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REVIEW

Unsupervised physical activity interventions for people with COPD: A systematic review and meta-analysis

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Abstract
Introduction and objectives: Unsupervised PA interventions might have a role in the management of chronic obstructive pulmonary disease (COPD) but their effectiveness is largely unknown. Thus, we aimed to identify and synthesise data on the effects of unsupervised PA interventions in people with COPD.
Material and methods: Databases were systematically searched in April 2020, with weekly updates until September 2021. Randomised controlled trials and quasi-experimental studies comparing unsupervised PA with usual care, were included. Primary outcomes were dyspnoea, exercise capacity and physical activity. The effect direction plot was performed to synthesise results. Meta-analysis with forest plots were conducted for the Chronic Respiratory Disease questionnaire — dyspnoea domain (CRQ-D), 6-minute walk distance (6MWD) and incremental shuttle walk distance (ISWD).
Results: Eleven studies with 900 participants with COPD (68±10 years; 58.8% male, FEV_1 63.7± 15.8% predicted) were included. All interventions were conducted at home, most with daily sessions, for 8-12 weeks. Walking was the most common component. The effect direction plot showed that unsupervised PA interventions improved emotional function, fatigue, health-related quality of life, muscle strength and symptoms of anxiety and depression. Meta-analysis showed statistical, but not clinical, significant improvements in dyspnoea (CRQ-D, MD=0.12, 95% CI 0.09-0.15) and exercise capacity, measured with 6MWD (MD=13.70, 95% CI 3.58-23.83). Statistical and clinical significant improvements were observed in exercise capacity, measured with ISWD

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(MD=58.59, 95% CI 5.79-111.39). None to minor adverse events and a high adherence rate were found.

Conclusions: Unsupervised PA interventions benefits dyspnoea and exercise capacity of people with COPD, are safe and present a high adherence rate. Unsupervised PA interventions should be considered for people with COPD who cannot or do not want to engage in supervised PA interventions or as a maintenance strategy of PA levels.

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Introduction

Chronic obstructive pulmonary disease (COPD) is a global public health concern.[1] People with COPD present higher sedentary behaviour and lower levels of physical activity (PA) than their healthy peers.[2] Physical inactivity has been associated with poor health outcomes (e.g., dyspnoea, exercise intolerance, reduced health-related quality of life [HRQoL]) in people with COPD,[3,4] being an independent risk factor for hospitalisations due to acute exacerbations and early mortality.[5,6] Therefore, improving PA levels in this population is imperative.[1,7]

Physical activity has well-established physiological, social and psychological benefits in people with COPD.[1,8] Despite these unequivocal benefits,[1] increasing PA levels in this population is often challenging.[9] Barriers to engage in PA include low motivation,[10,11] physical (e.g., symptoms-related) and psychological (e.g., fear) disease limitations,[11] limited access to[12] or lack of perceived benefit of PA interventions,[13,14] time requirements and[14] travel issues.[13,14]

Unsupervised PA may contribute to overcome some of these barriers as it: i) is low cost;[15] ii) presents a broad application (e.g., specialised equipment is not required);[15] and iii) can be undertaken in any environment and/or at any time, whatever suits the individuals best,[16] hence may enhance adherence to PA in people with COPD. Nevertheless, unsupervised PA interventions are still underused in this population.[15] One possible explanation could be the lack of synthesis of the most common unsupervised PA interventions and respective evidence.

Recently, a systematic literature review of unsupervised exercise-based interventions in this population was published.[17] However, they focussed on exercise interventions, which is just a subset of PA.[18] PA refers to all movement performed by an individual, which means other components besides exercise, such as everyday tasks, are included.[18] In fact, people with COPD reduce their participation in PA and adopt a sedentary lifestyle to avoid exertional dyspnoea,[11] leading to muscle deconditioning and accentuating exercise capacity impairment.[19,20] Therefore, synthesising evidence of the benefits obtained with unsupervised PA interventions and also including activities integrated in individuals' daily life may be highly meaningful for participants, and provide relevant information to healthcare professionals for the management of COPD, especially in limited resource settings.

Therefore, this systematic review aimed to identify which unsupervised PA interventions have been used for people with COPD and explore their effectiveness.

Material and methods

This systematic review was registered in the International Prospective Register of Systematic Reviews (PROSPERO – registration no. CRD42020162311) and follows the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidelines[21] and the Synthesis Without Meta-analysis (SWiM)[22] recommendations.

Eligibility criteria

Studies were included if: i) their sample was composed of adult (≥18 years) people with COPD in a stable phase of the disease (i.e., 4 weeks without hospital admissions or exacerbations, nor changes in medication, according to Global Initiative for Chronic Obstructive Lung Disease – GOLD report[1]); ii) included unsupervised PA interventions for people with COPD compared to usual care (i.e., had not received any PA intervention in the study period); iii) they were original randomised controlled trials (RCT) or quasi-experimental studies; iv) written in Portuguese, English, Spanish or French languages. Studies were excluded if they: i) involved proxy versions; ii) were qualitative studies; iii) included other treatments/activities as an intervention while performing PA; iv) included any directly supervised training (other than a single session), i.e., face-to-face or remote contact (e.g. video-conference); and, v) were performed in hospital-based settings.

For the purpose of this review, the following definition of PA was used: "any bodily movement produced by skeletal muscles that requires energy expenditure."[18] Unsupervised PA interventions were defined as any PA without any supervision, undertaken in any environment and/or at any time, which best suits the person.[16] It could include a single supervised session to explain and/or demonstrate the activities; and, remote contact with healthcare professional using technologies, such as, telephone, mobile phone and/or tablet devices, to check patients' health and monitor their evolution, without being used to interactively coach/instruct the patient (e.g., video-conference).

Information sources

A systematic literature search was conducted in April 2020, on the following electronic databases: Cochrane Library, PubMed, Scopus, Web of science, EBSCOhost. Electronic search was supplemented by weekly automatic updates retrieved from the databases until September 2021, and hand-searches of references in key systematic reviews.[17] The search strategy was performed by title, abstract,

keywords/MESH term. The full search strategy is presented in Supplementary material - Appendix 1.

Study selection

After removing duplicates, two reviewers (CP and VR) independently screened the potential studies (title and abstract), according to the eligibility criteria. The full-text of each potentially relevant study was then independently screened by the same reviewers to decide on its inclusion. Discrepancies were solved by consensus, and if agreement could not be reached, the other authors' opinion was obtained. Primary outcomes were dyspnoea, exercise capacity and PA. Secondary outcomes included body composition, emotional function, fatigue, health behaviours, healthcare utilisation, HRQoL, mastery, muscle strength, self-efficacy, symptoms of anxiety and depression, adverse events and, dropouts and adherence to interventions.

Data extraction

One reviewer independently extracted the data from included studies, and the other authors checked the accuracy and completeness of information. Data extraction was performed using a pre-developed and structured table-format covering the following topics: characteristics of the study (first author, year of publication, country and study design); setting (i.e., home-based); population (number of participants, sex, age, forced expiratory volume in one second percentage of predicted [FEV_{1pp}], severity of airway limitation [GOLD grades 1-4][1] and comorbidities [type and severity, classified with Charlson Comorbidity Index-CCI]; intervention (type, frequency and duration); outcome and outcome measures; and, results obtained in each outcome measure. Studies with multiple publications were identified to avoid duplicate reports (e.g., number of participants). Corresponding authors of the included studies were contacted via e-mail to request additional data (i.e., means and SD), whenever needed.

