

## Original Research



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# Development of a frailty prevention program including nutrition and exercise interventions for older adults in senior daycare centers in South Korea using a mixed methods research design

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## ABSTRACT

**BACKGROUND/OBJECTIVES:** The growing aging population has led to an increased utilization of senior daycare centers. This study was conducted to design a program to enhance the health of older adults in senior daycare centers in Chuncheon City, South Korea.

**SUBJECTS/METHODS:** The study explored the health conditions and dietary patterns of older adults in senior daycare centers. Participants included staff and older adults from senior daycare centers in Chuncheon City. A mixed methods research design was used to obtain both qualitative and quantitative data. Qualitative insights were obtained through in-depth interviews with 26 staff members and older adults, coupled with observations made at 10 senior daycare centers. The quantitative component comprised structured questionnaires and physical measurements of 204 older adults at these centers.

**RESULTS:** Many of the older adults relied on the meals provided by the center due to their limited cooking abilities. Dental health issues and dysphagia were common. Interviews highlighted the budgetary constraints of the centers in providing wholesome meals and the need for government support to alleviate meal expenses and enhance quality. A structured survey of older adults showed that the average age was 83.3 yrs, with an average of 2 chronic conditions per participant. Frailty analysis of the participants revealed that 56.2% were prefrail and 32.0% were frail. Almost half of the participants (47.0%) used dentures. Based on these findings, a preventive intervention program was proposed, addressing the specific needs and challenges of older adults while promoting overall well-being and preventing frailty.

**CONCLUSION:** Tailored health promotion strategies are crucial in senior daycare centers. Recommended interventions include staff nutrition education, improved dietary plans, and cost-effective strength training programs. These interventions aim to reduce frailty and enhance the quality of life of older adults in the community via interventions in daycare centers.

**Keywords:** Long-term care; aged; frailty; qualitative research; survey

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### Conflict of Interest

The authors declare no potential conflicts of interests.

### Author Contributions

Conceptualization: Park S, Lim J; Formal analysis: Park S, Sim J; Funding acquisition: Park S; Investigation: Sim J, Ko E, Jang E, Jeong M, Lim J; Methodology: Park S, Sim J; Supervision: Park S; Writing - original draft: Sim J; Writing - review & editing: Park S, Lim J, Ko E, Jang E, Jeong M.

## INTRODUCTION

With aging rapidly accelerating, the concept of healthy life expectancy becomes increasingly significant. Healthy life expectancy refers to the period during which an individual can live a healthy life without disease-induced disabilities or restrictions [1]. Extending the healthy life expectancy of older adults and enabling them to comfortably age in a familiar environment is a concept known as ‘aging in place’ (AIP) [2,3]. Prolonging healthy life expectancy through AIP not only enhances the quality of life of older adults but also reduces healthcare requirements, thereby lowering national healthcare expenditure [3,4].

To achieve AIP within the local community, one of the current policies is the establishment of senior daycare centers. These centers, often referred to as “older adult kindergartens,” offer services such as meals, health management, and cognitive and rehabilitation programs for older adults in the community from morning to evening. Older adults attending these daycare centers often suffer from multiple chronic conditions, such as metabolic disorders and dementia, necessitating proactive and systematic healthcare interventions. Inadequate healthcare may exacerbate the progression of frailty and associated adverse outcomes [5].

Frailty manifests as diminished physiological reserve and declining physical function with age, heightening susceptibility to health issues among older adults [6]. Notably, nutritional status significantly influences frailty, with ample evidence indicating that the adequate intake of protein-source foods, such as meat and dairy, mitigates its onset [7]. Studies investigating the impact of dietary protein on muscle mass have underscored its role in countering age-related decline and preventing frailty [8]. Reduced physical function and activity levels are key contributors to the onset of frailty in older adults. Prior research also emphasizes the importance of physical activity in delaying frailty and addressing sarcopenia, a common precursor [9,10]. Moreover, randomized controlled trials targeting frail older adults have highlighted the efficacy of exercise interventions in improving frailty [11]. Given the cyclical nature of frailty, whereby declining nutritional status and physical function exacerbate its progression [12], specialized intervention programs are imperative to prevent rapid deterioration [12-14].

