Effects of a Customized Physical Activity Program on Community-Dwelling Older Men with Sarcopenia

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Abstract: Sarcopenia is characterized by decreased muscle mass and muscular function related to aging and is a risk factor for geriatric illnesses. There is a need for physical activity programs appropriate for older men as most existing studies have focused on women. We aimed to develop and validate the effects of a customized physical activity program for male older adults with sarcopenia in South Korea. A non-equivalent control group pre-test and post-test design was used. The experimental group was provided with group education sessions and a customized physical activity program with individual intervention for 12 weeks. The control group was advised to continue their usual lifestyle and provided with education about sarcopenia, guidelines concerning physical activities, posters, and video clips after experiment completion. The groups differed significantly in self-efficacy, insulin-like growth factor-1, lower extremity endurance, and flexibility post-intervention. The customized physical activity program for male older adults with sarcopenia effectively improved participants’ health-related outcomes. The physical activity program developed in this study was effective in improving participants’ self-efficacy, insulin-like growth factor-1, and elasticity, and in alleviating decreases in lower limb endurance. Thus, it is necessary to systematically support such physical activity programs to help older adults address their sarcopenia.

Keywords: Health-related Quality of Life, Intervention, Older Adults, Outcomes, South Korea

1. Introduction

Sarcopenia, which is characterized by decreased muscle mass and muscular function related to aging, is a risk factor for geriatric illnesses. Factors influencing sarcopenia include decreased growth factor and insulin-like growth factor-1 (IGF-1) production and cytokine secretion changes [1].

In South Korea, sarcopenia occurs in 6.6% of men and 9.4% of women aged older than 65 years [2]. Its prevalence is 4.6% and 7.9% in British community-dwelling older men and women, respectively, and it affects 36.5% of adults older than 70 years in the United States [3, 4]. In Japan, the prevalence of sarcopenia ranges between 2.5% and 28.0% in older men and between 2.3% and 11.7% in women [5]. In Taiwan, the prevalence of sarcopenia is 3.9–13.5% in older adults [6]. Thus, sarcopenia is a global geriatric health issue.

Sarcopenia decreases basic physical fitness, including cardiopulmonary endurance, muscle strength, elasticity, and balance. It also increases fall risk, thus interfering with older adults’ independent living [6, 7]. Furthermore, sarcopenia can cause physical disabilities, depression, decreased quality of life, nursing home admission, and increased mortality [8–13]. The prevalence of sarcopenia is 35.9% in men aged over 65 years and 75% in men aged over 75 years in South Korea, the UK and China [4, 6, 11]. Meanwhile, Mesquita et al. [14] found male sex to be an influencing factor in Brazil. Further, among adults aged older than 65 years, the risk of death or nursing hospital admission for adults with sarcopenia was 5.2 times higher for men and 2.2 times higher for women, suggesting the importance of preventing and managing sarcopenia in older men [15].

Moreover, early detection and prevention of poor outcomes of sarcopenia in older adults are key interventions. In this context, physical activity (PA) is the safest, most effective method for managing sarcopenia, and PA combining
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Resistance and aerobic exercises is recommended [1, 6]. However, in South Korea, only 46.6% of adults aged 60–69 years, 38.3% of those who are older than 70 years, perform aerobic PA; further, only 11.4% of adults aged 60–69 years, and 7.2% of those older than 70 years, perform resistance exercises [16]. Additionally, as resistance exercise involves a risk of injury and can be boring when performed alone, PA continuation after participation in simple exercise programs is challenging [17]. Moreover, as most South Korean research has targeted socially active older women [18–20], there is a need for PA programs appropriate for older men.

As men are more likely than women to form relationships through economic activities, their social support networks shrink more after retirement, as they focus on their spouses and families [21]. Therefore, cohabitating family members can provide social support for older men. Considering that family support directly influences PA, it can be utilized to produce positive outcomes in older men with sarcopenia [21, 22]. Additionally, as family support can influence self-efficacy and self-regulation, which may influence PA continuation [23], family support can be incorporated into PA programs for older men with sarcopenia. Thus, we aimed to develop and analyze the effects of a customized PA program to manage sarcopenia that reflected the specific needs of community-dwelling older men.

2. Methods

2.1. Design

This was a quasi-experimental study with a non-equivalent control group (CG) pre-test–post-test design.

