Research Square

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The effectiveness of an information-motivation-behavioral skills model based sarcopenia prevention program for older adults: A quasi-experimental study

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Research Article

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Abstract

Background Sarcopenia is a critical health issue among older adults and is characterized by the loss of skeletal muscle mass and strength. This study aimed to verify the effectiveness of a sarcopenia prevention program based on the Information-Motivation-Behavioral skill (IMB) model for older adults.

MethodsThis quasi-experimental study was conducted with 50 older adults from senior welfare centers in Daegu, Korea. Participants were divided into experimental (n=25) and control (n=25) groups. The intervention program consisted of 12 sessions over 6 weeks. Data were analyzed using SPSS version 28.0 and R version 4.0.3.

Results The experimental group showed significant improvements in physical performance (OR 2.37, 95% CI=1.42–107.74, p=.002) and sarcopenia-related quality of life (t=8.02, p<.001). However, no significant differences were observed in muscle mass or strength between groups.

Conclusions The IMB model-based program effectively improved physical performance and quality of life in older adults and can be recommended as a nursing intervention for sarcopenia prevention.

Background

The global aging population is rapidly increasing, with sarcopenia emerging as a major health concern among older adults. In 2020, older adults represented 9.3% of the world's population, and this is projected to rise to 15.9% by 2050 [1,2]. In Korea, the proportion of people aged 65 and older was 16.6% of the total population in 2021, and it is expected to reach 39.8% by 2050 [3]. This demographic shift brings aging-related issues to the forefront, with sarcopenia being one of the most pressing concerns.

Sarcopenia is one of the primary physiological changes associated with aging, characterized by a decrease in skeletal muscle mass [4,5]. Muscle mass declines by approximately 1.0–2.0% annually, and muscle strength declines by about 1.5–3.0% per year [6]. Such muscle loss occurs with aging and has recently been recognized as a disease. Many countries, including the United States, classify sarcopenia as a disease, and Korea has also categorized it as a disease since 2021 [7].

Sarcopenia is diagnosed based on muscle mass, muscle strength, and physical performance. According to the European Working Group on Sarcopenia in Older People (EWGSOP) and the Asian Working Group for Sarcopenia (AWGS), sarcopenia is defined as muscle mass less than 7.0 kg/m² for men and 5.7 kg/m² for women, muscle strength less than 28 kg for men and 18 kg for women, or physical performance less than 1 m/s [8]. The prevalence of sarcopenia is approximately 10.0% worldwide, while in Korea, it is estimated to range from 6.5% to 42.8% [9,10].

Sarcopenia can be caused by reduced skeletal muscle use, decreased physical activity, and inadequate nutrition [11-13], which, in turn, increases the incidence and mortality of major chronic diseases such as falls, fractures, hypertension, diabetes, and cardiovascular disease [14-16], and reduces physical function

and quality of life [5,17,18]. Therefore, adequate physical activity and nutrition are essential for preventing and managing sarcopenia [11].

However, older adults often do not meet the standard criteria for physical activity and nutrition intake. Their physical activity levels for walking, aerobic exercise, and strength training are generally low [19], and protein and vitamin D intake, essential for sarcopenia prevention, is often insufficient [12,13,20]. Thus, there is a need for a program to support sustained health behaviors.

Various intervention methods have been developed to prevent or manage sarcopenia, and their effects on improving muscle mass, strength, and balance have been verified. However, most existing exercise interventions are one-time programs, and dietary interventions typically focus on the intake of specific nutrients, such as amino acids, proteins, and vitamins, without encouraging sustained behavioral changes [21-24]. Therefore, a program is needed to induce continuous health behavior maintenance by fostering changes in physical activity and diet in older adults [16,17].

The Information-Motivation-Behavioral Skills (IMB) Model, developed by Fisher & Fisher, has been applied to address health issues such as these [25]. The IMB model is based on the concept that adequate information acquisition, motivation, and behavioral skills support behavioral change and maintenance. The IMB model has been applied to strategies for self-management of diabetes, cardiovascular disease, HIV patients, medication adherence, and smoking cessation programs for adolescents [16]. While it has also been proven effective for self-management and health-risk behavior prevention in elderly individuals with osteoarthritis or obese older adults with knee osteoarthritis [26-29], there is limited research on applying this model to older adults with sarcopenia.

