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Early View

Original article

Home-based pulmonary rehabilitation in people with bronchiectasis, a randomised controlled trial

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Title: Home-based pulmonary rehabilitation in people with bronchiectasis, a randomized controlled trial.

Shor Title: Home-based pulmonary rehabilitation in people with bronchiectasis.

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Take Home Message:

Home-based pulmonary rehabilitation (HBPR) delivers improvements in functional capacity, peripheral muscle strength, and quality of life in people with bronchiectasis.
HBPR is safe, well tolerated and can be considered an alternative rehabilitation program.

Key words: *Randomised Controlled Trial, Bronchiectasis, Exercise; Rehabilitation, Physical Therapy (Specialty).*
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ABSTRACT

Aim: To investigate the short- and long-term effects of Home-based Pulmonary Rehabilitation (HBPR) on functional capacity, quality of life, peripheral muscle strength, dyspnea and daily physical activity in people with bronchiectasis.

Methods: Randomized controlled trial with 63 participants with bronchiectasis. The HBPR group performed three sessions per week for eight weeks (aerobic exercise: step training for 20 min; resistance training: exercises for quadriceps, hamstrings, deltoids, and biceps brachii with elastic bands). The control group received recommendation to walk at moderate intensity, three times per week. A weekly phone call was conducted for all participants, and the HBPR group received a home visit every 15 days. The primary outcome was distance in the incremental shuttle walk test (ISWT). Secondary outcomes were time in the endurance shuttle walk test (ESWT), number of steps in the incremental step test, quality of life, quadriceps muscle strength and daily physical activity. Measures were taken before and after intervention and six months later.

Results: After the intervention, the HBPR group had increased the distance in ISWT compared with the control group with between-group difference: 87.9m (95%CI 32.4 to 143.5). Between-group differences was found in ESWT, incremental step test, quality of life and quadriceps muscle strength in favor to HBPR group too. After 6 months, no differences were observed between the groups.

Conclusion: HBPR is an effective alternative for offering pulmonary rehabilitation for people with bronchiectasis. However, the program was not effective in maintaining the benefits after six months of follow-up.

Trial registration: ClinicalTrials.gov NCT02731482.

Keywords: Randomized Controlled Trial, Bronchiectasis, Exercise; Rehabilitation, Physical Therapy (Specialty).

INTRODUCTION

Bronchiectasis is a severe and progressive disease with a high economic burden worldwide.[1] In addition to respiratory symptoms, bronchiectasis leads to extrapulmonary manifestations such as fatigue, reduced exercise capacity, peripheral muscle endurance, daily physical activity and health status.[2-4] Pulmonary rehabilitation has been considered part of the comprehensive approach to bronchiectasis management,[5] but is still underused in this population. A recent systematic review found only four randomized clinical trials on pulmonary rehabilitation for patients with bronchiectasis.[6] It demonstrated that pulmonary rehabilitation was effective in improving exercise tolerance, cough-related symptoms, and quality of life and reducing the symptoms of dyspnea and fatigue.[6] Pulmonary rehabilitation is also effective in reducing the frequency of exacerbations in a period of 12 months.[6-7]

Despite the strong evidence of its benefits, offering pulmonary rehabilitation is still challenging because of barriers travel issues is a predictor of poor adherence to attending the pulmonary rehabilitation program.[8-9] In this context, home-based pulmonary rehabilitation (HBPR) may be an alternative to overcome some of the barriers to attendance at center-based programs. So far, only one study has demonstrated that HBPR in people with bronchiectasis improved the patient's level of physical activity and functional capacity; however, this was an uncontrolled study with a small sample size (19 participants), and the level of physical activity was measured indirectly using a questionnaire.[10]

One of the barriers for HBPR is developing a physical training program that does not require expensive resources such as treadmills, cycle ergometers, or weight training equipment. A low-cost physical training program was recently developed and was composed of functional activities with materials that were accessible in the home environment (i.e., sitting and getting up from a chair, climbing steps, and lifting weights with water bottles using the upper limbs) and walking as aerobic exercise.[11] However, performing walking-based training is sometimes difficult because of limited physical space, weather conditions, the absence of walking-friendly locations, and poorly maintained sidewalks. In addition, people undergoing long-term oxygen therapy may not adhere to this kind of training unless they have access to a portable oxygen concentrator.