2.2. Setting

Participants were recruited at a senior welfare center in Pohang City, South Korea. Approximately 150 older adults visit the center daily; the PA program was conducted at this center.

2.3. Sample

Individuals were considered to be sarcopenic if their skeletal muscle mass index (SMI) decreased by more than one standard deviation from the mean for healthy male and female participants aged 20–39 years. SMI is obtained by dividing the appendicular skeletal muscle mass by body weight and multiplying it by 100 to obtain a percentage. This method was developed by Janssen et al. [24] and validated for Koreans by Lim et al. [25]. In the present study, an SMI below 30.52% was used as the diagnostic criterion for sarcopenia, based on a study by Choi and Park [26].

The required sample size was calculated using G*Power 3.1.9.2 to allow for two-tailed testing, with a significance level of 0.05, testing power of 0.90, and an effect size of 1.12 [19]. The minimum experimental group (EG) sample size was 18. To account for a 20% dropout rate, 51 participants—25 in the EG and 26 in the CG—were recruited. To control for exogenous variables, matching was employed to ensure that groups had similar age composition and were within five years in age. Participants were initially assigned to only one group. One participant representing each group drew lots for assignment into the EG or CG. During the study, two EG participants dropped out (one due to poor attendance and one due to a fall) and two CG participants dropped out (one refused participation in the post-test investigation and one could not be contacted). Thus, data from 47 participants—23 EG and 24 CG—were analyzed, with a 7.8% dropout rate (Figure 1).

2.4. Inclusion and Exclusion Criteria

The inclusion criteria for the study were men aged older than 65 years who satisfied the sarcopenia diagnostic criteria, understood the study purposes, agreed to participate and complete questionnaires, understood the questionnaires, could perform program activities, did not have difficulties with activities of daily living, lived with family members such as a spouse or children, and whose family agreed to participate. Exclusion criteria were those who had been exercising regularly over the past six months at least thrice a week (30 minutes/session), had cognitive disabilities like Parkinson’s disease or dementia, had lost consciousness from severe light-headedness or vertigo, had joint or bone diseases that exercise might worsen, had cardiovascular diseases or chest pain at rest or during exercise, or could not communicate owing to severe perception disorders.

2.5. Instruments

2.5.1. Self-efficacy

A questionnaire on PA self-efficacy, developed by Seo [27] and translated into Korean by Lee and Chang [28], was used after obtaining the authors’ consent. The tool consists of five questions on older adults’ confidence in successfully continuing PA even when difficult. Responses are provided on a five-point Likert scale: strongly disagree (1), disagree (2),
neutral (3), agree (4), and strongly disagree (5). Higher scores indicate higher PA self-efficacy. Seo’s study had a Cronbach’s α of .86 [27]; in the present study, it was .77.

2.5.2. PA Self-regulation

The PA Self-Regulation-12, modified for older adults by Umstutd et al. [29], was used after obtaining the authors’ consent. It consists of 12 questions: two on self-monitoring, two on goal-setting, two on time management, two on reinforcement, two on social support, and two on relapse prevention. The self-report tool originally required respondents to indicate their activities in the past six months. However, considering the intervention, respondents were asked to respond to the tool concerning the past three months. Items are scored on a five-point Likert scale: strongly disagree (1), disagree (2), neutral (3), agree (4), and strongly agree (5). Higher scores indicate higher levels of PA self-regulation. Cronbach’s α was .86 in a study with Japanese workers [30]; it was .89 in the present study.

2.5.3. PA

The PA Scale for the Elderly–Korean version, originally developed by Washburn et al. [31] and revised for Korean older adults by Choe et al. [32], was used after obtaining the authors’ consent. It consists of six questions on leisure activities, three on house chores, and four on work, and asks respondents to evaluate their activity in the past week. Higher scores indicate higher PA. When reliability was assessed through a test-retest conducted two weeks apart at the time of development, Cronbach’s α was .94.

2.5.4. Body Composition

Bioelectrical impedance analysis was used for body composition analysis. Height was measured using a manual stadiometer (P000FAOE, Korea), and body weight and appendicular skeletal muscle mass were measured on an InBody 430 (InBody 430; Korea). By using the data from five older adults aged over 65 years and one in his 20s to evaluate the tools’ reliability, the intraclass correlation coefficient was .998 (p < .001), indicating the tools were reliable. To decrease measurement errors, the same examiners used the same tools for pre-test and post-test measurements.

