SYSTEMATIC REVIEW

Effectiveness of home-based exercise delivered by digital health in older adults: a systematic review and meta-analysis

LILIAN SOLIS-NAVARRO[1,2,3], AINA GISMERO[2], CARLES FERNÁNDEZ-JANÉ[2], RODRIGO TORRES-CASTRO[3,4,5], MIREIA SOLÁ-MADURELL[6], CLARA BERGÉ[7], LAURA MÓNICA PÉREZ[8], JOAN ARS[8,9], CARME MARTÍN-BORRÀS[1,10], JORDI VILARÓ[2], MERCÈ SITJÀ-RABERT[2]

[1]Departmentof Physical Therapy, Facultat Ciències de la Salut Blanquerna, Universitat Ramon Llull, Barcelona, Spain
[2]Global Research on Wellbeing (GRoW), Facultat Ciències de la Salut Blanquerna, Universitat Ramon Llull, Barcelona, Spain
[3]Department of Physical Therapy, University of Chile, Santiago, Chile
[4]Institut d'Investigacions Biomèdiques August Pi i Sunyer (IDIBAPS), Barcelona, Spain
[5]Department of Pulmonary Medicine, Hospital Clínic, University of Barcelona, Barcelona, Spain
[6]Associació de Dones no Estàndards, Barcelona, Spain
[7]Department of Physiotherapy, School of Health Sciences, TecnoCampus-Pompeu Fabra University, Barcelona, Spain
[8]RE-FiT Barcelona Research Group, Vall d'Hebron Institute of Research & Parc Sanitari Pere Virgili, Barcelona, Spain
[9]Medicine Department, Universitat Autonoma de Barcelona, Barcelona, Spain
[10]Facultat de Psicologia, Ciències de l'Educació i l'Esport (FPCEE), Universitat Ramon Llull, Barcelona, Spain

Address correspondence to: Mercé Sitjà-Rabert, Global Research on Wellbeing (GRoW), Facultat Ciències de la Salut Blanquerna, Universitat Ramon Llull, Barcelona, Spain. Tel: +(34) 932533256. Email: mercesr@blanquerna.url.edu

Abstract

Background: regular physical exercise is essential to maintain or improve functional capacity in older adults. Multimorbidity, functional limitation, social barriers and currently, coronavirus disease of 2019, among others, have increased the need for home-based exercise (HBE) programmes and digital health interventions (DHI). Our objective was to evaluate the effectiveness of HBE programs delivered by DHI on physical function, health-related quality of life (HRQoL) improvement and falls reduction in older adults.
Design: systematic review and meta-analysis.
Participants: community-dwelling older adults over 65 years.
Intervention: exercises at home through DHI.
Outcomes measures: physical function, HRQoL and falls.
Results: twenty-six studies have met the inclusion criteria, including 5,133 participants (range age 69.5 ± 4.0–83.0 ± 6.7). The HBE programmes delivered with DHI improve muscular strength (five times sit-to-stand test, -0.56 s, 95% confidence interval, CI -1.00 to -0.11; $P = 0.01$), functional capacity (Barthel index, 5.01 points, 95% CI 0.24–9.79; $P = 0.04$) and HRQoL (SMD 0.18; 95% CI 0.05–0.30; $P = 0.004$); and reduce events of falls (odds ratio, OR 0.77, 95% CI 0.64–0.93; $P = 0.008$). In addition, in the subgroup analysis, older adults with diseases improve mobility (SMD -0.23; 95% CI -0.45 to -0.01; $P = 0.04$), and balance (SMD 0.28; 95% CI 0.09–0.48; $P = 0.004$).
Conclusion: the HBE programmes carried out by DHI improve physical function in terms of lower extremity strength and functional capacity. It also significantly reduces the number of falls and improves the HRQoL. In addition, in analysis of only older adults with diseases, it also improves the balance and mobility.

Keywords: Home-based exercise, older adults, digital health intervention, physical function, systematic review, older people

Key points

- Regular physical exercise is essential to maintain or improve functional capacity in older adults.
- No systematic review focuses on the effects of home-based exercise (HBE) delivered with digital health interventions (DHI) on physical function.
- Home-based exercise (HBE) programmes carried out by using digital health interventions (DHI) improved physical function and reduced the falls in older adults.
- In older adults with diseases, home-based exercise (HBE) using digital health interventions (DHI) improves the balance and mobility

Introduction

The older population is growing worldwide. Between 2015 and 2050, the proportion of the world's population over 60 years will nearly double from 12 to 22% [1]. The challenge for this population is to achieve healthy ageing [1]. The clinical guidelines widely report recommendations for physical activity as a central axis of healthy ageing [2, 3]. Regular exercise leads to ageing actively and satisfactorily because it is associated with physical, functional, psychological and cognitive improvement [4]. Moreover, physical exercise is the basis for treating many diseases, such as hypertension, stroke, osteoporosis, metabolic syndrome, obesity, cancer and depression, among others [4–6].

Different aspects of physical functioning deteriorate with increased age and physical inactivity [7]. Therefore, regular physical exercise is essential for healthy ageing. It can help prevent or manage many costly chronic diseases that affect older adults. It can also reduce the risk of developing functional limitations and premature death [4]. In addition the World Health Organisation (WHO) states that older people over 65 years old should dedicate 150 min a week to do moderate physical activity or 75 min of vigorous physical activity [2].

Physical exercise is a planned, structured and repetitive physical activity done to improve and/or maintain one or more of the basic capacities of physical fitness [8]. The physical function should be assessed in older adults with objectively quantitative measures, which include: muscular strength, gait speed, balance, mobility, cardiorespiratory endurance, physical performance and functional capacity [5, 9, 10].

