Effects of the @ctivehip telerehabilitation program on the quality of life, psychological factors and fitness level of patients with hip fracture

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Effects of the @ctivehip telerehabilitation program on the quality of life, psychological factors and fitness level of patients with hip fracture

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Abstract

Introduction: Telerehabilitation has emerged in the last years as a promising alternative to conduct the rehabilitation process at home. However, there are no studies testing the effects of telerehabilitation interventions for patients with hip fracture on quality of life nor psychological factors, whereas the evidence on fitness level is scarce. Thus, the aim of this study is to test the effects of the @ctivehip telerehabilitation program on the quality of life, psychological factors and fitness level of patients who had suffered a hip fracture.

Methods: The present study is a non-randomized clinical trial that includes patients older than 65 years old with a hip fracture and their family caregivers (ClinicalTrials.gov; Identifier: NCT02968589). Per-protocol (64 participants) and intention-to-treat (71 participants) analyses were performed, the first being the main analysis. The intervention group received a home-based multidisciplinary telerehabilitation intervention, called @ctivehip, that lasted 12 weeks. The control group received the traditional care and rehabilitation provided by the Andalusian Public Health Care System. The outcomes measured were the patients' quality of life through the EuroQol Quality of Life Questionnaire (EQ-5D), physiological factors (anxiety and depression) using the Hospital Anxiety and Depression Scale (HADS) and the fitness level, assessed with the International Fitness Scale (IFIS).

Results: The quality of life of the telerehabilitation group increased, while the control group scored worsened at the 3-month follow up (medium effect size: 0.66 SDs; p = 0.006). The telerehabilitation group demonstrated a greater decrease than the control group in the total HADS score (medium effect size: -0.50 SDs; p = 0.015). Lastly, the telerehabilitation group recovered a fitness level close to the pre-hip fracture in comparison with the control group (small effect size: 0.49 SDs; p = 0.022).

Discussion: The @ctivehip telerehabilitation program seems to be a promising treatment to improve the quality of life and psychological factors (i.e., anxiety and depression) of older adults after a hip fracture, as well as to recover their previous fitness level.

KEYWORDS: Hip fracture, telemedicine, depression, stress, elderly.

1. Introduction

Hip fracture is currently a major public health problem because of the incidence and the important physical, social and economic implications.[1] It represents a challenge

for Health Care Systems in the future due to the rise of life expectancy and the increasingly complex medical, social and rehabilitation needs. Hip fracture has a severe impact on the patients' quality of life and psychological factors.[2] A study has shown that 46% of patients with a hip fracture suffer from anxiety and depression, significantly higher in women.[3] At the same time, psychosocial factors and symptoms of depression could increase the severity of pain and emotional distress after surgery.[2] These consequences are partially due to a considerable deterioration in their physical function, ability to perform activities of daily living and fitness level,[4] which negatively impact the patients' quality of life, anxiety and depression.[1,3]

Home-based rehabilitation is a promising management strategy for older adults with hip fracture mainly due to 1) hospital saturation and lack of resources and medical staff, especially in the current Covid-19 pandemic[5] and 2) allowing patients and caregivers to follow the rehabilitation at home, in a more comfortable environment, and to transfer the rehabilitation process to their context.[6] The advances in Information Communication Technology Services (ICTS) together with the need to provide new home-based treatments give rise to telerehabilitation as a promising alternative. Telerehabilitation is defined as a set of tools, procedures and protocols to deliver the rehabilitation process remotely.[7] Recent systematic reviews suggest that telerehabilitation has comparable effectiveness to, or even superior than, face-to-face interventions on key clinical outcomes (e.g., quality of life, physical function and psychological factors) in the orthopedic field.[8–10] However, the evidence in patients with hip fracture is still limited,[11] with only three telerehabilitation interventions available to date.[12–14] Furthermore, these three previous studies are focused on functional status and fitness outcomes but, to the best of our knowledge, there is no study testing the effects of telerehabilitation on quality of life nor psychological factors in older adults with hip fracture.

This project aims to test the effectiveness of the @ctivehip telerehabilitation on the quality of life, psychological factors (i.e., anxiety and depression) and the fitness level of patients with hip fracture.

2. Methods

2.1. Study Design and Population

The present study is a non-randomized clinical trial, conducted according to the established guidelines by the Helsinki Declaration and Law 14/2007 on Biomedical Research. This project was approved by the Ethics Committee of the Research Center of Granada (CEI-GRANADA) and registered at ClinicalTrials.gov (Identifier: NCT02968589).

The inclusion criteria to be included in the study were: (1) to have hip fracture surgery; (2) to be 65 years or older; (3) to have a high (self-reported) pre-fracture functional level the week before the fracture (Functional Independence Measure (FIM) index > 90 points); (4) to allow weight-bearing at 48 h after surgery; (5) to have community-dwelling after hospitalization; and (6) to have a family caregiver with internet access. The exclusion criteria were: (1) the presence of severe cognitive impairment (Mini-mental State Examination score lower than 24 points);[15] (2) to have a terminal disease; or (3) to have post-surgery complications, that made it impossible to begin rehabilitation during the first week after surgery. A total of 71 patients and their family caregivers were assigned to the intervention group (N=35) or to the control group (N=36). Both patients and caregivers signed consent forms.

2.2. Recruitment, Allocation and Blinding

Patient recruitment took place at the Granada University Hospital, between the months of January 2017 and July 2018. During this time interval, all patients who met the inclusion criteria were invited to participate by an occupational therapist or a physiotherapist who worked at the hospital. The assignment was not random due to an

ethical question based on the preference of patients and family caregivers derived from problems for access to the platform or lack of time among others.

It was not possible to blind the patients and their caregivers to the group assignment. However, data collection was done by an occupational therapist, a physical therapist, and a sport science specialist who were previously trained for the assessment and blinded to the group assignment.