There is a significant gap in research targeting the users of senior daycare centers, on the benefits of health promotion programs involving both nutrition and exercise components to prevent the progression of frailty. Those who use senior daycare centers reside in their own homes and maintain a certain level of daily living activities, rendering them a pivotal group for preventing hospitalization and promoting AIP. Given the need to enhance the quality of life of older adults and to address national healthcare expenditure as the larger goal, the objectives of this study were as follows: 1) To evaluate the operations of senior daycare centers in Chuncheon City, 2) To assess the health and nutritional status of the older adults in these centers, and 3) To provide data for the development of a health promotion program focused on nutrition and exercise.

## SUBJECTS AND METHODS

### Study design

This study employed a mixed methods research design, combining qualitative and quantitative data collection methods. The qualitative research aimed to understand the perspectives of older adults and staff in the senior daycare centers, capturing their needs, experiences, opinions,

and emotions through in-depth interviews. Since not many studies have documented the physical conditions and health services provided at senior daycare centers in Korea in detail, we conducted visits and reported our observations to fill this gap. Additionally, quantitative data collection methods, such as surveys and physical measurements, were used to explore the key characteristics of older adults. These qualitative and quantitative data were used to design health promotion programs for older adults in senior daycare centers in Korea. The specific research methods employed are outlined below. This study was approved by the Institutional Review Board of Hallym University (HIRB-2022-021-2-RR).

### Qualitative components of data collection

#### *Study duration and participants*

The qualitative research phase was conducted at senior daycare centers in Chuncheon City from April 2022 to June 2022. Among a total of 30 senior daycare centers listed by the Chuncheon City Hall, a sample comprising 10 centers was selected using convenience sampling for both interviews and observations. The number of participants selected at each center varied from 1 to 4 individuals, depending on their willingness and availability. For interviews involving staff members, participants were chosen to include individuals from diverse occupations. Older adults from the centers were recruited for interviews based on their communication capability. Those with severe impairments in physical or cognitive functions were excluded from the recruitment. Two trained researchers conducted the interviews after obtaining written informed consent from each participant.

#### *Data collection*

##### 1) Interviews

The interviews lasting approximately 10–40 min per session were conducted at the senior daycare centers, either as one-on-one interviews or two-on-one interviews with one researcher and 2 participants. Before commencing the interviews, participants were provided with an explanation of the research process and objectives. Informed consent was obtained with respect to research participation and personal information, and the interviews were recorded. Interviews with staff members covered topics such as their daily work routines, challenges faced in their roles, career history, and overall characteristics of the older adults using the center. Interviews with older adults addressed subjects including their daily routines, health status, experiences with falls, meal consumption, difficulties in daily life, and satisfaction or dissatisfaction with aspects related to life at the center (**Table 1**).

A total of 26 individuals were recruited for the interviews, including 18 senior daycare center employees and 8 senior adults using the daycare center. Among the employee participants, 16 (88.9%) were female. The employee roles included 2 dietitians (11.1%), 1 cook (5.6%), 1 care worker (5.6%), 3 nurses (16.7%), 1 nursing assistant (5.6%), 4 center managers (22.2%), 1 office worker (5.6%), and 5 social workers (27.8%) (**Table 2**).

##### 2) Observations

Observations were conducted to supplement the data collected from the interviews. This was done to verify the interview data, thereby performing data triangulation, which is often a part of qualitative research and can result in complementary data. Conducting interviews and supplementing the data through observations proved to be helpful in familiarizing researchers with the issues and challenges, especially because the existing academic literature on daycare centers for older adults in Korea is very limited. For instance, it was noted that snacks with high-sugar content were provided even though they were not listed on the menu,

**Table 1.** List of questions for the interviews conducted for daycare center staff and older adults

Participants	Questions
Staff	<ol style="list-style-type: none"> <li>1. What is your daily routine?</li> <li>2. What is your main job?</li> <li>3. What do you care about the most while working?</li> <li>4. What are the recent health-related issues among the older adults using the center?</li> <li>5. How do you anticipate the direction of the government’s support for the daycare center will change or how would you like it to change in the near future?</li> <li>6. (For the nutrition specialist) What factors do you consider when planning the meals?</li> <li>7. In the operation of the center, what do you think is the weakest aspect in running the center?</li> </ol>
Older adults	<ol style="list-style-type: none"> <li>1. What is your daily routine?</li> <li>2. Whom do you live with?</li> <li>3. What is the reason for coming to the center?</li> <li>4. Are there any specific behaviors you engage in or refrain from for health management?</li> <li>5. Do you have any chronic diseases?</li> <li>6. What do you think about the meals, exercise, and other programs provided by the center?</li> <li>7. How do you eat meals other than those served at the center?</li> <li>8. Do you have any special foods that you try to eat or try not to eat?</li> <li>9. What do you think is a healthy eating habit and a healthy life?</li> <li>10. What kind of help do you want to get from the center in order to maintain your well-being?</li> </ol>

