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Effects of a Dual-Task Net-Step Exercise Program on Vitality, Cognitive Function, and Physical Function in Korean Older Adults: A Pilot Pre-Post Study

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ABSTRACT

Korea's demographic transition has made community programs that address late-life physical, cognitive, and emotional health increasingly important. This archived pilot evaluation assessed whether a Korean dual-task Net-Step exercise program was associated with changes in depressive symptoms, vitality, cognition, static balance, and functional mobility among older adults. A one-group pre-post design was used at a senior mental health promotion center in Suwon, Republic of Korea. Eleven participants completed the final assessment (mean age, 80.09 +/- 3.11 years; 10 women). The intervention consisted of one 60-minute session per week for 7 weeks. Sessions paired familiar Korean songs with word-picture matching, visual stepping cues, tactile foot input, partner interaction, and movement on a textured low-cost mat. Outcomes were the Korean Short Form Geriatric Depression Scale, the vitality items of the Korean Short Form-36 Health Survey, the Mini-Mental State Examination-Dementia Screening, one-leg standing with arms extended, and a timed 244-cm up-and-go task. Archived SPSS Wilcoxon signed-rank results were used.

Depression, vitality, and MMSE-DS did not show statistically significant pre-post differences. One-leg standing increased from 4.68 +/- 2.99 to 9.35 +/- 8.29 seconds (z=-1.988, p=.047), whereas up-and-go time increased from 7.16 +/- 1.90 to 8.33 +/- 2.80 seconds (z=-2.075, p=.038), indicating slower mobility at follow-up. Participant comments described the program as enjoyable, socially rewarding, and mentally stimulating. These early findings support feasibility and possible benefit for static balance, but they do not demonstrate short-term improvement in mood, vitality, or global cognition. The mobility result highlights the need to refine future protocols so that gait speed and agility are trained alongside balance and safety.

Keywords: Dual-Task Training; Net-Step Exercise; Stepping-Mat exercise; Vitality; Cognitive Function; Balance; Depression; Older Adults; Korea; Pilot Study

Introduction

Korea's rapid population aging has created a demanding context for community gerontology and public health planning. National statistics indicate that people aged 65 years or older represented 20.3% of the population in 2025; this proportion is expected to pass 30% in 2036 and 40% in 2050 [1]. Such demographic change increases the need for accessible programs that help older adults maintain independence, manage multimorbidity, and remain socially and psychologically engaged. Recent Korean surveillance data show that emotional, cognitive, and functional risks often overlap in later life. In the 2023 National Survey of Older Koreans, depressive symptoms were reported by 11.3% of older adults, with higher prevalence among those living alone than among older couples (16.1% vs. 7.8%) [2]. The same survey documented limitations in activities of daily living or instrumental activities of daily living in 18.6% of older adults and an average of 2.2 chronic diseases [2]. Dementia-related burden is also substantial: the 2023 Dementia Epidemiology Survey estimated dementia prevalence at 9.25% and mild cognitive impairment prevalence at 28.42% among Koreans aged 65 years or older [3]. Together, these findings support integrated interventions that combine movement, cognitive stimulation, and social participation rather than targeting a single domain.

Physical activity is a broadly recommended approach for maintaining function in old age. The World Health Organization advises older adults to engage in regular activity and to include multicomponent exercise focused on strength and functional balance at least 3 days per week to support capacity and reduce fall risk [4]. The 2024 Lancet Commission on dementia prevention similarly identifies depression, physical inactivity, and social isolation as modifiable risk factors relevant to late-life cognitive health [5]. Evidence from mental health research also supports exercise as an intervention for depression, while recognizing that effects vary by modality, dose, adherence, and participant profile [6]. Dual-task training is particularly suitable for older adults because everyday mobility rarely involves movement alone. Walking across a room, avoiding obstacles, following instructions, and keeping balance can all require attention, memory, planning, and postural control at the same time. Meta-analytic evidence suggests that simultaneous cognitive-motor training may improve global cognition, executive function, gait, physical activity, and depressive symptoms among older adults with cognitive impairment [7]. Other reviews have reported benefits for cognition, gait, and balance [8], and dual-task balance programs have been proposed as useful for improving balance in healthy older adults [9].