2.3. Intervention

2.3.1. Telerehabilitation Group

This group of patients received a home-based multidisciplinary telerehabilitation intervention, which lasted 12 weeks. This program included a program of occupational therapy and physical exercise and also recommendations for patients and their family caregivers (about postoperative patient management and home environment recommendations) provided through a website. This group had the opportunity to perform five 50-to-60-minute online-based sessions per week (two of occupational therapy and three sessions of physical exercise) that used content delivered through the @ctivehip online platform. The difficulty of the sessions was categorized into four levels (Beginners, Moderate, Advanced 1 and Advanced 2), and each patient was individually assigned to the most appropriate level. A broader description of the intervention program was provided elsewhere.[16]

2.3.2. Control group

The control group received the usual care and rehabilitation delivered by the Andalusian Public Health Care System (between 5-15 sessions of home-base in person rehabilitation). The total number of rehabilitation sessions performed by each patient was recorded and were controlled for the statistical analyses. The control group received also an information leaflet with recommendations and physical exercises to do at home.

2.3.3. Common intervention of both groups

All patients (telerehabilitation and control groups) received a few sessions of rehabilitation during their hospital stay. In addition, both patients and family caregivers were invited to participate in the workshops offered about handling patients twice a week at the Traumatology Service by the @ctivehip team during the hospital stay of the patient. The workshops were focused on training family caregivers in handling patients and providing them useful information and recommendations to help patients during the recovery process after surgery.

2.4. Outcomes

All patients enrolled in the study were assessed at three time points: (1) during the first week after surgery (at hospital discharge); (2) one month later; and (3) three months after hospital discharge (end of the telerehabilitation program).

2.4.1. Quality of life

The quality of life was measured through the EuroQol Quality of Life Questionnaire (EQ-5D).[17] The EuroQol (EQ-5D) is a patient-reported outcome measure used to evaluate the generic quality of life of the patient. The questionnaire consists of five main areas (mobility, self-care, usual activities, pain, depression) and is used to evaluate perceived health status from a range of 0 (the worst score) to 100 (the best score).[18] This outcome measure has previously been used to evaluate patients with a hip fracture[19] and has been reported to have good internal consistency (Cronbach's $\alpha = 0.83$).[20]

2.4.2. Psychological factors

The psychological factors were measured by the Hospital Anxiety and Depression Scale (HADS).[21] The HADS measures the presence of anxiety and depression in patients. It has a total of 14 items, each one with four possible answers (0–3 points), divided into two subscales: seven items for status of depression and the remaining items for presence of anxiety. The maximum score of each subscale is 21 points, where scores

below 11 indicate the presence of depression or anxiety. The internal consistency of the HADS is good with Cronbach's α = 0.80.[21]

2.4.3. Fitness level

The fitness level was measured by the International Fitness Scale (IFIS).[22] The IFIS is a scale consisting of five questions concerning the patient's perception of his/ her general physical condition (cardio-respiratory, muscular, agility and flexibility). Each question has five possible answers (very poor, poor, average, good and very good) scored from 1 to 5 points, where the highest score corresponds to the best perception of fitness. The test–retest reliability of the IFIS, as measured by the average weighted K, is 0.45.[22]

2.5. Sample Size

A priori sample size analysis was performed using functional status data (primary outcome) from the telerehabilitation intervention in patients with hip fracture carried out by Tappen et al.[14] By adding 35% to account for potential losses, this study required 70 participants (35 intervention, 35 control group) for 80% power at an alpha error of 5% using a two-sample t-test. We used the Epidat 3.1 Software (Xunta of Galicia) for the sample size calculation. We set the alpha error at 5% and used a two-sample t-test. We also considered the minimal clinically significant difference in the FIM index (11 points) between groups at three months.

2.6. Statistical analyses

Before performing the analyses, the continuous variables were checked for normal distribution via the visual inspection of histograms together with the Kolmogorov-Smirnov test. Those variables demonstrating a non-normal distribution were transformed using the Blom formula.[23] The characteristics of the sample are presented as mean values and SDs or percentages. To test baseline differences between the telerehabilitation group and the control group, we used an independent sample t-test for continuous variables

and an χ^2 test or Mann–Whitney U test for categorical binomial and polynomial, respectively.

The main effects of the telerehabilitation program were tested with the per-protocol approach, which included those participants who met the following criteria: 1) to have valid data in both pre- and post-intervention assessments and 2) to have completed at least 10 sessions of the telerehabilitation program, criterion that only applies to the telerehabilitation group. The statistical test used was the analysis of covariance (ANCOVA). The post-rehabilitation outcomes were used as dependent variables, the group (i.e., tele-rehab vs. control) as a fixed factor, and the baseline outcomes as a covariate. The z-scores for each outcome at the post-rehabilitation were also formed by dividing the difference of the post-rehabilitation raw score of each participant from the baseline mean by the baseline standard deviation (i.e., (post-rehabilitation individual raw value – baseline mean) / baseline SD). This way of reporting the effects has been used in recent leading RCTs[24] and has two main advantages: 1) it provides standardized estimates that allow comparisons among outcomes with different original measurement units and 2) these z-scores of change can be interpreted as effect size indicators, e.g., 0.5 z-score means that the mean value at post-rehabilitation is 0.5 SDs higher than the mean value at baseline, which indicates a positive medium-size change. As for effect size indicators, they can be interpreted according to the standard benchmarks, i.e., a value around 0.2 is considered a small effect size, 0.5 is considered a medium effect size and 0.8 is considered a large effect size.[25] The @ctivehip effects in categorical variables (i.e., EQ-5D and IFIS individual tests) were tested with the Wilcoxon signed-rank and Mann–Whitney U tests to examine the within-group and between-group changes, respectively. The intention-to-treat analyses are presented as supplementary material and followed the same procedure as the explained above for the per-protocol analyses. For the intention-to-treat approach all participants (N=71) were included and those without valid data were imputed through multiple imputation.

