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Health Study for Elderly Using Tele-Exercise in Japan During The COVID-19 Pandemic

Tetsuaki Oda [1, 3*], Chikako Oda [2] And Yumi Kanegae[3]

[1] *Graduate School of Technology Management, Ritsumeikan University*

[2] *Department of Medical Information and Life Sciences, Graduate School of New Areas, The University of Tokyo, Tokyo, Japan*

[3] *Core Research Facilities, The Jikei University School of Medicine, Tokyo, Japan*

Abstract: This study investigates the effects of a three-month online exercise and nutritional guidance program on two groups of elderly individuals in Japan: healthy elderly persons and those requiring nursing care. Conducted against the backdrop of Japan's aging population and the heightened risks of frailty during the COVID-19 pandemic, the study aims to enhance elderly welfare through supportive community initiatives and technological interventions. Participants from both groups engaged in structured online exercise routines and received tailored nutritional guidance. Physical abilities were measured before and after the program using grip strength, one-leg stand, 5-meter walk, Timed Up and Go (TUG), and functional reach tests. The study utilized t-tests and correlation analyses to evaluate the changes in these measurements and assess the program's effectiveness. Results indicate significant improvements in walking speed and balance for the healthy elderly group, evidenced by decreased times in the 5-meter walk and TUG tests. Although grip strength increased and functional reach decreased in this group, these changes were not statistically significant. For the elderly requiring nursing care, significant improvements were observed in functional reach, suggesting enhanced physical flexibility, while grip strength showed a slight but not significant decline. Feedback from participants highlighted high satisfaction with the program, improved exercise habits, and increased motivation, particularly among those requiring nursing care. The study underscores the potential of tele-exercise to reduce social isolation and promote health in elderly populations, advocating for the continued use and development of such interventions to foster a sustainable, health-oriented community for the elderly in Japan.

Keywords: Frail, Tele-exercise intervention, Elderly Health, COVID-19 Pandemic

***Corresponding Author**

Tetsuaki Oda , Graduate School of Technology Management, Ritsumeikan University;Core Research Facilities, The Jikei University School of Medicine, Tokyo, Japan

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1. INTRODUCTION

If the risk of frailty is left unaddressed, elderly individuals may become more vulnerable and eventually transition into a state requiring long-term care. In Japan, the progression of a low birthrate and an aging population has weakened community ties, leading to increased social isolation among the elderly. Given this backdrop, it is crucial to build a sustainable society where the elderly can live healthily, through the realization of a supportive, symbiotic community and the enhancement of elderly welfare. Particularly during the COVID-19 pandemic, which has heightened the risks of frailty, it is important to support the exercise and dietary habits of the elderly online as part of the community. This support can promote behavioral changes in the elderly while they remain at home, reduce their social isolation, and consequently mitigate the physical and psychological risks of frailty. Therefore, the effectiveness of this study is highly anticipated. Previous studies have shown the effectiveness of online exercise programs in improving physical function among the elderly[1]. Additionally, research indicates that social isolation significantly impacts the health of the elderly, increasing risks of cardiovascular diseases and depression[2]. Online nutritional guidance has also been found to improve dietary habits among the elderly, enhancing their overall nutrition[3]. Frailty prevention exercise programs have proven effective in improving muscle strength and balance, thereby preventing frailty[4]. Furthermore, during the COVID-19 pandemic, online exercise programs have been particularly effective in maintaining the exercise habits of the elderly[5]. Exercise is crucial for psychological health, helping to reduce stress and anxiety among the elderly[6]. Technological solutions, including wearable devices and online platforms, have been effective in promoting behavior change among the elderly[7]. Online communities have played a vital role in reducing social isolation and promoting health among the elderly[8]. Finally, sustainable exercise programs for the elderly require continuous support and individualized approaches to ensure long-term adherence [9]. Additionally, research indicates that peer support significantly reduces emergency room visits and hospitalizations, leading to better overall health management[10].

