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Telerehabilitation for chronic respiratory disease (Review)

Cox NS, Dal Corso S, Hansen H, McDonald CF, Hill CJ, Zanaboni P, Alison JA, O'Halloran P, Macdonald H, Holland AE

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TABLE OF CONTENTS

HEADER 1
ABSTRACT 1
PLAIN LANGUAGE SUMMARY 2
SUMMARY OF FINDINGS 4
BACKGROUND 8
OBJECTIVES 9
METHODS 9
RESULTS 12
Figure 1. 13
Figure 2. 16
Figure 3. 17
Figure 4. 18
Figure 5. 19
Figure 6. 20
Figure 7. 22
DISCUSSION 24
AUTHORS' CONCLUSIONS 26
ACKNOWLEDGEMENTS 27
REFERENCES 28
CHARACTERISTICS OF STUDIES 38
DATA AND ANALYSES 107
Analysis 1.1. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 1: Outcome 1 Exercise capacity - 6minute walk test distance at end intervention 112
Analysis 1.2. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 2: Outcome 1 Exercise capacity - Change in endurance shuttle walk test time (seconds) at end intervention 112
Analysis 1.3. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 3: Outcome 1 Exercise capacity - change in endurance cycle time at end intervention 113
Analysis 1.4. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 4: Outcome 1 Exercise capacity - Peak watts on CPET at end intervention 113
Analysis 1.5. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 5: Outcome 1 Exercise capacity - Change in 30 sec STS repetitions at end intervention 113
Analysis 1.6. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 6: Outcome 1 Exercise Capacity - Long term (>6months) change in 6MWD from baseline to end followup 113
Analysis 1.7. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 7: Outcome 3 Dyspnoea - MMRC at end intervention 114
Analysis 1.8. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 8: Outcome 3 Dyspnoea - Change in CRQ Dyspnoea domain at end intervention 114
Analysis 1.9. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 9: Outcome 3 Dyspnoea - Long term (>6 months) change in CRQ Dyspnoea score from baseline to end followup 114
Analysis 1.10. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 10: Outcome 4 Quality of life - SGRQ total score at end intervention 115
Analysis 1.11. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 11: Outcome 4 Quality of life - Change in SGRQ symptom score at end intervention 115
Analysis 1.12. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 12: Outcome 4 Quality of life - Change in SGRQ activity score at end intervention 115
Analysis 1.13. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 13: Outcome 4 Quality of life - Change in SGRQ impact score at end intervention 115
Analysis 1.14. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 14: Outcome 4 Quality of life - CAT score at end intervention 116
Analysis 1.15. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 15: Outcome 4 Quality of life - Change in CRQ Dyspnoea domain at end intervention 116
Analysis 1.16. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 16: Outcome 4 Quality of life - Change in CRQ Fatigue domain at end intervention 116

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Analysis 1.17. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 17: Outcome 4 Quality of life - Change in CRQ Emotion domain at end intervention 117
Analysis 1.18. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 18: Outcome 4 Quality of life - Change in CRQ Mastery domain at end intervention 117
Analysis 1.19. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 19: Outcome 4 Quality of life - Change in CCQ Function domain at end intervention 117
Analysis 1.20. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 20: Outcome 4 Quality of life - Change in CCQ Mental domain at end intervention 117
Analysis 1.21. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 21: Outcome 4 Quality of life - Change in CCQ Symptom domain at end intervention 118
Analysis 1.22. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 22: Outcome 4 Quality of life - Change in CCQ total score at end intervention 118
Analysis 1.23. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 23: Outcome 4 Quality of life - Change in EQ-5D-VAS score at end intervention 118
Analysis 1.24. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 24: Outcome 4 Quality of Life - Long term (>6 months) change in CRQ Dyspnoea score from baseline to end followup 118
Analysis 1.25. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 25: Outcome 4 Quality of Life - Long term (>6 months) change in CRQ Fatigue score from baseline to end followup 119
Analysis 1.26. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 26: Outcome 4 Quality of Life - Long term (>6 months) change in CRQ Emotion score from baseline to end followup 119
Analysis 1.27. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 27: Outcome 4 Quality of Life - Long term (>6 months) change in CRQ Mastery score from baseline to end followup 119
Analysis 1.28. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 28: Outcome 5 Completion of the intervention 120
Analysis 1.29. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 29: Outcome 6 Anxiety/Depression - Change in HADS Anxiety score at end intervention 120
Analysis 1.30. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 30: Outcome 6 Anxiety/Depression - Change in HADS Depression score at end intervention 120
Analysis 1.31. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 31: Outcome 6 Anxiety/Depression - Long term (>6 months) change in HADS Anxiety score from baseline to end followup 121
Analysis 1.32. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 32: Outcome 6 Anxiety/Depression - Long term (>6 months) change in HADS Depression score from baseline to end followup 121
Analysis 1.33. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 33: Outcome 7 Physical activity - Change in MVPA time (minutes/day) at end intervention 121
Analysis 1.34. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 34: Outcome 7 Physical activity - Sedentary time (minutes/day) at end intervention 121
Analysis 1.35. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 35: Outcome 7 Physical activity - Change in steps/day at end intervention 122
Analysis 1.36. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 36: Outcome 7 Physical Activity - Change in total daily Energy Expenditure (k/cal) at end intervention 122
Analysis 1.37. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 37: Outcome 7 Physical activity - Light physical activity time (minutes)/day at end intervention 122
Analysis 1.38. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 38: Outcome 7 Physical Activity - Lifestyle physical activity time (minutes)/day at end intervention 122
Analysis 1.39. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 39: Outcome 7 Physical Activity - Moderate physical activity time (minutes)/day at end intervention 123
Analysis 1.40. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 40: Outcome 7 Physical activity - Change in time active (minutes) at end intervention 123
Analysis 1.41. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 41: Outcome 8 Health care utilisation - Respiratory related hospitalisation 123
Analysis 3.1. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 1: Outcome 1 Exercise capacity - 6minute walk distance at end intervention 128
Analysis 3.2. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 2: Outcome 1 Exercise capacity - Peak watts on CPET at end intervention 128
Analysis 3.3. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 3: Outcome 1 Exercise capacity - Change in ISWT distance at end intervention 128

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Analysis 3.4. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 4: Outcome 1 Exercise capacity - Change in ESWT time at end of intervention 128
Analysis 3.5. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 5: Outcome 3 Dyspnoea - Change in CRQ Dyspnoea domain at end intervention 129
Analysis 3.6. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 6: Outcome 3 Dyspnoea - Change in exercise isotime breathlessness score at end intervention 129
Analysis 3.7. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 7: Outcome 3 Dyspnoea - MMRC at end intervention 129
Analysis 3.8. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 8: Outcome 4 Quality of life - SGRQ total score at end intervention 130
Analysis 3.9. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 9: Outcome 4 Quality of life - CAT score at end intervention 130
Analysis 3.10. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 10: Outcome 4 Quality of life - Change in CRQ total score at end intervention 130
Analysis 3.11. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 11: Outcome 4 Quality of life - Change in CRQ Dyspnoea domain at end intervention 131
Analysis 3.12. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 12: Outcome 4 Quality of life - Change in CRQ Fatigue domain at end intervention 131
Analysis 3.13. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 13: Outcome 4 Quality of life - Change in CRQ Emotion domain at end intervention 131
Analysis 3.14. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 14: Outcome 4 Quality of life - Change in CRQ Mastery domain at end intervention 132
Analysis 3.15. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 15: Outcome 4 Quality of life - Change in MLHFQ at end intervention 132
Analysis 3.16. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 16: Outcome 5 Anxiety/Depression - Change in HADS Anxiety score at end intervention 132
Analysis 3.17. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 17: Outcome 5 Anxiety/Depression - Change in HADS Depression score at end interveniton 132
Analysis 3.18. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 18: Outcome 6 Physical activity - Change in total Energy Expenditure (kcal)/day at end intervention 133
Analysis 3.19. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 19: Outcome 6 Physical activity - Change in steps/day at end intervention 133
Analysis 3.20. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 20: Outcome 6 Physical activity - Sedentary time (minutes)/day at end intervention 133
Analysis 3.21. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 21: Outcome 6 Physical activity - Light physical activity time (minutes)/day at end intervention 134
Analysis 3.22. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 22: Outcome 6 Physical activity - Lifestyle physical activity time (minutes)/day at end intervention 134
Analysis 3.23. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 23: Outcome 6 Physical activity - Moderate intensity physical activity time (minutes)/day at end intervention 134
Analysis 3.24. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 24: Outcome 6 Physical activity - Change in Vigorous physical activity time (minutes)/day at end intervention 134
Analysis 3.25. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 25: Outcome 6 Physical activity - Change in Very Vigorous physical activity time (minutes)/day at end intervention 135
Analysis 3.26. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 26: Outcome 6 Physical activity - Change in number sedentary bouts/day at end rehabilitation 135
Analysis 3.27. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 27: Outcome 6 Physical activity - Change in time spent in sedentary bouts minutes/day at end rehabilitation 135
Analysis 3.28. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 28: Outcome 6 Physical activity - Change in moderate-vigorous physical activity time minutes/day at end rehabilitation 135
Analysis 3.29. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 29: Outcome 6 Physical activity - Change in number of bouts moderate-vigorous physical activity/day at end rehabilitation 135
Analysis 3.30. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 30: Outcome 6 Physical activity - Change in time spent in moderate-vigorous bouts, minutes/day at end rehabilitation 136
Analysis 3.31. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 31: Outcome 6 Physical activity - Change in metabolic equivalents (METs)/day at end rehabilitation 136

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Analysis 3.32. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 32: Outcome 7 - Health care utilisation .. 136
ADDITIONAL TABLES 136
APPENDICES 145
HISTORY 148
CONTRIBUTIONS OF AUTHORS 148
DECLARATIONS OF INTEREST 148
SOURCES OF SUPPORT 149
DIFFERENCES BETWEEN PROTOCOL AND REVIEW 149
INDEX TERMS 149

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[Intervention Review]

Telerehabilitation for chronic respiratory disease

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ABSTRACT

Background

Pulmonary rehabilitation is a proven, effective intervention for people with chronic respiratory diseases including chronic obstructive pulmonary disease (COPD), interstitial lung disease (ILD) and bronchiectasis. However, relatively few people attend or complete a program, due to factors including a lack of programs, issues associated with travel and transport, and other health issues. Traditionally, pulmonary rehabilitation is delivered in-person on an outpatient basis at a hospital or other healthcare facility (referred to as centre-based pulmonary rehabilitation). Newer, alternative modes of pulmonary rehabilitation delivery include home-based models and the use of telehealth.

Telerehabilitation is the delivery of rehabilitation services at a distance, using information and communication technology. To date, there has not been a comprehensive assessment of the clinical efficacy or safety of telerehabilitation, or its ability to improve uptake and access to rehabilitation services, for people with chronic respiratory disease.

Objectives

To determine the effectiveness and safety of telerehabilitation for people with chronic respiratory disease.

Search methods

We searched the Cochrane Airways Trials Register, and the Cochrane Central Register of Controlled Trials; six databases including MEDLINE and Embase; and three trials registries, up to 30 November 2020. We checked reference lists of all included studies for additional references, and handsearched relevant respiratory journals and meeting abstracts.

Selection criteria

All randomised controlled trials and controlled clinical trials of telerehabilitation for the delivery of pulmonary rehabilitation were eligible for inclusion. The telerehabilitation intervention was required to include exercise training, with at least 50% of the rehabilitation intervention being delivered by telerehabilitation.

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Data collection and analysis

We used standard methods recommended by Cochrane. We assessed the risk of bias for all studies, and used the ROBINS-I tool to assess bias in non-randomised controlled clinical trials. We assessed the certainty of evidence with GRADE. Comparisons were telerehabilitation compared to traditional in-person (centre-based) pulmonary rehabilitation, and telerehabilitation compared to no rehabilitation. We analysed studies of telerehabilitation for maintenance rehabilitation separately from trials of telerehabilitation for initial primary pulmonary rehabilitation.

Main results

We included a total of 15 studies (32 reports) with 1904 participants, using five different models of telerehabilitation. Almost all (99%) participants had chronic obstructive pulmonary disease (COPD). Three studies were controlled clinical trials. For primary pulmonary rehabilitation, there was probably little or no difference between telerehabilitation and in-person pulmonary rehabilitation for exercise capacity measured as 6-Minute Walking Distance (6MWD) (mean difference (MD) 0.06 metres (m), 95% confidence interval (CI) -10.82 m to 10.94 m; 556 participants; four studies; moderate-certainty evidence). There may also be little or no difference for quality of life measured with the St George's Respiratory Questionnaire (SGRQ) total score (MD -1.26, 95% CI -3.97 to 1.45; 274 participants; two studies; low-certainty evidence), or for breathlessness on the Chronic Respiratory Questionnaire (CRQ) dyspnoea domain score (MD 0.13, 95% CI -0.13 to 0.40; 426 participants; three studies; low-certainty evidence). Participants were more likely to complete a program of telerehabilitation, with a 93% completion rate (95% CI 90% to 96%), compared to a 70% completion rate for in-person rehabilitation. When compared to no rehabilitation control, trials of primary telerehabilitation may increase exercise capacity on 6MWD (MD 22.17 m, 95% CI -38.89 m to 83.23 m; 94 participants; two studies; low-certainty evidence) and may also increase 6MWD when delivered as maintenance rehabilitation (MD 78.1 m, 95% CI 49.6 m to 106.6 m; 209 participants; two studies; low-certainty evidence). No adverse effects of telerehabilitation were noted over and above any reported for in-person rehabilitation or no rehabilitation.

Authors' conclusions

This review suggests that primary pulmonary rehabilitation, or maintenance rehabilitation, delivered via telerehabilitation for people with chronic respiratory disease achieves outcomes similar to those of traditional centre-based pulmonary rehabilitation, with no safety issues identified. However, the certainty of the evidence provided by this review is limited by the small number of studies, of varying telerehabilitation models, with relatively few participants. Future research should consider the clinical effect of telerehabilitation for individuals with chronic respiratory diseases other than COPD, the duration of benefit of telerehabilitation beyond the period of the intervention, and the economic cost of telerehabilitation.

PLAIN LANGUAGE SUMMARY

How does using technology to deliver pulmonary rehabilitation (PR) compare to centre-based PR, or no PR in people with chronic lung disease?

Background

For people with chronic lung conditions, pulmonary rehabilitation is proven to improve physical functioning and general well-being, and to reduce symptoms, particularly breathlessness. Pulmonary rehabilitation is a program of exercise training and education that is traditionally offered as an in-person program at a healthcare facility such as a hospital, where people attend program appointments but are not hospitalised overnight. To make it easier for more people to access pulmonary rehabilitation, new ways of delivering programs using technology have been investigated. Pulmonary rehabilitation delivered using technology is known as telerehabilitation. Telerehabilitation models can include (but are not limited to) talking with a health professional and/or other patients on the telephone, using a website or mobile application, or via video-conferencing. In some circumstances, undertaking telerehabilitation may require patients to have access to their own device (e.g. telephone, smart phone, tablet or computer) in order to participate.

Study characteristics

This review included 15 studies involving 1904 people with chronic lung disease, the majority (99%) of whom had chronic obstructive pulmonary disease (COPD). The studies described a variety of different ways to use technology to deliver pulmonary rehabilitation including over the telephone, using mobile phone applications, via video-conferencing in a virtual group and through the use of websites. The studies of telerehabilitation were collectively compared to traditional in-person PR, or to no rehabilitation. The variety of technology used, as well as differing levels of support from health professionals in the different studies, makes it difficult to determine if there is one best type of technology, amount of assistance or place to which to deliver a telerehabilitation program.

Key results

Across multiple studies using different types of technology to deliver pulmonary rehabilitation, telerehabilitation probably produces similar results to the traditional in-person outpatient pulmonary rehabilitation programs. Telerehabilitation may help people walk further when compared to no rehabilitation, but we have low certainty in these results. People were more likely to finish a full program of telerehabilitation compared to traditional pulmonary rehabilitation (93% compared to 70% completion). Very few of the studies followed people up after the intervention was finished, so it is difficult to say what the long-term effect is of telerehabilitation.

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Certainty of the evidence

The certainty of evidence (our confidence that the statistical effect estimates are correct) was generally low, because the number of studies, patients, and lung conditions in which telerehabilitation was studied is small. This means these results may not apply to all people with chronic lung disease or to all types of technology used to deliver pulmonary rehabilitation.

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SUMMARY OF FINDINGS

Summary of findings 1. Telerehabilitation compared to centre-based (outpatient) pulmonary rehabilitation for chronic respiratory disease

Telerehabilitation compared to centre-based (outpatient) pulmonary rehabilitation for chronic respiratory disease

Patient or population: Chronic respiratory disease
Setting: Rehabilitation centres, hospital outpatient departments, home
Intervention: Telerehabilitation
Comparison: Centre-based (outpatient) pulmonary rehabilitation

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with centre-based (outpatient) pulmonary rehabilitation	Risk with telerehabilitation				
Primary rehabilitation						
Exercise capacity - 6MWD (m) Follow-up: end of rehabilitation (range 6 weeks to 12 weeks)	The change in 6MWD in the control groups ranged from **11 m to 29 m**	Mean change in 6MWD was **0.06 m higher** in the telerehabilitation groups (11 lower to 11 higher)	MD 0.06 (-10.82 to 10.94	556 (4 RCTs)	⊕⊕⊕⊖ MODERATE [1]	
Breathlessness - CRQ dyspnoea domain Follow-up: end of rehabilitation (range 8 weeks to 11 weeks)	The mean change in CRQ dyspnoea in the control groups was **0.7 points**	The mean change in CRQ dyspnoea was **0.13 points higher** in the telerehabilitation groups (0.1 points lower to 0.4 higher) with higher scores indicating improvement	MD 0.13 (-0.13 to 0.40)	394 (3 RCTs)	⊕⊕⊖⊖ LOW [2 3]	
Quality of life - SGRQ Follow-up: end of rehabilitation (range 6 weeks to 8 weeks). Lower scores indicating better quality of life	The change in SGRQ in the control groups ranged from **-6.3 to 1.6 points**	The mean change in SGRQ score was **1.3 points lower** in the telerehabilitation groups (4 points lower to 1 point higher)	MD -1.26 (-3.97 to 1.45)	274 (2 RCTs)	⊕⊕⊖⊖ LOW [1 3]	The MCID for the SGRQ is 4 points
Quality of life - CAT Follow-up: end of rehabilitation (range 6 weeks to 12 weeks)	The change in CAT in the control groups ranged from **-1.1 to -0.3 points**	The mean change in CAT score was **1.4 points lower** in the telerehabilitation groups	MD 1.37 (-3.1 to 0.36)	224 (2 RCTs)	⊕⊕⊕⊖ MODERATE [1]	

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		(3 points lower to 0.4 points higher) with lower scores indicating better health status			

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the __relative effect__ of the intervention (and its 95% CI).

6MWD: six-minute walk distance; **CAT**: COPD Assessment Test; **COPD**: chronic obstructive pulmonary disease; **CI:** Confidence interval; **CRQ**: chronic respiratory disease questionnaire; **m:** metres; **MD**: mean difference; **OR:** Odds ratio; **RR:** Risk ratio; **SGRQ**: St George's Respiratory Questionnaire.

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

[1]High risk of bias for performance bias
[2]High risk of bias for performance bias and possibly reporting bias
[3]Risk of imprecision due to width of confidence intervals
[4]Risk of inconsistency due to limited overlap of confidence intervals

Summary of findings 2. Telerehabilitation compared to no rehabilitation control for chronic respiratory disease

Telerehabilitation compared to no rehabilitation control for chronic respiratory disease

Patient or population: Chronic respiratory disease
Setting: Home or community based exercise
Intervention: Telerehabilitation
Comparison: No rehabilitation control

Outcomes	Anticipated absolute effects* (95% CI)		Relative effect (95% CI)	№ of participants (studies)	Certainty of the evidence (GRADE)	Comments
	Risk with no rehabilitation control	Risk with telerehabilitation				
Primary rehabilitation						
Exercise capacity - 6MWD (m) Follow-up: end of rehabilitation (mean 8 weeks)	The mean change in 6MWD in the control groups was **10 m**	The mean change in the telerehabilitation groups was **22 m higher** (39 lower and 83 higher)	MD 22.17 (-38.89 to 83.23)	94 (2 RCTs)	⊕⊕⊖⊖ LOW [1,2]	

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Breathlessness - CRQ dyspnoea domain Follow-up: end of rehabilitation (mean 8 weeks)	The mean change in CRQ dyspnoea in the control groups was **0.6 points**	The mean change in the telerehabilitation groups was **2 points higher** (1 point lower to 5 points higher) with higher scores indicating better outcomes	MD 1.97 (-1.07 to 5.02)	94 (2 RCTs)	⊕⊕⊖⊖ LOW [1 2]	This difference was measured using a maximum score of 35 on the CRQ scale, so would be equivalent to a mean difference of 0.06 units on a 7-point scale.
Quality of life - CRQ total score Follow-up: end of rehabilitation (mean 8 weeks)	The mean change in CRQ total score in the control groups was **3.3 points**	The mean change in the telerehabilitation groups was **7 points higher** (0.6 points lower to 14 points higher) with higher scores indicating better outcomes	MD 6.90 (-0.57 to 14.36)	94 (2 RCTs)	⊕⊕⊖⊖ LOW [1 2]	This difference was measured using a maximum score of 140 on the CRQ scale, so would be equivalent to a mean difference of 0.345 units on a 7-point scale.
Quality of life - CRQ dyspnoea domain Follow-up: end of rehabilitation (mean 8 weeks)	The mean change in CRQ dyspnoea domain in the control groups was **0.6 points**	The mean change in the telerehabilitation groups was **2 points higher** (1 point lower to 5 points higher) with higher scores indicating better outcomes	MD 1.97 (-1.07 to 5.02)	94 (2 RCTs)	⊕⊕⊖⊖ LOW [1 2]	
Maintenance rehabilitation						
Exercise capacity - 6MWD (m) Follow-up: end of rehabilitation (range 4 months to 12 months)	The change in 6MWD in the control groups ranged from **-45 to -15 m**	The mean change in the maintenance telerehabilitation groups was **78 m higher** (50 higher to 107 higher)	MD 78.10 (49.6 to 106.6)	209 (2 RCTs)	⊕⊕⊖⊖ LOW [2 3]	
Dyspnoea - mMRC Follow-up: end of rehabilitation (range 4 months to 12 months)	The change in mMRC in the control groups ranged from **0.07 to 0.9 points**	The mean change in the maintenance telerehabilitation groups was 0.86**points lower** (2 points lower to 0.4 points higher) with lower scores indicating better outcome	MD -0.86, 95% CI -2.10 to 0.37; participants)	189 (2 RCTs)	⊕⊖⊖⊖ VERY LOW [2 3 4]	I^2 = 97%

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Quality of life - CAT Follow-up: end of re-habilitation (range 4 months to 12 months)	The change in CAT in the control groups ranged from **1.6 to 5.1 points**	The mean change in the maintenance telerehabilitation groups was **7 points lower** (9 points lower to 5 points lower) with lower scores indicating better outcome	MD -7.34 (-9.20 to -5.48)	189 (2 RCTs)	⊕⊖⊖⊖ VERY LOW [2 3 4]

*__The risk in the intervention group__ (and its 95% confidence interval) is based on the assumed risk in the comparison group and the **relative effect** of the intervention (and its 95% CI).

6MWD: six-minute walk distance; **CAT**: COPD Assessment Test; **COPD**: chronic obstructive pulmonary disease; **CI:** Confidence interval; **CRQ**: chronic respiratory disease questionnaire; **m:** metres; **mMRC**: modified medical research council dyspnoea scale; **MD**: mean difference; **OR:** Odds ratio; **RR:** Risk ratio; **SGRQ**: St George's Respiratory Questionnaire;

GRADE Working Group grades of evidence
High certainty: We are very confident that the true effect lies close to that of the estimate of the effect
Moderate certainty: We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low certainty: Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect
Very low certainty: We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

[1]High risk of bias for performance bias
[2]Risk of imprecision due to width of confidence intervals
[3]High risk of bias for performance bias and detection bias
[4]Risk of inconsistency due to high degree of heterogeneity

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BACKGROUND

Description of the condition

Chronic respiratory diseases, including chronic obstructive pulmonary disease (COPD), interstitial lung diseases (ILD), bronchiectasis and chronic asthma, contribute 7% to the global burden of disease (GBD 2020). These conditions cause chronic inflammation and/or infection of the airways and other structures of the lungs (Bousquet 2007). As a group, chronic respiratory diseases are the third leading cause of death worldwide, and account for 10% of all disability adjusted life years (a metric that estimates the amount of active and productive life lost due to a condition) (FIRS 2017). This level of disability is second only to that of cardiovascular disease, including stroke (FIRS 2017). The estimated prevalence of preventable chronic respiratory diseases exceeds 800 million people globally (Bousquet 2007), with four million premature deaths attributed to chronic respiratory disease each year (Ferkol 2014).

Chronic respiratory disease commonly develops as a consequence of repeated exposure to noxious environmental stimuli such as cigarette smoke, air pollution or occupational hazards. Other possible causes for the development of a chronic respiratory disease include immunological disorders, iatrogenic responses, genetic factors, repeated severe respiratory infections during childhood and low socioeconomic status (GOLD 2020). Collectively, people with a chronic respiratory disease experience breathlessness limiting functional capacity, reduced exercise tolerance, impaired health-related quality of life, repeated need for hospitalisation, and an increased prevalence of anxiety and depression (Celli 2004). The adverse social and economic effects of chronic respiratory disease experienced by individuals, families and societies are large and projected to increase substantially in the future (Bousquet 2007).

Description of the intervention

Pulmonary rehabilitation aims to improve the physiological and psychological condition of individuals with chronic respiratory disease through exercise training accompanied by education and behaviour change (Spruit 2013). Pulmonary rehabilitation is commonly delivered in an outpatient or community setting and comprises two or more sessions per week delivered over a period of at least four weeks (McCarthy 2015). Where healthcare system culture and resources allow, pulmonary rehabilitation may also be delivered in the inpatient setting (McCarthy 2015). The exercise training component of pulmonary rehabilitation includes both aerobic training and strength training. Typically, each session consists of up to 30 minutes of aerobic training (often a combination of walking and cycle training), with exercise prescription individualised on the basis of a pre-rehabilitation assessment of functional exercise capacity (Spruit 2013). Strength training for the upper and lower limbs is achieved through repetitive lifting of loads equivalent to 60% to 70% of the maximum load able to be moved through the full range of movement once (i.e. one repetition maximum) or that which produces fatigue after eight to 12 repetitions (Chodzko-Zajko 2009). To improve strength the American College of Sports Medicine recommends adults undertake strengthening exercises on two or three days in the week, comprising one to three sets of eight to 12 repetitions (Chodzko-Zajko 2009). Progression of training intensity, or overload, over the course of the rehabilitation period is paramount in order to achieve optimal gains in functional exercise tolerance (Spruit 2013). While individually tailored exercise training is the cornerstone of pulmonary rehabilitation, programmes may also include disease-specific education and self-management training (Spruit 2013). Self-management training aims to help people with COPD develop and implement the skills necessary to perform their health management tasks, guide behaviour change and provide support to achieve optimal function and disease control (Zwerink 2014). However, the most effective content for self-management training remains unclear (Zwerink 2014).

Telehealth interventions are those that provide healthcare at a distance through the use of telecommunications or virtual technology (WHO 2016). Telerehabilitation is a domain of telehealth, distinct from telemonitoring (the monitoring of patients at a distance using information technology), which makes use of information and communication technologies to provide clinical rehabilitation services from a distance (Kairy 2009). Remote communication between the patient and healthcare professional may utilise telephone (including text messaging), internet or videoconferencing technologies (Hwang 2015), in order to enable pulmonary rehabilitation services to be delivered to a satellite healthcare centre or directly to the patient's home (Lee 2015). Telerehabilitation may provide greater healthcare access and service delivery options for individuals who are geographically or socially isolated, for patients in full-time work or study, or for individuals who find travel difficult due to their disease severity or comorbidities. There is some evidence that a proportion of people with COPD attending pulmonary rehabilitation are interested in utilising telerehabilitation services (Seidman 2017). In addition to exercise training, telerehabilitation models may also include other components of centre-based pulmonary rehabilitation such as self-management education and education regarding disease management. Telerehabilitation models for pulmonary rehabilitation have the potential to positively influence uptake and accessibility of pulmonary rehabilitation services for all patients with a chronic respiratory disease.

How the intervention might work

Pulmonary rehabilitation is a proven, effective intervention which enables individuals with a variety of chronic respiratory diseases, including COPD (McCarthy 2015), bronchiectasis (Lee 2017), ILD (Dowman 2014), and asthma (Trevor 2014), to achieve clinically important gains in exercise and functional capacity, as well as improvement of symptoms and health-related quality of life (Spruit 2013). Participation in pulmonary rehabilitation results in fewer symptoms, reduced hospitalisations due to an acute exacerbation of respiratory disease (Guell 2000), and reduced healthcare utilisation (Puhan 2005). The exercise training component of pulmonary rehabilitation helps to achieve these outcomes through improved capacity and efficiency of skeletal muscle function, which serves to reduce fatigue and perception of dyspnoea, allowing for increased exercise tolerance and physical functioning (Spruit 2013). Pulmonary rehabilitation also helps to improve disease self-management and control through education and training (McCarthy 2015).

Pulmonary rehabilitation delivered via telerehabilitation may utilise any of a number of technological modalities including, but not limited to, telephone (audio calls or text messaging), the internet (e.g. mobile application or web platform), or videoconferencing to deliver the requisite components of

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pulmonary rehabilitation to people with chronic respiratory disease. These technological modalities have the capacity to deliver the essential components of pulmonary rehabilitation, including the monitoring of physiological signs and symptoms during exercise remotely in real-time or in a 'store and forward' capacity. In addition, they can provide supervision and feedback for exercise training, and discussion of self-management education. Supervision of exercise training during telerehabilitation may involve direct (e.g. auditory or audio-visual communication in real-time) or indirect (e.g. via text message) feedback from a clinician. Telerehabilitation models may also offer unsupervised exercise training, whereby standard or automated prompts and feedback are provided via technological modalities to individuals. Telerehabilitation may be delivered directly to a patient's home or to a nearby healthcare facility. It is unclear whether telerehabilitation in general, or a particular mode of telerehabilitation delivery, can achieve improvements in physical function and health-related quality of life equivalent to those achievable using traditional models of pulmonary rehabilitation delivery. Telerehabilitation has the ability to overcome barriers to pulmonary rehabilitation participation, including issues of patient travel and transport, and staffing and resource limitations (Keating 2011). Telerehabilitation could be a relevant treatment alternative across all chronic respiratory diseases where rehabilitation is a proven therapeutic intervention. However, it is also possible that the lack of in-person supervision and peer support could adversely affect rehabilitation outcomes.

Why it is important to do this review

Despite the proven benefits of pulmonary rehabilitation for people with chronic respiratory disease, only a very small percentage of people who are eligible to attend pulmonary rehabilitation ever do so (Brooks 2007). Significant patient-centred barriers to attendance and completion of pulmonary rehabilitation relate to travel and transport to the rehabilitation centre (Keating 2011). In addition, access to pulmonary rehabilitation in non-metropolitan areas is limited due to lack of services and suitably trained healthcare professionals (Johnston 2012). Improving patient access to pulmonary rehabilitation, through alternative models of service delivery, has the potential to improve health outcomes and reduce total hospitalisations and healthcare utilisation for people with chronic respiratory disease. Economic modelling from Australia suggests that increasing the number of patients who complete pulmonary rehabilitation from 5% to 20% at a single institution might reduce that hospital's admission rates related to COPD by 75% per year, with associated cost savings (NSW ACI 2010).

While people with COPD previously formed the majority of candidates for pulmonary rehabilitation, recent evidence of the efficacy of pulmonary rehabilitation in other lung diseases has broadened the application of this intervention (Spruit 2013), and treatment recommendations in pulmonary rehabilitation guidelines now encompass the spectrum of chronic respiratory disease (e.g. Alison 2017). As such, individuals referred to pulmonary rehabilitation now have a variety of chronic respiratory diseases. These include, but are not limited to COPD, chronic airflow limitation in the absence of smoking history, bronchiectasis, ILD and chronic asthma. Consistent with the changing demographic of pulmonary rehabilitation participants, research studies in pulmonary rehabilitation increasingly include people with a broad cross section of lung disease, to ensure the included study populations are reflective of those individuals who are referred to and attend pulmonary rehabilitation (Greening 2014). Results from such studies may have a greater capacity for translation into clinical practice because they represent the real-world clinical situation (Grimshaw 2012).

Telerehabilitation has the potential to overcome known barriers to pulmonary rehabilitation participation, and could be a relevant treatment alternative across all chronic respiratory diseases where rehabilitation is an accepted therapeutic intervention. The COVID-19 pandemic has seen rapid transition of pulmonary rehabilitation programs to a remote-delivery format, which increases the urgency of understanding the safety and efficacy of such a model. To date, there has not been a comprehensive assessment of the capacity of telerehabilitation to achieve improvements in exercise capacity, breathlessness and health-related quality of life in people with chronic respiratory disease, or its ability to improve uptake and access to rehabilitation services. This Cochrane Review aims to evaluate the efficacy of telerehabilitation on clinical and patient-related outcomes in people with chronic respiratory disease, and to highlight directions for future work.

OBJECTIVES

1. To determine whether telerehabilitation in people with chronic respiratory disease has beneficial effects on exercise capacity, breathlessness and health-related quality of life when compared to traditional, centre-based pulmonary rehabilitation or no rehabilitation control.
2. To assess the safety of telerehabilitation in people with chronic respiratory disease.

METHODS

Criteria for considering studies for this review

Types of studies

We included randomised controlled trials (RCTs) and controlled clinical trials (CCTs) of telerehabilitation in people with chronic respiratory disease. We included CCTs in order to encompass studies where randomisation may not have been possible, e.g. where regional cohorts were compared to metropolitan patients. We included studies reported in full text, those published as an abstract only, and unpublished data.

For the purposes of this review, the following definitions applied.

- Telerehabilitation is the delivery of pulmonary rehabilitation services at a distance, using telecommunications technology as a delivery medium (Lee 2015).
- Traditional (centre-based) pulmonary rehabilitation is that which is conducted in an outpatient or inpatient setting, and comprises supervised exercise training (with or without education and psychological support) for at least four weeks (McCarthy 2015).

Types of participants

We included studies of adults (aged 18 and older) with a diagnosis of a chronic respiratory disease (according to relevant established criteria) of any disease severity, in stable state (i.e. not during an inpatient admission for an acute exacerbation). We included

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studies that incorporated a mix of chronic diseases but only where data relating to review outcomes was able to be obtained separately for participants with chronic respiratory disease.

We excluded studies of participants with the following comorbidities/characteristics:

- a diagnosis of cystic fibrosis. Standard pulmonary rehabilitation models have not been tested or applied to individuals with cystic fibrosis due to infection control; or
- a primary diagnosis of a neuromuscular disease.

Types of interventions

We included studies that compared telerehabilitation with traditional pulmonary rehabilitation or a no rehabilitation control; and defined these rehabilitation models collectively as 'primary pulmonary rehabilitation'. We also included telerehabilitation interventions for the delivery of maintenance rehabilitation following an initial pulmonary rehabilitation period (i.e. interventions designed to maintain health benefits gained from a primary pulmonary rehabilitation programme) (Yorke 2010) and classify these interventions as 'maintenance rehabilitation'.

To be included in the review, the telerehabilitation intervention needed to include exercise training, with at least 50% of the rehabilitation intervention being delivered by telerehabilitation (Hwang 2015).

Telerehabilitation could be delivered to any of a variety of locations, including directly into the patient's home or to a healthcare centre where patients attended. Telerehabilitation could be performed in a group (physical or virtual) or individually. It could include visual interaction (e.g. videoconferencing) or audible interaction, or both, between patient's and healthcare providers.

Telehealth interventions for the purposes of monitoring symptoms or physiological parameters alone (i.e. telemonitoring), without delivery of pulmonary rehabilitation, were excluded.

Comparisons

1. Telerehabilitation compared to centre-based (outpatient) pulmonary rehabilitation.
2. Telerehabilitation compared to inpatient pulmonary rehabilitation.
3. Telerehabilitation compared to a no rehabilitation control.

We analysed studies of telerehabilitation for maintenance rehabilitation separately from trials of telerehabilitation for primary pulmonary rehabilitation.

Types of outcome measures

Primary outcomes

- Exercise capacity, measured by a laboratory test or standardised field test
- Adverse events (e.g. musculoskeletal injuries, falls, medical emergencies)
- Dyspnoea (any validated measure, including isotime measures from exercise tests)
- Quality of life (generic or disease-specific)

The primary time point for analysis was change from baseline to end of intervention. We have reported any follow-up measurements after completion of the intervention as medium-term (up to and including six months after completion of the intervention) or long-term (longer than six months after completion of the intervention).

Secondary outcomes

- Adherence to the intervention or completion of pulmonary rehabilitation/telerehabilitation, as defined by specific criteria of individual included studies or more than 70% of prescribed classes (Williams 2014)
- Anxiety or depression, or both (any validated measure)
- Physical activity, using any objective measure of physical activity such as pedometer, accelerometer, physical activity monitor providing a measure of step count, activity counts, energy expenditure or physical activity time (different intensities, range of thresholds used)
- Healthcare utilisation (including hospitalisation)

Where documented, issues of a technological nature and the incidence of such issues (e.g. loss of internet connection, failure of technological devices) are reported narratively.

Reporting one or more of the outcomes listed here in the study was not an inclusion criterion for the review.

Search methods for identification of studies

Electronic searches

We identified studies from searches of the following databases and trials registries:

1. Cochrane Airways Trials Register (Cochrane Airways 2019), via the Cochrane Register of Studies, all years to 30 November 2020;
2. Cochrane Central Register of Controlled Trials (CENTRAL), via the Cochrane Register of Studies, all years to 30 November 2020;
3. MEDLINE Ovid SP 1946 to 30 November 2020;
4. Embase Ovid SP 1974 to 30 November 2020;
5. US National Institutes of Health Ongoing Trials Register ClinicalTrials.gov (www.clinicaltrials.gov) to 30 November 2020;
6. World Health Organization International Clinical Trials Registry Platform (apps.who.int/trialsearch) to 30 November 2020.

The database search strategies are presented in Appendix 1. The search strategies were developed and conducted in collaboration with the Cochrane Airways Information Specialist. The initial search strategy was developed in MEDLINE and adapted for use in the other databases. All databases and trial registries were searched from their inception to 5 June 2018, and updated on 28 January 2020 and 30 November 2020, with no restriction on language or type of publication. Handsearched conference abstracts and grey literature were searched for through the Cochrane Airways Trials Register and the CENTRAL database.

Searching other resources

We reviewed the reference lists of all primary studies for additional references.

We searched for errata or retractions from included studies published in full text on PubMed on 21 September 2020.

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Data collection and analysis

Selection of studies

Three review authors (NSC, SDC, HH) screened the titles and abstracts of the search results independently and coded them as 'retrieve' (eligible or potentially eligible/unclear) or 'do not retrieve'. We retrieved the full-text study reports of all eligible and potentially eligible studies and three review authors (NSC, SDC, HH) independently screened them for inclusion, recording the reasons for exclusion of ineligible studies. We resolved any disagreement through discussion or, if required, through consultation with another review author (AEH). We identified and excluded duplicates and collated multiple reports of the same study so that each study, rather than each report, is the unit of interest in the review. We recorded the selection process in sufficient detail to complete a PRISMA flow diagram and 'Characteristics of excluded studies' table (Moher 2009).

Data extraction and management

We used a data collection form for study characteristics and outcome data. Data and study characteristics from all included studies were extracted independently by two review authors with review and check by a third review author. Study characteristics extracted from included studies encompassed the following.

- Methods: study design, duration of the intervention, length of any follow-up period, study location, study setting, withdrawals, date of study
- Participant characteristics: number, mean age, age range, gender, diagnosis, severity of condition, diagnostic criteria, baseline lung function, smoking history, inclusion criteria, exclusion criteria
- Interventions: intervention, comparison, concomitant medications
- Outcomes: primary and secondary outcomes specified and collected (at baseline and at the time of intervention completion) and follow-up measures at any other time point reported
- Notes: funding for studies and notable conflicts of interest of trial authors

We documented in the 'Characteristics of included studies' table if outcome data were not reported in a usable way. Any disagreements were resolved by consensus or by involving another review author (AEH or CFM). One review author (NSC) transferred data into the Review Manager 5 file (RevMan 2014). Accuracy of data entered was checked by the Cochrane Airways editorial group (EB) by comparing the data presented in the systematic review with the study reports. Two review authors (SDC and AEH) spot-checked study characteristics entered into Review Manager 5 for accuracy against the study report.

Assessment of risk of bias in included studies

Two review authors (NSC, SDC) assessed risk of bias independently for each randomised controlled trial included using version one of the risk of bias tool and the criteria outlined in Chapter 8 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2017).

We assessed the risk of bias according to the following domains:

1. random sequence generation;
2. allocation concealment;
3. blinding of participants and personnel;
4. blinding of outcome assessment;
5. incomplete outcome data;
6. selective outcome reporting;
7. other bias.

We judged each potential source of bias as high, low or unclear and provide a quote from the study report, together with a justification for our judgement, in the 'Risk of bias' table. We resolved any discrepancies by discussion or by involving another review author (AEH).

For non-RCTs, we used the 'Risk Of Bias in Non-randomised Studies of Interventions' (ROBINS-I) tool to assess risk of bias. The ROBINS-I tool assesses risk of bias across seven domains, providing an overall classification of risk of bias which corresponds to the highest level of risk in any one domain (Sterne 2016). This assessment was completed independently by two review authors (NSC, SDC) using the criteria outlined in the detailed guidance for ROBINS-I (Sterne 2016). ROBINS-I clarification, guidance and independent review was sought from the Cochrane Airways editorial office and provided by Dr Rebecca Fortescue. For non-RCTs we assessed the risk of bias according to three domains: pre-intervention bias (due to confounding or in selection of participants), at-intervention bias (in classification of the intervention), and post-intervention bias (due to deviations from intended interventions or missing data; in measurement of outcomes and reported results).

We summarised the 'Risk of bias' judgements across different studies for each of the three domains in a 'Risk of bias' table.

When considering treatment effects, we took into account the risk of bias for the studies that contribute to that outcome.

Assessment of bias in conducting the systematic review

We conducted the review according to the published protocol and provide justification for any deviations from it in the 'Differences between protocol and review' section of this systematic review.

Measures of treatment effect

We analysed data for each outcome, irrespective of reported participant dropout (intention-to-treat analysis). We would have analysed dichotomous data as odds ratios (ORs) with 95% confidence intervals (CIs); however, none were reported in the included studies. For continuous data, we calculated the mean difference (MD) (for same scale metric) or standardised mean difference (SMD) (for different scale metrics) with 95% CIs. Skewed data are described narratively using medians and interquartile ranges (IQRs).

We undertook meta-analyses only where meaningful; that is, if the treatments, participants and the underlying clinical question were similar enough for pooling to make sense.

Where multiple trial arms were reported in a single study, we included only the relevant trial arms. If two comparisons (e.g. intervention A versus placebo and intervention B versus placebo) were combined in the same meta-analysis, we halved the control group to avoid double-counting.

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Where both change from baseline and endpoint scores were available for continuous data, we used change from baseline unless there was low correlation between measurements in individuals. Where adjusted analyses were available (ANOVA or ANCOVA) we preferentially used these in our meta-analyses.

Unit of analysis issues

Where studies randomly allocated individual participants to a telerehabilitation intervention or control group, we considered the participant as the unit of analysis. We did not include cross-over trials in this review due to the potential carryover effects associated with exercise training or behavioural interventions. There were no cluster randomised trials included in this review – if there are in future updates, we will use the generic inverse variance method to combine the results of cluster-randomised trials with those from parallel group studies, as long as the results have been adjusted (or can be adjusted) to take account of the clusters.

Dealing with missing data

Where there were missing data in included studies, we contacted the investigators in order to verify key study characteristics and obtain missing numerical outcome data where possible (e.g. when a study is reported as an abstract only). Where this was not possible, or data were unable to be provided, and the missing data were thought to introduce serious bias, the impact of including such studies in the overall assessment of results was analysed by performing a sensitivity analysis.

Assessment of heterogeneity

We used the I^2 statistic to measure heterogeneity among the studies in each analysis. Where substantial heterogeneity was identified we report this and explore the possible causes by prespecified subgroup analysis.

Assessment of reporting biases

We were not able to pool more than 10 studies. In future updates of this review, if we are able to pool more than 10 studies, we will create and examine a funnel plot to explore possible small study and publication biases.