All analyses were performed using the SPSS software (version 24.0, IBM Corporation) and the level of significance was set at $p < 0.05$.

3 Results

Figure 1 shows the flow chart with the included participants for both the intention-to-treat and per-protocol analyses.

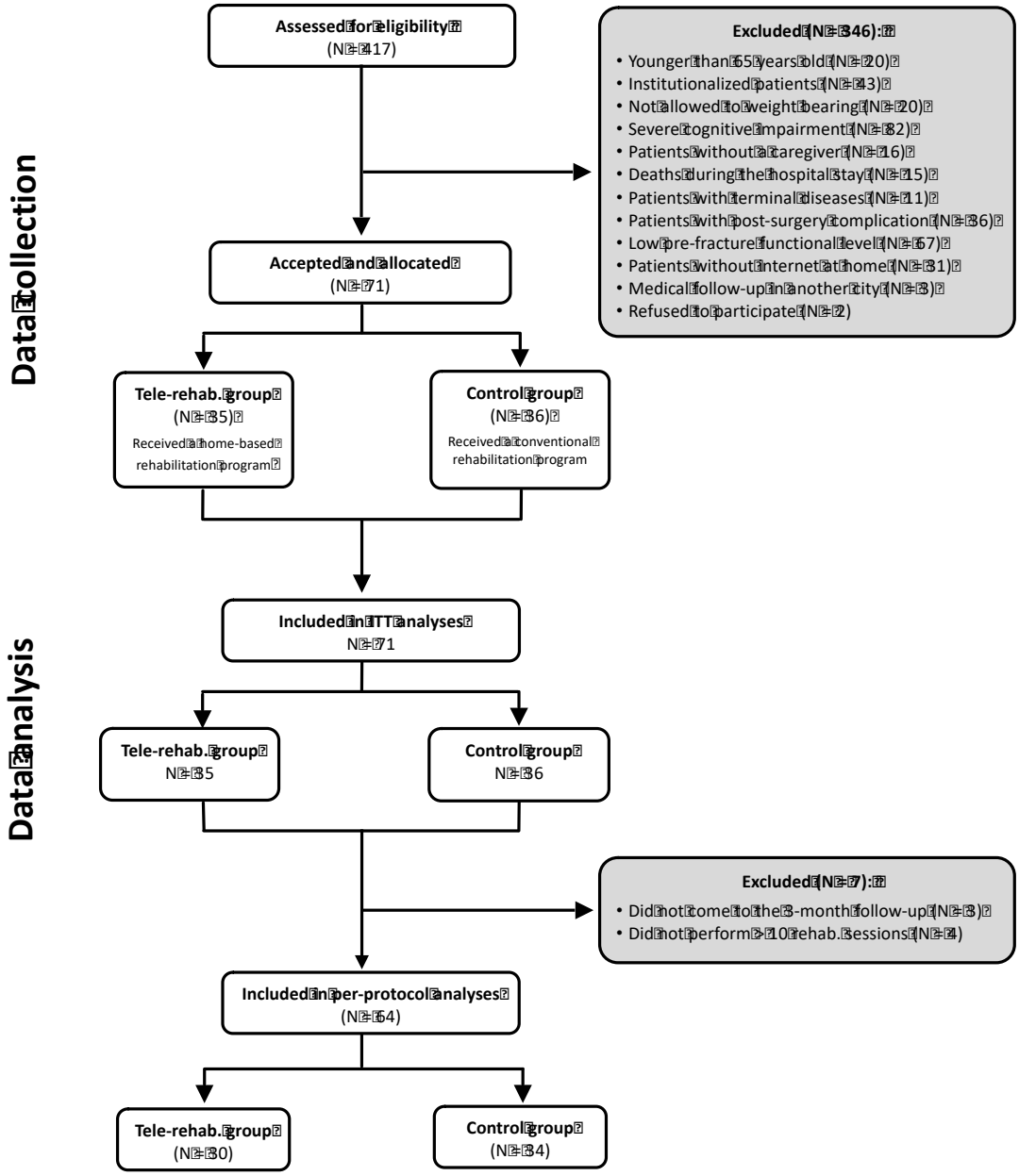


Figure 1. Flow chart describing the included participants for both the intention-to-treat and per-protocol analyses.

A total of 417 potentially eligible older patients with hip fracture were identified, of which 71 participants met the inclusion criteria and were allocated into the control (N = 36) or telerehabilitation (N = 35) groups. The per-protocol analysis included 64 participants (34 in the control group and 30 in the telerehabilitation group), while the intention-to-treat analysis considered the whole sample of 71 participants. The adherence was 17% (n = 6) to the full @ctivehip rehabilitation program (50-60 sessions), 69% (n = 24) to at least 20 sessions and 89% (n = 31) to at least 10 sessions. The latter was considered a minimum criterion to be included in the per-protocol analysis. The characteristics of all participants and also divided by telerehabilitation and control groups are shown in *Table 1* for the per-protocol analysis. Participants in the telerehabilitation group were younger and had a higher fitness level (all P < 0.05) in comparison with the control group at baseline.

Table 1. Baseline characteristics of the sample divided by telerehabilitation (tele-rehab.) and control group.