This study, therefore, aims to develop and verify the effectiveness of a sarcopenia prevention and management program for older adults based on the IMB model. To promote sustainable adherence to physical activity and dietary practices, we implemented the IMB model's components: knowledge, motivation, and behavioral skills (Fig 1). The program provides information, fosters motivation through shared goals and self-awareness, and enhances behavioral skills to encourage continuous sarcopenia prevention and management practices. The program incorporates information provision, motivation enhancement, and skill-building, and seeks to verify its clinical effects on indicators such as muscle mass, strength, and physical performance. Additionally, the study evaluates quality of life related to sarcopenia among older adults.

The purpose of this study is to develop and verify the effectiveness of a sarcopenia prevention and intervention program for older adults based on the IMB model. The specific objectives are as follows:

First, to assess the effects of the sarcopenia prevention and intervention program based on the IMB model on muscle mass, muscle strength, and physical performance. Second, to evaluate the impact of the sarcopenia prevention and intervention program based on the IMB model on the quality of life related to sarcopenia.

Methods

Research Design

This study is a quasi-experimental study with a non-equivalent control group pre-test and post-test design. It was conducted to develop and verify the effectiveness of a sarcopenia prevention and intervention program based on the IMB model for older adults.

Participants

Participants were recruited from two senior welfare centers in City D, using a coin toss to assign participants to the experimental and control groups to prevent treatment diffusion. Participants who agreed to join after being informed about the purpose and methods of the study were conveniently sampled. The inclusion criteria were as follows: (1) individuals aged 65 or older and (2) individuals not participating in other sarcopenia prevention or intervention programs. The exclusion criteria were (1) those with conditions that make understanding information or receiving education difficult (e.g., dementia or disabilities) and (2) those with restrictions on physical activity (e.g., fractures, strokes, paralysis, heart disease). The sample size was calculated using G*Power 3.1.7, based on Yoshimura et al.'s study [12] and Cohen's formula, resulting in 40 participants (20 per group) with an effect size of .35, a significance level of .05, and a power of .80. Considering a 20.0% dropout rate, a total of 50 participants were recruited (25 in the experimental group and 25 in the control group). No participants dropped out during the study, so data from all 50 participants were included in the final analysis (Fig. 2).

Sarcopenia Prevention and Intervention Program Based on the IMB Model

The intervention program was designed based on the IMB model, providing information related to sarcopenia and encouraging participants to recognize their own condition, thereby motivating them and enhancing their skills in exercise and nutrition. The program was developed based on previous studies, focusing on promoting physical activity and dietary changes. The final program consisted of 12 sessions over 6 weeks (two sessions per week), with each session lasting 20-30 minutes. The exercise program aimed to promote physical activity, including "stretching" and "whole-body vibration exercises" for 20-30 minutes per session. Dietary education was conducted for 10 minutes per session and covered topics such as "the importance of diet, food composition guidelines, nutrients and roles of food groups, protein-rich foods, vitamin D foods, and meal planning" (Table 1).

Information was provided on topics such as "physical and physiological changes in older age, definition and diagnostic criteria for sarcopenia, causes, risk factors, and diet and exercise for sarcopenia prevention" through handouts, videos [30,31], and face-to-face education. A motivational strategy was employed by sharing the benefits of health behaviors and providing feedback at each session, allowing participants to monitor changes in their sarcopenia status and dietary patterns [32-34]. Behavioral skills were enhanced by applying suitable exercise programs and dietary education for older adults. The exercise program consisted of warm-up, upper body exercise, lower body exercise, and cool-down. The

warm-up and cool-down were light stretches lasting 3 minutes 30 seconds and 2 minutes 30 seconds, respectively [35,36]. The upper body exercise included resistance band exercises using an elastic band (Melkin Stretching Band, Yellow Level 1, Melkin Sports, Seoul, Korea) for approximately 4 minutes, based on studies indicating that resistance band exercises improve muscle mass and physical performance in older adults [37]. The lower body exercise involved whole-body vibration exercises using a vibration machine (DA604, Egofit, Gyeonggi, Korea) at 20-40 Hz, with each session lasting 10 minutes for sessions 1-4, 15 minutes for sessions 5-8, and 20 minutes for sessions 9-12[38-41]. Dietary education was based on the dietary reference intakes developed by the Korea Health Promotion Institute [42], encouraging participants to keep a dietary log and plan meals, then providing feedback on protein and vitamin D intake to improve dietary habits.