Mat-based stepping programs, including square-stepping exercise, operationalize cognitive-motor training in a simple group format. Participants follow visual stepping patterns, remember sequences, and coordinate lower-limb movement while maintaining posture. A 2021 systematic review and meta-analysis reported improvements in static and dynamic balance, fall risk, and agility after square-stepping exercise in older adults, although cognitive findings were less uniform [10]. A 2024 review also indicated potential effects on physical-cognitive function, body composition, biomarkers, and mental health in adults aged 60 years or older [11]. Korean research has reported benefits of a 12-week square-stepping exercise trial for fall-related fitness and brain-derived neurotrophic factor [12], and a recent Korean dual-task training study in older adults with mild cognitive impairment showed improvements in cognition, physical function, self-efficacy, and life satisfaction [13]. Nevertheless, little Korean pilot evidence is available on programs that blend familiar music, word-symbol matching, tactile foot input, and stepping activity for older adults with depressive symptoms. This manuscript reexamines the 2016 community program 'Balpan Pak! Dosa' as a culturally adapted Net-Step exercise model and situates its archived findings within contemporary gerontological and public health literature.

Purpose

This pilot study aimed to estimate pre-post changes in depressive symptoms, vitality, cognitive function, static balance, and functional mobility after a 7-week dual-task Net-Step exercise program for Korean community-dwelling older adults. Participant feedback was also summarized to guide protocol improvement for future studies.

Method

Study Design and Setting

This manuscript reports a retrospective analysis of an archived 2016 community program evaluation using a single-arm pre-post pilot design. The intervention took place at a senior mental health promotion center in Suwon, Republic of Korea, with collaboration from Kangnam University. As the program was implemented in a real-world community setting, the analysis was intended to describe feasibility-oriented outcomes rather than to provide confirmatory evidence of efficacy.

Participants

Recruitment was conducted through the collaborating center. Participants were eligible when they were aged 65 years or older, could follow program instructions, had no severe cognitive, psychiatric, or physical condition that would make stepping activity or physical function testing unsafe or infeasible, and agreed voluntarily to take part. Program records indicate that 12 older adults were initially connected to planning or attendance, and 11 completed the final health assessment. Because some paired observations were missing, the analytic sample size varied by outcome.

Intervention: Dual-Task Net-Step Exercise Program

The Net-Step intervention was designed as an older-adult-friendly adaptation of a dance-stepping game. The program combined auditory cues from familiar Korean popular songs, word-symbol association and recall, picture-based targets on the mat, tactile stimulation through different floor textures, and partner-based social interaction such as clapping or arm movement. Participants attended weekly 60-minute sessions for 7 weeks. A typical session comprised a 5- to 10-minute warm-up, 30-40 minutes of song-linked dual-task stepping, and a 5- to 10-minute closing period for discussion, feedback, and memory homework. The mat was constructed from inexpensive materials, including nonwoven fabric, anti-slip support, Lego-like textured blocks, handmade acupressure pads, and bubble-wrap sections. Most activities were performed in pairs, and trained student facilitators provided close assistance to support comprehension and safety. Program cues were embedded in two familiar songs: 'What About My Age?' and 'Ddaengbeol.' For 'What About My Age?', participants moved to a person symbol for the word 'age,' a heart symbol for 'love,' a number-one symbol for 'one' while completing a partner action, and a smile symbol for 'appearance.' For 'Ddaengbeol,' they stepped to a person symbol for 'person,' a bee symbol for 'bee,' and a heart symbol for 'you.' Difficulty was raised over time by adding new target words and symbols. Implementation notes document several safety and usability adjustments, including stronger anti-slip matting, removal of confusing right-foot/left-foot commands, continuous display of lyrics, and replacement of clapping with arm movement when clapping made the music harder to hear.

Outcome Measures

Five outcome domains were extracted from the archived program materials. Depressive symptoms were measured with the Korean Short Form Geriatric Depression Scale; higher scores represent greater depressive symptom burden [14]. Vitality was measured with the vitality items from the Korean Short Form-36 Health Survey, where higher scores reflect greater perceived energy [15]. Cognitive function was assessed using the Mini-Mental State Examination-Dementia Screening, a Korean screening instrument scored from 0 to 30, with higher values indicating better global cognition [16]. Physical function was evaluated with selected Senior Fitness Test-related tasks [17]. Static balance was recorded as the number of seconds participants could stand on one leg with arms extended. Functional mobility was assessed by a timed 244-cm up-and-go task, conceptually related to the 8-foot up-and-go test, with shorter time indicating better performance.