Then, we have developed a single-step physical training program whose exercise intensity is based on an incremental step test.[12] In addition, single-step training can be attractive because it is simple to perform at home, is inexpensive, does not require much space or depend on weather conditions, and may be more appropriate for people dependent on oxygen.

This clinical trial aims to investigate the short- and long-term effects of HBPR on functional capacity, quality of life, peripheral muscle strength, dyspnea, and daily physical activity in people with bronchiectasis.

METHODS

Design

This is a randomized controlled trial with concealed allocation. The trial protocol was registered at www.clinicaltrials.gov (NCT02731482) and published further.[13] The participants were evaluated at baseline (i.e., before intervention), immediately after the intervention (two months), and six months after intervention (Figure 1). The baseline data collection included age, gender, body mass index, pulmonary function, dyspnea, measured by the modified Medical Research Council scale,[14] and severity of bronchiectasis, measured by the FACED[15] and E-FACED score.[16] The participants were randomly assigned to receive either standard care (control group) or HBPR (intervention group). The randomization schedule was generated using the website www.randomization.com with 1:1 allocation ratio. Randomization was blinded from the participants and investigators by using consecutively numbered, sealed, opaque envelopes that had been prepared by a researcher who was not involved in the study. Recruitment and data collection were performed identically for both groups and at the same locations.

Participants

Participants aged over 18 years with a clinical or tomographic diagnosis of bronchiectasis, who were in a stable clinical state for at least the previous 4 weeks (absence of changes in the symptoms of dyspnea and the volume and color of sputum)[5] and able to perform the tests and the training protocol were included in the study. Those who were smokers, who had a primary diagnosis of another lung disease (e.g., asthma, COPD, interstitial lung disease, and cystic fibrosis) or severe cardiovascular disease and musculoskeletal limitations were excluded. For safety reasons who presented significant levels of desaturation (pulse oxygen saturation $\leq 80\%$) during baseline exercise testing were excluded.

Participants were recruited from the Obstructive Disease Outpatient Clinic (Hospital das Clínicas of University of São Paulo) and were referred to Cardiopulmonary Rehabilitation (University Nove de Julho). This study was approved by the Human Research Ethics

Committee of Universidade Nove de Julho, Sao Paulo/SP, Brazil (no. 1249073). Written informed consent was obtained from all subjects.

Intervention

HBPR Group

Participants allocated to the HBPR group performed three non-supervised weekly sessions of 50 min duration each for eight weeks. The participants received an educational booklet with illustrated instructions for the exercise program and a diary in which they should report the activities performed. The following HBPR procedures were designed to be low-cost as well as easily implemented and understood:

Warm-up/stretching: The warm-up lasted approximately 5 min and was composed of active upper- and lower-limb exercises. Stretching, including of the pectoralis major, latissimus dorsi, trapezius, femoral quadriceps, and hamstrings muscles, also lasted ~5 min. Each stretch posture was maintained for 30 sec.

Aerobic training: This consisted of stepping on a platform (20 cm high, 60 cm wide, and 60 cm long). The training intensity was set at a cadence corresponding to 60–80% of the maximum stepping cadence achieved on the MIST,[12] performed during baseline. During the training sessions, the target heart rate, dyspnea, and fatigue were established as markers of training intensity.[17-18] The heart rate was measured using a heart rate monitor (Polar Precision Performance; Polar Electro, Kem-pele, Finland). If participants reported a score for dyspnea and/or fatigue below four and/or a target training heart rate below the one established, the exercise intensity was increased by one stepping speed level.