**Table 2.** General characteristics of the interviewees

Participants	Variables	Values
Senior daycare center staff	Sex	
	Male	2 (11.1)
	Female	16 (88.9)
	Total	18 (100.0)
	Job title	
	Dietitian	2 (11.1)
	Cook	1 (5.6)
	Care worker	1 (5.6)
	Nurse	3 (16.7)
	Nursing assistant	1 (5.6)
	Center manager	4 (22.2)
	Office worker	1 (5.6)
	Social worker	5 (27.8)
Total	18 (100.0)	
Older adults in senior daycare centers	Sex	
	Male	4 (50.0)
	Female	4 (50.0)
	Total	8 (100.0)
	Age (yrs)	
	Mean ± SD	80.6 ± 3.8
	65–80	3 (37.5)
	≥ 81	5 (62.5)
	Total	8 (100.0)
	Living arrangement	
	Living alone	5 (62.5)
Living with others	3 (37.5)	
Total	8 (100.0)	

Values are number (%) or mean ± SD.

and it was observed that there was a lack of guidelines and educational tools for cognitive and exercise programs, thereby posing challenges. Data collection involved carrying out comprehensive observations of the center’s facilities, programs provided, the daily routines of the older adults, meal preparation and tasting of the served meals, and observing cognitive and exercise sessions during the visits.

### *Data analysis*

Audio recordings of the interviews with participants were transcribed verbatim and documented in text format. The information gathered through observations was recorded on-site, both in the form of photographs and written notes. Subsequently, each data set was categorized by theme, and the content was detailed in a document format. Based on this, the common characteristics of the centers were identified. Documented data were then subjected to Framework Analysis using Microsoft Excel (Microsoft Corporation, Redmond, WA, USA).

## **Quantitative components of data collection**

### *Study duration and participants*

The quantitative research study was conducted in June 2022 at senior daycare centers in Chuncheon City. In line with the qualitative research sample, out of the 30 senior daycare centers identified by Chuncheon City Hall, 12 expressed interests in participating in the study. From these, 10 centers were selected through a random drawing of lots, conducted in the presence of staff from all 12 centers. These 10 centers participated in the quantitative study, which served as a baseline survey for future interventions. The study invited a total of 630 seniors from these centers to evaluate their eligibility for participation. Selection criteria were established in accordance with the study's objectives, requiring a willingness to participate, being 65 yrs or older, being able to communicate well, being physically active, and attending the center regularly for at least 3 days a week. Out of those invited, 420 individuals (approximately 66.7%) did not meet these criteria, and an additional 6 (1.0%) chose not to participate. Consequently, 204 participants (32.4%) qualified and were included in the survey, representing a sample coverage of approximately 32.4%.

### *Data collection*

For the quantitative research study, the body mass index (BMI) of the participants was calculated, and toe strength was measured. A survey was conducted which examined the participants general characteristics, presence or absence of chronic diseases, dental status, nutrition quotient (NQ) [15], care level, and the frailty scale. The care level is a numerical rating given by the government to seniors requiring care and is divided into 6 levels, with lower numbers indicating poorer health. The frailty level of the older adults was measured using a Korean translation of the original FRAIL scale (which includes 5 questions to assess fatigue, resistance, aerobic capacity, illnesses, and loss of weight) originally developed by Morley *et al.* [16]. In this questionnaire, a score of 0 is considered robust, a score of 1–2 indicates a prefrail status and 3–5 classifies the individual as frail. Many older adults in the senior daycare center faced difficulties in reading and writing. Therefore, the survey was carried out in an interview format, with researchers reading the questions and recording the responses.