Quality assessment

Two reviewers independently assessed the methodological quality of each study using the Quality Assessment Tool for Quantitative Studies, developed by the Effective Public Health Practice Project, Canada.[23] This tool is comprised of six domains of methodological quality: 1) selection bias; 2) study design; 3) confounders; 4) blinding; 5) data collection methods; and, 6) withdrawals and dropouts.[23] Each domain is rated as "strong", "moderate" or "weak", according to a standardized guide.[24] The overall rating of each study is determined by the total number of "weak" scores, i.e., if the study presented: i) no weak scores, it was rated as strong quality; ii) one weak rating - moderate quality; and, iii) two or more weak ratings - weak quality.[23]

Data analysis and synthesis

Inter-rater agreement analysis was assessed using Cohen's kappa to explore the consistency of the quality assessment performed by the two reviewers. The Cohen's kappa ranges from 0 to 1 and agreement was interpreted as: slight ($\leqslant$0.2), fair (0.21−0.4), moderate (0.41−0.6), substantial (0.61−0.8), or almost perfect ($\geq$0.81).[25]

Studies were grouped according to the outcome measures reported. An effect direction plot was computed to deal with the diversity of outcome measures used in the included studies, following the SWiM recommendations.[26] This plot considers the study design, effect estimates of each outcome (represented with arrows, i.e., upward arrow ▲= positive health impact, downward arrow ▼= negative health impact, sideways arrow ▶= no change/mixed effects/conflicting findings), sample size and studies quality (using a traffic light system, i.e., green for studies of high quality, amber for moderate and red for weak quality of evidence).[26] The effect estimates were analysed with the Cohen's d effect sizes (ES) based on the Pre/Post means and SD, according to the formula of Morris.[27] The ES were interpreted as very small ($\geq$0.01), small ($\geq$0.20), medium ($\geq$0.50), large ($\geq$0.80), very large ($\geq$1.20) and huge ($\geq$2.0).[28,29] Results were analysed by counting the effect direction and interpreted using the proportion of effects favouring the intervention [30] Proportions higher than 50% were considered as an improvement in the respective outcome measure.[30]

Meta-analysis, with forest plots, only included studies reporting the mean changes between the experimental (EG) and control (CG) groups and the respective SD or data allowing the calculation of these estimates. Between-study heterogeneity was quantified using I-squared (I^2) statistic. Statistical homogeneity was defined as $\leq$40%.[30]

Some data transformation occurred to compute ES. Data presented as 95% of confidence intervals (95% CI) [31] were transformed into SD, using the formula: $SD=\sqrt{n}*(upper\ limit - lower\ limit)/3.92$, where n is the sample size.[30] Additionally, data presented as median and interquartile range (IQR) [31] were converted into mean and SD using the summary table proposed by Wan and colleagues.[30,32]

Data analysis were performed using IBM SPSS 24.0 (IBM, Armonk, New York, USA) and RStudio, V1.2.5033 (RStudio, Inc; Boston, MA, USA).

Results

Study selection

The literature search provided 738 studies. After duplicates removed, 396 records were screened and 303 were excluded. The full-text of 93 articles was assessed and four studies were included. Seven additional studies were identified and retrieved, two from the databases weekly automatic updates and five from the reference list of a key systematic review [17] (Fig. 1). A total of 11 articles were included.

Quality assessment

Four studies were rated as strong [33-36] (36%), three [31,37,38] (28%) as moderate and four [39-42] (36%) as weak quality. Inter-rater agreement was substantial (Cohen's Kappa=0.72; 95% CI=0.37-1.07; p = 0.003; percentage of agreement= 82%). Quality assessment details can be found in Supplementary material (Table S1).

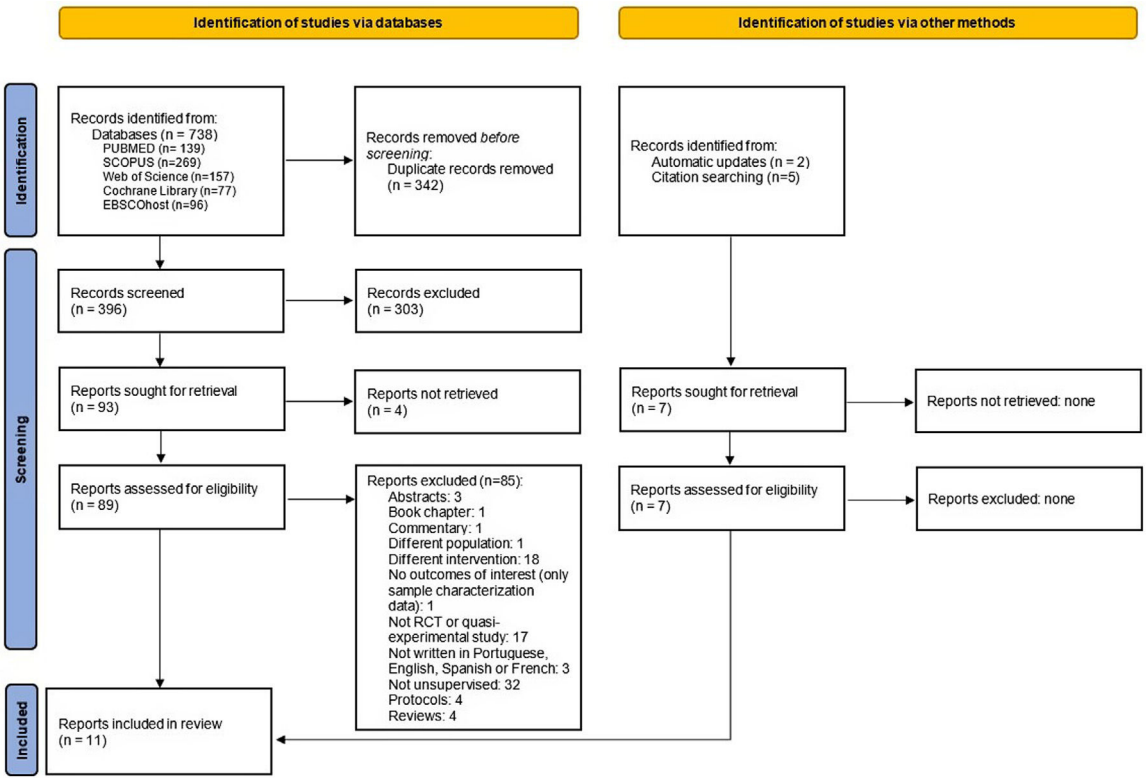

Fig. 1. Flow diagram of the articles screened and included in the study (n = 11) according to the preferred reporting items for systematic reviews and meta-analyses (PRISMA).
Abbreviations: RCT — randomised controlled trial.

Studies characteristics

Included studies were published between 1977[42] and 2020[31], and were mostly conducted in the United States of America,[33,34] Australia,[31,39] United Kingdom [36,38] and Taiwan.[35,41] A total of 900 participants with COPD, 446 in the EG and 454 in the CG, were included. Sample sizes ranged between 20[38] to 305 participants.[33,34] Participants were on average 68±10 years old (n = 6), 541 (59%; n = 9) were male, presented a mean FEV_1 of 63.7±15.8 %predicted (n = 3) and the majority had moderate to severe (GOLD grades 2-3) grades of the disease (n = 4). Comorbidities reported (n = 3) included: cardiovascular disease (hypertension, heart failure, myocardial infarction, and peripheral vascular diseases), metabolic syndrome (e.g., diabetes), depression, musculoskeletal disease (e.g., arthritis) and ulcer disease.[33,34,36] Table 1 presents detail characteristics of the included articles.