	All sample (n=64)	Tele-rehab. (n=30)	Control (n=34)	*P*
Age (years)	78.22 ± 6.02	75.77 ± 5.67	80.38 ± 5.54	**0.002**
Weight (kg)	68.43 ± 9.86	67.79 ± 9.67	69.15 ± 10.21	0.614
Height (cm)	159.53 ± 7.96	160.75 ± 7.07	158.04 ± 8.83	0.220
Body mass index (kg/m^2)	26.9 ± 3.76	26.29 ± 3.86	27.63 ± 3.58	0.202
Gender				0.390
Men	15 (23%)	8 (27%)	7 (21%)	
Women	49 (77%)	22 (73%)	27 (79%)	
Quality of life (EQ5D)				
Self-perceived health (0 - 100)	58.81 ± 18.96	62.97 ± 20.76	55.15 ± 16.67	0.100
Total index (-0.65 - 1)	0.25 ± .36	0.20 ± 0.40	0.29 ± 0.32	0.320
Anxiety and depression (HADS)				
Total score (0 – 14)	9.17 ± 6.31	8.4 ± 5.02	9.85 ± 7.27	0.362
Anxiety (0 – 7)	5.45 ± 4.28	5.2 ± 3.79	5.68 ± 4.72	0.661
Depression (0 – 7)	3.78 ± 3.08	3.2 ± 2.64	4.29 ± 3.37	0.158
Fitness level (IFIS)				
Total score (5 – 25)	18.16 ± 4.1	19.4 ± 3.25	17.06 ± 4.49	**0.021**

SD = standard deviation; n=sample size; IFIS: International Fitness Scale; HADS: Hospital Anxiety and Depression Scale.
Values are presented as mean ± SD or percentages. For continuous variables, p value was obtained by an independent samples T-test, whereas for categorical variables, p value was obtained by a chi-square test.
Significant differences (p < 0.05) are highlighted in bold.

the per-protocol analysis is presented in *Table 2*, which shows the differences between the telerehabilitation and control groups three months after hip fracture surgery adjusting for baseline values. The quality of life of the telerehabilitation group increased, evidenced in the EQ5D total index, while the control group scored worst at the 3-month follow up (medium effect size: 0.67 Cohen's d; p = 0.010). Regarding the fitness level, the telerehabilitation group recovered values closer to the level prior to the hip fracture, experiencing a better recovery in comparison with the control group (medium effect size: 0.70 Cohen's d; p = 0.008). Lastly, the telerehabilitation group demonstrated a greater decrease than the control group in the total HADS score (medium effect size: 0.70 Cohen's d; p = 0.007) and its subscales: the anxiety (medium effect size: 0.69 Cohen's d; p = 0.008) and depression scores (medium effect size: 0.58 Cohen's d; p = 0.026). Differences between the telerehabilitation and the control group were similar at the 3-month follow up for the rest of the self-perceived health. All these results are graphically presented in *Figure 2*.

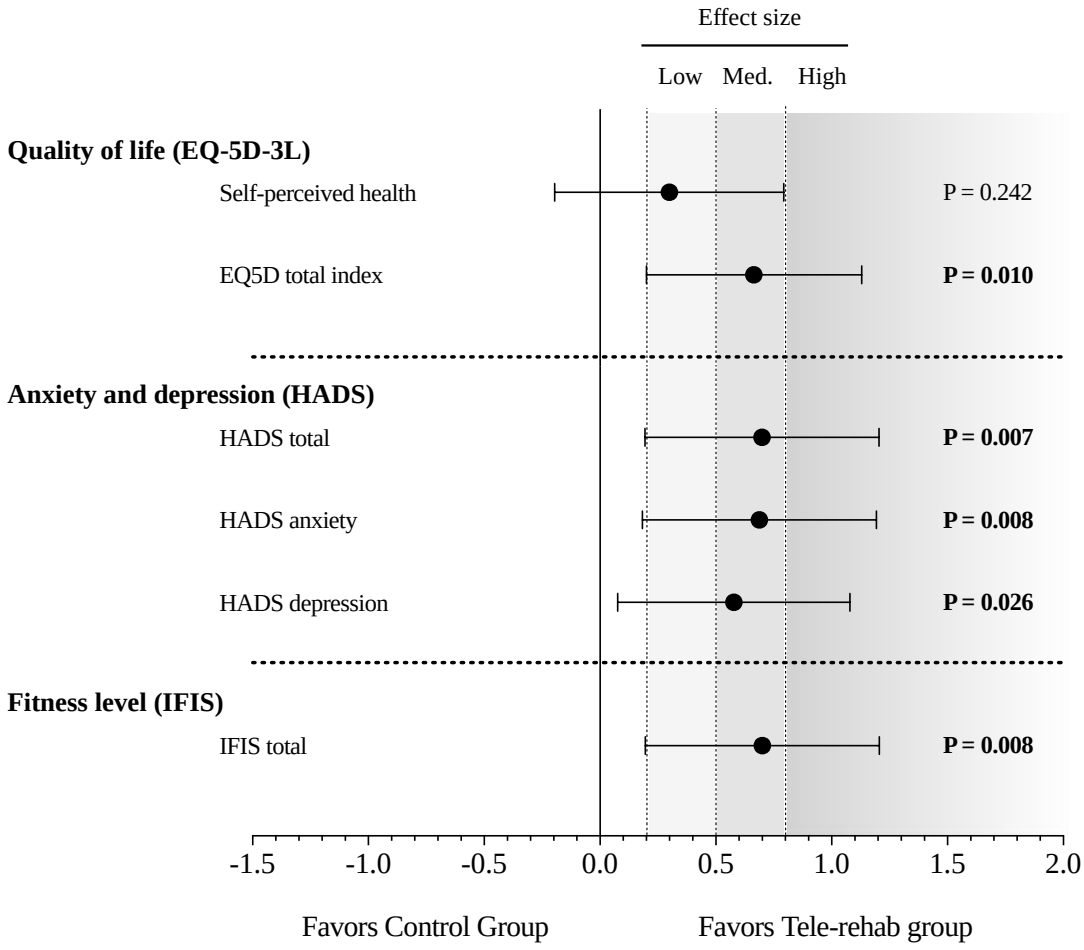
Table 2. Intervention effects of the @ctivehip project considering baseline and 3-month assessments (per-protocol analysis).

