

Research article

## A Long-Term Exercise Intervention Reduces Depressive Symptoms in Older Korean Women

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### Abstract

Despite its prevalence and significance, late life depression is underrecognized and undertreated. This study aimed to investigate the effect of a long-term exercise intervention on depressive symptoms in older Korean women. Thirty older women were assigned to exercise ( $n = 15$ , age of  $80.8 \pm 3.8$  years) or control group ( $n = 15$ , age of  $78.6 \pm 3.2$  years). The exercise group underwent a resistance exercise plus walking two times weekly on nonconsecutive days for 6 months. Post-intervention change in depressive symptoms was regarded as the primary outcome. Secondary outcomes included changes in body composition and physical performance. Repeated measures analysis of variance showed significant group by time interactions for depressive symptoms ( $F(1,23) = 37.540$ ,  $p < 0.001$ ), percent body fat ( $F(1,23) = 6.122$ ,  $p = 0.021$ ), lean body mass ( $F(1,23) = 5.662$ ,  $p = 0.026$ ), waist circumference ( $F(1,23) = 4.330$ ,  $p = 0.049$ ), handgrip strength ( $F(1,23) = 10.114$ ,  $p = 0.005$ ), 6-min walking ( $F(1,23) = 28.988$ ,  $p < 0.001$ ), and 2.44-m Up & Go ( $F(1,23) = 28.714$ ,  $p < 0.001$ ). The current findings support regular exercise as a therapeutic strategy to promote overall and mental health in older Korean women with depressive symptoms.

**Key words:** Aging; functional capacity; mental health; physical activity.

### Introduction

Depression is a worldwide problem and is projected to be the second leading cause of disability worldwide in 2020 (Whiteford et al., 2013). In particular, late life depression (LLD) is one of the most prevalent mental disorders in older adults, with prevalence estimates ranging from 4.6 to 9.3% (Luppa et al., 2012). LDD is associated with increased health care costs, increased morbidity and suicidal risks, impairments in physical, social, and cognitive functioning, and increased dementia (Georgakis et al., 2016).

Despite its prevalence and clinical significance, however, LLD is underrecognized and undertreated due to its complicated etiologies, and often being viewed as an inevitable part of the aging process.

Antidepressants, such as selective serotonin re-uptake inhibitors, have been the most common treatment choice (Allan and Ebmeier, 2018). However, the pharmacologic options are unfortunately often accompanied by many side effects, including falls, cardiovascular events,

fractures, epilepsy, hyponatremia, and increased risk of all-cause mortality (Stubbs, 2015). Hence, alternative strategies for treatment of LLD are needed.