2. PARTICIPANTS

Participants were healthy elderly persons and elderly persons requiring nursing care. The group of healthy elderly (G1) consisted of 16 men and women (7 men and 9 women) aged 65 to 85 years selected from JEXER GYM operated by JR East Sports. The survey was conducted over a 3-month period from September to November 2023 using an online system. The group of elderly requiring nursing care (G2) consists of 16 men and women aged 65 to 85 (7 men and 9 women) certified by the government as requiring nursing care and selected from day-care facility operated by JR East Sports. The survey was conducted over three months from June to August 2022, using an online system. Trainers provided exercise and nutritional guidance and set goals for each participant. In addition, the trainers facilitated the exchange of information among participants regarding their goal attainment and experiences.

3. MEASUREMENT ITEMS

Before and after the three-month online exercise guidance, the following physical abilities were measured: grip strength, one-leg stand, 5-meter walk, Timed Up and Go (TUG), and functional reach tests. TUG test measures the time it takes to rise from a seated position, walk 3 meters, turn around, walk back, and sit down again. Functional reach test measures the maximum distance one can reach forward while keeping the arms at 90 degrees to the body. For grip strength and the one-leg stand tests, both the left and right hands and feet were measured for the healthy elderly. In contrast, only the dominant hand and dominant foot were measured for the elderly requiring nursing care, as some participants had paralysis.

4. METHOD AND ANALYSIS

A t-test was conducted on the change in Measurement Items before and after the tele-exercise for each group to check whether the increase or decrease was statistically significant. In addition, a correlation analysis was performed on the changes in Measurement Items before and after the tele-exercise for each group to see if there was a correlation over time. In addition, a questionnaire was administered to each group after the tele-exercise, and the responses regarding exercise, literacy, motivation, and peer support of the tele-exercise were compared and analyzed. At the initiation of the exercise program, baseline data, including participants' height, weight, and the specified measurement items, were recorded. The same set of measurements was taken, and the questionnaire was redistributed at the three-month endpoint of the program. The questionnaire was designed to gather information on exercise, literacy, motivation, and peer support. The collected data for each dimension were analyzed using a t-test to identify any significant mean differences between baseline and endpoint in each group, G1 and G2, with a predetermined significance level of $P < 0.05$. Correlation analysis, using the Pearson method, was conducted on the baseline and endpoint data from both groups for each measured dimension. This statistical approach determines the existence and strength of a relationship between the baseline and endpoint data. Statistical analyses, including the t-test and correlation analysis, were performed using SPSS version 29.0 (IBM). Figure 1 demonstrates the initial and final participant counts for Group 1 (G1: Healthy Elderly) and Group 2 (G2: Elderly Requiring Nursing Care). Initially, G1 had sixteen participants, and G2 had seventeen participants. For G1, the analysis ultimately included data from fourteen participants, as two participants dropped out before the Baseline measurement. For G2, the analysis ultimately included data from sixteen participants. However, valid data for the one-leg stand test was obtained from fifteen participants, and valid data for the functional reach test was obtained from twelve participants. We were unable to collect functional reach data from three participants before the Baseline measurement and one participant before the end-point measurement. Additionally, we could not collect one-leg stand data from one participant before the end-point measurement.