Research Tools

Muscle Mass

Muscle mass was measured with a body composition analyzer (InBody H20B, InBody, Seoul, Korea), calculating skeletal muscle mass (kg) divided by height squared (m^2) [43]. Measurements were taken with participants standing barefoot on the device, holding the electrodes with arms extended comfortably. Lower values indicate less muscle mass, and the cut-off for sarcopenia is <7.0 kg/m² for men and <5.7 kg/m²for women [44].

Muscle Strength

Muscle strength was measured using a handgrip dynamometer (EH-101, CAMRY, Hong Kong), with participants standing with legs slightly apart and holding the dynamometer at thigh level. Grip strength was recorded in kg, with two measurements taken, and the higher value was used [40]. Lower values indicate weaker muscle strength, with the sarcopenia threshold set at <26 kg for men and <18 kg for women [44].

Physical Performance

Physical performance was measured by the average walking speed over a 6-meter straight path. Walking speed was calculated by the time (in m/s) taken to walk the 6 meters at a normal pace without slowing down, using a stopwatch (KS-201, Iwanna, Gyeonggi, Korea), with the average of two trials recorded [44]. Lower speeds indicate reduced physical performance, with the sarcopenia threshold set at <1 m/s [44].

Sarcopenia-Related Quality of Life

Quality of life related to sarcopenia was measured using the Sarcopenia Quality of Life (SarQoL) tool developed by Beaudart et al. [5], translated into Korean by Yoo et al. [45]. The tool comprises 55 items across 7 domains: physical and mental health, mobility, body composition, functionality, activities of daily living, leisure activities, and fear. Responses were scored with weighted values, with each domain's

total score ranging from 0 to 100; higher scores indicate better sarcopenia-related quality of life. The reliability of the tool was .87 in the original study by Yoo et al. [45] and .86 in this study.

Study Procedures

The study was conducted from August 2, 2022, to September 17, 2022, following these procedures:

Pre-test

The researcher conducted surveys, physical measurements, and sarcopenia diagnostic tests by visiting two senior welfare centers. The survey included general characteristics (6 items) and sarcopenia-related quality of life (22 items) for a total of 28 items, either completed by participants or, if needed, with assistance from the researcher. Physical and sarcopenia-related diagnostic indicators were measured with participants in light clothing. Muscle mass was measured using a body composition analyzer, muscle strength with a handgrip dynamometer, and physical performance with a stopwatch. The control group received the same survey, physical measurements, and diagnostic tests, with each participant taking approximately 20 minutes.

Intervention

The sarcopenia prevention and intervention program consisted of 12 sessions over 6 weeks, conducted twice a week. Participants were divided into small groups of 4-5. Each session included information, motivational feedback, an exercise program, and dietary education. The exercise program lasted about 30-40 minutes per session and included warm-up, cool-down, and upper/lower body resistance exercises (resistance band exercises and whole-body vibration exercises). Information related to sarcopenia prevention and management was provided using materials and videos for about 10 minutes each session. Dietary education included meal log writing, dietary planning, and self-assessment. After the post-test, the control group was provided with an educational booklet and a Q&A session on sarcopenia prevention and management used by the experimental group.

Post-test

After the intervention program, the experimental group completed the same survey, physical measurements, and sarcopenia diagnostic tests as in the pre-test.

Data Analysis

Data were analyzed using SPSS/WIN Statistics ver. 28.0 (IBM Corp., Armonk, NY, USA), R 4.0.3 (R Foundation for Statistical Computing, Vienna, Austria), and T&F software ver. 3.0 (YooJin Biosoft, Korea). General characteristics were analyzed with descriptive statistics such as frequency, percentage, mean, and standard deviation. Chi-square test, Fisher’s exact test, Independent t-test, and Mann-Whitney U test were used to test baseline homogeneity between groups. Sarcopenia criteria were based on the 2019 AWGS standards. Changes in muscle mass, muscle strength, and physical performance were evaluated

as “improved,” “deteriorated,” or “maintained” relative to these cut-offs. The program's effectiveness was verified using the Chi-square test, Independent t-test, and Linear trend test, with statistical significance set at α=.05.