Resistance training: Exercises were carried out using both limbs simultaneously and an elastic band (TheraBand®; The Hygenic Corporation, Akron, OH, USA). Three sets of eight repetitions each, with 1 min of rest between sets, were performed for the quadriceps, hamstrings, deltoids, and biceps brachii. The load was set at 70% of the maximum voluntary isometric contraction measured using a dynamometer (model DLC/DN; Kratos, São Paulo, SP, Brazil). The intensity adjustments were made by increasing the load of the elastic bands[19] and were guided by the level of dyspnea or fatigue of the trained muscle group.[17]

Follow-up: The participants received a weekly phone call and a supervised session at home

every two weeks. This visit aimed to correct errors, set the appropriate intensity of the step exercise for aerobic training, and ensure the intensity progression of the elastic bands for the peripheral muscle strength training.

Control Group

The participants allocated to the control group received an educational booklet containing instructions regarding how to perform the physical activities and walking at moderate intensity, which were to be performed three times per week for 30 min. Those allocated to this group did not receive any supervised physical training. During the eight-week intervention, the participants were contacted by the researchers (via telephone) every week to receive support and general advice, without discussing the proposed exercises.

Outcome measures

Primary outcome: The primary outcome was functional capacity and exercise tolerance, measured by the distance in the incremental shuttle walk test (ISWT).[20] Two tests were performed on the same day, with a rest period of one hour between them.

Secondary outcome: The secondary outcomes were functional capacity and exercise tolerance using the endurance shuttle walk test (ESWT)[21] and the incremental step test;[12] quadriceps muscle strength, measured using a dynamometer; physical activity, measured during 7 consecutive days, using an accelerometer (ActiGraph wGT3X-BT; ActiGraph Corp, Pensacola, Florida, USA) and quality of life, assessed using the Quality of Life Questionnaire Bronchiectasis (QoL-B).[22]

Data analysis

For sample size calculation, the primary outcome (distance walked in the ISWT) was considered, and a minimum of 40 participants was required (20 in each group) for this study. Based on a previous study,[23] we expected a difference after intervention of 61.3 m between the groups and a standard deviation of 63.2 m. These estimates resulted in an effect size of 0.83, based on an alpha error of 0.05 and a beta error of 0.20. The statistical analyses were performed using the SPSS Statistics software package, version 20.0 (IBM Corporation, Armonk, NY, USA). The Shapiro-Wilk test was used to determine data normality for all variables. Baseline differences between groups were analyzed using Student's t test or Chi-square test. Differences between the groups for change over time were analyzed using linear

mixed models. The models included treatment group, time, group × time interaction, and a random effect for participants. *Post-hoc* comparisons were performed using Fisher's Least Significant Difference. The standardized effect size was calculated using Cohen's d. The program G*Power, version 3.1 (Heinrich Heine University, Düsseldorf, Germany) was used for this analysis. A p-value of < 0.05 (2-tailed) was considered statistically significant. In the previously published protocol,[13] we described the intention-to-treat analysis; however, due to the percentage of missing data after a six-month follow-up, a per-protocol analysis was performed.[24]

RESULTS

Sixty-five participants were recruited. Of these, two individuals were excluded: one for presenting musculoskeletal disorders and the other refused to participate in the study. Thus, sixty-three participants were randomized. After intervention, 28 participants in the control group and 27 participants in the HBPR group were evaluated, while after the six months of follow-up, 18 participants in the control group and 19 participants in the HBPR group were assessed. (Figure 1). The MIST data were available for 26 participants in the control group and 25 in the HBPR group after intervention, as well as for 14 participants in the control group and 18 in the HBPR group after six months of follow-up.