BMI was calculated using the height data provided by the center and the weight measurements were taken with a portable scale (Inbody H20B; InBody Co. Ltd, Seoul, Korea), applying the formula (weight [kg]/height [m]<sup>2</sup>). The BMI classification was as follows: Underweight: BMI of less than 18.5, Normal: BMI between 18.5 and 22.9, Overweight: BMI between 23.0 and 24.9, and Obese: BMI of 25.0 or higher [17]. The measurement of toe strength was conducted to assess the surrogate of lower limb strength of the elderly. A T.K.3362 toe grip dynamometer (Takei Scientific Instruments, Niigata, Japan) was used to measure the toe strength. This tool was validated in previous studies wherein a correlation between toe strength and walking ability was established [18–21]. The quantitative research data was collected to develop an intervention program and evaluate its effectiveness.

### *Data analysis*

All the data measured through quantitative research were analyzed using the Stata17.0 software (StataCorp LLC, College Station, TX, USA). Descriptive statistics were used to analyze and calculate data counts, means, SDs, and other statistics for continuous variables.

## RESULTS

### **Findings from interviews and observations**

#### *Health and cognitive status of older adults in senior daycare center*

Compared to previous studies targeting older adults, the age of the older adults using the senior daycare centers in this study was considerably higher [22]. Consequently, these older adults had impaired cognitive function and physical abilities. The centers had structured their programs, taking these factors into account. Some of the responses of the participants on cognitive function and physical abilities are mentioned below:

“On the way to catch the bus, I must rest several times, and it's challenging for me to walk. So, even though they say you have to keep practicing walking with Parkinson's disease, I can hardly walk.” (Senior daycare center user, female)

“...you can't demand things like education from the older adults because they tend to forget quickly (laughs).” (Senior daycare center social worker)

“Now, we don't expect significant improvements through educational programs. ... (omission) ... The goal is to maintain cognitive levels. ... It is not like they'll improve dramatically, but if they continue consistently, it helps maintain their health.” (Senior daycare center social worker)

#### *Nutritional problems and meal skipping among older adults in senior daycare centers*

Most older adults in senior daycare centers relied totally on the meals provided by the center through the day and did not engage in cooking activities after returning home. For older adults living alone, there were instances when they skipped nearly 3 meals on the days when they did not visit the center. Some staff mentioned that the older adults appeared even more frail on Mondays, indicating potential challenges related to food intake outside the centers. Some of the responses of the participants on food intake are mentioned below:

“Some older adults are in good condition throughout the week, but on Sundays, when the center is closed, they don't eat anything at home. So, when Monday comes, they come in completely exhausted, with no energy at all.” (Senior daycare center nurse)

“When I'm at home, I don't eat at all. And I have dementia, so I almost caused a fire once.” (Senior daycare center user, female)

“They provide meals here. But when I'm at home, I often forget and don't eat.” (Senior daycare center user, female)

#### *Dysphagia and dental health issues among older adults in senior daycare centers*

Furthermore, older adults using daycare centers experienced deterioration of muscle and nerve function related to swallowing due to aging, and many of them had dental health issues.



Sometimes this resulted in dysphagia. Dysphagia is a disorder characterized by difficulty in chewing and swallowing food due to anatomical or physiological abnormalities in the oral, esophageal, pharyngeal, or laryngeal regions [23]. During the observation period at the center, there were instances when some of the older adults continued to cough during meals. Some of the responses of the participants to the challenges posed by dysphagia are mentioned below:

“While eating, some of the older adults experienced instances where food didn't pass through the esophagus and blocked the airway. Due to the poor condition of their teeth, they had difficulty with chewing, but they still had a desire to eat. They would hastily try to eat, which sometimes led to airway obstruction, causing them to lose consciousness, and we had to call 119 for emergency assistance.” (Senior daycare center nurse)

“Older adults here tend to have frequent diarrhea. Since they have difficulty in chewing, digestion isn't very efficient. So, they experience diarrhea more often than constipation.” (Senior daycare center nurse)

The center emphasized providing meals with appropriate protein content and easy chewing for older adults, considering their nutrition and dental health.

“Those with stomach issues or poor dental health, we chop the food finely so they can eat it comfortably, and we also prepare porridge. ... (omitted) ... The older adults here often have dental problems. We pay a lot of attention to that.” (Senior daycare center social worker)

However, it was observed that while finely chopped meals were prepared for seniors with dental issues to facilitate easier eating, the management of dysphagia was found to be inadequate and there is much room for improvement in this area.