Statistical Analysis

Participant characteristics and outcome scores were summarized descriptively. Given the pilot sample size and potential departure from normality, pre-post comparisons relied on Wilcoxon signed-rank tests from the archived SPSS 12.0 output. The threshold for statistical significance was $p<.05$. For interpretive purposes, effect size r was computed as $|z|/\sqrt{n}$, using the paired analytic n for each measure. Because this was an exploratory pilot analysis, p-values were not adjusted for multiple comparisons.

Results

Participant Characteristics

At the final assessment, the sample included 11 older adults with a mean age of 80.09 +/- 3.11 years. The participants were predominantly women, most had elementary-level education, many were widowed, and several lived either alone or with a spouse. Baseline scores suggested mild depressive symptoms and generally preserved global cognitive status (Table 1).

Table 1: Participant characteristics at baseline (N=11 unless otherwise indicated).

Characteristics	Net-Step group
n	11
Age, years	80.09 ± 3.11
Women, n (%)	10 (91%)
Education, n (%)	
No formal education	1 (9%)
Elementary school	8 (73%)
Middle school	2 (18%)
Marital status, n (%)	
Widowed	7 (64%)
Spouse present	4 (36%)
Living arrangement, n (%)	
Living alone	5 (45%)
Living with spouse	3 (27%)
Living with child	2 (18%)
Other	1 (9%)
Self-rated health, n (%)*	
Good to very good	1 (10%)
Fair	3 (30%)
Poor to very poor	6 (60%)
Common conditions, n (%)	
Arthritis, hypertension, or osteoporosis	7 (64%)
Cognitive function, MMSE-DS	24.73 ± 1.85
Depressive symptoms, SGDS	7.90 ± 1.91

Note: Data are presented as mean ± SD or n (%). Percentages use N=11 as the denominator unless another denominator is specified. *Self-rated health information was available for 10 participants in the archived summary.

Quantitative Outcomes

The archived analyses showed no statistically significant pre-post difference in depressive symptoms, vitality, or MMSE-DS global cognition. Balance performance improved significantly on the one-leg standing task. In contrast, up-and-go time increased significantly, meaning that mobility performance was slower at the post-test. Paired sample sizes differed across outcomes because some archived measurements were incomplete (Table 2).

Table 2: Pre-post changes in depressive symptoms, vitality, cognition, and physical function.

Outcome	n	Pre, mean +/- SD	Post, mean +/- SD	z	p	Effect size r
Depressive symptoms (SGDS)	10	7.90 +/- 1.91	7.90 +/- 2.02	-0.154	0.877	0.05
Vitality (SF-36 vitality)	10	224.00 +/- 68.51	228.91 +/- 87.02	-0.119	0.905	0.04
Static balance (one-leg stand, sec)	10	4.68 +/- 2.99	9.35 +/- 8.29	-1.988	0.047	0.63
Functional mobility (244-cm up-and-go, sec)	9	7.16 +/- 1.90	8.33 +/- 2.80	-2.075	0.038	0.69
Cognitive function (MMSE-DS)	11	24.73 +/- 1.85	24.82 +/- 2.99	-0.051	0.959	0.02

Note: Higher SGDS values reflect more depressive symptoms. Higher scores on vitality, one-leg standing, and MMSE-DS reflect better status. For the up-and-go task, lower time indicates better mobility; therefore, the post-program increase denotes slower performance. Effect size r was derived from the archived Wilcoxon z value and paired n.

Participant Feedback

Open-ended feedback indicated that participants accepted the program well and perceived it as mentally engaging. Some participants stated that it required more thinking than other programs and that matching similar words while lifting the legs supported concentration. Others highlighted the pleasure of moving to familiar songs, the perceived usefulness of foot stimulation, and the enjoyment of meeting, talking, and learning with others. These responses suggest possible psychosocial value even when short-term standardized mood and vitality scores remain statistically unchanged.