There no were difference in baseline characteristics of both groups (Table 1). The causes of bronchiectasis were: idiopathic (35%), recurrent pneumonia (24%), tuberculosis sequelae (8%), gastroesophageal reflux disease (8%) and post-infectious bronchopneumonia (5%), bronchiolitis obliterans (5%) and other causes (15%). During the 6-month study period, two participants (one from each group) had an acute episode of exacerbation. No adverse events were observed during the physical training program. On average, the HBPR group participants performed 20 ± 0.5 of the 24 physical training sessions, with an average of 2.8 ± 0.5 sessions per week.

After the intervention, significant improvement in walking distance in the ISWT was evident (MD 87.91 m 95% CI 32.98 to 142.85, effect size between-group: 0.863), but this was not maintained at six months. Improvements in time during the ESWT (MD 4.36 sec 95% CI 1.93 to 6.79, effect size: 0.967) and MIST (MD 81.35 steps 95% CI 43.10 to 119.60, effect size: 1.189) were observed in the HBPR group when compared to the control group at the end of rehabilitation. Nevertheless, improvements in the above-mentioned parameters were not maintained after six months (Table 2).

Improvement in peripheral muscle strength were greater in the HBPR group than the control group following rehabilitation in quadriceps strength (MD 5.72 kgf 95% CI 1.99 to 9.45, effect size: 0.829), but this improvement was not maintained at 6 months. No significant changes in daily steps were observed after HBPR (MD 1328.45 steps 95% CI -88.72 to 2745.61, effect size: 0.505) or 6-mouths follow-up (Table 2).

In the quality of life, the QoL-B questionnaire shows that "physical" (MD 11.44, 95% CI 0.83 to 22.06, effect size: 0.589), "role" (MD 11.52, 95% CI 2.38 to 20.66, effect size: 0.688) and "emotional" (MD 7.15, 95% CI 0.65 to 13.65, effect size: 0.600) domains were significantly better in the HBPR group compared to the control group at end rehabilitation, but this was not maintained at 6 months (Table 3).

DISCUSSION

This is the first clinical trial that aimed to evaluate the effects of HBPR in people with bronchiectasis and to compare this with a control group. Our results showed that externally paced step training as a strategy for aerobic training and the use of elastic bands as a resource for resistance training improve exercise tolerance, endurance, quality of life, and peripheral muscle strength. However, improvements were poorly maintained at six months of follow-up. As expected, no changes were observed in the outcomes studied for the control group. The physical training program was safe, and no adverse events were recorded. A high adherence to the training frequency was observed among the participants who completed the rehabilitation program.

The HBPR group presented increases in functional capacity and exercise tolerance, represented by the distance covered in the ISWT and the time in the ESWT. The improvement observed after exercise training was greater than the clinically important difference of the ISWT recommended for people with bronchiectasis (34 m)[25] and the minimal important difference of the ESWT for people with COPD (65 sec).[26] The improvement in functional capacity was similar to that of other studies that used walking training,[6-7] demonstrating that the stepping protocol proposed in this study was an effective aerobic exercise to increase exercise tolerance.

Another demonstration of the improvement in exercise tolerance provided by the physical training program proposed in this study is the result of the MIST. The HBPR group showed substantial improvements after the intervention as well as when compared to the control group, however, these improvements were not maintained after six months of follow-up. Since the same functional movements constitute this test and the home-based exercise

performed, the specificity of the physical activity elicited substantial improvements in the MIST, demonstrated by the effect size, greater in MIST (1.19) than in ISWT (0.86) and ESWT (0.97).

The protocol proposed in our study using the elastic bands was effective in increasing the quadriceps strength. The exercises using elastic bands are as effective as other resources used for strength training,[27] and the increase in peripheral muscle strength shown in our study was similar to that of other studies that used the elastic bands,[27] weights, and other resources.[28-29]

HBPR was effective in improving participants' quality of life compared to the control group, measured by the specific instrument for the assessment the QoL in bronchiectasis. This is the first study that used the QoL-B tool in evaluating the effectiveness of pulmonary rehabilitation in this population. This improvement in quality of life observed in the HBPR group has already been demonstrated in outpatient pulmonary rehabilitation in people with bronchiectasis.[7,23]