Data synthesis

For data from RCTs that were statistically and clinically homogenous, we performed a pooled quantitative synthesis. Data were pooled using a random-effects model to account for between-study heterogeneity in the meta-analysis. For trials that were clinically heterogeneous we present a narrative synthesis.

Data from non-randomised studies (NRS) were synthesised narratively. The results from NRS were not combined with the results of randomised controlled trials.

Trials of telerehabilitation for maintenance rehabilitation were analysed separately from trials of telerehabilitation for primary pulmonary rehabilitation, as it was expected that the nature and magnitude of effect for maintenance programs would differ to that of primary pulmonary rehabilitation.

Subgroup analysis and investigation of heterogeneity

We had planned to carry out the following subgroup analyses if appropriate data had been available.

1. Duration of intervention (at least four weeks but less than eight weeks; at least eight weeks but less than 12 weeks; 12 or more weeks)
2. By diagnosis (chronic obstructive pulmonary disease, interstitial lung diseases, bronchiectasis and chronic asthma)

We planned to use the primary outcomes (exercise capacity, adverse events, dyspnoea and quality of life) for subgroup analyses.

Sensitivity analysis

It was not possible to undertake sensitivity analyses due to the small number of included studies. If in future updates more studies are included, sensitivity analyses will be performed to assess the effects of allocation concealment and intention-to-treat analysis on study results.

Summary of findings and assessment of the certainty of the evidence

We created a 'Summary of findings' table using the following outcomes.

- Exercise capacity
- Dyspnoea
- Quality of life

We had intended to include adverse events in the 'Summary of findings' table. However, the manner in which data were presented for this outcome did not allow this.

We used the five GRADE considerations (risk of bias, consistency of effect, imprecision, indirectness and publication bias) to assess the quality of a body of evidence as it relates to the studies that contribute data for the prespecified outcomes. We used the methods and recommendations described in Section 8.5 and Chapter 12 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2017a), using GRADEpro GDT software (GRADEpro GDT). We present footnotes to justify all decisions to downgrade the quality of evidence, and we provide comments to aid the reader's understanding of the review where necessary.

RESULTS

Description of studies

See 'Characteristics of included studies', 'Characteristics of excluded studies' and 'Characteristics of studies awaiting classification' for complete details.

Results of the search

The PRISMA diagram in Figure 1 shows the results of the search. The latest search was conducted on 30 November 2020. A total of 4223 potentially relevant papers were identified. After removing duplicates and screening of title and abstract for irrelevant material, 149 full-text papers were selected to be further assessed for inclusion. After review by at least two review authors, we excluded 69 studies because they did not meet our inclusion criteria. We identified 14 ongoing studies (18 references), 12 studies (16 references) requiring further assessment, and 13 additional duplicate references. We deemed a total of 15 studies (32 references) to be eligible for inclusion.

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Figure 1. Study flow diagram.

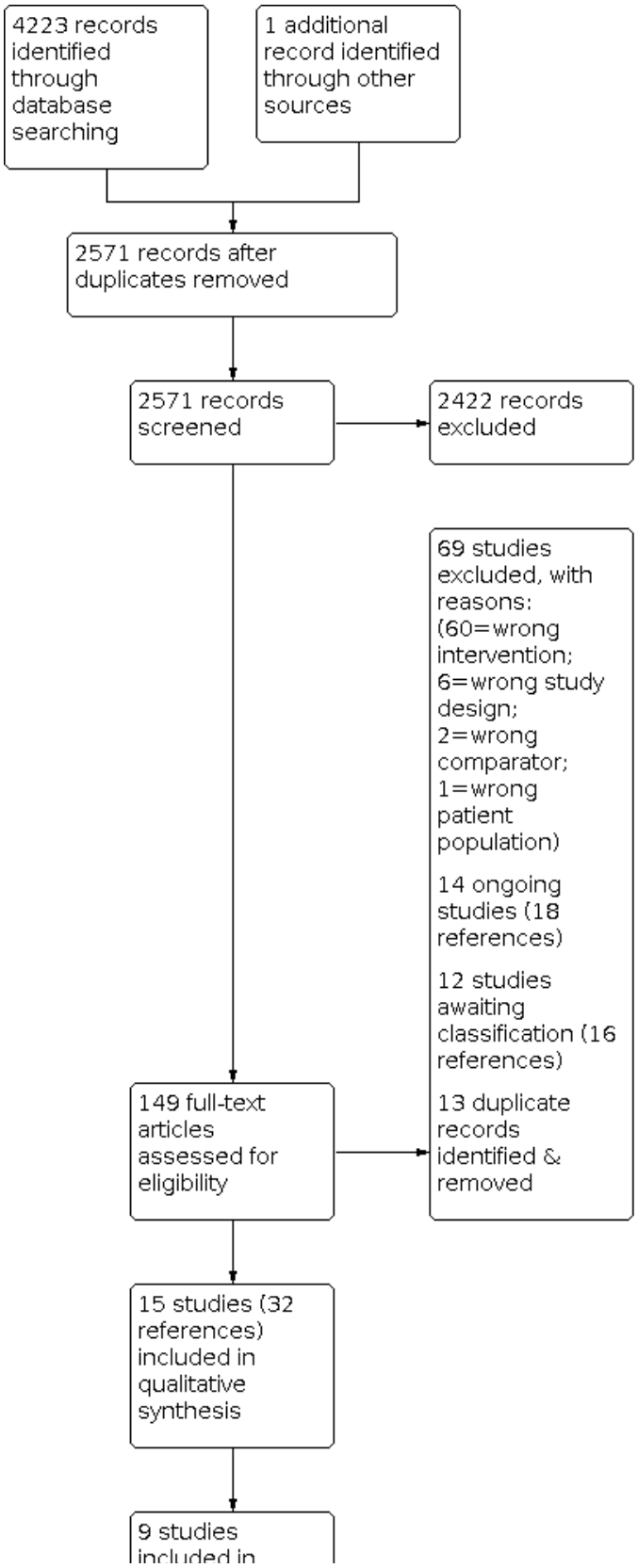

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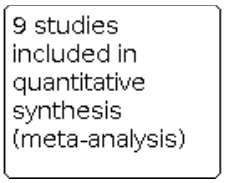
Figure 1. (Continued)



Included studies

Refer to Characteristics of included studies. A total of 15 studies (32 reports) were included in this review. There were two controlled clinical trials (CCTs) (Knox 2019; Stickland 2011). One paper reported results for multiple studies, including one RCT (conducted in Trondheim, Norway) (Barberan-Garcia 2014 (Trondheim)) and two CCTs (conducted in Barcelona, Spain and Athens, Greece) (Barberan-Garcia 2014 (Barcelona and Athens)). As such, we treated results reported in this paper as two separate studies. One RCT tested telerehabilitation against two different control conditions (centre-based rehabilitation and no rehabilitation) (Vasilopoulou 2017), and one RCT tested two different telerehabilitation interventions compared to no rehabilitation control (Kwon 2018). Data from all CCTs are reported narratively. Refer to Characteristics of included studies for relevant funding details for all included studies.

Participants

The total number of participants with chronic respiratory disease from included studies was 1904. Sample sizes ranged from 29 to 409 participants. The majority of studies (n = 12) were of participants with COPD (99% of all participants). In one study of 112 individuals, participants had both COPD and chronic heart failure (Bernocchi 2018). In one study of 45 participants, 35 participants had COPD, three had bronchiectasis, two had pulmonary fibrosis, three had asthma and two had other respiratory related diagnoses (Knox 2019). In another RCT, 26 individuals had COPD, with nine other participants having chronic heart failure and 20 having stroke (Barberan-Garcia 2014 (Trondheim). However, we could not obtain separate data relating to individuals with COPD from study investigators, so we could not include data from this RCT in our results (Barberan-Garcia 2014 (Trondheim)) . Overall, the mean age of participants ranged from 62 to 75 years, and the mean percentage of predicted normal for forced expiratory volume in one second (FEV_1 %predicted) ranged from 33%predicted to 92%predicted. The proportion of male participants ranged from 35% to 94%.

Interventions and comparisons

Eleven studies described interventions for primary rehabilitation (Bourne 2017; Chaplin 2017; Hansen 2020; Holland 2017; Knox 2019; Kwon 2018; Lahham 2020; Maltais 2008; Stickland 2011; Tabak 2014; Tsai 2017) and three studies reported interventions for maintenance rehabilitation (Barberan-Garcia 2014 (Barcelona and Athens); Barberan-Garcia 2014 (Trondheim); Bernocchi 2018; Vasilopoulou 2017). Four studies (Hansen 2020; Knox 2019; Stickland 2011; Tsai 2017) were delivered in a (virtual) group format, the remaining study interventions were delivered to individual participants. Seven studies of primary rehabilitation compared a telerehabilitation intervention to traditional centre-based pulmonary rehabilitation (Comparison 1) (Bourne 2017; Chaplin 2017; Hansen 2020; Holland 2017; Knox 2019; Maltais 2008; Stickland 2011). One study of maintenance rehabilitation had a traditional centre-based pulmonary rehabilitation comparison group (Comparison 1) (Vasilopoulou 2017). Four studies of primary pulmonary rehabilitation compared telerehabilitation to a no rehabilitation control group (Comparison 3) (Kwon 2018; Lahham 2020; Tabak 2014; Tsai 2017). Three studies of maintenance rehabilitation compared telerehabilitation to a no rehabilitation control group (Comparison 3) (Barberan-Garcia 2014 (Barcelona and Athens); Barberan-Garcia 2014 (Trondheim); Bernocchi 2018; Vasilopoulou 2017). One of these reported both an RCT and two controlled clinical trials (Barbaren-Garcia 2014), the results from which we have reported narratively.

Telerehabilitation interventions studied used videoconferencing (four studies: Hansen 2020; Knox 2019; Stickland 2011; Tsai 2017); telephone only (four studies: Barberan-Garcia 2014 (Trondheim); Holland 2017; Lahham 2020; Maltais 2008); website with telephone support (two studies: Bernocchi 2018; Chaplin 2017); website only (two studies: Bourne 2017; Tabak 2014); mobile phone for SMS feedback (one study describing two CCTs: Barberan-Garcia 2014 (Barcelona and Athens)); and a mobile application (one study: Kwon 2018). One study examined remote monitoring combined with telephone or videoconference support (Vasilopoulou 2017). Interventions that utilised videoconferencing enabled participants to see and talk to health professionals and/or other patients via a video enabled screen (e.g. computer or tablet device). In the two CCTs (Knox 2019; Stickland 2011) that used video conferencing, the intervention was delivered from a pulmonary rehabilitation centre to one or more remote healthcare facilities using a 'Hub and Spoke' model. Telerehabilitation interventions delivered by telephone involved participants speaking to a health professional at regular intervals (e.g. weekly), while website based interventions enabled participants to access information independently, at a time of their choosing, from an internet-enabled device, e.g. a computer. Studies where the intervention included SMS feedback (received three times weekly) or the use of a mobile application required participants to have a smartphone, which in some cases was provided for participants. Participants accessing a mobile application via smartphone were required to utilise additional equipment, including a pulse oximeter, to collect additional physiological outcomes. Outside of the two CCTs employing a 'Hub and Spoke' model of telerehabilitation, in all other studies the intervention was delivered to the patient's location, which was commonly their home. In four studies (Hansen 2020; Knox 2019; Stickland 2011; Tsai 2017) the intervention was undertaken in a group, whether physical (Knox 2019; Stickland 2011) or virtual (Hansen 2020; Tsai 2017). In all other studies, the intervention was delivered on an individual participant basis.

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Three studies (Barberan-Garcia 2014 (Barcelona and Athens); Barberan-Garcia 2014 (Trondheim); Bernocchi 2018; Vasilopoulou 2017) were of maintenance rehabilitation; all remaining studies were of primary pulmonary rehabilitation. Telerehabilitation interventions ranged in length from six weeks (Bourne 2017) to nine months (Tabak 2014) for primary rehabilitation; and from four months (Bernocchi 2018) to 22 months (Barberan-Garcia 2014 (Barcelona and Athens)) for maintenance rehabilitation. In seven studies (Bourne 2017; Chaplin 2017; Hansen 2020; Holland 2017; Maltais 2008; Stickland 2011) telerehabilitation was compared to traditional centre-based pulmonary rehabilitation (Comparison 1). In six studies (Barberan-Garcia 2014 (Barcelona and Athens); Barberan-Garcia 2014 (Trondheim); Bernocchi 2018; Kwon 2018; Lahham 2020; Tabak 2014; Tsai 2017) telerehabilitation was compared to a no rehabilitation control group (Comparison 3). One study of maintenance rehabilitation (Vasilopoulou 2017) compared telerehabilitation to both centre-based rehabilitation and a no rehabilitation control group.

There were no studies comparing telerehabilitation to in-patient pulmonary rehabilitation (Comparison 2).

Duration of follow-up

Five included studies of primary rehabilitation reported medium-term (up to six months; Hansen 2020; Lahham 2020; Stickland 2011) or longer-term follow-up (greater than six months; Holland 2017; Maltais 2008), beyond the end of the intervention period. No studies of telerehabilitation have undertaken follow-up beyond 12 months. There was no medium- or long-term follow-up of any trials of maintenance telerehabilitation. There were no studies of telerehabilitation compared to inpatient rehabilitation (Comparison 2). Only three studies reported details relating to technological issues (Hansen 2020; Knox 2019; Tsai 2017) (Table 1).

Excluded studies

Of the 149 full text papers reviewed, we excluded 82 studies. Reasons for exclusion were primarily that studies were the wrong intervention (n = 60). Fourteen studies (18 references) were classified as ongoing (see 'Characteristics of ongoing studies'); 12 studies (16 references) are awaiting classification. Full details of the reasons for exclusion are included in the 'Characteristics of excluded studies' section.

Risk of bias in included studies

Details on our assessment of the potential risk of bias of included studies are summarised in Figure 2 and Figure 3 for RCTs, with full details in the 'Characteristics of included studies' tables. Assessment of the risk of bias for non-RCTs and full details of the accompanying ROBINS-I ratings can be found in Table 2.

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Figure 2. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

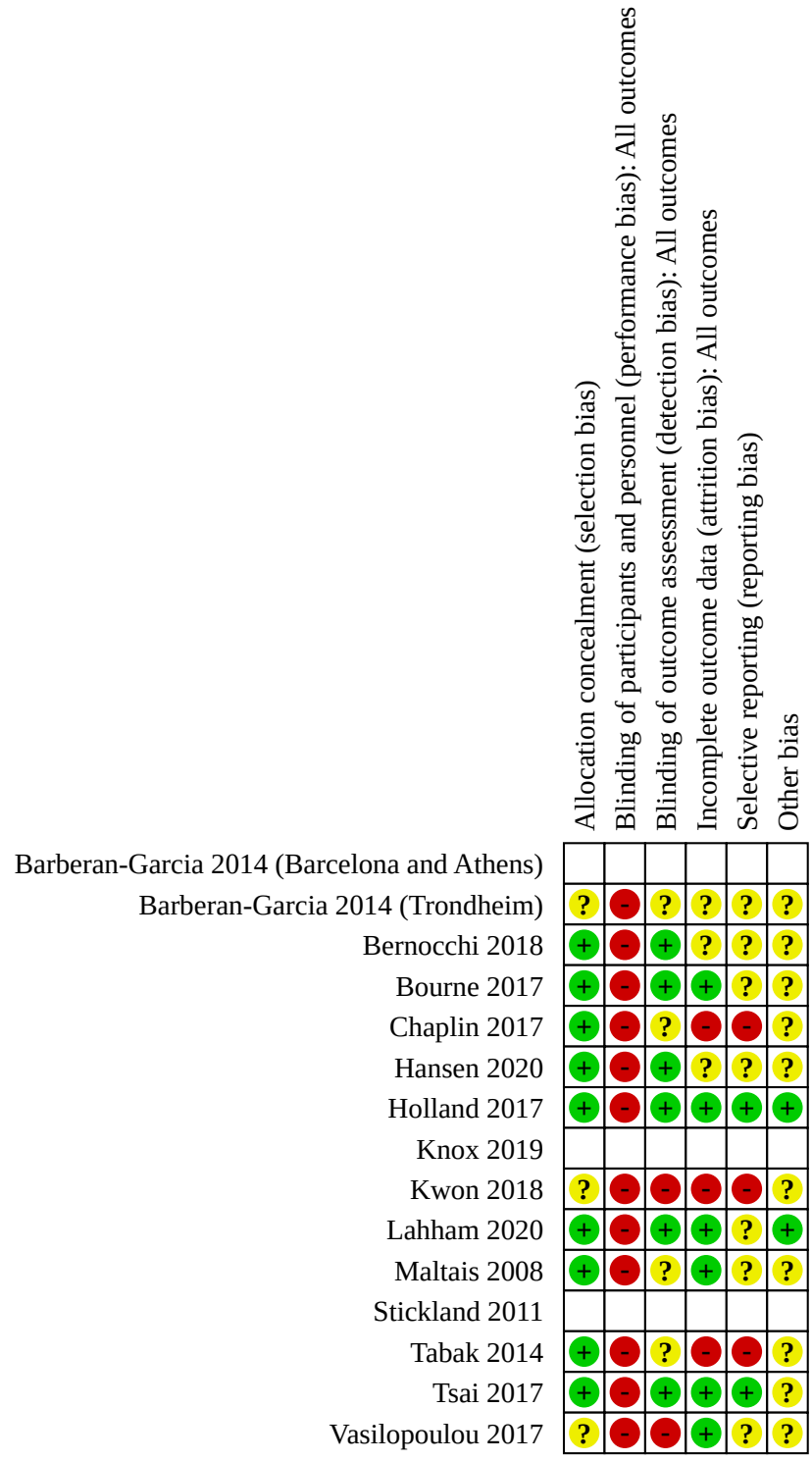

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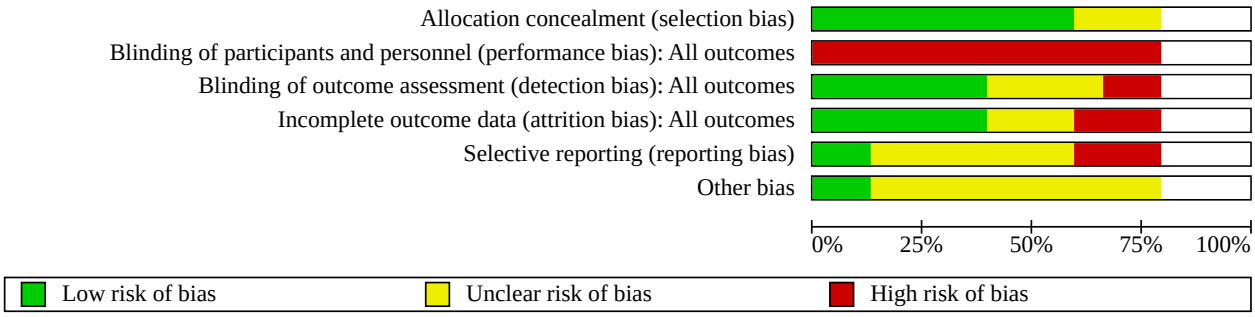
Figure 3. Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.



Allocation

Overall, the risk of bias relating to random sequence generation and allocation concealment was low. Two studies were rated to be at unclear risk of bias for random sequence generation (Barberan-Garcia 2014 (Trondheim); Kwon 2018), and three for allocation concealment (Barberan-Garcia 2014 (Trondheim); Kwon 2018; Vasilopoulou 2017), due to insufficient information.

Blinding

Due to the nature of the interventions it was not possible to blind participants, or personnel delivering the intervention, so by default all RCTs were classified as being at high risk for performance bias. Only half (n = 6) of the RCTs reported blinding of outcomes assessors (Bernocchi 2018; Bourne 2017; Hansen 2020; Holland 2017; Lahham 2020; Tsai 2017) and were classified as being at low risk of detection bias.

Incomplete outcome data

We rated six of the included RCTs as being at low risk for attrition bias (Bourne 2017; Holland 2017; Lahham 2020; Maltais 2008; Tsai 2017; Vasilopoulou 2017) due to only small numbers of reported dropouts. Three RCTs (Chaplin 2017; Kwon 2018; Tabak 2014) were rated to be at high risk of bias for attrition bias due to discrepancy in drop-outs reported between the intervention and control groups.

Selective reporting

Only two studies of RCTs were found to have low risk of reporting bias (Holland 2017; Tsai 2017). The majority of included RCTs were rated as having unclear risk of reporting bias due to discrepancies between reported data and that indicated in trial registries or published protocols. One study only presented data for clinical outcomes assessed during the intervention period, but not at the completion of the intervention (Tabak 2014).

Other potential sources of bias

We assessed two RCTs to be of low risk with respect to other sources of bias (Holland 2017; Lahham 2020). The remaining studies were determined to have an unclear risk of other sources of bias associated with timing of trial registration, variations in components of the intervention or control conditions between study sites, exclusion of participants without access to relevant smart-devices, and for one study competing interests noted for the authors.

Risk of bias for non-RCTs

Three studies, one of which reported two CCTs (Barberan-Garcia 2014 (Barcelona and Athens); Knox 2019; Stickland 2011), were assessed for bias using the ROBINS-I tool. Studies were classified with an overall risk of bias of critical (one study, two reports: Barberan-Garcia 2014 (Barcelona and Athens), serious (one study: Knox 2019) and moderate (one study: Stickland 2011).

All three non-RCTs were rated as serious for pre-intervention bias due to confounding. Patient-related factors including socio-economic status, geography (country, regional area or metropolitan area) were inherently unable to be controlled for and may have favoured one group over the other. One study (two CCTs) was classified as critical for risk of bias for selection of participants (Barberan-Garcia 2014 (Barcelona and Athens)) as participants were allocated to intervention or control groups based on access to and availability of technology. All studies were rated as moderate risk of bias in measurement of outcomes due to the use of standardised assessments, but it was unclear if assessors were blind to group allocation.

Effects of interventions

See: **Summary of findings 1** Telerehabilitation compared to centre-based (outpatient) pulmonary rehabilitation for chronic respiratory disease; **Summary of findings 2** Telerehabilitation compared to no rehabilitation control for chronic respiratory disease

See 'Summary of findings' tables for primary outcomes (exercise capacity, dyspnoea and quality of life) for the main comparisons: telerehabilitation compared to outpatient centre-based rehabilitation (Comparison 1, Summary of findings 1); and telerehabilitation compared to a no rehabilitation control (Comparison 3, Summary of findings 2). No studies compared telerehabilitation to in-patient pulmonary rehabilitation (Comparison 2).

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Primary outcomes

Comparison 1: Telerehabilitation compared to outpatient, centre-based (in-person) pulmonary rehabilitation

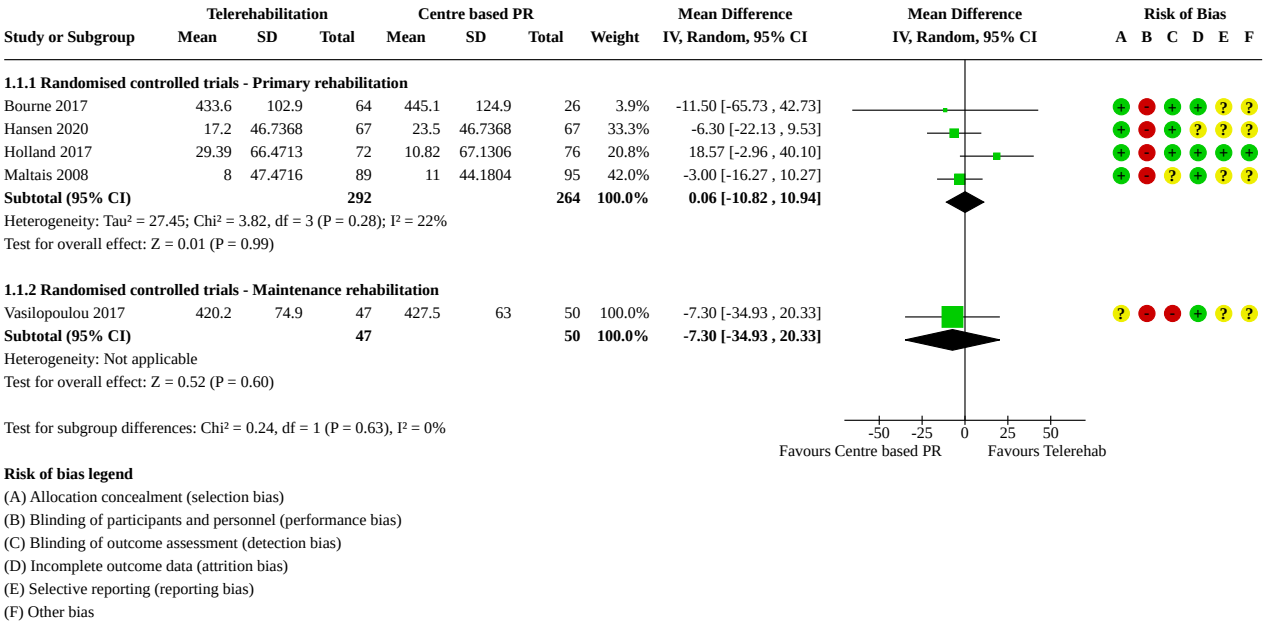
Exercise capacity

Primary rehabilitation

All included studies assessed at least one measure of exercise capacity. The most frequently reported measurement of exercise capacity was the six-minute walk distance (6MWD) (Bourne 2017; Hansen 2020; Holland 2017; Maltais 2008). Assessment of exercise capacity in studies of primary rehabilitation was also reported using the Incremental Shuttle Walk Test (ISWT) and Endurance Shuttle Walk Test (ESWT) (Chaplin 2017), endurance cycle time (ECT) (Maltais 2008) and 30 second sit-to-stand (STS) (Hansen 2020).

We were able to combine four RCTs of telerehabilitation for primary rehabilitation compared to outpatient, centre-based pulmonary rehabilitation in a meta-analysis. The mean difference in 6MWD between interventions was 0.06 metres (m) (95% CI -10.82 m to 10.94 m; 556 participants; four studies; I^2 = 22%, moderate-certainty evidence. Analysis 1.1; Figure 4) (Bourne 2017; Hansen 2020; Holland 2017; Maltais 2008).

Figure 4. Forest plot of comparison: 1 Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, outcome: 1.1 Outcome 1 Exercise capacity - 6minute walk test distance at end intervention.



In RCTs, there were wide confidence intervals when comparing telerehabilitation and centre-based pulmonary rehabilitation for 30 second STS (MD -0.04 repetitions, 95% CI -1.58 to 0.78; one study; 134 participants; Analysis 1.5 (Hansen 2020); endurance cycle test time (MD 9 seconds, 95% CI -92.19 to 110.19; 184 participants; one study; Analysis 1.3) (Maltais 2008); or ESWT (MD 4.50 seconds, 95% CI -112.37 to 121.37; 62 participants; one study; Analysis 1.2) (Chaplin 2017).

In one CCT, exercise capacity outcomes were reported to favour telerehabilitation compared to centre-based pulmonary rehabilitation for ISWT distance (change in ISWT distance 137 m versus 66 m, 95% CI of difference 9.31 m to 133 m; 45 participants; one study) (Knox 2019), whereas a second CCT did not demonstrate a difference in exercise capacity when telerehabilitation was compared to centre-based rehabilitation (change in twelve-minute walk distance (12MWD) at end intervention MD -20.2 m (95% CI -75.18 m to 34.78 m); 409 participants; one study) (Stickland 2011).

For primary rehabilitation, there were no reported differences between telerehabilitation and centre-based pulmonary rehabilitation for exercise capacity with medium-term follow-up (Hansen 2020, 6MWD at 10 to 12 weeks follow-up; Stickland 2011, twelve-minute walk test (12MWT) at six months follow-up). We combined in meta-analysis two RCTs of telerehabilitation compared to centre-based pulmonary rehabilitation with long-term follow-up at or around 12 months post-intervention. There may be little or no difference between interventions for exercise capacity (6MWD: MD 1.40 m, 95% CI -12.62 to 15.43, 308 participants; two studies; Analysis 1.6 (Holland 2017; Maltais 2008).

Maintenance rehabilitation

One RCT of maintenance telerehabilitation compared to centre-based maintenance rehabilitation (Vasilopoulou 2017) reported uncertain difference for 6MWD (MD -7.30 m, 95% CI -34.93 m to 20.33 m; 97 participants; Analysis 1.1) and for peak watts on cardiopulmonary exercise test (MD 9 watts, 95% CI -92.19 to 110.19; 97 participants; Analysis 1.4) at the end of the 12 month intervention.

Dyspnoea

Primary rehabilitation

Symptoms of breathlessness were assessed using the Medical Research Council (MRC) dyspnoea scale (studies = 1, Knox 2019), the modified MRC (mMRC) dyspnoea scale (studies = 2, Bourne 2017;

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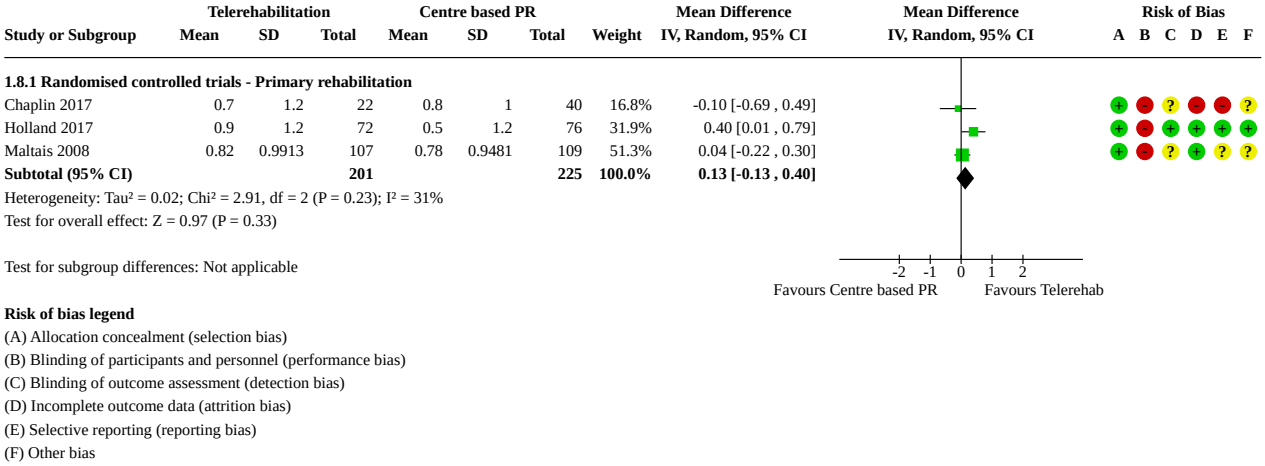
Holland 2017) and the dyspnoea domain of the chronic respiratory disease questionnaire (CRQ-D) (studies = 3, Chaplin 2017; Holland 2017; Maltais 2008). None of the included studies reported finding a difference between interventions for symptoms of breathlessness, on any measure.

We combined three RCTs of telerehabilitation for primary rehabilitation compared to outpatient, centre-based pulmonary rehabilitation in a meta-analysis. The mean difference in CRQ-D between interventions was 0.13 points (95% CI -0.13 to 0.40; 426 participants; two studies; I^2 = 31%, low-certainty evidence; Analysis 1.8; Figure 5) (Chaplin 2017; Holland 2017; Maltais 2008).

Figure 5. Forest plot of comparison: 1 Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, outcome: 1.8 Outcome 3 Dyspnoea - Change in CRQ Dyspnoea domain at end intervention.



Two RCTs of telerehabilitation compared to centre-based pulmonary rehabilitation with long-term follow-up at or around 12 months post intervention were combined in a meta-analysis. There was uncertain difference between interventions for breathlessness (mMRC MD 0.14 units, 95% CI -0.08 to 0.36; 364 participants; two studies; Analysis 1.9) (Holland 2017; Maltais 2008).

Maintenance rehabilitation

One RCT of maintenance telerehabilitation compared to centre-based maintenance rehabilitation did not find a difference between groups for mMRC dyspnoea score at the end of the 12-month intervention (MD 0.3, 95%CI -0.08 to 0.68; 97 participants; one study; Analysis 1.7) (Vasilopoulou 2017).

Quality of life

Primary rehabilitation

All included studies of telerehabilitation compared to centre-based pulmonary rehabilitation assessed at least one measure of quality of life. Tools used to assess quality of life were St George's Respiratory Questionnaire (SGRQ) (studies = 4, Bourne 2017; Maltais 2008; Stickland 2011; Vasilopoulou 2017), the chronic respiratory disease questionnaire (CRQ) (studies = 3, Chaplin 2017; Holland 2017; Maltais 2008), the EQ-5D-5L (studies = 2, Chaplin 2017; Hansen 2020), and the COPD Assessment Test (CAT) (studies = 4, Bourne 2017; Chaplin 2017; Hansen 2020; Knox 2019). One study assessed quality of life with the clinical COPD questionnaire (CCQ) (Hansen 2020).

For Comparison 1, telerehabilitation compared to centre-based pulmonary rehabilitation, we were able to conduct six meta-analyses of RCTs (Analysis 1.10; Analysis 1.14; Analysis 1.15; Analysis 1.16; Analysis 1.17; Analysis 1.18). There may be little or no differences between groups for any measure of quality of life.

In two non-RCTs of primary rehabilitation compared to centre-based pulmonary rehabilitation, one study reported not finding a difference between groups for improvement in CAT (MD not reported, 95% CI -3.35 to 1.70; 45 participants; one study) (Knox 2019), while one study reported a difference in SGRQ total score at the end of the intervention, favouring the centre-based rehabilitation group (MD 6.3, 95% CI 2.72 to 9.88; 409 participants; one study) (Stickland 2011).

Two studies reported no differences between telerehabilitation and centre-based pulmonary rehabilitation for quality of life with medium-term follow-up (assessed with CCQ and CAT at 10 to 12 weeks follow-up; 134 participants (Hansen 2020); assessed with SGRQ at six month follow-up; 409 participants (Stickland 2011)). We combined in a meta-analysis two RCTs of telerehabilitation compared to centre-based pulmonary rehabilitation with long-term follow-up, at or around 12 months post intervention (364 participants; Analysis 1.24; Analysis 1.25; Analysis 1.26; Analysis 1.27) (Holland 2017; Maltais 2008). There may be little or no difference between interventions for any CRQ domain score in the meta-analyses.

Maintenance rehabilitation

One study of maintenance telerehabilitation compared to centre-based maintenance rehabilitation assessed quality of life with the St George's Respiratory Questionnaire (SGRQ) and the COPD Assessment Test (CAT) (Vasilopoulou 2017). The study did not find a difference between maintenance telerehabilitation and centre-based rehabilitation for either CAT (MD 1.2 points, 95% CI -1.40 to 3.80; participants = 97; studies = 1, Analysis 1.14, Vasilopoulou 2017) or SGRQ total score (MD 4.80 points, 95% CI -2.63 to 12.23; participants = 97; studies = 1, Analysis 1.10, Vasilopoulou 2017).

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Adverse events

Adverse events were inconsistently defined, with variable reporting. Reported information relating to adverse events is detailed in Table 3. Six studies of telerehabilitation compared to centre-based pulmonary rehabilitation provided information regarding adverse events (Bourne 2017; Hansen 2020; Holland 2017; Knox 2019; Maltais 2008; Stickland 2011). Of these, no adverse events were noted in two studies (Holland 2017; Vasilopoulou 2017). One further study described monitoring for adverse events, but did not present any data (Chaplin 2017). The numbers of reported adverse events were similar between telerehabilitation and centre-based rehabilitation, where reported. As the results could not be combined we remain uncertain about possible differences in adverse events.

Secondary outcomes

Adherence/completion

Primary rehabilitation

Four RCTs of primary telerehabilitation compared to centre-based pulmonary rehabilitation reported a pre-determined definition for adherence to or completion of the intervention (Table 4). Adherence/completion was defined based on achieving a minimum percentage of prescribed exercise training sessions, either 60% (Maltais 2008) or 70% (Hansen 2020 Holland 2017); or minimum stage of the program (Chaplin 2017). The three RCTs that defined adherence by a minimum percentage of training sessions completed could be combined in a meta-analysis (419 participants, Analysis 1.28). Individuals undertaking telerehabilitation were more likely to complete the minimum percentage of prescribed training sessions when compared to centre-based pulmonary rehabilitation (OR 5.36, 95% CI 3.12 to 9.21; 516 participants; three studies; I^2 = 56%) (Hansen 2020, Holland 2017, Maltais 2008). In the control group, 70 people out of 100 were considered pulmonary rehabilitation completers over six to 12 weeks, compared to 93 (95% CI 80 to 96) out of of 100 people in the active treatment group. Please see the Cates plot in Figure 6.

Figure 6. In the control group 70 people out of 100 completed treatment over 6 to 12 weeks, compared to 93 (95% CI 80 to 96) out of 100 for the active treatment group.

In one study of a web-based telerehabilitation program, 53% of participants failed to progress past week 3 of the web-based program (Chaplin 2017). However, the proportion of dropouts from centre-based rehabilitation was not reported.

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Maintenance rehabilitation

One RCT of maintenance telerehabilitation reported a similar proportion of completed sessions to centre-based maintenance rehabilitation (93.5% and 91% respectively; 97 participants) (Vasilopoulou 2017).

Anxiety/depression

Primary rehabilitation

Symptoms of anxiety and depression were assessed using the Hospital Anxiety and Depression Scale (HADS). Two RCTs of telerehabilitation compared to centre-based pulmonary rehabilitation were able to be combined in a meta-analysis. The mean difference between interventions in HADS Anxiety scores favoured telerehabilitation (MD -1.05 points (95% CI -1.76 to -0.35; 282 participants; two studies; I^2 = 0%; Analysis 1.29 Analysis 1.30) (Hansen 2020; Holland 2017). The difference between interventions in HADS Depression scores was probably smaller at the end of the intervention (MD -0.36 points, 95% CI -1.05 to 0.34; 282 participants; two studies; Analysis 1.30) (Hansen 2020, Holland 2017). Two other RCTs (Bourne 2017; Chaplin 2017) and one CCT (Knox 2019) reported finding no differences between interventions for anxiety or depression, using the HADS at the end of intervention.

One study of long-term follow-up did not find a difference between interventions for anxiety or depression, using the HADS from baseline to 12 month follow-up (anxiety MD -1.00 points, 95% CI -2.27 to 0.27; and depression MD -1.00 points, 95% CI -2.15 to 0.15; 148 participants; Analysis 1.31 and Analysis 1.32) (Holland 2017).

Maintenance rehabilitation

No studies of maintenance rehabilitation assessed anxiety or depression.

Physical activity

Primary rehabilitation

Three RCTs of telerehabilitation compared to centre-based pulmonary rehabilitation assessed physical activity by accelerometry (Hansen 2020; Holland 2017; Vasilopoulou 2017). Two RCTs of telerehabilitation compared to centre-based pulmonary rehabilitation that assessed physical activity via accelerometry could be combined in a meta-analysis (Hansen 2020; Holland 2017). At end rehabilitation there was uncertain difference between groups in time spent in sedentary behaviours (MD -8.57 minutes, 95% CI -66.69 to 49.54; 192 participants; two studies; Analysis 1.34) (Hansen 2020; Holland 2017); or change in steps per day (MD 387.09 steps, 95% CI -84.64 to 858.81; 192 participants; two studies; Analysis 1.35) (Hansen 2020; Holland 2017). For all other physical activity outcomes, there was uncertainty in the difference between telerehabilitation and centre-based pulmonary rehabilitation at end intervention, medium- and long-term follow-up.

Maintenance rehabilitation

One RCT of maintenance telerehabilitation compared to centre-based maintenance rehabilitation also assessed physical activity by accelerometry (Vasilopoulou 2017). An increase in time per day spent in moderate intensity activity favoured the centre-based rehabilitation control group (MD -4.3 minutes, 95% CI -6.9 to -1.7; 97 participants; Analysis 1.39).

Healthcare utilisation

COPD exacerbations, hospitalisations and emergency department presentations were reported in five studies of telerehabilitation compared to centre-based pulmonary rehabilitation (Table 5).

Primary rehabilitation

Three RCTs of primary telerehabilitation compared to centre-based pulmonary rehabilitation could be combined in a meta-analysis (Analysis 1.41). The likelihood of being admitted to hospital during the study period (from enrolment to completion of follow-up) was lower for telerehabilitation compared to centre-based pulmonary rehabilitation (OR 0.65, 95% CI 0.43 to 0.99; 516 participants; three studies; I^2 = 37%, evidence not graded) (Hansen 2020; Holland 2017; Maltais 2008).

In one CCT of primary rehabilitation there were the same number of hospitalisations reported for both interventions (telerehabilitation: n = 3; centre-based rehabilitation: n = 3) (Stickland 2011).

Maintenance rehabilitation

One study of 12 months of maintenance telerehabilitation compared to centre-based maintenance rehabilitation reported a similar mean number of acute exacerbations between groups: 1.7 (SD 1.7) and 1.8 (SD 1.4), respectively (Vasilopoulou 2017).

Comparison 2: Telerehabilitation compared to inpatient rehabilitation

No studies assessed this comparison.

Comparison 3: Telerehabilitation compared to no rehabilitation control

Primary outcomes

Exercise capacity

Primary rehabilitation

Three RCTs of telerehabilitation compared to no rehabilitation control for primary rehabilitation reported exercise capacity outcomes using 6MWD (Kwon 2018; Lahham 2020; Tsai 2017) and ISWT and ESWT (Tsai 2017).

Two RCTs combined in a meta-analysis showed that telerehabilitation may increase 6MWD (MD 22.17 m; 95% CI -38.89 to 83.23; 94 participants; two studies; I^2 = 35%; low-certainty evidence; Analysis 3.1; Figure 7 (Lahham 2020; Tsai 2017). There was no significant heterogeneity across studies.

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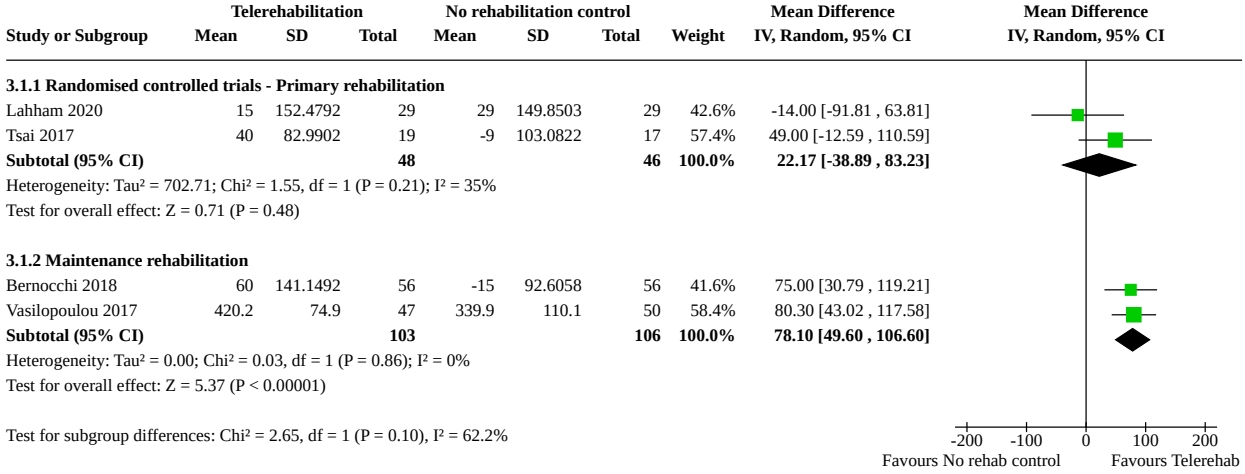
Figure 7. Forest plot of comparison: 3 Telerehabilitation vs no rehabilitation control, outcome: 3.1 Outcome 1 Exercise capacity - 6minute walk distance at end intervention.



In one RCT, when compared to no rehabilitation control, no difference in ISWT distance was reported at the end of the intervention (MD 4 m, 95% CI -23 m to 31 m; 36 participants; one study; Analysis 3.3) (Tsai 2017). However, a clear improvement in endurance cycle time was seen with telerehabilitation (MD 314 seconds, 95% CI 144 to 484; 36 participants; one study; Analysis 3.4) (Tsai 2017).

In one RCT, at month three of a nine-month intervention, outcomes for 6MWD favoured telerehabilitation compared to no rehabilitation control (MD 99.6 m, 95% CI 62.87 m to 136.33 m; 20 participants; one study) (Tabak 2014); however, no end intervention data were reported. One RCT that tested two different telerehabilitation interventions compared to a no rehabilitation control reported that there was no difference between groups for 6MWD, but data were not reported (Knox 2019; Kwon 2018).

One study of primary telerehabilitation compared to no rehabilitation control reported medium-term follow-up data. At six months, following the end of the intervention, no differences were reported between telerehabilitation and no rehabilitation control for 6MWD (MD 7 m, 95% CI -59 m to 72 m; 58 participants; one study) (Lahham 2020).

