Telerehabilitation in older adults with cardiopulmonary diseases and multimorbidity: a randomized controlled clinical trial

Telerehabilitación en adultos mayores con enfermedades cardiopulmonares y multimorbilidad: un ensayo clínico controlado aleatorizado

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Abstract

Introduction. Telerehabilitation has emerged as an innovative digital health strategy aimed at expanding healthcare access and coverage for older adults with chronic diseases, particularly in settings with limited access to conventional rehabilitation services.
Objective. To compare the effects of a multicomponent telerehabilitation program versus home-based physiotherapy on functional capacity in older adults with chronic cardiopulmonary conditions and multimorbidity.
Methods. A single-center, randomized, single-blind clinical trial was conducted with 34 older adults randomly allocated to a telerehabilitation group (n = 17) or an in-person home-based physiotherapy group (n = 17). Both groups completed supervised sessions twice weekly for 12 weeks. Physical performance was assessed using the Short Physical Performance Battery (SPPB), cardiorespiratory fitness with the Six-Minute Walk Test (6MWT), and functional flexibility with the Chair Sit-and-Reach (CSR) and Back Scratch (BS) tests.
Results: Both groups significantly improved SPPB scores ($p < .05$). The control group improved in the 6MWT ($p = .031$), while the intervention group showed greater flexibility gains ($p = .003$). No significant between-group differences were observed ($p > .05$).
Conclusion: Multicomponent exercise–based telerehabilitation produced outcomes comparable to home-based physiotherapy in physical performance, cardiorespiratory fitness, and functional flexibility among adults with cardiopulmonary disease and multimorbidity.

Keywords

Comorbidity; chronic disease; functional physical performance; multicomponent exercise; telerehabilitation.

Resumen

Introducción: La telerehabilitación se presenta como una estrategia eficaz para entregar programas de ejercicio a adultos mayores con enfermedades crónicas, especialmente en contextos con acceso limitado a servicios de salud.
Objetivo: Comparar los efectos de un programa multicomponente de telerehabilitación versus fisioterapia domiciliaria sobre la capacidad funcional en adultos mayores con enfermedades cardiopulmonares y multimorbilidad.
Métodos: Ensayo clínico aleatorizado, unicéntrico y simple ciego, con 34 participantes ≥60 años asignados a un grupo de telerehabilitación (n = 17) y a un grupo control con fisioterapia domiciliaria (n = 17). Ambos grupos realizaron sesiones supervisadas dos veces por semana durante 12 semanas. Se evaluó el rendimiento físico mediante la Short Physical Performance Battery (SPPB), la aptitud cardiorrespiratoria con el Test de Caminata de Seis Minutos (6MWT) y la flexibilidad funcional con las pruebas Chair Sit-and-Reach (CSR) y Back Scratch (BS).
Resultados: Ambos grupos mejoraron significativamente en la SPPB ($p < .05$), el grupo control mejoró en la 6MWT ($p = .031$), y el grupo intervención mostró mejoras en la flexibilidad ($p = .003$). Sin diferencias significativas entre grupos en los cambios ($p > .05$)
Conclusión: La telerehabilitación con un programa de ejercicio multicomponente logró efectos comparables a la fisioterapia domiciliaria en el rendimiento físico, aptitud cardiorrespiratoria y la flexibilidad funcional en adultos con enfermedades cardiopulmonares y multimorbilidad.

Palabras clave

Comorbilidad; ejercicio multicomponente; enfermedad crónica; rendimiento funcional físico; telerehabilitación.

Introduction

Population aging represents one of the most significant public health challenges. According to the World Health Organization (WHO), between 2015 and 2050, the proportion of people aged 60 years and older worldwide will double, increasing from 12% to 22% (Organization, 2015). This demographic transformation has led to a higher prevalence of noncommunicable diseases (NCDs), which contributed to 1.80 billion disability-adjusted life years (DALYs) in 2023, representing a substantial global burden of healthy life years lost (Hay et al., 2025). More than 37% of older adults experience multimorbidity, defined as the coexistence of two or more chronic conditions. is associated with increased disability, frequent hospitalizations, and premature mortality. (Chowdhury et al., 2023; Moffat & Mercer, 2015).