Design of the interventions

Interventions lasted from 6 [36,38] to 66 weeks,[33,34] being 8-12 weeks [31,35,37,39-42] the most common range duration, and were performed 3 days/week,[37] 4 days/week [38] or daily. [31,33-36,39-42] All interventions were designed by health professionals (i.e., general practioners,[35,42] nurses[35,37,39-41], physiotherapists[31,36,38] and health coachs[33,34]) and performed at home.[31,33-42]

Interventions were single-component in seven [33-35,37,39,41,42] and multi-component in four [31,36,38,40] studies. Aerobic exercise [31,35,36,38,39,41,42] (e.g., walking) and muscle strength [31,36-38,40] were the main training components. Two studies [33,34] focused on promotion of lifestyle PA (i.e., promotion of activities of daily living). Interventions also included diaries;[31,41,42] action plans;[39,41] information about healthy behaviours;[39] phone calls to support the intervention, promote healthy behaviours or deliver self-management training;[31,33,34,36,39,40] distribution of handbook/manual;[33,34,41] workbook activities;[33,34] reading assignments;[33,34] and nutritional and psychosocial support.[40] More details are presented in Table 1.

Effectiveness of unsupervised PA interventions

A total of 14 outcomes, evaluated by 44 different measurement tools were found in the included studies (Table S1, Figs. 2 and 3).

Primary outcomes

Dyspnoea

Dyspnoea was measured in seven studies, with the modified Borg scale (MBS)— dyspnoea,[35] the Chronic Respiratory Questionnaire - dyspnoea domain (CRQ-D) [31,34,36,38] and the modified British Medical Research Council (mMRC).[31,41]

Unsupervised PA interventions had a positive effect on dyspnoea, with four [34,35,38,40] of six studies [31,34-36,38,40] favouring the EG (67%, 95% CI 22-96%) (Fig. 2). Meta-analysis of the CRQ-D[34,35,38,40] showed this significant improvement (MD=0.12, 95% CI 0.09-0.15). Statistical heterogeneity was

Table 1 Design and effects of unsupervised physical activity interventions for people with chronic obstructive pulmonary disease (n = 11).

Study, country and design	Setting	Participants	Intervention	Outcome	Outcome measure	Results
McGavin *et al*. 1977 Scotland Non-RCT	Home-based	n_{Total}= 24 EG: n = 12 (61.4±5.6 yrs; FEV_1: 0.97±0.33 L) CG: n = 12 (57.2±7.9 yrs, FEV_1: 1.15±0.72 L)	**EG:** Description: • Graded stair-climbing exercises. ◦ Most disabled participants (walking distance <800m in 12 MWD): started with 2 steps up/down for 2 min. ◦ Less disabled (walking distance >800m in 12 MWD): started with 5 steps up/down for 5 min. ◦ Final aim: 10 steps (up/down) in 10 min. ◦ Progress: assessed after 2 weeks of the baseline and then monthly, at an outpatient clinic. Frequency: Once a day, at least 5 days/week. Duration: 3 months **CG:** Description: Regular assessments Frequency: Monthly clinic visits Duration: 3 months	Body composition	Weight, kg	EG: Pre 65.9±7.3 Post 66.7±8.4, p>0.05; CG: Pre 66±11.1 Post 65±10, p>0.05; $ES_{EG\ vs\ CG}$=0.19
				Exercise capacity	12MWD, m	EG: Pre 1018±313 Post 1082±292, $p < 0.001$; CG: Pre 1053±132 Post 1034±141, p>0.05; $ES_{EG\ vs\ CG}$=0.35
					HR_{ex}, bpm	EG: Pre 118±14 Post 125±10, p>0.05; CG: Pre 123±10 Post 119±11, p>0.05; $ES_{EG\ vs\ CG}$=0.95
					HR_{st}, bpm	EG: Pre 118±15 Post 120±11, p>0.05; CG: Pre 119±10 Post 116±14, p>0.05; $ES_{EG\ vs\ CG}$=0.39
					R_{ex}, cpm	EG: Pre 0.94±0.082 Post 0.97±0.059, p>0.05; CG: Pre 0.95±0.117 Post 0.96±0.150, p>0.05; $ES_{EG\ vs\ CG}$=0.18
					VE_{ex}, l/min	EG: Pre 35±13 Post 39±10, p>0.05; CG: Pre 36±14 Post 34±13, p>0.05; $ES_{EG\ vs\ CG}$=0.45
					VE_{st}, l/min	EG: Pre 35±4 Post 34±9, p>0.05; CG: Pre 32±12 Post 33±13, p>0.05; $ES_{EG\ vs\ CG}$=-0.19
					VO_{2ex}, mmol/min	EG: Pre 43.2±13.4 Post 50.0±15.3, p>0.05; CG: Pre 45.6±7.7 Post 40.3±8.4, $p < 0.05$; $ES_{EG\ vs\ CG}$=1.02
					WL_{ex}, W	EG: Pre 62.6±22.9 Post 77±26.7, $p < 0.05$; CG: Pre 63.9±14.7 Post 61.3±15.7, p>0.05; $ES_{EG\ vs\ CG}$=0.81
					Stride, mm	EG: Pre 790±90 Post 830±75, $p < 0.01$; CG: Pre 780±80 Post 760±89, p>0.05; $ES_{EG\ vs\ CG}$=0.70
Elçi *et al*. 2008 Turkey Prospective RCT	Home-based	n_{Total}= 78 (58.9±10,1 yrs; 84.6% male) EG: n = 39 (59.7±8.6yrs; 84.6% male; FEV_1pp: 47.8±18.8; GOLD 1-7.7%, GOLD 2-30.8%, GOLD 3-51.3%, GOLD 4-10.3%) CG: n = 39 (58.1±11.5yrs; 84.6% male; FEV_1pp: 46.3±15.5; GOLD 1-7.7%, GOLD 2-30.8%, GOLD 3-51.3%, GOLD 4-10.3%)	**EG:** Description: • Home-based PR: ◦ Endurance training (75% of 6MWT speed) ◦ Abdominal, upper and lower limb strengthening ◦ Nutritional and psychosocial counselling ◦ Weekly phone calls Frequency: 5 days/week, 90 min/day Duration: 3 months **CG:** Description: Usual care Duration: 3 months	Anxiety and depression	HADS total score, pts	EG: Pre 17.5±6.2 Post 13.5±3.9, p = 0.001; CG: Pre 20.4±7 Post 21.2±6.2, p = 0.065; $ES_{EG\ vs\ CG}$=-0.80
				Dyspnoea	mMRC, pts	EG: Pre 3.2±0.6 Post 2.9±0.7, p = 0.001; CG: Pre 3.1±0.5 Post 3.0±0.6, p = 0.324; $ES_{EG\ vs\ CG}$=-0.31
				Exercise capacity	6MWD, m	EG: Pre 312.4±51.3 Post 328.9±48.8, p = 0.001; CG: Pre 305.1±54.6 Post 298.2±52.8, p = 0.001; $ES_{EG\ vs\ CG}$=0.45
				HRQoL	SF-36, pts	EG: Pre 37.6±9.7 Post 49.3±8, $p < 0.05$; CG: Pre 34.1±10.9 Post 32±9, p>0.05; $ES_{EG\ vs\ CG}$=1.45
					SGRQ total score, pts	EG: Pre 60.3±18.2 Post 45.9±11.6, $p < 0.05$; CG: Pre 61.7±19.9 Post 65.5±17.4, p>0.05; $ES_{EG\ vs\ CG}$=-1.06

Table 1 (*Continued*)