Maintenance rehabilitation

Two RCTs of maintenance telerehabilitation compared to no rehabilitation control reported exercise capacity outcomes using 6MWD (Bernocchi 2018; Vasilopoulou 2017), with one RCT also reporting peak watts on cardiopulmonary exercise test (Vasilopoulou 2017). One study reporting two non-randomised controlled trials measured exercise capacity via 6MWD (Barberan-Garcia 2014 (Barcelona and Athens)).

Two RCTs of maintenance rehabilitation could be meta-analysed. The analysis showed that there may be a benefit of telerehabilitation over no rehabilitation control, with a mean difference in 6MWD of 78.10 m (95% CI 49.60 to 106.60; 209 participants; two studies; $I^2 = 40\%$; low-certainty evidence, Analysis 3.1, Figure 7) (Bernocchi 2018; Vasilopoulou 2017). The difference in 6MWD between telerehabilitation and no rehabilitation control for maintenance rehabilitation exceeded the minimal important difference for the 6MWD (Holland 2014b). There was no significant heterogeneity across studies.

One RCT of maintenance rehabilitation reported an improvement in peak watts on CPET at the end of the telerehabilitation intervention (MD 18 watts, 95% CI 6 to 30; 97 participants; one study; Analysis 3.2) (Vasilopoulou 2017).

In two non-RCTs, the exercise capacity outcomes differed (Barberan-Garcia 2014 (Barcelona and Athens)), favouring telerehabilitation compared to a no-rehabilitation control in one study (Barcelona: 6MWD at end intervention; MD 92 m, 95% CI 49.15 to 134.85; 77 participants), and reporting no difference in exercise capacity between groups in the other (Athens: change in 6MWD at end intervention; MD -5 m, 95% CI -20.58 to 10.58; 40 participants).

Dyspnoea

Primary rehabilitation

Breathlessness was assessed using the modified MRC dyspnoea scale (studies = 2, Kwon 2018; Lahham 2020) and the dyspnoea domain of the chronic respiratory disease questionnaire (CRQ-D) (studies = 2, Lahham 2020; Tsai 2017). None of the included studies reported a difference between groups for symptoms of breathlessness, on any measure.

When compared to a no-rehabilitation control, there may be a benefit of telerehabilitation for CRQ-D (MD 1.97 points, 95% CI -1.07 to 5.02; 94 participants; two studies; low-certainty evidence, Analysis 3.5) (Lahham 2020; Tsai 2017).

One RCT of telerehabilitation compared to no-rehabilitation control reported Borg dyspnoea at exercise (ESWT) isotime, but did not find a difference between groups (MD 1, 95% CI -0.31 to 2.31; 36 participants; one study; Analysis 3.6) (Tsai 2017).

One study of primary telerehabilitation compared to no rehabilitation control reported medium-term follow-up. At six months following the end of the intervention, no differences were reported between telerehabilitation and no rehabilitation control for mMRC (MD -0.0, 95% CI -0.5 to 0.5; 58 participants; one study) (Lahham 2020).

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Maintenance rehabilitation

Symptoms of breathlessness were assessed using the MRC dyspnoea scale (Bernocchi 2018), and the mMRC dyspnoea scale (Barberan-Garcia 2014 (Barcelona and Athens); Vasilopoulou 2017). None of the included studies reported a difference between groups for symptoms of breathlessness, on any measure.

Two RCTs of maintenance telerehabilitation compared to no rehabilitation control were combined in a meta-analysis and demonstrated a very uncertain improvement in change score for MRC/mMRC, favouring telerehabilitation (MD -0.86 points, 95% CI -2.10 to 0.37; 209 participants; two studies; very low-certainty evidence, Analysis 3.7) (Bernocchi 2018; Vasilopoulou 2017).

One non-RCT of maintenance telerehabilitation compared to no-rehabilitation control reported a reduction from 35% to 27% in the percentage of participants categorised as mMRC 3-4 in the intervention group, with no change in the control group (77 participants) (Barberan-Garcia 2014 (Barcelona and Athens)).

Quality of life

Primary rehabilitation

RCTs of primary telerehabilitation compared to no rehabilitation control assessed quality of life using the CRQ (studies = 2, Lahham 2020; Tsai 2017; Analysis 3.10; Analysis 3.11; Analysis 3.12; Analysis 3.13; Analysis 3.14), and the CAT (studies = 2, Kwon 2018; Tsai 2017). One study assessed quality of life with the clinical COPD questionnaire (CCQ) and the EQ-5D-5L (Tabak 2014).

When compared to a no rehabilitation control, there may be a higher CRQ total score on telerehabilitation (MD 6.90 points, 95% CI -0.57 to 14.36; 94 participants; two studies; low-certainty evidence; Analysis 3.10) (Lahham 2020; Tsai 2017). This difference was measured using a maximum score of 140 on the CRQ scale, so would be equivalent to a mean difference of 0.345 units on a 7-point scale.

At month 3 of a nine-month intervention in one RCT (n = 20) of primary telerehabilitation compared to no rehabilitation control, the authors reported better scores for CCQ (mean 1.8 (SD 0.24) versus mean 2.3 (SD 0.26)) and EQ-5D visual analogue scale (mean 72.3 (SD 3.1) versus mean 62.4 (SD 3.5)), respectively, for the telerehabilitation group compared to the no rehabilitation control (Tabak 2014). No data from end intervention were presented.

One study of primary telerehabilitation compared to no rehabilitation control reported medium-term follow-up (58 participants) (Lahham 2020). At six months, following the end of the intervention, no differences were reported between telerehabilitation and no rehabilitation control for any CRQ domain.

Maintenance rehabilitation

Studies of maintenance telerehabilitation compared to no rehabilitation control assessed quality of life using SGRQ (Barberan-Garcia 2014 (Barcelona and Athens); Vasilopoulou 2017), the CAT (Bernocchi 2018; Vasilopoulou 2017), and the Minnesota Lung Heart Failure Questionnaire (MLHFQ) (Bernocchi 2018).

When maintenance telerehabilitation was compared to no rehabilitation control there may or may not be a difference in CAT score favouring the telerehabilitation group (MD -7.34, 95% CI -9.20 to -5.48; 209 participants; two studies; very low-certainty evidence; Analysis 3.9) (Bernocchi 2018; Vasilopoulou 2017).

In one RCT of maintenance telerehabilitation compared to no rehabilitation control, in participants with a combined diagnosis of COPD and heart failure, there was an improvement in MLHFQ score favouring telerehabilitation at the end of the four month intervention (MD -10.06, 95% CI -15.68 to -4.44; 112 participants; one study; evidence not graded; Analysis 3.15 (Bernocchi 2018). In one RCT of maintenance telerehabilitation compared to no rehabilitation control, at the end of the 12 month intervention, improvement in total SGRQ score favoured telerehabilitation (MD -11.80, 95% CI -19.44 to -4.16; 97 participants; one study; evidence not graded; Analysis 3.8 (Vasilopoulou 2017).

In one study of two non-randomised controlled trials of maintenance rehabilitation compared to no rehabilitation control (Barberan-Garcia 2014 (Barcelona and Athens)) a significant effect for SGRQ total score favouring the telerehabilitation group was seen in one trial (Barcelona, MD -10, 95% CI -17.89 to -2.1) with no effect in the other trial (Athens, no data reported).

Adverse events

As noted in Comparison 1, adverse events were inconsistently defined, with variable reporting. Reported information relating to adverse events is detailed in Table 3. One RCT of primary telerehabilitation compared to no rehabilitation control (Tsai 2017) and two RCTs of maintenance telerehabilitation compared to no rehabilitation control (Bernocchi 2018; Vasilopoulou 2017) reported no study related adverse events. We are therefore uncertain about adverse events.

Secondary outcomes

Adherence/completion

Two studies of telerehabilitation compared to no rehabilitation control reported intervention adherence (primary telerehabilitation: Tsai 2017; maintenance rehabilitation: Vasilopoulou 2017). In primary telerehabilitation, the mean number of sessions attended was 22 (SD 5) out of a maximum total 24 sessions (36 participants; one study; Tsai 2017); while for maintenance telerehabilitation the percentage of sessions undertaken relative to the total available was 93.5% (97 participants; one study; Table 4) (Vasilopoulou 2017).

Anxiety/depression

Primary rehabilitation

One RCT of telerehabilitation compared to no rehabilitation control assessed anxiety and depression with the HADS (Analysis 3.16 and Analysis 3.17) and reported an improvement in HADS depression score at end intervention favouring the telerehabilitation group (MD -2.40, 95% CI -3.48 to -1.32; 36 participants; one study; evidence not graded) (Tsai 2017).

Maintenance rehabilitation

No studies of maintenance telerehabilitation compared to no rehabilitation control assessed anxiety or depression.

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Physical activity

Primary rehabilitation

Physical activity participation was assessed by accelerometry in three studies (Lahham 2020; Tabak 2014; Tsai 2017) of telerehabilitation compared to no rehabilitation. The effect of telerehabilitation on physical activity outcomes was inconsistent.

Two RCTs of telerehabilitation compared to no rehabilitation control measuring physical activity by accelerometry were combined in a meta-analysis. There was no clear improvement in steps per day (MD 489 steps, 95% CI -143 to 1120; 94 participants; two studies; evidence not graded, Analysis 3.19) (Lahham 2020; Tsai 2017) or time spent in sedentary behaviour (MD 42 minutes, 95% CI -26 to 111; 94 participants; two studies; evidence not graded; Analysis 3.20) (Lahham 2020; Tsai 2017) following telerehabilitation, compared to no rehabilitation control. In Tsai 2017, time spent in light intensity physical activity favoured the control group at end intervention (MD -44 minutes, 95% CI -87.4 to -0.59; 36 participants; one study; evidence not graded; Analysis 3.21).

One study of primary telerehabilitation compared to no rehabilitation control reported medium-term follow-up (58 participants) (Lahham 2020). At six months following the end of the intervention, no differences were reported between telerehabilitation and no rehabilitation control for any measure of physical activity.

Maintenance rehabilitation

One RCT of maintenance telerehabilitation compared to no rehabilitation control assessed physical activity by accelerometry. There was a small difference in time spent in moderate intensity physical activity, favouring the intervention group at end rehabilitation (MD 3.2 minutes, 95% CI 0.65 to 5.75; 97 participants; one study; evidence not graded; Analysis 3.23) (Vasilopoulou 2017).

Healthcare utilisation

COPD exacerbations, hospitalisations and emergency department presentations were reported in three studies of telerehabilitation compared to no rehabilitation (Table 5). The three studies reported healthcare utilisation only during the intervention period (primary rehabilitation: Tabak 2014; maintenance rehabilitation: Bernocchi 2018; Vasilopoulou 2017). Due to variable reporting of healthcare utilisation and time points, data could not be combined in a meta-analysis. Similar numbers of COPD related hospitalisations were reported for the telerehabilitation group and no rehabilitation group for primary rehabilitation, with four and five admissions respectively over the nine-month intervention period (Tabak 2014).

In one RCT of maintenance telerehabilitation compared to no rehabilitation, the likelihood of hospitalisation was lower for telerehabilitation (OR 0.31, 95% CI 0.14 to 0.67; 112 participants; one study; evidence not graded, Analysis 3.32) (Bernocchi 2018).In one RCT, the mean acute exacerbations of COPD were lower in the maintenance telerehabilitation group than in the no-rehabilitation control (mean 1.7 (SD 1.7) versus mean 3.5 (SD 1.8); P < 0.001; 97 participants; one study; evidence not graded) (Vasilopoulou 2017).

DISCUSSION

Summary of main results

The aim of this review was to assess the safety and potential beneficial effects of telerehabilitation on exercise capacity, breathlessness and health-related quality of life in people with chronic respiratory disease when compared to centre-based (in-person) pulmonary rehabilitation or no rehabilitation control. We included a total of 15 studies (32 reports) with 1904 participants, using five different models of telerehabilitation. Almost all (99%) included participants had COPD. Three studies were CCTs.

For primary pulmonary rehabilitation, there was probably little or no difference between telerehabilitation and in-person pulmonary rehabilitation for exercise capacity measured as 6MWD (MD 0.06 m, 95% CI -10.82 m to 10.94 m; 556 participants; four studies; moderate-certainty evidence). There may also be little or no difference for quality of life measured on SGRQ total score (MD -1.26, 95% CI -3.97 to 1.45; 274 participants; two studies; low-certainty evidence) or breathlessness on the CRQ dyspnoea domain score (MD 0.13, 95% CI -0.13 to 0.40; 426 participants; three studies, low-certainty evidence). Participants were more likely to complete a program of telerehabilitation with 93% (95% CI: 90 to 96%) completion rate, when compared to face-to-face rehabilitation (70% completion). When compared to no rehabilitation control, trials of primary telerehabilitation may increase exercise capacity in 6MWD (MD 22.17 m, 95% CI -38.89 m to 83.23 m; 94 participants; two studies; low-certainty evidence) and may also increase 6MWD when delivered as maintenance rehabilitation (MD 78.1 m, 95% CI 49.6 m to 106.6 m; 209 participants; two studies; low-certainty evidence). No adverse effects of telerehabilitation were noted over and above any reported for in-person rehabilitation or no rehabilitation.

Across multiple trials and models of telerehabilitation delivery, the results of this review have shown that telerehabilitation and in-person pulmonary rehabilitation have similar effects across a range of outcomes. Secondary outcomes showed that there may be a reduction in anxiety and 35% lower odds of hospital admission for those undertaking telerehabilitation, compared to in-person rehabilitation. However, these results should be interpreted with caution due to the limited number of studies, and the relatively small number of participants. Nonetheless, these benefits in terms of reduced hospitalisations and psychological well-being might suggest that supported rehabilitation interventions, delivered into the home, may help to alleviate stressors associated with access and participation in centre-based, in-person programs (Cox 2017), and may provide confidence in being able to exercise independently (Hoaas 2016).

These findings suggest that primary pulmonary rehabilitation programs delivered by telerehabilitation can provide a clinically effective alternative to centre-based rehabilitation models. The number of centre-based pulmonary rehabilitation programs available on a global scale is estimated to be able to service fewer than 2% of all people with COPD (Desveaux 2015). Being able to increase the number of individuals who can access and receive benefit from pulmonary rehabilitation is a key clinical and research priority (Rochester 2015). In addition, the 2020 global pandemic associated with coronavirus has had a profound impact on the ability to provide traditional, face-to-face, centre-based pulmonary rehabilitation services (Houchen-Wolloff 2020), with the effect potentially ongoing.

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Given that the physical benefits achieved in traditional centre-based pulmonary rehabilitation are mostly not maintained at one year after rehabilitation completion (Spencer 2019), the question of whether telerehabilitation can serve as a useful, long-term strategy to support maintenance of pulmonary rehabilitation gains requires further investigation. That both of the two included studies of maintenance telerehabilitation, which assessed outcomes at the end of the respective intervention periods, may have achieved clinically meaningful gains for exercise capacity, despite using vastly different delivery models (144 sessions over 12 months with physiological monitoring and weekly consultation with a health professional in Vasilopoulou 2017 or twice-weekly telephone contact with health professionals for four months with physiological monitoring and provision of exercise equipment in Bernocchi 2018) requires further exploration. In addition, these maintenance models are resource-intensive, so understanding the cost-effectiveness of any medium- to longer-term maintenance intervention will be necessary to justify the resources involved.

Overall completeness and applicability of evidence

Almost all participants in the included studies were individuals with COPD, which may have implications for the applicability of the findings to other groups with chronic respiratory disease. One RCT of maintenance telerehabilitation compared to no rehabilitation comprised participants with multiple diagnoses, one of which was COPD (Barberan-Garcia 2014 (Trondheim)). However, it was not possible to obtain data relating only to the COPD participants in this study. Whether individuals with ILD, bronchiectasis or asthma would respond differently to a rehabilitation intervention using telerehabilitation remains to be determined.

Although the interventions in this review met the definition of telerehabilitation, being rehabilitation delivered at a distance using information communication technology, they were heterogeneous in their components. The technology modalities employed differed widely between studies and encompassed telephone calls, bespoke websites or mobile applications, the use of videoconferencing and text messaging support. The degree of supervision of exercise training (in-person, real-time, or minimal) also varied, as did the location to which telerehabilitation was delivered (patient's home versus healthcare facility). Four studies in this review (Hansen 2020; Knox 2019; Stickland 2011; Tsai 2017) delivered telerehabilitation in a group setting, either at a healthcare facility or in a virtual group from the patient's home. Due to the limited number of studies, it was not possible to determine the effect of one model of delivery or location of telerehabilitation over another. Although we were unable to examine the relative efficacy of different models of telerehabilitation in the current review, this might be informative in future updates, if additional studies are available. That telerehabilitation can be delivered in a group environment, akin to traditional centre-based programs, creates the opportunity for participants to receive social support and modelling from their peers, a recognised important component of pulmonary rehabilitation (Hill 2013). That there was no difference between centre-based pulmonary rehabilitation and telerehabilitation in key outcomes including exercise capacity, quality of life and breathlessness, regardless of format, indicates the potential for the use of a wide range of telerehabilitation models as alternatives to centre-based delivery. The global COVID-19 pandemic has caused a dramatic and immediate change to the way pulmonary rehabilitation is delivered, largely precluding centre-based delivery of pulmonary rehabilitation and fast-tracking the need for remote program delivery. However, this has highlighted that for telerehabilitation to provide an entirely home-based or remote rehabilitation experience, options for remote physical assessment need to be explored (Holland 2020). None of the included studies reported undertaking remote or in-home physical assessment, and presently there are no tests of exercise capacity for people with respiratory disease that can identify desaturation and enable prescription of adequate training intensity that can be performed remotely (Holland 2020).

The duration of intervention in the included studies varied widely. Studies of primary rehabilitation ranged from six weeks (Bourne 2017) to nine months (Tabak 2014). Studies of maintenance rehabilitation ranged from four months (Bernocchi 2018) to 12 months or more (Barberan-Garcia 2014 (Barcelona and Athens); Barberan-Garcia 2014 (Trondheim); Vasilopoulou 2017). Five studies of primary rehabilitation reported follow-up beyond the end of the intervention, which ranged from 10 to 12 weeks (Hansen 2020) to around 12 months (Holland 2017; Maltais 2008). No follow-up data beyond the end of the intervention were reported for studies of maintenance rehabilitation. The lack of consistency in intervention duration makes it difficult to establish if there is a single best, or ideal duration of, telerehabilitation intervention. Likewise, the limited studies that provide follow-up data beyond the end of the intervention period make it difficult to draw conclusions about the long-term effectiveness of telerehabilitation. Despite that, the studies included in this review of primary pulmonary rehabilitation with follow-up beyond the end of the intervention did not demonstrate any difference between telerehabilitation and centre-based pulmonary rehabilitation (Hansen 2020; Holland 2017; Maltais 2008; Stickland 2011) or with no rehabilitation control (Lahham 2020) in the medium-term (up to six months post-intervention) or longer-term (more than six months after completion of the intervention).

No included studies in this review assessed the effect of telerehabilitation compared to inpatient rehabilitation. Furthermore, this review did not include studies of individuals during or immediately after experiencing an exacerbation of their respiratory disease. The timing and nature of pulmonary rehabilitation delivered during and immediately following a respiratory exacerbation in COPD is controversial (Holland 2014), and compounded by extremely low uptake rate of outpatient pulmonary rehabilitation services post discharge (Spitzer 2019); despite evidence that pulmonary rehabilitation commenced within two weeks of hospital discharge can reduce the likelihood of readmission (Puhan 2016). Randomised controlled trials examining if telerehabilitation is safe and effective if used to deliver pulmonary rehabilitation services in the period early post respiratory exacerbation are required.

Quality of the evidence

A number of potential sources of bias were identified in this review. Three included studies were of CCTs. The overall risk of bias for these CCTs ranged from moderate to critical, with data from these studies not contributing to meta-analyses and forest plots, but rather included as a narrative synthesis. Due to the nature of the intervention, and an inability to blind participants or personnel delivering the intervention, all included RCTs were judged to be at high risk of bias for performance bias. Blinding of outcome assessors may help to overcome this issue, but this

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was only reported in six of the RCTs (Bernocchi 2018; Bourne 2017; Hansen 2020; Holland 2017; Lahham 2020; Tsai 2017). Data that could be pooled for meta-analysis were usually limited to those of two studies, and four studies at most. Studies of telerehabilitation which only include participants who have access to or are familiar with the relevant technology may also pose a risk of bias for the reported outcomes.

Using GRADE, we judged review outcomes to provide moderate-certainty evidence (6MWD; CAT) or low-certainty evidence (all other graded outcomes). Performance bias and selective reporting in included studies contributed to downgrading for risk of bias. We also downgraded for imprecision because of the small numbers of included studies and participants, and for inconsistency due to heterogeneity in telerehabilitation models.

Potential biases in the review process

All data were extracted independently by two review authors, and discrepancies were resolved through discussion. 'Risk of bias' ratings were also completed independently by two review authors. Studies that were published only in abstract form were eligible for inclusion, as a means to ensure that we captured all available trials. However, despite attempts to contact the authors of potentially eligible abstracts, additional data were often not available. In addition, we had variable success in obtaining additional details from authors of full-text papers, where clarification of details was required. Of note, three studies included in this review were conducted by authors of this review. Where review authors were also included study authors, independent review authors undertook data extraction and assessment of risk of bias.

Agreements and disagreements with other studies or reviews

Our review extends results of a previous systematic review of telerehabilitation for patients with cardiopulmonary disease, which assessed home-based exercise training delivered using telerehabilitation, and reported no difference between telerehabilitation and other exercise rehabilitation models in terms of exercise capacity and quality of life (Hwang 2015). In the review by Hwang and colleagues, only two included studies were of individuals with pulmonary disease alone, and a meta-analysis was not able to be performed. Similar to our findings, there was the potential for higher adherence rates with telerehabilitation, but this was variable. Likewise, a systematic review of cardiac and pulmonary rehabilitation delivered via telerehabilitation, compared to usual centre-based rehabilitation, reported similar improvements between groups in the one included study of pulmonary rehabilitation (Chan 2016). A common feature of these previous reviews and the current review of telerehabilitation in chronic respiratory disease is the limited number of included studies, and relatively small sample sizes, indicating the ongoing need for investigation and evidence of effect in this rapidly expanding field of healthcare.

AUTHORS' CONCLUSIONS

Implications for practice

This review suggests that pulmonary rehabilitation, or maintenance rehabilitation, delivered via telerehabilitation for people with chronic respiratory disease, probably achieves outcomes similar to those of traditional in-person, centre-based pulmonary rehabilitation. No safety issues have been identified. Telerehabilitation has the potential to allow more people to access pulmonary rehabilitation programs and thus overcome common barriers to centre-based pulmonary rehabilitation attendance, including issues associated with travel, transport and a lack of suitably qualified professionals to delivery programs (Cox 2017; Keating 2011). However, providing a telerehabilitation service in clinical practice may also present challenges to patients and health systems in terms of the need to access and navigate special equipment. It is possible that the patient experience of telerehabilitation may vary, depending on the model of telerehabilitation employed, e.g. videoconferencing versus talking on the telephone versus using a web-enabled smartphone. Overall, the strength of the evidence provided by this review is limited by the small number of studies, of varying telerehabilitation models, with relatively few participants; of whom 99% had a diagnosis of chronic obstructive pulmonary disease (COPD).

Implications for research

This review does not identify one single best mode of telerehabilitation delivery, or duration of intervention, but does suggest that telerehabilitation may provide a feasible and clinically effective alternative to centre-based pulmonary rehabilitation, particularly for individuals with COPD. Future research should consider the clinical effect of telerehabilitation for individuals with chronic respiratory diseases other than COPD. The duration of benefit of telerehabilitation is also unclear, with few studies to date undertaking follow-up beyond the end of the intervention. Understanding whether maintenance of rehabilitation benefit can be achieved with primary or maintenance telerehabilitation interventions could have implications for the health outcomes of patients as well as available service provision, if maintenance of benefit reduces the needs for repeated doses of pulmonary rehabilitation. It is also unknown if there is a best time for initiation of a program of telerehabilitation. Participants in the included studies were all in stable health (i.e. not experiencing an exacerbation); the question of whether outcomes associated with telerehabilitation differ for individuals who have recently experienced a respiratory exacerbation requires investigation. Some of the included studies in this review were of telerehabilitation models that required bespoke equipment or for participants to be familiar with how to use the equipment or technology under investigation, in order to enrol. To truly improve equity of access to pulmonary rehabilitation services, future studies need to describe the degree of technology experience that participants possess and how adaptable the intervention is to novice users. Furthermore, the use of technology to receive telerehabilitation may necessitate patients to have their own equipment or to follow specific procedures, above and beyond undertaking pulmonary rehabilitation. This may create additional burden for patients in order to receive pulmonary rehabilitation. Future work describing the patient experience associated with undertaking different models of telerehabilitation is warranted. Given that equipment and infrastructure associated with telerehabilitation may be expensive, comprehensive economic analyses of the patient and health system costs and benefits, and description of procedures for implementation into clinical practice are required.

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* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Barberan-Garcia 2014 (Barcelona and Athens)

Study characteristics	
Methods	Controlled clinical trial
Participants	PARTICIPANTS & SETTING: BARCELONA: • Clinically stable COPD patients recruited from the hospital outpatient clinic and from several primary care units of the area ATHENS: • Clinically stable COPD patients recruited from the hospital outpatient clinic INCLUSION CRITERIA • Diagnosis of COPD • Clinically stable conditions with optimised pharmacological treatment EXCLUSION CRITERIA • History of lower respiratory track infection and/or COPD exacerbation within 6 weeks prior to initial measurements • Previous participation in a pulmonary rehabilitation program within 12 months prior to the initial evaluation CHARACTERISTICS INTERVENTION GROUP - Telerehabilitation BARCELONA • n = 26 • Age mean (SD) 64 (6) years • 92% male • FEV_1 56 (14) %predicted

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Barberan-Garcia 2014 (Barcelona and Athens) *(Continued)*

- 6MWD 513 (71) m

ATHENS

- n = 15
- Age mean (SD) 65 (8) years
- FEV_1 41 (10) %predicted
- 6MWD 374 (59) m

CONTROL GROUP

BARCELONA

- n = 51
- Age mean (SD) 66 (9) years
- 90% male
- FEV_1 43 (16) %predicted
- 6MWD 464 (95) m

ATHENS

- n = 25
- Age mean (SD) 62 (7) years
- FEV_1 44 (12) %predicted
- 6MWD 341 (68) m

Interventions	INTERVENTION GROUP - Cardiopulmonary rehabilitation (CPR) + integrated care service-information communication technology (ICS-ICT) supported community-based CPR and self-management during the maintenance follow-up period BARCELONA: • CPR = 1 hour, 3x/week for 8 weeks; cycle interval training (5 min of warm-up cycling at 30% of peak work rate, 40 min of interval training (2 min high intensity, 3 mins active rest; intensity at least 70%/40% peak work rate) and 5 min of cool-down pedalling at 20% of peak work-rate). Exercise progressed by approximately 5% every week up to a maximum of 100%. 2 x 90 education sessions. 1 x education session for ICT training • ICS-ICT community maintenance = exercise plan (community exercise at least from 4 to 5 days per week for at least 40 min each time at intensity between 3 and 5 in the modified Borg scale and exercise counselling supported by: 1. A mobile solution (5580 Music Xpress, Nokia, Espoo, Finland) connected with a wireless pulse oximeter (4100, NONIN MEDICAL, INC. Plymouth, MN USA) to monitor the exercise sessions 2. SMS prompts three times per week, fostering adherence to the program and; 3. Free access to a Personal Health Folder PHF (website) - where weekly symptom questionnaire and monthly CAT were completed. Physical activity and self-management educational material updated to PHF. Immediate graphical feedback provided of pre-defined clinical outcomes (number of exercise sessions, duration of session, symptoms ATHENS: • CPR = 45 min, 3x/week for 8 weeks; cycle interval training (high-intensity interval training 30 s of high-intensity pedalling and 30 s of active rest; work-load 100% of the peak work rate weeks 1 to 3, 120% weeks 4 to 6 and 140% of peak work-rate during the last 2 weeks. 2 x 1 hour education sessions. • ICS-ICT community maintenance = exercise counselling and ICT-supported exercise plan. On a bi-monthly basis, patients used a mobile solution (5580 Music Xpress, Nokia, Espoo,Finland) connected with a wireless pulse-oximeter (4100, NONIN MEDICAL, INC. Plymouth, MN USA) to monitor and tailor the exercise sessions. Data recorded during the bimonthly sessions were transmitted to the ICT platform (Linkcare), reviewed by a health professional and feedback provided. Physiological data (heart rate, oxygen arterial saturation, exercise duration and intensity of dyspnoea and leg discomfort) from

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Barberan-Garcia 2014 (Barcelona and Athens) *(Continued)*

	the remaining exercise sessions were reported by patients using spreadsheets that were regularly handed to the health professionals of the clinic. CONTROL GROUP - Cardiopulmonary rehabilitation (CPR) + usual care (UC) BARCELONA: • CPR = 1 hour, 3x/week for 8 weeks; cycle interval training (5 min of warm-up cycling at 30% of peak work rate, 40 min of interval training (2 min high intensity, 3 mins active rest; intensity at least 70%/40% peak work rate) and 5 min of cool-down pedalling at 20% of peak work-rate). Exercise progressed by approximately 5% every week up to a maximum of 100%. 2 x 90 education sessions. 1 x education session for ICT training. ATHENS: • CPR = 45 min, 3x/week for 8 weeks; cycle interval training (high-intensity interval training 30 s of high-intensity pedalling and 30 s of active rest; work-load 100% of the peak work rate weeks 1 to 3, 120% weeks 4 to 6 and 140% of peak work-rate during the last 2 weeks. 2 x 1 hour education sessions.
Outcomes	ASSESSMENT TIMEPOINTS: • Baseline • End of 8-weeks primary rehabilitation • End of telerehabilitation maintenance follow up (BARCELONA: 22 ± 12 months; ATHENS: 12 months) PRIMARY OUTCOME: • 6MWD SECONDARY OUTCOMES: • Self-reported physical activity using a structured questionnaire • SGRQ • mMRC dyspnoea scale
Notes	ETHICS APPROVAL: • The Human/Medical Ethics Committees at each site approved the study and all the participants signed an informed consent previous to any procedure. FUNDING: • Supported by NEXES e Supporting Healthier and Independent Living for Chronic Patients and Elderly (UE Grant CIPICT- PSP-2007-225025) and PITES (FIS-PI09/90634). CONFLICT OF INTEREST: • JR is founder of Linkcare Health Services, a spin-off company generated by Hospital Clinic de Barcelona, and he has a small percentage of stocks. CONTACT: A Barbaren-Garcia: anbarber@clinic.ub.es

Barberan-Garcia 2014 (Trondheim)

Study characteristics	
Methods	Randomised controlled trial
Participants	PARTICIPANTS & SETTING:

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Barberan-Garcia 2014 (Trondheim) *(Continued)*

	• Successive eligible patients were included from health care units in five municipalities in Norway INCLUSION CRITERIA: • Patients living at home older than 45 years • At least one of: COPD according to the GOLD criteria; CHF (NYHA level I-III); or stroke • clinically stable with optimised pharmacological therapy • 6MWT distance not greater than 550 m EXCLUSION CRITERIA: • Not stated CHARACTERISTICS: INTERVENTION GROUP: Cardiopulmonary rehabilitation (CPR) + Integrated Care Service and Information Communication Technology (ICS-ICT) follow up • Participant characteristics relating to individuals with chronic respiratory disease unable to be obtained • Of n = 28 randomised to CPR + ICS-ICT intervention group n = 19 completed 12 month follow up period of whom n = 6 had COPD. • Age (total group) 65 (8) years • Male: 36% CONTROL GROUP: CPR + UC follow up • Participant characteristics relating to individuals with chronic respiratory disease unable to be obtained • Of n = 27 randomised to CPR + UC control group n = 18 completed 12 month follow up period of whom n = 9 had COPD • Age (total group) 62 (7) years • Male: 55%
Interventions	INTERVENTION GROUP - traditional centre-based PR with Integrated Care Service (ICS) and Information Communication Technology (ICT) support during follow up period. • 8 week supervised outpatient program (exercise and self management education) • 1 hour, twice/week endurance training at approximately 70% peak work rate • 2 hours education, once/week for six weeks • ICT support follow up comprising exercise and self-management counselling tailored to patient needs via bi-monthly telephone calls from healthcare professionals CONTROL GROUP - traditional centre-based PR with usual care follow up • 8-week supervised outpatient program (exercise sessions only) • 1 hour, twice/week endurance training at approximately 70% peak work rate • Maintenance follow up - usual care consisting of pharmacological treatment and educational program following international guidelines
Outcomes	ASSESSMENT TIMEPOINTS: • Baseline • End of 8-weeks primary rehabilitation • End of telerehabilitation maintenance follow up (12 months) PRIMARY OUTCOME: • 6MWT distance
Notes	ETHICS APPROVAL

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Barberan-Garcia 2014 (Trondheim) *(Continued)*

- The Human/Medical Ethics Committees at each site approved the study and all the participants signed an informed consent previous to any procedure.

FUNDING

- Supported by NEXES e Supporting Healthier and Independent Living for Chronic Patients and Elderly (UE Grant CIPICT- PSP-2007-225025) and PITES (FIS-PI09/90634).

CONFLICT OF INTEREST

- JR is founder of Linkcare Health Services, a spin-off company generated by Hospital Clinic de Barcelona, and he has a small percentage of stocks.

CONTACT:

A Barbaren-Garcia; anbarber@clinic.ub.es

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Unclear risk	• Allocation concealment not stated
Blinding of participants and personnel (performance bias) All outcomes	High risk	PARTICIPANTS: • Not possible due to nature of intervention PERSONNEL: • Not possible due to nature of intervention
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Insufficient information, not stated
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	• n = 9 participants were lost to follow up from both the control and intervention groups, but reasons for loss/exclusion not stated. • Largest dropout group were those with COPD (baseline n = 26; lost to follow up n = 11)
Selective reporting (reporting bias)	Unclear risk	• Unable to locate study protocol • Main outcome variable of study of Trondheim was long-term sustainability of training induced enhancement of aerobic capacity assessed using 6MWT at baseline, after the 8-week training program and at the end of the follow up period (PAPER). • Results: Change in 6MWD from baseline to end 8-week training program. P-value only for 6MWT outcome after 12-month follow up.
Other bias	Unclear risk	• Inclusion of participants other than COPD - unable to assess COPD data in isolation

Bernocchi 2018

Study characteristics

Methods	Randomised controlled trial

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Bernocchi 2018 *(Continued)*

Participants	PARTICIPANTS & SETTING: • Individuals with combined COPD and chronic heart failure undergoing in-hospital rehabilitation within the Cardiology and Pulmonary Departments of three rehabilitation hospitals in Italy (Salvatore Maugeri Foundation IRCCS Institutes of Lumezzana and Montescano; and San Raffaele Pisana IRCCS, Rome). INCLUSION CRITERIA: • Age over 18 years • COPD GOLD classification classes B, C and D - documented by spirometry within the previous 12 months • Systolic and/or diastolic heart failure NYHA classes II, III and IV - documented by echocardiogram within the previous 12 months • At least one hospitalisation due to heart failure or COPD in previous 12 months • Able to sign informed consent EXCLUSION CRITERIA: • Did not return to home after hospitalisation • Physical activity limitation due to non-cardiac/pulmonary conditions • Limited life expectancy (< 6 months) • Severe cognitive impairment (Mini Mental Test Examination < 16) CHARACTERISTICS: INTERVENTION GROUP: Home maintenance telerehabilitation • n = 56 • Age mean (SD) 71 (9) years • 88% male (n = 50) • FEV_1 66.6 (18.6) %predicted CONTROL GROUP: No rehabilitation control • n = 56 • Age 70 (9.5) years • 75% male (n = 42) • FEV_1 66.1 (16.4) %predicted
Interventions	INTERVENTION GROUP: Home maintenance telerehabilitation • 4 month intervention with 2 month follow up • Provided with a pulse oximeter and 1-lead ECG for remote telemonitoring of vital signs • Weekly structured phone call with nurse to review symptoms, receive advice on diet, lifestyle, medication. • Personalised exercise program provided by physiotherapist incorporating mini-ergometer, callisthenic exercises, free walking. Received pedometer and diary. • Initial exercise load 15 to 25 mins mini-ergometer and 30 mins callisthenic exercises 2 to 3 times/week, plus free walking on two days. • Weekly telephone call with physiotherapist to review training level and set new targets. CONTROL GROUP: No rehabilitation control • Standard care including medications and oxygen prescription, visits from general practitioner, in-hospital checkups. • Instructed in an educational session about maintaining a healthy lifestyle. • Invited to practice 'daily activity as preferred'.

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Bernocchi 2018 *(Continued)*

Outcomes	ASSESSMENT TIMEPOINTS: • Baseline • End 4-month intervention • 2 months after intervention (month 6) PRIMARY OUTCOME: • change in 6MWD from baseline SECONDARY OUTCOMES: • Reduced time to event (hospitalisation for any reason, or death) • Change from baseline in dyspnoea (mMRC), PASE, impairment/disability (BARTHEL index), quality of life (MLHFQ, CAT) ADHERENCE/COMPLETION: • Number of patients who completed the program • Percentage of prescribed training sessions actually performed NON-CLINICAL OUTCOMES: • Patient satisfaction with the telerehabilitation service, use of devices, healthcare professional willingness to respond to patient needs, clarity of recommendations from nurse and physiotherapist, feeling of support, helpfulness of service.
Notes	ETHICS APPROVAL • Institutional review board of the Salvatore Maugeri Foundation (CEC deliberation No. 916, 3 June 2013). FUNDING • Ministero della Salute Italian Ministry of Health (CCM2011; project no. 14) CONFLICT OF INTEREST • None declared CONTACT: Prof Palmira Bernocchi; palmira.bernocchi@icsmaugeri.it

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Low risk	• Sequentially numbered opaque, sealed envelopes. (PROTOCOL)
Blinding of participants and personnel (performance bias) All outcomes	High risk	PARTICIPANTS: • Due to the nature of the intervention, neither the patients nor the physicians were blinded to patients' group allocation....(PROTOCOL) • Due to the nature of the trial, it was not possible to blind patients and healthcare personnel to intervention. (PAPER) PERSONNEL: • Due to the nature of the intervention, neither the patients nor the physicians were blinded to patients' group allocation....(PROTOCOL)

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Bernocchi 2018 *(Continued)*

		• Due to the nature of the trial, it was not possible to blind patients and health-care personnel to intervention. (PAPER)
Blinding of outcome assessment (detection bias) All outcomes	Low risk	• Outcome assessors and data analysts will be blinded. (PROTOCOL) • Outcome assessors and data analysts were blinded to the allocation. (PAPER)
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	• In total, 112 patients were randomised (56 per group). (PAPER) • at 80% of power and a significance level of p < 0.05 m our RCT would need a sample size consisting of at least 44 participants in each group (PROTOCOL and PAPER). • We decided to include at least 55 to 60 patients in each group (PROTOCOL and PAPER) • Overall, 11 (20%) patients in IG were lost to follow-up, and 21 (37.5%) in CG (P = 0.0365) (PAPER)
Selective reporting (reporting bias)	Unclear risk	• Trial registration and published protocol available PRIMARY OUTCOME: • Trial registration: Improvement tolerance capacity (4 months and 6 months) (walking test) • Protocol: 6MWT • Paper: 6MWT reported at 4 months and 6 months SECONDARY OUTCOMES: • Trial registration: [at 4 months] hospitalisation (cardiac/respiratory); hospitalisation (all cause); MLHFQ; CAT; clinical instabilities without hospital admission; Barthel index. [at 4 months and 6 months] physical activity/energy expenditure; adherence to at least 70% proposed rehabilitative sessions • Protocol: [at 4 months] hospitalisation (cardiac/respiratory); hospitalisation (all cause); MLHFQ; CAT; Barthel index. [at 4months and 6 months] Adherence to at least 70% proposed rehabilitative sessions. Additional secondary outcomes all participants: mMRC; BORG scale; PASE; daily steps reported by patients; improvement in oxygenation. Additional secondary outcomes IG only: qualitative evaluation of compliance with rehabilitation program; use of health services calculated as total and per-person number of PT and NT scheduled and unscheduled calls; total and per-person number of PT home visits; total and per-person number of educational sessions; total and per-person time spent by the PT and NT in the study. • Paper: [at 4 months] MLHFQ; CAT; Barthel index; Program adherence reported but not based on at least 70% of proposed sessions; mMRC; daily steps reported by patients; qualitative evaluation; use of health services being total and per-person number of PT and NT scheduled and unscheduled calls; total and per-person number of PT home visits; total and per-person number of educational sessions; total and per-person time spent by the PT and NT in the study. [at 6 months] all cause hospitalisation; mortality; MLHFQ; CAT; Barthel index; mMRC; daily steps reported by patients. Hospitalisation rate (cardiac/respiratory) reported, time-point unknown.
Other bias	Unclear risk	• Trial started June 2013; registered October 2014 with recruitment completion date October 2014; Data collection complete March 2015. • Enrolment of participants started in July 2013 and ended in October 2014. Follow-up data ended in April 2015. (PAPER) • The exercise programme carried out was more a programme of physical activity maintenance than exercise training in the true sense. Only in a subgroup of patients, in fact, did we measure the incremental load (watts) performed by the patients during the 4 months of the telerehab-HBP. (PAPER)

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Bourne 2017

Study characteristics	
Methods	Randomised controlled trial, parallel group
Participants	PARTICIPANTS & SETTING: • Individuals with COPD suitable for pulmonary rehabilitation from the Portsmouth NHS outpatient respiratory clinic. INCLUSION CRITERIA: • Diagnosis of COPD (defined by NICE COPD guidelines) and referred to PR • mMRC dyspnoea score of grade 2 or greater • Access to the internet and ability to operate a web-platform • Aged 40 years or older • Able to complete study procedures and provide consent EXCLUSION CRITERIA: • Respiratory exacerbation requiring antibiotics and/or steroids within 2 weeks prior to study screening • Pulmonary rehabilitation within last 6 months • Individuals with another respiratory disease as their main complaint, other than COPD • Uncontrolled hypertension • Unstable cardiovascular disease or significant desaturation that would make pulmonary rehabilitation exercise unsafe or prevent program participation. • Individuals unable to walk or whose ability to walk safely and independently is significantly impaired due to non-respiratory related conditions and/or cognitive impairment • Individuals who are unable to read or use an internet-enabled device or do not have access to the internet at home • TUG test > 4 seconds CHARACTERISTICS: INTERVENTION GROUP: • n = 64 • Age mean (SD) 69.1 (7.9) years • 62% male (n = 41) • FEV_1 58 (23.6) %predicted CONTROL GROUP: • n = 26 • Age 71.4 (8.6) years • 69% male (n = 18) • FEV_1 60.5 (20.1) %predicted
Interventions	INTERVENTION GROUP - ONLINE PULMONARY REHABILITATION (myPR) • Brief (5-10min) introductory face-to-face session • Instructed to access myPR at least twice and up to 5 times/week • Program duration 6 weeks • 10 exercises starting at 60 second duration in week 1, increasing by 30 seconds each week up to 3.5 minutes in week 6. Exercises (same as control group) included: bicep curls; wall pushups; leg extension in sitting; upright rowing with weight; sit-to-stand; arm swing with stick; leg kicks to side; arm punches with weight; step ups

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Bourne 2017 *(Continued)*

- 1 minute of rest between each exercise
- Directed to watch 3 different educational videos each week - including: anatomy of the lungs; explanation of COPD; management of anxiety and depression; claiming benefits; self-management; managing breathlessness; medications and treatments; sputum clearance; nutrition; pacing; smoking cessation

CONTROL GROUP - CONVENTIONAL (OUTPATIENT) PULMONARY REHABILITATION

- Two supervised sessions/week for 6 weeks. Participants asked to carry out exercises at home an additional 3 times/week
- 10 exercise stations identical to exercises in myPR
- Education sessions the same as those in myPR presented and discussed orally

Outcomes

ASSESSMENT TIMEPOINTS:

- Baseline
- End intervention

PRIMARY OUTCOME:

- 6MWD and CAT

SECONDARY OUTCOMES:

- SGRQ, HADS, mMRC (data reported, but not listed as outcome measure), safety, adherence.

ADVERSE EVENTS:

- Captured in the face-to-face (control) group at the start of each session of the 6 week intervention and at the final assessment.
- For intervention (myPR) participants, telephone call each week from study team to ascertain adverse event

Notes

ETHICS APPROVAL

- Approved by the research ethics committee for Berkshire B of the UK Health Research Authority (15/SC/0345).