The progressive decline in physical function is one of the most clinically relevant consequences of multimorbidity in this population. The objective assessment of functional performance has been strengthened through instruments such as the Short Physical Performance Battery (SPPB), which integrates tests of balance, gait speed, and lower limb muscle strength. Low SPPB scores (< 8 points) have been consistently associated with frailty, increased risk of hospitalization, institutionalization, and mortality(Guralnik et al., 1994; Pavasini et al., 2016).

Among the most evidence-supported interventions are multicomponent exercise programs, which combine aerobic, resistance, balance, and flexibility training(Ozemek et al., 2025). Even among older adults with multiple comorbidities, these interventions have demonstrated significant improvements in functional capacity, mobility, autonomy, and quality of life(Cadore et al., 2013). Moreover, they are considered safe and adaptable strategies that can be individualized according to each patient's clinical condition and functional level.

The expansion of telerehabilitation defined as the remote delivery of rehabilitation services through information and communication technologies has opened new opportunities to implement these programs in an accessible and cost-effective manner(Richmond et al., 2017). Emerging evidence suggests that telerehabilitation may be as effective as face-to-face rehabilitation for older adults with chronic conditions, representing a viable and efficient strategy to overcome traditional access barriers (Gamble et al., 2023; Wicks & al., 2023).

Geographical barriers, inequities in access to specialized services, and structural limitations within healthcare systems continue to restrict participation in conventional rehabilitation programs. Globally, in 2019, 2.41 billion people had one or more conditions that could benefit from rehabilitation. It is estimated that at least one in three individuals worldwide will require rehabilitation at some point during the course of illness. However, rehabilitation remains underprioritized and underfunded in many countries (Cieza et al., 2020). In this context, telerehabilitation represents a feasible and potentially effective alternative to conventional care across diverse clinical populations. A 2025 randomized controlled trial on telerehabilitation for carpal tunnel syndrome found improvements in pain and function comparable to conventional therapy, supporting its potential to reduce healthcare burden. This trial supports the development of more patient-centered, sustainable, and accessible care models, demonstrating the effectiveness of this approach in a clinically vulnerable population(Hassan et al., 2025).

Therefore, this study aimed to compare the effects of a multicomponent telerehabilitation program versus face-to-face home-based physiotherapy on functional capacity in older adults with chronic cardiopulmonary conditions and multimorbidity.

Method

This was a single-center, single-blind, randomized controlled trial (RCT). The study was designed in accordance with the CONSORT (Consolidated Standards of Reporting Trials) guidelines to ensure transparency in clinical trial reporting (Schulz et al., 2010). Additionally, the TIDieR (Template for Intervention Description and Replication) checklist was used to support clarity and replicability(Hoffmann et al., 2014). The study also followed the recommendations proposed by Page et al. to improve the reporting of therapeutic exercise interventions in rehabilitation research (Page et al., 2017).

The study was approved by the ethics committee of the International Iberoamerican University (approval code: CR-222) and conducted in accordance with the Declaration of Helsinki. The protocol was registered at https://clinicaltrials.gov/study/ (identifier: NCT07299786) (Betancur Bedoya, 2025). Participants were selected through convenience sampling between January 2024 and October 2025.

Participants

A total of 34 participants were recruited through open calls promoted by the university's academic programs. Inclusion criteria consisted of adults over 60 years of age with stable cardiac or pulmonary conditions (Stable cardiac or pulmonary conditions mean chronic heart or lung issues managed long-term, without acute worsening, involving predictable symptoms like stable angina (predictable chest pain with exertion) or stable COPD (not in an exacerbation), and multimorbidity, previously assessed in person by a physiotherapist. Clinical eligibility criteria were based on guidelines from the American Heart Association (AHA) and the American College of Sports Medicine (ACSM) (Ozemek et al., 2025). All participants had medically controlled cardiopulmonary chronic conditions and no contraindications to physical exercise.