Ethical Considerations

This study was approved by the Institutional Review Board (IRB No: 40525-202002-HR-089-03) of K University. Participants were informed orally and in writing about the study's purpose, procedures, possible side effects, confidentiality, data anonymity, data destruction after completion, and the right to withdraw at any time without repercussions. Participants who voluntarily agreed to join the study signed an informed consent form, and a small gift was provided as a token of appreciation.

Results

General Characteristics and Sarcopenia-Related Characteristics of Participants

The average age of the 50 participants was 69.9 years; 50.0% were aged 70-75, and 70.0% were women. Among the participants, 74.0% (37 individuals) were married, and 74.0% lived with family. Education levels included elementary school or lower for 18 participants (36.0%), middle school for 13 (26.0%), high school for 11 (22.0%), college for 7 (14.0%), and graduate school for 1 (2.0%). Of the participants, 54.0% (27 individuals) were employed. There were no statistically significant differences between the groups based on these general characteristics (Table 2).

For sarcopenia-related characteristics, the experimental group had a muscle mass of 8.51±1.21 kg/m², and the control group had 8.60±0.63 kg/m², with 96.0% of the experimental group and 100.0% of the control group above the threshold for sarcopenia. Muscle strength was 27.70±6.89 kg in the experimental group and 24.49±6.11 kg in the control group, with 84.0% of the experimental group and 80% of the control group above the sarcopenia threshold. Physical performance was 0.99±0.11 m/s in the experimental group and 0.96±0.19 m/s in the control group, with 52.0% of the experimental group and 40.0% of the control group above the threshold. The pre-intervention sarcopenia-related quality of life score was 80.46±11.07 in the experimental group and 76.39±10.9 in the control group. No statistically significant differences were observed between groups for muscle mass, muscle strength, physical performance, or sarcopenia-related quality of life.

Effectiveness of the IMB Model-Based Sarcopenia Prevention and Intervention Program

The effects of the sarcopenia prevention and intervention program on muscle mass, muscle strength, physical performance, the number of sarcopenia diagnosis indicators, and sarcopenia-related quality of life are presented in Table 3.

Muscle Mass

After the intervention, one participant (4.0%) in the experimental group showed improvement in muscle mass, while none in the control group did. The number of participants with unchanged muscle mass was 24 (96.0%) in the experimental group and 25 (100.0%) in the control group. The odds of improvement in muscle mass were higher in the experimental group than in the control group, with an odds ratio of 3.12 (95% CI=0.12-80.40, p=1.000), although this was not statistically significant (Table 3).

Muscle Strength

Following the intervention, muscle strength improved in 4 participants (16.0%) in the experimental group and 2 (8.0%) in the control group. The number of participants with unchanged muscle strength was 21 (84.0%) in both groups, and muscle strength declined in 2 (8.0%) participants in the control group. The odds of muscle strength improvement were higher in the experimental group, with an odds ratio of 2.00 (95% CI=0.33-12.12, p=.153), though this was not statistically significant (Table 3).

Physical Performance

The intervention led to improved physical performance in 9 participants (36.0%) in the experimental group and 1 (4.0%) in the control group, while 16 (64.0%) in the experimental group and 22 (88.0%) in the control group showed no change. Two participants (8.0%) in the control group experienced a decline. The odds of improved physical performance were significantly higher in the experimental group, with an odds ratio of 12.38 (95% CI=1.42-107.74, p=.002) (Table 3).

Sarcopenia-Related Quality of Life

After the intervention, sarcopenia-related quality of life was significantly higher in the experimental group (86.68±8.73) compared to the control group (68.60±12.85), showing a statistically significant difference (t=5.82, p<.001). The post-pre difference was also significantly higher in the experimental group (6.22±5.16) than in the control group (-7.79±7.04) (t=8.02, p<.001) (Table 4).