2.5.5. Physical Performance

The physical fitness testing tool for older adults, developed by the Korea Sports Promotion Foundation [33], was used to measure muscle strength, lower limb endurance, cardiopulmonary endurance, elasticity, gait speed, and coordination. When Choi et al. [34] analyzed each item’s test-retest reliability, reliability was significant (p < .001) at .619–.925. Each item was measured as follows.

(i) Muscle Strength

A grip dynamometer (GRIP-D 5101, Takei, Japan) was used to obtain one measurement of the grip strength for each hand; the higher measurement was recorded to the second decimal place (0.01 kg), and muscle strength was calculated using the equation grip strength/body weight × 100. Higher values from the equation indicated greater muscle strength.

(ii) Lower Limb Endurance

The number of squats performed for 30 seconds by sitting on and standing back up from a chair was measured. Higher measurements indicated higher lower limb endurance.

(iii) Cardiopulmonary Endurance

A two-minute step test was conducted; higher numbers indicated higher cardiopulmonary endurance.

(iv) Elasticity

Participants sat on a mat with knees straight and soles of their feet touching the sit-and-reach test box (TKK-5403; Kyunghhee Sports Business, Korea); they reached forward as much as possible with straight hands. The finger position was measured to the first decimal place (0.1 cm) once. Higher measurements indicated greater elasticity.

(v) Gait Speed

Participants sat on a chair, stood up, and walked to and back from a target 3 m away. Time taken was measured once in 0.01-second units. Lower measurements indicated a higher gait speed.

(vi) Gait Speed (Complex)

Complex gait speed during coordination was evaluated in a Figure-of-8 Walk Test. Participants waited while sitting on a chair in the center of a rectangle. When prompted, they walked around a cone located to the right posterior of the chair and then around another cone located to the left posterior of the chair without rest before sitting back down. The time taken was measured once to the second decimal place (0.01 seconds). A shorter time indicated higher coordination.

(vii) IGF-1

After 12 hours of fasting, 3.5 cc of blood was collected from the median cubital vein using 5 ccs disposable syringes. Serum was isolated through centrifugation and stored at -84°C until analysis. IGF-1 was measured through the chemiluminescent immunometric assay on an analyzer (Liaison XL; DiaSorin, USA).

(viii) Dietary Intake

Dietary intake was measured by types, portions, and ingredients of all food consumed in the past 24 hours (breakfast, lunch, dinner, snacks) through 24-hour recollection. Data were analyzed with CANPro 5.0 (Computer Aided Nutritional Analysis Program 5.0), a nutritional analysis program. Food type and the amount consumed at each meal were analyzed to obtain total caloric, protein, and calcium intake.

2.6. Intervention

2.6.1. Customized PA Program Development

The customized PA program was developed through a literature review after assessing patient needs through a focus group (FG) with five community-dwelling older men with decreased muscle mass (confirmed by InBody) who visited the welfare center. FG questions were based on “What do older men with sarcopenia need for continued PA?” and...
included the following: “How do you think muscle mass influences health?,” “What factors interfere with regular PA?,” “What factors support/promote regular PA?,” and “What kind of family support helps PA?”

The FG revealed that older men felt regular PA was necessary but complicated by lack of time, pain, fear of falls, and lack of immediate benefit. They needed support from family/others, expert advice, and ways to perform PA easily at home. Therefore, family support was included in the program to promote self-efficacy and self-regulation, which contribute to PA continuation. The program also utilized group/individual education sessions and PA sessions, conducted five times with gradual increases in intensity. For the individual intervention and to promote continued PA and identify social support problems [35], two telephone monitoring calls and ten reminder text messages on PA were provided.

Based on previous research [18, 36], the PA program included both resistance and aerobic exercises. It followed Garber et al.’s recommendations [37] after obtaining expert opinions from three nursing professors, one sports medicine professor, one visiting nurse with over five years of work experience, and one exercise instructor for older adults with over five years of work experience.