Exclusion criteria included dependence on assistive walking devices or any exacerbation of chronic conditions in the past six months. Convenience sampling was used to recruit participants based on practical considerations. Group assignment was stratified by participants' sex and primary diagnosis and subsequently randomized. Seventeen participants were allocated to the control group (CG) (multicomponent home-based physiotherapy) and seventeen to the intervention group (IG) (telerehabilitation).

Procedure

Preparatory Phase

After signing the informed consent, each patient was assigned to a rehabilitation team composed of licensed physiotherapists and physiotherapy students in their final stage of training: one responsible for data management, two responsible for supervising and delivering the intervention sessions, and one responsible for assessments and session scheduling. All activities were supervised by a licensed physiotherapist specialized in cardiopulmonary rehabilitation or related areas.

The intervention group (IG) received exercise sessions twice weekly for three months, delivered via video calls through Microsoft Teams. The control group (CG) followed a multicomponent, home-based, face-to-face program, also twice weekly, administered by the same trained research team.

Individualized instructions for creating email accounts and using the Microsoft Teams platform were provided to participants requiring assistance. To facilitate communication between participants and the rehabilitation team, a WhatsApp group was established. To minimize assessment bias, outcome assessors remained blinded to group allocation. To reduce intervention-related risks, the delivery of both interventions was framed within routine service provision and supervised academic training activities.

Exercise Protocol (Both Groups)

Each session lasted 45 to 60 minutes and included monitoring of vital signs at the beginning and end, specifically heart rate (HR), blood pressure (BP), peripheral oxygen saturation (SpO_2), and, in participants with diabetes, capillary glucose levels. Exercise intensity was controlled using heart rate (HR) and the Borg CR10, OMNI-RES, and PERFLEX visual scales.

In the intervention group (IG), participants performed home self-monitoring, and the values were displayed on the devices and reported in real time. Heart rate (HR) and SpO_2 were monitored by pulse oximetry every 15 minutes, with continuous or more frequent monitoring when clinically indicated by the physiotherapist. Rating scales were assessed when exercise modality changed or when clinically indicated.

Exercise progression was individualized. The first four weeks constituted an adaptation phase at light to moderate intensity. From week four onward, workload was progressively increased weekly based on physiological responses (HR, SpO_2, BP) and exercise tolerance. SpO_2 was maintained at ≥90%, except in participants with chronic CO_2 retention (baseline range 88–90%). Intensity was adjusted to maintain perceived exertion and dyspnea below 8 points on the Borg scale.

Aerobic component

Moderate intensity (5–6 on the Borg scale), with target heart rate set at ≥10 bpm below 70–80% of maximum heart rate calculated using the Karvonen method or the Tanaka equation, or ≥20 bpm below the target range in participants receiving negative chronotropic medication. Progression up to 8 on the Borg scale was permitted if tolerated. The exercises included stationary walking, skipping, and indoor walking circuits.

Strength and endurance component

Moderate intensity (5–6 on the OMNI Resistance Exercise Scale). Exercises included dumbbells, elastic bands, household objects, and bodyweight exercises(Colado et al., 2018).

Flexibility component

Intensity ranged from 30–80 points on the PERFLEX (Perceived Flexibility Scale), progressing from static to dynamic exercises for upper and lower limbs, with stretches held for 30–60 seconds per exercise(Dantas et al., 2008).

Balance and coordination component

Intensity was adjusted according to postural demand and neuromotor challenge. Progression was achieved by increasing task complexity according to individual tolerance and performance. Exercises included static and dynamic balance tasks, reduced base of support activities, unstable surface training, and functional gait activities.

Outcomes

Both groups were evaluated in person at the participants' homes at the beginning and end of the intervention.