#### *Food costs and nutritional considerations in planning meals at senior daycare centers*

Interviews revealed that the staff involved in the food service operations at senior daycare centers understood the importance of adequate protein content in the meals served at the centers.

“And every day, they need to eat protein-rich foods like beef, pork, fish, and so on, to prevent nutritional imbalance. We are constantly mindful of this and make sure they are included in their daily diet.” (Senior daycare center dietitians)

“We ensure that the diet always includes protein so that there is no nutritional deficiency.” (Senior daycare center social worker)

However, they experienced challenges due to the inadequate budget allocated for meal service operations. Many daycare centers were primarily funded by the government, but meal expenses were entirely borne by the older adults. Most daycare centers provided one meal and 2 snacks a day at a cost ranging from 3,500 to 4,500 KRW per day. Due to the low meal cost, there were limitations in providing high-quality meals, including adequate protein, and this was a common concern expressed by the participants.

“I want to prepare high-quality dishes, but that's the biggest problem. When we ask the older adults to pay more for better foods, no one would like that.” (Senior daycare center manager)

“With the amount that the users pay, we can't fully cover the meal expenses. Honestly, how can we provide rice, soup, four side dishes, and snacks for just 3,500 KRW per day?” (Senior daycare center manager)

In numerous instances, when the expenses associated with food ingredients were elevated, establishments frequently found themselves compelled to reallocate meal expenditures from other operational budgets. Moreover, the imposition of increased costs on individual users often correlated with dissatisfaction among them and their families. The imperative to consistently recruit new users to the centers poses a significant challenge. Consequently, despite the availability of dietary plans on local health center websites, adherence to these plans is not always easy. In smaller centers, managers often undertook personal visits to local traditional markets 2–3 times weekly to procure seasonal ingredients in bulk. This proactive approach enabled them to creatively integrate these ingredients into diverse menus, thereby enhancing meal quality within the constraints of their limited budgets.

Furthermore, comprehensive educational sessions on meal planning and preparation are lacking. Given that many smaller-scale centers lack dietitians and staff members with formal nutrition training, the task of devising nutritionally balanced meals with appropriate textures for the elderly remains challenging.

#### *Support needs of senior daycare centers and suggested policies*

Based on interviews conducted with daycare center staff, several policy support needs were identified, yielding the following results: First, there was a recommendation for support aimed at furnishing nutritious meals and snacks. As previously noted, there exists a systemic challenge in augmenting meal expenses for the elderly, notwithstanding the crucial significance of quality meals for them. Given the substantial difficulty in providing nutritionally sufficient and physiologically appropriate meals for seniors in daycare centers within the confines of user-contributed resources, the provision of governmental assistance for meal expenses was strongly advocated. Interviewees highlighted the potential of governmental subsidies akin to those provided through the national healthcare system in Korea for hospitalized patients, suggesting that a similar support system could significantly enhance meal quality.

Second, there was a demand for support in the form of exercise equipment and teaching materials, along with guidelines for programs tailored to older adults. Offering detailed directions on how to deliver exercise programs to encourage such activities at the centers.

“We were provided with rubber bands that are used for exercise. So, the older adults found them very useful during their gymnastics sessions.” (Senior daycare center manager)

“We need to establish a basic system and create a curriculum that aligns with it so that we can conduct programs accordingly.” (Senior daycare center manager)

Third, the participants mentioned support for nursing services. Due to the nature of daycare centers, medical services are in high demand, and there is a strong focus on disease prevention, especially in light of the coronavirus disease-2019 (COVID-19) pandemic. Consequently, demands for medical and nursing services support were identified.