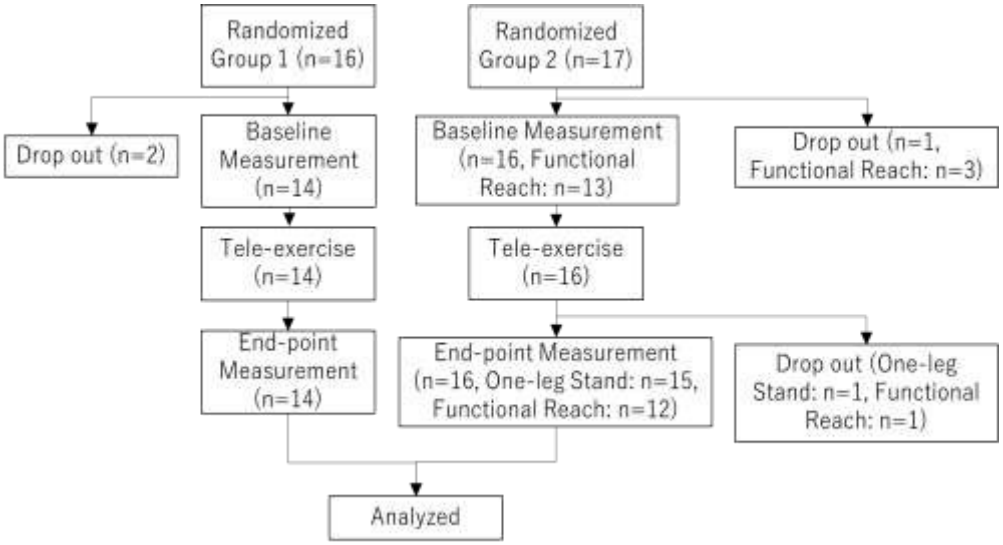

Fig.1 The initial and final participant

5. RESULTS

5.1 Descriptive Statistics

5.1.1 Healthy Elderly Group (G1)

Table 1 provides an overview of the participants' demographics and baseline measurements in G1, highlighting the variability in physical performance measures such as grip strength, balance, and mobility. The data demonstrate statistical variance in the following variables: 118.951 for weight, 42.123 for right-hand grip strength, 37.581 for left-hand grip strength, 1648.11 for right one-leg stand test, 1519.187 for left one-leg stand test, 0.295 for a 5-meter walk test, 0.648 for TUG (Timed Up and Go) test, and 26.533 for functional reach test. Notably, the right and left one-leg stand measures exhibit particularly large variances.

Table1: Descriptive statistics for Healthy Elderly (G1)

Variable	N Statistic	Range Statistic	Minimum Statistic	Maximum Statistic	Mean Statistic	Std. Error	Std. Deviation Statistic	Variance Statistic
Sex	16 (M: 7, F: 9)							
Age#	16	14	67	81	73.9375	0.81378	3.25512	10.596
Height#	16	21	149	170	160.9063	1.63568	6.54273	42.807
Weight1#	14	37.4	44	81.4	60.3857	2.91487	10.90645	118.951
GripStrengthR1#	14	20.9	20.8	41.7	30.6571	1.73458	6.4902	42.123
GripStrengthL1#	14	19	21	40	29.7929	1.63389	6.13031	37.581
OnelegStandR1#	14	115	5	120	45.4286	10.84998	40.59692	1648.11
OnelegStandL1#	14	119	1	120	36.4286	10.41697	38.97675	1519.63
Walk5m1#	14	1.87	1.78	3.65	2.4079	0.14526	0.5435	0.295
TUG1#	14	2.74	4.54	7.28	5.8086	0.21508	0.80475	0.648
FunctionalReach1#	14	16	27	43	37.0714	1.37667	5.11502	26.533
Valid N (listwise)	14 (M: 6, F: 8)							

 # indicates baseline data taken in September 2023.
N Statistic for "Sex" and "Valid N (listwise)" indicates the number of participants and their gender distribution (M: Male, F: Female).

5.1.2 Elderly Requiring Nursing Care Group (G2)

Table 2 provides an overview of the participants' demographics and baseline measurements in G2, highlighting the variability in physical performance measures such as grip strength, balance, and mobility. The data demonstrate statistical variance in the following variables: 140.32 for weight, 17.929 for grip strength, 357.761 for one-leg stand test, 1.836 for a 5-m walk test, 10.105 for TUG (Timed Up and Go) test, and 29.946 for functional reach test. Notably, the one-leg stand test measures exhibit particularly large variances, as well as G1.

Table2: Descriptive statistics for Elderly Requiring Nursing Care (G2)

Variable	N Statistic	Range Statistic	Minimum Statistic	Maximum Statistic	Mean Statistic	Std. Error	Std. Deviation Statistic	Variance Statistic
Sex	17 (M: 7, F: 10)							
Age#	17	22	68	90	78.5294	1.66079	6.84761	46.89
Height#	17	27.9	144	171.9	158.2624	2.46696	10.17153	103.46
Weight1#	16	38.5	41.7	80.2	57.9125	2.96142	11.84567	140.32
GripStrengthR1#	16	12.3	17.7	30	23.65625	1.58056	4.23425	17.93
OnelegStand1#	16	57.9	2.1	60	25.4531	4.72864	18.91457	357.761
Walk5m1#	16	5.34	2.3	7.64	6.3931	0.33872	1.35499	1.835
TUG1#	16	10.52	5.14	15.66	8.86	0.79471	3.17885	10.11
FunctionalReach1#	16	18.6	24.2	42.8	32.1692	1.51773	5.47226	29.946
Valid N (listwise)	13 (M: 5, F: 8)							

