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

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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, dyspnoea and daily physical activity in people with bronchiectasis.

Methods: Randomised controlled trial with 63 participants with bronchiectasis. The HBPR group performed three sessions per week for 8 weeks (aerobic exercise: step training for 20 min; resistance training: exercises for quadriceps, hamstrings, deltoids and biceps brachii using elastic bands). The control group received a 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 6 months later.

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

Conclusion: HBPR is an effective alternative offering of pulmonary rehabilitation for people with bronchiectasis. However, the programme was not effective in maintaining the benefits after 6 months of follow-up.

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Home-based pulmonary rehabilitation (HBPR) delivers improvements in functional capacity, peripheral muscle strength and QoL in people with bronchiectasis. HBPR is safe, well tolerated and can be considered an alternative rehabilitation programme. https://bit.ly/2Q2Bout

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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 and 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 randomised 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 dyspnoea and fatigue [6]. Pulmonary rehabilitation is effective in reducing the frequency of exacerbations over a period of 12 months [6, 7].

Despite the strong evidence of its benefits, offering pulmonary rehabilitation is still challenging because of barriers to attendance; travel issues are a predictor of poor adherence to attendance at a pulmonary rehabilitation programme [8, 9]. In this context, home-based pulmonary rehabilitation (HBPR) may be an alternative to overcome some of the barriers to attendance at centre-based programmes. 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 programme that does not require expensive resources such as treadmills, cycle ergometers or weight training equipment. A low-cost physical training programme was developed recently 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 using the upper limbs to lift weights with water bottles) 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.

We have developed a single-step physical training programme 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, dyspnoea and daily physical activity in people with bronchiectasis.

Methods

Design

This is a randomised controlled trial with concealed allocation. The trial protocol was registered at www.clinicaltrials.gov (NCT02731482) and published elsewhere [13]. The participants were evaluated at baseline (*i.e.* before intervention), immediately after the intervention (2 months) and 6 months after intervention (figure 1). The baseline data collection included age, gender, body mass index, pulmonary function, dyspnoea measured by the modified Medical Research Council scale [14], and severity of bronchiectasis, measured by the FACED (forced expiratory volume in 1 s, age, chronic colonisation by *Pseudomonas aeruginosa*, radiological extension and dyspnoea) [15] and E-FACED (FACED criteria plus exacerbations) score [16]. The participants were randomly assigned to receive either standard care (control group) or HBPR (intervention group). The randomisation schedule was generated using the website www.randomization.com with a 1:1 allocation ratio. Randomisation 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 >18 years with a clinical or tomographic diagnosis of bronchiectasis, who were in a stable clinical state for the previous ⩾4 weeks (absence of changes in the symptoms of dyspnoea and the volume and colour 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, those who presented significant levels of desaturation (pulse oxygen saturation ⩽80%) during baseline exercise testing were excluded.

