## Home-Training Smart Multi-Fitness Equipment on Senior Women

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## Abstract

This study analyzed three exercise programs using smart multi fitness equipment applied to female seniors. The study was conducted as a mixed study method and used health evaluation before and after application of the smart multi fitness equipment, in-depth interviews, participatory observation, and field notes for collecting data. The study participants were composed of four female seniors aged 65 or older. The study period was from December 2020 to May 2021. The results obtained from this study are as follows. First, there were results of quantitative research. As a result of analyzing the data with a matching sample t-test in using SPSS 25.0 program, it was identified that as the changes in the fitness evaluation before and after application of smart multi fitness equipment, the flexibility in right and left limbs and the right lower limb showed statistically significant differences (p<.05), and the flexibility in left lower limb and the muscle strength of lower limb also showed statistically significant differences (p<.01). Qualitative research was used for the analysis of the results. The participants of this study noted the Smart Multi Fitness Equipment as a suitable, effective and useful fitness equipment for the senior. And they evaluated the applied exercise programs as discriminatory programs with sufficient intensity and effect of exercise. In terms of appropriateness as a home training fitness equipment and program, (they mentioned that the individual's will to practice exercise is rather the most important factor. Nonetheless,) they assessed this equipment and related programs to be an attractive exercise device and programs which can be done alone at home, as long as they learn the right exercise method and their motivation persists.

Keywords: female senior, home training, home training equipment, chair based exercise, smart multi fitness equipment

## **1. INTRODUCTION**

According to the data analyzing and comparing the results of global population outlook released by UN in 2019 and Korean population status and outlook, Korea's ratio of the senior population aged 65 or older is expected to be the highest in the world from 14.9\$ in 2019 to 37.0% in 2045 [1]. The increase in average life expectancy is not a matter just about living a long life, but about how to spend as much as time as the extended life expectancy, so practical methods and institutional measures for a healthy life are discussed [2]. To address the importance of healthy aging in terms of human quality of life and the problems resulting from the increased medical expenditure for the seniors, an approach to seeking qualitative changes in the population is recently attempted [3]. The approach is evaluated as a meaningful trial in terms of extending health life expectancy where the standard of age is approached on the premise of the level of health until death, not just the senior group.

Because the decline in musculoskeletal functions due to aging decreases proportionally to age [4], The decrease of muscle mass and muscle strength can lead to loss of basic physical strength required for daily life and can increase the risk of injury due to instability in walking and decreased balance ability. It can be known that particularly, for female senior people whose average life expectancy are longer than male senior people are most vulnerable to weakening of physical functions due to aging, but rather show lower subjective health status than male senior people and have more chronic diseases [5][30]. The female seniors should pay more attention on their health care, and dramatic hormonal changes caused by menopause can also threaten their physical health. This is because the risk of falls increases due to vascular, motor nerve symptoms and decreased bone density. Besides, abdominal muscle strength weakened through the pregnancy and childbirth experience can

eventually affect the entire body with appearing as the symptoms of lumbar spine and pelvis bent back and back pain [6].

To prevent high blood pressure, diabetes, cerebrovascular disease, and chronic degenerative diseases and to increase health life, it is most important to participate in physical activities, that is, exercise to improve health. As the result of applying complex exercise composing of aerobic exercise, muscle strength exercise, flexibility, and balance exercise to middle-aged women, it was reported that the complex exercises positively influenced the middle-aged women's health self-efficacy and exercise continuality will, decreased body fat and increased skeletal muscle mass, thus the complex exercise for health management was effective in middle-aged women [7].

Physical activity can not only improve a senior's physical strength, but also delay functional restrictions related to aging, promote health aging [8], prevent chronic diseases and lower mortality [9]. Such that, for healthy life, it is essential to develop physical strength through physical exercise. Physical strength is a physical ability that is the basis for human life [10], and it can be divided into "health-related physical strength improving or keeping health through the improvement of immunity and the prevention from chronic diseases, and "functions-related physical strength exercise functions. The most important physical strength factors for a senior's daily life are muscle strength, flexibility, agility, and balance, and they are physical strength factors required for a healthy independent life [11].