 # indicates baseline data taken in June 2022.
N Statistic for "Sex" and "Valid N (listwise)" indicates the number of participants and their gender distribution (M: Male, F: Female).

5.2 t-test

5.2.1 Healthy Elderly Group (G1)

Table 3 presents statistics for various measures across baseline and end-point data. Table 4 presents the results of paired samples t-tests for various measures between baseline and end-point data, providing the mean difference, standard deviation of the differences, standard error of the mean difference, 95% confidence interval of the difference, t-value, degrees of freedom (df), and significance levels (both one-sided and two-sided p-values). After the three-month tele-exercise guidance, grip strength increased by 2.3% in the right hand and 2.7% in the left hand. One-leg stand time increased by 11.0% for the right leg and 17.6% for the left leg. The 5-meter walk time significantly decreased by 12.9% ($p<0.05$), TUG time significantly decreased by 7.3% ($p<0.01$). The result indicates improved physical ability. However, functional reach decreased by 6.4%, showing a declined physical ability.

Table3: The data of baseline and end-point for Healthy Elderly (G1)

Variable	Mean	N	Std. Deviation	Std. Error Mean	%
Weight					
Weight1#	60.3857	14	10.90645	2.91487	
Weight2#	60.3857	14	10.90645	2.91487	
Right Hand Grip Strength					
GripStrengthR1#	30.6571	14	6.4902	1.73458	
GripStrengthR2#	31.1714	14	7.63445	2.0402	+1.7
Left Hand Grip Strength					
GripStrengthL1#	29.7929	14	6.13031	1.63389	
GripStrengthL2#	30.6429	14	7.54651	2.01665	+2.9
Right One-leg Stand					
OnelegStandR1#	45.4286	14	40.59692	10.84998	
OnelegStandR2#	42.7143	14	39.38951	10.5259	-6.0
Left One-leg Stand					
OnelegStandL1#	36.4286	14	38.97675	10.41697	
OnelegStandL2#	42.8571	14	46.01167	12.29617	+17.7
5-m Walk					
Walk5m1#	2.4079	14	0.5435	0.14526	
Walk5m2#	2.5014	14	0.55508	0.14837	+3.9
TUG					
TUG1#	5.8086	14	0.80475	0.21508	
TUG2#	5.3829	14	0.8735	0.23345	-7.3
Functional Reach					
FunctionalReach1#	37.0714	14	5.11502	1.37667	
FunctionalReach2#	34.7143	14	5.4831	1.46542	-6.4

 # indicates baseline data taken in September 2023.
indicates end-point data taken in November 2023.
The percentage column (%) reflects changes from baseline to end-point.

Table 4: The results of t-tests for Healthy Elderly (G1)

Variable	Mean	Std. Deviation	Std. Error	95% Confidence Interval of the Difference	t	df	One-Sided p	Two-Sided p
GripStrengthR1#- - GripStrengthR2##	-0.71429	2.15544	0.57607	-1.95880 to 0.53023	-1.240	13	0.118	0.237
GripStrengthL1#- - GripStrengthL2##	-0.80714	2.19386	0.58633	-2.07384 to 0.45955	-1.377	13	0.096	0.192
OnelegStandR1#- - OnelegStandR2##	-5	20.01538	5.34933	-16.55654 to 6.55654	-0.935	13	0.183	0.367
OnelegStandL1#- - OnelegStandL2##	-6.42857	21.96401	5.87013	-19.11021 to 6.25307	-1.095	13	0.147	0.293
Walk5m1#- - Walk5m2##	0.31071	0.4874	0.13026	0.02930 to 0.59213	2.385	13	0.016	0.033*
TUG1#- - TUG2##	0.42571	0.49107	0.13124	0.14218 to 0.70925	3.244	13	0.003	0.006**
FunctionalReach1#- - FunctionalReach2##	2.35714	6.61696	1.76846	-1.46338 to 6.17766	1.333	13	0.103	0.205