Resistance exercises incorporated towels and empty water bottles, and a two-week adjustment period was provided at the beginning of the program based on participants’ conditions. PA intensity was manipulated by adjusting the amount of water in the bottle, which participants could adjust independently [18]. Aerobic exercises were conducted while wearing a pedometer. Participants were encouraged to engage in daily activities as this can reduce physical function loss [1, 15, 38, 39]. Table 1 shows program activities.

| Table 1. Customized content for the physical activity program. |
|---------------------------------------------------------------|
| **Session and items** | **Family support** | **PA** | **Aerobic activity** |
| **Session 1:** Weeks 1–2 **Adjustment period for PA and family support training** | Education on importance of family participation, introduction of ways to show family support, setting short- and long-term PA goals, writing supportive sentences of family support, completion of a written exercise oath | Muscle-strengthening activity | **Muscle types** |
| | Methods | | Strengthens pectoralis, brachialis, antebrachialis, deltidoi, trapezius, abdominal, gluteal, quadriceps femoris, biceps femoris, gastrocnemius, and soleus muscles. |
| | 1. Equipment-free exercises (3 times/week): Start with stretching | | Walking |
| | 2. Stretch arms while holding a towel, shake a 500-ml water bottle up and down. | | Strengthens pectoralis, brachialis, antebrachialis, deltidoi, trapezius, abdominal, gluteal, quadriceps femoris, biceps femoris, gastrocnemius, and soleus muscles. |
| | 3. Lift one leg while sitting and maintain the posture, bend knees while lying down, and pull knees toward the chest. | | Walking |
| | 4. Lift heels while holding a chair when standing up. | | Strengthens pectoralis, brachialis, antebrachialis, deltidoi, trapezius, abdominal, gluteal, quadriceps femoris, biceps femoris, gastrocnemius, soleus, and latissimus dorsi muscles. |
| | 1. Low intensity (3 times/week): Start with stretching | | Walking |
| | 2. Stand with feet apart and stretch arms straight ahead, parallel. Bend knees and maintain posture. | | Strengthens pectoralis, brachialis, antebrachialis, deltidoi, trapezius, abdominal, gluteal, quadriceps femoris, biceps femoris, gastrocnemius, soleus, and latissimus dorsi muscles. |
| | 3. Hold a 2-L bottle filled with water (1/4, adjust amount according to your own physical fitness) while standing. Shake bottle side to side at navel, without moving legs. | | Walking |
| | 4. Quickly lift the heels while standing and holding a chair. | | Strengthens pectoralis, brachialis, antebrachialis, deltidoi, trapezius, abdominal, gluteal, quadriceps femoris, biceps femoris, gastrocnemius, soleus, and latissimus dorsi muscles. |
| | 5. Run lying down, lift one leg straight to 30 degrees, maintain posture. | | Walking |
| **Session 2:** Weeks 3–4 **Making PA a habit, education on family support** | Identifying and planning ways to overcome obstacles, describing feelings about PA, writing sentences to overcome obstacles, introduction of strategies to change the environment, planning for compensation | Muscle-strengthening activity | **Equipment-free exercises (3 times/week):** |
| | 1. Moderate-intensity (twice a week): Start with stretching | | Strengthens pectoralis, brachialis, antebrachialis, deltidoi, trapezius, abdominal, gluteal, quadriceps femoris, biceps femoris, gastrocnemius, soleus, and latissimus dorsi muscles. |
| | 2. Hold 500-ml bottles filled with water (1/2, adjust amount according to your own physical fitness) in both hands while standing and lift them parallel to the floor. Maintain posture. | | Walking |
| | 3. Bend forward while bending knees. Hold plastic bottles filled with water (adjust amount according to your own physical fitness) in both hands while standing and keep them parallel to the floor. Maintain posture. | | Strengthens pectoralis, brachialis, antebrachialis, deltidoi, trapezius, abdominal, gluteal, quadriceps femoris, biceps femoris, gastrocnemius, soleus, and latissimus dorsi muscles. |
| | 4. Stand with feet hip-width apart and stretch arms straight ahead, parallel. Bend knees and maintain posture. | | Walking |
| | 5. Hold a 2-L bottle filled with water (1/2, adjust amount according to your own physical fitness) with both hands while bending forward with knees bent. Shake bottle side to side at navel, without moving the legs (20–30 times; 2–5 times). | | Strengthens pectoralis, brachialis, antebrachialis, deltidoi, trapezius, abdominal, gluteal, quadriceps femoris, biceps femoris, gastrocnemius, soleus, and latissimus dorsi muscles. |
| | 6. Bend one knee and lift to navel while standing and holding chair. | | Walking |
| | 7. Lift one leg straight to 45 degrees while lying down and maintain posture. | | Strengthens pectoralis, brachialis, antebrachialis, |
| | **Session 3:** Weeks 5–8 **Moderate-intensity exercise, education on family support** | Presentation of feelings gained from family support, presentation of experiences of PA failure and identification of problems, presentation of ways to overcome PA obstacles, verbal convincing, introduction of examples of environmental changes | | Walking |
| | 1. High-intensity (2 times/week): Start with stretching | | Strengthens pectoralis, brachialis, antebrachialis, |
| | 2. Hold 500-ml bottles filled with water (3/4, adjust amount | | Walking |
| | **Session 4:** Weeks 9–11 **Taking photos while exercising with family and friends** | | |
### Session and items | Family support | PA  
--- | --- | ---  
**High-intensity PA, increasing intensity, education on family support** | Presenting them, sharing changes after exercising, identifying/solving obstacles in increasing intensity, sharing difficulties in family support | According to your own physical fitness in both hands while standing and lift them parallel to the floor. Lift heels and maintain posture.  
3. Bend forward while bending knees. Hold 500-ml bottles filled with water (3/4, adjust amount according to your own physical fitness) in both hands and shake up and down while keeping your arms straight.  
4. Stand with feet hip-width apart and stretch arms straight ahead, parallel. Bend knees and maintain posture.  
5. Hold a 2 L bottle filled with water (3/4, adjust amount according to your own physical fitness) with both hands while bending forward with knees bent. Shake bottle from knees to shoulders without moving the legs.  
6. Lift one leg to the navel while standing and holding a chair and lift the heel of the supporting leg.  
7. Lie down with knees bent, lift hips, and maintain posture.  
**Session 5: Week 12 Maintaining PA and completion ceremony** | 1. Encouraging continued exercises: high-intensity exercises after which participants would feel out of breath  
2. Participants independently adjust composition and repetition of exercises they learned thus far.  
|  
| deltoid, trapezius, abdominal, gluteal, quadriceps femoris, biceps femoris, gastrocnemius, soleus, latissimus dorsi, and psoas muscles.  