This physical exercise can be performed in different scenarios such as rehabilitation centres, gym's, public parks or at home. The exercise programme is considered home-based if the physical exercise is performed in an informal and flexible place such as the individual's house. The programme, should have clear goals and include monitoring, follow-up visits, calls from health professionals or self-monitoring diaries [11].

Digital health intervention (DHI) is the use of digital, mobile and wireless technologies to support the achievement of health objectives [12]. It describes the general use of information and communications technologies (ICT) for health and includes mHealth and eHealth [12]. DHI combined with physical exercise may be an opportunity to promote more active and healthy ageing [13]. The coronavirus disease of 2019 pandemic has shown how important it is to make good use of it and have clear information about its effectiveness, especially in a population where the digital divide is still a reality [14].

There are currently different studies on the effects of DHI and exercise in older people, although no systematic review focuses on the effects on physical function. The main objective of this systematic review is to evaluate the effects of home-based exercise (HBE) programmes delivered with DHI on physical function in community-dwelling older adults.

Methods

Protocol and registration

We performed a systematic review using Preferred Reporting Items for Systematic Reviews and Meta-analyses (PRISMA) guidelines [15]. The review was registered in the International Prospective Register of Systematic Reviews (PROSPERO) CRD42021192499.

Criteria for considering the studies in this review

We included randomised clinical trials (RCTs) in older adults over 65 years of age who participate in HBE programmes delivered with DHI. We included studies if they fulfilled the following criteria: (i) original research; (ii) people older than 65 years; (iii) reported intervention of HBE programme; (iv) used a DHI and (v) reported a physical function measure.

The main outcome was the physical function within which was considered: muscle strength, gait speed, balance, mobility, cardiorespiratory endurance or physical performance tests [16]. The secondary outcomes were functional ability, health-related quality of life (HRQoL), falls and adherence to treatment. DHI includes those related to the internet, for example the use of telephone calls, and video games, when these play a significant role in the delivery and dosage of the exercise programme.

Search strategies and data resources

We reviewed six databases: Embase, PubMed/MEDLINE, CINAHL, Web of Science, Cochrane Central Register of Controlled Trials (CENTRAL) and ScienceDirect from their inception to 1 December 2021. We imposed no language or publication restrictions.

The terms selected were combined using Boolean logical operators (OR, AND and NOT). Moreover, we did a manual search of the references that were included in the selected articles.

Reviewing procedure and study selection

Two investigators (LSN–AG) performed the review independently. The 1st step consisted of reviewing the titles and abstracts of all the references retrieved by the database searches (LSN–AG) and identifying the studies that met the inclusion criteria. Next, we selected all articles that were deemed potentially eligible by at least one of the reviewers. In the 2nd step, the reviewed the full texts, and a decision on inclusion or exclusion was made according to the predefined selection criteria (LSN–AG). A 3rd reviewer (MSR) solved any disagreement in any step. All studies that did not fulfil the predefined criteria were excluded, and their bibliographic details were listed with the specific reason for exclusion.

Data extraction

Two authors (LSN–AG) extracted the data independently and in duplicate, using a standardised protocol and reporting forms. The following information was extracted from each included study: author(s), year of publication, publication details, population characteristics (sample size, age and gender), type of physical exercise performed and typology of DHI, description of the test, test/scale for each variable and a description of the results. This compilation was done using the COVIDENCE© platform [17]. If some relevant data were not included in the article, the author was contacted to request the information.

Methodological quality assessment

An assessment of the methodological quality of the primary articles was carried out using the Cochrane Collaboration tool for assessing the risk of bias (the Cochrane Handbook for Systematic Reviews of Interventions; [18]). Two reviewers (CF–MS) independently assessed the risk of bias of the studies. A 3rd author (RTC) was consulted for discrepancies that could not be resolved.

Data synthesis and analysis

We reported summaries of the association between the interventions and the outcomes for each study in terms of the mean differences of absolute values. We obtained combined measurements of effect for each primary outcome through meta-analysis under a random-effect model due to the expected heterogeneity between the studies. Statistical heterogeneity was measured through the I^2 statistic and classified as low ($I^2 < 25\%$), moderate (I^2 25–50%) or high ($I^2 > 50\%$) [18]. Subgroup analysis was performed (whenever possible) according to type of population classifying the intervention in healthy older adults or with diseases depending on the population described by the author.

Results

Study selection

From the 4,323 identified references, 26 articles were finally included. We removed 1,176 duplicated studies and screened 3,147 studies. Finally, we had 167 studies assessed based on the full text. We excluded 84 studies for wrong populations, 26 for wrong intervention, 15 for wrong study designs, 7 studies for being conference abstracts, 5 for wrong outcome and 4 for duplicate data (Supplementary Figure 1, Supplementary data are available in *Age and Ageing* online).

Characteristics of the included studies

Eleven studies were performed in Europe [19–29], six in North America [30–35], six in Asia [36–41] and four in Oceania [24, 42–44]. Out of the 26 studies, 20 were unicentric RCTs [20–22, 26–30, 32, 33, 35–44], and 6 were multicentric RCTs [19, 23–25, 31, 34] (Supplementary Table 1).

Participants

In total, 5,133 participants were enrolled in the included studies, 2,542 (66.4% females) in the intervention group (IG) and 2,591 (65.0% females) in the control group (CG). Thirteen studies were performed in healthy and/or sedentary community-dwelling older adults [22, 24–26, 28–31, 37, 38, 41, 42, 44], and 13 included pathologies like cardiorespiratory problems [23, 33, 40, 43], balance disorders [20, 27, 34, 36], musculoskeletal disorders [32, 39], cancer [19, 35] and others [21].