#baseline data taken in September 2023,
end-point data taken in November 2023
p<0.05, ## p<0.01

5.2.2 Elderly Requiring Nursing Care Group (G2)

Table 5 presents statistics for various measures across baseline and endpoint data. Table 6 presents the results of paired samples t-tests for various measures between baseline and endpoint data, providing the mean difference, standard deviation of the differences, standard error of the mean difference, 95% confidence interval of the difference, t-value, degrees of freedom (df), and significance levels (both one-sided and two-sided p-values). After the three-month tele-exercise guidance, grip strength decreased by 3.2%. The result indicates declined physical ability. However, one-leg stand time increased by 1.1%. The 5-meter walk time decreased by 2.8%, TUG time decreased by 1.2%, and functional reach significantly increased by 11.3% ($p<0.05$), showing an improved physical ability.

Table 5: The data of baseline and end-point for Elderly Requiring Nursing Care (G2)

Parameter	Mean	N	Std. Deviation	Std. Error Mean	%
Weight		16			
Weight1#	57.9125		11.84567	2.96142	-0.6
Weight2##	57.5688		12.75836	3.18959	
Grip Strength		16			-3.2
GripStrength1#	23.5566		4.23425	1.05856	
GripStrength2##	22.8063		3.78365	0.94591	
One-leg Stand		16			1.1
OnelegStand1#	23.156		17.09921	4.2748	
OnelegStand2##	23.406		16.52551	4.13138	
5-m Walk		16			-2.8
Walk5m1#	3.6391		1.3549	0.3387	
Walk5m2##	3.5894		1.1044	0.2761	
TUG		16			-1.2
TUG1#	8.86		3.17885	0.79471	
TUG2##	8.74		3.2882	0.8221	
Functional Reach		16			11.3
FunctionalReach1#	32.35		5.54663	1.38666	
FunctionalReach2##	36.0167		5.46623	1.57797	

#: Baseline data taken in June 2022
##: End-point data taken in August 2022

Table 6: The results of t-tests for Elderly Requiring Nursing Care (G2)

Comparison	Mean	Std. Deviation	Std. Error Mean	95% Confidence Interval of the Difference	t	df	One-Sided p	Two-Sided p
GripStrength1# - GripStrength2##	0.75938	2.2173	0.55432	-0.42214 to 1.94089	1.370	15	0.095	0.191
OnelegStand1# - OnelegStand2##	-0.256	10.76233	2.77882	-6.21598 to 5.70399	-0.092	15	0.463	0.926

Walk5m1# - Walk5m2##	0.10375	0.49427	0.12357	-0.15963 to 0.36713	0.840	15	0.208	0.423
TUG1# - TUG2##	0.11062	1.22165	0.30541	-0.54043 to 0.76159	0.362	15	0.361	0.723
FunctionalReach1# - FunctionalReach2##	-3.66667	4.61683	1.33277	-6.60006 to -0.73327	-2.751	15	0.009**	0.019*

#: Baseline data taken in June 2022
##: End-point data taken in August 2022
p < 0.05 (*), p < 0.01 (**)

5.3 Correlation

5.3.1 Healthy Elderly Group (G1)

Table 7 presents the paired samples correlations for various measures across baseline and end-point data, showing the correlation coefficients and the significance levels for both one-sided and two-sided tests. There is a very strong positive correlation for the grip strength in both of right and left hands, one-leg stand in both of right and left legs, and TUG tests between baseline and end-point data, indicating strong consistency over time. Weak correlations for the 5-meter walk and functional reach tests indicate more variability and less consistency in these measurements, with neither being statistically significant. These correlations suggest that the 5-meter walk and functional reach tests show more variability and less consistency over time.