Note. PA = physical activity.

### 2.6.2. Research Assistant Training
Five nursing students collected data as research assistants (RAs). They received sufficient training to administer the questionnaires and familiarize themselves with them. Each RA demonstrated the data collection process for the researcher and received additional training on areas requiring improvement. Two nurses collected blood, for which they received training. One exercise instructor for older adults with at least five years of experience received a study explanation and was provided with PA guidelines and exercise videos to familiarize herself with the exercises. Three exercise instructors at Pohang City’s awarded physical fitness center with prior training received an explanation on study purpose before testing.

### 2.6.3. Pre-intervention
Participants received an explanation of the study rationale, purpose, contents, and program plans. A written study explanation was distributed to participants and their families to obtain informed consent. The senior welfare center director also received the explanation and approved the study. Primary screening was conducted only for those who wished to participate, provided consent, answered the primary screening questions, and whose family members had also consented. The five RAs explained the primary screening questionnaire prior to completion. Body composition analysis and physical fitness testing were conducted by three trained testers at Pohang City physical fitness center. EG and CG participants who satisfied the criteria for sarcopenia at the primary screening were surveyed by the five trained RAs, who read aloud questionnaires on general and health-related characteristics, self-efficacy, self-regulation, family support, and PA and recorded the participants’ answers. Dietary intake was surveyed using 24-hour recollection forms, and the researcher entered data into CANPro 5.0. RAs confirmed if participants had fasted for 12 hours and explained possible side effects prior to blood collection.

### 2.6.4. Conducting the Customized PA Program
The program ran for 12 weeks from May 17 to August 9, 2018. The group program was provided at 4:30 PM every Thursday at the senior welfare center: 60 minutes per session across five sessions. The researcher provided training on reinforcing family support and to the exercise instructor on increasing PA. Each group session was conducted on the first day of the week when PA intensity was increased. Before the program, the EG was given guidelines on PA, exercise logs, posters, and exercise videos to be used every week. Participants conducted the exercises at planned intensities. Once they began, exercise reminder text messages were sent once/week for 10 weeks (except weeks 7 and 11, when phone call monitoring was conducted). The program was conducted in the senior welfare center auditorium. The CG was asked to maintain their usual daily routine. After study completion, CG participants who wished to participate in the program were provided with sarcopenia education in the auditorium, guidelines on PA, exercise videos, and posters, and their questions were answered.