Our group has previously demonstrated that people with bronchiectasis present an important reduction in daily physical activity.[3] The HBPR proposed in this study demonstrate an increase in daily steps above the minimum important difference values for people with COPD (600 steps).[30] The improvement in physical activity after HBPR in people with bronchiectasis has been previously demonstrated using a questionnaire,[10] something that was confirmed in our study through direct measurement using accelerometers. In this sense, it is important to remove the barriers that hinder the participation of individuals with chronic lung diseases, considering the low demand and adherence to pulmonary rehabilitation programs. HBPR has the potential to overcome these limitations and give patients the opportunity to self-manage their treatment. We were able to verify that the majority of the participants carried out the three weekly sessions per week and showed good adherence in filling out the follow-up worksheet.

One of the strengths of our study is the physical training protocol. Following the principles of physical training used in HBPR for other chronic pulmonary diseases,[11,28] we have developed a low-cost program that requires little space to be performed, and it is easy for the participant to understand. The aerobic exercise was the step training, externally paced by sound stimuli, with an individualized cadence, and based on a percentage of the maximum workload obtained from the MIST. Although step training seems be problematic to perform in older population, people with musculoskeletal limitation and balance issues, we believe that this type of aerobic training for HBPR is an alternative to walking-based programs because it

is not dependent on large and adequate areas of physical space, a common need in HBPR programs that use walking-based training. Moreover, step-based training is inexpensive, not dependent on the weather conditions, simple to perform at home, not reliant on large areas of space, and more appropriate for people dependent on oxygen. Another strength of our physical training program is the type of peripheral muscle strength training. Elastic bands are a practical and low-cost option for strength training when there is no access to more expensive or sophisticated equipment.

This study has some limitations. The number of participants is relatively small in each arm and the loss in follow-up rate was significant, so, the results of the study should be interpreted with caution. However, the established sample size after intervention was studied and was sufficient to demonstrate significant differences between groups. The sample was composed of younger and in better clinical conditions people than the population with bronchiectasis because of the inclusion criteria (participants able to perform the tests and the training protocol). Because this study excluded participants with musculoskeletal limitations, further evaluation in this subpopulation with bronchiectasis may be warranted. We have described an intention-to-treat approach in both the ClinicalTrials.gov registration and published protocol.[13] However, some missing data occurred, thus, according to recommendations,[24] the complete cases were adequately analyzed by using linear mixed models. Finally, as already described in the ClinicalTrials.gov, the present study was conducted without blinding the evaluator.

In conclusion, the HBPR proved to be safe and well tolerated and provided short-term improvements in functional capacity, peripheral muscle strength and quality of life in people with bronchiectasis. However, the program was not effective in maintaining improvements after a six-month follow-up period. Therefore, HBPR can be considered an effective and safe alternative rehabilitation program to offer individuals with bronchiectasis.

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Table 1 Baseline characteristics of participants.