Despite the importance of exercise for healthy old age is widely known, the seniors' exercise practice rate is not good. Some causes for low sports participation rate in the seniors can be found in the lack of conditions for the senior to naturally participate in sports with young people, and the insufficient sports facilities exclusively for the senior citizens. Among the seniors aged 70 or older in Korea, 32.2% of them do not use sports facilities at all, which is the highest compared to other generations, and the sports facilities for the senior citizens demands for gym use, their use rate of weight training fixtures was low compared to those of aerobic or free fitness equipment because of the weights of weight training fixtures, which makes it difficult for the senior to use them accurately [13]. In addition, as a result of survey researching the their demand and consumption characteristics of senior-friendly products [14], it was found that the seniors suggested complaints such as difficulty in using them differently according to their functions, difficulty in distinguishing them due to so many kinds of products, discomfort caused from not fitting perfectly with their bodies, and difficulty in using them by themselves.

With the recent increase in the number of people enjoying home training activities, relevant industries are also growing significantly [15]. This can be attributed to the characteristics of home training, which allows them to easily access exercise videos regardless of time and place, or the gaze of others [16], and the exercise method utilizing home training equipment and videos is suitably perceived as a non-face-to-face alternative measure due to COVID-19 [32]. Especially if senior people regularly, who are restricted from outdoor activities due to the risks of fine dust and falling on icy roads as well as COVID-19, practice exercises effectively at home, then the home training exercise can be a very desirable measure to improve the senior's health and quality of life. As seen in a recent study that verified the effectiveness of improving balance of senior people who live alone and at high risk of falling, using a small, inexpensive Nintendo Wii game console [17] is needed to spread exercise practice methods that are easily accessible at home.

To this end, it is relatively not difficult to find information related to health exercise, and relevant information can be easily obtained through TV health programs and YouTube's video content. However, many restrictions are expected for the senior, who lack expertise in exercise, to select and practice appropriate exercise directly considering their characteristics. The scale of senior-friendly industry is gradually increasing (from 8.71% in 2012 to 14.36% in 2019) compared to the entire scale of all industries [18], but, as discussed earlier, in a situation where there are still many areas to be improved in terms of consumers, it is considered a very valuable attempt in an aging society to find ways for female senior people with low exercise rates to practice effective exercise at home. In a situation where there are still many areas to be improved from the perspective of

customers, it is considered a very valuable attempt in an aging society to find ways for female senior people with low exercise practice rate to practice effective exercises at home.

This study applied a smart multi fitness equipment, which combines the fitness equipment developed as a whole-body fitness equipment with a touch screen monitor, to female seniors, and studied their cases to see if the equipment is possible as a fitness equipment and program for home training. This study can be expected to contribute not only to the development of senior-friendly industry, but also to find out ways to practice physical activities of senior people by providing evidence data for the development of fitness equipment for seniors in the future.

In this study, the research questions to be clarified through the causes applying a smart multi fitness equipment to female seniors are as follows.

First, what is the difference in physical strength factors of female seniors before and after applying a smart multi fitness equipment and exercise programs?

Second, what kind of awareness do female seniors participating in the exercise through the smart multi fitness equipment have about the complex smart fitness equipment they experienced?

Third, how do female seniors who have experienced exercise programs (chair, band, bar exercises) embedded in the smart multi fitness equipment perceive their exercise experience?

Fourth, what is the appropriateness of smart multi fitness equipment as a home training fitness equipment and program for female seniors?

## 2. RESEARCH DESIGN AND METHOD

This study used a mixed method. It is a research method in which an investigator collects data using qualitative and quantitative methods in a single study and integrate them to derive inference [19]. This study conducted pre-evaluation before the experiment, and post-evaluation after applying the three exercise programs. In-depth interview with the participants was conducted once during the period of applying exercise and another one interview after 12 weeks of participation, a total of two interviews. Through this, this study tried to clarify the understanding of the research questions.

## **2.1 Study Participants**

While conducting this study, quarantine guidelines for social distancing were implemented in the Seoul metropolitan area due to COVID-19 situation. So, this study considered the study participants appropriate for such situational factors. The standards for selecting the study subjects are as follows. The participants are seniors aged 65 or older who are willing to voluntarily participate in this study, can come to places with fitness equipment, and can participate in the fitness program using the smart senior complex fitness equipment three (3) times a week for a total of 12 weeks. The investigator provided five-page 'Explanation on Participation in Study' to the candidates and this study was conducted after receiving their study consent form. Finally, four female seniors who met all these factors were selected. Their basic information is shown in Table 1 below.

ID	Age	Height(cm)	Weight (kg)	Physical Activities Participated in Pas	Disease
А	69	153	69	None	High Blood Pressure
В	69	153.3	53	Walking	Back Stenosis
С	67	156	65	Weight training	None
D	66	144.6	60	Yoga	High Blood Pressure

## 2.2 Study Period and Procedures

This study was conducted from December 2020 to May 2021. After selecting the study topic, collecting literature data, measuring the participating seniors' body sizes, preliminary analysis and tests through preliminary fitness evaluation were conducted, and then the participants performed the exercises of upper and lower limb muscle strength, flexibility, and balance for 12 weeks. During the 12-week fitness program, the researchers participated and observed the participants in the program, and prepared the observation diary. Posthealth evaluation and in-depth interviews were conducted after the fitness program was completely implemented.