Study, country and design	Setting	Participants	Intervention	Outcome	Outcome measure	Results
Moore *et al*. 2009 UK Pilot RCT	Home-based	n_{Total}= 20 (50% male) EG: *n* = 10 (70 [13]yrs, 60% male, FEV_1pp: 40 [36.5-49]) CG: *n* = 10 (70.5 [57.5-78.5] yrs, 40% male, FEV_1pp: 41.5 [30-55])	**EG:** Description: • Home exercise video/DVD programme: ◦ Warm-up ◦ High-intensity interval exercise (upper and lower limb strengthening, aerobic exercise) ◦ Cool-down Frequency:4 days/week, 30 min/day Duration: 6 weeks **CG:** Description: Usual care, educational COPD booklet Duration: 6 weeks	Dyspnoea Emotional function Exercise capacity Fatigue Mastery	CRQ-D, pts CRQ emotional function domain, pts ISWD, m CRQ fatigue domain, pts CRQ mastery domain, pts	EG: Pre Median 3.3 [1.8-4.1] Post Median 3.6 [2.6-4.4], p = 0.027; CG: Pre Median 2.7 [2.1-4.8] Post Median 2.5 [2-3.2], p = 0.326; ES $_{EG\ vs\ CG}$=0.68 EG: Pre Median 4.4 [3.2-5] Post Median 5.4 [4.8-6], p = 0.002; CG: Pre Median 4 [2.4-5.8] Post Median 4 [2.9-5.9], p = 0.73; ES $_{EG\ vs\ CG}$=0.45 EG: Pre Median 110 [35-265] Post Median 200 [69-333], p = 0.021; CG: Pre Median 160 [48-288] Post Median 175 [39-215], p = 0.256; ES $_{EG\ vs\ CG}$=0.43 EG: Pre Median 2.9 [2-4.4] Post Median 4.9 [4-5.1], p = 0.004; CG: Pre Median 2.5 [2-4.6] Post Median 2.5 [1.9-4.5], p = 0.74; ES $_{EG\ vs\ CG}$=0.82 EG: Pre Median 4.8 [4.1-5.5] Post Median 5.4 [4.6-5.9], p = 0.06; CG: Pre Median 3.5 [2.9-5.6] Post Median 4.5 [3-5.4], p = 0.64; ES $_{EG\ vs\ CG}$=0.11
Ho *et al*. 2012 Taiwan Prospective RCT	Home-based	n_{Total}= 41 (74±10.3 yrs, 95.1% male) EG: *n* = 20 (73.1±11.2 yrs, 95% male, FEV_1pp: 60.6±18.9) CG: *n* = 21 (75.1±9.6 yrs, 95.2% male, FEV_1pp: 61.2±26.3)	**EG:** Description: • Pace walking to music: ◦ Endurance training walk: ▫ 80% VO_2 peak based on ISWD, increasing gradually each month ▫ Participants should match their walking speed to the tempo of their favourite songs Frequency: 5 days/week, 30 min/day Duration: 12 weeks **CG:** Description: Usual care Duration: 12 weeks	Dyspnoea Exercise capacity Health care utilisation HRQoL 	MBS – dyspnoea, pts ISWD, m Emergency visits, no Hospitalisations, no Length of hospitalisations, days Unscheduled clinic visits, no SGRQ activity domain, pts SGRQ impact domain, pts SGRQ symptoms domain, pts SGRQ total score, pts	EG: Pre 2.2±1.3 Post 0.8±1.1, p < 0.001; CG: Pre 1.4±1.6 Post 1.5±1.6, p>0.05; ES $_{EG\ vs\ CG}$=-1.05 EG: Pre 243.5±135.4 Post 306±107.3, p < 0.001; CG: Pre 237.6±124.4 Post 218.5±119.4, p>0.05; ES $_{EG\ vs\ CG}$=0.79 EG: Mean Pre/Post 0.03±0.2; CG: Mean Pre/Post 0.04±0.3; p $_{EG\ vs\ CG.}$=0.52 EG: Mean Pre/Post 0.03±0.2; CG: Mean Pre/Post 0.04±0.2; p $_{EG\ vs\ CG.}$=0.11 EG: Mean Pre/Post 0.2±1.4; CG: Mean Pre/Post 0.3±1.3; p $_{EG\ vs\ CG.}$=0.64 EG: Mean Pre/Post 0.03±0.2; CG: Mean Pre/Post 0±0; p $_{EG\ vs\ CG.}$=0.001 EG: Pre 45.2±14.9 Post 34.5±8.4 p = ND; CG: Pre 44.8±20 Post 52.7±24.2 p = ND; ES $_{EG\ vs\ CG}$=-1.02 EG: Pre 22.7±18.1 Post 10.2±13.5, p = ND; CG: Pre 18.4±15.2 Post 21.7±15, p = ND; ES $_{EG\ vs\ CG}$=-1.01 EG: Pre 34.5±20.5 Post 14.5±9.6, p = ND; CG: Pre 27.5±21.1 Post 24.7±20.5 p = ND; ES $_{EG\ vs\ CG}$=-0.91 EG: Pre 31.6±14.4 Post 18.3±12.7 p = ND; CG: Pre 27.9±15.7 Post 31.6±16.3 p = ND; ES $_{EG\ vs\ CG}$=-1.13
Mitchell *et al*. 2014 UK RCT	Home-based	n_{Total}= 184 (54.9% male) Comorbidities: Hypertension, Diabetes, Heart Failure, Arthritis EG: *n* = 89 (69±8 yrs, 60.7% male, FEV_1pp: 56±16.8; GOLD 1-7, GOLD 2-51, GOLD 3-22, GOLD 4-9; CG: *n* = 95 (69±10.1yrs, 49.5% male, FEV_1pp: 59.6±17.4; GOLD 1-8, GOLD 2-60, GOLD 3-20, GOLD 4-7)	**EG:** Description: • SPACE for COPD: ◦ Home-based manual: ▫ Education material ◦ Exercise programme (walking, resistance training of upper limb and lower limb using free weights); ◦ Biweekly phone calls using motivational interview. Frequency: Daily (walking), 3x/week (resistance training) Duration: 6 weeks **CG:** Description: Usual care Duration: 6 weeks	Anxiety COPD-related knowledge Depression Dyspnoea	HADS-A, pts BCKQ, pts HADS-D, pts CRQ-D, pts	EG: Mean difference -0.73 [-1.28;-1.17] 95% CI; CG: Mean difference 0.12 [-0.38;0.62]95% CI; p $_{EG\ vs\ CG}$=0.04; ES $_{EG\ vs\ CG}$=-0.24 EG: Mean difference 2.79 [0.97;4.6] 95% CI; CG: Mean difference 0.44 [-1.02;1.9] 95% CI; p $_{EG\ vs\ CG}$=0.04; ES $_{EG\ vs\ CG}$=0.20 EG: Mean difference -0.5 [-1.03;0.03] 95% CI; CG: Mean difference 0.22 [-0.3;0.75] 95% CI; p $_{EG\ vs\ CG}$=0.1; ES $_{EG\ vs\ CG}$=-0.16 EG: Mean difference 0.71 [0.45;1] 95% CI; CG: Mean difference 0.72 [0.2;0.65] 95% CI; p $_{EG\ vs\ CG}$=0.049; ES $_{EG\ vs\ CG}$=-0.01

Table 1 (*Continued*)