Interventions

The DHI used in the articles selected were nine mobile applications [23, 26–30, 39, 40, 44], six phone calls [19, 22, 25, 32, 34, 37], three websites [20, 21, 33], three DVDs [35, 36, 41], two exergames [24, 42], two videoconferences [38, 43] and one embodied conversational agent [31]. The exercise interventions were multicomponent (two or more components as strength, balance or endurance) in 17 articles [19, 20, 24–29, 32–37, 39, 41, 43], physical activity incentive in three articles [21, 22, 31], balance in three articles [30, 42, 44], endurance in two articles [23, 40] and strength in one article [38].

The interaction was via communication with the therapist in 16 articles, automatic in seven articles [24, 26, 29–31, 42, 44], one with the support of home helper [27] and two did not report. The communication frequency was, at least, every week in 17 articles [20, 23, 24, 26–32, 36–39, 42–44] with eight studies with feedback every session [24, 27, 30, 38, 39, 42–44].

The comparator groups were heterogeneous including usual care [20, 23, 25, 27, 33, 42–44], lifestyle intervention [28, 35, 38], no intervention [34, 37, 41], wait list [21, 32], education [24, 36], exercise without DHI [29, 30, 39] and exercise/physical activity recommendations [19, 22, 26, 31, 40] (Supplementary Table 2).
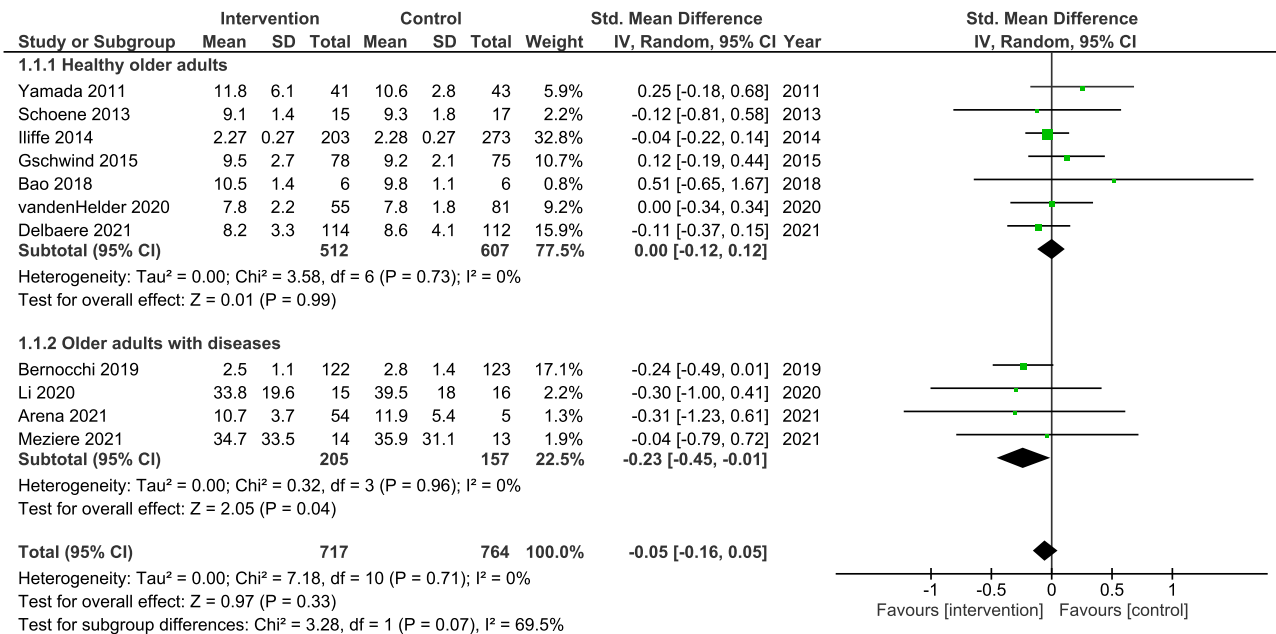
Study or Subgroup	Intervention			Control			Weight	Std. Mean Difference IV, Random, 95% CI	Year
	Mean	SD	Total	Mean	SD	Total			
1.1.1 Healthy older adults									
Yamada 2011	11.8	6.1	41	10.6	2.8	43	5.9%	0.25 [-0.18, 0.68]	2011
Schoene 2013	9.1	1.4	15	9.3	1.8	17	2.2%	-0.12 [-0.81, 0.58]	2013
Iliffe 2014	2.27	0.27	203	2.28	0.27	273	32.8%	-0.04 [-0.22, 0.14]	2014
Gschwind 2015	9.5	2.7	78	9.2	2.1	75	10.7%	0.12 [-0.19, 0.44]	2015
Bao 2018	10.5	1.4	6	9.8	1.1	6	0.8%	0.51 [-0.65, 1.67]	2018
vandenHelder 2020	7.8	2.2	55	7.8	1.8	81	9.2%	0.00 [-0.34, 0.34]	2020
Delbaere 2021	8.2	3.3	114	8.6	4.1	112	15.9%	-0.11 [-0.37, 0.15]	2021
Subtotal (95% CI)			512			607	77.5%	0.00 [-0.12, 0.12]	

Heterogeneity: Tau² = 0.00; Chi² = 3.58, df = 6 (P = 0.73); I² = 0%
Test for overall effect: Z = 0.01 (P = 0.99)