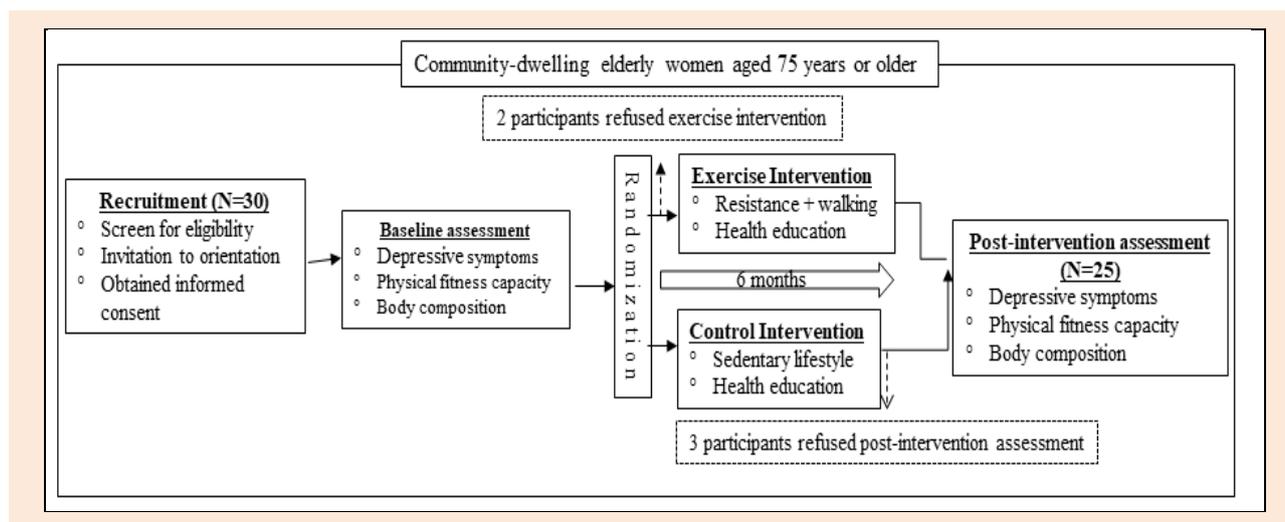
Whether exercise improves depressive symptoms in older populations has not been consistently demonstrated in trials; some have been positive (Williams and Lord, 1997), whereas others have yielded null effects (Jette et al., 1996). In a cluster-randomized controlled trial, for example, Underwood et al. found that a moderately intense exercise program did not reduce depressive symptoms in 65 years or older residents in care homes (Underwood et al., 2013). In a meta-analysis of seven exercise intervention studies, Bridle and his colleagues found a small to moderate effect (standardized mean difference =  $-0.34$ , 95% confidence interval  $-0.52$  to  $-0.17$ ) of exercise on depression in older adults (Biddle et al., 2015). Conversely, exercise may have beneficial effects as an adjunctive treatment for older adults who partially respond to antidepressant medications (Mura and Carta, 2013).

The lack of consistent results from exercise trials in patients with LLD appears multifactorial. In particular, previous research has shown positive effects of exercise on depression but studies have mainly focused on the short-term effects; few have examined the long-term effects (Helgadóttir et al., 2017). In this study, therefore, we report the beneficial effects of a long-term exercise intervention on depressive symptoms in older Korean women.

### Methods

Overall study design is illustrated in Figure 1. At baseline, a total of 30 older women were recruited from local retirement centers via flyers and advertisement. Study participants attended an orientation session where they received an explanation regarding the study and underwent a screening for study participation.

Eligibility criteria were: (a) age of 75 years or older; (b) having clinically significant depressive symptoms but not taking anti-depressants; (d) no pain in the knee(s) on most days of the month; or (e) no difficulty with the following due to knee pain: walking one-quarter mile; climbing stairs; getting in and out of a car, bath, or bed; rising from a chair; or performing shopping, cleaning, or self-care activities. Exclusion criteria were: (a) presence of a medical condition that precluded participation in a safe exercise program (e.g., recent myocardial infarction or stroke, severe chronic obstructive pulmonary disease, congestive heart failure); (b) inflammatory arthritis; (c) regular participation in exercise (more than once a week for at least 20 minutes); or (d) inability to walk without assistance.



**Figure 1.** Flow chart of the study design.

Afterward, participants completed baseline assessments including depressive symptoms, physical fitness capacity, and body composition. Participants were then assigned to either control ( $n = 15$ , mean age of  $78.6 \pm 3.2$  years) or exercise ( $n = 15$ , mean age of  $80.8 \pm 3.6$  years) group ( $p$  value for age = 0.120). The sample size for each group was determined so that the study would be sufficiently powered to detect group differences in the primary outcome of depressive symptoms in this study. Based on our preliminary data, we calculated that a sample size of 12 participants per group would provide 85% power with probability of alpha error of 0.05 for detecting a statistically significant difference in the primary outcome between the two groups.

Individuals in the exercise group underwent a 6-month exercise program, while individuals in the control group maintained their sedentary lifestyles. Then, participants had post-intervention assessments using the same procedures as at baseline. Two participants in the exercise group refused to participate in the exercise intervention due to personal reasons, and three participants in the control group refused post-intervention assessment. Consequently, data obtained from 13 (retention rate of 90%) and 12 participants (retention rate of 85%) out of the exercise and control groups, respectively, were used for statistical analyses.