Table 7: Correlation for Healthy Elderly (G1)

Comparison	N	Correlation	One-Sided p	Two-Sided p
GripStrengthR1# & GripStrengthR2##	14	0.959	<0.001***	<0.001***
GripStrengthL1# & GripStrengthL2##	14	0.973	<0.001***	<0.001***
OnelegStandR1# & OnelegStandR2##	14	0.889	<0.001***	<0.001***
OnelegStandL1# & OnelegStandL2##	14	0.867	<0.001***	<0.001***
Walk5m1# & Walk5m2##	14	0.449	0.054	0.107
TUG# & TUG2##	14	0.795	<0.001***	<0.001***
FunctionalReach1# & FunctionalReach2##	14	0.227	0.218	0.435

#: Baseline data taken in September 2023
##: End-point data taken in November 2023
p < 0.05 (), p < 0.01 (), p < 0.001 ()

5.3.2 Elderly Requiring Nursing Care Group (G2)

Table 8 presents the paired sample correlations for various measures across baseline and endpoint data, showing the correlation coefficients and the significance levels for both one-sided and two-sided tests. There is a very strong positive correlation for the grip strength, one-leg stand, 5-meter walk, and TUG tests between baseline and endpoint data, indicating strong consistency over time. The correlation for the functional reach test also indicates consistency over time, with statistical significance.

Table 8: Correlation for Elderly Requiring Nursing Care (G2)

Test Pair	N	Correlation	One-Sided p	Two-Sided p
GripStrength1# & GripStrength2##	16	0.853	<0.001***	<0.001***
OnelegStand1# & OnelegStand2##	15	0.852	<0.001***	<0.001***
Walk5m1# & Walk5m2##	16	0.946	<0.001***	<0.001***
TUG# & TUG2##	16	0.929	<0.001***	<0.001***
FunctionalReach1# & FunctionalReach2##	12	0.657	0.01**	0.02*

Baseline data taken in June 2022
End-point data taken in August 2022
p-values: * p<0.05, ** p<0.01, *** p<0.001

6. FEEDBACK ON TELE-EXERCISE GUIDANCE

Figure 2 shows the results of feedback obtained from participants after the tele-exercise. According to the survey, participants from both groups, G1 and G2, rated the tele-exercise guidance highly. They gave scores higher than 4 out of 5 for satisfaction with the exercise (Q1), habitualization (Q2), obtaining useful information (Q3), motivation improvement (Q8), willingness to try (Q11), and tolerance of the tele-exercise (Q12). Additionally, the group of elderly participants requiring nursing care (G2) gave scores higher than 4 out of 5 for willingness to participate (Q9) and observing other participants (Q16), while the group of healthy elderly participants (G1) scored less than 4.

Table 8: The results of feedback from participants

Category	Questionnaire	G1	G2
Exercise (Agree: 5, Disagree: 1)	Q1: Were you satisfied with the exercise guidance this time?	4.3	4.4

	Q2: Did you develop a habit of exercising due to this exercise guidance?	4.4	4.4
	Q3: Did you obtain meaningful information from this exercise guidance?	4.3	4.4
	Q4: Was the duration of the exercise guidance (30 minutes) appropriate?	3.3	3.8
	Q5: Was the frequency of the exercise guidance (once a week/4 times a month) appropriate?	3.5	3.9
Literacy (Agree: 5, Disagree: 1)	Q6: Did you become familiar with operating a computer or mobile phone through this exercise guidance?	3.8	3.9
	Q7: Have you gained confidence in operating a computer or mobile phone?	3.8	3.9
Motivation (Agree: 5, Disagree: 1)	Q8: Did your motivation for exercise improve with this exercise guidance?	4.2	4.5
	Q9: If there's a similar monitor session in the future, would you like to participate again?	4.5	4.7
	Q10: Are you confident in continuing your exercise even without any guidance?	3.7	4.0
	Q11: Has this exercise guidance prompted you to try something new in the future?	4.2	4.4
	Q12: Did you have any reservations about receiving tele-exercise guidance?	4.3	4.5
	Q13: When receiving exercise guidance, which is better: tele-exercise or in-person exercise? (Tele-exercise preference: 5, In-person exercise preference: 1)	3.7	4.1
Peer Support (Agree: 5, Disagree: 1)	Q14: If you couldn't match the time, would you like to watch the recorded video later?	3.8	4.0
	Q15: Is it better to participate with everyone else? Or is it better to participate alone? (Everyone: 5, Alone: 1)	3.9	3.9
	Q16: Did you find it helpful to watch other participants?	3.4	4.0
	Q17: Did you want to interact with other participants?	3.5	3.7