FUNDING

- Funded by a Small Business Research Initiative (SBRI) grant from NHS England

CONFLICT OF INTEREST

- SB: grants and personal fees from myMHealth (a medical software company) during the conduct of the study; other frommyMHealth, outside the submitted work. He is CEO, co-founder and part owner of this company.
- RDV: personal fees from myMHealth, during the conduct of the study; and is a partner in the rehabilitation facility that hosted some of the clinical trial activity.
- BG: grants to Portsmouth Hospitals NHS Trust from myMHealth, during the conduct of the study.
- VC: personal fees from myMHealth, during the conduct of the study.
- TB: grants from myMHealth, during the conduct of the study.
- TW: grants and personal fees from myMHealth during the conduct of the study. He is co-founder and part owner of this company.

CONTACT:

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Risk of bias

Bias	Authors' judgement	Support for judgement

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Bourne 2017 *(Continued)*

Allocation concealment (selection bias)	Low risk	• A concealed allocation was performed. (PAPER) • Used an online system for concealed allocation. (PAPER)
Blinding of participants and personnel (performance bias) All outcomes	High risk	PARTICIPANTS: • Due to the nature of the intervention, blinding of participants was not possible. (PAPER) PERSONNEL: • Not possible due to nature of intervention
Blinding of outcome assessment (detection bias) All outcomes	Low risk	• Study staff carrying out the post intervention assessments (outcome assessors) were blind to which arm the patient had been randomised to. (PAPER) • To ensure the study team remained blind as to which arm of the study each participant was on, they were divided into two teams. One team was responsible for the assessment and randomisation of participants onto the study and the other team provided the after-intervention assessment. (PAPER) • All subjects were asked in advance not to discuss their PR programme during assessments. (PAPER)
Incomplete outcome data (attrition bias) All outcomes	Low risk	• 143 subjects were screened for eligibility….. for the randomised 90 patients. • Statistical analysis was performed for both the ITT population and PP population. ITT analysis included all participants in the arms they were randomised to regardless of adherence to either intervention. The frequency, patterns and predictors of missing data were explored. Data at follow-up was imputed regardless of the reason for missing. (PAPER)
Selective reporting (reporting bias)	Unclear risk	PRIMARY OUTCOME: • Trial registry (submitted March 7 2016): 6MWD • Paper: 6MWD and CAT SECONDARY OUTCOMES: • Trial registry (submitted March 7 2016): CAT Trial registry (submitted September 13 2016): SGRQ, HADS, mMRC, Safety, Adherence, Usability of online system. • Paper: SGRQ, HADS, mMRC (data reported, but not listed as outcome measure), Safety, Adherence.
Other bias	Unclear risk	• Trial registration posted March 2016; Trial registration completed September 2016 • A 2:1 ratio was used to reduce the number of subjects in the more costly face to-face arm while maintaining power • Exclusion criteria: patients who …… do not have access to the internet at home • Competing interests of authors

Chaplin 2017

Study characteristics

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Chaplin 2017 *(Continued)*

Methods	Randomised controlled trial, parallel group
Participants	PARTICIPANTS & SETTING: • Individuals with COPD referred to pulmonary rehabilitation at the University Hospital of Leicester NHS Trust, and from primary care and rehabilitation services within Leicester Partnership Trust. INCLUSION CRITERIA: • COPD FEV_1 < 80% FER 0.70 • MRC dyspnoea 2-5 • access to Internet for > 3 months • ability to navigate websites • able to read and write English EXCLUSION CRITERIA: • Comorbidities preventing exercise • Pulmonary rehabilitation within preceding 12 months CHARACTERISTICS: INTERVENTION GROUP: • n = 51 • Age mean (SD) 66.4 (10.1) years • 74.5% male • FEV_1 58.7 (29.1) %predicted CONTROL GROUP: • n = 52 • Age 66.1 (8.1) years • 63.5% male • FEV_1 55 (20.5) %predicted
Interventions	INTERVENTION GROUP - web-based pulmonary rehabilitation • Participants attended a standardised introductory session. • Website access provided (password-protected, secure log-in) and written instructions on website navigation. • Intended to log in daily; actual • Website sections included home exercise program and goal setting; personalised web page with action plan. • Encouraged to exercise daily and record progress in online diary. • Exercise program included aerobic and strength training (walking prescribed at 85% baseline ISWT). Exercise target set by patient. UL and LL resistance training with hand held weights. Walking time and strength training progressed to achieve VAS4-7. • Weekly contact between healthcare professional and patients by phone or email (including motivational interviewing). • Education content based on SPACE for COPD manual which participants worked through at their own pace - but certain milestones required completion before access to further content. • Anticipated program duration 6 to 8 weeks. CONTROL GROUP - conventional (outpatient) pulmonary rehabilitation • Twice weekly session lasting 2 hours (1 hour of exercise training and 1 hour education session). • Hospital outpatient pulmonary rehabilitation program comprised 4 weeks supervised training and 3 weeks unsupervised; community based rehabilitation maximum 12 sessions.

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Chaplin 2017 *(Continued)*

- Exercise training was aerobic (walking speed prescribed from ISWT and ESWT and progressed according to BORG score); UL and LL resistance training based on 1RM, progression based on maintaining BORG perceived exertion 13 to 15. Static cycling, if tolerated, prescribed on basis of breathlessness and perceived exertion.
- Patients encouraged to complete a home exercise program on non-rehabilitation days and complete an exercise diary.

Outcomes	ASSESSMENT TIMEPOINTS: • Baseline • Following program completion (usually 6 to 7 weeks after commencement) PRIMARY OUTCOME: • Exercise capacity (ISWT/ESWT) SECONDARY OUTCOMES: • HADS; CRQ; CAT; PRAISE; BCKQ; EQ-5D-5L; patient cost questionnaire; physical activity. ADVERSE EVENTS: • A serious adverse event was defined as an acute exacerbation of their COPD that resulted in a hospital admission. ADHERENCE/COMPLETION: • Patients were classed as a completer if they had reached stage 3 or above of the web programme, achieving 75% of the programme which is standard in clinical practice for attending classes. NON-CLINICAL OUTCOMES: • Web-usage audit; recruitment rates; eligibility; patient preference.
Notes	ETHICS APPROVAL • Northampton Research Ethics Committee of the UK National Research Ethics Service (Ethics Ref: 12/EM/0351. FUNDING • Work funded by the RfPB (PB-PG-0711-25127) which is part of the funding body NIHR. CONFLICT OF INTEREST • None declared CONTACT: Emma.chaplin@uhl-tr.nhs.uk

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Low risk	• "group allocation …. was performed using a web-based programme (www.sealedenvelope.com)" (PAPER)
Blinding of participants and personnel (performance bias) All outcomes	High risk	PARTICIPANTS: • Not possible to blind participants to the intervention PERSONNEL:

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Chaplin 2017 *(Continued)*

		• Not possible to blind personnel to the intervention
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	• Measures used and collected in the trial…included clinical and non clinical. (PAPER) • Clinical measures were conducted by a research physiotherapist who was blinded to treatment group allocation (PAPER) • Non-clinical outcomes included a web-usage audit for the internet-based programme, recruitment rates, eligibility and patient preference as well as dropout and completion rates in both treatment groups. (PAPER)
Incomplete outcome data (attrition bias) All outcomes	High risk	• One hundred and three patients were recruited and randomised to the study between May 2013 and July 2015: 52 to the conventional PR group and 51 to the web group (PAPER) • More patients dropped out from the web intervention group (n = 29) but there were no significant differences between the baseline characteristics of those patients that dropped out of the two groups (PAPER). • The only significant characteristic between web completers and dropouts was the pre anxiety scores (P < 0.05) with those that dropped out being more anxious (table 2). • Flow chart provided (PAPER).
Selective reporting (reporting bias)	High risk	• All measures will be repeated again at the discharge assessment following completion of either rehabilitation programme (usually approximately 6 to 7 weeks after starting the programme) • The study protocol is available (BMC 2015) • Trial registration indicates secondary outcome measure 'Health status measures' – types not specified. Measured at baseline and discharge PRIMARY OUTCOME: • Trial registration: Change in exercise capacity (ISWT) • Published protocol: Change in exercise capacity (ISWT) and (ESWT) • Paper: Change in exercise capacity (ESWT) (no data presented for ISWT) SECONDARY OUTCOMES: • Trial registration: Anxiety and depression; ESWT; Health status measures; Physical activity. Measured at baseline and discharge. • Published protocol: Physical activity (Sensewear armband - step count and energy expenditure); Health status (CRQ and CAT); self efficacy (PRAISE); EQ-5D-5L; anxiety and depression (HADS and CAQ); information needs (BCKQ); patient cost questionnaire; physical activity questionnaire (PACER); number of patients eligible; number of participants who proceed to consent; number of participants who complete and who drop out; weekly and total web usage statistics; number and type of technical problems; adverse events • Paper: Data reported for change in ESWT and CRQ dyspnoea domain; number of weeks to complete programme; average number of logins per week. "Qualitative and physical activity data are to be presented in future publications."
Other bias	Unclear risk	• We anticipate….. it will take approximately 6 weeks to work through the online program. (PROTOCOL) • The average number of weeks to complete the website was 11 ± 4 with an average number of four logins per week. (PAPER) • Exclusion criteria - Unwilling/unable to take part in the web-based programme (REGISTRATION)

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Chaplin 2017 *(Continued)*

- Inclusion criteria – 'Access to the internet for more than 3 months, the ability to navigate around a variety of websites and regular use of email was required (PAPER).
- The target number of participants was changed from 100 to 120 (date of change unknown) (REGISTRATION)

Hansen 2020

Study characteristics	
Methods	Randomised controlled trial, parallel group
Participants	PARTICIPANTS & SETTING: • Potentially eligible patients will be identified and recruited by respiratory nurses during out-patient COPD control visits. • Individuals with severe and very severe COPD • Patients were recruited from the respiratory departments of eight different university hospitals in Greater Copenhagen during March 2016 to October 2017. Inclusion and exclusion criteria corresponded to the criteria for outpatient hospital-based routine PR in the Capital Region of Copenhagen, Denmark. INCLUSION CRITERIA: • Age 18 years or older • Severe and very severe COPD (FEV_1/FVC < 0.70; FEV_1 < 50%) • MRC ≥ 2 EXCLUSION CRITERIA: • Participation in/or recent completion of pulmonary rehabilitation within the last 6 months before start of intervention • Dementia/ Cognitive impairment or symptomatic psychiatric illness • An impaired hearing and / or vision disability which means that the instructions are not understood • Unable to understand and speak Danish • Unable to read Danish • Severe co-morbidity which means that exercise is contraindicated CHARACTERISTICS: Whole group: • n = 134 • Age 68 (9) years • n = 74 (55%) female • FEV_1: 33 (9) %predicted • 6MWD: 327 (103) m INTERVENTION GROUP: • n = 67 • Age 68 (9) years • n = 35 (52%) female • FEV_1: 33 (10) %predicted • 6MWD: 322 (108) m

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Hansen 2020 *(Continued)*

	CONTROL GROUP: • n = 67 • Age 68 (9) years • n = 39 (58%) female • FEV_1: 34 (8) %predicted • 6MWD: 332 (98) m
Interventions	INTERVENTION - pulmonary tele-rehabilitation: • Receive the supervised COPD Online Rehabilitation Program (CORe) • Supervised exercise training by skilled physiotherapists and respiratory nurses with at least 2 years of experience with COPD rehabilitation,and delivered via a web-cam at Bispebjerg Hospital to a group of 4–8 patients who exercise at home and communicate via a computer • 60 min/session (5 min warm up, 30 min exercise and 25 min patient education), 3 sessions/week, 10 weeks • Exercises using dumbbells or body weight, involve larger muscle groups with 50/50% exercises for upper and lower extremities, respectively. Comprise sit-to-stand, bicep curls, step-ups, bent over rowing, static-dynamic squat, front raise dumbbells. • Exercises completed in 4 sets; Each set carried for a predefined period of 20 to 40 seconds with a maximum number of repetitions performed, i.e. 8 to 25 repetitions depending on the patients exercise capacity and motivation, but with the aim of 12 to 20 repetitions. • Training intensity determined by self-rated Borg CR-10 scale (score range 0–10), with a training intensity target of Borg 4 to 7. CONTROL - conventional pulmonary rehabilitation: • Supervised exercise training (skilled physiotherapist, at least 2 years experience) • Exercise 60 min/session, 2 sessions/week, 10 to 12 weeks plus 60 to 90 min education session once weekly • Exercise training comprises 5 to 10 min warm up, 20 to 30 min endurance training (walking, cycling, circuit, treadmill), 20 to 30 min resistance training (machine, circuit, dumbbells, elastic bands), 5 to 10min cool down (breathing exercises, yoga, relaxation)
Outcomes	ASSESSMENT TIMEPOINTS: • Baseline • End of intervention (10 to 2 weeks) • 22 weeks after baseline (approximately 3 months post intervention) PRIMARY OUTCOME: • 6MWD SECONDARY OUTCOMES: • CAT • HADS • EQ-5D • Physical activity level (ActivePAL accelerometer)- time spent sedentary, time spent upright • 30 sec STS ADHERENCE/COMPLETION: • Completed 70% per cent of the COPD rehabilitation program (to be included in the per- protocol analysis)
Notes	ETHICS APPROVAL

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Hansen 2020 *(Continued)*

- The trial protocol was approved by the Ethics Committee of theCapital Region of Denmark (H-15019380) and the Danish Data Protection Agency (jr. no.: 2012–58–0004).

FUNDING

- Danish Lung Foundation; Telemedical Center Regional Capital Copenhagen; TrygFonden Foundation

CONFLICT OF INTEREST

- HH received personal grants from the Danish Lung Foundation (charitable funding), Telemedical Center Regional Capital Copenhagen(governmental funding), TrygFonden foundation (charitable funding). The grants cover expenses conducting the trial, salary and university fee for the PhD education.TB, NB, TK, TW, LØ, HFA, GM, ML, AF and NG have nothing to disclose.

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Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Low risk	• patients were randomly allocated 1:1 to receive PTR or conventional hospital-based PR. (PAPER) • The allocation followed a computer-generated randomisation list made by a biostatistician for each recruiting hospital; treatment was denoted as A and B to ensure blinding of the biostatistician. (PAPER) • A senior manager from an independent research department was responsible for the randomisation list and provided the draw to ensure concealment (PAPER)
Blinding of participants and personnel (performance bias) All outcomes	High risk	PARTICIPANTS: • Patients were not possible to blind for allocation. (PAPER) • Due to the nature of the study the patients cannot be blinded, but prior to the assessments they are reminded not to disclose their group allocation to the assessors. (TRIAL REGISTRATION) PERSONNEL: • Due to nature of the intervention not possible to blind personnel
Blinding of outcome assessment (detection bias) All outcomes	Low risk	• All assessors were blinded to group allocation, hypotheses and intervention details. (PAPER) • In the case of failure to keep the assessor blinded, a second assessor was available to conduct the blinded assessment on another day. (PAPER) • The biostatistician had the main responsibility for the data analyses.(PAPER)
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	• Of the patients suitable for hospital-based PR, 1099 met the inclusion criteria and were considered; 714 patients refused PR and were thus deemed ineligible. Of 385 eligible patients, the majority (n = 251) wished to undertake conventional PR and declined participation in the study. 134 patients provided informed consent and were randomised (n = 67 in each group) (Paper) (PAPER FIGURE 1) • n = 67 allocated to each group • Did not complete intervention n = 10 telerehabilitation; n = 24 conventional PR control

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Hansen 2020 *(Continued)*

		• Intention to treat analysis with all participants; per protocol analysis with n = 49 telerehab (excluded those who did not complete or did < 70% of PR), n = 42 excluded those who did not complete or did < 70% of PR). • "The attendance rate was a median of 25 session (IQR: 20 to 28) in the PTR group and 16 session (IQR: 8 to 19) in the PR group and thus the exercise volume was a median of 750 min (IQR: 600 to 840) in the PTR group and 960 min (IQR: 480 to 1140) in the PR group. A significantly higher number of patients remained in the PTR programme for the full intervention period compared with the PR programme (PTR: 57/67 vs PR: 43/67; OR: 3.18 (95% CI: 1.37 to 7.35), p < 0.01). No difference could be shown between patients with and without missing outcome measurement on sex, all p values > 0.07. By contrast, the median age was significantly higher among patients with missing values for 6MWD, 30-STST, repetitions and CCQ mental score."
Selective reporting (reporting bias)	Unclear risk	• Trial registered prospectively (NCT02667171): Jan 28 2016 (recruitment March 2016-October 2017) PRIMARY OUTCOME: TRIAL REGISTRATION: Change in 6MWT [Time Frame: baseline (before intervention), after 10 weeks, after 22 weeks (average of 3 month follow up)] PAPER- methods: Briefly, the primary outcome was change in the 6MWD on completion of the programme. [PAPER PG 2] PAPER – reported: 6MWD (baseline, end rehab, 22 weeks from baseline) SECONDARY OUTCOMES: TRIAL REGISTRATION: baseline (before intervention), after 10 weeks, after 22 weeks (average of 3 month follow up) - Change in 30 second sit-to-stand test (30-STST); Change in PAL (ActivPAL – worn for 5 days); Change in CCQ; Change in CAT; Change in HADS; Change in EQ-5D. Total attendance in rehabilitation. Number of hospital admissions, number of hospital days, outpatient visits at hospital and GP, mortality [Time Frame: number of hospital admissions - after 10 weeks, after 22 weeks (average of 3 month follow up), after 36 weeks (average of 6 month follow up), after 62 weeks (average of 12 month follow up)] PAPER- methods: All assessment procedures were performed at baseline, end of intervention and at 22 weeks' follow-up from baseline. Secondary outcomes were CAT, HADS, EQ-5D, 30s STS, CCQ and PAL. Adverse events, hospitalisations and deaths were recorded throughout the trial by the National Health Data Authorities PAPER – reported: baseline, end rehab, 22 weeks from baseline 30 s STS, CAT, HADS, EQ-5D, CCQ, PAL; adherence. SUPPL MATERIAL: Hospital days (all cause and respiratory) – average/admission, total; outpatient visits 10 weeks and 22 weeks from baseline.
Other bias	Unclear risk	• More people failed to complete PR in the control group (n = 24 vs n = 10) • Telerehab intervention = 3x week for 10 weeks (weekly exercise volume 105 min; Conventional PR = 2 x week 10 weeks weekly exercise volume 120 min). • One of the control sites undertook 12 weeks of rehabilitation vs 10 weeks at all other sites

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Holland 2017

Study characteristics	
Methods	Randomised, controlled equivalence trial
Participants	PARTICIPANTS & SETTING: • Individuals with COPD referred for pulmonary rehabilitation at one of two tertiary hospitals in Melbourne, Australia. INCLUSION CRITERIA: • Diagnosis of COPD (FER < 0.70) • Current or former smoker with a minimum 10 pack-year history • Able to read and speak English • Able to provide informed consent EXCLUSION CRITERIA: • Diagnosis of asthma • Attended pulmonary rehabilitation within the last 2 years • Experienced an exacerbation of COPD within the last 4 weeks • Co-morbidities that prevent participation in an exercise training program CHARACTERISTICS: INTERVENTION GROUP: • n = 80 • Age mean (SD) 69 (13) years • 60% male (n = 48) • FEV_1 mean (SD) 52 (19) %predicted CONTROL GROUP: • n = 86 • Age 69 (10) years • 59% male (n = 51) • FEV_1 49 (19) %predicted
Interventions	INTERVENTION GROUP- home based pulmonary rehabilitation with telephone support • 8 week, home-based rehabilitation program • Initial home visit by a physiotherapist, followed by seven once-weekly structured telephone calls from a physiotherapist using a motivational interviewing approach. • Aerobic and resistance strength training program. Participants encouraged to exercise for 30 min five times/week. • Initial walking speed set at 80% of 6MWT speed. Resistance training for arms and legs utilised daily activities (e.g. sit-to-stand) and equipment readily available in the home (e.g. water bottles for upper limb weights). • Exercise program reviewed and progressed during weekly telephone calls; disease specific self-management addressed using structured telephone modules and menu of discussion topics for participants to choose from. CONTROL GROUP- traditional centre-based pulmonary rehabilitation • 8 week, supervised centre-based (outpatient) program

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Holland 2017 *(Continued)*

- 2 sessions/week including 30 min aerobic exercise plus resistance training and health professional delivery of education topics.
- Aerobic exercise training prescribed at 80% of the 6MWT speed (walking training) and 60% of the maximal work rate for cycling. Resistance training used functional activities.

Outcomes	ASSESSMENT TIMEPOINTS: • Baseline • End of 8-week intervention period • 12 months from completion of intervention PRIMARY OUTCOME: • Change in 6MWD from baseline to end intervention SECONDARY OUTCOMES: • At end rehabilitation - completion rate. • At end rehabilitation and 12 months, change in: CRQ, mMRC, PRAISE, HADS, physical activity ADHERENCE/COMPLETION: • Completion defined a priori as undertaking a minimum of 70% of planned pulmonary rehabilitation sessions ECONOMIC EVALUATION: • Economic evaluation including direct (health system) and indirect (personal) health care costs during the intervention and the 12 month follow up period (to be reported separately)
Notes	ETHICS APPROVAL • Alfred Hospital HREC, Austin Health HREC, La Trobe University FUNDING • Lung Foundation Australia/Boehringer Ingelheim COPD Research Fellowhsip; National Health and Medical Research Council (Australia) project grant 1046353. CONFLICT OF INTEREST • None declared CONTACT: Dr Anne E Holland; a.holland@alfred.org.au

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Low risk	• Participants were randomised to treatment groups ….. using a computer generated sequence …… concealed *using opaque envelopes*.(PAPER) • The sequence was generated by an individual unrelated to the study.(PAPER)
Blinding of participants and personnel (performance bias) All outcomes	High risk	PARTICIPANTS: • Due to nature of intervention not possible to blind participants PERSONNEL: • Due to nature of intervention not possible to blind personnel

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Holland 2017 *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	Low risk	• Assessments were performed by an individual blinded to group allocation, who had no involvement in provision of either intervention (PAPER) • Success of assessor blinding was evaluated after the 12-month assessment (PAPER) • At the end of the trial, the assessors correctly identified group allocation for 52% of participants (κ = 0.26), demonstrating the success of blinding (PAPER).
Incomplete outcome data (attrition bias) All outcomes	Low risk	• Of eligible patients who did not consent (n = 67), the majority (n = 54) wanted to undertake rehabilitation in a centre-based programme. (PAPER) • One hundred and sixty-six participants were randomised (n = 80 intervention; n = 86 centre-based PR control). • At the end of the intervention n = 73 followed up in the intervention group, n = 77 in the control group. • Similar reasons for failure to attend assessments/loss to follow up in both groups. • At the end of the trial, data were available for the primary outcome in 90% of the home-based group and 88% of the centre-based group. (PAPER) • All data were analysed by intention-to-treat analysis. (PAPER)
Selective reporting (reporting bias)	Low risk	• Trial registration August 25 2011 PRIMARY OUTCOME: • Trial registration: Change in 6MWD at end rehabilitation • Protocol: Change in 6MWD at end rehabilitation • Paper: Change in 6MWD at end rehabilitation SECONDARY OUTCOMES: • Trial registration: At end rehabilitation and 12 months, change in: CRQ, mMRC, cost effectiveness, SF36-V2, program completion rate. At 12 months, change in 6MWD. • Protocol: At end rehabilitation - completion rate. At end rehabilitation and 12 months, change in: CRQ, mMRC, SF36-V2, SF36-6D (for economic analysis), PRAISE, HADS, physical activity (objectively measured, in a subset of participants) • Paper: At end rehabilitation - completion rate. At end rehabilitation and 12 months, change in: CRQ, mMRC, PRAISE, HADS, physical activity
Other bias	Low risk	-

Knox 2019

Study characteristics	
Methods	Parallel group (controlled clinical) service evaluation trial
Participants	PARTICIPANTS & SETTING: • Individuals with COPD who fulfilled British Thoracic Society guidelines of suitability and safety to undergo pulmonary rehabilitation referred to centre-based pulmonary rehabilitation between September 2017 and April 2018 within the Hywel Dda University Health Board, Wales UK. INCLUSION CRITERIA: • Individual with moderate to severe COPD

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Knox 2019 *(Continued)*

- MRC breathlessness score greater than or equal to 3
- On optimal medications
- No exacerbation within 6 weeks

EXCLUSION CRITERIA:

- Not stated

CHARACTERISTICS:

INTERVENTION GROUP:

- n = 21
- Age mean (SD) 70 (10) years
- 33% female (n = 7)

CONTROL GROUP:

- n = 24
- Age mean (SD) 69 (13) years
- 58% female (n = 14)

Interventions	INTERVENTION GROUP - Telerehabilitation (Spoke) • Conducted in a rural village hall or community independent living centre • 6-8 participants/group, 2 sessions/week • 7 week program • Physiotherapy technician delivered exercise training component under supervision of staff from hub site via videoconferencing. • Education components delivered from Hub site via videoconferencing in real time. CONTROL GROUP - Centre-based pulmonary rehabilitation (Hub) • Hospital (centre-based) pulmonary rehabilitation • 7-10 participants/group, 2 sessions/week • 7 week program • Supervised exercise training for 1 to 1.5 hours followed by a 20 to 40min education session delivered by an OT, PT, respiratory nurse, dietitian or respiratory physician. • 1:1 sessions offered to participants relating to anxiety management, breathlessness control and breathing exercises.
Outcomes	ASSESSMENT TIMEPOINTS: • Baseline • End intervention PRIMARY OUTCOME: • Not specified ALL OUTCOMES: • HADS • MRC • CAT • ISWT
Notes	ETHICS APPROVAL • 'As this was a service evaluation, the authors did not seek research ethical approval'. [Paper pg 776]

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Knox 2019 *(Continued)*

FUNDING

- Not stated

CONFLICT OF INTEREST

- None declared

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Kwon 2018

Study characteristics

Methods	Randomised controlled trial
Participants	PARTICIPANTS & SETTING: • Individuals with COPD were recruited from outpatient clinics of 4 secondary or tertiary hospitals in Korea INCLUSION CRITERIA: • Age > 20 years • Post bronchodilator FEV_1 < 80% predicted • Ability to walk > 150 m on 6MWT • Android smartphone owner EXCLUSION CRITERIA: • Unable to follow the exercise regimen CHARACTERISTICS: INTERVENTION GROUP: Fixed Regimen • n = 27 • Age mean (SD) 64 (8) years • 85% male (n = 23) • FEV_1 mean (SD) 59 (16) %predicted • 6MWD 356 (98) m INTERVENTION GROUP: Interactive Regimen • n = 30 • Age mean (SD) 65 (7) years • 86% male (n = 26) • FEV_1 mean (SD) 57 (17) %predicted • 6MWD 392 (84) m CONTROL GROUP: • n = 28 • Age mean (SD) 64 (8) years • 75% male (n = 21) • FEV_1 mean (SD) 56 (15) %predicted

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Kwon 2018 *(Continued)*

	• 6MWD 356 (84) m
Interventions	INTERVENTION GROUP -Telerehabilitation Comprised 1 wearable pulse oximeter, 2 mobile apps (Android operating system version 4.4.4 and above) and 1 patient monitoring website. Apps were linked to the wearable pulse oximeter via Bluetooth with activity data (exercise compliance, heart rate, oxygen saturation) sent to the monitoring website. Mobile phone vibrates if oxygen saturation falls below 90% prompting participant to pause and rest. App contains audioguides and clickable links to provide guided resistance exercises. App includes a simple exercise diary. - Fixed regimen app • 12 weeks - fixed exercise regimen via app • 6 levels of walking distance - 600 m, 1200 m, 1800 m, 2400 m, 3000 m and 3600 m • When fixed walking distanced achieved in a day, for a total of 14 occasions, app increases walking distance to next level. - Interactive regimen app • Conforms to exercise recommendations of the Consensus Document on Pulmonary Rehabilitation in Korea 2015 • 12 weeks - 6 weeks fixed exercise regimen, then 6 weeks interactive exercise regimen via app. • 12 levels, using metronome in app to guide walking speed • Walking intensity set to 80% of maximum walking speed on 6MWT • Exercise progressed based on modified Borg scale - user records Borg score at the end of a walking session. When a score of less than or equal to 3 is recorded for 3 consecutive days, exercise intensity increases by 1 level. If a score of greater than or equal to 7 is recorded on 3 consecutive days the level goes down by 1. • When the final 12th walking level is reached, participant performs another 6MWT and walking intensity is readjusted to an initial level of 7. CONTROL GROUP - Daily activities without use of app
Outcomes	ASSESSMENT TIMEPOINTS: • Baseline • Week 6 of intervention • End intervention (week 12) PRIMARY OUTCOME: Change from baseline to 12 weeks in • mMRC • CAT • 6MWD
Notes	ETHICS APPROVAL: • The trial commenced in May 2017 and ended in December 2017 and was approved by the Institutional Review Board of each participating hospital FUNDING: • This study was supported by the Creative Industrial Technology Development Program (10053249, Development of Personalized Healthcare System Exploiting User Life-Log and Open Government Data for Business Service Model Proof on Whole Life Cycle Care) funded by the Ministry of Trade, Industry & Energy (Korea). CONFLICT OF INTEREST: • None declared

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Kwon 2018 *(Continued)*

CONTACT:

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Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Unclear risk	• Insufficient information • "A random allocation (1:1:1) within each center was moderated by an independent coordinator" [Paper]
Blinding of participants and personnel (performance bias) All outcomes	High risk	PARTICIPANTS: • Due to nature of intervention, unable to blind participants PERSONNEL: • Insufficient information • No details provided regarding blinding of personnel to group allocation
Blinding of outcome assessment (detection bias) All outcomes	High risk	• "..attempted to minimise further bias by blinding the person who obtained the primary endpoints or analysed the data" [Paper Pg 10]
Incomplete outcome data (attrition bias) All outcomes	High risk	• Dropout from baseline to 12 weeks (primary endpoint) 27% (n = 23) • More dropout in the fixed-exercise group n = 11 (41%) than other groups (fixed interactive n = 5, 17%; control n = 6, 21%) • What constitutes "withdrawal of consent" not clear
Selective reporting (reporting bias)	High risk	• Trial registered – retrospectively (trial registration 28/2/2018; study period May 15, 2017- Dec 28 2017) • No published protocol • One or more outcomes of interest in the review are reported incompletely so that they cannot be entered in a meta-analysis; PRIMARY OUTCOME: TRIAL REGISTRATION: change from baseline to week 12 (V3) for mMRC, CAT, 6MWD PAPER (methods): change of respiratory function parameters (6MWT, CAT mMRC) at visit 3 compared with baseline PAPER (reported): pre and post scores (Figure 8, graph) for CAT, mMRC and 6MWD. No change scores presented. No between group analysis presented. SECONDARY OUTCOMES: TRIAL REGISTRATION: Change from baseline to 12 weeks in objectively measured physical activity and Eq-5D-5L At 12 weeks: subject satisfaction with service; healthcare resource utilisation (the number of hospitalisation, duration of hospital stay, emergency room visits) (compared to same period last year) PAPER: No secondary outcomes reported
Other bias	Unclear risk	• Retrospective trial registration • Inclusion criteria: requirement to own an Android phone

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Kwon 2018 *(Continued)*

- Exclusion criteria: "patients who were unable to follow the exercise regimen were excluded from the screening process" [Paper pg 3]
- Control group - different descriptor between paper and trial registration:

PAPER: "the control group went on with their daily lives without using the app" [Pg 2]

Trial registration: "Ordinary rehabilitation service of the site"

Lahham 2020

Study characteristics	
Methods	Randomised controlled trial
Participants	PARTICIPANTS & SETTING: • People diagnosed with spirometrically defined mild COPD, identified through screening Respiratory Function and Pulmonary Rehabilitation databases at two tertiary hospitals in Melbourne, Australia. INCLUSION CRITERIA: • Mild COPD (FEV_1/FVC < 70%; FEV_1 > 80%predicted) • Age 40 years or older • Smoking history at least 10 pack years • No reported hospitalisation or exacerbation in the month before recruitment EXCLUSION CRITERIA: • Formal diagnosis of asthma • Comorbidities that preclude exercise training CHARACTERISTICS: INTERVENTION GROUP: • n = 29 • Age mean (SD) 68 (9) years • Male/Female(n) 17/12 • FEV_1 90 (8) %predicted CONTROL GROUP: • n = 29 • Age mean (SD) 67 (10) years • Male/Female (n) 17/12 • FEV_1 92 (7) %predicted
Interventions	INTERVENTION GROUP - home based pulmonary rehabilitation with telephone support • 8 week, home-based rehabilitation program • Initial home visit by a physiotherapist, followed by seven once-weekly structured telephone calls from a PT using a motivational interviewing approach. • Aerobic and resistance strength training program. Participants encouraged to exercise for 30 min five times/week. • Initial walking speed set at 80% of 6MWT speed. Resistance training for arms and legs utilised daily activities (e.g. sit-to-stand) and equipment readily available in the home (e.g. water bottles for upper limb weights).

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Lahham 2020 *(Continued)*

	• Exercise program reviewed and progressed during weekly telephone calls; disease specific self-management addressed using structured telephone modules and menu of discussion topics for participants to choose from. CONTROL GROUP - standard care • Advice to keep active and follow medication prescriptions • Eight once-weekly social phone calls to control for attention (enquiries regarding perceived general wellbeing, daily activity routine, and any need for additional support).
Outcomes	ASSESSMENT TIMEPOINTS: • Baseline • End of intervention • 6 month follow up after completion of intervention PRIMARY OUTCOME: • Change in 6MWD at end intervention and after 6 months SECONDARY OUTCOMES: • Change in: mMRC scale; CRQ; PAL (Sensewear armband) ADVERSE EVENTS: • Not stated ADHERENCE/COMPLETION: • Not defined
Notes	ETHICS APPROVAL • The Human Research Ethics Committees of the participating institutions approved this study. FUNDING • The Eirene Lucas Foundation and Institute for Breathing and Sleep CONFLICT OF INTEREST • None declared CONTACT: aroub.lahham@monash.edu

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Low risk	• "Participants were randomly allocated using a computer generated sequence that was concealed from researchers using an online database." (PAPER)
Blinding of participants and personnel (performance bias) All outcomes	High risk	PARTICIPANTS: • Due to nature of intervention not possible to blind participants PERSONNEL: • Due to nature of intervention not possible to blind personnel

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Lahham 2020 *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	Low risk	• "Outcomes were measured by an assessor who was blind to group allocation at baseline, 8 weeks from baseline and 6 months after completion of the intervention." (PAPER)
Incomplete outcome data (attrition bias) All outcomes	Low risk	• Of eligible people invited to participate (982 invitation letters sent), a total of 912 did not reply to the invitation letter. (PAPER) • 58 participants were randomised; n = 50 analysed for primary outcome (PAPER, Figure 1) • Loss to follow up n = 1 intervention; n = 3 control
Selective reporting (reporting bias)	Unclear risk	• Trial registered retrospectively (ACTRN12616000965404), registered 22/7/2016, recruitment period April 2015-January 2017 (PAPE) PRIMARY OUTCOME: • TRIAL REGISTRATION: Change in 6MWD from baseline to end intervention and 6 months following completion of intervention • PAPER: Changes from baseline in the primary outcome of 6MWD at end-intervention and 6 months. SECONDARY OUTCOMES: • TRIAL REGISTRATION: change in HRQoL (chronic respiratory disease questionnaire); change in physical activity (Sensewear armband); change in MMRC dyspnoea scale. (All baseline to end intervention and 6 months following) • PAPER: change in mMRC, HRQoL (CRQ), PAL (Sensewear armband). All outcomes reported: Table 2 and Table 3 [PAPER]
Other bias	Low risk	-

Maltais 2008

Study characteristics	
Methods	Parallel-group, randomised, non-inferiority multi-centre trial
Participants	PARTICIPANTS & SETTING: • Individuals with COPD from pulmonary clinics of participating centres (Hopital Laval, Montreal Chest Institute, Queen Elizabeth II Health Sciences Centre, Centre Hospitalier Universitaire Associe de Quebec, Mount Sinai Hospital, Hopital Sacre-Coeur, Jewish Rehabilitation Hospital, Hotel-Dieu de Levis, St Paul's Hospital, Centre Hospitalier Baie-des-Chaleurs). INCLUSION CRITERIA: • Stable COPD (no change in symptoms for 4 weeks) • Age 40 years or older • Current or former smoker of at least 10 pack-years • FEV_1 < 70% predicted • FEV_1/FVC ratio < 0.70 • MRC 2 to 5 EXCLUSION CRITERIA: • Diagnosis of asthma • Congestive left heart failure as the primary disease

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Maltais 2008 *(Continued)*

- A terminal disease
- Dementia or an uncontrolled psychiatric illness

CHARACTERISTICS:

INTERVENTION GROUP:

- n = 126
- Age mean (SD) 66 (9) years
- 54% male (n = 68)
- FEV_1 46 (13) %predicted

CONTROL GROUP:

- n = 126
- Age 66 (9) years
- 57% male (n = 72)
- FEV_1 43 (13) %predicted

Interventions	All participants undertook 4 weeks (2 sessions per week) of centre-based health professional delivered education prior to randomisation. INTERVENTION GROUP - home-based pulmonary rehabilitation with weekly telephone contact • Self monitored • 3 sessions/week for 8 weeks • Initial home-visit from exercise specialist, then weekly telephone call to reinforce exercise and detect problems • Aerobic and strength training - cycle ergometer (provided for 8 weeks) at a target intensity of 60% of maximum work rate on peak exercise capacity test for 40 min, three times/week; strength training for 30 min commencing with 1 set of 10 repetitions for a maximum of 3 sets, resistance increased using elastic bands, sand bags and weights against gravity. • Follow-up maintenance period included a phone call every 2 months to reinforce mastery of intended behaviour. Maintenance period did not include supervised exercise training. CONTROL GROUP - centre-based (outpatient) pulmonary rehabilitation • 3 sessions/week for 8 weeks • Aerobic and strength training - cycle ergometer at a target intensity of 80% of maximum work rate on peak exercise capacity test for 25-30 min at each session; strength training for 30 min commencing with one set of 10 repetitions for a maximum of 3 sets, resistance increased using elastic bands, sand bags and weights against gravity. • Exercise training supervised by a qualified exercise specialist in a ratio of 4 to 5 participants for one trainer. • Follow-up maintenance period included a phone call every two months to reinforce mastery of intended behaviour. Maintenance period did not include supervised exercise training.
Outcomes	ASSESSMENT TIMEPOINTS: • Baseline • End of intervention • 12 months after study enrolment PRIMARY OUTCOME: • CRQ Dyspnoea score at 12 months SECONDARY OUTCOMES: • CRQ domains; SGRQ; 6MWD; ECT.

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Maltais 2008 *(Continued)*

	ADVERSE EVENTS: • Participants kept a weekly diary card for the 8-week exercise intervention, and a monthly card during the follow up maintenance phase, to record medical events (COPD exacerbations, hospitalisation etc). • Serious adverse event defined as death or hospitalisation for any cause. • Adverse events asked about throughout the study during standardised telephone calls.
Notes	ETHICS APPROVAL • Not specified FUNDING • Canadian Institutes of Health Research (MCT-63162) and the Respiratory Health Network of the Fonds de la recherche en sante du Quebec. CONFLICT OF INTEREST • None disclosed CONTACT: Dr Francois Maltais; francois.maltais@med.ulaval.ca

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Low risk	• Neither research staff nor patients were aware of treatment assignments before patients received them. We used a centrally administered, computer-generated permuted block randomisation scheme using blocks of 2, stratified according to sex and participating site. We communicated assignments by e-mail to research staff who were not otherwise involved in the trial. The case manager subsequently informed patients of their group allocation. Study personnel were unaware of the permuted block size. (PAPER)
Blinding of participants and personnel (performance bias) All outcomes	High risk	PARTICIPANTS: • Due to nature of intervention not possible to blind participants PERSONNEL: • Due to nature of intervention not possible to blind personnel
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Adverse event reporting = LOW RISK • An independent research assistant, unaware of the patient's group assignment, conducted a standardized telephone interview every 4 weeks to identify adverse events (PAPER) All other outcomes = UNCLEAR RISK • Insufficient information. • The study was unblinded, and its primary outcome was self-reported.(PAPER) • Trials registration notes single blinded (investigator
Incomplete outcome data (attrition bias) All outcomes	Low risk	• Missing outcome data balanced in numbers across groups, similar reasons for missing data. • n = 126 participants in both outpatient PR group (control) and home-based PR group (intervention)

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Maltais 2008 *(Continued)*

		• At 3 months outpatient PR (control) n = 114, home based PR group (intervention) n = 119 • At 1 year outpatient PR (control) n = 109, home based PR group (intervention) n = 107.
Selective reporting (reporting bias)	Unclear risk	• Trial registration September 15 2005 PRIMARY OUTCOME: • Trial registration: CRQ Dyspnoea at 12 months • Paper: CRQ Dyspnoea at 12 months SECONDARY OUTCOMES: • Trial registration: [at 4 months] CRQ; 6MWD; Submaximal exercise test; ADL (not defined). Health service utilisation over 12 months. Intervention cost. • Paper: (at 3 months) CRQ; SGRQ; 6MWD; ECT.
Other bias	Unclear risk	• Difference between inclusion criteria on trial registration (6MWD >110 m) and noted in paper (criteria related to 6MWD not noted in paper). • Planned to assign 240, but assigned 256 (PAPER) • Lower training intensity but longer session duration for home based group (PAPER) • 2 centres with no previous experience of delivering pulmonary rehabilitation (PAPER)

Stickland 2011

Study characteristics	
Methods	Parallel group (controlled clinical) non-inferiority trial
Participants	PARTICIPANTS & SETTING: • Individuals with COPD referred to standard pulmonary rehabilitation at the Centre for Lung Health, Edmonton, Alberta, Canada or to Telehealth-PR a their local health centre (within one of nine small communities in central and northern Alberta). INCLUSION CRITERIA: • Diagnosis of COPD confirmed by lung function testing • Suitable for enrolment in pulmonary rehabilitation EXCLUSION CRITERIA: • Unstable cardiovascular disease • Dementia CHARACTERISTICS: INTERVENTION GROUP: Telehealth-PR • n = 147 • Age mean(SD) 69.2 (8.6) years • 53% male (n = 78) COMPARISON GROUP: Standard, centre-based PR • n = 262

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Stickland 2011 *(Continued)*

- Age 69.5 (9.7) years
- 44% male (n = 125)

Interventions	INTERVENTION GROUP: Telehealth-PR • Two sessions week/ 8 weeks within local community • Group exercise for 2 hours plus 1 hour education • Typically 2-6 patients per site • Exercise program, including aerobic exercise (walking track or treadmill; cycle and arm ergometer) and resistance training (hand weights, elastic bands), flexibility and breathing retraining. • Exercise training supervised by a healthcare professional • Education sessions delivered to local sites via videoconferencing COMPARISON GROUP: Standard centre-based pulmonary rehabilitation • Two sessions week/ 8 weeks within local community • Group exercise for 2 hours plus 1 hour education • Typically 8 to 12 patients per site • Exercise program, including aerobic exercise (walking track or treadmill; cycle and arm ergometer) and resistance training (hand weights, elastic bands), flexibility and breathing retraining. • Exercise training supervised by a healthcare professional • Education sessions delivered in person
Outcomes	ASSESSMENT TIMEPOINTS: • Baseline (before pulmonary rehabilitation) • At the end of the pulmonary rehabilitation intervention • At 6 month follow up PRIMARY OUTCOME: • Change in SGRQ total score at end rehabilitation SECONDARY OUTCOMES: • 12 minute walk distance
Notes	ETHICS APPROVAL • University and Hospital ethics approval was obtained FUNDING • Alberta Health Services Telehealth Clinical Grant Fund and Covenant Health Research Foundation CONFLICT OF INTEREST • Dr Stickland: funded by the Canadian Institutes of Health Research New Investigator award; speaking honoraria from GlaxoSmithKline. • Dr Wong: speaking honoraria from AstraZeneca, GlaxoSmithKline, Pfizer and Boehringer Ingelheim. CONTACT: Dr Michael Stickland; michael.stickland@ualberta.ca

Tabak 2014

Study characteristics

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Tabak 2014 *(Continued)*

Methods	Randomised controlled trial
Participants	PARTICIPANTS & SETTING: • Individuals with COPD meeting recruitment criteria for COPE II study from the pulmonary medicine outpatient department of Medisch Spectrum Twente Hospital, Enschede, The Netherlands. INCLUSION CRITERIA: • Diagnosis of COPD according to the GOLD criteria • No exacerbation in the month before enrolment • 3 exacerbations, defined as respiratory problems that required a course of oral corticosteroids and/or antibiotics, or 1 hospitalisation for respiratory problems in the 2 years preceding study entry • (ex) smoker • Age 40 to 75 years • Post-bronchodilator FEV_1 25 to 80% predicted • Able to understand and read Dutch • Have a computer with Internet access at home • Written informed consent from the subject prior to participation EXCLUSION CRITERIA: • Serious other disease with a low survival rate • Other diseases influencing bronchial symptoms and/or lung function (e.g. cardiac insufficiency, sarcoidosis) • Severe psychiatric illness • Uncontrolled diabetes mellitus during a COPD exacerbation in the past or a hospitalisation for diabetes mellitus in the 2 years preceding the study • Need for regular oxygen therapy (16 hours/day or oxygen tension 7.2 kPa) • Maintenance therapy with antibiotics • Known Alpha1- antitrypsin deficiency • Disorders or progressive disease seriously influencing walking ability (e.g., amputation, paralysis, progressive muscle disease) CHARACTERISTICS: INTERVENTION GROUP: Telehealth program • n = 12 • Age mean (SD) 64.1 (9.0) years • 50% male (n = 6) • FEV_1 median [IQR] 50 [33.3 to 61.5] %predicted CONTROL GROUP: Usual care • n = 12 • Age 62.8 (7.4) years • 50% male (n = 6) • FEV_1 median [IQR] 36.0 [26.0 to 53.5] %predicted
Interventions	INTERVENTION GROUP: Telehealth program Technology supported care program - Condition Coach, comprising: • Web based exercise program on the web portal - including breathing exercises, relaxation, mobilisation, resistance and endurance training and mucus clearance.