### 2.6.5. Post-intervention
Immediately after the 12-week program, the EG and CG were tested for self-efficacy, self-regulation, PA, body composition, and physical fitness, and blood was collected to analyze IGF-1 levels. The pre-intervention researcher and RAs also performed the post-intervention tests using the same methods, and these were conducted simultaneously for both group.

### 2.7. Ethical Considerations
We obtained approval from K university’s institutional review board (no: 40525-201712-HR-109-05). The participant consent form included the study purpose, study participants and procedures, participation risks and benefits, confidentiality, and the right to withdraw at any time. Written consent was obtained.
after providing explanations to the EG and CG. Written consent for the provision of human-derived materials was obtained after explaining the blood collection purpose, collection method, precautions, the amount collected, benefits, inconvenience, and risks. Participants were assured that collected individual data and personal information would not be published and only considered for research purposes. To ensure data confidentiality, questionnaires were collected immediately after completion and stored at a secure, locked location. Small gifts such as warm socks were provided to all participants.

### 2.8. Statistical Analysis

SPSS 24.0 was used to analyze participants’ general characteristics through descriptive statistics and test tool reliability through Cronbach’s α. To test for homogeneity between the EG and CG, chi-squared tests and Fisher’s exact tests were conducted, and independent samples *t*-tests were used to analyze between-group differences pre- and post-intervention.

#### 3. Results

##### 3.1. Participant Characteristics

Participants’ characteristics are shown in Table 2.

| Variable                        | Category          | Experimental group (*n* = 23) | Control group (*n* = 24) | *χ²/t* | *p*   |
|---------------------------------|-------------------|-------------------------------|--------------------------|--------|-------|
| Age (years)                     |                   |                               |                          | 0.17   | .863  |
| Alcohol consumption             | Yes               | 7 (30.4)                      | 9 (37.5)                 | 0.26   | .609  |
|                                 | No                | 16 (69.6)                     | 15 (62.5)                | 1.00   | .348  |
| Smoking                         | Yes               | 1 (4.3)                       | 3 (12.5)                 |        | .00   |
|                                 | No                | 22 (95.7)                     | 21 (87.5)                |        | .00   |
| Marital status                  | Married           | 21 (91.3)                     | 21 (87.5)                | 0.17   | 1.00  |
| Fracture (last five years)      | Widower           | 2 (8.7)                       | 3 (12.5)                 |        | .00   |
|                                 | Yes               | 3 (13.0)                      | 1 (4.2)                  | 1.19   | .348  |
|                                 | No                | 20 (87.0)                     | 23 (95.8)                |        | .00   |
| Hospital admission (last five years) | Yes          | 10 (43.5)                     | 11 (45.8)                | 0.26   | 1.00  |
|                                 | No                | 13 (56.5)                     | 13 (54.2)                |        | .00   |
| Hypertension                    | Yes               | 11 (47.8)                     | 12 (50.0)                | 0.22   | .882  |
|                                 | No                | 12 (52.2)                     | 12 (50.0)                |        | .00   |
| Rheumatoid arthritis            | Yes               | 4 (17.4)                      | 5 (20.8)                 | 0.90   | 1.00  |
|                                 | No                | 19 (82.6)                     | 19 (79.2)                |        | .00   |
|                                 | Yes               | 3 (13.0)                      | 4 (16.7)                 |        | .00   |
| Diabetes mellitus               | Yes               | 5 (21.7)                      | 5 (20.8)                 | 0.12   | 1.00  |
|                                 | No                | 20 (87.0)                     | 20 (83.3)                |        | .00   |
|                                 | Not healthy       | 5 (21.7)                      | 5 (20.8)                 |        | .00   |
| Health status (subjective)      | Healthy           | 16 (69.6)                     | 16 (66.6)                | 2.31   | .531  |
|                                 | Very healthy      | 2 (8.7)                       | 3 (12.5)                 |        | .00   |
| Total kcal                      |                   | 1,858.93 ± 64.83              | 1,735.70 ± 38.81         | 1.63   | .112  |
|                                 |                   | 70.33 ± 2.16                  | 70.11 ± 2.04             | 0.07   | .942  |
| Protein (g)                     |                   | 574.83 ± 19.49                | 565.84 ± 24.94           | 0.28   | .779  |
|                                 |                   | 73.09 ± 1.69                  | 68.46 ± 2.20             | 1.66   | .104  |
| Family caregiver (age in years) | Spouse            | 21 (91.3)                     | 21 (87.5)                | 2.31   | .967  |
|                                 | Partner           | 1 (4.3)                       | 2 (8.3)                  |        | .00   |
|                                 | Child/sibling     | 1 (4.3)                       | 1 (4.2)                  |        | .00   |

*Note.* *Fisher’s* exact test.