The Short Physical Performance Battery (SPPB) is a validated instrument used to assess physical performance, defined as the observable ability to perform standardized functional tasks integrating strength, balance, and mobility (Guralnik et al., 1994). It demonstrates high test–retest reliability (ICC > 0.80) and adequate construct validity (Gómez et al., 2013)2013). In remote assessment contexts, the SPPB total score shows moderate agreement with in-person measurements (ICC 0.51–0.67) when standardized protocols are applied(Fyfe et al., 2025).

Cardiorespiratory fitness was assessed using the six-minute walk test (6MWT), a practical and widely recommended test with excellent reproducibility and validity in patients with cardiopulmonary conditions(Pollentier et al., 2010). Distance was recorded in meters; an increase in the value indicates functional improvement.

Functional flexibility, defined as the range of joint motion required for independent functioning in older adults, was assessed using the Chair Sit-and-Reach and Back Scratch tests from the Senior Fitness Test battery. This battery demonstrates adequate internal consistency (Cronbach's alpha = 0.708) and high reproducibility (ICC 0.851–0.960; 95% CI; $p < 0.005$) in the Colombian population (Cobo-Mejía et al., 2016). Measurements were expressed in centimeters; a decrease in the value or the presence of negative values indicates functional improvement.

Data analysis

Statistical analysis was performed using JASP software, version 2.6 (JASP Team, University of Amsterdam, Netherlands) (project, 2024). Descriptive statistics (mean, standard deviation, and frequencies) were used to characterize the sample. Between-group comparisons were made using parametric or non-parametric tests depending on data distribution (independent t test or Mann–Whitney U test). Within-group comparisons were made using paired t tests or Wilcoxon signed-rank tests. 95% confidence intervals (CI) and p-values were reported. Effect sizes were calculated using Cohen's d. A significance level of $p < 0.05$ was considered statistically significant.

Results

Both groups showed a similar sex distribution, with a mean age of 76.0 ± 8.72 years in the IG and 74.6 ± 9.88 years in the CG. No significant differences were found between the groups in sociodemographic,

clinical, or functional variables at baseline. The main comorbidities identified included hypertension, pulmonary hypertension, dyslipidemia, obesity, renal disease, myocardial infarction, peripheral vascular disease, mild liver disease, and diabetes mellitus with or without organ involvement. Given the clinical heterogeneity of the sample, the Charlson Comorbidity Index (CCI)(Charlson et al., 2008) was calculated as a global measure of disease burden. The IG had a mean CCI of 7.57 ± 1.36, while the CG showed a mean of 7.11 ± 1.45 (see Table 1).

Table 1. Baseline Sociodemographic, Clinical, and Functional Characteristics of Participants.

	Intervention Group (IG)	Control Group (CG)	P value
Sex	Male = 6 (18.2%) Female = 11 (33.3%)	Male = 7 (21.2%) Female = 9 (27.3%)	
Age[1]	M = 76.00, SD = 8.72	M = 74.56, SD = 9.88	0.6622
Height (m)	Md = 1.55, IQR = 0.13	Md = 1.58, IQR = 0.13	
Weight (kg)	Md = 64.00, IQR = 18.00	Md = 66.00, IQR = 11.50	
BMI	Md = 27.29, IQR = 5.02	Md = 27.21, IQR = 3.28	
Main Diagnosis	CAD = 7 (41.2%) COPD = 6 (35.3%) HF = 3 (17.6%) Asthma = 1 (5.9%)	CAD = 7 (43.8%) COPD = 5 (31.2%) HF = 3 (18.8%)Asthma = 1 (6.2%)	
Education Level	Primary = 6 (35.3%) High school = 7 (41.2%) Technical = 2 (11.8%) Undergrad = 1 (5.9%) Postgrad = 1 (5.9%)	Primary = 8 (50.0%) High school = 4 (25.0%) Technical = 3 (18.8%) Undergrad = 1 (6.2%) Postgrad = 0 (0.0%)	
Socioeconomic Status	1 Very low = 0 (0%) 2 Low = 5 (29.4%) 3 Lower-middle = 5 (29.4%) 4 Middle = 4 (23.5%) 5 Upper-middle = 3 (17.6%) 6 High = 0 (0%)	1 Very low = 1 (6.2%) 2 Low = 4 (25.0%) 3 Lower-middle = 6 (37.5%) 4 Middle = 3 (18.8%) 5 Upper-middle = 2 (12.5%) 6 High = 0 (0%)	
SPPB – Balance	3.0 (IQR: 1.0)	3.0 (IQR: 2.0)	0.530[1]
SPPB – Chair and Stand	2.0 (IQR: 2.0)	3.0 (IQR: 1.0)	0.210[1]
SPPB – Gait Speed	3.0 (IQR: 0.0)	3.0 (IQR: 1.0)	0.373[1]
SPPB – Total Score	8.24 ± 1.95	7.94 ± 2.38	0.696[2]
6-min. walk test (m)	245 (IQR: 99.0)	313 (IQR: 135.0)	0.201[1]
Chair sit-and-reach (cm)	−4.0 (IQR: 10.0)	0.0 (IQR: 6.0)	0.175[1]
Back Scratch (cm)	−12.0 (IQR: 13.0)	−7.0 (IQR: 14.0)	0.857[1]