Discussion

This archived pilot suggests that a short, culturally adapted dual-task Net-Step program may improve static balance in Korean community-dwelling older adults. The balance result fits the theoretical rationale for cognitive-motor stepping interventions, which repeatedly involve weight transfer, single-leg support, visual attention, and coordinated lower-limb movement [7-11]. Mechanistically, participants had to stabilize the stance leg while directing the moving leg toward visual targets, a practice pattern that plausibly trains postural control. The balance gain must be considered together with the slower up-and-go result. One interpretation is that the program practiced stability and cue recognition more than rapid mobility. The sessions emphasized safe stepping, lyric recognition, and target matching rather than fast sit-to-stand movement, gait speed, or agility. The mobility sample was also very small, the intervention dose was modest, and participants may have approached post-testing more cautiously after repeated safety instruction. Thus, the TUG finding should not be treated as conclusive evidence of harm. It should, however, be viewed as an important signal for protocol development. Future versions should add progressive gait-speed and agility work, monitor fatigue and adverse events formally, and provide enough repetitions to train both stability and mobility.

Neither depressive symptoms nor vitality showed statistically significant improvement. This finding is understandable given the once-weekly schedule, 7-week duration, and absence of a specific depression-treatment module. Exercise has evidence for reducing depressive symptoms, but stronger effects are generally expected when programs are delivered with adequate frequency, intensity, duration, and psychosocial support [6]. Even so, participant comments pointed to enjoyment, laughter, focused attention, and social connection. These process outcomes matter in gerontology because meaningful and enjoyable activities are more likely to be sustained over time. Global cognitive screening results were also stable rather than improved. The baseline MMSE-DS level was relatively preserved, which may have limited observable change. In addition, a brief global screening tool may not detect short-term changes in attention, working memory, inhibition, or dual-task interference. Future evaluations should therefore include domain-specific neuropsychological measures, dual-task gait outcomes, and more ecological assessments of cognitive-motor performance. Several practical features make this program relevant for community health practice. It used inexpensive materials, drew on familiar Korean songs, could be delivered in a community center, and was understandable for older adults with limited formal education. Visible symbols lowered instructional burden, while textured mat surfaces provided additional sensory feedback.

With appropriate facilitator training in fall prevention and step progression, similar low-cost activities may be adaptable for senior centers, dementia-prevention services, and community mental health programs. These findings should be read within important constraints. The study had a small one-group pre-post design and no comparison group, so causality cannot be inferred. Participants were mostly women from a single center, which limits generalizability. Outcome-specific n values differed because paired data were missing for some measures. The manuscript is based on archived 2016 aggregate materials rather than reanalysis of complete participant-level data. In addition, there was no follow-up assessment, formal adverse-event log, or direct measurement of dual-task cost. Standard mood and cognition scales may also have missed short-term changes in engagement, motivation, or specific cognitive processes. Next-stage research should test the program with larger samples, randomization or wait-list control conditions, and longer exposure, ideally 12-24 weeks with at least two sessions per week. Protocols should specify progressive balance, gait, and agility components; facilitator training;

fidelity checks; adverse-event monitoring; and outcomes for depression, loneliness, vitality, executive function, gait speed, dual-task cost, falls, and quality of life. A mixed-methods design would be valuable because enjoyment, cultural familiarity, and perceived cognitive challenge may strongly influence adherence and long-term public health usefulness.

Conclusion

In this archived pilot, a 7-week dual-task Net-Step exercise program was feasible and acceptable for Korean community- dwelling older adults and was linked to a statistically significant gain in static balance. No statistically significant improvements were observed for depressive symptoms, vitality, or global cognition, and functional mobility time increased after the program. The results justify further development of culturally familiar cognitive-motor stepping programs, but future studies should strengthen mobility progression, increase intervention dose, include a control condition, and incorporate systematic safety monitoring before drawing efficacy conclusions.

Declarations

Ethics Approval and Consent to Participate

The archived program records indicate voluntary participation in the 2016 community program and its pre-post assessment.

Consent for Publication

Not applicable. No identifiable personal information is reported.

Competing Interests

The author declares no competing interests.

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