#### 3.2. Comparison of EG and CG Outcomes

The self-efficacy score significantly increased by 0.96 in the EG and 0.18 in the CG, and IGF-1 level significantly increased by 3.27 ng/mL in the EG but decreased by 13.5 ng/mL in the CG. Lower limb endurance score significantly decreased by 0.93 in the EG and 4.8 in the CG. Elasticity score significantly increased by 5.24 cm in the EG and 1.31 cm in the CG. Differences in other variables were non-significant (Table 3).
4. Discussion

We developed and evaluated a customized PA program for older men with sarcopenia. The EG’s self-efficacy increased significantly, which differs from the result of Riemsmma et al. [40], who implemented family support through group education for patients with osteoarthritis and found no significant difference in self-efficacy. The present result may indicate that older men’s needs for improving self-efficacy were reflected in the program, and that the family’s participation, continued encouragement/support, and sharing of negative feelings about PA contributed to increasing self-efficacy. Moreover, older men’s need for family support reflects sociocultural environments for older adults in Korean society. This finding should be considered when establishing future health policies on sarcopenia among older adults, especially for men. However, we believe this finding is not restricted by sex.

IGF-1 increased by 3.27 ng/mL (EG) and decreased by 13.55 ng/mL (CG). This coincides with previous findings [20, 41] that revealed that combined exercise improves IGF-1. Indeed, IGF-1 is vital in myocyte development, growth, and maintenance, and is positively correlated with muscle mass. Lower testosterone levels in older men are known to decrease IGF-1 [1, 42], and the PA program influenced the reduction in IGF-1. Moreover, although the increase in IGF-1 in the EG was not immense, its decrease in the CG was substantial. Considering that muscle mass did not increase, the exercise program delayed the IGF-1 decrease. Moreover, considering previous findings that IGF-1 increases significantly over 24 weeks of high-intensity resistance exercise [43], the observed significant difference after 12 weeks is a key finding.

Rather than having participants rely solely on family, the present program also utilized five group sessions and individual interventions through phone calls/text messages to increase motivation for regular PA. We also attempted to increase intervention effects by monitoring participants’ program compliance. To help them and their family perform the exercises accurately while maintaining interest, PA guidelines and materials were utilized, as were weekly exercise logs to evaluate whether family support and PA were implemented as planned. These various strategies led to continued PA at home, resulting in improvements in sarcopenia markers.

Significant differences were also observed in lower limb endurance and elasticity, which were physical fitness indices. These findings differ from those of previous studies that found leg endurance improvement using combined exercise for older women with sarcopenia [20, 36]. Previous studies reporting muscle strength and endurance improvement used exercise programs at facilities used most often by older women [20]. Considering that leg muscle strength decreases more in men than women [44], our finding of no decrease in lower limb endurance in our program is meaningful. Meanwhile, the elasticity score increased by 5.24 cm (EG) and 1.01 cm (CG). Pre-intervention elasticity was -3.70 cm, which is considerably lower than the mean of 3.8 cm for individuals aged 75–79 years [45]. In this context, less elasticity leads to decreased range of joint motion in common daily-life movements, thus increasing the risk of falls and musculoskeletal injuries and negatively influencing independent daily living [46, 47]. In this study, the pre-exercise stretching may have led to these positive findings.

The present study is significant in that it developed a new PA program utilizing family support for older men with sarcopenia. Particularly, the program was developed to reflect the assessed needs of community-dwelling older men. Unlike gym programs, it can be applied flexibly, thus making implementation easier. Water bottle and towel use also enables...