Informed consent was obtained from all participants prior to study participation. The Institutional Review Board, in accordance with the World Medical Association Declaration of Helsinki, reviewed and approved the study protocol (SKKU 2017-06-009).

### Assessment of depressive symptoms

The Korean version of the Short form of the Geriatric Depression Scale (SGDS-K) was administered as a screening measure for depression. This is a 15-item self-report binary response format (yes/no) with scores ranging from 0 to 15. Depression was defined when diagnosed by a physician in participants with a score of 8 or higher on the 15-item, short-form of the self-administered GDS-K of which its validity and reliability were previously tested and reported (Bae and Cho, 2004).

### Measurement of handgrip strength and physical fitness capacity

Handgrip strength was measured to the nearest kilogram of each participant's dominant hand using a hand grip dynamometer (TANITA No. 6103, Tokyo, Japan). Participants performed 2 trials with 1-minute pause between each trial, and verbal encouragement was given during each trial. The best value of 2 trials was taken as the score for maximal voluntary handgrip strength (kg).

Physical fitness capacity was measured using the senior fitness test battery, as described previously (Rikli and Jones, 2013). Briefly, the senior fitness test assesses the physiological capacity for performing normal daily activities independently and safely without the appearance of fatigue. After 10 minutes of warm-up (i.e., walking around indoor tracks and stretching), participants performed the SFT in the following order: (1) chair stand for 30 seconds to assess lower-body strength (number of stands), (2) arm curl for 30 seconds to assess upper-body strength (number of curls), (3) chair-sit-and-reach to assess flexibility of lower extremities (cm +/-), (4) the 2.44-m up-and-go to assess agility as an index of basic mobility skill (seconds), and (5) a 6-minute walk test to assess aerobic capacity (meters). Test validity and reliability of the senior fitness test was previously published (Rikli and Jones, 2013).

### Measurement of body composition

Height and weight were recorded with a stadiometer attached to a scale (Jenix, Seoul, Korea). Body mass index ( $\text{kg}\cdot\text{m}^2$ ) was calculated as the ratio of weight (kg) to squared height ( $\text{m}^2$ ). Percent body fat and lean body muscle were assessed using the bioelectrical impedance Inbody 720 (Biospace, Seoul, Korea). Bioelectrical impedance was chosen for its ease of use, less invasive nature, and good validity and reliability for assessment of body composition in the older adults (Kelly Metcalfe, 2012). In addition, waist circumference was measured to the nearest 0.1 cm at the umbilicus level between the lower rib and the iliac crest.

### Exercise intervention

Participants in the exercise group underwent a six-month

exercise intervention consisting of three times of resistance exercise (i.e., Monday, Wednesday, and Friday) and two times of walking (i.e., Tuesday and Thursday) on nonconsecutive days each week under supervision of a certified exercise leader and two exercise scientists.

Resistance exercise was performed in a group and in the following order to provide a stimulus to all the major muscle groups; chest press, leg press and extension, shoulder press, abdominal curl, and biceps curl using a low-load, elastic band (TheraBand, Performance Health, Akron, OH, USA). Resistance exercise was performed using two sets of 15-20 repetitions.

Walking, with a duration of 20 minutes per session and an intensity of 40-50% of heart rate reserve, was performed in a group on a walking trail in a public park. During each session, the prescribed exercise intensity was monitored by wearing a heart monitor (Polar OH1 HR Sensor, Polar, Finland).

Additionally, for the first three months, both exercise and control groups received monthly education sessions by a nurse on issues related to arthritis management so that participants could have sufficient skills and knowledge to cope with the disease. Later, participants were called bimonthly to maintain health updates and provide mental and social support.

### Statistical analyses

The Shapiro–Wilk test was performed to examine the normality of data ( $p > 0.05$ ). The repeated measures analysis of variance (RM-ANOVA) was used to compare any significant differences in the measured parameters from pre- and post-tests between the two groups while controlling for baseline values as covariates. In addition, paired t-test with Bonferroni correction was used to test any significant within-group differences in the parameters from pre- and post-tests. Multivariate linear regression was performed to determine predictors of changes in depressive symptoms after the exercise intervention. Statistical analyses were performed using SPSS-PC 23.0 (SPSS, Chicago, IL, USA) software. All data are reported as mean  $\pm$  standard deviation, and statistical significance was assumed at  $p < 0.05$ .