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Tabak 2014 *(Continued)*

	• Activity coach for ambulant activity registration and real-time feedback to improve daily activity - an accelerometer-based activity sensor and a smartphone able to show cumulative activity graphically. Participants received motivational cues/messages for awareness and motivation. • Self-management module on the web portal to allow participants to treat exacerbations themselves, without intervention of a healthcare professional. Participants completed 2 x 90 min self management training sessions prior to the intervention and completed a daily diary via the web-portal which incorporated a decision support tree to advise in the case of worsening clinical condition. • Teleconsultation with the patient's primary care physiotherapist via the web portal. • 9 month intervention period CONTROL GROUP: Usual care • In the event of impending exacerbation, participants to contact their medical doctor as usual. • Patients in the usual care group were allowed to attend regular physiotherapy sessions if this was prescribed as part of usual care
Outcomes	ASSESSMENT TIMEPOINTS: • T0 (inclusion), T1 (1 month), T2 (3 months), T3 (6 months) and T4 (9 months) OUTCOMES: • Number of hospitalisations • Length of stay • Emergency department visits • Exacerbations • Physical activity levels (activity sensor) and Baecke Physical Activity Questionnaire • Exercise tolerance (6MWT) • Fatigue (Multidimensional Fatigue Inventory 20) • Health status (Clinical COPD Questionnaire) • Dyspnoea (MRC) • Quality of life (EuroQol-5D). ADHERENCE/COMPLETION: • Use of the application • Adherence to the online diary by dividing the number of diary fill-outs by the number of treatment days • Adherence to the exercise scheme by dividing the number of schemes prescribed by the number performed NON-CLINICAL OUTCOMES: • satisfaction with received care (Client Satisfaction Questionnaire 8)
Notes	ETHICS APPROVAL • Twente Medical Ethical Committee FUNDING • None declared CONFLICT OF INTEREST • None declared CONTACT: Dr Monique Tabak; m.tabak@utwente.nl

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Tabak 2014 *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Low risk	• Participants were allocated by a data manager in order of inclusion following the randomisation list, placed in a sealed envelope. (PAPER)
Blinding of participants and personnel (performance bias) All outcomes	High risk	PARTICIPANTS • Due to nature of intervention, blinding of participants not possible PERSONNEL • Due to nature of intervention, blinding of personnel not possible
Blinding of outcome assessment (detection bias) All outcomes	Unclear risk	Not stated
Incomplete outcome data (attrition bias) All outcomes	High risk	• As this was a miniature randomised controlled trial without power analysis, no statistical tests were performed. (PAPER) • Sample size was based upon the estimated number of patients that could be included within the recruitment period and the availability of technology. (PAPER) • Although 101 patients fulfilled the COPE II study criteria, only 29 patients (29%) were able and willing to participate. (PAPER) • Intervention n = 15; Control n = 14 at baseline. At T4 (month 9) Intervention n = 10; Control n = 2. (Figure 2, PAPER) • The reason for not participating was that patients did not fulfil the additional criterion of having a computer with Internet access at home. (PAPER) • A large number of patients were not able or willing to continue study participation: 33% in the intervention group and 86% in the control group. (PAPER)
Selective reporting (reporting bias)	High risk	TRIAL REGISTRATION: • Primary outcome: Evaluated… in terms of use of the application (registered by system), satisfaction with the application, satisfaction with received care, and quality of care. • Secondary outcomes: Exacerbations (number, duration); amount of activity; exercise tolerance; fatigue; health status and symptoms quality of life. PAPER: • Outcomes as specified in methods (primary outcome not distinguished). • Use of the application; adherence to the online diary; adherence to the exercise scheme; satisfaction with received care (Client Satisfaction Questionnaire 8); number of hospitalisations; length of stay; emergency department visits; exacerbations; activity sensor of the activity coach was used for registration of activity levels; Baecke Physical Activity Questionnaire; exercise tolerance (6MWT); fatigue (Multidimensional Fatigue Inventory 20); health status (CCQ); dyspnoea (MRC); HRQoL(EuroQol-5D).
Other bias	Unclear risk	• As this was a miniature randomised controlled trial without power analysis, no statistical tests were performed. (PAPER) • Sample size was based upon the estimated number of patients that could be included within the recruitment period and the availability of technology (PAPER)

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Tabak 2014 *(Continued)*

- Outcome measures administered at T0 (inclusion), T1 (1 month), T2 (3 months), T3 (6 months) and T4 (9 months) - clinical measures data only reported at T0, T1 and T2.

Tsai 2017

Study characteristics	
Methods	Randomised controlled trial, parallel group
Participants	PARTICIPANTS & SETTING: • Individuals with a primary diagnosis of COPD referred to a tertiary hospital pulmonary rehabilitation program in Sydney, Australia. INCLUSION CRITERIA: • Stable COPD (FER < 70% and FEV_1 < 80% predicted post-bronchodilator) • Can operate a computer independently (following training) with adequate hearing and eyesight • Weighs less than 150 kg due to the weight limit of the bike • Uses a stationary exercise cycle independently • Has adequate space in the home for a stationary lower limb cycle ergometer and a walking course • Has a walking course of at least 8 m long measured by a physiotherapist using a trundle wheel • Can mobilise independently without a walking frame EXCLUSION CRITERIA: • Participated in any exercise program in the last 12 months • Been admitted to hospital for an acute exacerbation of COPD in the last two months • Cognitive impairment (Mini Mental State Examination score < 24) • Unstable cardiac or neurological disease • On home oxygen therapy • Unable to understand English • Lived in an area without adequate internet coverage CHARACTERISTICS: INTERVENTION GROUP (home-based telerehabilitation with video-conferencing): • n = 19 • Age mean (SD) 73 (8) years • 63% male (n = 12) • FEV_1 60 (23) %predicted CONTROL GROUP (no rehabilitation): • n = 17 • Age 75 (9) years • 35% male (n = 6) • FEV_1 68 (19) %predicted
Interventions	INTERVENTION GROUP - home-based telerehabilitation using video-conferencing • Supervised group exercise training • 3 sessions/week for 8 weeks • Up to 4 participants exercising remotely at home using real time desktop video conferencing.

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Tsai 2017 *(Continued)*

- Participants could see and talk to each other and the physiotherapist
- Session comprised: Warm up - 5 min cycle ergometer; cardiovascular exercise - 15 to 20 min cycle ergometer (initial prescription 60 to 80% of peak work rate from 6MWT using an algorithm; progression in increments of 5 watts based on symptoms (BORG dyspnoea and RPE)), 15-20 min walking training (initial prescription 80% of best 6MWD; progression based on symptoms); LL strengthening exercises - sit-to-stand 3 x 10 repetitions, squats 3 x 10 repetitions.

CONTROL GROUP - no rehabilitation

- Usual medical management
- Provided with an action plan
- No exercise training

Outcomes

ASSESSMENT TIMEPOINTS:

- Baseline
- End intervention

PRIMARY OUTCOME:

- Endurance exercise capacity (ESWT)

SECONDARY OUTCOMES:

- Peak exercise capacity (ISWT); functional exercise capacity (6MWD); PA (objective- EE, step count, PAL, PA duration, PA intensity; subjective-FPI-SF); HRQoL (CRQ); dyspnoea (mMRC); anxiety and depression (HADS); health status (CAT); self efficacy (PRAISE); patient satisfaction (CSQ-8).

COMPLIANCE:

- Recorded as the number of completed exercise training sessions as prescribed out of a possible 24 sessions

Notes

ETHICS APPROVAL

- South Eastern Sydney Local Health District Human Research Ethics Committee (12/177)

FUNDING

- NSW Agency for Clinical Innovation (ACI) NSW, Australia and South Eastern Local Health District Chronic Care Service Redesign Grant, NSW Australia

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Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Low risk	• ….and concealed allocation to one of the two groups (PAPER) • using a central randomisation process by phone ….i.e. external to investigators with concealed allocation) (TRIAL REGISTRATION)
Blinding of participants and personnel (performance bias) All outcomes	High risk	PARTICIPANTS: • Unable to blind participants due to nature of intervention PERSONNEL: • Unable to blind intervention personnel due to nature of intervention

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Tsai 2017 *(Continued)*

Blinding of outcome assessment (detection bias) All outcomes	Low risk	• Blinded (masking used) (TRIAL REGISTRATION –type not specified) • blinded (assessor and statistician) RCT (PAPER) • measurements, which were performed by a research assistant who was blind to group allocation. (PAPER)
Incomplete outcome data (attrition bias) All outcomes	Low risk	• Of the 128 consecutive patients referred to PR with COPD, 37 were enrolled in the trial (Fig. 1 PAPER). Thirty-six participants completed the study as there was one death from an adverse reaction to a medication unrelated to the study. (PAPER) • Randomised, n = 20 telerehab, n = 17 control. Baseline data n = 19 telerehab, n = 17 control. Final assessment n = 19 telerehab, n = 17 control. Included in analysis n = 19 telerehab, n = 17 control.
Selective reporting (reporting bias)	Low risk	• Trial registration published prospectively (ACTRN12612001263886) registered 3/12/2012. • Recruitment commenced 24/3/2014 PRIMARY OUTCOME: • TRIAL REGISTRATION: Endurance exercise capacity (ESWT) • PAPER: Endurance exercise capacity (ESWT) SECONDARY OUTCOMES: • TRIAL REGISTRATION: Peak exercise capacity (ISWT); Functional exercise capacity (6MWD); PA (objective- Sensewear armband- EE and step count; subjective-FPI-SF); Quality of life (CRQ); Dyspnoea (mMRC); Anxiety and Depression (HADS); Health status (CAT); Self efficacy (PRAISE); Patient satisfaction (CSQ-8). • PAPER: Peak exercise capacity (ISWT); Functional exercise capacity (6MWD); PA (objective- EE, step count, PAL, PA duration, PA intensity; subjective-FPI-SF); Quality of life (CRQ); Dyspnoea (mMRC); Anxiety and Depression (HADS); Health status (CAT); Self efficacy (PRAISE); Patient satisfaction (CSQ-8). • Intention-to-treat analysis was conducted with no imputation of missing values. Analysis of covariance (ANCOVA) was used to conduct between-group comparisons of outcomes after adjusting for pre-intervention values. (PAPER)
Other bias	Unclear risk	• Additional secondary outcomes added to trial registration 23/9/2014 (semi-structured interview, intervention group; telerehabilitation participant survey; occupant survey on telerehabilitation) - not reported in paper.

Vasilopoulou 2017

Study characteristics	
Methods	Randomised controlled trial
Participants	PARTICIPANTS & SETTING: • Individuals with clinically stable COPD attending the outpatient respiratory clinic at Athens University Medical School at Sotiria General Chest Hospital, Athens, Greece. INCLUSION CRITERIA: • Age older than 40 years • Diagnosis of COPD (FEV_1/FVC < 0.70; FEV_1 %predicted < 80)

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Vasilopoulou 2017 *(Continued)*

- On optimal medical treatment without regular use of systemic corticosteroids
- History of acute exacerbation of COPD in year prior to study
- Able to provide informed consent

EXCLUSION CRITERIA:

- Diagnosis of orthopaedic, neurological and other conditions that significantly impair exercise tolerance
- Diagnosis of respiratory disorders other than COPD
- Cognitive impairment and/or difficulties to manage electronic devices that precluded interactions with the tablet
- Patients not on optimal pharmacotherapy

CHARACTERISTICS:

INTERVENTION GROUP: Home maintenance telerehabilitation

- n = 47
- Age mean (SD) 66.9 (9.6) years
- 94% male (n = 44)
- FEV_1 49.6 (21.9) %predicted

COMPARISON GROUP: Hospital maintenance rehabilitation

- n = 50
- Age 66.7 (7.3) years
- 76% male (n = 38)
- FEV_1 51.8 (17.3) %predicted

CONTROL GROUP: No rehabilitation usual care

- n = 50
- Age 64.0 (8.0) years
- 74% male (n = 37)
- FEV_1 51.7 (21) %predicted

Interventions	Participants in both exercise intervention groups undertook a 2 month outpatient primary pulmonary rehabilitation before commencing the 12 months maintenance follow up intervention. Participants randomised to the usual care control group did not receive any exercise intervention. INTERVENTION GROUP: Home maintenance telerehabilitation • 144 sessions over 12 months • Individualised action plan; physical exercise sessions with remote monitoring; access to a call centre 5 days/week; psychological support; dietary and self-management support via weekly contacts with a physiotherapist, exercise scientist, dietician and physician using telephone or video conference. • Monitoring of physiological parameters and transmission of data collected and sent via patients 3 times/week. Daily step count, spirometry, oximetry and responses to questionnaires recorded and transmitted twice weekly. • Exercise program comprised arm and leg exercise and walking - individually tailored to each participant. COMPARISON GROUP: Hospital maintenance rehabilitation • Multidisciplinary maintenance rehabilitation program including exercise training, PT, dietary and psychological advice. • Two sessions/week for 12 months (total 96 sessions) CONTROL GROUP: No rehabilitation, usual care

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Vasilopoulou 2017 *(Continued)*

- Optimal pharmacotherapy, oxygen therapy in the presence of respiratory failure, vaccination for Streptococcus pneumonia, annual vaccination for influenza, regular follow up by respiratory physician according to guidelines.
- Training in the early recognition of acute exacerbation COPD.

Outcomes	ASSESSMENT TIMEPOINTS: • Baseline • End of centre-based primary pulmonary rehabilitation program (or corresponding time point for usual care control group) • 12 months PRIMARY OUTCOME: • Rate of moderate to severe acute exacerbation of COPD, hospitalisations because of acute exacerbation of COPD and ED visits SECONDARY OUTCOMES: • Spirometry; Incremental exercise capacity (peak work rate cycle ergometer); functional exercise capacity (6MWD); daily physical activity (actigraph- time spent in different intensity activity); HRQoL and symptoms (SRGQ, CAT; mMRC). ADHERENCE/COMPLETION: • Adherence to exercise training calculated as actual number of sessions/total expected number of sessions x 100 • Adherence to data transmission (physiological monitoring, questionnaires etc) calculated as number of registrations entered divided by the number of those recommended.
Notes	ETHICS APPROVAL • Scientific Board of Clinical Studies at Sotiria Hospital approval number 22964 FUNDING • Co-financed by Greece (General Secretariat for Research and Technology) and the European Union via the National Strategic Reference Framework (NSRF 2007-2013; Competitiveness and Entrepreneurship) CONFLICT OF INTEREST • Dr. Kostikas reports personal fees and other from Novartis, during the conduct of the study; personal fees from Astra Zeneca, personal fees from Boehringer Ingelheim, personal fees from Chiesi, personal fees from ELPEN, personal fees from Novartis, personal fees from Takeda, outside the submitted work. CONTACT: Prof Ioannis Vogiatzis; ioannis.vogiatzis@northumbria.ac.uk

Risk of bias

Bias	Authors' judgement	Support for judgement
Allocation concealment (selection bias)	Unclear risk	• Method of concealment not described
Blinding of participants and personnel (performance bias) All outcomes	High risk	PARTICIPANTS: • Masking: None (Open Label) (TRIAL REGISTRATION) • Unable to blind participants due to nature of intervention

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Vasilopoulou 2017 *(Continued)*

		• Importantly, patients were given general information about their participation in the study and details on the interventions related only to their intervention arm.(PAPER) PERSONNEL: • Masking: None (Open Label) (TRIAL REGISTRATION) • Unable to blind personnel due to nature of intervention • Our study design was not blinded, and as such the investigators were aware of the allocation of patients into the different maintenance rehabilitation groups.(PAPER)
Blinding of outcome assessment (detection bias) All outcomes	High risk	• Masking: None (Open Label) (TRIAL REGISTRATION) • Moreover, the choice of objective endpoints that were related to healthcare resource use (moderate or severe acute exacerbations of COPD, hospitalisations and ED visits) minimises to the best possible extent potential biases.(PAPER)
Incomplete outcome data (attrition bias) All outcomes	Low risk	• n = 150 COPD patients were randomised into three groups……(PAPER) • During the 2-month primary PR programme, three patients from group A were discontinued from the study because of transport barriers. (PAPER) • T3 (14months from baseline) Group A (home maintenance telerehabilitation) n = 47; Group B (hospital maintenance rehabilitation) n = 50; Group C (control) n = 50 (Figure 1, PAPER). • All participants who entered the maintenance rehabilitation phase at T2 were followed up at T3 (Figure 1, PAPER).
Selective reporting (reporting bias)	Unclear risk	• Trial registered retrospectively. PRIMARY OUTCOME: • Trial registration: Number of exacerbations (at 12 months) • Paper: The primary end-point was the rate of moderate to severe acute exacerbation of COPD, hospitalisations because of acute exacerbation of COPD and ED visits. SECONDARY OUTCOMES: • Trial registration: Functional capacity (6MWT); Number of visits to Emergency Outpatient Clinic; Daily PA (accelerometry); Quality of life and symptoms (questionnaires). • Paper: Spirometry; Incremental exercise capacity (peak work rate cycle ergometer); Functional exercise capacity (6MWD); Daily PA (actigraph- time spent in different intensity activity); HRQoL and symptoms (SRGQ, CAT, mMRC)
Other bias	Unclear risk	• Trial registered December 2015; final collection of primary outcome July 2015; Trial recruitment commenced 2013.(TRIAL REGISTRATION) • Patients were also excluded on grounds of cognitive impairment and/or difficulties to managing electronic devices that precluded interactions with the tablet, as judged by the investigator.(PAPER) • To compensate for a potential dropout rate of 20%, a total sample size of 138 patients (46 patients in each group) was determined to be sufficient.(PAPER) Total randomised 150. • During the period spanning from December 2013 to July 2015, patients in groups A and B initially completed a multidisciplinary intense hospital-based, outpatient, PR programme lasting for 2 months (supplementary material [18]), which was followed by a 12-month maintenance rehabilitation programme at home (group A) or at hospital (group B). Patients in group

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Vasilopoulou 2017 *(Continued)*	C followed the usual care treatment throughout the 14-month period, without participation to either the 2-month primary or the 12-month maintenance programmes (figure 1). In Greece, only few university medical departments deliver PR. Hence, the majority of COPD patients follow usual care only….(PAPER)

6MWD: 6-minute walk distance; 6MWT: 6-minute walk test; BCKQ: Bristol COPD Knowledge Questionnaire; CAQ: COPD Anxiety Questionnaire; CAT: COPD Assessment Test; CCQ: Clinical COPD Questionnaire; CHF: congestive heart failure; COPD: chronic obstructive pulmonary disease; CRP: C-reactive protein; CRQ: Chronic Respiratory disease Questionnaire; CSQ-8: Client Satisfaction Questionnaire 8; ECG: electro cardiograph; ECT: endurance cycle time; ED: emergency department; EE: energy expenditure; EQ-5D: EuroQol 5-Dimension Questionnaire; ESWT: Endurance Shuttle Walk Test; FEV_1: forced expiratory volume in one second; FPI-SF: Functional Performance Inventory – Short Form; FVC: forced vital capacity; GOLD: Global initiative for obstructive lung disease; HADS: Hospital Anxiety and Depression Scale; HRQoL: health related quality of life; IG: intervention group; IQR: interquartile range; ISWT: Incremental Shuttle Walk Test; ITT: intention to treat; LL: lower limb; m: metres; min: minutes; MLHFQ: Minnesota Living with Heart Failure Questionnaire; MRC: Medical Research Council dyspnoea scale; mMRC: modified Medical Research Council dyspnoea scale; NHS: National Health Service; NICE: National Institute for health and Care Excellence; NT: nursing; NYHA: New York Heart Association; OT: occupational therapist; PA: physical activity; PAL: physical activity level; PASE: physical activity scale for the elderly; PP: per protocol; PR: pulmonary rehabilitation; PRAISE: Pulmonary Rehabilitation Adapted Index of Self Efficacy; PTR: pulmonary telerehabilitation; PT: physiotherapist; RCT: randomised controlled trial; RM: repetition maximum; SD: standard deviation; SF36-v2: Medical Outcomes Survey Short-form 36-v2; SGRQ: St George's respiratory questionnaire; SMS: short messaging service; STS: sit-to-stand; TUG: timed up and go; UC: usual care; UL: upper limb; VAS: visual analogue scale

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Ahmed 2011	Wrong intervention
Ahmed 2016	Wrong intervention
Ancochea 2018	Wrong intervention
Anonymous 2009	Wrong intervention
Arbillaga-Extarri 2018	Wrong intervention
Aymerich 2016	Wrong intervention
Barnes 2016	Wrong intervention
Bender 2015	Wrong intervention
Bhatt 2019	Wrong intervention
Broadbent 2018	Wrong intervention
Burkow 2015	Wrong intervention
Cameron-Tucker 2014	Wrong intervention
Cameron-Tucker 2016	Wrong intervention
Coultas 2014	Wrong intervention
Coultas 2018	Wrong intervention

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Study	Reason for exclusion
Demeyer 2015	Wrong intervention
Demeyer 2017	Wrong intervention
Dinesen 2012	Wrong intervention
Feng 2018	Wrong intervention
Gaeckle 2016	Wrong intervention
Hamir 2010	Wrong intervention
Hoaas 2016	Wrong intervention
Hornikx 2014	Wrong intervention
Hornikx 2015	Wrong intervention
Horton 2014	Wrong intervention
Jackson 2015	Wrong intervention
Jansen-Kosterink 2011	Wrong intervention
Kaliaraju 2017	Wrong study design
Liu 2008	Wrong comparator
Loeckx 2015	Wrong intervention
Loeckx 2016	Wrong intervention
Martinez 2014	Wrong intervention
Martinez 2014a	Wrong intervention
Mazzoleni 2014	Wrong intervention
Mitchell 2013	Wrong intervention
Moreau 2008	Wrong intervention
Morso 2017	Wrong study design
Moy 2014	Wrong intervention
Moy 2015	Wrong intervention
Moy 2015a	Wrong intervention
Moy 2015b	Wrong intervention
Moy 2016	Wrong intervention
Napolitano 2002	Wrong intervention

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Study	Reason for exclusion
NCT00512837	Wrong intervention
NCT00563745	Wrong intervention
NCT00752531	Wrong intervention
NCT01724684	Wrong intervention
NCT01987544	Wrong intervention
NCT02085187	Wrong intervention
NCT03489642	Wrong study design
Nguyen 2009	Wrong comparator
North 2018	Wrong intervention
NTR3365	Wrong study design
Nyberg 2019	Wrong intervention
Reguera 2017	Wrong intervention
Ries 2003	Wrong intervention
Ringbaek 2016	Wrong intervention
Rosenbek 2015	Wrong intervention
Segrelles 2012	Wrong intervention
Soriano 2018	Wrong intervention
Stenlund 2019	Wrong intervention
Tabak 2014a	Wrong intervention
Tabak 2014b	Wrong intervention
Talboom-Kamp 2019	Wrong study design
Voncken-Brewster 2015	Wrong patient population
Vorrinck 2016	Wrong intervention
Wan 2017	Wrong intervention
Wootton 2017	Wrong intervention
Yorke 2012	Wrong study design

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Characteristics of studies awaiting classification *[ordered by study ID]*

Benzo 2020

Methods	Randomised
Participants	People with COPD
Interventions	Intervention: Home-based pulmonary rehabilitation including activity tracker, oximeter and a computer tablet. Control group: no intervention
Outcomes	• CRQ • Self-management ability scale (SMAS-30) • Working Alliance Inventory – Short Revised • Physical activity (actigraph monitor)
Notes	Additional details of intervention required to determine eligibility.

Iturri 2018

Methods	Randomised controlled trial
Participants	Participants: People with COPD
Interventions	Intervention: Telerehabiliation Telemedicine: Maintenance Respiratory Rehabilitation supported by telemedicine for 12 months. Control: No intervention
Outcomes	At baseline and 12 months • 6MWD • CRQ • SF36 • BODE index
Notes	Additional clarification on intervention required.

Jiang 2020

Methods	Randomly selected
Participants	People with COPD
Interventions	Intervention: WeChat official account (Pulmonary Internet Explorer Rehabilitation [PeR]) based on social media. Control: Outpatient face-to-face group
Outcomes	• CAT • Exercise self-regulatory efficacy scale

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Jiang 2020 *(Continued)*

	• SGRQ
Notes	Additional details of intervention and methodology required to determine eligibility.

Jimenez-Reguera 2020

Methods	Randomised
Participants	People with COPD
Interventions	Intervention: HappyAir TM Control: no intervention
Outcomes	• Adherence to physical activity (Morisky-Green test) • CAT • SGRQ • EuroQol-5D • 6MWT • Lung function
Notes	Additional details of intervention required to determine eligibility

Leal 2019

Methods	Randomised
Participants	People with COPD
Interventions	Intervention: instructed to perform exercises sent by message application in smartphone. Control: instruction to maintain clinical appointments and to maintain a healthy life habit
Outcomes	• 6 min stepper test • Londrina ADL protocol • handgrip strength • postural control with functional reach test
Notes	Additional details required regarding intervention to determine eligibility

Lowe 2018

Methods	Randomised controlled trial (pilot)
Participants	Adults with asthma
Interventions	Group 1: Aerobic exercise intervention with weekly home-based exercise goals Group 2: Remote asthma care guidance with phone calls and SMS text messaging regarding asthma care.

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Lowe 2018 *(Continued)*

Outcomes	At baseline and 12 weeks: • IPAQ • ASUI • ACT • Time on treadmill and peak oxygen consumption VO2 on a sub-maximal treadmill test • Recruitment challenges retention differential attrition.
Notes	Additional details required to determine eligibility. Unclear whether the remote guidance group had exercise training and/or whether the aerobic exercise group received telerehabilitation type intervention also.

NCT04284865

Methods	Additional detail required
Participants	People with COPD • Have access to a computer, laptop or cell phone at home with an high speed internet service.
Interventions	Intervention: Web platform including respiratory exercises. Control: additional detail required
Outcomes	• Adherence • Exercise capacity (6MWT) • CAT • MRC • Hospitalisations • Exacerbation
Notes	Additional details on metholdology and intervention required to determine eligiblity

NCT04521608

Methods	Randomised
Participants	Inclusion criteria: • COPD related hospitalization and eligible for PR • Age 40+ • Confidence (score > 5 in a self-efficacy question (1-10 scale): how confident you feel to use this system on a daily basis)
Interventions	Intervention: Home-based pulmonary rehabilitation. Control: Choice of centre-based pulmonary rehabilitation or telehealth based pulmonary rehabilitation.

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NCT04521608 *(Continued)*

Outcomes	• Adherence to pulmonary rehabilitation • CRQ • Self management ability scale • Daily physical activity • Healthcare utilisation • Duke-UNC functional support questionnaire
Notes	Additional details required to determine eligibility of intervention and comparator.

NCT04533412

Methods	Randomised
Participants	Inclusion Criteria: • Age > 40 years • Chart-document severe or very severe COPD (FEV1 < 50% predicted) or COPD-related ED/hospitalization ≥ 1 visit within the past 12 months • Prescribed any daily medication for COPD, English or Spanish speaking, Smoking history ≥ 10 pack-years
Interventions	Intervention: Targeted self-management barrier support, home-based pulmonary rehabilitation, and emergency medication with community health workers Active comparator: Guided COPD education with a COPD educator
Outcomes	• CAT • Medication adherence • 6MWT
Notes	Additional details regarding intervention required to determine eligibility

NCT04550741

Methods	Randomised
Participants	People with COPD
Interventions	Intervention: M-Réhab BPCO telerehabilitation solution Control: standard chronic care
Outcomes	• SGRQ • Physical activity • Perceived risk • Expectation of consequences • Self efficacy • Planning • Social support
Notes	Additional details regarding intervention required to determine eligibility

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UMIN000042022

Methods	Randomised
Participants	Inclusion: Cases decided by a doctor to be indicated for pulmonary rehabilitation Cases who can obtain a sufficient understanding of how to use the equipment of the tele-rehabilitation system by themselves or their housemates
Interventions	Intervention: Pulmonary telerehabilitation Control: Centre-based pulmonary rehabilitation
Outcomes	• ISWT • CPET • Daily step count • CAT • HADS • Program sessions • Exacerbations/Hospitalisations • Client Satisfaction Questionnaire-8
Notes	Additional details regarding intervention required to determine eligibility

Yuen 2019

Methods	Random assignment
Participants	People with idiopathic pulmonary fibrosis
Interventions	Intervention: Relatively unsupervised Wii Fit exergame. Control: Wii video game control.
Outcomes	• 6MWD • Exercise related dyspnoea • SGRQ
Notes	Additional details required regarding intervention and comparator to determine eligibility

6MWD: 6 minute walk distance; ACT: asthma control test; ADL: activities of daily life; ASUI: Asthma Symptom Utility Index; CAT: COPD assessment test; COPD: chronic obstructive pulmonary disease; CPET: cardiopulmonary exercise test; CRQ: chronic respiratory disease questionnaire; ED: emergency department; FEV1: forced expiratory volume in one second; HADS: hospital anxiety and depression scale; IPAQ: international physical activity questionnaire; ISWT: incremental shuttle walk test; MRC: medical research council dyspnoea scale; PR: pulmonary rehabilitation; SF36: short form 36; SGRQ: St George's respiratory questionnaire.

Characteristics of ongoing studies *[ordered by study ID]*

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ACTRN12619001122145

Study name	Early home-based pulmonary rehabilitation after hospitalisation in chronic obstructive pulmonary disease (COPD)
Methods	Design: Randomised controlled trial, multi-site Sample size: n = 166 Random allocation: Central allocation by phone/fax/computer Sequence generation: Block randomisation with stratification for i) disease severity (FEV1 greater than or equal to 50% predicted vs less than 50% predicted) ii) age (greater than or equal to 75 years vs less than 75 years) iii) site of recruitment Blinding patients/personnel: The people assessing the outcomes only. Patients and personnel delivering intervention not blind to group allocation Assessor blinding: Yes
Participants	Participants: Individuals with COPD admitted to hospital with an exacerbation Location & setting: Tertiary hospitals in metropolitan and regional Australia (Metro: Alfred Health, Melbourne, Victoria; RPAH and POWH, Sydney, NSW. Regional: Wimmera Health Care Group, Vic; Coffs Harbour Health Campus, NSW). Inclusion criteria: • Have a diagnosis of COPD • Be admitted to hospital for an acute exacerbation of their COPD • Aged 40 years or older • Able to read and speak English Exclusion criteria • Life expectancy less than 6 months • Comorbidities which preclude exercise training • Inability to follow verbal instructions, suffer from cognitive impairment, or have language difficulties • Unable to provide informed consent
Interventions	Intervention: 8-week home-based rehabilitation program commenced within 2 weeks of hospital discharge. One home visit with a physiotherapist to establish exercise training, facilitate goal setting and ensure safety; followed by seven once weekly telephone calls based in motivational interviewing to undertake self-management and promote exercise progression. Exercise training predominantly walking based, with light resistance training for upper and lower limbs. Aim to exercise at least 5 times/week, working toward 30minutes of aerobic training on most days of the week. Also receive standard usual care. Participants randomised to the intervention will be precluded from attending outpatient pulmonary rehabilitation during the intervention period (ie. weeks 0-10 post hospital discharge), but

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ACTRN12619001122145 *(Continued)*

	will not be precluded from referral to or attending outpatient pulmonary rehabilitation at any time during the 12 month follow up period. Control: Standard usual care, including guideline based medical management of COPD exacerbation. May include referral to traditional outpatient (centre-based) pulmonary rehabilitation after hospital discharge.
Outcomes	Assessment time points: Baseline (T0) End of intervention (T1) 12 month follow up (T2) Primary outcome: All cause hospitalisation from end of intervention (T1) to 12 months of follow up (T2)- data collection to take place at 12 months Secondary outcomes: At T1 and T2, change from baseline in: • Functional capacity assessed by the one-minute sit-to-stand (number of repetitions) • Health related quality of life measured using Chronic Respiratory Disease Questionnaire (CRDQ) and EQ-5D-5L • Hospital Anxiety and Depression scale • Pulmonary Rehabilitation Adapted Index of Self Efficacy tool (PRAISE) • Health status using the Modified Medical Research Council dyspnoea scale (mMRC) • Physical activity participation measured by accelerometry From T1 to T2 Healthcare costs assessed from healthcare utilisation data (medical record and MBS/PBS data)
Starting date	13 January 2020
Contact information	Dr Narelle Cox; narelle.cox@monash.edu
Notes	Funding: National Health and Medical Research Council Ethics approval: Alfred Health HREC 4/4/2019

ChiCTR1900021320

Study name	The effect of remote-monitor pulmonary rehabilitation in family for stable COPD patients
Methods	Design: Interventional; parallel groups Sample size: n = 120 Random allocation: Randomisation procedure was performed via random number generators (SPSS (17.0)) by statistical staff
Participants	Inclusion criteria: • COPD patients diagnosed according to GOLD 2018 and lung function belong to grade II to IV

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ChiCTR1900021320 *(Continued)*

	• The subjects are required to attend to PR and maintenance programme • Aged 40 to 75 years • Living in Tianjin in 2 years during research period Exclusion criteria: • The subject who have participated in PR in the past • Combined with asthma and OSAS • Combined with dysfunction of heart, lung, kidney and arthrosis disease • Cognition dysfunction and mental stress • Without informed consent
Interventions	Intervention: PR at home Intervention: PR at the outpatient department Control: Usual treatment
Outcomes	Assessment time points: not stated Primary outcome: • Frequency of acute exacerbation • Hospitalisation Secondary outcomes: • 6MWD • Lung function
Starting date	11 March 2019
Contact information	Hongyu Qian hongyuin999@sina.com Tianjin Chest Hospital, Tianjin China
Notes	Funding: China song Ching Ling Foundation Ethics approval: Ethics committee of Tianjin Chest Hospital 18 January 2019

Cox 2018

Study name	Telerehabilitation versus traditional centre-based pulmonary rehabilitation for people with chronic respiratory disease (REAcH)
Methods	Design: Randomised controlled, assessor-blinded equivalence trial Sample size: n = 142 Random allocation: Participants randomly allocated (1:1) to traditional centre-based pulmonary rehabilitation or telerehabilitation. A computer-generated, block randomisation scheme will be used. with stratification for i) recruitment in stable vs post-hospitalisation; ii)site of recruitment; iii)diagnosis of ILD vs other diagnoses. …randomisation will occur using an online database. Participants will be allocated to groups after completion of the baseline assessment.

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Cox 2018 *(Continued)*

	Sequence generation: Sequence generation will be performed by an individual who is independent of the research team and randomisation will occur using an online database. The randomisation sequence will be concealed from investigators. Blinding patients/personnel: Given the nature of the intervention (exercise training) participants will not be blinded to the intervention. Assessor blinding: All outcomes will be measured by an independent assessor blind to group allocation.
Participants	Participants: Potential participants will be individuals referred to pulmonary rehabilitation at the established centre-based programs of the participating sites. Location & Setting: Mulit-site. Two metropolitan (Alfred Health and Austin Health, Melbourne, Vic) and one regional site (Wimmera Health Care Group, Horsham, Vic). Inclusion criteria: • Primary diagnosis of a chronic lung disease • Be aged greater than or equal to 40 years • Be able to read and speak English Exclusion criteria: • A primary diagnosis of pulmonary hypertension or lung cancer • Attended pulmonary rehabilitation within the previous 18 months and had no hospitalisation for a respiratory cause since rehabilitation completion • Oxygen desaturation resulting in cessation of cardiopulmonary exercise testing • Unstable or brittle asthma with a hospital admission or emergency department presentation with the preceding 3 months • Co-morbidities which preclude exercise training e.g.. neurological or musculoskeletal impairment • Unable to follow verbal instruction, suffer from cognitive impairment or have language difficulties
Interventions	Intervention: Telerehabilitation Remotely supervised telerehabilitation at home, twice per week for 8 weeks in groups (4-6 participants). Video-conferencing via Zoom to enable all participants to see and speak to each other. Session 1 will be a home visit with a physiotherapist to establish the exercise program, ensure safety and understanding of equipment operation. Exercise training will comprise 30mins of lower limb aerobic training (cycle ergometer) and individualised strength training exercises (load prescribed to achieve 8-12 repetitions x 3 sets). Encouraged to perform an additional 3 unsupervised sessions each week. Equipment: using readily available equipment. A step-through exercise bike (Bodyworkx A915), a tablet computer (iPad) fixed to a stand, and a pulse oximeter (Nonin Palmsat 2500A). The oximeter will be position such that the display is visible to the supervising physiotherapist. Control: Centre-based pulmonary rehabilitation 8 weeks, twice weekly supervised group exercise sessions (8-12 participants). Undertake at least 30minutes of lower limb aerobic training each session (cycling and walking). Resistance training will utilise functional activities and upper limb weights (load prescribed to achieve 8-12 repetitions x 3 sets). Participants encouraged to perform an additional 3 unsupervised sessions each week.
Outcomes	Assessment time points:

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Cox 2018 *(Continued)*

	Baseline End of intervention 12 months follow up from end of intervention Primary outcome: Change in Chronic Respiratory Disease Questionnarie (CRQ) dyspnoea domain from baseline to end of intervention. Secondary outcomes: Pulmonary rehabilitation adherence At end rehabilitation and 12 months follow up, change in: • 6MWD • Endurance cycle time • CRQ domains of fatigue, mastery and emotional function. • SF36-v2 • Pulmonary Rehabilitation Adapted Index of Self-Efficacy (PRAISE) • Modified Medical Research Council dyspnoea scale (mMRC) • Hospital Anxiety and Depression scale (HADS) • Physical activity levels measured objectively using a wrist worn activity monitor Economic evaluation encompassing self-reported healthcare utilisation, healthcare service use from medical records.
Starting date	August 2016
Contact information	Dr Narelle Cox narelle.cox@monash.edu
Notes	Funding: National Health and Medical Research Council (NHMRC) project grant (GNT1101616). NSC is supported by an NHMRC Early Career Fellowship (GNT1119970) Ethics approval: Granted by the Alfred Health Human Research Ethics Committee (HREC15/Alfred/101; Project 26/16) in February 2016. Local governance approvals were received from each of the participating sites. Trial registration: ANZCTRN 12616000360415 registered 21 March 2016

NCT02258646

Study name	Long-Term Integrated Telerehabilitation of COPD Patients. A Multi-Centre Trial (iTrain)
Methods	Design: International, three-arm multi-centre randomised controlled trial Sample size: n = 120 Random allocation: Web-based and performed via the WebCRF program.…computerised block randomisation,…. Sequence generation: concealed from the study team by the (web-based) program. Blinding: Single blinding (outcomes assessor)
Participants	Participants: People with COPD

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NCT02258646 *(Continued)*

	Location & Setting: Norway, Australia, Denmark Inclusion criteria: • Diagnosis of COPD (FEV_1/FVC<70%) • FEV_1 %predicted <80% • At least one COPD-related hospitalisation or COPD-related ED presentation in the 12 months prior to enrolment • Aged between 40 and 80 years • Capable of providing signed, written informed consent Exclusion criteria: • Attendance at a rehabilitation program in the 6 months prior to enrolment • Participation in another clinical study that may have an impact on the primary outcome • Deemed by the healthcare team to be physically incapable of performing the study procedures • Presence of comorbidities which in the opinion of the healthcare team might prevent patients from undertaking an exercise program at home (e.g.. severe orthopaedic or neurological impairments) • Home environment not suitable for installation and use of rehabilitation and monitoring equipment
Interventions	Intervention - Telerehabilitation: Integrated intervention consisting of exercise training at home, telemonitoring and self-management. Equipment includes a treadmill, pulse oximeter, a tablet computer (and holder). Videoconferencing sessions performed through Acano. Individualised exercise training program comprising continuous or interval treadmill training and strength training exercises. Treadmill program lasts at least 30 minutes. Continuous training at Borg scale up to 4, 3-5 times/week. Interval training at Borg scale up to 6, 3 times/week. Customised website to access individual training program, fill in daily diary and training diary, reviewing history, exchange messages, schedule videoconferencing, assess goal attainment. Scheduled videoconferencing session with physiotherapist: at least 1 session/week in the first 8 weeks after enrolment and at least 1 session/month in the follow up period. If admitted to hospital at least 1 videoconferencing session/week will be applied in the month after discharge. Intervention - Treadmill: Participants are provided with a treadmill for unsupervised exercise training at home. Individualised unsupervised training, with no regular review or progression of the program. Participants are asked to record each training session in a paper based diary. Control - Standard care: May include participation in a traditional PR program at any time during the 2-year study period if it is considered clinically indicated by the usual treating team.
Outcomes	Assessment time points: Baseline 6 months

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NCT02258646 *(Continued)*

	1 year 2 years Primary outcome: Combined number of hospitalisations and emergency department presentations at two years. Secondary outcomes: Hospitalisations ED presentations Mortality Time free from first event (days to first hospitalisation or ED presentation) Health status (COPD assessment test) Quality of life (EQ-5D-5L) Anxiety and Depression (Hospital anxiety and depression scale) Self-efficacy (Generalised self-efficacy scale) Subjective impression of overall change (Patient global impression of change) Physical performance (6MWD) Level of physical activity (daily number of steps; daily minutes of moderate-vigorous physical activity and sedentary time) Cost-effectiveness (cost per QALY) Experience in telerehabilitation (qualitative interview)
Starting date	October 2014 End date: December 2018
Contact information	Paolo Zanaboni paolo.zanaboni@telemed.no
Notes	Funding: This study was funded by the Research Council of Norway (Project Grant 22891/H10) and the Northern Norway Regional Health Authority (Project Granst HST1117-13 and HST1118-13) Ethics approval: Regional Committee for Medical and Health Research Ethics in Norway (2014/676/REK nord), the Alfred Hospital Human Research Ethics Committee (289/14), and the North Denmark Region Committee on Health Research Ethics (N-20140038).

NCT02404831

Study name	An Evaluation of Web Based Pulmonary Rehabilitation (webbasedPR)
Methods	Randomised controlled pilot study
Participants	Participants: People with COPD eligible for pulmonary rehabilitation in the NHS Lanarkshire PR programme

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NCT02404831 *(Continued)*

	Location: Scotland, UK Inclusion criteria: • A diagnosis of COPD • Independently mobile • Access to the internet in their own home Exclusion criteria: • Unstable cardiac or other health problems which may prevent participation in study • Under the age of 18 • Pregnant • Unable to read/understand English • Unwilling to be randomised into PR delivered via the hospital or internet
Interventions	Intervention: Telerehabilitation Web-based PR twice/week for 6 weeks. Given individual log-in details to access the website with access to exercises and education pages. Participants will be provided with a standardised exercise programme at the start of the study. The level of intensity of exercises will be progressed as appropriate on an individual basis for all participants in the group. Participant log-ins and diaries will be monitored remotely and participants will be telephone at weeks 2 and 4 by their physiotherapist to discuss their progress and, at this time, exercises may be progressed by changing the level of difficulty/intensity. This is done remotely by physiotherapy staff. Control: Centre-based pulmonary rehabilitation Hospital-based PR twice per week for 6 weeks comprising exercise and education.
Outcomes	Change from baseline to 6 weeks in: • Shuttle walk test • Chronic disease questionnaire • HADS • Borg breathlessness scale • Website evaluation questionnaire
Starting date	April 1, 2015
Contact information	Dr Lorna Paul, University of Glasgow
Notes	

NCT03007485

Study name	A comprehensive disease management program to improve quality of life in disparity Hispanic and African-American patients admitted with exacerbation of chronic pulmonary diseases
Methods	Design: Randomised, parallel assignment Sample size: n = 276 Random allocation: Study will involve randomly assigning participants… Method of randomisation unclear.