	Control (n = 30)	Home-Based (n = 33)	p-value
Sex, female n (%)	18 (60)	16 (48.5)	.360
Age, years	49.27 ± 14.10	44.42 ± 16.16	.209
BMI	24.02 ± 2.91	23.96 ± 2.56	.933
MRC, score	2.90 ± 0.92	2.48 ± 1.03	.097
Etilogy, n (%)			
Idiopathic	15 (50)	7 (21)	
Recurrent pneumonia	6 (20)	9 (27)	
Gastroesophageal reflux disease	4 (13)	1 (3)	
Other causes	5 (17)	16 (49)	
MRC, n (%)			.366
1	1 (3.3)	6 (18.2)	
2	10 (33.3)	11 (33.3)	
3	11 (36.7)	11 (33.3)	
4	7 (23.3)	4 (12.1)	
5	1 (3.3)	1 (3.0)	
FACED, score	2.50 ± 1.04	2.27 ± 1.23	.431
Mild/Moderate severity	15 (50) / 15 (20)	16 (49) / 17 (51)	
E-FACED, score	2.57 ± 1.19	2.45 ± 1.37	.730
Mild/Moderate severity	24 (80) / 6 (20)	26 (79) / 7 (21)	.905
Pseumonas colonization, n (%)	14 (46.7)	10 (30.3)	.189
FVC, L	2.35 ± 0.81	2.59 ± 0.97	.296
FVC, % pred.	68.90 ± 20.57	72.30 ± 21.89	.527
FEV_1, L	1.37 ± 0.56	1.63 ± 0.84	.151
FEV_1, % pred.	51.21 ± 0.56	55.15 ± 27.19	.535
FEV_1/FVC	59.09 ± 14.30	61.47 ± 16.49	.542
ISWT, m	433.79 ± 145.74	477.40 ± 196.88	.319
ESWT, min	8.22 ± 6.87	8.14 ± 6.90	.961
MIST, total steps	115.92 ± 71.74	141.94 ± 93.89	.230
Daily steps	6045 ± 2731	7340 ± 4754	.186

Quadriceps strength, kgf	26.46 ± 12.15	26.52 ± 10.76	.983

Data are presented in mean ± SD except for sex and MRC presented in absolute value and percentage. BMI: Body Mass Index; FEV_1: Forced expiratory volume in first second; FVC: Forced vital capacity; ESWT: endurance shuttle walk test; ISWT: incremental shuttle walk test; MIST: modified incremental step test; MRC: Medical Research Council dyspnea scale.

Table 2 Change in clinical differences from baseline to two months and follow-up (six months).

	Within-group differences from baseline (95% CI)				Between-group differences	
	Home-based (n=33)		Control (n=30)		Home-based minus Control (95% CI)	
	End rehabilitation minus baseline (n=27)	6 months minus end rehabilitation (n=19)	End rehabilitation minus baseline (n=28)	6 months minus end rehabilitantion (n=18)	End rehabilitation minus baseline	6 months minus end rehabilitation
ISWT, m	60.94 ± 119.79 (21.84 to 100.04)*	-32.39 ± 50.63 (-80.08 to 10.49)	-26.97 ± 80.15 (-65.37 to 11.42)	31.55 ± 131.74 (-13.67 to 78.85)	87.91 (32.98 to 142.85)‡	-63.94 (-129.87 to 1.99)
ESWT, min	4.62 ± 5.43 (2.88 to 6.35)*	-0.14 ± 3.82 (-2.88 to 2.60)	0.26 ± 3.34 (-1.44 to 1.96)	0.43 ± 7.47 (-2.38 to 3.25)	4.36 (1.93 to 6.79)‡	-0.57 (-4.50 to 3.35)
MIST, total steps	66.11 ± 87.86 (38.80 to 93.42)*	-32.73 ± 54.08 (-54.30 to -11.16)†	-15.24 ± 40.47 (-42.02 to 11.54)	-3.99 ± 28.46 (-28.45 to 20.47)	81.35 (43.10 to 119.60)‡	-28.74 (-61.35 to 3.88)
Daily steps	735.76 ± 3114.20 (-275.40 to 1746.61)	-815.90 ± 4359.73 (-2501.33 to 869.54)	-592.70 ± 2032.41 (-1585.63 to 400.24)	-834.05 ± 2614.79 (-2565.67 to 897.57)	1328.45 (-88.72 to 2745.61)	-18.15 (-2398.30 to 2434.59)
Quadriceps strength, kgf	4.90 ± 7.63 (2.24 to 7.56)*	-3.06 ± 8.67 (-6.78 to 0.66)	-0.82 ± 6.09 (-3.43 to 1.79)	-0.24 ± 7.19 (-4.07 to 3.58)	5.72 (1.99 to 9.45)‡	-2.82 (-8.15 to 2.51)

Data are mean, standard deviation and 95% CIs. ESWT: Endurance Shuttle Walk Test; FEV_1: Forced expiratory volume in first second; FVC: Forced vital capacity; ISWT: Incremental Shuttle Walk Test; MIST: Modified Incremental Step Test; PADL: Physical activity in daily life.
* $p < 0.05$ vs. baseline; † $p < 0.05$ vs. end rehabilitation; ‡ $p < 0.05$ between groups.