### Results

With respect to depressive symptoms and body composition shown in Table 1, the RM-ANOVA showed a significant time by group interaction ( $F(1,23) = 37.540$ ,  $p < 0.001$ ) for mean values in GDS-K scores from pre- and post-tests between the two groups. The participants in the exercise group has a significant decrease in GDS-K scores ( $p < 0.001$ ), while the participants in the control group did not. In addition, there were significant time by group interactions for mean values in percent body fat ( $F(1,23) = 6.122$ ,  $p = 0.021$ ), lean body mass ( $F(1,23) = 5.662$ ,  $p = 0.026$ ), and waist circumference ( $F(1,23) = 4.330$ ,  $p = 0.049$ ) from pre- and post-tests between the two groups. The participants in the exercise group had significant decreases in percent body fat ( $p = 0.005$ ) and waist circumference ( $p = 0.050$ ) in conjunction with a significant increase in lean body mass ( $p = 0.012$ ) after the exercise intervention, while the participants in the control group did not.

With respect to physical functional capacity parameters shown in Table 2, the RM-ANOVA showed significant time by group interactions for mean values in handgrip strength ( $F(1,23) = 10.114$ ,  $p = 0.005$ ), the distance walked in 6 minutes ( $F(1,23) = 28.988$ ,  $p < 0.001$ ), and the 2.44-m up-and-go time ( $F(1,23) = 28.714$ ,  $p < 0.001$ ) from pre- and post-tests between the two groups. After the intervention, the participants in the exercise group had significant increases in handgrip strength ( $p = 0.030$ ) and the distance covered in 6-min walking ( $p = 0.001$ ) in conjunction with a significant decrease in the 2.44-m up-and-go time ( $p < 0.001$ ), while the participants in the control group did not.

With respect to metabolic risk factors shown in Table 3, the RM-ANOVA showed no significant time by group interactions for any metabolic risk factor from pre- and post-tests between the two groups.

Finally, multivariate linear regression analysis showed that changes in percent body fat ( $p = 0.018$ ) and agility/dynamic balance ( $p < 0.001$ ) were two independent factors for predicting changes in depressive symptoms after the exercise intervention (Table 4).

**Table 1. Depressive symptoms and body composition parameters of pre- and post-intervention.**

Variables	Control (n=12)		Exercise (n=13)		F	P value	
	Pre-test	Post-test	Pre-test	Post-test			
SGDS-K (scores)	8.7 $\pm$ 0.7	6.5 $\pm$ 1.1	8.6 $\pm$ 0.8	8.8 $\pm$ 1.3	0.386	a	0.541
					0.033	b	0.858
					36.395	c	<0.001
BMI (kg/m <sup>2</sup> )	27.0 $\pm$ 2.1	26.7 $\pm$ 2.3	26.1 $\pm$ 3.2	25.8 $\pm$ 3.2	0.742	a	0.398
					7.534	b	0.012
					0.030	c	0.863
Body fat (%)	42.0 $\pm$ 6.0	41.9 $\pm$ 6.6	41.1 $\pm$ 6.1	39.5 $\pm$ 7.0	0.377	a	0.545
					10.457	b	0.004
					6.122	c	0.021
LBM (kg)	17.3 $\pm$ 1.7	16.4 $\pm$ 2.2	17.9 $\pm$ 2.1	18.3 $\pm$ 1.8	2.522	a	0.126
					0.477	b	0.497
					5.662	c	0.026
WC (cm)	95.3 $\pm$ 5.8	95.0 $\pm$ 7.1	94.7 $\pm$ 8.4	91.7 $\pm$ 9.3	0.498	a	0.488
					6.606	b	0.017
					4.330	c	0.049