“Nowadays, you must go get vaccines like COVID-19 or flu shots. For COVID-19 vaccines, you must go to the local clinic, and even going there carries a risk of infection. So, I thought it would be nice if medical personnel could come from the health center and do it for us.” (Senior daycare center nurse)

#### *Major findings from observations*

Along with the interviews, the series of observations at the centers provided valuable insights about the daycare centers. The capacity of these centers ranged from 20 to over 50 individuals, showing a significant diversity in size. Most centers accommodated fewer than 50 people and did not have a dietitian. Instead, center directors and cooks were often responsible for meal operations. While the size of the centers varied depending on their capacity, most facilities were commonly equipped with senior restrooms, bathing facilities, exercise equipment, dining areas, and staff offices. Cognitive enhancing and physical activity programs that the older adults could participate in were conducted daily. Most of the program coordination was handled by the center’s staff, although occasionally, external instructors were invited to lead programs. During the visit, we observed that a variety of exercise sessions were being conducted and were led by caregivers or social workers at the centers. Primarily, screens displayed exercise videos from YouTube, with some seniors following along. However, due to limited personnel, seniors with restricted physical abilities and mobility were unable to actively participate in the sessions and were often left out.

Meals provided to the seniors at the daycare centers generally comprised rice, soup, and side dishes, but the quality varied across centers. Certain centers provided meals rich in nutrients, incorporating meat and leafy vegetables, while others primarily offered side dishes consisting of pickled vegetables. In some instances, despite the high meal quality, portion sizes were inadequate. Notably, some newly established centers regularly posted meal photos on their websites for promotional purposes. Regarding snacks, the afternoon options mainly comprised packaged processed foods with high sugar content, such as Choco pies, or fruit-flavored yogurts. Occasionally, morning snacks consisted of porridges or thick-grain tea, such as *yulmoo-cha*.

#### **Findings from surveys and measurements**

Quantitative research data were collected from 204 users in 10 daycare centers. The average age of the survey participants was 83.3 yrs, with 43.1% (n = 88) being late older adults aged 85 yrs and above. Among the participants, 70.6% (n = 144) were female, and 30.9% (n = 63) were living alone. The analysis demonstrated that 37.3% (n = 75) of the participants were obese, 19.4% (n = 39) were overweight, 35.3% (n = 71) were of normal weight, and 8.0% (n = 16) were underweight among 201 participants who provided weight and height data. The care level, which indicates lower health when the number is lower, was most prevalent at level 3–4, accounting for 63.2% (n = 129) of older adults, followed by level 5–6 at 32.8% (n = 67), and level 1–2 at 3.9% (n = 8). On average, the participants had 2 chronic diseases and took 4.6 medications daily. Additionally, 47% (n = 79) of the participants used dentures, and 27.4% (n = 46) reported experiencing pain when chewing food. The frailty scale analysis indicated that 56.2% (n = 86) of participants were categorized as prefrail, while 32.0% (n = 49) were classified as frail. Toe strength measurements were derived from both left and right foot assessments, with an average of 3.6 kg (**Supplementary Table 1**).

#### **Developing frailty prevention programs for daycare centers**

The results of the mixed methods research used here revealed that most of the participants were categorized as prefrail (56.2%) and frail (32.0%), most of them relied on the food

served at the centers, and there was a high prevalence of dental problems and chewing function issues. Additionally, most of the older adults could perform only limited physical functions with inadequate resources available for tailored exercise programs at the centers. Consequently, this study aimed to improve health-related issues identified in older adults at senior daycare centers through nutritional and exercise interventions, with the goal of preventing frailty in this population. Data was collected through mixed methods research design to develop a preventive intervention program for senior daycare centers. Based on the analyzed content, a health promotion program was developed, including 3 nutritional interventions and one exercise intervention (Table 3).

### Components of the suggested nutrition intervention programs

The first intervention involved designing a nutrition education program targeting the staff of centers for older adults. Many of the older adults using these centers often did not prepare their meals at home, and due to cognitive impairments, they were not capable of receiving education on nutrition. Taking these constraints into consideration, the senior daycare center employees were selected as the target audience for nutrition education. It was observed that center staff played a significant role in the meals for the older adults and had a direct impact on their nutritional status. Furthermore, in most senior daycare centers, meal services were operated by personnel without the necessary qualifications required to handle nutrition and cooking. Based on this analysis, the senior daycare center employees were confirmed as the target for nutrition education, and a nutrition education program was developed, which included theoretical lectures and training in practical cooking techniques to ensure better nutrition for older adults.