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NCT03007485 *(Continued)*	Blinding: Masking – Double (participant and outcome assessor)
Participants	Participants: Latino and African-American patients with COPD Location & Setting: USA Inclusion criteria: • Adult patients with a diagnosis of COPD (defined by spirometry • Hispanic or African-American (defined by the patient themselves) • Age 18 years or older Exclusion criteria: • Individuals who have completed pulmonary rehabilitation within the last year • Those unable to exercise or follow directions as determined by their outpatient pulmonologist/cardiologist • A diagnosis of dementia listed in the patients electronic medical record • Patients who weigh more than 300 pounds
Interventions	Intervention- Telerehabilitation: Telehealth pulmonary rehabilitation, twice/week for 8 weeks. Exercise bikes equipped with software enabling respiratory therapist to remotely conduct pulmonary rehabilitation session with a patient while the patient is at home (or a local community centre). Vital signs are continually monitored and the RT able to alert 911 (emergency services) if patient in distress. Educational videos and stretches also incorporated. Control: Standard pulmonary rehabilitation, twice/week for 8 weeks.
Outcomes	Assessment time points: Baseline End of rehabilitation Primary outcome: Change in the rate of rehospitalisation in patients with COPD at 6 months post-discharge from hospitalisation following exacerbation of COPD. Secondary outcomes: • Change in functional status after pulmonary rehabilitation (baseline, end rehabilitation, 6 months and 12 months post discharge from hospital) • Change in self-reported quality of life after pulmonary rehabilitation (baseline, end rehabilitation, 6 months and 12 months post discharge from hospital) • Measure of patients adherence to completing pulmonary rehabilitation (8-weeks post-discharge from hospitalisation following COPD exacerbation)
Starting date	1 April 2017
Contact information	A/Prof Negin Hajizadeh Nhajizadeh@northwell.edu
Notes	

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NCT03089853

Study name	Smart Telehealth Exercise Intervention to Reduce COPD readmissions
Methods	Design: Prospective randomised controlled study Sample size: n = 40 (30 intervention: 10 usual care) Random allocation: Randomised 2:1 – allocation method unclear Blinding: Masking – none (open label)
Participants	Participants: People with COPD admitted to hospital with an exacerbation Location & Setting: University at Alabama, Birmingham, USA Inclusion criteria: • Subjects hospitalised with an acute exacerbation of COPD and can be enrolled within 36 hours of hospitalisation • Age 40 years or older Exclusion criteria: • Secondary diagnosis of congestive heart failure and other respiratory conditions that could confound the diagnosis such as pneumonia, bronchiectasis and lung cancer • Those on invasive or mechanical ventilation • Participants with pacemakers/defibrillators- due to concern for interaction with NMES • Inability to consent for themselves • Pregnant or breastfeeding women to minimize risks of NMES
Interventions	Intervention- Telerehabilitation: Remote tele pulmonary rehabilitation and NMES (neuromuscular electrical stimulation) 30 mins daily NMES to thigh for 2 weeks (30Hz trains of 300µsec biphasic pulses; using a 5sec on/25 sec off work:rest ratio progressing to 10sec on/30sec off). This will be followed by pulmonary rehabilitation exercises delivered to the home via a smart phone for an additional 10 weeks. Control - Usual care. Usual care – will consist of a protocolized regime of 5 days of systemic steroids, unless the treating physician determines a different regimen, in which case the change will be documented.
Outcomes	Assessment time points: Baseline 30 days from hospital discharge (primary outcome) 12 weeks from hospital discharge (end intervention) Primary outcome: Rate of all-cause readmissions within 30 days following an index hospitalisation for COPD exacerbation. Secondary outcomes: At 12 weeks, change in: • FEV_1 • Dyspnoea (mMRC)

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NCT03089853 *(Continued)*

	• CAT • Quadriceps muscle strength (dynamometer) • 30sec chair test • Systemic inflammation (CRP, fibrinogen, IL-6, TNF-alpha) • Muscle inflammation (pro-inflammatory signalling quadriceps skeletal muscle)
Starting date	14 July 2016
Contact information	Surya Bhatt sbhatt@uabmc.edu
Notes	Funding: NIH

NCT03443817

Study name	Feasibility and Effect of a Follow-up Telerehabilitation Program for COPD vs Standard Follow-up (2-TELEKOL)
Methods	Design: Prospective, randomised, parallel assignment Sample size: n = 54 Blinding: Masking: Triple (participant, care provider, outcomes assessor)
Participants	Participants: Individuals with stable COPD Location & Setting: Denmark Inclusion criteria: • Stable COPD • Signing informed consent • Completion of standard rehabilitation program • Permanent oxygen therapy not an obstacle for participants Exclusion criteria: • Patient has significant musculoskeletal disorders that limit his/her function levels to a degree that is not caused by dyspnoea • Patient has pronounced dizziness, significant sensory or motor disability, dementia or terminal malignant disease • Serious comorbidities (unstable heart disease, irregular diabetes, known malignant disease, another disease that makes the patient unfit to participate in the study) • Non-compliant patient (e.g.. nursing home residents) • Participation in another project within the last 30 days • Mini-mental state examination score less than 24 points • Severe vision or hearing loss • Non-Danish speaking • Lack of will to implement the protocol • Motor or sensory disease which makes it impossible for walk training • Experienced a worsening in the last 4-6 weeks • Musculoskeletal disorders • Serious heart diseases (ejection fraction <30%, daily angina, or as indicated by the treating cardiologist) • Can not understand informed consent

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NCT03443817 *(Continued)*

	• Other factors that inhibit the use of telerehabilitation
Interventions	Intervention -Telerehabilitation (maintenance): Video consultation – minimum once/week in first month; one every second week month 2. Video consultation includes – breathing techniques, chat session with physiotherapist, work out session with a virtual physiotherapist agent (VPA) (10-20 minutes daily at home) Control - No intervention control
Outcomes	Assessment time points: Baseline After 8 weeks 6 months after cessation of the training program Primary outcome: Change in 6 minute walk test after 8 weeks Secondary outcomes: • Change in 6MWT at 6 months follow up • Change in total score and component scores of SGRQ after 8 weeks and at 6 months follow up • Change in total Generalised Anxiety Disorder Assessment (GAD-7) after 8 weeks and at 6 months follow up • Cost of telerehabilitation program at 6 months
Starting date	1 March 2018
Contact information	Jose Cerdan, University of Aarhus, Denmark joscer@rm.dk Elisabeth Bendstrup karbends@rm.dk
Notes	Sponsors and collaborators: University of Aarhus and Eurostars

NCT03548181

Study name	Feasibility and Effect of a Telerehabilitation Program in Idiopathic Pulmonary Fibrosis (IPF) (3-IPF)
Methods	Design: Prospective, randomised controlled trial Sample size: n = 30 Random allocation: Randomisation will be performed electronically Blinding: Masking: Double (participants and outcome assessors)
Participants	Participants: Consecutive clinical stable patients with definitive or possible IPF Location & Setting: Outpatient clinic at the Danish Center of Interstitial Lung Diseases at Aarhus University Hospital Inclusion criteria: • Diagnosis of either definite or possible IPF according to ATS/ERS criteria

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NCT03548181 *(Continued)*

	• Signed informed consent • DLCO ≥30%predicted and FVC ≥50%predicted • 6MWT≥150m • ≥18years • Clinically stable • Absolute decline in DLCO and FVC should be less than 10% in the past 6 months Exclusion criteria: • Participation in an official rehabilitation program <4 months before start of the study • Musculoskeletal disorders • Severe cardiac disease (ejection fraction <30%, daily angina or otherwise specified by treating cardiologist) • Unable to understand informed consent • Other conditions that hamper the use of telerehabilitation • Non-Danish speaking • Unwillingness to implement the protocol
Interventions	Intervention - Telerehabilitation (12 weeks) Video consultation – minimum once/week in first month; one every second week month 2, and one a month for remainder of trial. Video consultation includes – breathing techniques, chat session with physiotherapist, work out session with a virtual physiotherapist (10-20 minutes daily at home using elastics, weights and fitness step). Includes a digital diary that automatically registers data obtained on the system on patients performance. Control - Usual care Outpatient visits every 3 months
Outcomes	Assessment time points: Baseline 12 weeks (end intervention) 3 months follow up 6 months follow up Primary outcome: Change in 6MWD at week 12 Secondary outcomes: • Change in 6MWD 3 and 6 months after end of rehabilitation At week 12, and 3 and 6 months after end of rehabilitation change in: • Total SGRQ-IPF • Total score of the KBILD • Total score of the GAD-7 • Component scores of the SGRQ-IPF • Number of steps (pedometer) Cost of the telerehabilitation program at 12 weeks
Starting date	1 September 2017

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NCT03548181 *(Continued)*

Contact information	Jose Cerdan Aarhus, Denmark joscer@rm.dk Elisabeth Bendstrup karbends@rm.dk
Notes	Sponsors and collaborators: University of Aarhus, Eurostars

NCT03569384

Study name	Feasibility and Effect of a Telerehabilitation Program for COPD vs standard rehabilitation (TELEKOL-1)
Methods	Design: Randomised, parallel Sample size: n = 54 Random allocation: Randomisation will be performed electronically Blinding: Masking: Triple (participant, care provider, outcomes assessor)
Participants	Participants: Individuals with COPD referred for COPD rehabilitation Location & Setting: Aarhus University Hospital (Denmark) Inclusion criteria: • Diagnosis of COPD (FEV1/FVC<70% in stable disease) • Age >18years • Referred for conventional COPD rehabilitation • Compliant patient willing to fulfil study requirements • Signed informed consent (Oxygen therapy not an obstacle for participation) Exclusion criteria: • Musculoskeletal disorders limiting training • Dizziness, significant sensory or motor disabilities, dementia or terminal malignant disease precluding training • Severe comorbidities such as unstable heart disease, dysregulated diabetes, known malignant disease, any other illness making the patient inappropriate for participating in the study • Non-compliant patient • Severe vision or hearing impairment • Non-Danish speaking • Unwillingness or inability to follow the protocol • COPD exacerbation in the preceding 6 weeks
Interventions	Intervention - Telerehabilitation (maintenance) 8 weeks. Video consultation – minimum once/week in first month; one every second week month 2. Video consultation includes – breathing techniques, chat session with physiotherapist, work out session with a virtual physiotherapist agent (training 10-20minutes/day) Control: Standard rehabilitation as implemented at the Department of Respiratory Medicine and Allergy, Aarhus University Hospital. 8 weeks 2 weekly group training sessions at the hospital with instruction from the physiotherapist and 6 hours of education about COPD and its treatment.
Outcomes	Assessment time points:

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NCT03569384 *(Continued)*

	Baseline 8 weeks (end intervention) 3 month follow up 6 month follow up Primary outcome: Change in 6MWD at end intervention Secondary outcomes: • Change in 6MWD at 3 and 6 month follow up At end intervention, and 3 and 6 month follow up change in: • SGRQ total score • GAD-7 total score • SGRQ component scores • IADL (Instrumental activities of daily living) Cost of telerehabilitation
Starting date	1 March 2017
Contact information	Jose Cerdan ppmanucerdan@yahoo.es Elisabeth Bendstrup karbends@rm.dk
Notes	Funding & collaborators: Eurostars Foundation and Aarhus University

NCT03634553

Study name	Evidence Based Training and Physical Activity With an E-health Program – a New Method for People With COPD to become more physically active
Methods	Design: Non-randomised, parallel assignment Sample size: n = 80 Blinding: Masking: single (outcomes assessor)
Participants	Location & setting: Participants will be recruited from both Stockholm and Västerbotten county, university hospitals and primary care Inclusion criteria: • Diagnosis of COPD • Age over 40 years Exclusion criteria: • Medical barriers to participate in training at home with e-health program
Interventions	Intervention - Telerehabilitation e-health product Training with the e-health product follows recommendations of ACSM – including muscle strengthening (UL and LL; 5-8pc with progression in three levels), cardiovascular (30min walk, 5-7x/week) and balance exercises.

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NCT03634553 *(Continued)*

	Control - Usual care Participates in regular training regime at the physiotherapy department
Outcomes	Assessment time points: Baseline 10 weeks 6 months follow up 12 months follow up Primary outcome: CAT change from baseline to 10 weeks, 6 months, 12 months Secondary outcomes: Change from baseline to 10 weeks, 6 months, 12 months in: • EQ5D • Leicester cough questionnaire • MMRC • HADS • SCI Exercise Self-efficacy Scale • Frändin Grimby scale to assess physical activity level • Accelerometer to assess physical activity level and pattern • MiniBESTest assess balance performance • Activities Specific Balance Confidence scale • 6MWT • 30 sec STS test • 60 sec STS test • Hand grip strength (dynamometer) • Fall efficacy scale internation (FES-I)
Starting date	(estimated) 28 August 2019
Contact information	Alexandra Havarsson Alexandra.halvarsson@ki.se Kirsti Skavberg Roaldsen Kirsti.skavber.roaldsen@ki.se
Notes	Sponsors & collaborators: Karolinska Institute

NCT03914027

Study name	Feasibility and effect of a telerehabilitation program in pulmonary sarcoidosis (TeleSarco)
Methods	Design: Randomised controlled trial Sample size: n = 24

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NCT03914027 *(Continued)*

	Random allocation: Performed electronically using a randomisation plan generator. Block randomisation will be used to ensure that the numbers of participants assigned to each group is equally distributed during the different seasons. Sequence generation: Electronically using a randomisation plan generator Blinding: Masking: Double (participant, investigator)
Participants	Inclusion criteria: • Diagnosis of pulmonary sarcoidosis • Signed informed consent • Age ≥18 years • DLCO ≥30%predicted and FVC≥50%predicted • 6MWD ≥150m Exclusion criteria: • Participation in an official rehabilitation program <3 months before start of the study • Musculoskeletal disorders • Severe cardiac diseases (ejection fraction <30%, daily angina, or otherwise specified by treating cardiologist) • Unable to understand informed consent • Other conditions that hamper the use of telerehabilitation • Non-Danish speaking • Unwillingness to implement the protocol
Interventions	Intervention - Telerehabilitation (12 weeks): Video consultation – minimum once/week in first month; one every second week month 2, and one a month for remainder of trial. Video consultation includes – breathing techniques, chat session with physiotherapist, work out session with a virtual physiotherapist (10-20 minutes daily at home using elastics, weights and fitness step. Control - Standard treatment only Outpatient visits approximately every 3rd month
Outcomes	Assessment time points: Baseline 12 weeks (end intervention) 6 months from baseline 9 months from baseline Primary outcome: Change in 6MWD measured at 12 weeks Secondary outcomes: At 6 and 9 months, change in: 6MWD At 12 weeks, 6 and 9 months change in: • Muscle strength (MVC dominant arm)

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NCT03914027 *(Continued)*

	• Total score on SGRQ • 10-item Fatigue Assessment Scale • KBILD • GAD-7 • Component scores of SGRQ Cost of telerehabilitation program
Starting date	12 December 2018
Contact information	Jose Cerdan joscer@rm.dk Elisabeth Bendstrup karbends@rm.dk
Notes	Sponsors and collaborators: Aarhus University Hospital, Eurostars, University of Aarhus

NCT03981783

Study name	Informatics framework for Pulmonary Rehabiliation (CHIEF-PR) (Comprehensive Health Informatics Framework for Pulmonary Rehab)
Methods	Design: Randomised, parallel assignment Sample size: n = 120 Blinding: Masking: none (open label)
Participants	Participants.: Individuals with COPD who are within 4 weeks of an acute exacerbation Inclusion criteria: • Age 40 or older at time of randomisation • Physician diagnosis of COPD • Moderate-severe COPD (GOLD stages II-III) • Understand spoken English or Spanish • Urgent care event due to COPD within 4 weeks of enrolment • Have no other member of the household enrolled in the study Exclusion criteria: • Evidence that the patient may move from the study area before the completion of the study • Impaired cognitive status as indicated by MMSE <24 • Presence of any health condition, that would preclude participation (e.g.. psychiatric diagnosis, unstable cardiovascular condition or physical disability)
Interventions	Intervention - Telerehabilitation: Comprehensive Health Informatics Engagement Framework which facilitates referral and promotes adherence with pulmonary rehabilitation using an innovative approach. Includes computer mediated counselling to increase patient motivation in joining PR followed by ongoing home-based support of PR by a telerehabilitation system that monitors patients progress and allows remote oversight by clinical PR team. Control - Standard pulmonary rehabilitation

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NCT03981783 *(Continued)*

Outcomes	Assessment time points: ?baseline 3 months (primary outcome only) 12months Primary outcome: % of patients who complete the program (3months) Secondary outcomes: At 12 months: • 6MWD • CRDQ • SF36 • COPD self-efficacy scale (CSES) • Shortness of breath questionnaire
Starting date	1 March 2020
Contact information	Joseph Finkelstein Icahn School of Medicine at Mount Sinai joseph.finkelstein@mssm.edu Venus Velez venus.velez@mssm.edu
Notes	Funding: NHLBI

NCT03997513

Study name	The impact of a home-based pulmonary telerehabilitation program in acute exacerbations of COPD (The impact of a home-based pulmonary telerehabilitation program on muscle function and quality of life following acute exacerbations of COPD)
Methods	Design: Randomised controlled trial Sample size: n = 38 Random allocation: Will randomise (1:1 allocation) veterans hospitalised with an AECOPD to either Blinding: Masking: Open label
Participants	Participants: Veterans with COPD admitted with an acute exacerbation Location & Setting: VA Pittsburgh Healthcare System Inclusion criteria: • Veterans • Moderate or severe COPD with FEV1/FVC<70% and FEV1<80%predicted

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NCT03997513 *(Continued)*

- Hospitalisation with a primary diagnosis of AECOPD, defined as an increase in shortness of breath, cough, and/or sputum production beyond the normal day-to-day variation necessitating a change in regular medication when other causes of increased shortness of breath, cough and/or sputum have been ruled out
- Capable of operating a tablet independently with adequate vision and hearing

Exclusion criteria:

- Acute hypercapneic respiratory failure with a requirement for either non-invasive (i.e.. bilevel) or invasive mechanical ventilation during hospitalisation
- Hospitalisation <72hours
- A secondary diagnosis of acute congestive heart failure, myocardial infarction, or pneumonia during hospitalisation or unstable cardiac or neurologic disease at discharge
- Enrolment in a pulmonary rehabilitation program within 12 months of hospitalisation
- A medical condition that makes exercise unsafe (determined by chart review, discussion with patient (known cardiac issues, chest pain with exertion, lightheaded with exertion), discussion with the physician caring for the patient in hospital, direct observation and assessment during bedside pulmonary rehab sessions
- Inclusion in another greater than minimal risk study

Interventions	Intervention - Telerehabilitation: 8 weeks, 3 x/week home-based pulmonary telerehabilitation program incorporating lower extremity endurance and UL and LL resistance training. Also one hour twice monthly support group via video conferencing (education and group discussion) Control - 'Usual care group' Participants will be enrolled in the institution's telehealth program and will receive an automatic blood pressure monitor, portable pulse oximeter, and scale and will be in regular contact with a telehealth provider. A study member will discuss the importance of exercise and will encourage exercise (strength training, light aerobic activity) a minimum of 20-40 minutes 3 x /week at discharge.
Outcomes	Assessment time points: Baseline (pre-discharge) 10 weeks Primary outcome: From baseline to 10 weeks, change in: • Quadriceps muscle strength test (from baseline to 10 weeks) measured with a Keiser leg press • ESWT time from baseline to 10 weeks • HRQOL as measured on the SF36 Participant satisfaction survey (5 point Likert scale) Secondary outcomes: From baseline to 10 weeks, change in: • 1minSTS • Hand grip strength (dynamometer) • Disease specific HRQOL (SGRQ) • Symptoms during 1minSTS Post intervention survey (regarding social support, psychiatric attributes and other factors potentially associated with program adherence)

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NCT03997513 *(Continued)*

Starting date	unclear
Contact information	Jessica Bon Field Jessica.field@va.gov
Notes	Sponsors and collaborators: VA office of research and development

COPD - chronic obstructive pulmonary disease, AECOPD - acute exacerbation of COPD, CRQ/CRDQ - chronic respiratory disease questionnaire, n = number, FEV1 - forced expiratory volume in one second, FVC - forced vital capacity, EQ-5D - EuroQol Quality of life 5 domain, MBS - medicare benefits scheme, PBS - pharmaceutical benefits schedule, PR - pulmonary rehabilitation, 6MWD - six minute walk distance, 6MWT - six minute walk test, ILD - interstitial lung disease, IPF - idiopathic pulmonary fibrosis, SF36-v2 - short form 36 version 2, QALY - quality adjusted life year, HADS - hospital anxiety and depression scale, NMES - neuromuscular electrical stimulation, mMRC - modified medical research council dyspnoea scale, CAT - COPD Assessment Test, SGRQ - St George's Respiratory Questionnaire, SGRQ-IPF - St George's Respiratory Questionnaire Idiopathic Pulmonary Fibrosis, KBILD - King's Brief Interstitial Lung Disease questionnaire, GAD-7 - General Anxiety Disorder-7, ATS/ERS - American Thoracic Society/European Respiratory Society, STS - sit to stand, ACSM - American College of Sports Medicine, DLCO - diffusing capacity of lung for carbon monoxide, MMSE - mini mental state examination, UL - upper limb, LL - lower limb, HRQOL - health related quality of life, ESWT - endurance shuttle walk test

DATA AND ANALYSES

Comparison 1. Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.1 Outcome 1 Exercise capacity - 6minute walk test distance at end intervention	5		Mean Difference (IV, Random, 95% CI)	Subtotals only
1.1.1 Randomised controlled trials - Primary rehabilitation	4	556	Mean Difference (IV, Random, 95% CI)	0.06 [-10.82, 10.94]
1.1.2 Randomised controlled trials - Maintenance rehabilitation	1	97	Mean Difference (IV, Random, 95% CI)	-7.30 [-34.93, 20.33]
1.2 Outcome 1 Exercise capacity - Change in endurance shuttle walk test time (seconds) at end intervention	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.2.1 Randomised controlled trials - Primary rehabilitation	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.3 Outcome 1 Exercise capacity - change in endurance cycle time at end intervention	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.3.1 Randomised controlled trials - Primary rehabilitation	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.4 Outcome 1 Exercise capacity - Peak watts on CPET at end intervention	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected

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Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.4.1 Maintenance rehabilitation	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.5 Outcome 1 Exercise capacity - Change in 30 sec STS repetitions at end intervention	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.5.1 Randomised controlled trials - Primary rehabilitation	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.6 Outcome 1 Exercise Capacity - Long term (>6months) change in 6MWD from baseline to end followup	2	308	Mean Difference (IV, Random, 95% CI)	1.40 [-12.62, 15.43]
1.7 Outcome 3 Dyspnoea - MMRC at end intervention	2		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.7.1 Randomised controlled trial - Primary rehabilitation	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.7.2 Randomised controlled trial - Maintenance rehabilitation	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.8 Outcome 3 Dyspnoea - Change in CRQ Dyspnoea domain at end intervention	3		Mean Difference (IV, Random, 95% CI)	Subtotals only
1.8.1 Randomised controlled trials - Primary rehabilitation	3	426	Mean Difference (IV, Random, 95% CI)	0.13 [-0.13, 0.40]
1.9 Outcome 3 Dyspnoea - Long term (>6 months) change in CRQ Dyspnoea score from baseline to end followup	2	364	Mean Difference (IV, Random, 95% CI)	0.14 [-0.08, 0.36]
1.10 Outcome 4 Quality of life - SGRQ total score at end intervention	3		Mean Difference (IV, Random, 95% CI)	Subtotals only
1.10.1 Randomised controlled trial - Primary rehabilitation	2	274	Mean Difference (IV, Random, 95% CI)	-1.26 [-3.97, 1.45]
1.10.2 Randomised controlled trials - Maintenance rehabilitation	1	97	Mean Difference (IV, Random, 95% CI)	4.80 [-2.63, 12.23]
1.11 Outcome 4 Quality of life - Change in SGRQ symptom score at end intervention	1		Std. Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.11.1 Randomised controlled trial - Primary rehabilitation	1		Std. Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.12 Outcome 4 Quality of life - Change in SGRQ activity score at end intervention	1		Std. Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.12.1 Randomised controlled trial - Primary rehabilitation	1		Std. Mean Difference (IV, Fixed, 95% CI)	Totals not selected

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Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.13 Outcome 4 Quality of life - Change in SGRQ impact score at end intervention	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.13.1 Randomised controlled trial - Primary rehabilitation	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.14 Outcome 4 Quality of life - CAT score at end intervention	3		Mean Difference (IV, Random, 95% CI)	Subtotals only
1.14.1 Randomised controlled trial - Primary rehabilitation	2	224	Mean Difference (IV, Random, 95% CI)	-1.37 [-3.10, 0.36]
1.14.2 Maintenance rehabilitation	1	97	Mean Difference (IV, Random, 95% CI)	1.20 [-1.40, 3.80]
1.15 Outcome 4 Quality of life - Change in CRQ Dyspnoea domain at end intervention	3		Mean Difference (IV, Random, 95% CI)	Subtotals only
1.15.1 Randomised controlled trials - Primary rehabilitation	3	426	Mean Difference (IV, Random, 95% CI)	0.13 [-0.13, 0.39]
1.16 Outcome 4 Quality of life - Change in CRQ Fatigue domain at end intervention	2		Mean Difference (IV, Random, 95% CI)	Subtotals only
1.16.1 Randomised controlled trials - Primary rehabilitation	2	364	Mean Difference (IV, Random, 95% CI)	-0.03 [-0.24, 0.18]
1.17 Outcome 4 Quality of life - Change in CRQ Emotion domain at end intervention	2		Mean Difference (IV, Random, 95% CI)	Subtotals only
1.17.1 Randomised controlled trials - Primary rehabilitation	2	364	Mean Difference (IV, Random, 95% CI)	-0.02 [-0.20, 0.16]
1.18 Outcome 4 Quality of life - Change in CRQ Mastery domain at end intervention	2		Mean Difference (IV, Random, 95% CI)	Subtotals only
1.18.1 Randomised controlled trials - Primary rehabilitation	2	364	Mean Difference (IV, Random, 95% CI)	0.03 [-0.17, 0.23]
1.19 Outcome 4 Quality of life - Change in CCQ Function domain at end intervention	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.19.1 Randomised controlled trials - Primary rehabilitation	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.20 Outcome 4 Quality of life - Change in CCQ Mental domain at end intervention	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.20.1 Randomised controlled trial - Primary rehabilitation	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.21 Outcome 4 Quality of life - Change in CCQ Symptom domain at end intervention	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected

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Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.21.1 Randomised controlled trials - Primary rehabilitation	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.22 Outcome 4 Quality of life - Change in CCQ total score at end intervention	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.22.1 Randomised controlled trial - Primary rehabilitation	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.23 Outcome 4 Quality of life - Change in EQ-5D-VAS score at end intervention	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.23.1 Randomised controlled trials - Primary rehabiliation	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.24 Outcome 4 Quality of Life - Long term (>6 months) change in CRQ Dyspnoea score from baseline to end followup	2	364	Mean Difference (IV, Random, 95% CI)	0.14 [-0.08, 0.36]
1.25 Outcome 4 Quality of Life - Long term (>6 months) change in CRQ Fatigue score from baseline to end followup	2	364	Mean Difference (IV, Random, 95% CI)	0.02 [-0.31, 0.35]
1.26 Outcome 4 Quality of Life - Long term (>6 months) change in CRQ Emotion score from baseline to end followup	2	364	Mean Difference (IV, Random, 95% CI)	0.04 [-0.13, 0.21]
1.27 Outcome 4 Quality of Life - Long term (>6 months) change in CRQ Mastery score from baseline to end followup	2	364	Mean Difference (IV, Random, 95% CI)	0.09 [-0.11, 0.30]
1.28 Outcome 5 Completion of the intervention	3		Odds Ratio (M-H, Fixed, 95% CI)	Subtotals only
1.28.1 Randomised controlled trials - primary rehabilitation	3	516	Odds Ratio (M-H, Fixed, 95% CI)	5.36 [3.12, 9.21]
1.29 Outcome 6 Anxiety/Depression - Change in HADS Anxiety score at end intervention	2		Mean Difference (IV, Random, 95% CI)	Subtotals only
1.29.1 Randomised controlled trials - Primary rehabilitation	2	282	Mean Difference (IV, Random, 95% CI)	-1.05 [-1.76, -0.35]
1.30 Outcome 6 Anxiety/Depression - Change in HADS Depression score at end intervention	2		Mean Difference (IV, Random, 95% CI)	Subtotals only
1.30.1 Randomised controlled trial - Primary rehabilitation	2	282	Mean Difference (IV, Random, 95% CI)	-0.36 [-1.05, 0.34]
1.31 Outcome 6 Anxiety/Depression - Long term (>6 months) change in HADS Anxiety score from baseline to end followup	1		Mean Difference (IV, Random, 95% CI)	Totals not selected

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Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.32 Outcome 6 Anxiety/Depression - Long term (>6 months) change in HADS Depression score from baseline to end followup	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
1.33 Outcome 7 Physical activity - Change in MVPA time (minutes/day) at end intervention	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.33.1 Randomised controlled trial - Primary rehabiliation	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.34 Outcome 7 Physical activity - Sedentary time (minutes/day) at end intervention	3		Mean Difference (IV, Random, 95% CI)	Subtotals only
1.34.1 Randomised controlled trial - Primary rehabiliation	2	192	Mean Difference (IV, Random, 95% CI)	-8.57 [-66.69, 49.54]
1.34.2 Randomised controlled trials - Maintenance rehabilitation	1	97	Mean Difference (IV, Random, 95% CI)	34.00 [-225.49, 293.49]
1.35 Outcome 7 Physical activity - Change in steps/day at end intervention	2		Mean Difference (IV, Random, 95% CI)	Subtotals only
1.35.1 Randomised controlled trial - Primary rehabilitation	2	192	Mean Difference (IV, Random, 95% CI)	387.09 [-84.64, 858.81]
1.36 Outcome 7 Physical Activity - Change in total daily Energy Expenditure (k/cal) at end intervention	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.36.1 Randomised controlled trial - Primary rehabilitation	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
1.37 Outcome 7 Physical activity - Light physical activity time (minutes)/day at end intervention	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
1.37.1 Randomised controlled trial - Maintenance rehabiliation	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
1.38 Outcome 7 Physical Activity - Lifestyle physical activity time (minutes)/day at end intervention	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
1.38.1 Randomised controlled trial - Maintenance rehabiliation	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
1.39 Outcome 7 Physical Activity - Moderate physical activity time (minutes)/day at end intervention	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
1.39.1 Randomised controlled trial - Maintenance rehabiliation	1		Mean Difference (IV, Random, 95% CI)	Totals not selected

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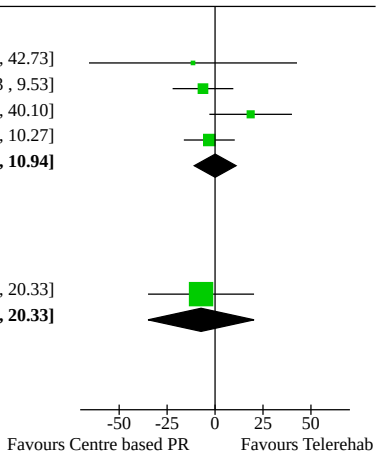
Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1.40 Outcome 7 Physical activity - Change in time active (minutes) at end intervention	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
1.40.1 Randomised controlled trial - Primary rehabilitation	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
1.41 Outcome 8 Health care utilisation - Respiratory related hospitalisation	3		Odds Ratio (M-H, Fixed, 95% CI)	Subtotals only
1.41.1 Randomised controlled trials - Primary rehabilitation	3	516	Odds Ratio (M-H, Fixed, 95% CI)	0.65 [0.43, 0.99]

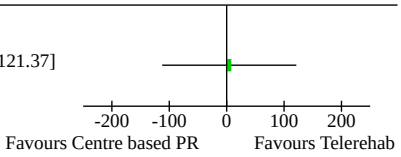
Analysis 1.1. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 1: Outcome 1 Exercise capacity - 6minute walk test distance at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.1.1 Randomised controlled trials - Primary rehabilitation								
Bourne 2017	433.6	102.9	64	445.1	124.9	26	3.9%	-11.50 [-65.73 , 42.73]
Hansen 2020	17.2	46.7368	67	23.5	46.7368	67	33.3%	-6.30 [-22.13 , 9.53]
Holland 2017	29.39	66.4713	72	10.82	67.1306	76	20.8%	18.57 [-2.96 , 40.10]
Maltais 2008	8	47.4716	89	11	44.1804	95	42.0%	-3.00 [-16.27 , 10.27]
Subtotal (95% CI)			**292**			**264**	**100.0%**	**0.06 [-10.82 , 10.94]**
Heterogeneity: Tau² = 27.45; Chi² = 3.82, df = 3 (P = 0.28); I² = 22%								
Test for overall effect: Z = 0.01 (P = 0.99)								
1.1.2 Randomised controlled trials - Maintenance rehabilitation								
Vasilopoulou 2017	420.2	74.9	47	427.5	63	50	100.0%	-7.30 [-34.93 , 20.33]
Subtotal (95% CI)			**47**			**50**	**100.0%**	**-7.30 [-34.93 , 20.33]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 0.52 (P = 0.60)								
Test for subgroup differences: Chi² = 0.24, df = 1 (P = 0.63), I² = 0%								



Analysis 1.2. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 2: Outcome 1 Exercise capacity - Change in endurance shuttle walk test time (seconds) at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Mean Difference IV, Fixed, 95% CI
1.2.1 Randomised controlled trials - Primary rehabilitation							
Chaplin 2017	189	211.1	22	184.5	247.4	40	4.50 [-112.37 , 121.37]



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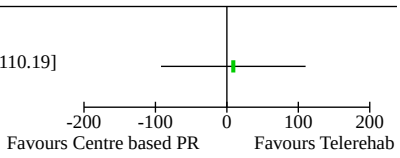
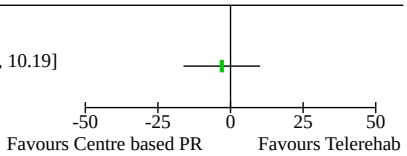
Analysis 1.3. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 3: Outcome 1 Exercise capacity - change in endurance cycle time at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Mean Difference IV, Fixed, 95% CI	Mean Difference IV, Fixed, 95% CI
1.3.1 Randomised controlled trials - Primary rehabilitation								
Maltais 2008	246	351.2898	89	237	348.534	95	9.00 [-92.19 , 110.19]	



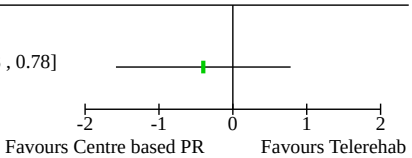
Analysis 1.4. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 4: Outcome 1 Exercise capacity - Peak watts on CPET at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Mean Difference IV, Fixed, 95% CI	Mean Difference IV, Fixed, 95% CI
1.4.1 Maintenance rehabilitation								
Vasilopoulou 2017	76	35	47	79	31	50	-3.00 [-16.19 , 10.19]	



Analysis 1.5. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 5: Outcome 1 Exercise capacity - Change in 30 sec STS repetitions at end intervention

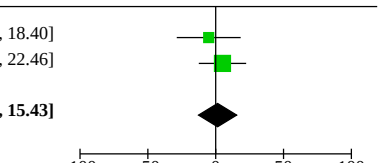
Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Mean Difference IV, Fixed, 95% CI	Mean Difference IV, Fixed, 95% CI
1.5.1 Randomised controlled trials - Primary rehabilitation								
Hansen 2020	1.3	3.6897	67	1.7	3.2798	67	-0.40 [-1.58 , 0.78]	



Analysis 1.6. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 6: Outcome 1 Exercise Capacity - Long term (>6months) change in 6MWD from baseline to end followup

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI
Holland 2017	-4.74	67.8473	62	0.41	65.9572	62	35.5%	-5.15 [-28.70 , 18.40]	
Maltais 2008	0	61.7131	89	-5	58.9072	95	64.5%	5.00 [-12.46 , 22.46]	
Total (95% CI)			**151**			**157**	**100.0%**	**1.40 [-12.62 , 15.43]**	

Heterogeneity: Tau² = 0.00; Chi² = 0.46, df = 1 (P = 0.50); I² = 0%
Test for overall effect: Z = 0.20 (P = 0.84)
Test for subgroup differences: Not applicable



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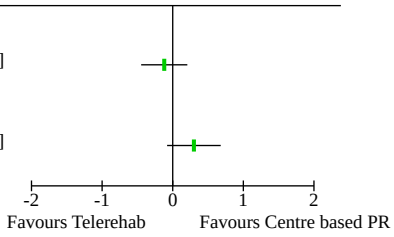
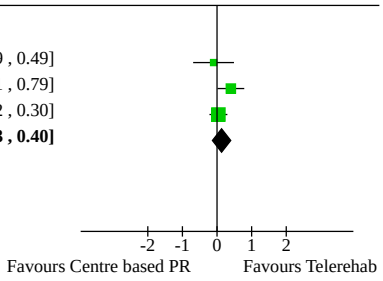
Analysis 1.7. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 7: Outcome 3 Dyspnoea - MMRC at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Mean Difference IV, Fixed, 95% CI
1.7.1 Randomised controlled trial - Primary rehabilitation							
Holland 2017	-0.12	1.0213	72	0	1.0065	76	-0.12 [-0.45 , 0.21]
1.7.2 Randomised controlled trial - Maintenance rehabilitation							
Vasilopoulou 2017	1.6	1	47	1.3	0.9	50	0.30 [-0.08 , 0.68]



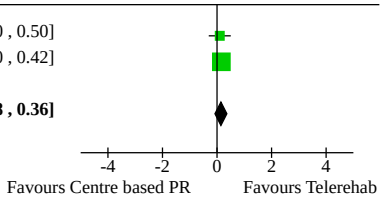
Analysis 1.8. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 8: Outcome 3 Dyspnoea - Change in CRQ Dyspnoea domain at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.8.1 Randomised controlled trials - Primary rehabilitation								
Chaplin 2017	0.7	1.2	22	0.8	1	40	16.8%	-0.10 [-0.69 , 0.49]
Holland 2017	0.9	1.2	72	0.5	1.2	76	31.9%	0.40 [0.01 , 0.79]
Maltais 2008	0.82	0.9913	107	0.78	0.9481	109	51.3%	0.04 [-0.22 , 0.30]
Subtotal (95% CI)			**201**			**225**	**100.0%**	**0.13 [-0.13 , 0.40]**
Heterogeneity: Tau² = 0.02; Chi² = 2.91, df = 2 (P = 0.23); I² = 31%								
Test for overall effect: Z = 0.97 (P = 0.33)								
Test for subgroup differences: Not applicable								



Analysis 1.9. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 9: Outcome 3 Dyspnoea - Long term (>6 months) change in CRQ Dyspnoea score from baseline to end followup

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
Holland 2017	0.4	1.3	72	0.3	1.2	76	29.1%	0.10 [-0.30 , 0.50]
Maltais 2008	0.62	0.9913	107	0.46	0.9481	109	70.9%	0.16 [-0.10 , 0.42]
Total (95% CI)			**179**			**185**	**100.0%**	**0.14 [-0.08 , 0.36]**
Heterogeneity: Tau² = 0.00; Chi² = 0.06, df = 1 (P = 0.81); I² = 0%								
Test for overall effect: Z = 1.28 (P = 0.20)								
Test for subgroup differences: Not applicable								



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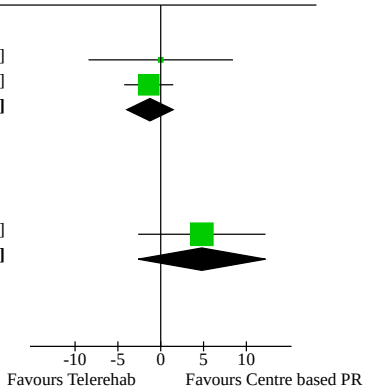
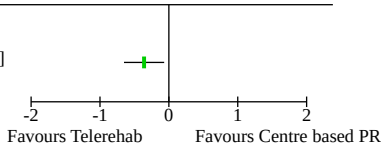
Analysis 1.10. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 10: Outcome 4 Quality of life - SGRQ total score at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.10.1 Randomised controlled trial - Primary rehabilitation								
Bourne 2017	39.3	18.5	64	39.3	18.5	26	10.3%	0.00 [-8.43 , 8.43]
Maltais 2008	-7.7	9.969	89	-6.3	9.8179	95	89.7%	-1.40 [-4.26 , 1.46]
Subtotal (95% CI)			**153**			**121**	**100.0%**	**-1.26 [-3.97 , 1.45]**
Heterogeneity: Tau² = 0.00; Chi² = 0.09, df = 1 (P = 0.76); I² = 0%								
Test for overall effect: Z = 0.91 (P = 0.36)								
1.10.2 Randomised controlled trials - Maintenance rehabilitation								
Vasilopoulou 2017	38.4	20.5	47	33.6	16.5	50	100.0%	4.80 [-2.63 , 12.23]
Subtotal (95% CI)			**47**			**50**	**100.0%**	**4.80 [-2.63 , 12.23]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 1.27 (P = 0.21)								



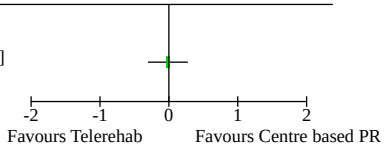
Analysis 1.11. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 11: Outcome 4 Quality of life - Change in SGRQ symptom score at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Std. Mean Difference IV, Fixed, 95% CI
1.11.1 Randomised controlled trial - Primary rehabilitation							
Maltais 2008	-9.2	17.0898	89	-3.1	16.6904	95	-0.36 [-0.65 , -0.07]



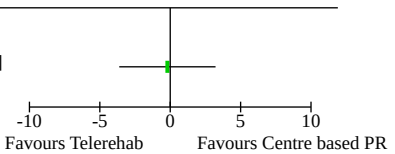
Analysis 1.12. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 12: Outcome 4 Quality of life - Change in SGRQ activity score at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Std. Mean Difference IV, Fixed, 95% CI
1.12.1 Randomised controlled trial - Primary rehabilitation							
Maltais 2008	-5.9	14.7162	89	-5.7	14.7268	95	-0.01 [-0.30 , 0.28]



Analysis 1.13. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 13: Outcome 4 Quality of life - Change in SGRQ impact score at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Mean Difference IV, Fixed, 95% CI
1.13.1 Randomised controlled trial - Primary rehabilitation							
Maltais 2008	-8.1	11.8679	89	-7.9	11.7814	95	-0.20 [-3.62 , 3.22]



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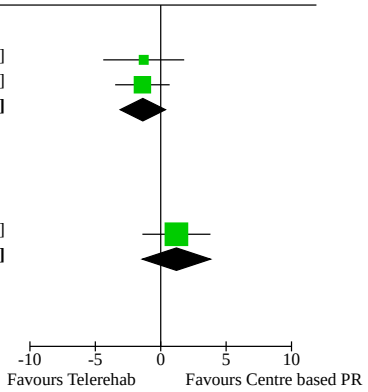
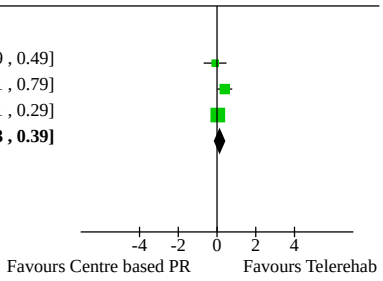
Analysis 1.14. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 14: Outcome 4 Quality of life - CAT score at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.14.1 Randomised controlled trial - Primary rehabilitation								
Bourne 2017	14.9	7	64	16.2	6.7	26	31.2%	-1.30 [-4.39 , 1.79]
Hansen 2020	-1.7	6.1496	67	-0.3	6.1496	67	68.8%	-1.40 [-3.48 , 0.68]
Subtotal (95% CI)			**131**			**93**	**100.0%**	**-1.37 [-3.10 , 0.36]**
Heterogeneity: Tau² = 0.00; Chi² = 0.00, df = 1 (P = 0.96); I² = 0%								
Test for overall effect: Z = 1.55 (P = 0.12)								
1.14.2 Maintenance rehabilitation								
Vasilopoulou 2017	13	7.3	47	11.8	5.6	50	100.0%	1.20 [-1.40 , 3.80]
Subtotal (95% CI)			**47**			**50**	**100.0%**	**1.20 [-1.40 , 3.80]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 0.90 (P = 0.37)								