	Adjusted mean (95% CI)			*P*
	Tele-rehab. (N = 30)	Control group (N = 34)	Groups difference (Rehab – Control)	
Quality of life (EQ5D)				
Self-perceived health				
Raw score	69.08 (61.24 to 76.92)	62.67 (55.31 to 70.02)	6.41 (-4.45 to 17.28)	0.242
z Score	0.60 (0.18 to 1.02)	0.25 (-0.14 to .65)	0.34 (-0.24 to 0.93)	
EQ5D total index				
Raw score	0.69 (0.57 to 0.82)	0.47 (0.35 to 0.58)	0.23 (0.06 to 0.40)	**0.010**
z Score	1.20 (0.85 to 1.55)	0.56 (0.24 to 0.89)	0.64 (0.16 to 1.12)	
Anxiety and depression (HADS)				
HADS total				
Raw score	0.42 (0.33 to 0.50)	0.57 (0.50 to 0.65)	-0.16 (-0.27 to -0.05)	**0.007**
z Score	-0.34 (-0.65 to -0.04)	0.24 (-0.04 to 0.52)	-0.58 (-1.00 to -0.17)	
HADS anxiety				
Raw score	0.42 (0.33 to 0.50)	0.58 (0.50 to 0.66)	-0.17 (-0.29 to -0.05)	**0.008**
z Score	-0.35 (-0.68 to -0.02)	0.27 (-0.04 to 0.58)	-0.62 (-1.07 to -0.17)	
HADS depression				
Raw score	0.43 (0.35 to 0.51)	0.56 (0.48 to 0.64)	-0.13 (-0.24 to -0.02)	**0.026**
z Score	-0.30 (-0.61 to 0.01)	0.19 (-0.10 to 0.47)	-0.49 (-0.91 to -0.06)	
Fitness level (IFIS)				
IFIS total				
Raw score	16.94 (15.63 to 18.24)	14.44 (13.22 to 15.66)	2.49 (0.67 to 4.32)	**0.008**
z Score	-0.24 (-0.56 to 0.08)	-0.85 (-1.15 to -0.55)	0.61 (0.17 to 1.06)	

CI = confidence interval; n=sample size; IFIS: International Fitness Scale; HADS: Hospital Anxiety and Depression Scale.
A one-way analysis of covariance (ANCOVA) was used to test raw and z-score differences between the tele-rehab and control group at the post-intervention, adjusting for basic pre-intervention values. Adjusted means and confidence intervals of the mean are represented. Differences between groups are presented as: post-intervention mean minus pre-intervention mean. Significant differences ($p < 0.05$) are highlighted in bold.

Figure 2. Effect sizes of the @ctivehip project on quality of life, anxiety and depression and fitness level (per-protocol analysis).

A one-way analysis of covariance (ANCOVA) was used to test z-score differences between the telerehabilitation and control groups at the 3-month assessment,



Results from categorical variables (i.e., scores ranging from 1 to 5 points) are presented in **Table 3**. In regard to the quality of life assessment, both the telerehabilitation and control groups improved their scores in the self-care (Z = -4.05 and -1.97; p = <0.001 and 0.049, respectively) and usual care dimensions (Z = -4.56 and –2.42; p = <0.001 and 0.016 respectively), while only the telerehabilitation group

improved the mobility (Z = -3.84; p = <0.001) and anxiety (Z = -2.36; p = 0.018) domains. Focusing on the fitness level, both the telerehabilitation and control groups improved the strength (Z = -2.06 and -2.57; p = 0.040 and 0.010 respectively), speed (Z = -2.98 and -2.86; p = 0.003 and 0.004 respectively) and flexibility (both Z = -2.43; both p = 0.015). On the other hand, only the control group improved the general fitness domain (Z = -2.31; p = 0.021). In regard with the between-group analysis, the telerehabilitation group had a better improvement in the mobility, self-care and usual care dimensions (Z = -3.79, -2.97 and -3.38; p = <0.001, 0.003 and 0.001, respectively).

The intention-to-treat analysis is presented in the Supplementary Material (Table S1, S2 and S3). The effects of the @ctivehip telerehabilitation intervention found in this analysis were less beneficial in comparison with the per-protocol analysis since there was not a significant improvement in the HADS total score and subscales of anxiety and depression (all p >0.050). The effects in the EQ5D total index and IFIS total scores remained superior favoring the @ctivehip intervention (medium effect size: 0.58 Cohen's d; p = 0.018, and medium effect size: 0.58 Cohen's d; p = 0.018, respectively), although there was an attenuation in the effect sizes in comparison with the per-protocol analysis. Lastly, results from categorical variables remained almost similar in the intention-to-treat analysis, with the exception that the @ctivehip group alone improved the anxiety domain in the EQ5D (Z = -2.36 and p = 0.018), whereas none of the two groups improved the cardiorespiratory category in the IFIS assessment (both p > 0.050).

Table 3. Within-group and between-group changes in the individual tests of quality of life and fitness level (per-protocol analysis).