1.1.2 Older adults with diseases									
Bernocchi 2019	2.5	1.1	122	2.8	1.4	123	17.1%	-0.24 [-0.49, 0.01]	2019
Li 2020	33.8	19.6	15	39.5	18	16	2.2%	-0.30 [-1.00, 0.41]	2020
Arena 2021	10.7	3.7	54	11.9	5.4	5	1.3%	-0.31 [-1.23, 0.61]	2021
Meziere 2021	34.7	33.5	14	35.9	31.1	13	1.9%	-0.04 [-0.79, 0.72]	2021
Subtotal (95% CI)			205			157	22.5%	-0.23 [-0.45, -0.01]	

Heterogeneity: Tau² = 0.00; Chi² = 0.32, df = 3 (P = 0.96); I² = 0%
Test for overall effect: Z = 2.05 (P = 0.04)

Total (95% CI)			717			764	100.0%	-0.05 [-0.16, 0.05]	

Heterogeneity: Tau² = 0.00; Chi² = 7.18, df = 10 (P = 0.71); I² = 0%
Test for overall effect: Z = 0.97 (P = 0.33)
Test for subgroup differences: Chi² = 3.28, df = 1 (P = 0.07), I² = 69.5%

Std. Mean Difference IV, Random, 95% CI
-1 -0.5 0 0.5 1
Favours [intervention]   Favours [control]

Figure 1. Forest plot for mobility (TUG)

Risk of bias assessment

Due to insufficient information, most trials were scored unclear in the selection bias category (random sequence generation and allocation concealment). Most trials were scored as unclear or high risk for blinding of participants and personnel. Close to half of the authors did not report it, and those who did report it raised the difficulty of blinding due to the intervention's nature. About two-thirds of the trials were unclear or high risk of detection, attrition and reporting bias. However, most of the trials provided insufficient information to assess whether a critical risk of bias existed for other sources of bias (Supplementary Figures 2 and 3, Supplementary data are available in *Age and Ageing* online).

Main findings

Physical function

Thirteen studies examined mobility with the timed up and go test (TUG) [20, 24, 25, 27, 28, 30, 32, 34, 36, 39, 41, 42, 44] analysing 717 participants in the IG and 764 participants in the CG [20, 24, 25, 27, 28, 30, 34, 39, 41, 42, 44]. The forest plot showed that both groups had similar values (SMD −0.05; 95% confidence interval, CI −0.16 to 0.05; $P = 0.33$, $I^2 = 0\%$). If we analysed by type of population, the studies with healthy older adults showed that both groups had similar values (SMD 0.00; 95% CI −0.12 to 0.12; $P = 0.99$, $I^2 = 0\%$) and in the studies that included older adults with diseases the IG showed a significant improvement (SMD −0.23; 95% CI −0.45 to −0.01; $P = 0.04$, $I^2 = 0\%$) in comparison with the CG (Figure 1).

Eight studies examined physical performance with the short physical performance battery (SPPB; [19, 24, 26, 28, 29, 34, 35, 44]) analysing 307 participants in the IG and 332 participants in the CG [19, 24, 28, 29, 34,

35]. The forest plot showed that both groups had similar values (MD 0.22 points; 95% CI −0.05 to 0.49; $P = 0.12$, $I^2 = 16\%$; Supplementary Figure 4, Supplementary data are available in *Age and Ageing* online). If we analysed by type of population, the studies with healthy older adults showed that both groups had similar values (MD 0.13 points; 95% CI −0.10 to 0.36; $P = 0.26$, $I^2 = 0\%$). A similar result was observed in the studies that included older adults with diseases (MD 0.56; 95% CI −0.38 to 1.50; $P = 0.24$, $I^2 = 65\%$) in comparison with the CG.

Seven studies examined the strength of lower limbs with five times sit-to-stand test (5STS) [24, 30, 34, 36, 41, 42, 44] analysing 543 participants in the IG and 577 in the CG [24, 30, 34, 36, 41, 42, 44]. The forest plot showed that IG significantly improved in −0.56 s (95% CI −1.00 to −0.11; $P = 0.01$, $I^2 = 2\%$). If we analysed by type of population, the studies with healthy older adults the IG showed a significant improvement (MD −0.51; 95% CI −0.95 to −0.08; $P = 0.02$, $I^2 = 0\%$) in comparison with the CG (Figure 2).

Ten studies reported the balance with Berg balance scale (BBS), functional reach test (FRT), SPPB balance score [20, 25, 30, 34–37, 39, 42, 44] analysing 457 participants in the IG and 517 participants in the CG [20, 25, 30, 34, 35, 37, 39]. The forest plot showed that both groups had similar values (SMD 0.17; 95% CI −0.12 to 0.45; $P = 0.25$, $I^2 = 64\%$). If we analysed by type of population, the studies with healthy older adults showed that both groups had similar values (SMD 0.20; 95% CI −0.76 to 1.17; $P = 0.68$, $I^2 = 76\%$) and in the studies that included older adults with diseases the IG showed a significant improvement (SMD 0.28; 95% CI 0.09–0.48; $P = 0.004$, $I^2 = 1\%$) in comparison with the CG (Figure 3).