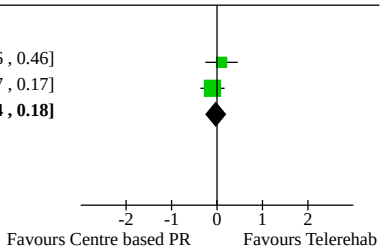
Analysis 1.15. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 15: Outcome 4 Quality of life - Change in CRQ Dyspnoea domain at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.15.1 Randomised controlled trials - Primary rehabilitation								
Chaplin 2017	0.7	1.2	22	0.8	1	40	16.6%	-0.10 [-0.69 , 0.49]
Holland 2017	0.9	1.2	72	0.5	1.2	76	31.5%	0.40 [0.01 , 0.79]
Maltais 2008	0.82	0.9391	107	0.78	0.9481	109	51.9%	0.04 [-0.21 , 0.29]
Subtotal (95% CI)			**201**			**225**	**100.0%**	**0.13 [-0.13 , 0.39]**
Heterogeneity: Tau² = 0.02; Chi² = 2.94, df = 2 (P = 0.23); I² = 32%								
Test for overall effect: Z = 0.97 (P = 0.33)								
Test for subgroup differences: Not applicable								



Analysis 1.16. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 16: Outcome 4 Quality of life - Change in CRQ Fatigue domain at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.16.1 Randomised controlled trials - Primary rehabilitation								
Holland 2017	0.5	1.2	72	0.4	1	76	35.7%	0.10 [-0.26 , 0.46]
Maltais 2008	0.36	0.9913	107	0.46	1.0007	109	64.3%	-0.10 [-0.37 , 0.17]
Subtotal (95% CI)			**179**			**185**	**100.0%**	**-0.03 [-0.24 , 0.18]**
Heterogeneity: Tau² = 0.00; Chi² = 0.78, df = 1 (P = 0.38); I² = 0%								
Test for overall effect: Z = 0.26 (P = 0.79)								
Test for subgroup differences: Not applicable								



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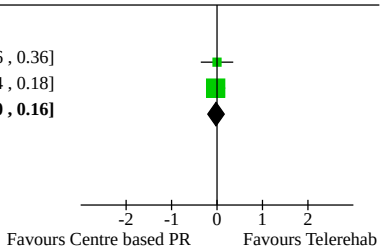
Analysis 1.17. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 17: Outcome 4 Quality of life - Change in CRQ Emotion domain at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.17.1 Randomised controlled trials - Primary rehabilitation								
Holland 2017	0.4	1.2	72	0.4	1	76	25.7%	0.00 [-0.36 , 0.36]
Maltais 2008	0.35	0.7826	107	0.38	0.7901	109	74.3%	-0.03 [-0.24 , 0.18]
Subtotal (95% CI)			**179**			**185**	**100.0%**	**-0.02 [-0.20 , 0.16]**

Heterogeneity: Tau² = 0.00; Chi² = 0.02, df = 1 (P = 0.89); I² = 0%
Test for overall effect: Z = 0.24 (P = 0.81)

Test for subgroup differences: Not applicable

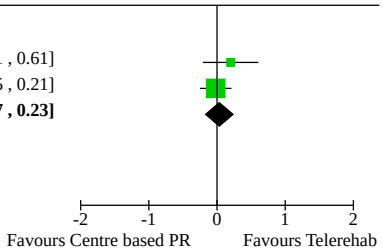


Analysis 1.18. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 18: Outcome 4 Quality of life - Change in CRQ Mastery domain at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.18.1 Randomised controlled trials - Primary rehabilitation								
Holland 2017	0.7	1.4	72	0.5	1.1	76	24.3%	0.20 [-0.21 , 0.61]
Maltais 2008	0.49	0.887	107	0.51	0.8427	109	75.7%	-0.02 [-0.25 , 0.21]
Subtotal (95% CI)			**179**			**185**	**100.0%**	**0.03 [-0.17 , 0.23]**

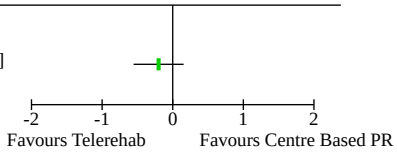
Heterogeneity: Tau² = 0.00; Chi² = 0.85, df = 1 (P = 0.36); I² = 0%
Test for overall effect: Z = 0.33 (P = 0.74)

Test for subgroup differences: Not applicable



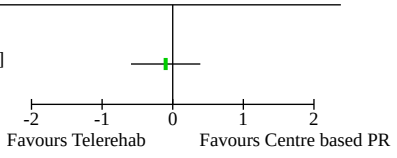
Analysis 1.19. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 19: Outcome 4 Quality of life - Change in CCQ Function domain at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Mean Difference IV, Fixed, 95% CI
1.19.1 Randomised controlled trials - Primary rehabilitation							
Hansen 2020	-0.3	0.8199	67	-0.1	1.2299	67	-0.20 [-0.55 , 0.15]



Analysis 1.20. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 20: Outcome 4 Quality of life - Change in CCQ Mental domain at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Mean Difference IV, Fixed, 95% CI
1.20.1 Randomised controlled trial - Primary rehabilitation							
Hansen 2020	-0.2	1.6399	67	-0.1	1.2299	67	-0.10 [-0.59 , 0.39]



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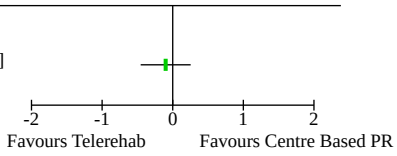
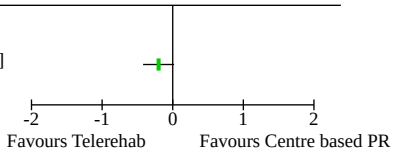
Analysis 1.21. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 21: Outcome 4 Quality of life - Change in CCQ Symptom domain at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Mean Difference IV, Fixed, 95% CI	Mean Difference IV, Fixed, 95% CI
1.21.1 Randomised controlled trials - Primary rehabilitation								
Hansen 2020	-0.3	1.2299	67	-0.2	0.8199	67	-0.10 [-0.45 , 0.25]	



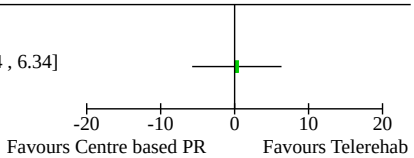
Analysis 1.22. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 22: Outcome 4 Quality of life - Change in CCQ total score at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Mean Difference IV, Fixed, 95% CI	Mean Difference IV, Fixed, 95% CI
1.22.1 Randomised controlled trial - Primary rehabilitation								
Hansen 2020	-0.3	0.41	67	-0.1	0.8199	67	-0.20 [-0.42 , 0.02]	



Analysis 1.23. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 23: Outcome 4 Quality of life - Change in EQ-5D-VAS score at end intervention

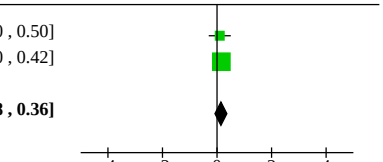
Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Mean Difference IV, Fixed, 95% CI	Mean Difference IV, Fixed, 95% CI
1.23.1 Randomised controlled trials - Primary rehabiliation								
Hansen 2020	3.2	18.0388	67	2.9	17.6288	67	0.30 [-5.74 , 6.34]	



Analysis 1.24. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 24: Outcome 4 Quality of Life - Long term (>6 months) change in CRQ Dyspnoea score from baseline to end followup

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI
Holland 2017	0.4	1.3	72	0.3	1.2	76	29.1%	0.10 [-0.30 , 0.50]	
Maltais 2008	0.62	0.9913	107	0.46	0.9481	109	70.9%	0.16 [-0.10 , 0.42]	
Total (95% CI)			**179**			**185**	**100.0%**	**0.14 [-0.08 , 0.36]**	

Heterogeneity: Tau² = 0.00; Chi² = 0.06, df = 1 (P = 0.81); I² = 0%
Test for overall effect: Z = 1.28 (P = 0.20)
Test for subgroup differences: Not applicable



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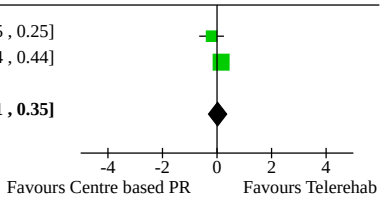
Analysis 1.25. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 25: Outcome 4 Quality of Life - Long term (>6 months) change in CRQ Fatigue score from baseline to end followup

	Telerehabilitation			Centre based PR				Mean Difference	Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI	IV, Random, 95% CI
Holland 2017	0.2	1.5	72	0.4	1.3	76	36.9%	-0.20 [-0.65 , 0.25]	
Maltais 2008	0.25	0.9913	107	0.1	1.1588	109	63.1%	0.15 [-0.14 , 0.44]	
Total (95% CI)			**179**			**185**	**100.0%**	**0.02 [-0.31 , 0.35]**	

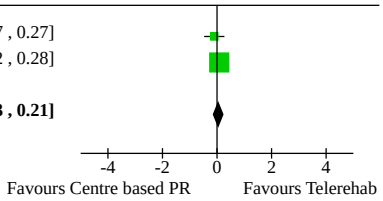
Heterogeneity: Tau² = 0.02; Chi² = 1.63, df = 1 (P = 0.20); I² = 39%
Test for overall effect: Z = 0.12 (P = 0.90)
Test for subgroup differences: Not applicable



Analysis 1.26. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 26: Outcome 4 Quality of Life - Long term (>6 months) change in CRQ Emotion score from baseline to end followup

	Telerehabilitation			Centre based PR				Mean Difference	Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI	IV, Random, 95% CI
Holland 2017	0.4	1.1	72	0.5	1.2	76	21.8%	-0.10 [-0.47 , 0.27]	
Maltais 2008	0.28	0.7304	107	0.2	0.7374	109	78.2%	0.08 [-0.12 , 0.28]	
Total (95% CI)			**179**			**185**	**100.0%**	**0.04 [-0.13 , 0.21]**	

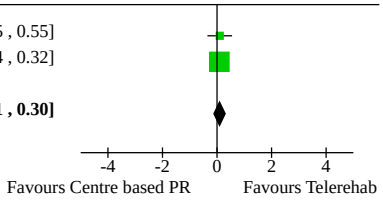
Heterogeneity: Tau² = 0.00; Chi² = 0.71, df = 1 (P = 0.40); I² = 0%
Test for overall effect: Z = 0.46 (P = 0.64)
Test for subgroup differences: Not applicable



Analysis 1.27. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 27: Outcome 4 Quality of Life - Long term (>6 months) change in CRQ Mastery score from baseline to end followup

	Telerehabilitation			Centre based PR				Mean Difference	Mean Difference
Study or Subgroup	Mean	SD	Total	Mean	SD	Total	Weight	IV, Random, 95% CI	IV, Random, 95% CI
Holland 2017	0.5	1.4	72	0.4	1.4	76	20.7%	0.10 [-0.35 , 0.55]	
Maltais 2008	0.39	0.8348	107	0.3	0.8954	109	79.3%	0.09 [-0.14 , 0.32]	
Total (95% CI)			**179**			**185**	**100.0%**	**0.09 [-0.11 , 0.30]**	

Heterogeneity: Tau² = 0.00; Chi² = 0.00, df = 1 (P = 0.97); I² = 0%
Test for overall effect: Z = 0.88 (P = 0.38)
Test for subgroup differences: Not applicable



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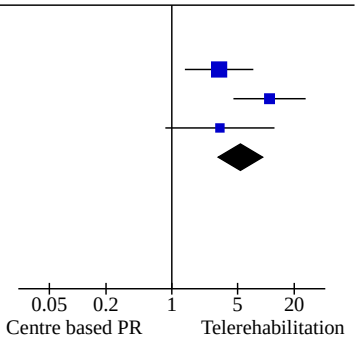
Analysis 1.28. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 28: Outcome 5 Completion of the intervention

Study or Subgroup	Telerehabilitation Events	Total	Centre based PR Events	Total	Weight	Odds Ratio M-H, Fixed, 95% CI
1.28.1 Randomised controlled trials - primary rehabilitation						
Hansen 2020	57	67	43	67	50.6%	3.18 [1.38 , 7.35]
Holland 2017	73	80	42	86	27.9%	10.93 [4.52 , 26.43]
Maltais 2008	106	109	98	107	21.5%	3.24 [0.85 , 12.33]
Subtotal (95% CI)		**256**		**260**	**100.0%**	**5.36 [3.12 , 9.21]**
Total events:	236		183			

Heterogeneity: Chi² = 4.53, df = 2 (P = 0.10); I² = 56%
Test for overall effect: Z = 6.08 (P < 0.00001)

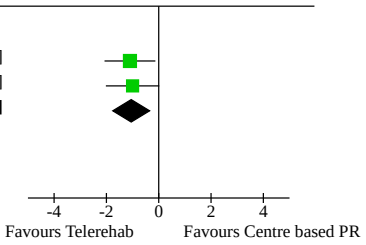
Test for subgroup differences: Not applicable



Analysis 1.29. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 29: Outcome 6 Anxiety/Depression - Change in HADS Anxiety score at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.29.1 Randomised controlled trials - Primary rehabilitation								
Hansen 2020	-1	2.8698	67	0.1	2.8698	67	52.5%	-1.10 [-2.07 , -0.13]
Holland 2017	-1	3.4	72	0	2.9	76	47.5%	-1.00 [-2.02 , 0.02]
Subtotal (95% CI)			**139**			**143**	**100.0%**	**-1.05 [-1.76 , -0.35]**

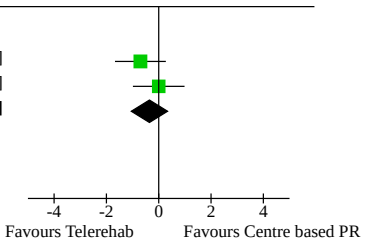
Heterogeneity: Tau² = 0.00; Chi² = 0.02, df = 1 (P = 0.89); I² = 0%
Test for overall effect: Z = 2.93 (P = 0.003)



Analysis 1.30. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 30: Outcome 6 Anxiety/Depression - Change in HADS Depression score at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.30.1 Randomised controlled trial - Primary rehabilitation								
Hansen 2020	-0.4	2.8698	67	0.3	2.8698	67	50.8%	-0.70 [-1.67 , 0.27]
Holland 2017	0	2.7	72	0	3.4	76	49.2%	0.00 [-0.99 , 0.99]
Subtotal (95% CI)			**139**			**143**	**100.0%**	**-0.36 [-1.05 , 0.34]**

Heterogeneity: Tau² = 0.00; Chi² = 0.98, df = 1 (P = 0.32); I² = 0%
Test for overall effect: Z = 1.01 (P = 0.31)



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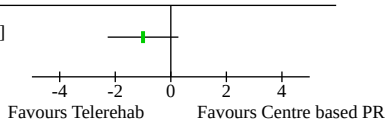
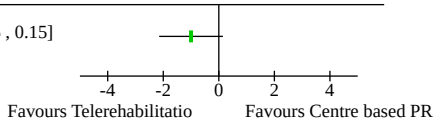
Analysis 1.31. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 31: Outcome 6 Anxiety/Depression - Long term (>6 months) change in HADS Anxiety score from baseline to end followup

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI
Holland 2017	-1	3.8	72	0	4.1	76	-1.00 [-2.27 , 0.27]	



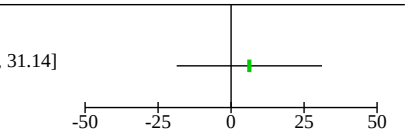
Analysis 1.32. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 32: Outcome 6 Anxiety/Depression - Long term (>6 months) change in HADS Depression score from baseline to end followup

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI
Holland 2017	-1	3.2	72	0	3.9	76	-1.00 [-2.15 , 0.15]	



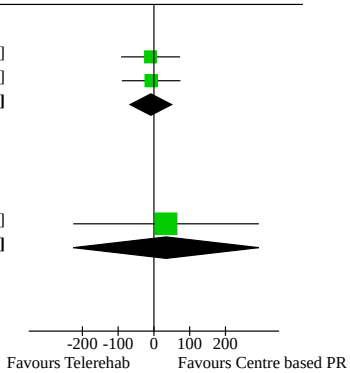
Analysis 1.33. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 33: Outcome 7 Physical activity - Change in MVPA time (minutes/day) at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Mean Difference IV, Fixed, 95% CI	Mean Difference IV, Fixed, 95% CI
1.33.1 Randomised controlled trial - Primary rehabiliation								
Holland 2017	11.37	47.58	25	5.12	48.3	33	6.25 [-18.64 , 31.14]	



Analysis 1.34. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 34: Outcome 7 Physical activity - Sedentary time (minutes/day) at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI
1.34.1 Randomised controlled trial - Primary rehabiliation									
Hansen 2020	29	241.4734	67	38.3	245.9831	67	49.6%	-9.30 [-91.84 , 73.24]	
Holland 2017	-33.73	131.89	25	-25.87	185.9923	33	50.4%	-7.86 [-89.71 , 73.99]	
Subtotal (95% CI)			**92**			**100**	**100.0%**	**-8.57 [-66.69 , 49.54]**	
Heterogeneity: Tau² = 0.00; Chi² = 0.00, df = 1 (P = 0.98); I² = 0%									
Test for overall effect: Z = 0.29 (P = 0.77)									
1.34.2 Randomised controlled trials - Maintenance rehabilitation									
Vasilopoulou 2017	578	674	47	544	627	50	100.0%	34.00 [-225.49 , 293.49]	
Subtotal (95% CI)			**47**			**50**	**100.0%**	**34.00 [-225.49 , 293.49]**	
Heterogeneity: Not applicable									
Test for overall effect: Z = 0.26 (P = 0.80)									
Test for subgroup differences: Chi² = 0.10, df = 1 (P = 0.75), I² = 0%									



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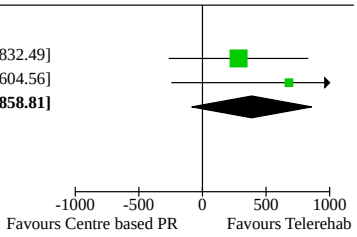
Analysis 1.35. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 35: Outcome 7 Physical activity - Change in steps/day at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
1.35.1 Randomised controlled trial - Primary rehabilitation								
Hansen 2020	-116	1586.5912	67	-400	1652.1867	67	74.0%	284.00 [-264.49 , 832.49]
Holland 2017	520	1763.65	25	-160	1799.29	33	26.0%	680.00 [-244.56 , 1604.56]
Subtotal (95% CI)			**92**			**100**	**100.0%**	**387.09 [-84.64 , 858.81]**

Heterogeneity: Tau² = 0.00; Chi² = 0.52, df = 1 (P = 0.47); I² = 0%

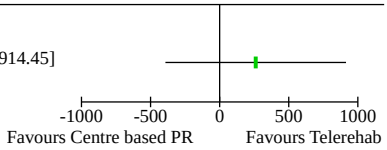
Test for overall effect: Z = 1.61 (P = 0.11)

Test for subgroup differences: Not applicable



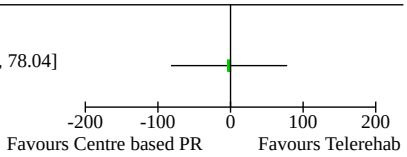
Analysis 1.36. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 36: Outcome 7 Physical Activity - Change in total daily Energy Expenditure (k/cal) at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Mean Difference IV, Fixed, 95% CI
1.36.1 Randomised controlled trial - Primary rehabilitation							
Holland 2017	-33	1245.2162	25	-294	1273.32	33	261.00 [-392.45 , 914.45]



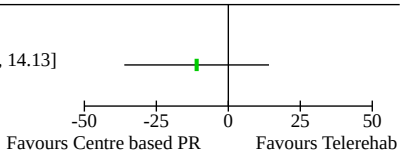
Analysis 1.37. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 37: Outcome 7 Physical activity - Light physical activity time (minutes)/day at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Mean Difference IV, Random, 95% CI
1.37.1 Randomised controlled trial - Maintenance rehabiliation							
Vasilopoulou 2017	157	201	47	159	201	50	-2.00 [-82.04 , 78.04]



Analysis 1.38. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 38: Outcome 7 Physical Activity - Lifestyle physical activity time (minutes)/day at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Mean Difference IV, Random, 95% CI
1.38.1 Randomised controlled trial - Maintenance rehabiliation							
Vasilopoulou 2017	41	57	47	52	69	50	-11.00 [-36.13 , 14.13]



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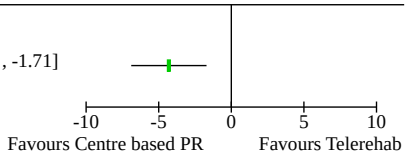
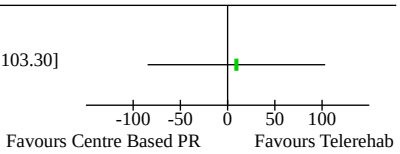
Analysis 1.39. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 39: Outcome 7 Physical Activity - Moderate physical activity time (minutes)/day at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Mean Difference IV, Random, 95% CI
1.39.1 Randomised controlled trial - Maintenance rehabiliation							
Vasilopoulou 2017	17.2	5.9	47	21.5	7.1	50	-4.30 [-6.89 , -1.71]



Analysis 1.40. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 40: Outcome 7 Physical activity - Change in time active (minutes) at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	Centre based PR Mean	SD	Total	Mean Difference IV, Random, 95% CI
1.40.1 Randomised controlled trial - Primary rehabilitation							
Hansen 2020	-29	272.2213	67	-38.3	282.8806	67	9.30 [-84.70 , 103.30]



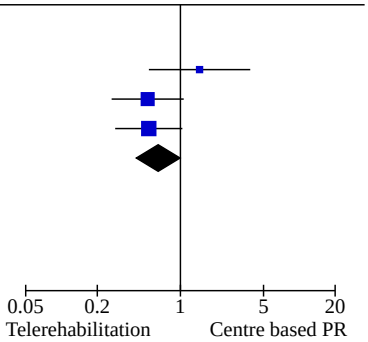
Analysis 1.41. Comparison 1: Telerehabilitation vs Centre-based (outpatient) pulmonary rehabilitation, Outcome 41: Outcome 8 Health care utilisation - Respiratory related hospitalisation

Study or Subgroup	Telerehabilitation Events	Total	Centre based PR Events	Total	Weight	Odds Ratio M-H, Fixed, 95% CI
1.41.1 Randomised controlled trials - Primary rehabilitation						
Hansen 2020	59	67	56	67	12.5%	1.45 [0.54 , 3.87]
Holland 2017	17	80	29	86	41.0%	0.53 [0.26 , 1.07]
Maltais 2008	19	109	30	107	46.6%	0.54 [0.28 , 1.04]
Subtotal (95% CI)		**256**		**260**	**100.0%**	**0.65 [0.43 , 0.99]**
Total events:	95		115			

Heterogeneity: Chi² = 3.19, df = 2 (P = 0.20); I² = 37%

Test for overall effect: Z = 2.00 (P = 0.05)

Test for subgroup differences: Not applicable



Comparison 3. Telerehabilitation vs no rehabilitation control

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3.1 Outcome 1 Exercise capacity - 6minute walk distance at end intervention	4		Mean Difference (IV, Random, 95% CI)	Subtotals only
3.1.1 Randomised controlled trials - Primary rehabilitation	2	94	Mean Difference (IV, Random, 95% CI)	22.17 [-38.89, 83.23]
3.1.2 Maintenance rehabilitation	2	209	Mean Difference (IV, Random, 95% CI)	78.10 [49.60, 106.60]

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Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3.2 Outcome 1 Exercise capacity - Peak watts on CPET at end intervention	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
3.2.1 Randomise controlled trial - Maintenance rehabilitation	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
3.3 Outcome 1 Exercise capacity - Change in ISWT distance at end intervention	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
3.3.1 Randomised controlled trial - Primary rehabilitation	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
3.4 Outcome 1 Exercise capacity - Change in ESWT time at end of intervention	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
3.4.1 Randomised controlled trial - Primary rehabilitation	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
3.5 Outcome 3 Dyspnoea - Change in CRQ Dyspnoea domain at end intervention	2		Mean Difference (IV, Random, 95% CI)	Subtotals only
3.5.1 Randomised controlled trial - Primary rehabilitation	2	94	Mean Difference (IV, Random, 95% CI)	1.97 [-1.07, 5.02]
3.6 Outcome 3 Dyspnoea - Change in exercise isotime breathlessness score at end intervention	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
3.6.1 Randomised controlled trial - Primary rehabilitation	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
3.7 Outcome 3 Dyspnoea - MMRC at end intervention	3		Mean Difference (IV, Random, 95% CI)	Subtotals only
3.7.1 Randomised controlled trial - Primary rehabilitation	1	58	Mean Difference (IV, Random, 95% CI)	0.00 [-0.61, 0.61]
3.7.2 Randomised controlled trial - Maintenance rehabilitation	2	189	Mean Difference (IV, Random, 95% CI)	-0.86 [-2.10, 0.37]
3.8 Outcome 4 Quality of life - SGRQ total score at end intervention	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
3.8.1 Randomised controlled trial -Maintenance rehabilitation	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
3.9 Outcome 4 Quality of life - CAT score at end intervention	3		Mean Difference (IV, Random, 95% CI)	Subtotals only
3.9.1 Randomised controlled trial - Primary rehabiliation	1	36	Mean Difference (IV, Random, 95% CI)	-4.00 [-7.35, -0.65]
3.9.2 Randomised controlled trial - Maintenance rehabilitation	2	189	Mean Difference (IV, Random, 95% CI)	-7.34 [-9.20, -5.48]

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Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3.10 Outcome 4 Quality of life - Change in CRQ total score at end intervention	2		Mean Difference (IV, Random, 95% CI)	Subtotals only
3.10.1 Randomised controlled trial - Primary rehabilitation	2	94	Mean Difference (IV, Random, 95% CI)	6.90 [-0.57, 14.36]
3.11 Outcome 4 Quality of life - Change in CRQ Dyspnoea domain at end intervention	2		Mean Difference (IV, Random, 95% CI)	Subtotals only
3.11.1 Randomised controlled trial - Primary rehabilitation	2	94	Mean Difference (IV, Random, 95% CI)	1.97 [-1.07, 5.02]
3.12 Outcome 4 Quality of life - Change in CRQ Fatigue domain at end intervention	2		Mean Difference (IV, Random, 95% CI)	Subtotals only
3.12.1 Randomised controlled trial - Primary rehabilitation	2	94	Mean Difference (IV, Random, 95% CI)	2.30 [0.31, 4.30]
3.13 Outcome 4 Quality of life - Change in CRQ Emotion domain at end intervention	2		Mean Difference (IV, Random, 95% CI)	Subtotals only
3.13.1 Randomised controlled trial - Primary rehabilitation	2	94	Mean Difference (IV, Random, 95% CI)	2.43 [-0.98, 5.85]
3.14 Outcome 4 Quality of life - Change in CRQ Mastery domain at end intervention	2		Mean Difference (IV, Random, 95% CI)	Subtotals only
3.14.1 Randomised controlled trial - Primary rehabilitation	2	94	Mean Difference (IV, Random, 95% CI)	0.30 [-1.54, 2.14]
3.15 Outcome 4 Quality of life - Change in MLHFQ at end intervention	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
3.15.1 Randomised controlled trial - Maintenance rehabilitation	1		Mean Difference (IV, Fixed, 95% CI)	Totals not selected
3.16 Outcome 5 Anxiety/Depression - Change in HADS Anxiety score at end intervention	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
3.16.1 Randomised controlled trial - Primary rehabilitation	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
3.17 Outcome 5 Anxiety/Depression - Change in HADS Depression score at end interveniton	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
3.17.1 Randomised controlled trial - Primary rehabilitation	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
3.18 Outcome 6 Physical activity - Change in total Energy Expenditure (kcal)/day at end intervention	1		Mean Difference (IV, Random, 95% CI)	Totals not selected

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Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3.18.1 Randomised controlled trials - Primary rehabilitation	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
3.19 Outcome 6 Physical activity - Change in steps/day at end intervention	2		Mean Difference (IV, Random, 95% CI)	Subtotals only
3.19.1 Randomised controlled trial - Primary rehabilitation	2	94	Mean Difference (IV, Random, 95% CI)	488.78 [-142.84, 1120.40]
3.20 Outcome 6 Physical activity - Sedentary time (minutes)/day at end intervention	3		Mean Difference (IV, Random, 95% CI)	Subtotals only
3.20.1 Randomised controlled trial - Primary rehabilitation	2	94	Mean Difference (IV, Random, 95% CI)	42.44 [-25.77, 110.66]
3.20.2 Randomised controlled trial - Maintenance rehabilitation	1	97	Mean Difference (IV, Random, 95% CI)	-29.00 [-299.13, 241.13]
3.21 Outcome 6 Physical activity - Light physical activity time (minutes)/day at end intervention	2		Mean Difference (IV, Random, 95% CI)	Totals not selected
3.21.1 Randomised controlled trial - Primary rehabilitation	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
3.21.2 Randomised controlled trial - Maintenance rehabilitation	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
3.22 Outcome 6 Physical activity - Lifestyle physical activity time (minutes)/day at end intervention	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
3.22.1 Randomised controlled trial - Maintenance rehabilitation	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
3.23 Outcome 6 Physical activity - Moderate intensity physical activity time (minutes)/day at end intervention	2		Mean Difference (IV, Random, 95% CI)	Totals not selected
3.23.1 Randomised controlled trial - Primary rehabilitation	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
3.23.2 Randomised controlled trial - Maintenance rehabilitation	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
3.24 Outcome 6 Physical activity - Change in Vigorous physical activity time (minutes)/day at end intervention	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
3.24.1 Randomised controlled trial - Primary rehabilitation	1		Mean Difference (IV, Random, 95% CI)	Totals not selected

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Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
3.25 Outcome 6 Physical activity - Change in Very Vigorous physical activity time (minutes)/day at end intervention	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
3.25.1 Randomised controlled trial - Primary rehabilitation	1		Mean Difference (IV, Random, 95% CI)	Totals not selected
3.26 Outcome 6 Physical activity - Change in number sedentary bouts/day at end rehabilitation	1		Mean Difference (IV, Random, 95% CI)	Subtotals only
3.27 Outcome 6 Physical activity - Change in time spent in sedentary bouts minutes/day at end rehabilitation	1		Mean Difference (IV, Random, 95% CI)	Subtotals only
3.28 Outcome 6 Physical activity - Change in moderate-vigorous physical activity time minutes/day at end rehabilitation	1		Mean Difference (IV, Random, 95% CI)	Subtotals only
3.29 Outcome 6 Physical activity - Change in number of bouts moderate-vigorous physical activity/day at end rehabilitation	1		Mean Difference (IV, Random, 95% CI)	Subtotals only
3.30 Outcome 6 Physical activity - Change in time spent in moderate-vigorous bouts, minutes/day at end rehabilitation	1		Mean Difference (IV, Random, 95% CI)	Subtotals only
3.31 Outcome 6 Physical activity - Change in metabolic equivalents (METs)/day at end rehabilitation	1		Mean Difference (IV, Random, 95% CI)	Subtotals only
3.32 Outcome 7 - Health care utilisation	1		Odds Ratio (M-H, Fixed, 95% CI)	Totals not selected
3.32.1 Randomised controlled trials - maintenance rehabilitation	1		Odds Ratio (M-H, Fixed, 95% CI)	Totals not selected

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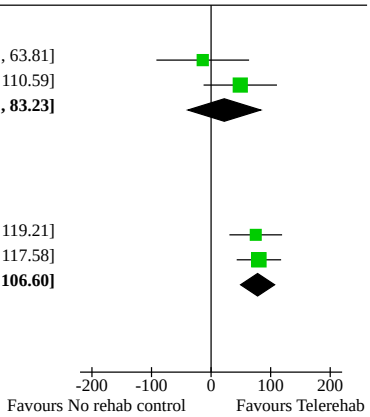
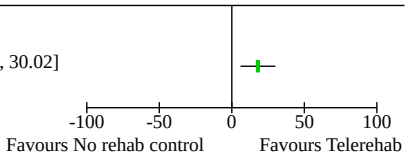
Analysis 3.1. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 1: Outcome 1 Exercise capacity - 6minute walk distance at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
3.1.1 Randomised controlled trials - Primary rehabilitation								
Lahham 2020	15	152.4792	29	29	149.8503	29	42.6%	-14.00 [-91.81 , 63.81]
Tsai 2017	40	82.9902	19	-9	103.0822	17	57.4%	49.00 [-12.59 , 110.59]
Subtotal (95% CI)			**48**			**46**	**100.0%**	**22.17 [-38.89 , 83.23]**
Heterogeneity: Tau² = 702.71; Chi² = 1.55, df = 1 (P = 0.21); I² = 35%								
Test for overall effect: Z = 0.71 (P = 0.48)								
3.1.2 Maintenance rehabilitation								
Bernocchi 2018	60	141.1492	56	-15	92.6058	56	41.6%	75.00 [30.79 , 119.21]
Vasilopoulou 2017	420.2	74.9	47	339.9	110.1	50	58.4%	80.30 [43.02 , 117.58]
Subtotal (95% CI)			**103**			**106**	**100.0%**	**78.10 [49.60 , 106.60]**
Heterogeneity: Tau² = 0.00; Chi² = 0.03, df = 1 (P = 0.86); I² = 0%								
Test for overall effect: Z = 5.37 (P < 0.00001)								
Test for subgroup differences: Chi² = 2.65, df = 1 (P = 0.10), I² = 62.2%								



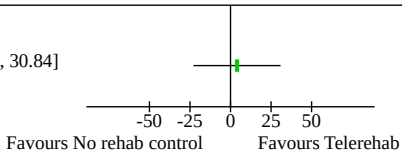
Analysis 3.2. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 2: Outcome 1 Exercise capacity - Peak watts on CPET at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Mean Difference IV, Fixed, 95% CI
3.2.1 Randomise controlled trial - Maintenance rehabilitation							
Vasilopoulou 2017	76	35	47	58	24	50	18.00 [5.98 , 30.02]



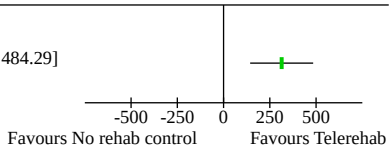
Analysis 3.3. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 3: Outcome 1 Exercise capacity - Change in ISWT distance at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Mean Difference IV, Fixed, 95% CI
3.3.1 Randomised controlled trial - Primary rehabilitation							
Tsai 2017	12	49.7941	19	8	31.1192	17	4.00 [-22.84 , 30.84]



Analysis 3.4. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 4: Outcome 1 Exercise capacity - Change in ESWT time at end of intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Mean Difference IV, Fixed, 95% CI
3.4.1 Randomised controlled trial - Primary rehabilitation							
Tsai 2017	283	367.2317	19	-31	87.5227	17	314.00 [143.71 , 484.29]



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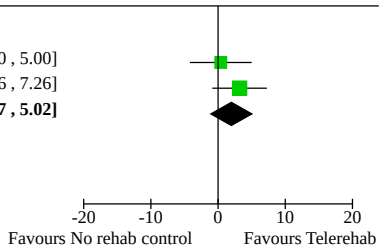
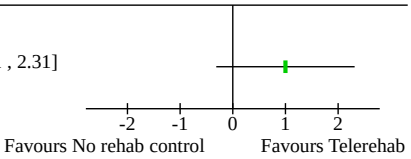
Analysis 3.5. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 5: Outcome 3 Dyspnoea - Change in CRQ Dyspnoea domain at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
3.5.1 Randomised controlled trial - Primary rehabilitation								
Lahham 2020	2.6	9.2	29	2.2	8.68	29	43.8%	0.40 [-4.20 , 5.00]
Tsai 2017	2.2	3.73	19	-1	7.78	17	56.2%	3.20 [-0.86 , 7.26]
Subtotal (95% CI)			**48**			**46**	**100.0%**	**1.97 [-1.07 , 5.02]**
Heterogeneity: Tau² = 0.00; Chi² = 0.80, df = 1 (P = 0.37); I² = 0%								
Test for overall effect: Z = 1.27 (P = 0.20)								
Test for subgroup differences: Not applicable								



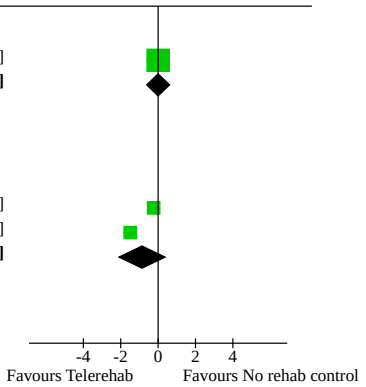
Analysis 3.6. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 6: Outcome 3 Dyspnoea - Change in exercise isotime breathlessness score at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Mean Difference IV, Fixed, 95% CI
3.6.1 Randomised controlled trial - Primary rehabilitation							
Tsai 2017	1	2.0748	19	0	1.9449	17	1.00 [-0.31 , 2.31]



Analysis 3.7. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 7: Outcome 3 Dyspnoea - MMRC at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
3.7.1 Randomised controlled trial - Primary rehabilitation								
Lahham 2020	-0.3	1.0516	29	-0.3	1.3145	29	100.0%	0.00 [-0.61 , 0.61]
Subtotal (95% CI)			**29**			**29**	**100.0%**	**0.00 [-0.61 , 0.61]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 0.00 (P = 1.00)								
3.7.2 Randomised controlled trial - Maintenance rehabilitation								
Bernocchi 2018	-0.17	0.4477	48	0.07	0.5592	44	50.7%	-0.24 [-0.45 , -0.03]
Vasilopoulou 2017	1.6	1	47	3.1	0.8	50	49.3%	-1.50 [-1.86 , -1.14]
Subtotal (95% CI)			**95**			**94**	**100.0%**	**-0.86 [-2.10 , 0.37]**
Heterogeneity: Tau² = 0.77; Chi² = 35.00, df = 1 (P < 0.00001); I² = 97%								
Test for overall effect: Z = 1.37 (P = 0.17)								



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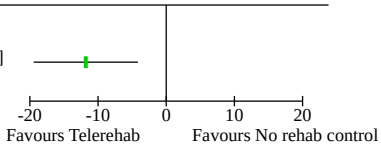
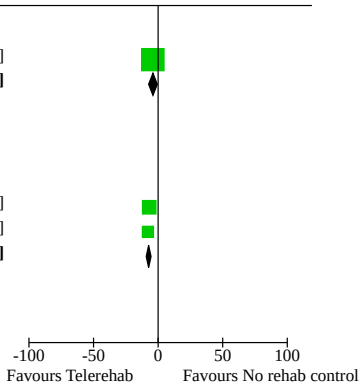
Analysis 3.8. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 8: Outcome 4 Quality of life - SGRQ total score at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Mean Difference IV, Fixed, 95% CI
3.8.1 Randomised controlled trial -Maintenance rehabilitation							
Vasilopoulou 2017	38.4	20.5	47	50.2	17.7	50	-11.80 [-19.44 , -4.16]



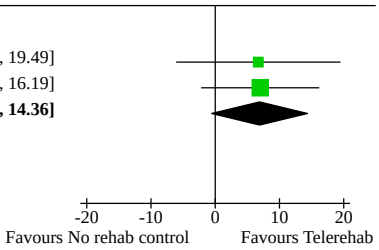
Analysis 3.9. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 9: Outcome 4 Quality of life - CAT score at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
3.9.1 Randomised controlled trial - Primary rehabiliation								
Tsai 2017	-1	6.2243	19	3	3.8899	17	100.0%	-4.00 [-7.35 , -0.65]
Subtotal (95% CI)			**19**			**17**	**100.0%**	**-4.00 [-7.35 , -0.65]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 2.34 (P = 0.02)								
3.9.2 Randomised controlled trial - Maintenance rehabilitation								
Bernocchi 2018	-5.3	5.5102	48	1.6	6.5783	44	55.9%	-6.90 [-9.39 , -4.41]
Vasilopoulou 2017	13	7.3	47	20.9	6.76	50	44.1%	-7.90 [-10.70 , -5.10]
Subtotal (95% CI)			**95**			**94**	**100.0%**	**-7.34 [-9.20 , -5.48]**
Heterogeneity: Tau² = 0.00; Chi² = 0.27, df = 1 (P = 0.60); I² = 0%								
Test for overall effect: Z = 7.72 (P < 0.00001)								



Analysis 3.10. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 10: Outcome 4 Quality of life - Change in CRQ total score at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
3.10.1 Randomised controlled trial - Primary rehabilitation								
Lahham 2020	11.3	24.975	29	4.6	24.7122	29	34.1%	6.70 [-6.09 , 19.49]
Tsai 2017	9	14.5233	19	2	13.6146	17	65.9%	7.00 [-2.19 , 16.19]
Subtotal (95% CI)			**48**			**46**	**100.0%**	**6.90 [-0.57 , 14.36]**
Heterogeneity: Tau² = 0.00; Chi² = 0.00, df = 1 (P = 0.97); I² = 0%								
Test for overall effect: Z = 1.81 (P = 0.07)								
Test for subgroup differences: Not applicable								



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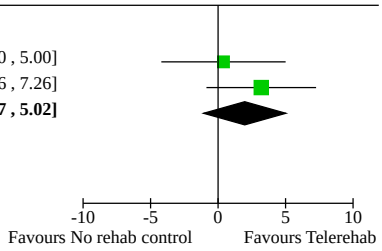
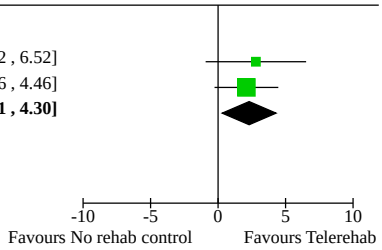
Analysis 3.11. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 11: Outcome 4 Quality of life - Change in CRQ Dyspnoea domain at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
3.11.1 Randomised controlled trial - Primary rehabilitation								
Lahham 2020	2.6	9.2	29	2.2	8.68	29	43.8%	0.40 [-4.20 , 5.00]
Tsai 2017	2.2	3.73	19	-1	7.78	17	56.2%	3.20 [-0.86 , 7.26]
Subtotal (95% CI)			**48**			**46**	**100.0%**	**1.97 [-1.07 , 5.02]**
Heterogeneity: Tau² = 0.00; Chi² = 0.80, df = 1 (P = 0.37); I² = 0%								
Test for overall effect: Z = 1.27 (P = 0.20)								
Test for subgroup differences: Not applicable								



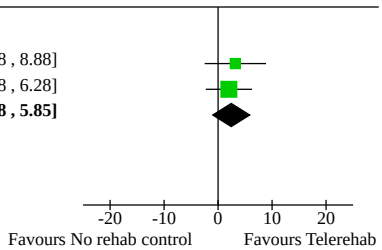
Analysis 3.12. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 12: Outcome 4 Quality of life - Change in CRQ Fatigue domain at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
3.12.1 Randomised controlled trial - Primary rehabilitation								
Lahham 2020	3.8	7.36	29	1	7.1	29	28.7%	2.80 [-0.92 , 6.52]
Tsai 2017	2	4.25	19	-0.1	2.92	17	71.3%	2.10 [-0.26 , 4.46]
Subtotal (95% CI)			**48**			**46**	**100.0%**	**2.30 [0.31 , 4.30]**
Heterogeneity: Tau² = 0.00; Chi² = 0.10, df = 1 (P = 0.76); I² = 0%								
Test for overall effect: Z = 2.26 (P = 0.02)								
Test for subgroup differences: Not applicable								



Analysis 3.13. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 13: Outcome 4 Quality of life - Change in CRQ Emotion domain at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
3.13.1 Randomised controlled trial - Primary rehabilitation								
Lahham 2020	2.6	11.04	29	-0.6	11.04	29	36.2%	3.20 [-2.48 , 8.88]
Tsai 2017	4	6.22	19	2	6.81	17	63.8%	2.00 [-2.28 , 6.28]
Subtotal (95% CI)			**48**			**46**	**100.0%**	**2.43 [-0.98 , 5.85]**
Heterogeneity: Tau² = 0.00; Chi² = 0.11, df = 1 (P = 0.74); I² = 0%								
Test for overall effect: Z = 1.40 (P = 0.16)								
Test for subgroup differences: Not applicable								



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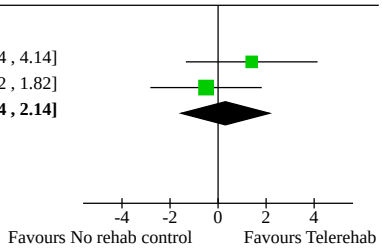
Analysis 3.14. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 14: Outcome 4 Quality of life - Change in CRQ Mastery domain at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
3.14.1 Randomised controlled trial - Primary rehabilitation								
Lahham 2020	2.3	6.5724	29	0.9	3.6805	29	42.3%	1.40 [-1.34 , 4.14]
Tsai 2017	0.5	3.11	19	1	3.89	17	57.7%	-0.50 [-2.82 , 1.82]
Subtotal (95% CI)			**48**			**46**	**100.0%**	**0.30 [-1.54 , 2.14]**