Table 3 Change in quality of life differences from baseline to two months and follow-up (six months).

	Within-group differences from baseline (95% CI)				Between-group differences	
	Home-based (n=33)		Control (n=30)		Home-based - Control (95% CI)	
	End rehabilitation (n=27)	6 months (n=19)	End rehabilitation (n=28)	6 months (n=18)	End rehabilitation	6 months
QoL-B (physical)	10.30 ± 18.05 (2.79 to 17.80)*	-10.11 ± 18.78 (-18.26 to -1.95)†	-1.15 ± 20.73 (-8.66 to 6.36)	-1.76 ± 15.94 (-10.39 to 6.86)	11.44 (0.83 to 22.06)‡	-8.34 (-20.21 to 3.53)
QoL-B (role)	11.30 ± 12.85 (4.84 to 17.76)*	-5.58 ± 12.74 (-11.09 to -0.07) †	-0.22 ± 19.87 (-6.69 to 6.24)	-1.24 ± 10.67 (-7.06 to 4.59)	11.52 (2.38 to 20.66)‡	-4.34 (-12.36 to 3.67)
QoL-B (vitality)	0.37 ± 15.90 (-5.85 to 6.59)	-11.79 ± 16.74 (-19.18 to -4.40)†	-1.00 ± 16.29 (-7.22 to 5.22)	-2.24 ± 14.81 (-10.05 to 5.58)	1.37 (-7.42 to 10.16)	-9.55 (-20.31 to 1.21)
QoL-B (emotional)	3.52 ± 12.34 (-1.08 to 8.12)	-0.89 ± 12.98 (-5.83 to 7.62)	-3.63 ± 11.46 (-8.23 to 0.97)	-4.41 ± 15.90 (-11.52 to 2.70)	7.15 (0.65 to 13.65)‡	5.31 (-4.48 to 15.10)
QoL-B (social)	1.26 ± 26.41 (-7.83 to 10.35)	1.68 ± 17.82 (-7.24 to 10.61)	-3.41 ± 20.28 (-12.50 to 5.68)	-0.06 ± 20.53 (-9.49 to 9.38)	4.67 (-8.19 to 17.52)	1.74 (-11.24 to 14.73)
QoL-B (treatment burdem)	-5.30 ± 25.15 (-15.10 to 4.51)	5.68 ± 19.69 (-4.92 to 16.29)	-0.07 ± 25.63 (-9.88 to 9.73)	-2.71 ± 25.76 (-13.92 to 8.51)	-5.22 (-19.09 to 8.64)	8.39 (-7.04 to 23.82)
QoL-B (health)	-2.63 ± 17.71 (-9.05 to 3.79)	9.84 ± 18.64 (1.73 to 17.96)†	-1.15 ± 15.44 (-7.57 to 5.26)	8.65 ± 15.91 (0.07 to 17.23)†	-1.48 (-10.56 to 7.59)	1.20 (-10.62 to 13.01)
QoL-B (respiratory)	3.04 ± 11.31 (-1.93 to 8.00)	-4.68 ± 11.33 (-10.26 to 0.89)	-0.56 ± 14.23 (-5.52 to 4.41)	-7.88 ± 2.62 (-13.78 to -1.99)†	3.59 (-3.43 to 10.61)	3.20 (-4.91 to 11.31)

Data are mean, standard deviation and 95% CIs. QoL-B: Quality of Life Questionnaire Bronchiectasis.
* $p < 0.05$ vs. baseline; † $p < 0.05$ vs. end rehabilitation; ‡ $p < 0.05$ between groups.