Note. IG = Intervention Group; CG = Control Group; M = Mean; SD = Standard Deviation; Md= Median; IQR = Interquartile Range; CAD = Coronary Artery Disease; COPD = Chronic Obstructive Pulmonary Disease; HF = Heart Failure; SPPB = Short Physical Performance Battery; *m* = meters; *cm* = centimeters.
[1] p value calculated using the Mann–Whitney U test.
[2] p value calculated using the independent samples t-test.

Balance (using the SPPB balance score)

Both groups showed statistically significant improvements following the intervention, with large effect sizes (IG: p = 0.004; d = 0.83; CG: p = 0.001; d = 0.98). No statistically significant between-group differences were observed (p = 0.251).

Lower Limb Strength (using the Chair Stand test)

Both groups showed statistically significant improvements with moderate effect sizes (IG: p = 0.008; d = 0.74; CG: p = 0.029; d = 0.60). The between-group comparison did not reach statistical significance (p = 0.481).

Gait Speed (using the SPPB gait speed score)

Both groups improved statistically significantly (IG: p = 0.001; d = 0.95; CG: p < 0.001; d = 1.08), with large effect sizes. No significant between-group differences were detected (p = 0.717).

Overall Physical Performance (using the SPPB Total Score)

Significant improvements were found in both groups (IG: p < 0.001, d = 1.30; CG: p < 0.001, d = 1.45). The between-group comparison was not statistically significant (p = 0.930).

Cardiorespiratory fitness (using the 6-Minute Walk Test)

Only the CG showed a statistically significant improvement (p = 0.031; d = 0.60), although the IG also showed an increase in walking distance, this change did not reach statistical significance (p = 0.231; d = 0.30). However, no significant between-group differences were found (p = 0.176).

Flexibility (using the Chair Sit-and-Reach /Back scratch test)

In the Chair Sit-and-Reach test, IG showed a non-significant trend toward improvement (p = 0.076; d = 0.46), with a near-significant between-group difference (p = 0.056). These findings suggest a trend favoring the telerehabilitation group, although statistical significance was not reached. In the back-scratch test, only the IG demonstrated a significant improvement (p = 0.003; d = 0.85), although no significant between-group differences were observed (p = 0.805) (see Table 2).

Table 2. Pre–Post Comparison of Functional Outcomes Within and Between Groups.