Study, country and design	Setting	Participants	Intervention	Outcome	Outcome measure	Results
				Emotion	CRQ-emotion domain, pts	EG: Mean difference 0.34 [0.11;0.57] 95% CI; CG: Mean difference -0.07 [-0.27;0.11] 95% CI; $p_{EG\ vs\ CG}$=0.011; $ES_{EG\ vs\ CG}$=0.22
				Exercise capacity	ESWT, s	EG: Mean difference 209.7 [122.3;297.1] 95% CI; CG: Mean difference 92.1 [32.8;151.4] 95% CI; $p_{EG\ vs\ CG}$=0.006; $ES_{EG\ vs\ CG}$=0.30
					ISWD, m	EG: Mean difference 9.4 [-5;24] 95% CI; CG: Mean difference -6.7 [-17.9;4.5] 95% CI; $p_{EG\ vs\ CG}$=0.017; $ES_{EG\ vs\ CG}$=0.08
				Fatigue	CRQ-fatigue domain, pts	EG: Mean difference 0.49 [0.24;0.66] 95% CI; CG: Mean difference 0.01 [-0.21;0.22] 95% CI; $p_{EG\ vs\ CG}$=0.013; $ES_{EG\ vs\ CG}$=0.26
				Mastery	CRQ-mastery domain, pts	EG: Mean difference 0.15 [-0.06;0.37] 95% CI; CG: Mean difference 0.11 [-0.35;0.13] 95% CI; $p_{EG\ vs\ CG}$=0.1; $ES_{EG\ vs\ CG}$=0.02
				Self-efficacy	PRAISE, pts	EG: Mean difference 0.9 [-0.34;2.15] 95% CI; CG: Mean difference -1.08 [-2.67;0.51] 95% CI; $p_{EG\ vs\ CG}$=0.32; $ES_{EG\ vs\ CG}$=0.17
Cameron-Tucker *et al*. 2016 Australia Parallel-group RCT	Home-based	n_{Total}= 65 (69±9 yrs, 45% male) EG: *n* = 35 (68±10 yrs, 46% male; GOLD 1-3, GOLD 2-12, GOLD 3-10, GOLD 4-4) CG: *n* = 30 (70±7 yrs, 43% male; GOLD 1-1, GOLD 2-10, GOLD 3-14, GOLD 4-3)	**EG:** Description: • Home-based walking program: ◦ Walk at a moderate intensity to accumulate 30 minutes daily ◦ Personal walking action plan ◦ Personal SNAPPS summary ◦ Information concerning health behaviours ◦ 2 phone calls weekly, with a minimum of 4 during the study, to support the home-walking action plan and any other health behaviour plan. Frequency: All week days, preferably Duration: 8-12 weeks **CG:** Description: Usual care Frequency: None Duration: 8-12 weeks	Exercise capacity	6MWD, m	EG: Median Pre/Post 0 [41]; CG: Median Pre/Post 12 [39]; $p_{EG\ vs\ CG<0}$=0.01
				Health behaviours	"SNAPPS" snapshot questionnaire, scale 0-60	EG: Median Pre/Post 2 [6]; CG: Median Pre/Post 1 [4]; $p_{EG\ vs\ CG<0}$=0.42
					"SNAPPS" snapshot domains, scale 0-10:	EG: Median Pre/Post 0 [0]; CG: Median Pre/Post 0 [0]; $p_{EG\ vs\ CG<0}$=0.99
					Smoking	EG: Median Pre/Post 0 [0]; CG: Median Pre/Post 0 [0]; $p_{EG\ vs\ CG<0}$=0.989
					Nutrition	EG: Median Pre/Post 0 [0]; CG: Median Pre/Post 0 [0]; $p_{EG\ vs\ CG<0}$=0.28
					Alcohol	EG: Median Pre/Post 0 [4]; CG: Median Pre/Post 0 [4]; $p_{EG\ vs\ CG<0}$=0.4
					Physical activity	EG: Median Pre/Post 0 [0]; CG: Median Pre/Post 0 [0]; $p_{EG\ vs\ CG<0}$=0.737
					Psychosocial	EG: Median Pre/Post 0 [1]; CG: Median Pre/Post 0 [2]; $p_{EG\ vs\ CG<0}$=0.85
					Symptom management	EG: Median Pre/Post 0 [6]; CG: Median Pre/Post 0 [6]; $p_{EG\ vs\ CG<0}$=0.48
				HRQoL	CAT, scale 0-40	EG: Median Pre/Post 0 [5]; CG: Median Pre/Post 0 [0]; $p_{EG\ vs\ CG<0}$=0.64
				Physical activity	SNAPPS snapshot self-reported walking, days/week	EG: Median Pre/Post 14 [26]; CG: Median Pre/Post 16 [40]; $p_{EG\ vs\ CG<0}$=0.10
					SNAPPS snapshot self-reported walking, min/day	
Coultas *et al*. 2016 USA Pragmatic RCT	Home-based	n_{Total}= 305 (70.3±9.5 yrs, 49.5% male) Comorbidities: Hypertension, heart failure, myocardial infarction, peripheral vascular diseases, depression, diabetes, ulcer disease EG:	**EG:** Description: • Lifestyle PA intervention: ◦ Weeks 1-6: self-management education (manual, weekly phone calls) ◦ Weeks 7-26: PA self-management (activation phase): ▫ Accumulate, at least, 30 min of moderate PA intensity	Dyspnoea	CRQ-D, pts	EG: Pre 4.48±1.30 Post 4.50±1.39, p = 0.82; CG: Pre 4.33±1.35 Post 4.23±1.49, p = 0.43; $ES_{EG\ vs\ CG}$=0.09
				Exercise capacity	6MWD, m	EG: Pre 342.8±91.03 Post 343.1±99.81, $p < 0.001$; CG: Pre 337.5±96.37 Post 324.1±107.5, $p < 0.001$; $ES_{EG\ vs\ CG}$=0.14

Table 1 (*Continued*)

Study, country and design	Setting	Participants	Intervention	Outcome	Outcome measure	Results
		n = 149 (70.8±9.5 yrs, 49.7% male; GOLD 2-59, GOLD 3-71, GOLD 4-19; CCI 3.1±2.2 pts) CG: *n* = 156 (69.8±9.5 yrs, 49.4% male; GOLD 2-75, GOLD 3-59, GOLD 4-22; CCI 2.9±1.7 pts)	(4-5 on MBS-dyspnoea), taking 1-2 minutes to recover ▫ Those who not achieve the recommendations were instructed to strive for multiple intervals of moderate PA intensity (weekly workbook activities) ▫ Phone calls once every other week alternated by text messages; ◦ Weeks 27-66 (Maintenance phase): ▫ Maintenance of PA lifestyle ▫ 5 reading assignments; ▫ 1 monthly phone call. Frequency: Weeks 7-26, daily Duration: 66 weeks **CG:** Description: ◦ Weeks 1-6: self-management education (manual, weekly phone calls) ◦ Usual care (regular FU with their physician) Frequency: NA Duration: 66 weeks			
Chen *et al*. 2017 China Prospective RCT	Home-based	n_{Total}= 47 (67.1±10 yrs, 78.7% male, FEV_1pp: 54.7±24.3) EG: *n* = 25 (69±8.1 yrs, 88% male, FEV_1pp: 54.5±23.6) CG: *n* = 22 (65±11.6 yrs, 68.2% male, FEV_1pp: 54.9±25.6)	**EG:** Description: • Home-based lower-limb resistance training, through theraband and self-gravity resistance. ◦ 6 different sets of exercises: straight-leg lifting, prone hip extension, thigh abduction, posterior muscle group, anterior muscle group and standing calf raise. ◦ Best effort, not exceeding MBS-dyspnoea of 5. Frequency: 3 day/week, 20-30 minute each day Duration: 12 weeks **CG:** Description: Usual care: Frequency: NA Duration: 12 weeks	Exercise capacity HRQoL Muscle strength

Table 1 (*Continued*)