Variables	Baseline						3-month assessment						Within-group change		Between-group change	
	Mean (SD)	Scores (N)					Mean (SD)	Scores (N)								
		1	2	3	4	5		1	2	3	4	5	Z	p	Z	P
Quality of life (EQ-5D)																
Mobility															-3.788	**<0.001**
Tele-rehab	2.03 (0.32)	1	27	2	-	-	1.43 (0.50)	17	13	0	-	-	-3.838	**<0.001**		
Control	2.03 (0.17)	0	33	1	-	-	1.94 (0.34)	3	30	1	-	-	-1.342	0.180		
Self-care															-2.974	**0.003**
Tele-rehab	2.30 (0.70)	4	13	13	-	-	1.37 (0.62)	21	7	2	-	-	-4.054	**<0.001**		
Control	2.12 (0.48)	2	26	26	-	-	1.82 (0.67)	11	18	5	-	-	-1.966	**0.049**		
Usual care															-3.379	**0.001**
Tele-rehab	2.47 (0.68)	3	10	17	-	-	1.37 (0.56)	20	9	1	-	-	-4.562	**<0.001**		
Control	2.32 (0.48)	0	23	11	-	-	1.94 (0.65)	8	20	6	-	-	-2.419	**0.016**		
Pain															-0.086	0.932
Tele-rehab	2.00 (0.53)	4	22	4	-	-	1.77 (0.73)	12	13	5	-	-	-1.410	0.159		
Control	1.97 (0.72)	9	17	8	-	-	1.74 (0.62)	12	19	3	-	-	-1.496	0.135		
Anxiety															-1.204	0.229
Tele-rehab	1.63 (0.62)	13	15	2	-	-	1.30 (0.70)	25	1	4	-	-	-2.357	**0.018**		
Control	1.74 (0.71)	14	15	5	-	-	1.56 (0.71)	19	11	4	-	-	-1.414	0.157		
Fitness level (IFIS)																
General fitness															-0.777	0.437
Tele-rehab	3.87 (0.97)	1	1	7	13	8	3.57 (0.82)	1	1	10	16	2	-1.403	0.161		
Control	3.56 (0.93)	0	3	16	8	7	2.97 (0.90)	3	4	19	7	1	-2.315	**0.021**		
Cardiorespiratory															-0.614	0.539
Tele-rehab	3.87 (0.82)	0	0	12	10	8	3.53 (0.86)	9	4	9	14	3	-1.895	0.058		
Control	3.41 (0.99)	0	6	14	8	6	3.18 (0.72)	0	6	16	12	0	-1.286	0.199		
Strength															-0.631	0.528
Tele-rehab	3.83 (0.75)	0	1	8	16	5	3.40 (0.89)	1	3	11	13	2	-2.057	**0.040**		
Control	3.47 (1.02)	0	6	13	8	7	2.82 (0.83)	2	9	16	7	0	-2.573	**0.010**		
Speed															-0.076	0.939
Tele-rehab	4.07 (0.83)	0	1	6	13	10	3.37 (0.89)	1	4	9	15	1	-2.976	**0.003**		
Control	3.38 (1.05)	0	8	11	9	6	2.62 (0.85)	4	9	17	4	0	-2.865	**0.004**		
Flexibility															-0.340	0.734
Tele-rehab	3.70 (1.09)	1	3	8	10	8	3.27 (0.87)	1	4	12	12	1	-2.430	**0.015**		
Control	3.29 (1.09)	1	7	13	7	6	2.71 (0.76)	3	7	21	3	0	-2.430	**0.015**		

EQ-5D scores: 1 = no problems; 2 = some problems; 3 = severe problems. IFIS scores: 1 = very poor; 2 = poor; 3 = average; 4 = good; 5 = very good.
Wilcoxon signed-rank and Mann–Whitney U were used to test within-group and between-group changes respectively. Significant differences ($p < 0.05$) are highlighted in bold

4 Discussion

This study shows the positive effect of a telerehabilitation program on quality of life, psychological factors and fitness level of patients with hip fracture. The quality of life and the fitness level of the patients who used the @ctivehip telerehabilitation increased compared with the levels of patients who received usual home-based in-person rehabilitation. The anxiety and depression in the telerehabilitation group had a greater decrease compared to the control group.

The effects of different telerehabilitation programs have been analyzed in survivors of cancer, stroke, Parkinson's or severe COPD among others.[4,26–29] However, the literature on the effects of telerehabilitation in hip fracture is very limited and the present study covers important gaps in the telerehabilitation of patients with hip fracture. For instance, none of the previous intervention studies conducted in patients with hip fracture has evaluated the effects of telerehabilitation on quality of life and physiological factors of the patients.[12,30,31] The @ctivehip telerehabilitation has demonstrated an increase in the quality of life together with a decrease in anxiety and depression symptoms at 3 months after surgery. Previous cohort studies in patients with hip fracture show that their quality of life tend to decline during the first 3 months and starts improving from the third month to the first 12 months.[32] In view of this, the improvements in the quality of life obtained in this study in just 3 months are promising. It is expected that patients with a better quality of life will face better the recovery process.[32,33] Likewise, psychosocial factors such as symptoms of depression have demonstrated to increase pain severity and emotional distress in the recovery process of the patient.[2] Although further research on this regard is still needed, improvements observed in both the quality of life and psychological factors of patients suggest a more successful recovery process derived from a telerehabilitation process.

Regarding the fitness level and functional capacity, we have identified three previous studies that report results of telerehabilitation interventions in patients

recovering from a hip fracture.[12,13,30] Kalron et al.[12] found that their telerehabilitation intervention led to greater improvements in mobility outcomes such as the 2-min walking test and walking speed in comparison with a control group that received an exercise booklet. Li et al.[30] also obtained more satisfactory results of a telerehabilitation program on the performance of ADL compared to a control group that received an exercise booklet. However, there were not significant differences between both groups in regard to other physical fitness variables. Lastly, Ortiz et al.[13], in a previous study belonging to the @ctivehip project, examined the effect of the same telerehabilitation program on functional status and objectively measured physical performance tests (i.e., Short Physical Performance Battery [SPPB] and time up and go test) in older adults with hip fracture. We found that the @ctivehip intervention had better performance in the Functional Independence Measure (FIM) score and the time up and go test in comparison with the control group, that received the usual treatment provided by the Andalusian Public Health Care System. What makes this article different is that we evaluated self-reported physical fitness, whereas the previous literature used objectively measures batteries of physical performance. Although self-reported fitness does not seem to offer a satisfactory agreement when compared to objectively measured physical fitness,[34] it has demonstrated a predictive capacity for all-cause mortality and is considered a longevity indicator.[35] Considering that objective fitness measures are often not feasible in clinical settings due to the limited time available and the need of trained staff and facilities, fitness questionnaires represent an efficient and cost-effective solution to estimate the fitness level of patients. The @ctivehip already demonstrated to be superior to the usual care in improving objectively measured physical performance; this article provides the first findings that also demonstrate improvements in self-reported fitness level.