## 2.3 FITNESS EQUIPMENT

In this study, the participant used the fitness equipment around a chair having attached band and bar, which was developed as a smart, multi exercise for home training so that seniors could also use it at home, as seen in [Fig. 2]. The main characteristic of this fitness equipment total two monitors, where the first monitor is located on the bar, and the second monitor is on the chair. This fitness equipment is equipped with a touch screen monitor to match the name of a smart fitness equipment, and three exercise programs is embedded in the equipment. Its fitness program can be continuously updated, can check the user's exercise time and frequency, and exercise date, and will also add the functions like checking the user's heart rate, etc. in the future. Second, the attached band and ball for upper limb exercise are located at the top and center of this fitness equipment, and ankle straps for lower limb exercise at the bottom. Third, a user can perform the flexibility exercise with a bar consisting of three stages. This fitness equipment has the advantage of being able to perform both upper and lower body strength exercises and flexibility exercise at a time. Fourth, there is an adjustment device under the chair so that the chair can move, and there is an oval-shaped roll in front of the chair that a user can hold it between their two legs. Through this roll, the lumbar exercise and sphincter exercise necessary for seniors can be performed. Fifth, there is a band to assist a user's force without falling when performing a squat position on the fitness equipment to which the monitor attached.



<Side Appearance>



<Front Appearance>



<Back Appearance>

Figure 1: Appearance of Smart Multi Fitness Equipment

## 2.4 Fitness Program and its Application

The fitness program embedded in the smart multi fitness equipment consist of chair gymnastics, bar gymnastics, and band gymnastics, and the movements improving upper limb muscle strength, lower limb muscle strength, upper limb flexibility, lower limb flexibility, and balance. The content of the fitness program embedded in the smart multi fitness equipment which can be identified through the video displayed on the monitor are as seen in [Table 2].

## Table 2: Fitness program

	Exercise Movement	Expected Effect by Movement
Chair Exercise	<ul> <li>Neck and shoulder exercise</li> <li>Twist the entire arms</li> <li>Arms and flank exercise</li> <li>Stimulate the lumbar spine by moving the left and right center of gravity of the hip</li> <li>Tighten the sphincter</li> </ul>	<ul> <li>Improving the strength of arms and chest</li> <li>Increasing the flexibility of neck and shoulder joints</li> <li>Strengthening gluteus maximus, and balancing the back.</li> <li>Preventing urinary incontinence</li> </ul>
Band Exercise	<ul> <li>Walk sideways, walk gathering feet</li> <li>Stretch legs to the side with tightening stomach</li> <li>Hold the band and stand up still(squat position), and pull both elbows back in that position.</li> </ul>	<ul> <li>Using the band attached under the chair, strengthen the femoral muscle, calf muscle, and expand of movement range of hip joint.</li> <li>Prevent urinary incontinence</li> <li>Strengthen abdominal muscles</li> </ul>
Bar Exercise	<ul> <li>Shake right and left legs.</li> <li>Turn right and left ankles to the outside and inside.</li> <li>Twist the upper body.</li> <li>Grab the bar and lift toes and heels.</li> <li>Shake right leg and left leg alternatively.</li> </ul>	<ul> <li>Increase of movement range of the hip joint</li> <li>Increase of flexibility and movement range of the spine</li> <li>Increase flexibility of lower lib</li> </ul>

#### 2.5 Pre and Post Fitness Evaluation

Based on the items of Senior Fitness Test (SFT) [20] and the measurement and evaluation data of the Ministry of Culture's [21] 'National Fitness Survey' and 'National Physical Activity 100 Project', the items related to this study were adopted as the items of fitness evaluation.

The items for measuring Korean senior's fitness, which were set by the Ministry of Culture, Sports and Tourism, can be divided into two main categories: 'health-related fitness' and 'exercise-related fitness'. First, factors of 'health-related fitness" include muscle strength, muscle endurance, flexibility, and cardiopulmonary endurance, and 'exercise-related fitness' includes balance and coordination. Among them, this study selected the items of standing up from the chair and sitting, holding hands behind the back, sitting up on the chair, measuring the grasping power, and standing one foot with eyes open. These items overlap with those in the SFT.