	IG Pre → Post	CG Pre → Post	p Intergroup
SPPB – Balance	3.12 ± 0.78 → 3.71 ± 0.47, p = 0.004[2]	2.75 ± 1.24 → 3.44 ± 0.81, p = 0.001[2]	p = 0.251[3]
SPPB – Chair and Stand	2.18 ± 0.95 → 2.71 ± 1.16, p = 0.008[2]	2.56 ± 1.03 → 3.00 ± 1.21, p = 0.029[2]	p = 0.481[3]
SPPB – Gait Speed	2.94 ± 0.83 → 3.53 ± 0.72, p = 0.001[2]	2.63 ± 0.96 → 3.44 ± 0.73, p < 0.001[2]	p = 0.717[3]
SPPB – Total Score	8.24 ± 1.95 → 9.94 ± 1.82, p < 0.001[1]	7.94 ± 2.38 → 9.88 ± 2.42, p < 0.001[2]	p = 0.930[3]
6-min. walk test (m)	283.82 ± 120.18 → 298.82 ± 114.77, p = 0.231[1]	353.00 ± 207.03 → 376.69 ± 199.48, p = 0.031[2]	p = 0.176[3]
Chair sit-and-reach (cm)	−5.82 ± 8.64 → −3.59 ± 4.26, p = 0.076[2]	−1.94 ± 5.80 → −1.06 ± 2.89, p = 0.353[2]	p = 0.056[3]
Back Scratch (cm)	−10.85 ± 7.66 → −8.56 ± 6.29, p = 0.003[2]	−9.69 ± 9.21 → −9.13 ± 6.75, p = 0.711[2]	p = 0.805[3]

Note. IG = Intervention Group; CG = Control Group; M = Mean; SD = Standard Deviation; Md= Median; IQR = Interquartile Range; CAD = Coronary Artery Disease; COPD = Chronic Obstructive Pulmonary Disease; HF = Heart Failure; SPPB = Short Physical Performance Battery; m = meters; cm = centimeters.
[1] p value calculated using the Mann–Whitney U test.
[2] p value calculated using the independent samples t-test.

An analysis of covariance (ANCOVA) was performed (see Table 4) to control for baseline differences in functional performance, using baseline values as covariates. For overall physical performance (SPPB Total Score), no statistically significant differences were found between the intervention and control groups (p = 0.703, η^2p = 0.005). However, baseline SPPB score had a highly significant effect on post-intervention performance (p < 0.001, η^2p = 0.656), indicating that initial functional status significantly influenced the final outcomes. The model assumptions were met, with normality (p = .438) and homogeneity of variances (p = 0.509) confirmed (see Table 3).

Table 3. ANCOVA Results for Functional Outcomes Adjusted by Baseline Performance.

	Source Of Variation	SS	df	MS	F	p	η^2p
SPPB Total Score	Group (IG vs. CG)	0.239	1	0.239	0.148	0.703	0.005
	Covariate (SPPB Pre)	92.342	1	92.342	57.297	< .001	0.656
6-Min. Walk Test (M)	Group (IG vs. CG)	254	1	254	0.138	0.713	0.006
	6MWT Pre	663,475	1	663,475	360.702	< .001	0.938
	Main diagnosis	6,850	3	2,283	1.241	0.317	0.134
	Group × Diagnosis	6,903	3	2,301	1.251	0.313	0.135

Note. IG = Intervention Group; CG = Control Group;
SS = Sum of Squares; df = Degrees of Freedom; MS = Mean Square; F = F-ratio; p = p value; η^2p = Partial Eta Squared (effect size);
SPPB = Short Physical Performance Battery; 6MWT = Six-Minute Walk Test; M = meters.
Significance threshold set at p < .05.

Similarly, the ANCOVA for cardiorespiratory fitness (6-Minute Walk Test) revealed no significant between-group effect (p = 0.713, η^2p = 0.006). Pre-intervention walking distance demonstrated a strong predictive effect on post-intervention outcomes (p <0.001, η^2p = 0.938). Neither primary diagnosis (p = 0.317) nor the group-by-diagnosis interaction (p = 0.313) showed statistically significant effects.

Overall, these findings indicate that baseline functional capacity, rather than the type of intervention delivered, accounted for a substantial proportion of the observed improvements in walking performance and overall physical function. Baseline performance has been identified as a key predictor of responsiveness to exercise-based interventions, reflecting physiological reserve, neuromuscular capacity, and adaptability to training stimuli. In this context, the absence of between-group differences suggests

that telerehabilitation and home-based face-to-face physiotherapy were similarly effective, and that improvements were primarily influenced by participants' initial functional status rather than by the mode of intervention delivery.