Six studies assessed the gait speed [19, 24, 30, 34, 41, 44] analysing 293 participants in the IG and 286 participants

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Study or Subgroup	Intervention Mean	SD	Total	Control Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI	Year	Mean Difference IV, Random, 95% CI
1.3.1 Healthy older adults										
Yamada 2011	20.6	7.6	41	19.4	5.3	43	2.5%	1.20 [-1.61, 4.01]	2011	
Schoene 2013	10.7	2.8	15	10.3	2.1	17	6.5%	0.40 [-1.33, 2.13]	2013	
Iliffe 2014	11.4	3.35	245	11.86	3.57	285	51.9%	-0.46 [-1.05, 0.13]	2014	
Gschwind 2015	10.8	3.2	78	12.1	3.3	75	18.1%	-1.30 [-2.33, -0.27]	2015	
Bao 2018	10.7	2.87	6	10.78	2.17	6	2.4%	-0.08 [-2.96, 2.80]	2018	
Delbaere 2021	11	3.8	114	11.5	4.7	112	15.5%	-0.50 [-1.62, 0.62]	2021	
Subtotal (95% CI)			499			538	96.9%	-0.51 [-0.95, -0.08]		

Heterogeneity: Tau² = 0.00; Chi² = 4.85, df = 5 (P = 0.43); I² = 0%
Test for overall effect: Z = 2.30 (P = 0.02)

1.3.2 Older adults with diseases										
Arena 2021	14.7	6.5	44	16.7	5.3	39	3.1%	-2.00 [-4.54, 0.54]	2021	
Subtotal (95% CI)			44			39	3.1%	-2.00 [-4.54, 0.54]		

Heterogeneity: Not applicable
Test for overall effect: Z = 1.54 (P = 0.12)

| Total (95% CI) | | | 543 | | | 577 | 100.0% | -0.56 [-1.00, -0.11] | | |

Heterogeneity: Tau² = 0.01; Chi² = 6.12, df = 6 (P = 0.41); I² = 2%
Test for overall effect: Z = 2.46 (P = 0.01)
Test for subgroup differences: Chi² = 1.28, df = 1 (P = 0.26), I² = 21.6%

−4 −2 0 2 4
Favours [intervention] Favours [control]

Figure 2. Forest plot for muscular strength of lower limbs (5STS)

Study or Subgroup	Intervention Mean	SD	Total	Control Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI	Year	Std. Mean Difference IV, Random, 95% CI
1.4.1 Healthy older adults										
Chang 2011	57.85	2.134	10	54.44	2.449	8	5.5%	1.43 [0.36, 2.49]	2011	
Iliffe 2014	26.84	7.64	232	27.13	6.82	293	25.7%	-0.04 [-0.21, 0.13]	2014	
Bao 2018	31.9	5	6	35	2.7	6	4.7%	-0.71 [-1.90, 0.47]	2018	
Subtotal (95% CI)			248			307	35.9%	0.20 [-0.76, 1.17]		

Heterogeneity: Tau² = 0.54; Chi² = 8.40, df = 2 (P = 0.02); I² = 76%
Test for overall effect: Z = 0.41 (P = 0.68)

1.4.2 Older adults with diseases										
Bernocchi 2019	38.5	11.6	122	32.8	15	123	23.1%	0.42 [0.17, 0.68]	2019	
Li 2020	5.2	3.5	15	5.5	3.4	16	10.2%	-0.08 [-0.79, 0.62]	2020	
Arena 2021	2.9	2.8	50	2.6	0.9	47	18.0%	0.14 [-0.26, 0.54]	2021	
Salerno 2021	3.6	0.6	22	3.5	1	24	12.8%	0.12 [-0.46, 0.70]	2021	
Subtotal (95% CI)			209			210	64.1%	0.28 [0.09, 0.48]		

Heterogeneity: Tau² = 0.00; Chi² = 3.03, df = 3 (P = 0.39); I² = 1%
Test for overall effect: Z = 2.86 (P = 0.004)

| Total (95% CI) | | | 457 | | | 517 | 100.0% | 0.17 [-0.12, 0.45] | | |

Heterogeneity: Tau² = 0.07; Chi² = 16.80, df = 6 (P = 0.01); I² = 64%
Test for overall effect: Z = 1.15 (P = 0.25)
Test for subgroup differences: Chi² = 0.03, df = 1 (P = 0.87), I² = 0%

−2 −1 0 1 2
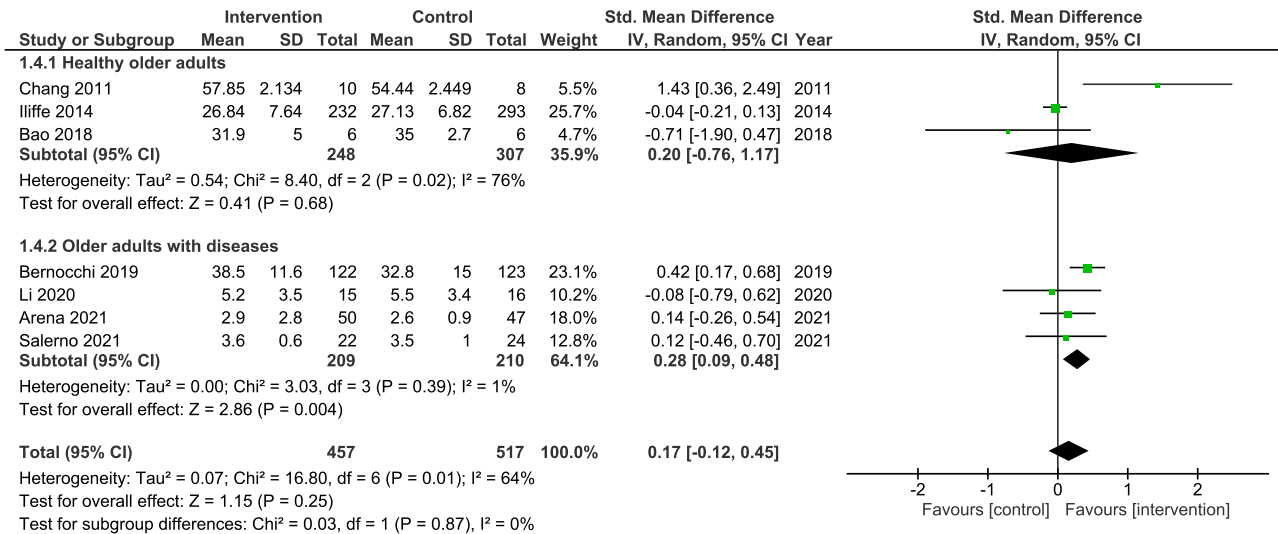Favours [control] Favours [intervention]

Figure 3. Forest plot for balance (BBS, FRT, SPPB balance score)

in the CG [19, 24, 30, 34, 41, 44]. The forest plot showed that both groups had similar values (SMD −0.07; 95% CI −0.23 to 0.10; P = 0.42, I² = 0%) (Supplementary Figure 5, Supplementary data are available in *Age and Ageing* online). We did not analyse by type of population due to insufficient number of studies.