## 1) Upper Limb Muscle Strength

In order to measure the upper limb muscle strength, the participants' grip power was measured using the grip dynamometer. After measuring the grip power in right and left alternatively, the measuring person record the highest value in unit of 0.1kg.

## 2) Lower Limb Muscle Strength

In order to measure the participants' lower limb muscle strength, they performed the movement of standing up from the chair and sitting down. When the measuring person shouted, "Start" order, the participants repeated the movement of standing up from the chair and sitting down as fast as possible for 30 seconds.

## 3) Upper Limb Flexibility

In order to measure the upper limb flexibility, the participants performed the movement of holding hands behind the back. After two practices, the distance between the middle fingers of both hands were measured twice and the maximum value in unit of 0.1 cm was recorded.

## 4) Lower Limb Flexibility

In order to measure the lower limb flexibility, the participants performed the movement of bending forward on the chair. The measure length between the tip of the middle finger and the tip of the toe was measured. They performed the movement twice and recorded the maximum value in unit of 0.1 cm.

## 5) Balance

In order to measure the balance, the participants performed the movement of standing one foot with eyes open. The movement was practiced once, and measured twice, and the highest value was recorded in unit of 0.1 second.

## 2.6 In-Depth Interview with Participants

In this study, an in-depth interview was conducted one-on-one with the four study participants, and the interviews were recorded after getting the agreement from the participants in advance. The interview format was composed of semi-structured and unstructured interviews, which allowed the participants to freely say their experiences and opinions.

## **2.7 DATA ANALYSIS**

## 1) Analysis on Results of Fitness Evaluation

Three exercise programs using a smart multi fitness equipment was applied to the female senior participants for 12 weeks (three times a week) and the results before and after the application of exercise programs were measured and analyzed. In order to find out the changes in the factors in the fitness evaluation before and after the application of exercise programs, the mean and standard deviation (SD) were calculated, and a paired t-test was conducted. All statistical significance levels were set as p<.05, and the statistical analysis was conducted using SPSS 25.0. Also, the effectiveness of the smart multi fitness equipment and the exercise programs was presented by comparing and analyzing the senior citizens' fitness standards and the health and fitness standards among the national fitness standards suggested in the National Fitness Survey (Ministry of Culture, Sports and Tourism, 2015). The standards for senior fitness generated from the comparison and analysis of data of participants in this study are shown in [Table 3].

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5
Upper Limb Muscle Strength	29.1↑	25.1-29.0	20.6-25.0	15.9-20.5	15.8↓
Lower Limb Muscle Strength	24.1↑	18.1-24.0	14.1-18.0	10.5-14.0	10.4↓
Upper Limb Flexibility	8.6↑	1.6-8.5	-4.8-1.5	-4.9-12.6	-12.7↓
Lower Limb Flexibility	24.1↑	18.2-24.0	10.1-18.1	0.5-10.0	0.4↓
Balance	65-69	57.9 이상	27.1-57.8	8.3-27.0	4.1-8.2

 Table 3: Standards for Female Seniors aged 65~69 among Senior Fitness Standards in the National Fitness

 Survey

## 2) Analysis on the Results of In-Depth Interview

What is the important in the data analysis process for qualitative research can be said to be a significant nomadic process of collected data, that is, coding process [22]. This study applied the methods of domain analysis, taxonomic analysis, and theme analysis among the analysis methods suggested by Spradley [23]. This study tried to find out the subject of core meaning while the process identifying the meaning of the collected data and exploring whether the meaning can be developed into a higher concept.

In addition, in order to enhance the internal validity of qualitative research, this study conducted the triangulation through diversified data collection, the member check, and the colleague verification from one professor and two doctoral researchers in the field of sports sociology.

## 3. RESULTS AND CONCLUSION

## 3.1 T-Test Results for Matching Sample

The results of analyzing the evaluation results of female senior fitness before and after the exercise through exercise programs using a smart multi fitness equipment for home training were presented in [Table 4]. As a result, there was a significant difference in the lower limb muscle strength (p<.01), and statistically significant difference in the flexibility of upper and lower limbs (p<.05) appeared. There was a statistically significant difference in left limb flexibility (p<.01), and the right lower limb flexibility showed statistically significant difference (p<.05). Therefore, statistical significance was verified in three factors of fitness evaluation of lower limb muscle strength, upper limb flexibility and lower limb flexibility.