No clinically relevant adverse events were reported in either group, apart from mild fatigue or transient muscle soreness.

Discussion

The effects of a multicomponent exercise program delivered via telerehabilitation were evaluated, compared with face-to-face home-based physiotherapy, on physical performance, cardiorespiratory fitness, and functional flexibility in older adults with multiple chronic conditions. The results indicate that both intervention modalities produced functional improvements, with no statistically significant differences between groups.

The internal validity of the analysis was strengthened by the similarity of baseline sociodemographic, clinical, and functional characteristics between groups. Therefore, the observed changes are likely attributable to the interventions rather than to baseline imbalances, supporting the effectiveness of both modalities given the absence of significant differences in age, primary diagnosis, educational level, and initial functional performance.

Both the telerehabilitation and home-based physiotherapy groups demonstrated statistically significant and clinically meaningful improvements. These findings reinforce the effectiveness of multicomponent exercise programs in older adults with chronic conditions. The moderate-to-large effect sizes observed are consistent with those reported in meta-analyses of exercise interventions in older populations, which describe comparable improvements in gait speed and overall physical performance (Di Lorito et al., 2021; Solis-Navarro et al., 2022).

Improvements in balance, lower limb strength, gait speed, and overall physical performance (SPPB) were statistically significant within each group, with moderate-to-large effect sizes. However, no statistically significant between-group differences were detected, suggesting that telerehabilitation may be as effective as face-to-face supervision for improving functional status. This is consistent with systematic reviews that found no inferiority of telerehabilitation compared to face-to-face therapy in older adults(Wicks & al., 2023).

Aerobic capacity, assessed using the 6MWT, improved in both groups; however, statistically significant changes were observed only in the control group. This finding may be related to challenges in ensuring optimal cardiovascular intensity in a remote setting, as well as limitations within the home environment.

The IG increased by an average of +15.0 ± 49.7 m, and the CG by +23.7 ± 39.8 m. These changes approach the minimum clinically important difference (MCID) proposed by Bohannon et al. (14–30.5 m)(Bohannon & Crouch, 2017). However, according to Daynes et al., MCID values may vary by clinical population, with reported thresholds of 25 m (24–26) for respiratory conditions, 23 m (8–37) for cardiac conditions, and 37 m (26–49) for other conditions(Daynes et al., 2025). Therefore, the clinical relevance of the observed improvements should be interpreted cautiously.

Based on the 6MWT, estimates were calculated for predicted percentages according to Troosters, maximal METs, METs at ventilatory threshold (VT)(Porcari et al., 2021), and mean peak VO_2(Ross et al., 2010). Both groups showed improvements in aerobic capacity after the intervention. In the IG, significant improvements were observed in maximal METs (4.05 ± 2.22 to 4.52 ± 2.28; $p < 0.001$; $d = -1.52$) and VT METs (2.82 ± 1.59 to 3.26 ± 1.54; $p = 0.007$; $d = -0.75$), whereas predicted percentage and peak VO_2 did not reach statistical significance: % Troosters (71.8 ± 39.1 % to 76.9 ± 38.0 %; $p = 0.032$), maximal METs ($p < 0.001$), VT METs ($p = 0.003$), and peak VO_2 (13.07 ± 4.76 to 13.61 ± 4.59 $mL \cdot kg^{-1} \cdot min^{-1}$; $p = 0.031$). Effects were moderate to large in both groups and confirmed by non-parametric tests. However, no significant differences were found between groups ($p > 0.05$), further supporting the benefit of multicomponent exercise regardless of delivery modality.

Regarding flexibility, the intervention group showed significant intragroup improvements in the Back Scratch test, while the Chair Sit-and-Reach test demonstrated a non-significant positive trend. This may

reflect the greater difficulty in providing precise biomechanical corrections and manual facilitation in remote settings. Nevertheless, no statistically significant between-group differences were observed, indicating comparable flexibility outcomes across modalities. These results are consistent with the meta-analysis by Siu-Shing Man et al., which reviewed 19 studies and found that telerehabilitation was more effective than in-person therapy, especially in older women and in interventions shorter than 12 weeks, with notable improvements in musculoskeletal and emotional areas ($p < 0.01$) (Man et al., 2024).