Study, country and design	Setting	Participants	Intervention	Outcome	Outcome measure	Results
			▫ Phone calls once every other week alternated by text messages; ▫ Weeks 27-66 (Maintenance phase): ▫ Maintenance of PA lifestyle ▫ 5 reading assignments; ▫ 1 monthly phone call. Frequency: Weeks 7-26, daily Duration: 66 weeks **CG:** Description: ◦ Weeks 1-6: self-management education (manual, weekly phone calls) ◦ Usual care (regular FU with their physician) Frequency: NA Duration: 66 weeks			Mean absolute difference$_{EG\ vs\ CG}$ (%) 15.8 [4.0;27.7] 95% CI
Lin *et al*. 2019 Taiwan RCT	Home-based	n_{Total}= 78 (95.2% male) EG: *n* = 38 (70.92±7.89 yrs) CG: *n* = 40 (73.5±8.31 yrs)	**EG:** Description: • Breathing-based walking: ◦ Combination of breathing, mediation and walking ◦ One-to-one breathing-based walking guidance by the researcher until they practice correctly. ◦ Handbook with instructions, pictures and a diary to practice breathing-based walking in daily life; ◦ Home diary, progress the exercise prescription and deliver self-management training. Frequency: 30 min/day, 5x/week. Duration: 2 months **CG:** Description: Usual care Frequency: None Duration: 2 months	Anxiety Depression Dyspnoea HRQoL	HADS-A, pts HADS-D, pts mMRC, pts CAT, pts	EG: Pre 3.03 Post 1.16, $p < 0.05$; CG: Pre 1.63 Post 2.45, $p < 0.05$; p-value$_{EG\ vs\ CG}$<0.05 EG: Pre 7.0 Post 2.37, $p < 0.05$; CG: Pre 5.71 Post 5.90, p-value NS; p-value$_{EG\ vs\ CG}$<0.05 EG: Pre 1.16 Post 0.89, $p < 0.05$; CG: Pre 1.32 Post 1.35, p-value NS; p-value$_{EG\ vs\ CG}$<0.05 EG: Pre 11.63 Post 5.11, $p < 0.05$; CG: Pre 9.82 Post 11.33, p-value NS; p-value$_{EG\ vs\ CG}$<0.05
Lahham *et al*. 2020 Australia RCT	Home-based	n_{Total}= 58 (68±9 yrs, 58.6% male, FEV_1pp: 90±7) EG: *n* = 29 (68±9 yrs 58.6% male, FEV_1pp: 90±8) CG: *n* = 29 (67±10 yrs 58.6% male, FEV_1pp: 92±7)	**EG:** Description: • Home-based PR: ◦ Endurance training: ▫ Initial walking speed: 80% of the speed walked during a 6-minute walk test (6MWT). The distance walked was recorded using a pedometer. ◦ Strength training ▫ Resistance training for the arms and legs used equipment available at home (e.g. home stairs for step ups and sealed water bottles as weights). • Initial exercise prescription was established during a home visit by a physiotherapist to ensure safety and understanding of the exercise program. • Participants were encouraged to exercise for 30 min, 5x/week and to record the completion of this activity in a home diary. • 7 phone calls (1/week) to review the home diary, progress the exercise prescription and deliver self-management training. Duration: 8 weeks	Dyspnoea Emotional function Exercise capacity Fatigue HRQoL Mastery Physical activity	mMRC, pts CRQ-D, pts CRQ-emotional function domain, pts 6MWD, m CRQ fatigue domain, pts CRQ total, points CRQ mastery domain, pts METs/day	EG: Mean difference -0.3 [-0.7;0.1] 95% CI; CG: Mean difference -0.1 [-0.5;0.3] 95% CI EG: Mean difference 2.6 [-0.9;5.8] 95% CI; CG: Mean difference 2.2 [-1.1;5.6] 95% CI; ES $_{EG\ vs\ CG}$=0.03 EG: Mean difference 2.6 [-1.6;6.9] 95% CI; CG: Mean difference -0.6 [-4.8;5.6] 95% CI; ES $_{EG\ vs\ CG}$=0.21 EG: Mean difference 15 [-43;76] 95% CI; CG: Mean difference 29 [-28;87] 95% CI; ES $_{EG\ vs\ CG}$=-0.07 EG: Mean difference 3.8 [1.0;6.5] 95% CI; CG: Mean difference 1.0 [-1.7;3.7] 95% CI; ES $_{EG\ vs\ CG}$=0.28 EG: Mean difference 11.3 [1.8;20.8] 95% CI; CG: Mean difference 4.6 [-4.8;14] 95% CI; ES $_{EG\ vs\ CG}$=0.19 EG: Mean difference 2.3 [-0.2;4.8] 95% CI; CG: Mean difference 2.0 [-0.5;4.5] 95% CI; ES $_{EG\ vs\ CG}$=0.03

Table 1 (*Continued*)

Study, country and design	Setting	Participants	Intervention	Outcome	Outcome measure	Results
			CG: Description: Usual care (counselling to keep active and to follow medication) Frequency: 8 weekly phone calls to control for attention- Duration: 8 weeks			EG: Mean difference 0.1 [-0.1;0.2] 95% CI; CG: Mean difference 0 [-0.2;0.2] 95% CI; ES $_{EG\ vs\ CG}$=0.05
					MVPA bouts, no/day	EG: Mean difference -0.3 [-1.6;1.0] 95% CI; CG: Mean difference -0.6 [-1.9;0.7] 95% CI; ES $_{EG\ vs\ CG}$=0.07
					MVPA time, min/day	EG: Mean difference -5 [-301;290] 95% CI; CG: Mean difference -211 [-497;76] 95% CI; ES $_{EG\ vs\ CG}$=0.34
					Sedentary bouts, no/day	EG: Mean difference -0.6 [-1.6;0.4] 95% CI; CG: Mean difference 0.2 [-0.8;1.1] 95% CI; ES $_{EG\ vs\ CG}$= -0.31
					Sedentary time, min/day	EG: Mean difference 32 [-63;128] 95% CI; CG: Mean difference 8 [-84;101] 95% CI; ES $_{EG\ vs\ CG}$= 0.08
					Steps/day, no	EG: Mean difference 303 [-1607;2215] 95% CI; CG: Mean difference -106 [-1962;1749] 95% CI; ES $_{EG\ vs\ CG}$= 0.06
					Time spent in MVPA bouts, min/day	EG: Mean difference -4 [-29;22] 95% CI; CG: Mean difference -13 [-38;12] 95% CI; ES $_{EG\ vs\ CG}$= 0.11
					Time spent in sedentary bouts, min/day	EG: Mean difference 4 [-55;63] 95% CI; CG: Mean difference - 21 [-37;78] 95% CI; ES $_{EG\ vs\ CG}$= 0.13
					Total EE	EG: Mean difference -4 [-1425;1418] 95% CI; CG: Mean difference 82 [-1299;1463] 95% CI; ES $_{EG\ vs\ CG}$= -0.02

5STS, five times sit-to-stand test; 6MWD, 6-minute walking distance; 6MWT, 6-minute walk test; 12MWD, 12-minute walking distance; 95% CI, 95% of confidence intervals; %, percentage; ADLs, activities of daily living; BCKQ, Bristol COPD Knowledge Questionnaire; bpm, beats per minute; CAT, COPD assessment test; CCI, Charlson Comorbidity Index; CG, control group; cpm, cycles per minute; CRQ, Chronic Respiratory Questionnaire; CRQ-D, CRQ – dyspnoea domain; EE, energy expenditure; EG, experimental group; ES, effect size; ESWT, endurance shuttle walk test; FEV1pp, forced expiratory volume in 1 second – percentage predicted; HADS, Hospital Anxiety and Depression Scale; HADS-A, HADS – anxiety; HADS-D, HADS – depression; HR_{ex}, heart rate during the greatest work load that a subject could maintain for 1 minute; HRQoL, health-related quality of life; HR_{st}, heart rate during the greatest work load that was common to both the initial and follow-up exercise in any one subject; ISWD, incremental shuttle walk distance; kg, kilograms; l/min, litres per minute; m, meters; MBS, modified Borg scale; min/day; minutes per day; mm, millimetres; mmol/min, millimole per minute; mMRC, modified British Medical Research Council; MVPA, moderate-vigorous physical activity; NA, Not applicable; ND, Not described; Nm, Newton meters; no, number; PA, physical activity; PR, pulmonary rehabilitation; PRAISE, Pulmonary Rehabilitation Adapted Index of Self-Efficacy; PT, peak torque; pts, points; PT/BW, peak torque/body weight; pts, points; RAPA, Rapid Assessment of Physical Activity questionnaire; R_{ex}, respiratory exchange ratio during the greatest work load that a subject could maintain for 1 minute; RCT, randomised controlled trial; s, seconds; SF-36, 36-item short form survey; SGRQ, St. George's respiratory questionnaire; TDI, Transition Dyspnea Index; UK, United Kingdom; W, Watts; WL_{ex}, work load during the greatest work load that a subject could maintain for 1 minute; VE_{ex}, minute ventilation during the greatest work load that a subject could maintain for 1 minute; VO_{2ex}, oxygen uptake during the greatest work load that a subject could maintain for 1 minute.