		Pre M(SD)	Post M(SD)	t	р		
Linnan Limh Mussels Steen oth	L	22.38 (2.55)	24.55 (3.04)	-3.148	.051		
Opper Linto Muscle Strength	R	23.08 (1.36)	26.83 (1.28)	-2.983	.058		
Lower Limb Muscle Strength		14.50 (0.6)	25.25 (3.30)	-6.507**	.007		
Linner Linch Elevihiliter	L	-16.38 (8.44)	-8.75 (9.43)	-3.286*	.046		
Opper Limb Flexibility	R	-8.75 (9.43)	-4.88 (7.33)	-4.243*	.041		
Lenner Linch Elerikilier	L	2.00 (1.78)	11.80 (2.84)	-12.048**	.001		
Lower Limb Flexibility	R	1.50 (1.96)	12.30 (4.78)	-5.948*	.010		
	*p<0.05, **p<0.01						

Table 4: Analysis Results of Fitness Evaluation Results

## 3.2 RESULTS OF COMPARING AND ANALYZING

## 1) Muscle Strength of Upper Limb

The results of measuring the grip measurements are shown in the [Table 5]. For the grip power as the evaluation item of upper limb muscle strength, the participants' grip power before and after the exercise were measured with a grip dynamometer. First of all, judging from the grip standards of absolute evaluation, the grip power 20.3 is the minimum fitness level required for health maintenance and active daily life, and when measuring the grip power of left hand before the exercise, all participants except for participant D exceeded the absolute evaluation standard for grip power, and it can be seen from the measurement table that participant D also exceeded the absolute evaluation standard for grip power by increasing the grip power after 12 weeks of exercise.

т	Left(kg)		Result	Grade change		Right(kg)		Result	Grade change	
ш	Pre	Post		Pre	Post	Pre	Post		Pre	Post
А	24.5	25.3	Improved	3	2	24.3	25.3	Improved	3	2
В	24.6	28.2	Improved	3	2	23	26.4	Improved	3	2
С	20.7	23.8	Improved	3	3	21.2	28.3	Improved	3	2
D	19.7	20.9	Improved	4	3	23.8	27.3	Improved	3	2

**Table 5:** Measurement Record of Upper Limb Muscle Strength

## 2) Muscle Strength of Lower Limb

By dividing the absolute evaluation standard into five-grade standard, participant A rose two grades from grade 4 before the exercise to grade 2 after the exercise, and participant B also rose two grades from grade 3 before the exercise to grade 1 after the exercise. Participant C showed the greatest change in the movement of standing up and sitting on the chair before and after the exercise, rising three grades from grade 4 to grade 1. Participant D rose one grade from grade 3 before the exercise to grade 2 after the exercise.

Ш	Dro	Post	Rocult	Grade change			
ID	110	1 051	Kesuit	Pre	Post		
А	14	23	Improved	4	2		
В	15	29	Improved	3	1		
С	14	27	Improved	4	1		
D	15	22	Improved	3	2		

**Table 6**: Measurement Record of Lower Limb Muscle Strength

## 3) Flexibility of Upper Limb

The absolute evaluation standard of this movement, holding hands behind the back was -5.0cm. For the flexibility of right upper limb, participant A and participant C exceeded the absolute evaluation standard before and after the exercise, but participant B and participant D did not. Next, By dividing the absolute evaluation standard into five-grade standard, for the flexibility of left upper limb, participant A rose two grades from grade 4 before the exercise to grade 2 after the exercise, but both participant B and participant D did not show any grade change at grade 5 before and after the exercise. Participant C also had no grade change at grade 4 before and after the exercise, participant A, participant C rising one grade from grade 4 before the exercise to grade 3 after the exercise, participant A, participant B and participant D had no grade change at grade 4, and grade 5, respectively before and after the exercise.

ID	Left(cm)		Result	Grade	Grade change		( <b>cm</b> )	Result	Grade change	
	Pre	Post		Pre	Post	Pre	Post		Pre	Post
А	-7.5	5	Improved	4	2	2	3	Improved	2	2
В	-25	-15	Improved	5	5	-12	-8	Improved	4	4
С	-11	-8.5	Improved	4	4	-5	-1	Improved	4	3
D	-22	-17	Improved	5	5	-20	-13.5	Improved	5	5

**Table 7:** Measurement Result of Upper Limb Flexibility

## 4) Flexibility of Lower Limb

The absolute evaluation standard of bending forward on the chair was 10cm. By measuring the flexibility of right and left lower limbs before the exercise, all participants did not exceed the absolute evaluation standard, but participant A, participant B, and participant C exceeded the absolute evaluation standard after the exercise, except participant D. Next, by dividing the absolute evaluation standard into five-grade standard, for the flexibility of left lower limb, participant A, participant B, and participant C rose one grade from grade 4 before the exercise to grade 3 after the exercise, but participant A rose two grades from grade 5 before the exercise to grade 3 after the exercise, and both participant B and participant C rose one grade from grade 4 before the exercise to grade 3 after the exercise. Participant B and participant C rose one grade from grade 4 before the exercise to grade 3 after the exercise. Participant B and participant C rose one grade from grade 4 before the exercise to grade 3 after the exercise. Participant B and participant C rose one grade from grade 4 before the exercise to grade 3 after the exercise. Participant D had no grade change at grade 4 before and after the exercise.

