MD±SD	MD±SD
BBS (score)	Pre	35.3±1.8	34.9±4.6
	Post	38.0±2.0	35.1±4.4
	Post-pre	-2.7±0.9*,**	-0.2±2.4**
MFES (score)	Pre	39.9±6.1	37.4±6.9
	Post	42.5±6.7	38.0±7.2
	Post-pre	-2.6±1.0*,**	-0.6±0.9**

*, Significant post-pre difference (p<0.05)

** , Significant difference between the groups (p<0.05)

BBS: Berg Balance Scale, MFES: Modified Falls Efficacy Scale

Table 5. Comparison of DSF, DSB, 7MS within groups (n=20)

Parameters		CAE (n=11)	CA (n=9)
		MD±SD	MD±SD
DSF(score)	Pre	6.6±1.2	6.9±2.0
	Post	8.7±1.2	8.1±1.6
	Post-pre	-2.1±1.1*	-1.2±1.2
DSB(score)	Pre	19.9±6.6	1.1±0.8
	Post	26.4±6.6	1.3±0.5
	Post-pre	-0.9±0.5*,**	-0.2±0.4**
7MS(score)	Pre	50.6±34.7	44.0±36.2
	Post	39.8±33.0	39.6±37.1
	Post-pre	10.8±8.4*	4.3±5.0*

*Significantly Post-pre different from CAE group (p<0.05)

**Significantly Post-pre between CAE and CA groups (p<0.05)

DSF: Digit Span Forward, DSB: Digit Span Backward, 7MS: 7 Minute Screening

The pre- and post-intervention values of the static balance amplitudes are summarized in Table 2 (path length and velocity of COP). The CAE group showed a significantly different path length in ECNB and a significantly different velocity in EOWB ($p < 0.05$). In addition, the measures of dynamic balance, BBS and MFES scores, showed significant increases in the CAE group ($p < 0.05$), but not in the CA group (Table 3). Scores of the GDS, KSCE DSF, DSB, and 7MST showed significant improvements in the CAE group ($p < 0.05$) as well (Tables 4, 5).

In summary, static balance (path length in ECNB, velocity in EOWB) dynamic balance abilities (BBS and MFES), memory (DSB), and quality of life (GDS, KSCE) showed significant differences between the CAE and CA groups ($p < 0.05$).

DISCUSSION

Most individuals with dementia suffer reductions in proprioceptive sensation, as well as in the visual, vestibular and memory functions. Therefore, such individuals can suffer from issues related to both cognition and gait. Furthermore memory decline is a hallmark of the aging process¹⁶.

Harlein and Yeol YY^{3, 10} showed the impact of balance ability on dementia patients. Sixty patients performed both

cognitive and physical exercise training. This intervention increased balance and cognitive performance in the cognitive activity exercise group as compared to the control group.

Penades¹⁷⁾ also examined improvements in cognitive function using an integrated training program and found significant improvements in task execution and attentional function. Another study showed that cognitive training combined with exercise produced increased concentration and attentional ability as compared to when only cognitive training was provided¹⁸⁾.

Tappen RM¹⁹⁾ suggested that an intervention that combines cognitive training with physical activity is necessary to increase active participation in the intervention and improve aspects of daily living.

In this study, we used an intervention combining cognitive training with physical exercise to improve balance, gait, memory, and QOL. After the 12-week intervention, the CAE group showed significant improvement as, compared to the CA group in all the measures studied.

The COP balance measures only revealed differences in velocity in EOWB and path length in ECNB. The BBS and MFES scores significantly improved for the CAE group. In contrast to previous studies, the results of the present study for static balance did not reveal significant group differences. One possible reason for this could be the large individual differences in SD of measurement shown by the participants in this study. One plausible cause of the cognitive changes observed among the dementia patients is the fact that many suffer from emotional and psychological problems, and are a burden on their family, which can lead to nursing home admittance. Depression is known to increase among patients who are in long-term nursing care^{19, 20)}. Psychological problems particularly depression and dementia are common in long term nursing care. Studies of successful aging show that lifestyle habits like having physical activity, influence the physical and mental health of dementia patients²¹⁾. The present study combined improving levels of sustained attention, using three-back working memory, with increasing activity of elderly patients with dementia by CAE. Interventions tailored to the patient on modified and sustainable movement.

The results of the DSB and 7MST show significant differences between the two groups ($p < 0.05$). The variation between results of the groups in this study might not have differed as much if a smaller number of assessment tools used for hospitalization for dementia had been used²²⁾.

We recommend taking advantage of social psychological approaches to properly manage physical and cognitive functions, to help improve the QOL of suffering from dementia. Increasing QOL has been the main area of interest for social policy interventions.

In this study, the CAE group showed improved GDS and KSCE scores ($p < 0.05$) and had improved scores as compared to the CA group ($p < 0.05$). The present study demonstrated the beneficial effects of cognitive activity combined with physical exercise on balance, gait, memory, and QOL. In conclusion, cognitive activity combined with physical activity can help improve balance, memory function, and QOL of individuals with dementia.