Three studies examined the functional ability with the Barthel index (BI) [20, 27, 39] analysing 155 participants in the IG and 156 participants in the CG. The forest plot shows that the IG had a significant improvement in 5.01 points (95% CI 0.24–9.79 points; P = 0.04, I² = 39%; Supplementary Figure 6, Supplementary data are available in *Age and Ageing* online).

Falls

Seven studies examined the falls events [24–27, 34, 36, 44] analysing 1,048 participants in the IG and 1,083 participants in the CG. The forest plot showed that the odds ratio (OR) was reduced 0.77 in the IG (95% CI 0.63–0.94; P = 0.007,

I² = 2%). If we analysed by type of population, the studies with healthy older adults showed that both groups had similar values (OR 0.85; 95% CI 0.68–1.07; P = 0.17, I² = 0%) and in the studies that included older adults with diseases the IG showed a significant reduction in risk of falls (OR 0.60; 95% CI 0.42–0.87; P = 0.01, I² = 2%) in comparison with the CG (Figure 4).

Eight studies examined the falls efficacy scale-international (FES-I; [20, 24, 29, 36, 39, 42, 44]). The studies that reported the score between groups post-intervention analysed 371 participants in the IG and 377 participants in the CG [20, 24, 29, 39, 42, 44]. The forest plot showed that both groups had similar values (MD −0.05 points; 95% CI −1.27 to 1.17; P = 0.94, I² = 44%). If we analysed by type of population, the studies with healthy older adults showed that both groups had similar values (MD 0.16 points; 95% CI −1.32 to 1.64; P = 0.83, I² = 54%). A similar result was observed in the studies that included older adults with diseases (MD −1.05; 95% CI −2.98
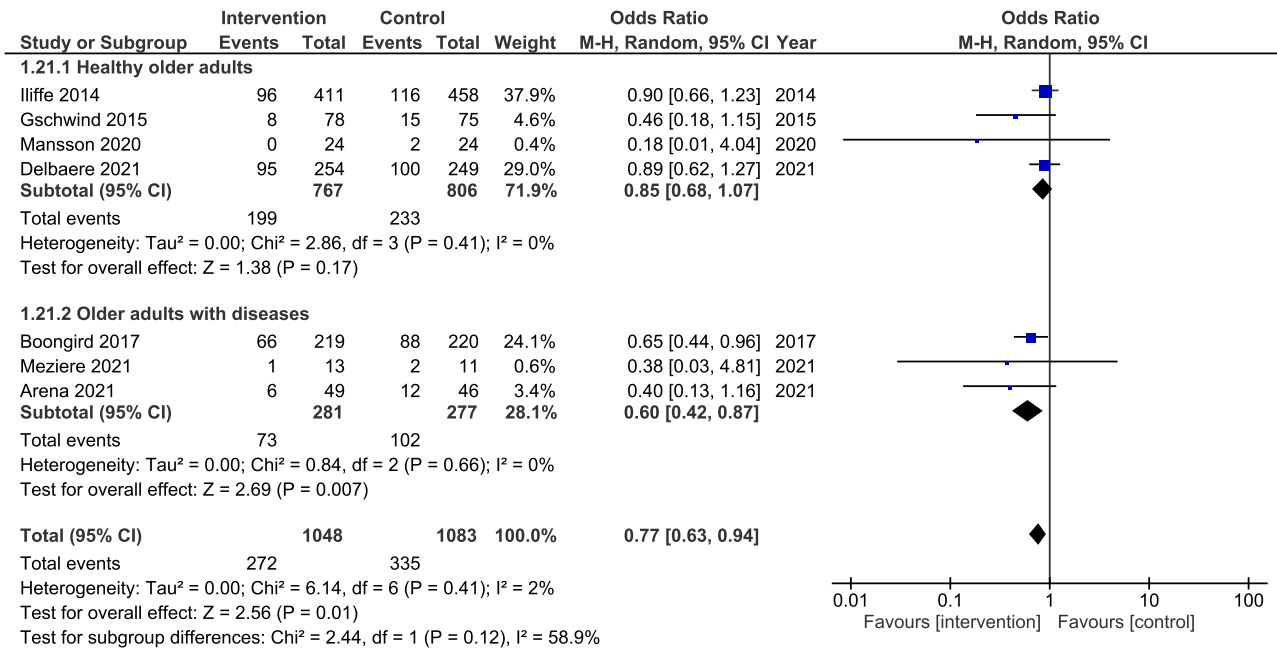
Study or Subgroup	Intervention Events	Total	Control Events	Total	Weight	Odds Ratio M-H, Random, 95% CI	Year	Odds Ratio M-H, Random, 95% CI
1.21.1 Healthy older adults								
Iliffe 2014	96	411	116	458	37.9%	0.90 [0.66, 1.23]	2014	
Gschwind 2015	8	78	15	75	4.6%	0.46 [0.18, 1.15]	2015	
Mansson 2020	0	24	2	24	0.4%	0.18 [0.01, 4.04]	2020	
Delbaere 2021	95	254	100	249	29.0%	0.89 [0.62, 1.27]	2021	
Subtotal (95% CI)		**767**		**806**	**71.9%**	**0.85 [0.68, 1.07]**		
Total events	199		233					