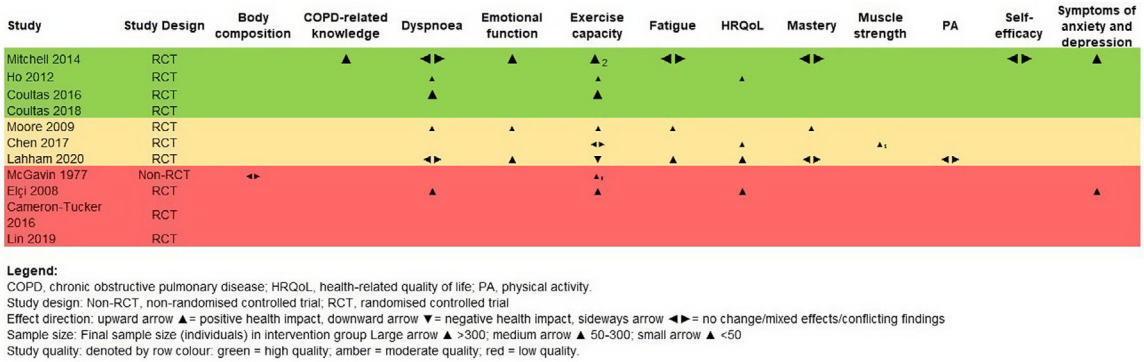

Fig. 2. Effect direction plot of unsupervised physical activity interventions in people with chronic obstructive pulmonary disease (n = 11).

not apparent (I^2=0%) however, the intervention effect was heavily weighted towards one trial[34] (Fig. 3).

Exercise capacity

Exercise capacity was measured in nine studies.[31,34-40,42] Most common measures used were the 6-minute walk distance (6MWD)[31,34,37,39,40] and the incremental shuttle walk distance (ISWD).[35,36,38] The 12-minute walk distance,[42] the heart rate,[42] the respiratory exchange ratio,[42] the minute ventilation,[42] the oxygen uptake,[42] the work load,[42] the stride[42] and the endurance shuttle walk test[36] were also reported. A positive effect on exercise capacity was observed, with six[34-36,38,40,42] of the eight studies[31,34-38,40,42] favouring the EG (75%, 95% CI 35-97%) (Fig. 2). These positive effects were also observed in meta-analysis of the 6MWD[31,34,37,40] (MD=13.70, 95% CI 3.58-23.83) and ISWD[35,36,38] (MD=58.59, 95% CI 5.79-111.39). However, a substantial heterogeneity was observed in both meta-analysis (I^2=98%, $p < 0.01$; I^2=86%, $p < 0.01$; respectively) (Fig. 3).

Physical activity

Physical activity was assessed in three studies,[31,33,39] using METs/day,[31] moderate-vigorous PA (MVPA) bouts and time,[31] Rapid Assessment of Physical Activity questionnaire,[33] "SNAPPS" (Smoking, Nutrition, Alcohol, Physical activity, Psychosocial wellbeing and symptom management) snapshot

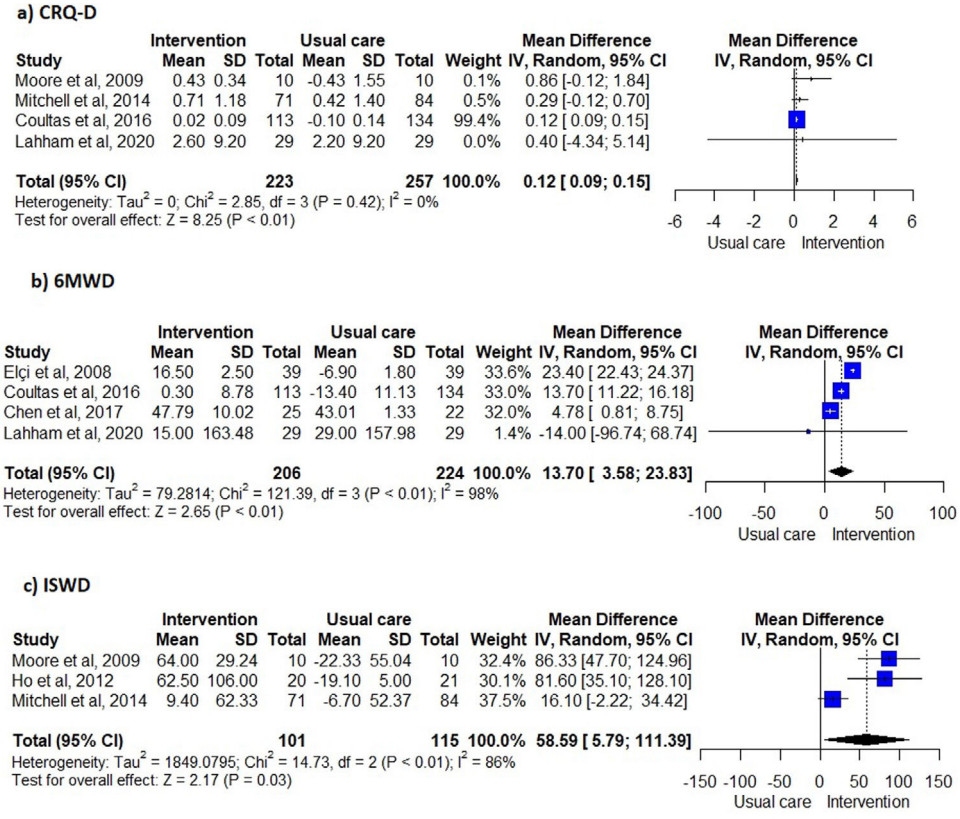

Fig. 3. Forest plots illustrating the effect of unsupervised PA interventions on: a) Chronic respiratory questionnaire – dyspnea domain (CRQ-D), b) 6-minute walk distance (6MWD), and c) incremental shuttle walk distance (ISWD), in comparison to usual care.

questionnaire self-reported walking,[39] sedentary bouts and time,[31] steps/day,[31] time spent in MVPA[31] and in sedentary bouts[31] and total energy expenditure.[31] The direction of effect was only evaluated in one study,[31] however a consistent direction of the effect was not determined.

Secondary outcomes

Body composition

Body composition was assessed in one study using weight and no differences were observed between groups.[42]

Emotional function

Emotional function was assessed with the CRQ-emotional function domain, in three studies[31,36,38] and positive effects were observed, favouring the EG (100%, 95% CI 29-100%).

Fatigue

Fatigue was assessed with the CRQ-fatigue domain in three studies,[31,36,38] and a positive effect was found in two[31,38] of these studies, favouring the EG (67%, 95% CI 9-99%) (Fig. 2).

Health behaviours

Health behaviours were evaluated using the SNAPPS snapshot questionnaire, total score and per domains, in one study.[39] Direction of the effect was not possible to be determined and no significant differences were observed between groups.[39]

Healthcare utilisation

Healthcare utilisation was assessed in two studies.[33,35] One used the number of emergency visits, hospitalisations, unscheduled clinic visits and length of hospitalisations[35] and the other the lung-related health care utilisation.[33] No differences were observed between groups, although lung-related health care utilisation was lower in the EG after the intervention (risk ratio=0.68, 95% CI 0.47-1 and rate ratio=0.64, 95% CI 0.42-0.99).[33]

Health-related quality of life

Health-related quality of life was evaluated in six studies,[31,35,37,39-41] using the 36-item short form survey,[40] the COPD assessment test,[37,39,41] the CRQ total score[31] and the St. George's Respiratory Questionnaire.[35,40] Direction of effect was only possible to be determined in four studies.[31,35,37,40] Unsupervised PA interventions had a positive effect on HRQoL, favouring the EG (100%, 95% CI 40-100%) (Fig. 2).