Overall, the results are consistent with the available evidence demonstrating the non-inferiority of telerehabilitation compared to in-person rehabilitation. The meta-analysis by Ramachandran et al, with 2869 patients with ischemic heart disease, showed significant improvement compared to usual care in the 6MWT distance (MD 25.58 m; 95% CI: 14.74–36.42), with no differences compared to phase 2 in-person rehabilitation(Ramachandran et al., 2022). Similarly, Ora et al, in 758 patients with COPD, reported an improvement of 48 m in the 6MWT (95% CI: 24–72; $p<0.001$) compared to no rehabilitation, with no differences compared to in-person programs ($p>0.5$)(Ora et al., 2022). The Cochrane review by Cox et al, which included 1904 patients with chronic respiratory disease, concluded that there is little or no difference in functional capacity between telerehabilitation and in-person rehabilitation (MD 0.06 m; 95% CI: −10.82 to 10.94; moderate evidence), in addition to higher adherence rates (93% vs. 70%)(Cox et al., 2021).

Covariance analyses confirmed that baseline functional performance was the primary factor associated with the magnitude of improvement in both the SPPB and the 6MWT outcomes. This underscores the importance of considering initial functional status when designing interventions and setting realistic outcome expectations. The absence of a significant effect of intervention modality suggests that telerehabilitation is comparably effective, particularly among individuals with a minimum level of baseline functional capacity. These results are consistent with those reported by Carrrasco P, who reported that better baseline functional status predicts greater functional recovery and lower dependence at discharge and at three months of follow-up(Carrasco Paniagua et al., 2022).

These findings support the implementation of remote physical rehabilitation programs as a valid alternative that does not compromise the quality of functional outcomes, particularly in contexts where access to these services is limited and among populations with mobility or transportation difficulties.

Only one participant withdrew from the study after the first follow-up. Their withdrawal was attributed to a lack of time and was unrelated to the study or the intervention, which led to their exclusion from the statistical analysis. This represents a dropout rate of 2.9%, which is considerably low and consistent with the findings of Collins et al., who reported that 40% of dropouts in structured exercise interventions were due to lack of time, particularly during the initial phase or when the prescribed exercise volume and intensity were increased(Collins et al., 2022).

Future research should strengthen education on healthy lifestyle habits to enhance knowledge acquisition and promote sustained behavioral change in older adults over the long term, in line with findings reported by Roldán, who demonstrated statistically significant improvements in cardiovascular risk knowledge and healthy lifestyle behaviors following educational interventions(Echeverri et al., 2019).

This study had limitations related to sample size and duration of follow-up. The relatively small number of participants may limit the generalizability of the results and increase the influence of interindividual variability. Additionally, the absence of long-term follow-up prevents assessing the persistence of functional improvements over time. Future studies should include larger and more diverse samples, longer follow-up periods, and comprehensive reporting of exercise parameters following TIDieR recommendations (Hoffmann et al., 2014) including exercise type, dosage, intensity, and progression, as well as the use of standardized terminology to describe exercise intensity regardless of the delivery modality(Bishop et al., 2025). These improvements would strengthen the evidence base and support the scalability of telerehabilitation programs for older adults with chronic conditions.

Conclusions

Telerehabilitation delivered through a structured multicomponent exercise program demonstrated effects comparable to those of face-to-face home-based physiotherapy on physical performance, cardiorespiratory fitness, and functional flexibility in older adults with chronic diseases and multimorbidity. These findings suggest the feasibility and clinical applicability of telerehabilitation as an alternative mode of delivery in this population.

Although performance-based tests such as the 6MWT and Chair Sit-and-Reach may benefit from enhanced monitoring strategies, including the integration of wearable technologies or hybrid supervision models, to optimize training stimulus and maximize clinical impact.

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