Heterogeneity: Tau² = 0.00; Chi² = 2.86, df = 3 (P = 0.41); I² = 0%
Test for overall effect: Z = 1.38 (P = 0.17)

Study or Subgroup	Intervention Events	Total	Control Events	Total	Weight	Odds Ratio M-H, Random, 95% CI	Year	
1.21.2 Older adults with diseases								
Boongird 2017	66	219	88	220	24.1%	0.65 [0.44, 0.96]	2017	
Meziere 2021	1	13	2	11	0.6%	0.38 [0.03, 4.81]	2021	
Arena 2021	6	49	12	46	3.4%	0.40 [0.13, 1.16]	2021	
Subtotal (95% CI)		**281**		**277**	**28.1%**	**0.60 [0.42, 0.87]**		
Total events	73		102					

Heterogeneity: Tau² = 0.00; Chi² = 0.84, df = 2 (P = 0.66); I² = 0%
Test for overall effect: Z = 2.69 (P = 0.007)

		1048		**1083**	**100.0%**	**0.77 [0.63, 0.94]**		
Total (95% CI)								
Total events	272		335					

Heterogeneity: Tau² = 0.00; Chi² = 6.14, df = 6 (P = 0.41); I² = 2%
Test for overall effect: Z = 2.56 (P = 0.01)
Test for subgroup differences: Chi² = 2.44, df = 1 (P = 0.12); I² = 58.9%

0.01   0.1   1   10   100
Favours [intervention]   Favours [control]

Figure 4. Forest plot for falls events

to 0.88; $P = 0.29$, $I^2 = 0\%$) in comparison with the CG (Supplementary Figure 7, Supplementary data are available in *Age and Ageing* online).

Quality of life

Twelve studies examined the HRQoL [20, 23–25, 27, 28, 31, 33, 36, 40, 43, 44] analysing 536 participants in the IG and 563 participants in the CG [20, 24, 25, 40, 43, 44]. The forest plot shows that the IG had a significant improvement in respect to the CG (SMD 0.18; 95% CI 0.05–0.30; $P = 0.004$, $I^2 = 95\%$). If we analysed by type of population, the studies with healthy older adults showed that both groups had similar values (SMD 0.07; 95% CI −0.26 to 0.40; $P = 0.67$, $I^2 = 80\%$) and in the studies that included older adults with diseases the IG showed a significant improvement in HRQoL (SMD 2.77; 95% CI 0.41 to 5.12; $P = 0.02$, $I^2 = 97\%$) in comparison with the CG (Figure 5).

Adherence

Adherence was reported in more than half of the articles [19, 20, 24–26, 28, 29, 31–33, 36, 39, 40, 42, 43]. There were different forms to describe the adherence, like sessions completed [19, 28], and patients that completed the programme [20, 32], with a threshold of expected exercise [25, 26, 36, 39].

Discussion

The HBE programmes carried out by DHI improved physical function in terms of lower extremity strength and functional capacity. It also significantly reduced the number of falls and improved the HRQoL. In addition, if we analysed

only older adults with diseases, it improved the balance and mobility.

Our review included older adults with different baseline characteristics. Although the majority of studies were conducted in apparently healthy older adults, a significant proportion was performed in older adults with diseases. Therefore, the potential for improvement in these populations is different, since patients with diseases have a lower functional status [45].

This could explain why, when analysed at the entire population, only the 5STS showed a significant difference post-intervention. On the other hand, when analysing the disease group, TUG and balance were added with significant results. This is even more evident if we analysed some outcomes that turned out to be favourable to the intervention in the entire population, but that the effect is really due to the studies that had patients with diseases, such as HRQoL, or the number of falls.

Of all the evaluations, only the 5STS showed a significant post-intervention change in all patients. Our results are similar to those observed by Mañas *et al.*, who also analysed HBE but focused on resistance exercise [46]. And, as in our review, no significant changes were observed in performance or mobility tests such as SPPB or TUG. The 5STS is a widely used test in older adults, by itself or as part of the SPPB; it is used as a functional measure of strength of lower limbs, and has clinical relevance because the ability to go from sitting to standing position reflects an important functional skill in older people [9]. In addition, the 5STS is related to strength and balance, elements incorporated in the different training programmes, so it would be a possible explanation for this improvement [47].

Current recommendations indicate the importance of training lower limb strength in older adults, making it a

Study or Subgroup	Intervention			Control			Weight	Std. Mean Difference IV, Random, 95% CI	Year	Std. Mean Difference IV, Random, 95% CI
	Mean	SD	Total	Mean	SD	Total				
1.20.1 Healthy older adults										
Iliffe 2014	0.667	0.072	179	0.675	0.072	212	19.6%	-0.11 [-0.31, 0.09]	2014	
Gschwind 2015	0.86	0.15	78	0.87	0.13	75	18.9%	-0.07 [-0.39, 0.25]	2015	
Delbaere 2021	0.88	0.05	114	0.86	0.05	112	19.3%	0.40 [0.14, 0.66]	2021	
Subtotal (95% CI)			371			399	57.8%	0.07 [-0.26, 0.40]		

Heterogeneity: Tau² = 0.07; Chi² = 9.79, df = 2 (P = 0.007); I² = 80%
Test for overall effect: Z = 0.42 (P = 0.67)