ID	Left(cm)		Docult	Grade change		Right(cm)		Docult	Grade change	
	Pre	Post	Kesun	Pre	Post	Pre	Post	Kesut	Pre	Post
А	0.5	10.8	Improved	4	3	-0.5	11.2	Improved	5	3
В	4.5	15	Improved	4	3	4	16.3	Improved	4	3
С	2	13	Improved	4	3	2	15.7	Improved	4	3
D	1	8.4	Improved	4	4	0.5	6	Improved	4	4

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## 5) Balance

The absolute evaluation standard of standing one foot with eyes open was eight seconds. By measuring the balance of left leg before the exercise and after the exercise, all participants exceeded the absolute evaluation standard, and for the balance of right leg, all participants except participant B exceeded the absolute evaluation standard at measuring before the exercise. When measuring the balance of right leg after the exercise, all participants exceeded the absolute evaluation standard at measuring before the exercise. When measuring the balance of right leg after the exercise, all participants exceeded the absolute evaluation standard. Next, by dividing the absolute evaluation standard into a five-grade standard, for the balance of left leg, participant A and participant had no grade change at grade 1 before and after the exercise, but participant B rose one grade from grade 3 before the exercise to grade 2 after the exercise, and participant C rose one grade from grade 2 before the exercise to grade 1 after the exercise. For the balance of right leg, participant A had no grade change at grade 2 before and after the exercise, but participant B rose one grade from grade 3 after the exercise.

## Table 9: Measurement Result of Balance

Б	Left(sec)		Docult	Grade change		Right(sec)		Docult	Grade change	
ID ID	Pre	Post	Result	Pre	Post	Pre	Post	Reput	Pre	Post
А	60↑	60↑	-	1	1	51	44.01	Reduced	2	2
В	20	33.27	Improved	3	2	7	14.47	Improved	4	3
С	34	60↑	Improved	2	1	33	60↑	Improved	2	1
D	60↑	60↑	-	1	1	60↑	60↑	-	1	1

## 3.3 Analysis on in-Depth Interview

The analysis sought to find similarity through the process of convergence and divergence while repeatedly reviewing the raw data. The topic for this study was derived by expanding the discovered content and existing knowledge, and finding the convergence in the divergence process bridging different concepts. The results of qualitative research were presented in [Table 10], [Table 11], and [Table 12].

## 3.3.1 Perception of the Smart Multi Fitness Equipment

The perceptions of fitness equipment by female seniors having participated in the exercise using a smart multi fitness equipment were 'Proper equipment for elderly,' 'Experience physical and emotional effects to work out,' 'An alternative way to work out,' and 'Discriminatory equipment that has not been experienced', so through the core categories of such perceptions, the subject of 'Proper effective and useful equipment for applying for elderly' was derived.

Code	Code Bundle	Core Category	Subject
Easy way to use	Fact to follow		
The gym is a burden	Easy to follow	Proper equipment	
Almost all of elderly feel uncomfortable	Possibility of the overall	for elderly	
Overall, can work out	body		
Increasing muscle mass			
Tight sleep and good bowel movement	Effect of changes		Effective and useful equipment for elderly
Feels refreshed after workout	Developing setisfying	Experience physical	
Empowered feeling		effects to work out	
Work out at home though	Contribute to build work out		
Feeling different body condition not to work out	habit		
Inconvenience using the outdoor sports facility as not enough space because too much user came up	Inability to work out comfortably	An alternative way	
Burden barrier for visiting		to work out	
Suspended work out by COVID 19	Unable to work out voluntary		
Moving chair left to right side	Moving chair and special	Discriminatory	
Device to set the ankle	device	equipment that was	
Video watching to work out	Advantages of monitoring	not experienced	

## Table 10: Perception on Fitness Equipment

## **3.3.2** Perception on the Fitness Program

The exercise programs were embedded as video content on a monitor attached to the smart multi fitness equipment. Through the experiences of participants who joined in the three exercise programs of chair gymnastics, band gymnastics, and bar gymnastics, their exercises were sufficient, there were recovery and improvement effects of physical functions, and through the program's own differentiation category, the subject of 'Differently and effectively work out intensity' was found.