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REFERENCES

- 1) Suh GH, Son HG, Ju YS, et al.: A randomized, double-blind, crossover comparison of risperidone and haloperidol in Korean dementia patients with behavioral disturbances. *Alzheimer Dis Assoc Disord*, 2000, 14: 296–301.
- 2) Cummings JL, Vinters HV, Cole GM, et al.: Alzheimer's disease: etiologies, pathophysiology, cognitive reserve, and treatment opportunities. *Neurology*, 1998, 51: S2–S17. [[Medline](#)] [[CrossRef](#)]
- 3) Yeol YY, Gae YY: Affect the balance of elderly with dementia on the ability to perform cognitive activities combined exercise training. *J Occup Ther*, 2009, 17: 44–50.
- 4) Kim EY, Won IT, Gae YY, et al.: Effects of dynamic balance ability in the cognitive abilities of the elderly. *J Occup Ther*, 2007, 1: 16–22.
- 5) Lee J, Yeon HS, Young YE, et al.: The effect of multi-sensory environment (snoezelen) program of applying for the elderly with dementia. *J Occup Ther*, 2005, 13: 33–42.
- 6) Geun B: Gimnara: physical activity program on cognitive and physical ability to perform, the effects of gait, quality of life and depression in special education. *Rehab Sci Res*, 2011, 50: 33–41.
- 7) Baker LD, Frank LL, Foster SK, et al.: Effects of aerobic exercise on mild cognitive impairment. *Arch Neurol*, 2010, 67: 71–79. [[Medline](#)] [[CrossRef](#)]
- 8) Raggi A, Iannaccone S, Marcone A, et al.: The effects of a comprehensive rehabilitation program of Alzheimer's disease in a hospital setting. *Behav Neurol*, 2007, 18: 1–6. [[Medline](#)]
- 9) Tappen RM, Roach KE, Applegate EB, et al.: Effect of a combined walking and conversation intervention on functional mobility of nursing home residents with Alzheimer's disease. *Alzheimer Dis Assoc Disord*, 2000, 14: 196–201. [[Medline](#)] [[CrossRef](#)]
- 10) Härlein J, Dassen T, Halfens RJ, et al.: Fall risk factors in older people with dementia or cognitive impairment: a systematic review. *J Adv Nurs*, 2009, 65: 922–933. [[Medline](#)] [[CrossRef](#)]
- 11) Lee YM, Bak NH: Dementia prevention program mild cognitive impairment in the elderly cognitive function, the effects of depression, self-esteem and quality of life. *Adult Health Nurs*, 2007, 19: 59–66.
- 12) Sutoo D, Akiyama K: Regulation of brain function by exercise. *Neurobiol Dis*, 2003, 13: 1–14. [[Medline](#)] [[CrossRef](#)]
- 13) Ohn SH, Park CI, Lee BH, et al.: The effect of working memory improvement by repetitive pyramidal system stimulation in frontal lobe area. *Korea Rehab Associ*, 2008, 32: 13–18.
- 14) Clark RA, Bryant AL, Pua Y, et al.: Validity and reliability of the Nintendo Wii Balance Board for assessment of standing balance. *Gait Posture*, 2010, 31: 307–310. [[Medline](#)] [[CrossRef](#)]
- 15) Frank KA, Michael G, Wada A, et al.: Nintendo Wii Balance balance is sensitive to effects of visual tasks on standing sway in healthy elderly adults. *Gait Posture*, 2005, 36: 605–608.
- 16) Hernandez SS, Coelho FG, Gobbi S, et al.: Effects of physical activity on cognitive functions, balance and risk of falls in elderly patients with Alzheimer's dementia. *Rev Bras Fisioter*, 2010, 14: 68–74. [[Medline](#)] [[CrossRef](#)]
- 17) Penadés R, Boget T, Catala R, et al.: Cognitive mechanisms, psychosocial functioning, and neurocognitive rehabilitation in schizophrenia. *Schizophr Res*, 2003, 63: 219–227. [[Medline](#)] [[CrossRef](#)]
- 18) Baek SS: Postnatal exercise rat model of depression, serotonin synthesis, memory and learning ability, and the impact of neurogenesis in the hippocampus and neuronal cell death. *The Natio Rese Found of Korea (NRF)*, 2009, pp 55–70.
- 19) Paukert AL, Pettit JW, Kunik ME, et al.: The roles of social support and self-efficacy in physical health's impact on depressive and anxiety symptoms in older adults. *J Clin Psychol Med Settings*, 2010, 17: 387–400. [[Medline](#)] [[CrossRef](#)]
- 20) Yáguéz L, Shaw KN, Morris R, et al.: The effects on cognitive functions of a movement-based intervention in patients with Alzheimer's type dementia. *Int J Geriatr Psychiatry*, 2011, 26: 173–181. [[Medline](#)] [[CrossRef](#)]
- 21) Seyed SM, Kazem M: Mental disorder prevention and physical activity in Iranian elderly. *Int J Prev Med*, 2012, 3: 64–72.
- 22) Gräsel E, Wiltfang J, Kornhuber J, et al.: Non-drug therapies for dementia; an overview of the current situation with regard to proof of effectiveness. *Dement Geriatr Cogn Disord*, 2003, 15: 115–125. [[Medline](#)] [[CrossRef](#)]