### Table 3. Comparison of outcomes between experimental and control groups (N = 47).

| Variable          | Intervention | Experimental group (n = 23) | Control group (n = 24) | t    | p    |
|-------------------|--------------|-----------------------------|------------------------|------|------|
|                  |              | Mean ± SD                   |                        |      |      |
| Self-efficacy     | Pre          | 3.10 ± 0.67                 | 3.50 ± 0.78            | 3.98 | <.001|
|                   | Post         | 4.05 ± 0.46                 | 3.68 ± 0.66            |      |      |
| Self-control      | Pre          | 3.54 ± 0.74                 | 3.38 ± 0.76            | 1.99 | .053 |
|                   | Post         | 4.08 ± 0.67                 | 3.44 ± 0.61            |      |      |
| K-PASE            | Pre          | 127.77 ± 152.19             | 127.92 ± 85.03         | 1.05 | .226 |
|                   | Post         | 165.84 ± 87.96              | 133.90 ± 71.39         |      |      |
| ASM (kg)          | Pre          | 20.82 ± 1.98                | 19.68 ± 1.97           | 0.60 | .550 |
|                   | Post         | 21.02 ± 1.95                | 19.72 ± 2.47           |      |      |
| IGF-1 (ng/mL)     | Pre          | 177.47 ± 42.33              | 159.28 ± 33.36         | 2.02 | .049 |
|                   | Post         | 180.74 ± 57.42              | 145.73 ± 31.13         |      |      |
| Muscle strength (%)| Pre      | 47.37 ± 6.90                | 49.15 ± 9.10           | 1.07 | .290 |
|                   | Post         | 49.06 ± 7.99                | 49.58 ± 9.55           |      |      |
| Lower limb        | Pre          | 22.04 ± 8.02                | 22.13 ± 9.44           | 0.27 | .391 |
| endurance (count) | Pre          | 21.13 ± 7.00                | 17.33 ± 5.41           | 1.54 | .131 |
|                   | Post         | 102.91 ± 17.09              | 99.71 ± 21.42          |      |      |
| Cardiopulmonary endurance (count) | Pre | 113.83 ± 10.27 | 103.21 ± 22.54 | 1.54 | .131 |
|                   | Post         | -3.70 ± 8.98                | -1.16 ± 12.64          | 2.46 | .032 |
| Elasticity (cm)   | Pre          | 1.54 ± 8.98                 | -0.15 ± 11.94          |      |      |
|                   | Post         | 6.10 ± 6.1                  | 6.04 ± 1.37            | 1.93 | .060 |
| Gait speed (sec)  | Pre          | 6.40 ± 1.42                 | 6.92 ± 1.47            |      |      |
|                   | Post         | 31.26 ± 9.80                | 31.21 ± 8.09           |      |      |
| Gait speed complex (sec) | Pre | 27.77 ± 6.13 | 30.12 ± 8.50 | 1.53 | .132 |

Note. K-PASE = Korean Version of Physical Activity Scale for the Elderly, ASM = appendicular skeletal muscle mass, IGF-1 = insulin-like growth factor-1.
Programs for older adults can improve their health. As the program effectively improved self-efficacy, which influences sarcopenia in older men, and physical fitness markers—including IGF-1, lower limb endurance, and elasticity—it is expected to positively impact the negative influences of sarcopenia (including falls) and delay nursing home admission [48]. Even when admitted to nursing homes, consistent exercise may positively influence rehabilitation outcomes. Therefore, support-based exercise programs for older adults can improve their health.

This study had some limitations. First, selecting only older men who wished to participate based on family support raises the possibility of selection bias. Additionally, as this study focused on older men’s needs reflected through an FG conducted with older men from one community, future studies should also focus on sarcopenia in older women. Second, caregivers providing support were mostly spouses aged 75 years on average. Although they were also older, the study was limited in considering their physical health issues. Third, as the present study focused on reinforcing PA based on family support, we did not consider nutritional or dietary intake [49]. Therefore, future studies should implement a comprehensive intervention considering this aspect of the program.

5. Conclusions

The present study developed and evaluated a customized PA program for older men with sarcopenia based on community-dwelling older men’s needs. The program was effective in improving self-efficacy, IGF-1 level, and elasticity and in alleviating decreases in lower limb endurance. This program has been designed to help older adults to start exercising and continuously practice it at home by using family support as a PA promotion strategy. Although the home-centered program may not have a greater effect compared to facility-centered programs, it may have noteworthy results in the long term as it is effective in helping older adults initiate and maintain PA by themselves. Therefore, the customized PA program can be an effective intervention to improve sarcopenia indices in community-dwelling older men and to prevent sarcopenia-associated health issues.

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