Discussion

This study aimed to evaluate the effectiveness of a sarcopenia prevention and intervention program for older adults based on the Information-Motivation-Behavioral Skills (IMB) model developed by Fisher and Fisher [25]. The program's primary focus was to improve muscle mass, muscle strength, physical performance, and sarcopenia-related quality of life. Results indicated that while there were no statistically significant differences in muscle mass and strength between the experimental and control groups, the experimental group showed a higher likelihood of improvement. This finding differs from prior studies, such as those by Liao et al. [37] and Simao et al. [39], which reported significant increases in muscle mass and strength. One potential reason for this discrepancy is that most participants in this study had baseline muscle mass and strength above the sarcopenia threshold, which may have limited the potential for measurable gains. Future studies might benefit from stratifying participants by baseline sarcopenia risk to explore differential impacts. Additionally, the difference in muscle strength

measurement methods could have influenced the outcomes, as this study used handgrip strength, following AWGS guidelines, while other studies often measure knee flexion and extension strength. Such variability highlights the importance of standardizing assessment tools across sarcopenia research to enhance comparability of results.

Another significant outcome was the improvement in sarcopenia-related quality of life within the experimental group, aligning with Oh [46] and other international studies that showed enhanced quality of life in sarcopenia interventions involving physical exercise and nutritional education. These findings underscore the potential of multi-component interventions to improve both the physical and psychosocial well-being of older adults. Given the aging population's increasing size, the implications of these findings for public health policy are substantial. Programs like the one tested in this study can be integral to national health and welfare strategies for supporting aging populations, especially in societies with rising rates of age-related health issues.

The IMB model's core components—information, motivation, and behavioral skills—were effectively utilized throughout the intervention, supporting participants' engagement and sustained behavior changes. Information on sarcopenia and related lifestyle modifications was provided through audiovisual resources, which were tailored to enhance participants' understanding of sarcopenia's impact and preventive strategies. Motivational strategies, including goal setting and individualized counseling, were applied to foster participants' commitment to health behavior changes. Behavioral skills were developed through structured self-management exercises, with an emphasis on regular physical activity and improved dietary intake. By incorporating meal logs, dietary planning, and feedback on protein and vitamin D intake, the program promoted self-efficacy and self-management, aligning with findings from studies emphasizing these factors for sustained health behavior change [33,34].

Strengths and limitations

While this study contributes valuable insights into sarcopenia prevention and management for older adults, several limitations should be acknowledged. First, the study's quasi-experimental design, using a convenience sample, may limit the generalizability of the findings. Participants were drawn from two senior welfare centers, which may not represent the broader older adult population, particularly those in different regions or healthcare settings. Future studies should consider a randomized controlled trial design with a more diverse sample to enhance generalizability. Second, the study duration was relatively short at six weeks, with sessions held twice weekly. While this frequency demonstrated benefits in physical performance and quality of life, a longer intervention period may yield greater improvements in muscle mass and strength. Extending the intervention duration or increasing session frequency could provide more substantial results, particularly for muscle-related outcomes. Additionally, the lack of long-term follow-up limits the understanding of the program's sustainability. Future research should include follow-up assessments to determine if the observed improvements are maintained over time. Third, the study relied on handgrip strength as a measure of muscle strength, consistent with AWGS guidelines, but it may not capture all aspects of functional muscle capacity. Future studies might consider incorporating

multiple strength measurements, such as knee flexion and extension, to provide a more comprehensive evaluation of muscle strength and function in older adults. Finally, the study did not assess participants' adherence to the dietary component outside of the intervention sessions. While participants were encouraged to log and adjust their diets, actual adherence to protein and vitamin D intake recommendations was not monitored consistently. This lack of adherence tracking may have impacted the results, particularly regarding muscle mass improvements. Incorporating more robust dietary adherence monitoring in future studies could provide a clearer understanding of the role of nutritional intake in sarcopenia prevention.

Conclusions

This study confirmed that a sarcopenia prevention and intervention program based on the IMB model can improve physical performance and sarcopenia-related quality of life among older adults. These results suggest that IMB model-based programs are viable and effective interventions for sarcopenia management, helping older adults to adopt sustainable physical and dietary health behaviors. Given the improvements in physical performance and quality of life, such programs represent a promising approach for addressing sarcopenia in an aging population and could play a key role in national health promotion and welfare policies.