SGDS-K: the Korean version of the short form of the geriatric depression scale. BMI: body mass index; LBM: lean body mass; WC: waist circumference. a: group, b: time, c: group  $\times$  time

**Table 2.** Physical functional capacity parameters of pre- and post-intervention.

Variables	Control (n=12)		Exercise (n=13)		F	P value
	Pre-test	Post-test	Pre-test	Post-test		
Handgrip strength (kg)	18.8±3.0	18.1±2.3	20.3±2.9	21.1±3.0	3.802	a 0.065
					0.125	b 0.727
					10.114	c 0.005
6-min-walking (m)	370.1±51.4	346.4±51.2	397.2±52.2	416.8±56.1	5.512	a 0.028
					0.334	b 0.569
					28.988	c <0.001
The 2.44-m up-and-go (sec)	11.2±1.4	11.1±1.6	11.1±1.8	9.0±1.5	3.957	a 0.059
					34.267	b <0.001
					28.714	c <0.001
Sit and reach (cm)	1.2±2.1	1.6±2.2	1.7±2.3	1.8±2.3	0.143	a 0.709
					3.430	b 0.078
					1.036	c 0.320

Handgrip strength: upper body strength, 6-min-walking: cardiorespiratory fitness, the 2.44-m up-and-go: dynamic balance, Sit and reach: flexibility. a: group, b: time, c: group × time

**Table 3.** Metabolic risk factors of pre- and post-intervention.

Variables	Control (n=12)		Exercise (n=13)		F	P value
	Pre-test	Post-test	Pre-test	Post-test		
SBP (mmHg)	133.6±10.4	132.8±10.2	132.8±7.6	131.9±7.4	0.138	a 0.560
					2.945	b 0.092
					2.204	c 0.162
DBP (mmHg)	73.4±8.2	72.8±8.0	74.3±6.2	73.9±6.8	0.042	a 0.114
					0.121	b 0.423
					0.134	c 0.489
FBG (mg·dL <sup>-1</sup> )	105.6±16.9	108.6±18.1	106.1±21.9	103.6±20.1	0.143	a 0.708
					0.439	b 0.514
					3.695	c 0.067
TG (mg·dL <sup>-1</sup> )	159.7±53.3	162.3±75.3	161.8±68.0	147.8±77.4	0.207	a 0.654
					0.143	b 0.709
					2.599	c 0.122
HDL-C (mg·dL <sup>-1</sup> )	51.7±8.0	49.4±11.2	51.1±10.0	52.5±10.3	0.032	a 0.859
					0.204	b 0.656
					3.595	c 0.071

SBP: systolic blood pressure; BDP: diastolic blood pressure; FBG: fasting blood glucose; TG: triglycerides; HDL-C: high density lipoprotein-cholesterol; a: group, b: time, c: group × time

**Table 4.** Linear regression for predicting alleviated depression symptoms following the intervention.

Predictors	B	t	95% CI	P value
Δ Body fat	0.372	2.566	0.066 - 0.617	0.018
Δ the 2.44-m up-and-go	0.556	3.833	0.218 - 0.945	0.001

95% CI: 95% confidence interval. Δ: changed scores of pre-and post-tests.

## Discussion

Regular physical activity has been known to contribute to the overall health of older populations by influencing mental health and well-being as well as by preserving functional physical capacity. In this study, we investigated the beneficial effects of a six-month combined exercise intervention on depressive symptoms as well as body composition and functional physical capacity in older Korean women and found that the long-term exercise intervention led to a reduction in depressive symptoms in conjunction with improvements in body fatness and functional physical capacity parameters in older Korean women.