7. DISCUSSION

7.1 Healthy Elderly Group (G1)

This study evaluated the effects of a 3-month tele-exercise program on healthy elderly individuals (G1). Both right and left hands grip strength increased by 2.3% and 2.7%, respectively, although these increases were not statistically significant by t-test. However, correlation analysis suggests improvement over time. For the one-legged standing, rise times increased by 11.0% for the right leg and 17.6% for the left leg. While these increases were not statistically significant by t-test, correlation analysis indicates improved balance or stability over time. The 5-meter walking test showed a 12.9% decrease in walking time, which was statistically significant by t-test, indicating a significant improvement in walking speed. The TUG test showed a 7.3% decrease in time, which was also statistically significant by t-test, indicating a significant improvement in walking and standing abilities. On the other hand, the functional reach measurement decreased by 6.4%, but t-test and correlation analysis did not suggest a significant decrease in body flexibility. This analysis for healthy elderly individuals (G1) suggests improvements in grip strength and one-legged standing. Notably, the improvements in the 5-meter walk and TUG were statistically significant, indicating a trend toward improved walking and standing ability due to tele-exercise. On the other hand, the 5-meter walk, TUG, and functional reach improved after the tele-exercise session. It was suggested that walking and standing abilities, and especially flexibility based on functional reach, could improve even in the short term of three months. These results suggest that tele-exercise may contribute to improved walking speed and functional motor skills in healthy elderly individuals. However, the decrease in functional reach requires attention, and further research is needed to understand the effects on body flexibility. Future studies should include longer-term continuous exercise guidance and involve a more diverse group of participants. Exercise support using ICT was well received. Elderly patients during the COVID-19 pandemic are at risk of becoming severely ill, making it difficult for them to attend day care facilities. Therefore, tele-exercise support was considered effective. It was also beneficial for elderly caregivers, even on days when they were unable to leave their homes for care.

7.2 Elderly Requiring Nursing Care Group (G2)

This study evaluated the effects of a 3-month tele-exercise program on elderly individuals requiring nursing care (G2). Grip strength decreased slightly (3.2% decrease). Although this decrease was not statistically significant by t-test, correlation analysis suggests the progression of frailty. One-leg standing times increased slightly (1.1% increase), and while this was not statistically significant by t-test, correlation analysis indicates improved balance or stability over time. The 5-meter walking test showed an decrease in walking time (2.8% decrease). Although this increase was not statistically significant by t-test, correlation analysis suggests improvement in walking ability. The TUG test also showed an decrease in time (1.2% decrease). While not statistically significant by t-test, correlation analysis indicates improvement in walking and standing abilities. Functional reach test measurements increased (11.3%), which is statistically significant by t-test, indicating a significant improvement in body flexibility. This analysis for elderly individuals requiring nursing care (G2) suggests a decline in grip strength, indicating the progression of frailty, while also showing improvement in the 5-meter walk and TUG tests. Notably, the improvements in the functional reach test were statistically significant, indicating a trend toward improved body flexibility due to tele-exercise. Grip strength worsened slightly after the tele-exercise session. This could be influenced by the participants' worsening underlying conditions. Generally, the participants' physical abilities tended to decline. On the other hand, the 5-meter walk, TUG, and functional reach showed improvement after the tele-exercise session. It was suggested that walking and standing abilities, especially flexibility as measured by functional reach, could improve even within a short term of three months. Since the participants were elderly individuals requiring nursing care, there were limitations in the exercise content due to safety considerations. Additionally, the participants' levels of care

varied, and some had paralysis, limiting their basic exercise abilities. To improve sarcopenia in elderly individuals requiring support or long-term care, a long-term and careful exercise support plan is needed. Exercise support utilizing ICT was well-received. Many elderly individuals requiring support or long-term care often experience worsening health conditions, making it difficult to attend day care facilities. Thus, tele-exercise support was considered effective. Conversely, concerns were raised about the risk of worsening sarcopenia without exercise support, including day care facilities.