## Table 11: Perception on Fitness Program

Code	Code Bundle	Core Category	Subject
A little hard intensity	Appropriate intensity	Appropriate intensity Enough to work out	Differently and effectively work out intensity
Appropriate intensity			
Worthy following intensity			
Stretching for feeling lighter	Chair exercise	Effective for restoring and improving the	
At First, it was very difficult to do well			
Supporting For squat position	Band exercise		

Feeling like losing weight when using body energy		body functions	
Increased flexibility as leg height			
Stretch by pulling legs	Bar exercise		
Pelvic twisting action			
Experience movement first			
It feels that I'm exercising my whole body while using my muscles that I haven't used before	Adapting to a dominant work out		
It was awkward at first		Difference in the	
I'm used to it, now I'm fine	-	program	
Enjoyment of move with music			
Can do while listening to the teaching call	Enjoyable private work out		
Work out while watching the video			

# **3.3.3** Appropriateness of the Smart Multi Fitness Equipment as a Fitness Equipment and Exercise Programs for Home Training

Through the statements of participants who joined in the three exercise programs using the smart multi fitness equipment for 12 weeks, there were derived improvements and advantages after the exercise using a fitness equipment. From that, the appropriateness of the smart multi fitness equipment and exercise programs for home training could be confirmed. Thus, the subjects discovered through the categories, 'the equipment is an attractive fitness equipment to sufficiently exercise alone if right exercise method is learned and the exercise motivation is persisted.'

Code	Code Bundle	Core Category	Subject
A little inconvenient to use fixing device	Difficulty to use device	Improvement appeared, but the most important thing is the willingness	The equipment is an attractive fitness equipment to sufficiently exercise alone if right exercise method is learned and the exercise motivation is persisted
Needs to use easily to control the intensity			
So far, nothing else has been going well at home	Necessity of the stronger motivation		
If someone gave it to me as a gift, I'd bring it			
The idea that leaders can know more accurately if they tell them directly	How to combine lessons Time to adapt to the equipment and exercise program	Necessity of the coaching to correct work out	
I can't quite understand the video alone			
At first, I felt sick because it was too much			
Not used to it at first			
The advantage of being able to do it freely without having to go to the gym	Work out freely whenever to want	There are many	
Nothing is caring for anyone			
If getting used to it, can do it on my own	Effective Equipment to support work out	work out alone at home	
Every equipment take up much space as well			

## Table 12: Appropriateness of the Smart Multi Fitness Equipment

## 3.4 RESULTS AND DISCUSSION

This study applied a Smart Multi Fitness Equipment, utilizing Information and Communication Technology (ICT) and enabling multi exercises of upper and lower limbs, and related exercise programs to female senior participants and analyzed the cases of application. As a result of this study, the discussion about the improvement in physical strength of the participants and their positive assessment of the exercise equipment and program is as follows.

## 3.4.1 Quantitative Research Results

As a result of quantitative study applying the Smart Multi Fitness Equipment and exercise programs to the seniors, there were differences between health-related fitness and function-related fitness of the female senior participants. To be specific, on health-related fitness, the female senior participants' muscle strength and flexibility were improved, and on the function-related fitness, their balance was improved.

There are other studies partly supporting the results of this study. In one study applying the 12-week exercise training using a balance-fitness equipment for the senior to the female senior participants, their lower limb muscle strength was improved [24][31]. As a result of another study, which developed and applied a senior-friendly fitness chair for home training to the senior [25], there appeared improvements in the items of upper limb flexibility, lower limb muscle strength, and lower limb flexibility.

In this study, the participants' lower extremity muscle strength was significantly improved. It is known that muscle mass decreases gradually start from the age of 40, and muscle strength decreases are faster than muscle mass by 3% per year from the age of 60 [26]. In particular, it is necessary to improve body composition through regular exercise because elderly women who fall under both sarcopenia and obesity may have serious problems such as deterioration of physical strength necessary for daily life and major lifestyle-related diseases [27]. In this regard, the result of improved lower extremity muscle strength in this study can be viewed as verifying the effect of this exercise program and exercise equipment for the elderly women.

## 3.4.2 Qualitative Research Results

First, the participants of this study found the Smart Multi Fitness Equipment to be suitable for the seniors in that the equipment and exercise programs could easily be used and performed and that the individual exercises by body parts could be done selectively. The participants felt the complex effects of exercise practice in terms of clearly perceived exercise effects, psychological satisfaction and contribution to the formation of exercise habit. Additionally, they perceived the Smart Multi Fitness Equipment as an alternative way of exercise in a situation when they could not exercise comfortably, even though they wanted to.