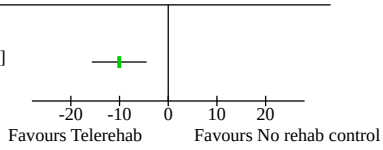
Heterogeneity: Tau² = 0.13; Chi² = 1.08, df = 1 (P = 0.30); I² = 7%
Test for overall effect: Z = 0.32 (P = 0.75)

Test for subgroup differences: Not applicable



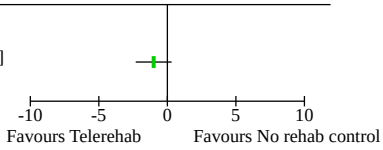
Analysis 3.15. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 15: Outcome 4 Quality of life - Change in MLHFQ at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Mean Difference IV, Fixed, 95% CI
3.15.1 Randomised controlled trial - Maintenance rehabilitation							
Bernocchi 2018	-10.5	12.7	48	-0.44	14.64	44	-10.06 [-15.68 , -4.44]



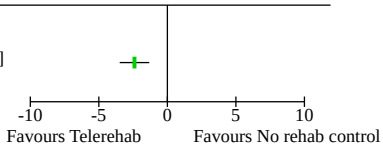
Analysis 3.16. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 16: Outcome 5 Anxiety/Depression - Change in HADS Anxiety score at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Mean Difference IV, Random, 95% CI
3.16.1 Randomised controlled trial - Primary rehabilitation							
Tsai 2017	-2	2.07	19	-1	1.94	17	-1.00 [-2.31 , 0.31]



Analysis 3.17. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 17: Outcome 5 Anxiety/Depression - Change in HADS Depression score at end interveniton

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Mean Difference IV, Random, 95% CI
3.17.1 Randomised controlled trial - Primary rehabilitation							
Tsai 2017	-1.4	1.24	19	1	1.94	17	-2.40 [-3.48 , -1.32]



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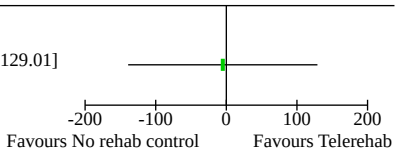
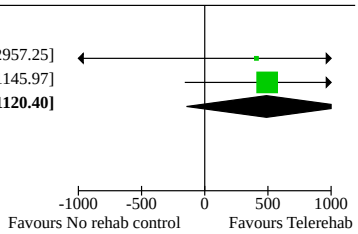
Analysis 3.18. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 18: Outcome 6 Physical activity - Change in total Energy Expenditure (kcal)/day at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Mean Difference IV, Random, 95% CI
3.18.1 Randomised controlled trials - Primary rehabilitation							
Tsai 2017	-75	240.67	19	-70	166.29	17	-5.00 [-139.01 , 129.01]



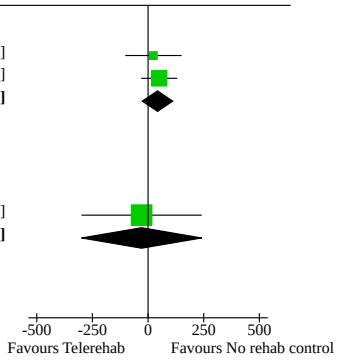
Analysis 3.19. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 19: Outcome 6 Physical activity - Change in steps/day at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
3.19.1 Randomised controlled trial - Primary rehabilitation								
Lahham 2020	303	5021.299	29	-106	4879.3356	29	6.1%	409.00 [-2139.25 , 2957.25]
Tsai 2017	207	1061.24	19	-287	934.55	17	93.9%	494.00 [-157.97 , 1145.97]
Subtotal (95% CI)			**48**			**46**	**100.0%**	**488.78 [-142.84 , 1120.40]**
Heterogeneity: Tau² = 0.00; Chi² = 0.00, df = 1 (P = 0.95); I² = 0%								
Test for overall effect: Z = 1.52 (P = 0.13)								
Test for subgroup differences: Not applicable								



Analysis 3.20. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 20: Outcome 6 Physical activity - Sedentary time (minutes)/day at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation controlontrol Mean	SD	Total	Weight	Mean Difference IV, Random, 95% CI
3.20.1 Randomised controlled trial - Primary rehabilitation								
Lahham 2020	32	249.7505	29	8	241.8636	29	29.1%	24.00 [-102.54 , 150.54]
Tsai 2017	30	81.95	19	-20	151.71	17	70.9%	50.00 [-30.99 , 130.99]
Subtotal (95% CI)			**48**			**46**	**100.0%**	**42.44 [-25.77 , 110.66]**
Heterogeneity: Tau² = 0.00; Chi² = 0.12, df = 1 (P = 0.73); I² = 0%								
Test for overall effect: Z = 1.22 (P = 0.22)								
3.20.2 Randomised controlled trial - Maintenance rehabilitation								
Vasilopoulou 2017	578	674	47	607	683	50	100.0%	-29.00 [-299.13 , 241.13]
Subtotal (95% CI)			**47**			**50**	**100.0%**	**-29.00 [-299.13 , 241.13]**
Heterogeneity: Not applicable								
Test for overall effect: Z = 0.21 (P = 0.83)								
Test for subgroup differences: Chi² = 0.25, df = 1 (P = 0.62), I² = 0%								



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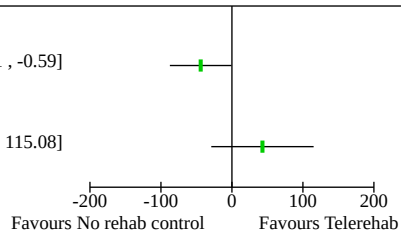
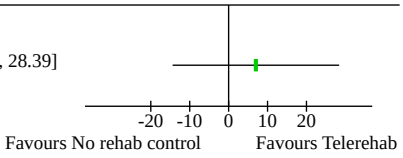
Analysis 3.21. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 21: Outcome 6 Physical activity - Light physical activity time (minutes)/day at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI
3.21.1 Randomised controlled trial - Primary rehabilitation								
Tsai 2017	-36	58.09	19	8	72.94	17	-44.00 [-87.41 , -0.59]	
3.21.2 Randomised controlled trial - Maintenance rehabilitation								
Vasilopoulou 2017	157	201	47	114	157	50	43.00 [-29.08 , 115.08]	



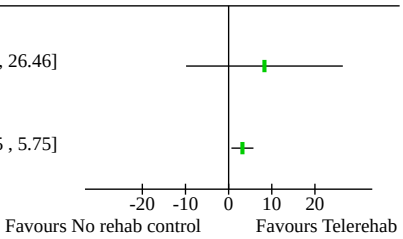
Analysis 3.22. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 22: Outcome 6 Physical activity - Lifestyle physical activity time (minutes)/day at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI
3.22.1 Randomised controlled trial - Maintenance rehabilitation								
Vasilopoulou 2017	41	57	47	34	50	50	7.00 [-14.39 , 28.39]	



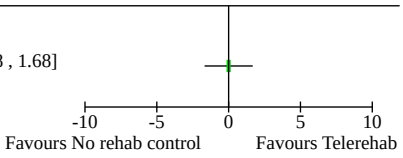
Analysis 3.23. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 23: Outcome 6 Physical activity - Moderate intensity physical activity time (minutes)/day at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI
3.23.1 Randomised controlled trial - Primary rehabilitation								
Tsai 2017	0.3	36.31	19	-8	16.73	17	8.30 [-9.86 , 26.46]	
3.23.2 Randomised controlled trial - Maintenance rehabilitation								
Vasilopoulou 2017	17.2	5.9	47	14	6.9	50	3.20 [0.65 , 5.75]	



Analysis 3.24. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 24: Outcome 6 Physical activity - Change in Vigorous physical activity time (minutes)/day at end intervention

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI
3.24.1 Randomised controlled trial - Primary rehabilitation								
Tsai 2017	0	3.11	19	0	1.94	17	0.00 [-1.68 , 1.68]	



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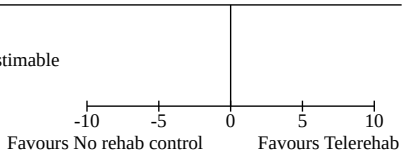
Analysis 3.25. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 25: Outcome 6 Physical activity - Change in Very Vigorous physical activity time (minutes)/day at end intervention

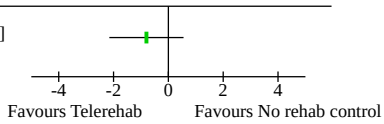
Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI
3.25.1 Randomised controlled trial - Primary rehabilitation								
Tsai 2017	0	0	19	0	0	17	Not estimable	



Analysis 3.26. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 26: Outcome 6 Physical activity - Change in number sedentary bouts/day at end rehabilitation

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI
Lahham 2020	-0.6	2.629	29	0.2	2.629	29	-0.80 [-2.15 , 0.55]	

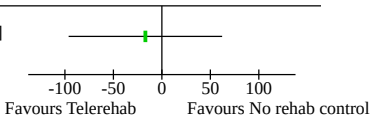
Test for subgroup differences: Not applicable



Analysis 3.27. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 27: Outcome 6 Physical activity - Change in time spent in sedentary bouts minutes/day at end rehabilitation

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI
Lahham 2020	4	155.1082	29	21	152.4792	29	-17.00 [-96.16 , 62.16]	

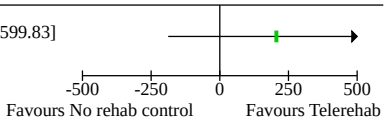
Test for subgroup differences: Not applicable



Analysis 3.28. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 28: Outcome 6 Physical activity - Change in moderate-vigorous physical activity time minutes/day at end rehabilitation

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI
Lahham 2020	-5	778.1699	29	-211	751.8804	29	206.00 [-187.83 , 599.83]	

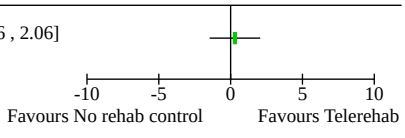
Test for subgroup differences: Not applicable



Analysis 3.29. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 29: Outcome 6 Physical activity - Change in number of bouts moderate-vigorous physical activity/day at end rehabilitation

Study or Subgroup	Telerehabilitation Mean	SD	Total	No rehabilitation control Mean	SD	Total	Mean Difference IV, Random, 95% CI	Mean Difference IV, Random, 95% CI
Lahham 2020	-0.3	3.4176	29	-0.6	3.4176	29	0.30 [-1.46 , 2.06]	

Test for subgroup differences: Not applicable



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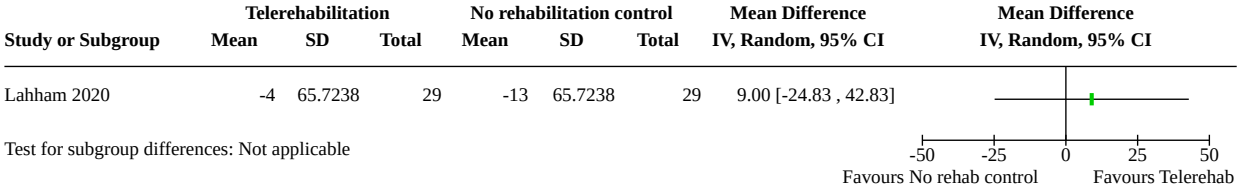
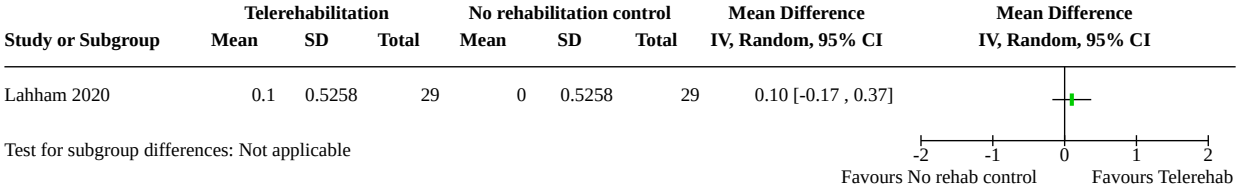
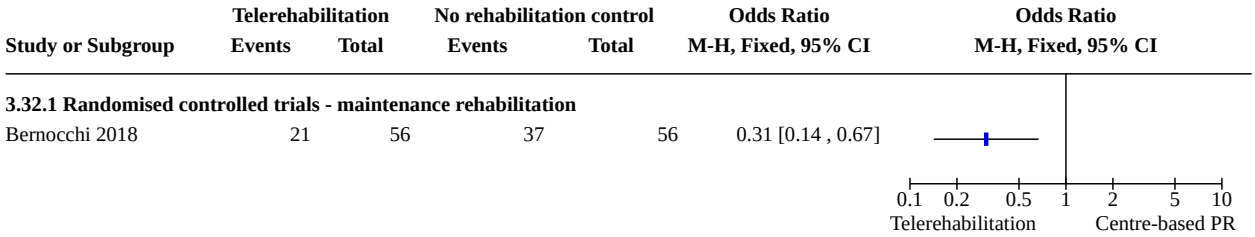
Analysis 3.30. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 30: Outcome 6 Physical activity - Change in time spent in moderate-vigorous bouts, minutes/day at end rehabilitation



Analysis 3.31. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 31: Outcome 6 Physical activity - Change in metabolic equivalents (METs)/day at end rehabilitation



Analysis 3.32. Comparison 3: Telerehabilitation vs no rehabilitation control, Outcome 32: Outcome 7 - Health care utilisation



ADDITIONAL TABLES

Table 1. Technological issues

Study	Intervention technology	Reported issues
Knox 2019	Hub and spoke telerehabilitation using videoconferencing (Polycom Real Presence Group 500 Video Conferencing System and Samsung DM65E-BR interactive screens, installed by Comcen).	The videoconferencing connection was lost in two out of 452 sessions, and sites were reconnected by redialing. Some participants had difficulty hearing a presentation in an early session which was resolved by microphone replacement and the closing of curtains to reduce echo.
Hansen 2020	In home telerehabilitation using video conferencing software installed on a single touch screen.	Major technical issues leading to cancellation and rescheduling of group sessions 2 of 360 group sessions. Minor technical issues (i.e., sound artefacts, screen freezes) not leading to cancellation or delay were present in 14% of the total group session (49/360).

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Table 1. Technological issues *(Continued)*

		Individual patient cancellation caused by technical problems was 12 of 1902 individual connections.
Tsai 2017	In home telerehabilitation using video conferencing and a tablet computer	Out of a total of 197 exercise training sessions there were 24 technical issues (12%) related to the use of technology (e.g. poor internet connection).

Table 2. ROBINS-I assessment of risk of bias in included studies (controlled clinical trials)

Study: Barbaren-Garcia 2014 (Barcelona and Athens)		
ROBINS-I domain	**Risk of Bias**	**Description**
Bias due to confounding	Serious	Confounding associated with country, socioeconomic status and health system inherently unable to be controlled for. Different components to information communication technology (ICT) support in both sub-studies.
Bias in selection of participants	Critical	Patients were allocated to the intervention or control group depending on availability of mobile phones with wireless sensors (Barcelona). Control group assessed first and afterward the intervention group due to delays in deployment of technological platform (Athens)
Bias in classification of interventions	Serious	Baseline cardiopulmonary rehabilitation and intervention differed between countries, however comparisons were not made between countries.
Bias due to deviations from intended interventions	Serious	Unable to determine if study participants adhered to the intervention; much larger drop out in the control group than intervention group - authors proposed this is due to issues with ICT in 54% of cases and access (travel) in another 25% (with proposed reason for dropout only noted for Barcelona study group)
Bias due to missing data	Serious	Large losses to follow up (47% Barcelona, 56% Athens) from the control groups. Reasons for loss to follow up from intervention groups not stated.
Bias in measurement of outcomes	Moderate	Standard tests common across groups and study sites, but unclear if outcome assessors blind. Much longer follow up for Barcelona study (mean (SD) 22 (12) months vs 12 months)
Bias in selection of the reported result	Moderate	Pre and post data presented for Barcelona group, change data presented for Athens group. SGRQ total and activity domain only presented for Barcelona group, component of SGRQ reported for Athens unclear (change data only).
Overall bias	**Critical**	
Study: Knox 2019		
ROBINS-I domain	**Risk of Bias**	**Description**
Bias due to confounding	Serious	Socio-economic status (regional vs metropolitan) unable to be accounted for. May favour control group.
Bias in selection of participants	Serious	Selection into the study was on the basis of the intervention and this was unable to be controlled for in the analysis.

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Table 2. ROBINS-I assessment of risk of bias in included studies (controlled clinical trials) *(Continued)*

Bias in classification of interventions	Low	Intervention groups were clearly defined.
Bias due to deviations from intended interventions	Moderate	Co-interventions balanced across groups (education delivered via videoconference from Hub site in real time). Hub staff were able to travel to Spoke site at their discretion if deemed more support was needed. This protocol deviation only impacted Spoke intervention sites and impact on outcomes is not able to be accounted for.
Bias due to missing data	No information	No information or insufficient information is reported about missing data. Reasons for missing data are not described. Numbers of individuals who completed the end intervention assessment are not reported in the paper. Only complete data set outcomes are reported for ISWT - other outcomes unclear (author communication)
Bias in measurement of outcomes	Moderate	Standardised assessments used (ISWT, CAT, HADS, MRC), but unclear if assessors were aware of intervention
Bias in selection of the reported result	No information	There is too little information to make a judgement
Overall bias	**Serious**	
Study: Stickland 2011		
ROBINS-I domain	**Risk of Bias**	**Description**
Bias due to confounding	Serious	Socio-economic status (regional vs metropolitan) unable to be accounted for. May favour control group.
Bias in selection of participants	Low	All enrolled participants had confirmed diagnosis of COPD. Inclusion and exclusion criteria applied equally across both groups.
Bias in classification of interventions	Low	Intervention groups were clearly defined and information to define characteristics of groups presented at the start of the intervention (baseline characteristics). Classification of intervention based on geography
Bias due to deviations from intended interventions	Low	Co-interventions balanced across group. Average number of sessions attended similar in both intervention (telehealth average 12.6 sessions) and control (standard pulmonary rehabilitation average 13.2 sessions)
Bias due to missing data	Moderate	High follow up and imputation analysis at end intervention; but significant loss to follow up data at 6-months and unable to perform imputation analysis
Bias in measurement of outcomes	Moderate	Standardised assessments used (12min walk test and SGRQ), but unclear if assessors were aware of intervention
Bias in selection of the reported result	Low	All outcome measures reported appropriately including total score and all domain scores of the SGRQ
Overall bias	**Moderate**	

CAT: COPD assessment test; **COPD:** chronic obstructive pulmonary disease; **HADS:** Hospital Anxiety and Depression Scale;**ISWT:** incremental shuttle walk test; **MRC:** medical research council dyspnoea scale; **SD:** standard deviation; **SGRQ:** St George's Respiratory Questionnaire.

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Table 3. Adverse events

Study	Adverse events details
Barberan-Garcia 2014 (Barcelona and Athens)	Not recorded as an outcome or reported.
Barberan-Garcia 2014 (Trondheim)	Not recorded as an outcome or reported.
Bernocchi 2018	PROTOCOL: • Adverse events monitoring: All adverse events that occurred during the 6-month study observation period will be reported in the final paper. A serious adverse event is defined as any untoward medical occurrence resulting in hospitalisation or prolongation of hospitalisation, or which results in a life threatening problem, death, or disability. Adverse events will be defined as any untoward occurrences in study participants, potentially related to implementation of the study protocol. All serious and unexpected adverse events will be reported to the Ethics Committee as required PAPER: • The feasibility was assessed in terms of side effects related to Telerehab-HBP,.... • In intervention group no major side effects were recorded.
Bourne 2017	• Safety was assessed by the incidence of adverse events (AEs) in each arm at study completion.(PAPER) • AEs were captured in the face-to-face group at the start of each session (twice a week) during the 6-week intervention and at final assessment. In the online arm, AEs were captured during a weekly phone call to the participant from the study clinical team and at final assessment. Causality and severity was assessed by the clinical study team. (PAPER) • Adverse events are summarised in table 5. Overall, both interventions were well tolerated with no safety issues identified. (PAPER) • Table 5- Intervention emergent adverse events: Outpatient rehabilitation control: Total n = 3 (back pain n = 1; Inguinal pain n = 1; Common cold n = 1). Online PR: Total n = 2 (back pain n = 1; muscular skeletal chest pain n = 1).
Chaplin 2017	PROTOCOL: • Any serious adverse events will be reported to the sponsor and patients' ability to exercise safely will be monitored. PAPER: • A serious adverse event was defined as an acute exacerbation of their COPD that resulted in a hospital admission. • No data reported.
Hansen 2020	• Adverse events, hospitalisations and deaths were recorded throughout the trial by the National Health Data Authorities. • n = 2 dropouts (Control, centre-based PR) potentially related to program - pain in the knee or groin, did not require medical treatment. • 41 hospital admissions related to COPD exacerbations were recorded (PTR: n = 21; PR: n = 20; P = 0.77) during the rehabilitation period, and 74 hospitalisations related to COPD exacerbations (PTR: n = 38; PR: n = 36; P = 0.97) were recorded at the 22-week follow-up. • Three deaths (PTR: n = 1; PR: n = 2) occurred during the rehabilitation period, and another three had died at the 22-week follow-up (P =1.0).
Holland 2017	• No adverse events occurred in either group.(PAPER)

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Table 3. Adverse events *(Continued)*

Knox 2019	• Any adverse event was reported and categorized as mild, moderate, or severe. • One adverse event of hypoglycaemia in a patient with diabetes in the hub. • There were no reported AEs in the three spoke cohorts. • One patient at a spoke site attended 2 sessions and was admitted to the hospital for 6 weeks where she died of a hospital-acquired pneumonia. This was not deemed to be related to the project.
Kwon 2018	Not recorded as an outcome or reported.
Lahham 2020	Not recorded as an outcome or reported.
Maltais 2008	• During the maintenance phase (3 to 12 months), contacts with study personnel were limited to telephone interviews to reinforce the importance of exercise and to ask about adverse events. (PAPER) • An independent research assistant, unaware of the patient's group assignment, conducted a standardized telephone interview every 4 weeks to identify adverse events.(PAPER) • We defined serious adverse events as death or hospitalisations for any cause.(PAPER) • Adverse events were mostly mild, although the outpatient, hospital-based group reported 51 serious adverse effects and the home-based group reported 52 (Table 4). Fourteen and 9 serious adverse effects occurred during the8-week training intervention in the outpatient, hospital based and home-based groups, respectively. Most were related to COPD exacerbations requiring hospitalisation. On review, treating physicians and the steering committee did not identify any serious adverse events that they believed were related to the study intervention.(PAPER) • Adverse events, outpatient rehabilitation: Total n = 330 (COPD exacerbation n = 198; hospitalisation n = 51; death n = 1; related to intervention n = 0; during intervention n = 14; during maintenance n = 37; cardiac events n = 22; other n = 68) (PAPER Table 4) • Adverse events, home rehabilitation (telerehabilitation): Total n = 335 (COPD exacerbation n = 184; hospitalisation n = 50, death n = 1; related to intervention n = 0; during intervention n = 9; during maintenance n = 43; cardiac events n = 31; other n = 76) (PAPER Table 4)
Stickland 2011	Definition of adverse event not specified. Reasons for patient dropout that could be considered adverse event detailed in Table 4 (PAPER). • Patient dropout during rehabilitation - Standard rehabilitation: respiratory exacerbation n = 7, hospitalisation (other) n = 3, non-respiratory injury/illness n = 6, deceased n = 1. Telehealth: respiratory exacerbation n = 6, hospitalisation (other) n = 3, non-respiratory injury/illness n = 1, deceased n = 1.
Tabak 2014	Not recorded as an outcome or reported.
Tsai 2017	• "...there was one death from an adverse reaction to a medication unrelated to the study." (PAPER) • No adverse events occurred. (PAPER)
Vasilopoulou 2017	• No adverse events were reported. (PAPER, ONLINE SUPPLEMENT)

Abbreviations: AE, adverse event; COPD, chronic obstructive pulmonary disease; HBP, home-based program; PR, pulmonary rehabilitation; PTR, pulmonary tele-rehabilitation.

Table 4. Adherence

Study	Comparison	Definition for Adherence/Completion	Result
Barberan-Garcia 2014 (Barcelona and Athens)	3 (maintenance)	Not defined	Not reported

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Table 4. Adherence *(Continued)*

Barberan-Garcia 2014 (Trondheim)	3 (maintenance)	Not defined	• Telerehab: Of n = 28 randomised to intervention group n = 19 completed 12 month follow up period of whom n = 6 had COPD • Control: Of n = 27 randomised to control group n = 18 completed 12 month follow up period of whom n = 9 had COPD
Bernocchi 2018	3 (maintenance)	Not defined	• Telerehab: n = 52 (93%) performed the prescribed exercises: 19% performed mean(SD) 2.3(0.5) activity sessions/week, 65% performed 4(0.5) activity sessions/week, 16% performed 6(0.6) activity sessions/week. • No rehabilitation control
Bourne 2017	1	Not defined	• Telerehab: Mean number of online sessions undertaken per week declined from 3.9 (week 1) to 2.5 (week 6) • Centre-based PR: Mean sessions attended per week ranged between 1.3 (week 2 and week 5) to 1.6 (week 1) (2 supervised sessions per week for 6 weeks)
Chaplin 2017	1	Reached stage 3 or above of the web program, achieving 75% of the program	• Telerehab: n = 27 (53%) dropped out of web-based program prior to week 3.
Hansen 2020	1	Undertaking a minimum of 70% of the planned pulmonary rehabilitation sessions	• Telerehab: n = 57 completed intervention • Centre-based PR: n = 43 completed intervention
Holland 2017	1	Undertaking a minimum of 70% of the planned pulmonary rehabilitation sessions	• Telerehab: 91% completion (n = 73). Attended mean 7.4 of 8 scheduled sessions (range 0-8) • Centre-based PR: 49% completion (n = 42). Attended mean 8.3 of 16 scheduled sessions (range 0-16)
Knox 2019	1	Not defined	• Telerehab: 61.9% of patients attended 12 or more sessions in the spoke sites • Centre-based PR: 54.6% attended 12 or more session in the hub.
Kwon 2018	3	Not defined	Not reported
Lahham 2020	3	Not defined	• Telerehab: A total of 27 participants randomised to the home-based group completed the programme (93%) • No rehabilitation control
Maltais 2008	1	Completion of at least 60% (n = 15) of the exercise training sessions	• Telerehab: n = 3 participants did not fulfil adherence criteria • Centre-based PR: n = 9 participants did not fulfil adherence criteria
Stickland 2011	1	To attend a minimum of nine of the 16 sessions	• Telerehab: Mean sessions attended 12.6 (n = 121) • Centre-based PR: mean sessions attended 13.2 (n = 232)

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Table 4. Adherence *(Continued)*

Tabak 2014	3	Not defined	• Telerehab: In total, 569 exercise schemes were prescribed to patients of which 127 schemes were completely performed (median adherence 21%) • No rehabilitation control
Tsai 2017	3	Compliance with telerehabilitation sessions was recorded by the number of completed exercise training sessions as prescribed out of a possible 24 sessions.	• Telerehab: mean (SD) sessions attended 22 (5) • No rehabilitation control
Vasilopoulou 2017	1, 3 (maintenance)	Adherence to home-based maintenance tele-rehabilitation and hospital-based maintenance programs was assessed by the adherence rate (actual number of sessions/total expected number of sessions*100).	• Maintenance telerehab: 93.5% • Centre-based maintenance rehabilitation: 91% • No rehabilitation control

Abbreviations: COPD, chronic obstructive pulmonary disease; n, number; SD, standard deviation.

Table 5. Healthcare utilisation

Study	Comparison	Outcome	Timepoint	Telerehabilitation	Control
Barberan-Garcia 2014 (Barcelona and Athens)	3	Use of healthcare resources.	During follow up intervention period	Barcelona (CCT): no difference between groups Athens (CCT): no data reported	
Barberan-Garcia 2014 (Trondheim)	3	No data reported			
Bernocchi 2018	3	Median time to event hospitalisation (any cause) or death	During the 4 month study period	113.4 days	104.7 days*
		Number of hospitalisations	During the 4 month study period	21 (11 for cardiovascular diseases, 6 for respiratory diseases, 5 for other causes)	37 (25 for cardiovascular diseases, 11 for respiratory diseases, 1 for other causes)
Bourne 2017	1	No data reported			
Chaplin 2017	1	No data reported			
Hansen 2020	1	Number hospitalisations related to COPD	During intervention	21	20

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Table 5. Healthcare utilisation *(Continued)*

			At 22 weeks follow-up from baseline	38	36
		Hospital days relating to all admissions, per admission/patient (median [IQR])	At 22 weeks follow-up from baseline	2.3 [1.3 to 3.4]	2.2 [1.1 to 4.7]
		Hospital days relating to all admissions, total admissions/patient (median [IQR])	At 22 weeks follow-up from baseline	11.8 [3.4 to 27.8]	5.2 [3.2 to 13.8]
		Hospital days for respiratory admissions, per admission/patient (median [IQR])	At 22 weeks follow-up from baseline	2.4 [1.6 to 3.7]	2.5 [1.2 to 5.2]
		Hospital days for respiratory admissions, total admissions/patient (median [IQR])	At 22 weeks follow-up from baseline	7.5 [3.1 to 14.4]	5.2 [2.6 to 10.0]
		Number of outpatient visits	At 10 weeks follow-up from baseline	113	744
			At 22 weeks follow-up from baseline	270	899
Holland 2017	1	Proportion with a hospital admission	During 12 months follow up *after* completion of intervention	n = 28 (35%)	n = 37 (43%)
		Proportion with a respiratory admission	During 12 months follow up *after* completion of intervention	n = 17 (21%)	n = 29 (34%)*
		Number all cause hospital admissions per participant (median [IQR])	During 12 months follow up *after* completion of intervention	0 [0-2]	0 [0-1.25]
		Number all cause hospital days (median [IQR])	During 12 months follow up *after* completion of intervention	0 [0-3.75]	0 [0-6.25]
		Number of respiratory admissions (median [IQR])	During 12 months follow up *after* completion of intervention	0 [0-0]	0 [0-1]
		Number hospital days for respiratory cause (median [IQR])	During 12 months follow up *after* completion of intervention	0 [0-0]	0 [0-5]
Knox 2019	3	No data reported			
Kwon 2018	3	No data reported			
Lahham 2020	3	No data reported			
Maltais 2008	1	Number of COPD exacerbations	During intervention period	9	14

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Table 5. Healthcare utilisation *(Continued)*

			During maintenance phase	43	37
		Number of hospitalisations	During entire study period	50 (not COPD related n = 31)	51 (not COPD related n = 21)
Stickland 2011	1	Number of hospitalisations	During rehabilitation period	3	3
		Number of respiratory exacerbations	During rehabilitation period	6	7
Tabak 2014	3	Number of COPD exacerbations	During study intervention period	33	not applicable
		Number of hospitalisations, COPD		4	5
		Number of hospitalisations, other		4	2
		Emergency department visits for COPD		5	5
		Length of stay, hospitalisation for COPD		22 days	36 days
		Length of hospital stay for COPD, days (median [IQR])		5.5 [4.8-6.3]	7.0 [6.0-7.0]
Tsai 2017	3	No data reported			
Vasilopoulou 2017	1 (maintenance)	Acute exacerbation of COPD (mean±SD):	During 12 month maintenance intervention	1.7±1.7	1.8 ± 1.4*
	3 (maintenance)				3.5 ± 1.8*
	1 (maintenance)	Hospitalisation for acute exacerbation COPD (mean±SD):		0.3±0.7	0.3 ± 0.6*
	3(maintenance)				1.2 ± 1.7*
	1 (maintenance)	Emergency department visits (mean±SD):		0.5±0.9	1.8 ± 1.5*
	3 (maintenance)				3.8 ± 1.5*

Abbreviations: CCT, controlled clinical trial; COPD, chronic obstructive pulmonary disease; ED, emergency department; IQR, interquartile range; n, number; PR, pulmonary rehabilitation; SD, standard deviation.
*between group difference P < 0.05

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APPENDICES

Appendix 1. Database & trial registry search strategies

Cochrane Airways Trial Register & CENTRAL (via Cochrane Register of Studies)

#1 MeSH DESCRIPTOR Asthma Explode All AND CENTRAL
#2 asthma*:ti,ab AND CENTRAL
#3 MeSH DESCRIPTOR Pulmonary Disease, Chronic Obstructive Explode All AND CENTRAL
#4 MeSH DESCRIPTOR Bronchitis, Chronic AND CENTRAL
#5 (obstruct*) near3 (pulmonary or lung* or airway* or airflow* or bronch* or respirat*) AND CENTRAL
#6 (COPD OR COAD OR COBD OR AECOPD):TI,AB,KW AND CENTRAL
#7 BRONCH:MISC1 AND CENTRAL
#8 MeSH DESCRIPTOR Bronchiectasis Explode All AND CENTRAL
#9 bronchiect* AND CENTRAL
#10 MESH DESCRIPTOR Lung Diseases, Interstitial EXPLODE ALL AND CENTRAL
#11 MESH DESCRIPTOR Pulmonary Fibrosis EXPLODE ALL AND CENTRAL
#12 (interstitial* NEAR3 (lung* or disease* or pneumon*)):ti,ab AND CENTRAL
#13 ((pulmonary* or lung* or alveoli*) NEAR3 (fibros* or fibrot*)):ti,ab AND CENTRAL
#14 ((pulmonary* or lung*) NEAR3 (sarcoid* or granulom*)):ti,ab AND CENTRAL
#15 AST:MISC1 OR COPD:MISC1 OR BRONCH:MISC1 OR ILD:MISC1 AND CENTRAL
#16 #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15
#17 MESH DESCRIPTOR Telerehabilitation AND CENTRAL
#18 MESH DESCRIPTOR Telemedicine AND CENTRAL
#19 MESH DESCRIPTOR Videoconferencing EXPLODE ALL AND CENTRAL
#20 MESH DESCRIPTOR telecommunications AND CENTRAL
#21 MESH DESCRIPTOR Computer Communication Networks EXPLODE ALL AND CENTRAL
#22 MESH DESCRIPTOR Remote Consultation AND CENTRAL
#23 MESH DESCRIPTOR Telephone EXPLODE ALL AND CENTRAL
#24 MESH DESCRIPTOR Electronic Mail AND CENTRAL
#25 MESH DESCRIPTOR Text Messaging AND CENTRAL
#26 MESH DESCRIPTOR Internet EXPLODE ALL AND CENTRAL
#27 (telemedicine or tele-medicine or telemetry or telerehab* or tele-rehab* or telehealth or tele-health or telehomecare or tele-homecare or telecoaching or tele-coaching or telecommunication* or tele-communication or videoconference* or video-conferenc* or videoconsultation or video-consultation or teleconference* or tele-conference* or teleconsultation or tele-consultation or telecare or tele-care):ti,ab,kw AND CENTRAL
#28 (ehealth or e-health or "mobile health" or mhealth or m-health):ti,ab,kw AND CENTRAL
#29 ((remote* or distance* or distant) NEAR5 (rehab* or therap* or treatment or consultation)):ti,ab,kw AND CENTRAL
#30 ((rehab* or therap* or treatment or communication or consultation) NEAR5 (telephone* or phone* or video* or internet* or computer* or modem or web* or email)):ti,ab,kw AND CENTRAL
#31 #30 OR #29 OR #28 OR #27 OR #26 OR #25 OR #24 OR #23 OR #22 OR #21 OR #20 OR #19 OR #18 OR #17
#32 #31 AND #15

MEDLINE (Ovid SP)

1. exp asthma/

2. (asthma$ or wheez$).ti,ab.

3. exp Pulmonary Disease, Chronic Obstructive/ or Lung Diseases, Obstructive/

4. (obstruct$ adj3 (pulmonary or lung$ or airway$ or airflow$ or bronch$ or respirat$)).ti,ab.

5. (COPD or COAD or COBD or AECB or AECOPD).ti,ab.

6. exp Bronchiectasis/

7. bronchiect$.ti,ab.

8. exp Lung Diseases, Interstitial/

9. exp Pulmonary Fibrosis/

10. (interstitial$ adj3 (lung$ or disease$ or pneumon$)).ti,ab.

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11. ((pulmonary$ or lung$ or alveoli$) adj3 (fibros$ or fibrot$)).ti,ab.

12. ((pulmonary$ or lung$) adj3 (sarcoid$ or granulom$)).ti,ab.

13. (chronic$ adj3 (lung$ or respiratory$ or pulmonary$)).ti,ab.

14. or/1-13

15. Telerehabilitation/

16. Telemedicine/

17. exp Videoconferencing/

18. telecommunications/

19. exp Computer Communication Networks/

20. Remote Consultation/

21. exp Telephone/

22. electronic mail/ or text messaging/

23. exp Internet/

24. (telemedicine or tele-medicine or telemetry or telerehab$ or tele-rehab$ or telehealth or tele-health or telehomecare or tele-homecare or telecoaching or tele-coaching or telecommunication$ or tele-communication or videoconference$ or video-conferenc$ or videoconsultation or video-consultation or teleconference$ or tele-conference$ or teleconsultation or tele-consultation or telecare or tele-care).ti,ab.

25. (ehealth or e-health or "mobile health" or mhealth or m-health).ti,ab.

26. ((remote$ or distance$ or distant) adj5 (rehab$ or therap$ or treatment or consultation)).ti,ab.

27. ((rehab$ or therap$ or treatment or communication or consultation) adj5 (telephone$ or phone$ or video$ or internet$ or computer $ or modem or web$ or email)).ti,ab.

28. or/15-27

29. (controlled clinical trial or randomised controlled trial).pt.

30. (randomised or randomised).ab,ti.

31. placebo.ab,ti.

32. dt.fs.

33. randomly.ab,ti.

34. trial.ab,ti.

35. groups.ab,ti.

36. or/29-35

37. Animals/

38. Humans/

39. 37 not (37 and 38)

Embase (Ovid SP)

1. exp asthma/
2. (asthma$ or wheez$).ti,ab.
3. chronic obstructive lung disease/ or lung disease/
4. (obstruct$ adj3 (pulmonary or lung$ or airway$ or airflow$ or bronch$ or respirat$)).ti,ab.

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5. (COPD or COAD or COBD or AECB or AECOPD).ti,ab.
6. exp bronchiectasis/
7. bronchiect$.ti,ab.
8. exp interstitial lung disease/
9. exp lung fibrosis/
10. (interstitial$ adj3 (lung$ or disease$ or pneumon$)).ti,ab.
11. ((pulmonary$ or lung$) adj3 (sarcoid$ or granulom$)).ti,ab.
12. (chronic$ adj3 (lung$ or respiratory$ or pulmonary$)).ti,ab.
13. ((pulmonary$ or lung$ or alveoli$) adj3 (fibros$ or fibrot$)).ti,ab.
14. or/1-13
15. telerehabilitation/
16. exp telemedicine/
17. videoconferencing/
18. exp telecommunication/
19. computer network/
20. teleconsultation/
21. telephone/
22. e-mail/
23. text messaging/
24. internet/
25. (telemedicine or tele-medicine or telerehab$ or tele-rehab$ or telehealth or tele-health or telehomecare or tele-homecare or telecoaching or tele-coaching or telecommunication$ or tele-communication or videoconference$ or video-conferenc$ or videoconsultation or video-consultation or teleconference$ or tele-conference$ or teleconsultation or tele-consultation or telecare or tele-care).ti,ab.
26. (ehealth or e-health or "mobile health" or mhealth or m-health).ti,ab.
27. ((remote$ or distance$ or distant) adj5 (rehab$ or therap$ or treatment or consultation)).ti,ab.
28. ((rehab$ or therap$ or treatment or communication or consultation) adj5 (telephone$ or phone$ or video$ or internet$ or computer $ or modem or web$ or email)).ti,ab.
29. or/15-28
30. Randomized Controlled Trial/
31. randomization/
32. controlled clinical trial/
33. Double Blind Procedure/
34. Single Blind Procedure/
35. Crossover Procedure/
36. (clinica$ adj3 trial$).tw.
37. ((singl$ or doubl$ or trebl$ or tripl$) adj3 (mask$ or blind$ or method$)).tw.
38. exp Placebo/
39. placebo$.ti,ab.
40. random$.ti,ab.
41. ((control$ or prospectiv$) adj3 (trial$ or method$ or stud$)).tw.
42. (crossover$ or cross-over$).ti,ab.
43. or/30-42
44. exp animals/ or exp invertebrate/ or animal experiment/ or animal model/ or animal tissue/ or animal cell/ or nonhuman/
45. human/ or normal human/ or human cell/
46. 44 and 45
47. 44 not 46
48. 43 not 47
49. 14 and 29 and 48

ClinicalTrials.gov

Study type	Interventional
Condition	COPD OR asthma OR bronchiectasis OR ILD or IPF
Intervention	telerehabilitation OR telemedicine OR telehealth OR teleconsultation

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WHO ICTRP (https://apps.who.int/ trialsearch /)

Condition	COPD OR asthma OR bronchiectasis OR ILD or IPF
Intervention	telerehabilitation OR telemedicine OR telehealth OR teleconsultation

HISTORY

Protocol first published: Issue 6, 2018
Review first published: Issue 1, 2021

CONTRIBUTIONS OF AUTHORS

NSC and AEH conceived the idea for this Cochrane Review. All protocol authors contributed to the development of the protocol. NSC will be guarantor of the review.

Contributions of editorial team

Chris Cates (Coordinating Editor) checked the data entry prior to the full write up of the review, edited the protocol; advised on methodology; approved the protocol prior to publication.

Emma Dennett (Managing Editor): coordinated the editorial process; advised on interpretation and content; edited the review.

Emma Jackson (Assistant Managing Editor): conducted peer review; obtained translations; edited the plain language summary and reference sections of the protocol and the review.

Elizabeth Stovold (Information Specialist): designed the search strategy; ran the searches; edited the search methods section.

DECLARATIONS OF INTEREST

NSC: Dr Cox holds a National Health and Medical Research Council (NHMRC) Australia Early Career Fellowship (GNT1119970). She presented workshops relating to pulmonary rehabilitation (including alternative models of delivery) at the 2018 National General Practitioners Meeting sponsored by Boeringher Ingelheim and monies were paid to her host institution. Dr Cox is an author on trials included in this review.

SDC: Professor Dal Corso was supported by funding from Sao Paulo Research Foundation (FAPESP SPRINT grant 17/50273-4), Brazil.

HH: Dr Hansen has received a personal post doctoral grants from the Capital Region of Copenhagen (governmental funding), teaching fee from GSK (private company), The association of Danish Physiotherapist (NGO) and royalties from educational books chapters written for Munksgaard Denmark (publisher). He is an author on trials included in this review.

CFM: Professor McDonald has developed educational presentations sponsored by Menarini and Astra Zeneca with monies to her institution. She has also received in kind support from Air Liquide for a clinical trial of oxygen therapy. She has received competitive research funding from the National Health and Medical Research Council (Australia) (GNT1101616) for a trial of telerehabilitation in COPD, and is an author on one of the trials included in this review. Professor McDonald is an author on trials included in this review.

CJH: none known

PZ: Dr Zanaboni holds a Research Council of Norway Project Grant (228919/H10) titled 'Long-term integrated telerehabilitation of COPD patients: a multi centre randomised controlled trial'.

JAA: Professor Alison has received competitive research funding from the National Health and Medical Research Council (Australia) (GNT1101616) for a trial of telerehabilitation in COPD, and is an author on one of the trials included in this review.

POH: Dr O'Halloran is an author on one of the trials included in this review.

HM: none known

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AEH: Professor Holland has received competitive research funding from the National Health and Medical Research Council (Australia) (GNT1101616) for a trial of telerehabilitation in COPD, and is an author on trials included in this review. The NHMRC supports the independent conduct and publication of this Cochrane Review.

Seven review authors (NSC, CFM, CJH, JAA, POH, HH, AEH) were co-authors on at least one study included in this review. As such, at least one independent co-author undertook data extraction and the assessment of risks of bias.

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DIFFERENCES BETWEEN PROTOCOL AND REVIEW

At the direction of the Cochrane editorial office, data from non-randomised studies (NRS) were synthesized narratively, and were not combined with the results of randomised controlled trials.

INDEX TERMS

Medical Subject Headings (MeSH)

Bias; Chronic Disease; Controlled Clinical Trials as Topic [statistics & numerical data]; Dyspnea [rehabilitation]; Exercise Tolerance [physiology]; Internet [statistics & numerical data]; Non-Randomized Controlled Trials as Topic [statistics & numerical data]; Patient Compliance [statistics & numerical data]; Pulmonary Disease, Chronic Obstructive [*rehabilitation]; Quality of Life; Randomized Controlled Trials as Topic [statistics & numerical data]; Respiration Disorders [*rehabilitation]; Telephone [statistics & numerical data]; Telerehabilitation [*methods] [statistics & numerical data]; Videoconferencing [statistics & numerical data]; Walk Test [statistics & numerical data]

MeSH check words

Humans

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