The results of this study let us affirm that a telerehabilitation program for patients with hip fracture and their family caregivers have better results than the tradition home-

based in-person rehabilitation offered by the Andalusian Public Health Care system. Furthermore, telerehabilitation seems more attractive and interesting for individuals with difficulties in accessing hospital services.[31] Regarding cost-effectiveness, a recent trial-based economic evaluation in patients after hip replacement demonstrated that telerehabilitation reduced the in-person economic cost and time burden for rehabilitation in comparison with traditional care.[36] On the other hand, this study measured how the quality of life, the fitness level and the level of anxiety and depression varied during a period of three months, after the effect of the telerehabilitation program, unlike studies such as the one carried out by Galiano-Castillo et al.[29], who analyzed the effect of telerehabilitation for a longer period, specifically 6 months, which makes us think that it is not enough time to appreciate the changes. Future intervention trials should include longer follow-up periods.

The study is not free of limitations since the allocation of participants to the intervention group or the control group was not random. The assignment to each group was carried out depending on the patients' choice. It is possible that participants of the intervention group are those most motivated to participate, with more possibilities in terms of time and resources or more involvement in the rehabilitation process. Nevertheless, all statistical analyses were adjusted for baseline values and the sensitivity analysis were performed accounting for potential confounders (i.e., age, sex, educational level, health status before the hip fracture, duration of the hospital stay, falls in the last year and type of fracture) to address this limitation. Another limitation is that the involvement of caregivers in the recovery process was not objectively measured neither in the telerehabilitation nor control groups, which could be influencing the success of the rehabilitation and should be considered in future studies. One last limitation is the use of new technologies by patients with hip fracture, who are usually older adults with limited computers and smartphones skills.[37] In our study, the support of family caregivers covered somehow this limitation since we ensured in the initial interview that they had

minimum skills for new technologies management to support patients in the development of the @ctivehip intervention. In addition, it is important to have in mind that telerehabilitation is intended to be an alternative or a complementary treatment for those patients that have no access to appropriate face-to-face treatment with health professionals. For instance, in the cases of patients who live in rural communities with no access to rehabilitation facilities, health systems that are not currently providing an optimal rehabilitation process in hospital settings, or in health crisis such as the current Covid-19 pandemic that collapses health systems and hinders the face-to-face rehabilitation process.

5 Conclusion

This study shows that a telerehabilitation program improves the quality of life and the fitness level of patients with a hip fracture and reduces their anxiety and depression compared to patients who receive the traditional home-based in-person rehabilitation offered so far by the Andalusian Public Health Care System. In light of these results, telerehabilitation interventions seem to be a promising treatment for some patients with a hip fracture, that help overcome the difficulties of some health care systems to provide in-person rehabilitation for some patients such as those who live in the countryside.

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Conflicts of Interest

The authors declare no conflict of interest.

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7 Supplementary Files

Table S1. Baseline characteristics of the sample divided by telerehabilitation (tele-rehab.) and control group (intention-to-treat analysis).

	All sample (n=71)	Tele-rehab. (n=35)	Control (n=36)	*P*
Age (years)	78.75 ± 6.12	76.71 ± 6.04	80.72 ± 5.59	**0.005**
Weight (kg)	69.15 ± 9.12	68.61 ± 9.46	69.68 ± 8.89	0.626
Height (cm)	158.44 ± 7.87	160.38 ± 6.57	156.56 ± 8.64	**0.040**
Body mass index (kg/m^2)	27.64 ± 3.90	26.75 ± 3.93	28.52 ± 3.71	0.055
Gender				0.580
Men	18 (25%)	9 (26%)	9 (25%)	
Women	53 (75%)	26 (74%)	27 (75%)	
Quality of life (EQ5D)				
Self-perceived health (0 - 100)	57.94 ± 18.65	61.69 ± 20.12	54.31 ± 16.57	0.096
Total index (-0.65 - 1)	0.27 ± 0.36	0.24 ± 0.39	0.30 ± 0.32	0.483
Anxiety and depression (HADS)				
Total score (0 – 14)	9.35 ± 6.45	8.6 ± 5.03	10.08 ± 7.59	0.337
Anxiety (0 – 7)	5.58 ± 4.36	5.37 ± 3.85	5.78 ± 4.86	0.698
Depression (0 – 7)	3.83 ± 3.10	3.23 ± 2.57	4.42 ± 3.48	0.107
Fitness Level (IFIS)				
Total score (5 – 25)	17.9 ± 4.08	18.94 ± 3.46	16.89 ± 4.42	**0.033**

SD = standard deviation; n=sample size; IFIS: International Fitness Scale; HADS: Hospital Anxiety and Depression Scale.

Values are presented as mean ± SD or percentages. For continuous variables, p value was obtained by an independent samples T-test, whereas for categorical variables, p value was obtained by an chi-square test.

Significant differences ($p < 0.05$) are highlighted in bold.

Table S2. Intervention effects of the @ctivehip project considering baseline and 3-month assessments (intention-to-treat analysis).