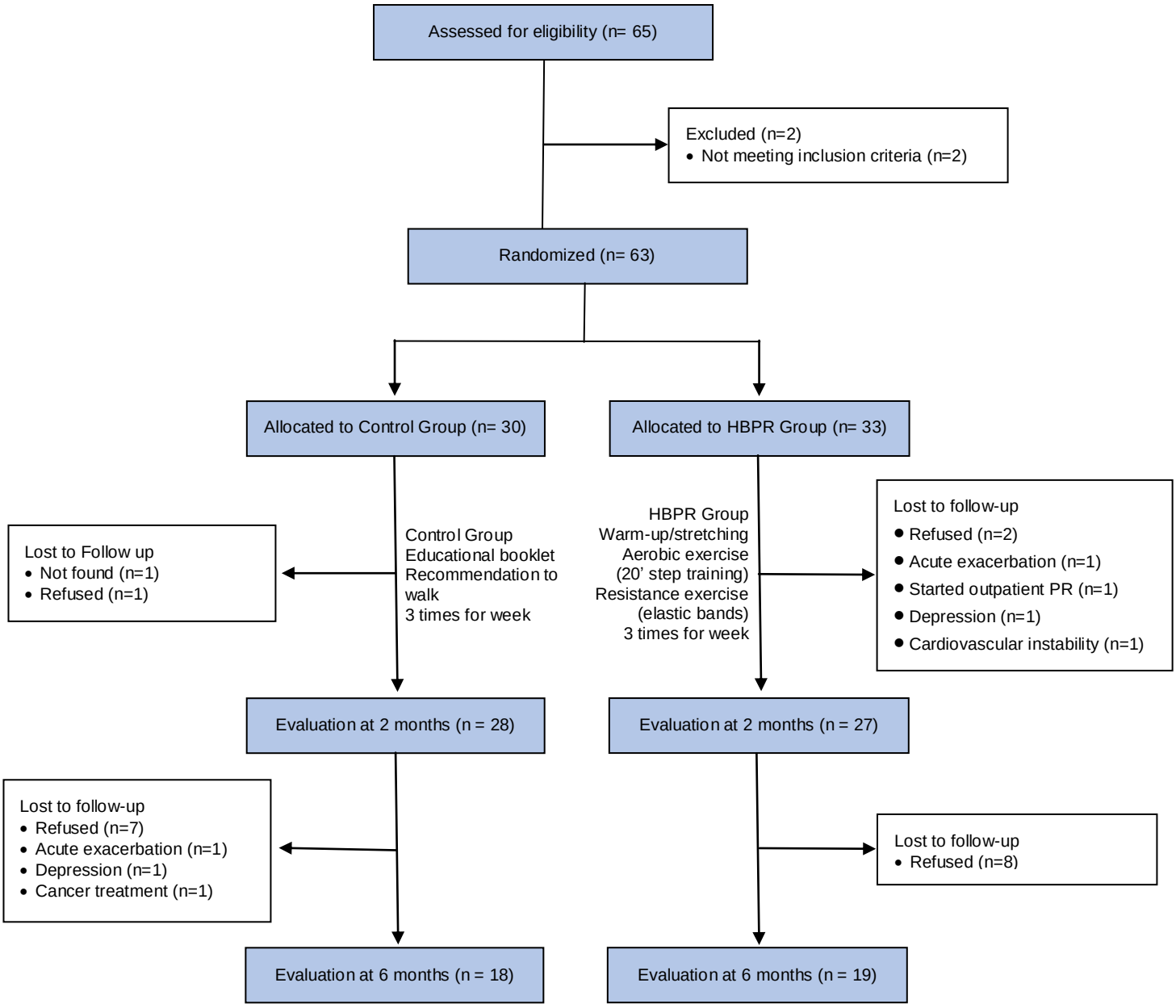

Figure 1. Consolidated Standards of Reporting Trials participant disposition.