Second, participants felt the effects of recovering and improving their physical functions by doing enough exercise through chair, band, and bar exercises programs. Being adapted to special and interesting exercise programs, they evaluated the three exercise programs as discriminatory programs with sufficient exercise intensity.

Third, the participants reported that some devices in the fitness equipment were inconvenient to use but they also agreed that more important factors were the individual's will to exercise and the need for accurate coaching, especially at the beginning of the exercise. On the whole, they considered the Smart Multi Fitness Equipment to have many appropriate advantages for exercising alone at home because they could exercise freely and effectively in their own time.

In conclusion, they perceived the Smart Multi Fitness Equipment as an attractive fitness equipment for them to exercise alone, if they could learn its right exercise method and their motivation could persist. So, from their statements, it was identified that the Smart Multi Fitness Equipment and its programs had the possibility to be a useful fitness equipment and programs for home training.

According to a study investigating the needs of the elderly in Korea who use a health club, the use rate of exercise equipment for weight training was lower than that of aerobic equipment such as treadmills. The cause of this was that it was difficult for the elderly to use the machine because of its weight, and that it was difficult

for them to operate the machine without the help of others [28]. The low exercise participation rate of the elderly in Korea is related to the lack of dedicated sports facilities for the elderly, and to the fact that existing sports facilities are not suitable for the elderly to use. Of course, there was an opinion that the operation method of the exercise equipment used in this study should be more convenient.

However, the participants of this study stated that compared to the existing exercise equipment that did not consider the characteristics of the elderly female, the apparatus and program used in this study were more suitable to perform full-body exercise with appropriate intensity. Due to these characteristics, it was evaluated as an appropriate exercise device for the elderly. As such, it is expected that the development of effective exercise equipment and programs that can be easily used by the elderly women will play a positive role in increasing the exercise participation rate of the elderly and prolonging their healthy lifespan.

According to a previous study that developed and applied an exercise chair for the elderly, an effective exercise program and appropriate exercise equipment should be provided for the effective participation of the elderly in home training. And more importantly, they argued that education using digital devices should be provided so that the elderly could easily execute exercise contents [25]. Although the demand on home training is increasing due to the advanced media technology and the spread of home training culture, it is not easy to have safe exercise in a right way. If a home visiting education system utilizing the home training is constructed to solve these complementary things, then it is judged that the Smart Multi Fitness Equipment will be an alternative to provide individuals with safe and right ways of exercise and to help them to stay motivated to exercise. Besides, in the situation where exercise equipment considering the senior's characteristics is insufficient, the results of this study, which applied a Smart Multi Fitness Equipment for home training to some female seniors, are expected to solve the problem of inconveniences of the existing senior-friendly industry.

The Ministry of Health and Welfare of Korea promotes a health promotion policy to discover and manage high-risk groups in order to increase the senior's health life expectancy, which is relatively low [29]. It is considered that what should be prioritized in implementing such policies is more active support to develop and distribute physical activity programs suitable for the senior citizens in discovering and managing high-risk senior groups through early medical check-ups. Also, the focus should be on creating an environment where exercise practice is easy and thus serve to prevent disease before the outbreak of diseases.

## **3.4.3 SUGGESTION**

The participants of this study were four female seniors aged between 65 and 69. This study was limited in that the age group was not diverse and the number of participants were not large. The reason of the low level of participation in the study was because COVID-19 made it difficult to recruit participants and to develop the research. Therefore, in future studies, if the research subjects are selected from more diverse age groups, it is believed that various research results can be obtained, such as comparison by age of the young seniors, the middle and old seniors, and the oldest seniors, and differences between male and female seniors.

Second, in this study, the applied exercise period of 12 weeks. At the end of the exercise period, all evaluation factors except balance showed improvement in all participants, and statistically significant differences were found overall. In the future, various studies need to be conducted, such as extending the exercise period or changing the frequency and intensity of exercise. Accordingly, it is hoped that the senior's participation in physical activities can increase, and researches focusing on the improvement of fitness factors and healthy life will continually be conducted.

Third, this study applied three exercises to the female senior participants through a Smart Multi Fitness Equipment utilizing ICT. In follow-up studies, if a research is conducted applying a format integrating ICT and sport industry to the medical and welfare fields, it is expected that such a research will contribute to develop the senior sports field and to increase senior citizens' health and life expectancy.

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