7.3 Feedback on Tele-exercise Guidance

This study evaluated the effects of a 3-month tele-exercise program on two groups: healthy elderly (G1) and elderly requiring nursing care (G2). The feedback collected through surveys provides valuable insights into the reception and impact of the program on both groups.The feedback, as depicted in Figure 2, indicates that both groups rated the tele-exercise guidance highly, with scores above 4 out of 5 for satisfaction with the exercise (Q1), habitualization (Q2), obtaining useful information (Q3), motivation improvement (Q8), willingness to try (Q11), and tolerance of the tele-exercise (Q12). This suggests that the tele-exercise program was generally well-received, easy to integrate into daily routines, and provided valuable and motivational content. Participants found the exercises manageable, indicating that the program was appropriately designed to match their physical capabilities. For elderly individuals requiring nursing care (G2), additional high scores were obtained for willingness to participate (Q9) and observing other participants (Q16), in contrast to the healthy elderly group (G1), which scored these aspects lower. This indicates that G2 participants found the tele-exercise program particularly beneficial in fostering a sense of community and providing encouragement through the observation of peers. These aspects are critical for this group, as social engagement and a supportive environment can significantly enhance their motivation and adherence to exercise programs.

8. CONCLUSION

Study results showed that both groups improved in one-leg stand, 5-meter walk, and TUG tests. In G1, improvements in the 5-meter walk and TUG test were statistically significant, suggesting that the tele-exercise improved walking speed and standing abilities. In G1, grip strength improved but functional reach decreased, while in G2, grip strength decreased but functional reach improved significantly, indicating an improvement in physical flexibility. The study highlights the effectiveness of using ICT for exercise support, particularly for healthy elderly individuals. For those requiring nursing care, the variability in levels of care and the presence of paralysis in some participants limited their basic exercise abilities, necessitating a tailored approach to exercise support. Tele-exercise support was well-received and effective, enhancing satisfaction, habitualization, and motivation. Additionally, elderly individuals requiring nursing care found the tele-exercise particularly beneficial in fostering a sense of community and providing encouragement through observing their peers. These aspects are critical for the elderly, as social engagement and a supportive environment can significantly enhance their motivation and adherence to exercise programs.

9. LIMITATIONS OF STUDY

While the sample size of participants may seem relatively small, it is a realistic and appropriate number from the perspective of observation and communication for a pilot study and indicates the value of such preliminary investigations in setting the groundwork for larger-scale research. Although the sample size is deemed realistic and suitable for exploratory studies from observational and communicational perspectives, the study is constrained by its small sample size and the fact that it was conducted at a single institution. Additionally, there is a potential for selection bias, as the participants who chose to partake in this study might not represent the broader population. These factors constitute limitations of the current study. Consequently, the efficacy results observed need to be validated through a larger-scale study to ensure broader applicability and reliability.

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11. AUTHORS DISCLOSURE STATEMENT

This study received ethical approval from the Ethics Committee of the Ritsumeikan University (Registration Number: BKC-LSMH-2021-090, February 9, 2022; BKC-LSMH-2023-016, June 7, 2023) and Jikei University School of Medicine (Registration Number: 35-130（11756）, June 8, 2023) and was conducted after obtaining written informed consent from all participants, who were fully informed about the study. The authors declare that (s)he has no relevant or material financial interests that relate to the research described in the manuscript.

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13. AUTHORS CONTRIBUTION STATEMENT

Conceptualization, Tetsuaki Oda; methodology, Chikako Oda; validation, Yumi Kanegae; writing-original draft preparation, T. Oda; writing-review and editing, Chikako Oda; visualization, Yumi Kanegae; supervision, Chikako Oda and Yumi Kanegae. All authors have read and agreed to the published version of the manuscript.

14. CONFLICT OF INTEREST

Conflict of interest declared none.

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