However, to address the study's limitations, future research should use a randomized controlled design with a larger and more diverse sample, an extended intervention duration, and more comprehensive outcome measures. Including long-term follow-up assessments and adherence monitoring can help refine the intervention's design and provide insights into its sustainability and impact on sarcopenia prevention. Through these enhancements, future studies can contribute to establishing effective, evidence-based sarcopenia management programs that support the health and well-being of older adults on a larger scale.

Declarations

Author Contributions: Y.J.K. and G.K.; methodology, Y.J.K.; formal analysis, G.K.; data curation, Y. J.K .and G.K.; writing-original draft preparation, G.K.; writing-review and editing. All authors have read and agreed to the published version of the manuscript.

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Data Availability Statement: The data presented in this study are available on request from the corresponding author. The data are not publicly available due to privacy issues.

Ethical approval and consent to participate: This study was conducted according to the guidelines of the Declaration of Helsinki, and approved by the Ethics Committee of the University of Keimyung (IRB No: 40525-202002-HR-089-03). Informed consent was obtained from all subjects involved in the study.

Clinical trial number: not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

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Tables

Tables 1 to 4 are available in the Supplementary Files section.

Figures

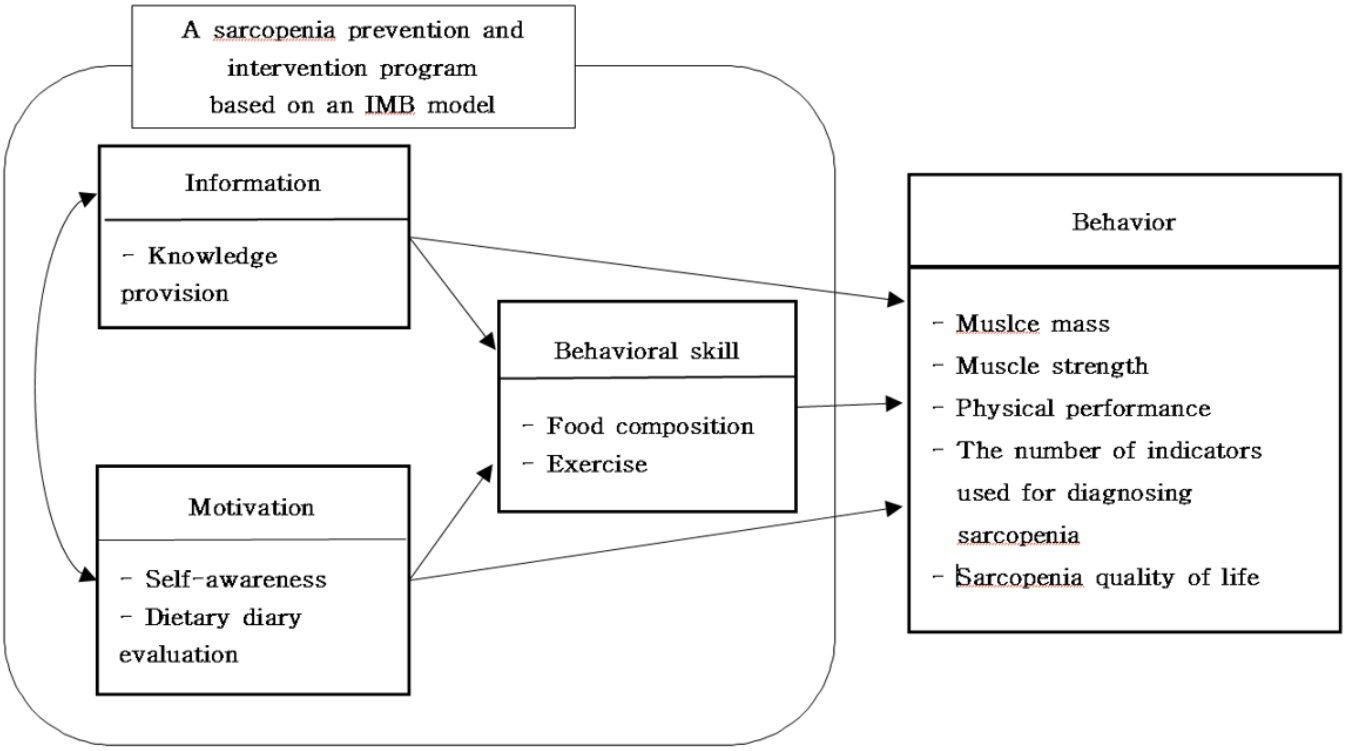


Figure 1

Conceptual framework of this study

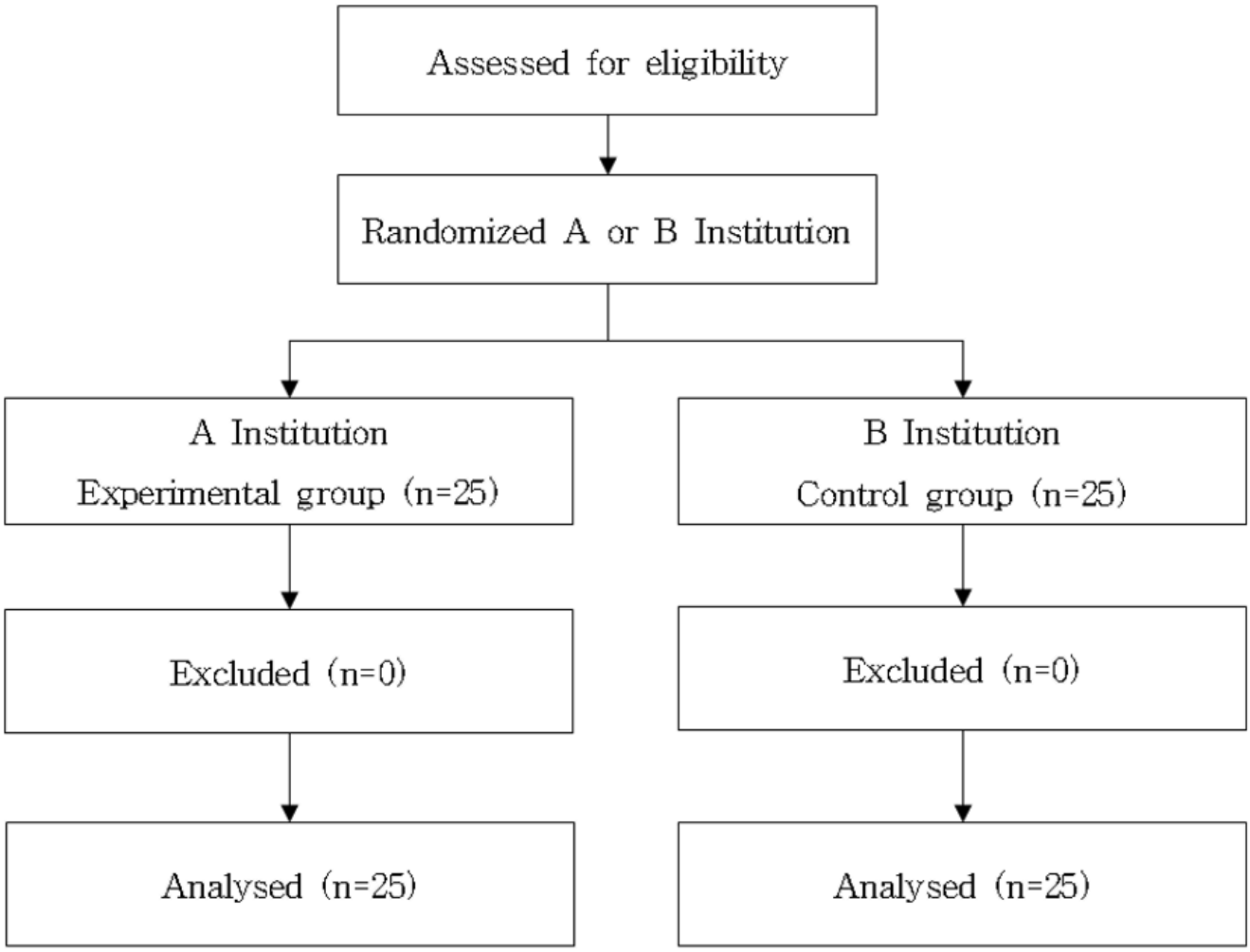


Figure 2

Flow of participants through the trial

Supplementary Files

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