1.20.2 Older adults with diseases										
Liu 2008	45.4	1.1	24	34.3	1.5	24	6.9%	8.30 [6.48, 10.12]	2008	
Tsai 2017	99	16	19	90	18	17	16.0%	0.52 [-0.15, 1.19]	2017	
Bernocchi 2019	0.42	0.53	122	0.18	0.7	123	19.3%	0.39 [0.13, 0.64]	2019	
Subtotal (95% CI)			165			164	42.2%	2.77 [0.41, 5.12]		

Heterogeneity: Tau² = 4.03; Chi² = 71.05, df = 2 (P < 0.00001); I² = 97%
Test for overall effect: Z = 2.30 (P = 0.02)

Total (95% CI)			536			563	100.0%	0.77 [0.18, 1.37]		

Heterogeneity: Tau² = 0.46; Chi² = 92.99, df = 5 (P < 0.00001); I² = 95%
Test for overall effect: Z = 2.56 (P = 0.01)
Test for subgroup differences: Chi² = 4.94, df = 1 (P = 0.03), I² = 79.8%

Figure 5. Forest plot for health-related quality of life (HRQoL)

very frequently training task, safe to perform without direct supervision and easy to progress (overload; [48]). Different exercise guides, for example Otago, incorporate sitting and standing exercises in their base routine, so it is very possible that this task is trained and, therefore, susceptible to change in a test that measures it in the same motor gesture [49].

HBE programmes did not show an improvement in balance. However, when considering only the studies with older adults with diseases, a positive effect in favour of the intervention was observed. A possible explanation for this improvement could be because some studies were specifically aimed at patients at risk of falling [20, 27, 34, 36], and the studies that performed a multicomponent intervention included the balance training.

In this systematic review, most of the studies included multicomponent exercises complying with the recommendations of the clinical guidelines [48]. The effectiveness of multicomponent exercise has been demonstrated in the literature in other populations with chronic non-communicable diseases or sedentary [50, 51], also associated with DHI [51] or in home-based setting [52].

Interestingly, the studies that evaluated the total number of falls showed that the IG reduced falls by 23%, being up to 40% in the group of older adults with diseases. However, this fact was not observed when the FES-I scale was evaluated. One possible explanation is that the FES-I is a subjective measure of 'fear of falling' or, more appropriately, 'concerns about falling' [53]; instead, the events of falls are objective. Both evaluations are complemented by what we consider relevant so that both are reported.

The functional ability evaluated through the BI showed an improvement. Although the literature suggests the assessment of both basic and instrumental activities of daily living (ADL) in older people [54, 55], the small number of studies that report it is striking. A possible explanation could be that many studies are done in community-dwelling and the ADL scales tend to reach a ceiling very quickly, so they are not usually used in exercise programmes.

Although more than half of the studies reported adherence to exercise [19, 20, 24–26, 28, 29, 31–33, 36, 39, 40, 42, 43], the concept of adherence is not well-established and varies between the studies [56], confusing adherence with attendance [19, 28], that is, the number or percentage of sessions to which patients are assisted [56]. Another way to describe exercise adherence is to count the number of dropouts during your exercise intervention [56]. Following this last conception, a good adherence to the programme could be interpreted when the percentage of its participants who finished the intervention is high [20, 32]. In this sense, adherence has been described as the degree to which a person's behaviour correlates with the intervention planned, thus it would be related to the degree to which the target intensity and volume are achieved [25, 26, 36, 39]. In the selected studies, adherence rates are highly variable, so it was not possible to compare adherence results, and this factor could influence that we do not observe effects in the majority of outcomes assessed.

Another critical point to consider is whether HBE with DHI is effective compared with face-to-face programs. This is particularly relevant since home physical training programs, which aim to improve health functions at a distance using telecommunication strategies, could provide equitable access to training/rehabilitation services [57], thus allowing many isolated people to slow down their loss of autonomy [58]. In addition, although we could not compare it in this study due to the heterogeneity of the comparators, a recent RCT comparing HBE through videoconference versus face-to-face in older people between 70 and 80 years old found similar effects on body composition and cardiorespiratory fitness, suggesting that when face-to-face training is not possible, HBE through videoconference should be advised [59].

Strengths and limitations

Our study has several strengths. This review shows that HBE with different types of technological support are effective in

improving physical function in older people and are more so in people with pathologies. This is important because people with a higher burden of disease, with multiple pathologies or frail are the ones who have more problems attending community programmes, so home interventions can be effective in different aspects of physical function, such as strength of lower limbs, mobility and balance, all important aspects to help maintain the functional independence of the older person.

Our study has some limitations. Most of the studies included populations with different types of diseases or comorbidities, which may limit the extrapolation of the results and recommendations to the entire spectrum of older people; even though our results were statistically significant. The heterogeneous nature of populations implies that many subjects have different pathophysiological behaviours and conditions, a wide spectrum of severity, as well as the implication or impact that suffering from associated comorbidities may influence the magnitude of reported results. In addition, there was heterogeneity in the CG since some of them performed no interventions, lifestyle interventions or only exercised without DHI, hindering the comparison between them. For example, some authors delivered written recommendations for exercise [24, 26], others through videos [35], and some through verbal recommendations [28]; however, it was not measured that the proposed exercises complied with the principles of training, so it cannot be concluded that only the DHI was really the difference. Finally, we do not compare the applied DHIs. Mainly because the studies that have an app are recent and those that have phone calls are older. Future reviews should consider the differences between DHI interventions in order to determine those which are more efficient in these populations.

Conclusion

The HBE programmes carried out by using DHI improved physical function in terms of lower extremity strength and functional capacity and also reduced the number of falls and improved the HRQoL in older adults. Additionally, for those older adults with diseases, it improves the balance and mobility.

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