	Adjusted mean (95% CI)			*P*
	Tele-rehab. (N = 34)	Control group (N = 35)	Groups difference (Rehab – Control)	
Quality of life (EQ5D)				
Self-perceived health				
Raw score	68.67 (61.7 to 75.65)	62.05 (55.17 to 68.92)	6.63 (-3.27 to 16.53)	0.186
z Score	0.58 (0.20 to 0.95)	0.22 (-0.15 to 0.59)	0.36 (-0.18 to 0.89)	
EQ5D total index				
Raw score	0.68 (0.56 to 0.79)	0.48 (0.37 to 0.59)	0.20 (0.03 to 0.36)	**0.018**
z Score	1.14 (0.82 to 1.47)	0.60 (0.28 to 0.91)	0.55 (0.10 to 1.00)	
Anxiety and depression (HADS)				
HADS total				
Raw score	0.47 (0.38 to 0.55)	0.57 (0.49 to 0.66)	-0.10 (-0.22 to 0.02)	0.091
z Score	-0.19 (-0.47 to 0.10)	0.16 (-0.12 to 0.44)	-0.35 (-0.75 to 0.06)	
HADS anxiety				
Raw score	0.47 (0.37 to 0.56)	0.58 (0.49 to 0.67)	-0.12 (-0.25 to 0.02)	0.085
z Score	-0.20 (-0.51 to 0.12)	0.19 (-0.12 to 0.50)	-0.39 (-0.83 to 0.05)	
HADS depression				
Raw score	0.49 (0.40 to 0.58)	0.56 (0.47 to 0.64)	-0.07 (-0.20 to 0.06)	0.269
z Score	-0.13 (-0.43 to 0.17)	0.11 (-0.19 to 0.41)	-0.24 (-0.67 to 0.19)	
Fitness Level (IFIS)				
IFIS total				
Raw score	16.51 (15.35 to 17.68)	14.49 (13.34 to 15.64)	2.02 (0.36 to 3.68)	**0.018**
z Score	-0.34 (-0.63 to -0.06)	-0.84 (-1.12 to -0.55)	0.50 (0.09 to 0.90)	

CI = confidence interval; n=sample size; IFIS: International Fitness Scale; HADS: Hospital Anxiety and Depression Scale.

A one-way analysis of covariance (ANCOVA) was used to test raw and z-score differences between the tele-rehab and control group at the post-intervention, adjusting for basic pre-intervention values. Adjusted means and confidence intervals of the mean are represented. Differences between groups are presented as: post-intervention mean minus pre-intervention mean. Significant differences ($p < 0.05$) are highlighted in bold.

Table S3. Within-group and between-group changes in the individual tests of quality of life and fitness level (intention-to-treat analysis).

Variables	Baseline						3-month assessment						Within-group change		Between-group change	
	Mean (SD)	Scores (N) 1	2	3	4	5	Mean (SD)	Scores (N) 1	2	3	4	5	Z	p	Z	P
Quality of life (EQ-5D)																
Mobility															-3.689	**<0.001**
Tele-rehab	2.03 (0.30)	0	35	1	-	-	1.47 (0.50)	3	32	1	-	-	-3.962	**<0.001**		
Control	2.03 (0.17)	1	32	2	-	-	1.94 (0.33)	18	17	0	-	-	-1.342	0.180		
Self-care															-2.942	**0.003**
Tele-rehab	2.29 (0.67)	2	28	6	-	-	1.39 (0.60)	13	18	5	-	-	-4.353	**<0.001**		
Control	2.11 (0.47)	4	17	14	-	-	1.79 (0.67)	23	10	2	-	-	-2.270	**0.023**		
Usual care															-3.084	**0.002**
Tele-rehab	2.43 (0.66)	0	25	11	-	-	1.42 (0.55)	9	21	6	-	-	-4.756	**<0.001**		
Control	2.31 (0.47)	3	14	18	-	-	1.91 (0.65)	21	13	1	-	-	-2.559	**0.010**		
Pain															-0.504	0.614
Tele-rehab	1.97 (0.51)	9	19	8	-	-	1.79 (0.72)	13	20	3	-	-	-1.188	0.235		
Control	1.97 (0.70)	5	26	4	-	-	1.71 (0.61)	13	16	6	-	-	-1.653	0.098		
Anxiety															-0.545	0.586
Tele-rehab	1.60 (0.60)	15	15	6	-	-	1.35 (0.73)	21	11	4	-	-	-1.964	0.050		
Control	1.75 (0.73)	16	17	2	-	-	1.53 (0.69)	28	2	5	-	-	-1.713	0.087		
Fitness Level (IFIS)																
General fitness															-0.756	0.450
Tele-rehab	3.77 (0.97)	0	3	18	8	7	3.47 (0.81)	3	4	21	7	1	-1.508	0.132		
Control	3.53 (0.91)	1	2	9	15	8	2.96 (0.88)	1	2	13	17	2	-2.315	**0.021**		
Cardiorespiratory															-0.813	0.416
Tele-rehab	3.83 (0.86)	0	6	16	8	6	3.46 (0.85)	0	6	18	12	0	-2.208	**0.027**		
Control	3.39 (0.96)	0	1	13	12	9	3.17 (0.70)	0	5	12	15	3	-1.286	0.199		
Strength															-0.296	0.767
Tele-rehab	3.74 (0.78)	0	7	14	8	7	3.31 (0.87)	2	9	18	7	0	-2.309	**0.021**		
Control	3.42 (1.03)	0	2	10	18	5	2.84 (0.82)	1	4	15	13	2	-2.434	**0.015**		
Speed															-0.012	0.991
Tele-rehab	3.94 (0.87)	0	9	12	9	6	3.27 (0.89)	4	9	19	4	0	-2.753	**0.006**		
Control	3.33 (1.04)	0	2	8	15	10	2.63 (0.83)	1	6	11	16	1	-3.089	**0.002**		
Flexibility															-0.447	0.655
Tele-rehab	3.60 (1.06)	1	7	15	7	6	3.2 (0.83)	3	7	23	3	0	-2.430	**0.015**		
Control	3.28 (1.06)	1	4	11	11	8	2.72 (0.74)	1	5	16	12	1	-2.240	**0.025**		

EQ-5D scores: 1 = no problems; 2 = some problems; 3 = severe problems. IFIS scores: 1 = very poor; 2 = poor; 3 = average; 4 = good; 5 = very good. Wilcoxon signed-rank and Mann–Whitney U were used to test within-group and between-group changes respectively. Significant differences (p,0.05) are highlighted in bold