The second intervention proposed involved providing nutritional protein supplements to older adults using the daycare center. The primary rationale for incorporating liquid protein supplements is multifaceted. First, many older adults attending daycare centers face dietary restrictions stemming from tooth loss, chewing discomfort, and diminished swallowing capacity due to aging. Consequently, their ability to consume adequate protein through solid sources is often compromised. Second, operational constraints, including low meal prices and personnel shortages for meal preparation, hinder the possibility of enhancing the quality of the meals. Given the limited preparation time, offering additional protein-rich dishes becomes challenging. Third, the predominant provision of sweets or carbohydrate-rich beverages as snacks further underscores the need for protein supplementation. Considering

**Table 3.** Summary of the interview results and suggested intervention components

Variables	Main issues regarding meal service and physical activity	Major intervention components
Nutrition	<p>Meal preparation</p> <ul style="list-style-type: none"> <li>Limited meal budget (2,500–3,500 KRW per day)</li> <li>No dietitian on site: Since the majority of centers have fewer than 50 seniors, there is no obligation to employ a dietitian</li> <li>Absence of nutrition and health education for employees</li> <li>Difficulty in providing quality meals</li> </ul> <p>User characteristics</p> <ul style="list-style-type: none"> <li>Having difficulty eating own meals</li> <li>Experiencing difficulty in chewing and swallowing due to aging</li> <li>Having an average of 2 chronic diseases</li> </ul>	<ul style="list-style-type: none"> <li>Provision of nutrition and health education for center directors, social workers, and all care workers</li> <li>Improving snack quality through the provision of protein beverages</li> <li>Providing posters and graphics with dietary guidelines for seniors with chronic diseases</li> </ul>
Physical activity	<p>User characteristics</p> <ul style="list-style-type: none"> <li>Decline in physical function due to aging and chronic diseases</li> <li>Discomfort in movement and increased risk of falls</li> <li>High demand for health programs due to COVID-19</li> <li>Lower level of toe strength</li> </ul>	<ul style="list-style-type: none"> <li>Provision of exercise program with personnel support and instruction videos</li> </ul>

KRW, Korean Won; COVID-19, coronavirus disease-2019.

these factors, integrating protein supplements into the snacks emerged as a viable solution to augment the protein intake of older adults at daycare centers.

Fourth, based on the results of the mixed methods research, the majority of seniors in the daycare centers had chronic diseases. Moreover, there was often a shortage of experts for conducting nutrition education for both staff and older adults, and there was a demand for updated and comprehensible educational materials for use by the staff and the seniors. In response to this, we aimed to provide nutrition guideline posters and news in graphic format for senior daycare centers. The posters could include basic information about dietary guidelines and recommended hydration for older adults presented through simple graphics and minimal text. The news in the graphic format aimed at the center staff and the older adults could focus on nutrition guidelines for seniors with chronic diseases and could be regularly delivered to center staff. The posters and the news items could be displayed in the senior daycare centers where users spend most of their time, bringing about an educational impact naturally.

### Exercise intervention components

In quantitative research, toe strength was measured, and the average result was found to be 3.6 kg. This is significantly lower compared to a previous study in Japan, which recorded an average toe strength of 10.4 kg for men in their 70s and 7.3 kg for women of the same age group. This comparison indicates a considerably lower level of toe strength among our study participants [24]. Accordingly, as part of the exercise intervention, a toe exercise program was developed to promote leg strength and prevent future falls, accommodating the elderly who may have mobility challenges during conventional exercises. The necessary equipment and guidelines for toe muscle exercises were devised based on the demands of daycare center staff, with the highest demand being for program guidelines and the provision of useful materials. The program was designed to enable self-directed and ongoing activities, eliminating the need for additional budget allocation at the center.

## DISCUSSION

This study was conducted as preliminary research for developing a health promotion program aimed at preventing frailty in older adults for use in daycare centers. To develop the intervention program, we sought to understand the overall operations of the daycare centers and the dietary habits, nutrition, health status, and lifestyle of the older adults using the centers. To achieve this, a mixed methods research design approach combining qualitative and quantitative research methods was employed.

The research results revealed that the average age of older adults in daycare centers is very high, with a high proportion of females and a significant number of older adults living alone. Through in-depth interviews, it was confirmed that older adults living alone faced a high risk of nutritional inadequacy due to social isolation with limited interaction with family or acquaintances, resulting in a lack of nutritionally balanced meals. Additionally, economic constraints often restricted their ability to have nutritious meals regularly, and physical changes could lead to difficulties in meal preparation and cognitive disabilities may result in forgetting mealtimes. These findings align with previous research that analyzed the nutritional status and living environment of older adults living alone, indicating that their nutrition tends to be poorer compared to those living with a spouse or partner [25-28].