Mastery

Mastery was assessed with the CRQ-mastery domain, in three studies[31,36,38] and no effects were observed, with only one study [38] favouring the EG (33%, 95% IC 1-96%) (Fig. 2).

Muscle strength

Lower-limb muscle strength was evaluated in one study,[37] with the five times sit-to-stand test, isokinetic and isometric peak torque and adjusted for body weight. Improvements were observed in all outcome measures (ES= -0.36 to 0.26) for the EG after the intervention.[37]

Self-efficacy

Self-efficacy was assessed in one study[36] with the Pulmonary Rehabilitation Adapted Index of Self-Efficacy and no differences were observed between groups.

Symptoms of anxiety and depression

Symptoms of anxiety and depression were measured in three studies[36,40,41] with the Hospital Anxiety and Depression Scale. Positive effects were observed, with two[36,40] studies favouring the EG (100%, 95% IC 16-100%) (Fig. 2).

Adverse events

Four studies[33,34,37,41] explored the adverse events of unsupervised PA interventions. Two[33,34] of these studies found that 63% (n = 192) of participants had no adverse events and 37% (n = 106) had, at least, one adverse event. The most common adverse event was acute exacerbation of COPD, with a twice higher prevalence in the CG (15%, n = 47) than in the EG (9%, n = 28) ($p < 0.01$).[33,34]

Dropouts and adherence to interventions

Nine studies[33-39,41,42] reported dropouts, ranging between 7.1%[41] to 38.5%.[39] Reasons to dropout included: abrupt dizziness,[37] acute exacerbation of COPD,[35,38] cataract surgery,[37] comorbidities,[36] death,[42] failure to keep appointments,[39] intercurrent depressive illness,[42] knee pain,[38] lack of enthusiasm,[42] lost to follow-up,[36,38,41] non-COPD related hospital admission,[35,37] poor health,[39,41] social reasons,[36] programme was too easy or not so serious,[36,37] time constraints,[35,39] travel issues,[37,39] too busy to participate [41] and work commitement.[36]

Only four studies reported adherence to the intervention,[31,35,37,39] which varied between limited[39] to 93%.[31]

Discussion

This systematic review provided an overview of the unsupervised PA interventions implemented in people with COPD and showed that these interventions are effective in improving dyspnoea and exercise capacity.

Unsupervised PA interventions were conducted at home,[31,33-42] in most cases lasted 8-12 weeks[31,35,37,39-42] and were performed daily.[31,33-36,39,41,42] Aerobic training was the most common component,[31,35,36,38,39,41,42] namely, walking, however strength training [31,36-38,40] was also included and done in isolation[33-35,37,39,41,42] or with others.[31,36,38,40] These findings are of special importance, since people with COPD spend most of their day in a sedentary behaviour and at home.[2,43] Therefore, conducting these interventions in patients' home-environment, integrated into their daily routines (e.g., aerobic training through walking[31,35,39] or home stairs[31]) and using everyday resources (e.g., water bottles as weights[31]), may be a person-centred and feasible approach to increase participation in PA for people with COPD. Therefore, such interventions should be considered for those people with COPD who cannot or do not want to be involved in supervised PA interventions, either by limited access or disease restrictions, or as a

strategy for maintaining PA levels (e.g., after pulmonary rehabilitation), with regular assessments and/or phone calls for monitoring the individuals' progress.[44]

Furthermore, these interventions were effective in improving dyspnoea and exercise capacity in people with COPD. Nevertheless, some caution is needed when interpreting the effects of unsupervised PA interventions in dyspnoea for several reasons. First, the meta-analysis for the CRQ-D was greatly weighted by one large study,[34] with other studies showing no effects. This might have led to an underestimation of the effect. Also, the observed improvement (0.12 points) in the CRQ-D was statistically significant but not clinically relevant, based on the minimal clinically important difference (MCID) of 0.5 points of CRQ-D.[45] Therefore, further studies with higher sample sizes assessing the effects of unsupervised PA interventions in dyspnea should be conducted, since this outcome is a cardinal symptom for people with COPD.[1] In terms of exercise capacity, unsupervised PA interventions lead to statistical improvements under the MCID (25m[46]) in the 6MWT, but statistical and meaningful improvements above the MCID (47.5m[46]) in the ISWT. Heterogeneity of the interventions might explain this finding. Interventions included in the 6MWD meta-analysis were heterogeneous, whilst all the interventions included in the ISWD meta-analysis were walking-based. Integrating a walking component into the unsupervised PA interventions seems therefore important to improve exercise capacity clinically.

Similar results, for dyspnoea and exercise capacity (measured with 6MWD), were found recently in a systematic review of unsupervised exercise-based interventions in this population.[17] This is of special importance for clinical practice and research communities, which have been increasingly focusing on the promotion of PA and can now see benefits in these outcomes also obtained with unsupervised PA interventions integrating activities of individuals' daily life.[8,47]

We were unable to draw conclusions using the effect direction plot for PA. Indeed, it is surprising that PA, a strong predictor of COPD progression,[48] was just assessed in three studies. Thus, studies assessing the effects of unsupervised PA interventions in PA levels of individuals with COPD are urgently needed.

Our findings also showed that unsupervised PA interventions were effective in improving emotional function, fatigue, HRQoL, lung-related healthcare utilisation, muscle strength, self-efficacy and symptoms of anxiety and depression. Prior studies have shown that these parameters play a role in the disease management and progression[1,49-53] however, evidence is still scarce. Given the social, economic and health burden of COPD worldwide,[1] further research focusing on the effects of unsupervised PA interventions on these outcomes is needed.

Overall, unsupervised PA interventions were shown to be safe, with no or minor adverse events being reported. Most of the included studies reported a high adherence to unsupervised PA interventions. Compared with supervised PA interventions, unsupervised PA interventions showed a higher rate of adherence.[54] These interventions are adapted to each person's context and needs, are low cost and have broad applicability, being easy to perform at home, which might explain the high levels of adherence.[15] Future research should explore important variables such as GOLD grades and groups and its influence on the results obtained, as well as the long-term effects of such interventions.

Limitations

This systematic review has several limitations that need to be acknowledged. Firstly, the small number of existing studies; their large diversity of designs, outcomes and outcome measures; lack of consensus on the definition of unsupervised PA; and, the high heterogeneity observed in the meta-analysis, limited our conclusions. Nevertheless, a synthesis of the results, using the effect direction plot was computed which provided a thorough synthesis of data. Secondly, the imbalance between participants, i.e., more males than females and moderate to severe participants, limited the generalisation of results. Further studies including more people with COPD in mild and very severe grades and females should be conducted. Thirdly, our search was limited to studies published in English, Portuguese, Spanish or French included in databases. Additional studies may exist in the unpublished grey literature and may have been missed. A thorough search in different databases and scanning the references of key articles and systematic reviews were however conducted to minimise this limitation. Finally, approximately one third of the included studies were of low quality, nevertheless most studies presented moderate to high quality.

Conclusions

This systematic review showed that unsupervised PA interventions improved dyspnoea (statistically but not clinically) and exercise capacity in people with COPD. Overall, these interventions seem to be safe and present a high adherence rate. The inclusion of a walking component for 8-12 weeks in the unsupervised PA interventions is recommended to optimise results. Unsupervised PA interventions should be considered for people with COPD who cannot or do not want to engage in supervised PA interventions or as a maintenance strategy of PA levels. Future studies with robust methodologies should now be conducted to strengthen these promising results with potential to optimise COPD management.

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Disclosure of interest

The authors have no conflicts of interest to declare.

Supplementary materials

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.pulmoe.2022.01.007.

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