The current findings of the present study support and extend those of previous studies reporting the beneficial effects of physical activity on body composition and physical fitness. For example, Lee et al. showed that, in older women 75 years of age and older, 12 weeks of a combined exercise program resulted in significantly decreased body mass index ( $p < 0.001$ ), body fat ( $p < 0.001$ ), and waist-hip

ratio ( $p < 0.001$ ) and increased basal metabolic rate ( $p < 0.05$ ) and ability to rise from and sit down on a chair (Lee et al., 2013). From a cross-sectional study involving 19,230 men and 140,578 women 40–69 years of age who participated in the UK Biobank in 2006–2010, Bradbury et al. (2017) al. found that physical activity was inversely associated with percent body fat independent of body mass index. Woo et al. (2013) examined the relative importance of fitness versus fatness for predicting mortality in Chinese men and women 70 years of age and older and found that, compared with the high fitness category, participants in the moderate and low categories had 43% and 68%, respectively, increased risk of mortality at 7 years after adjusting for multiple confounders including body fatness.

The beneficial effects of physical activity on depression symptoms have also been reported in children (Larun et al., 2006) and adults (Giacobbi et al., 2005). Similarly, the beneficial effects of regular physical activity on overall mental health and well-being in older populations have been reported in previous studies (Yadav et al., 2015). In

this aspect, exercise interventions have shown very promising results for reducing symptoms of major depression in older adults (Neviani et al., 2017). In an eight-year follow-up study, Lampinen et al. (2000) showed that physically active older subjects had fewer depression symptoms compared with their inactive counterparts. Based on the analysis of data from the Fitness, Arthritis, and Seniors Trial (FAST), Pennix et al. (2002) showed that an 18-month aerobic exercise program reduced depression symptoms in adults 60 years of age or older, and both aerobic and resistance exercise programs equally contributed to reduced disability and pain and increased walking speed in that older population. Similarly, Poelke et al. (2016) examined the effects of a 12-week intervention consisting of physical plus mental activities on depression symptoms in inactive older adults with cognitive complaints and found that leisure time activity reduced depression symptoms in the study population in a dose-response manner.

There are several explanations for the antidepressant effects associated with exercise intervention. First, physical activity including regular exercise has been known to provide an antidepressant effect via its thermogenic effect, endorphin release, and availability of neurotransmitters such as serotonin, dopamine, and norepinephrine (Ransford, 1982). Second, the neurocognitive benefits of physical activity involve the upregulation of neurotrophin production, including brain-derived neurotrophic factor, insulin-like growth factor, and vascular endothelial growth factors (deVries, 1981). Levels of these biomarkers are altered during and after exercise, which then trigger a cascade of changes in brain functioning that might explain the alleviation of depression symptoms (Helmich et al., 2010). Third, self-determination and self-efficacy theories have been proposed to explain the association between physical activity and depression symptoms (Bridle et al., 2012). Individuals become more confident in their abilities when engaging in physical activity and feel more in control. Lastly, physical activity-induced antidepressant effects might be due to distraction from stressful stimuli (Murri et al., 2018).

This study had several limitations. First, the assessment of depression symptoms was conducted at baseline and only after the intervention due to several practical difficulties. Multiple assessments over the six-month intervention period would have provided a better picture for delineating the nature of changes in depression symptoms in response to exercise intervention (Nyklicek et al., 2004). Second, measuring biomarkers would be necessary to better interpret the beneficial effects of the exercise intervention on depression symptoms in a cause-and-effect manner. Third, the current findings need to be confirmed using a study cohort involving both men and women.

## Conclusion

In this study, we showed that a long-term exercise intervention combined with resistance exercise and walking reduced depression symptoms and body fat, and improved physical functional capacity, in older women, implying a therapeutic role of regular exercise for promoting overall

and mental health in geriatric populations. Yet, an additional study will be necessary to elucidate the biologic link between the alleviation of depression symptoms and improvements of body composition and functional physical capacity observed in the current study.

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### Key points

- Low-volume HIIE and MICE does not decrease the habitual physical activity level over one week in inactive obese males.
- Late-life-depression is under recognized and under-treated due to its complicated aetiologies.
- The pharmacologic options are unfortunately often accompanied by many side effects, including falls, cardiovascular events, fractures, epilepsy, hyponatremia, and increased risk of all-cause mortality.
- The current findings support a therapeutic role of regular exercise for promoting overall and mental health in older Korean women with depressive symptoms.

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