Furthermore, the average nutritional status score of seniors in the daycare centers, as assessed by the Nutrition Quotient for the Elderly (NQ-E) index, was 50.1 points (not presented as a result). This score is approximately 10 points lower than the average score from a previous study that measured the NQ-E index among community-dwelling older adults in certain areas of Seoul, South Korea [29], suggesting that the nutritional status of older adults in daycare centers is not at an optimal level when compared to those who do not use daycare centers. This is also a reflection of their overall health status. Older adults using daycare centers generally suffer from complex chronic diseases, leading to the use of a significant number of medications. Previous research analyzing the relationship between medication intake and nutritional status in older adults with chronic illnesses indicated that chronic diseases and the resulting high medication use can have a negative impact on nutrient absorption and utilization in older adults, potentially leading to malnutrition and frailty [26,30].

In addition, dental health was found to be poor, with nearly half of the daycare center participants using dentures. As a result, they experienced discomfort while chewing food and had difficulties swallowing [31,32]. Also, there is reduction in saliva due to aging and a decline in the function of the muscles and nerve cells involved in swallowing can lead to swallowing difficulties, including dysphagia, in severe cases [33,34]. All the above factors have a significant impact on the nutritional status of older adults.

The health issues of the older adults in daycare centers are closely linked to their nutritional and physical functional status. Therefore, it is important to combine dietary and exercise interventions for them. Although previous intervention studies involving older adults were not specifically targeted at users of daycare centers, they have demonstrated the effectiveness of increasing muscle strength. In an earlier study that involved older adults in a nutritional and exercise intervention program lasting for over 12 weeks, participants experienced an increase in muscle strength. Furthermore, the best results were observed when both nutritional and exercise interventions were conducted simultaneously, as opposed to either nutritional or exercise intervention alone [35-38]. Also, previous research wherein strength training was implemented for older adults at daycare centers has demonstrated increased lower limb strength, physical function, and self-efficacy in preventing falls among participants. This suggests that intervention programs can have positive effects even within the same demographic group as the subjects in this study [39-41]. These results underscore the importance of developing programs to enhance muscular strength in older adults at daycare centers and provide evidence of potential effectiveness. However, to date, no studies have reported the development of a comprehensive health promotion program incorporating both nutritional and exercise interventions specifically for older adults in daycare centers.

The role of daycare centers is crucial for allowing older adults with cognitive impairments to continue to live in their own homes and communities without the need for institutionalization. Daycare centers provide care services during the daytime, serving as the foundation for realizing AIP. With the acceleration in the aging population, there is a growing shift towards policies targeting groups rather than individual interventions for older adults [42], and the demand for older adult welfare facilities like daycare centers is therefore expected to increase [43].

There was a lack of a direct application of the quantitative research results to program development. When planning this study, it was believed that quantitative measures, such as the NQ or food intake frequency surveys, could be used to quantify protein intake. However, the

age of the subjects encountered in the data collection field was much higher than anticipated, and even if quantitative surveys were conducted through interviews with researchers, it was deemed that items requiring the cognitive judgment of the elderly did not have high reliability. Therefore, while simple items such as BMI, toe strength, living status, and dental condition could be used, it was difficult to utilize indicators requiring cognitive judgment in the analysis and program development. More reliable data were obtained through interviews with the subjects and the facility staff who shared details of their daily lives, as well as direct observation by researchers, leading to the description of the research results. We believe that future research targeting senior daycare centers can benefit from the findings of this study.

Proactively conducting health management for older adults in the community, and providing high-quality healthcare services, meals, and physical activity services, are important community resources for the aging population. Since standardized healthcare services for daycare centers have not been specified currently, developing and evaluating various intervention programs is essential. This study, conducted through interviews, facility observations, and surveys, can serve as foundational data for future intervention research and effectiveness evaluations. Consequently, this study is expected to contribute to improving the quality of life of older adults using daycare centers and supporting independent living in their own homes and communities.

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## SUPPLEMENTARY MATERIAL

### Supplementary Table 1

General characteristics of the survey participants

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