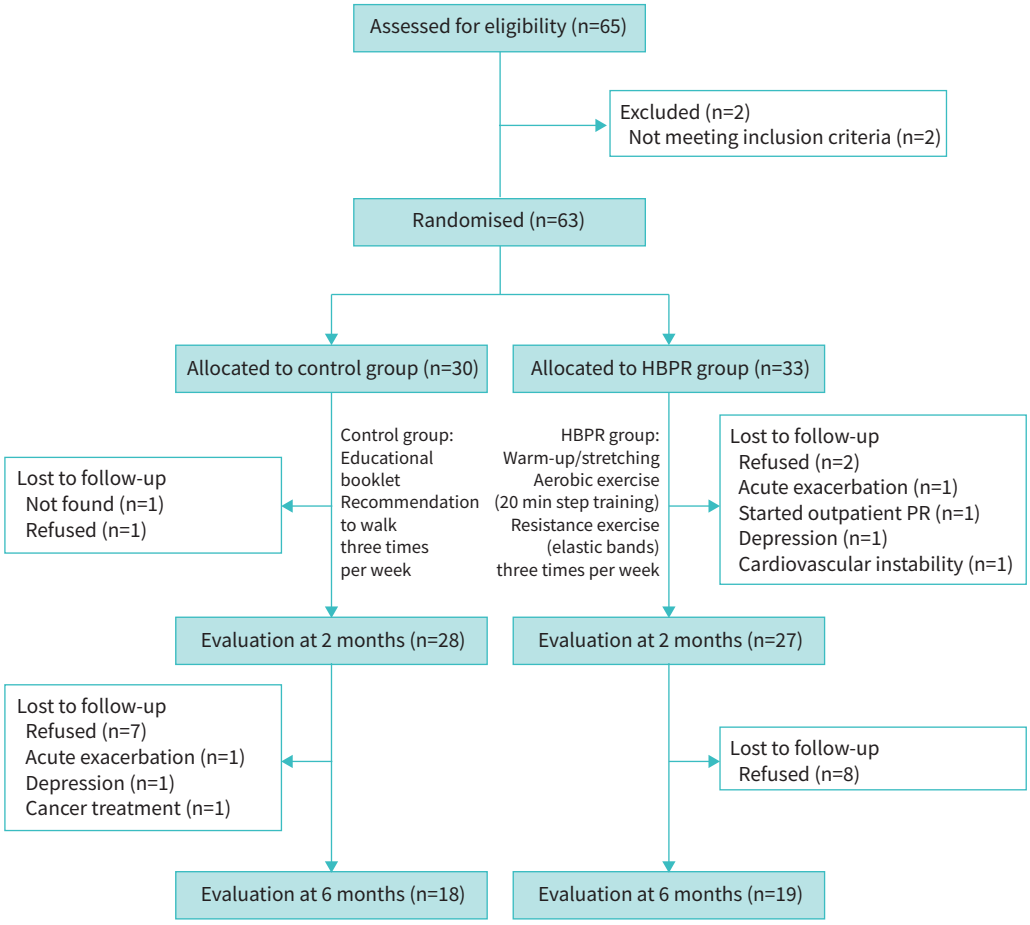

FIGURE 1 Consolidated standards of reporting trials participant disposition. HBPR: home-based pulmonary rehabilitation; PR: pulmonary rehabilitation.

Participants were recruited from the obstructive disease outpatient clinic (Hospital das Clínicas of the University of São Paulo, São Paulo, Brazil) and were referred to cardiopulmonary rehabilitation (University Nove de Julho, São Paulo). This study was approved by the human research ethics committee of Universidade Nove de Julho (no. 1249073). Written informed consent was obtained from all subjects.

Intervention

HBPR group

Participants allocated to the HBPR group performed three nonsupervised weekly sessions of 50 min duration each for 8 weeks. The participants received an educational booklet with illustrated instructions for the exercise programme and a diary in which they were to 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 ~5 min and was composed of active upper- and lower-limb exercises. Stretching lasted ~5 min, including the pectoralis major, latissimus dorsi, trapezius, femoral quadriceps and hamstrings muscles. Each stretch posture was maintained for 30 s.

Aerobic training

Aerobic training consisted of stepping onto 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 modified incremental step test (MIST) [12], performed during baseline. During the training sessions, target heart rate, dyspnoea 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 dyspnoea and/or fatigue <4 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 performed 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, Brazil). The intensity adjustments were made by increasing the load of the elastic bands [19] and were guided by the level of dyspnoea or fatigue of the trained muscle group [17].

Follow-up

The participants received a weekly phone call and a supervised session at home every 2 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 8-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 1 h 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 over seven consecutive days, using an accelerometer (ActiGraph wGT3X-BT; ActiGraph Corp, Pensacola, FL, USA); and quality of life, assessed using the Quality of Life Bronchiectasis questionnaire (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 α-error of 0.05 and a β-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 analysed using the t-test or Chi-squared test. Differences between the groups for change over time were analysed 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 standardised effect size was calculated using Cohen's d. The programme G*Power (version 3.1; Heinrich Heine University, Düsseldorf, Germany) was used for this analysis. A p-value <0.05 (two-tailed) was considered to be 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 6-month follow-up, a per-protocol analysis was performed [24].

Results

65 participants were recruited. Of these, two individuals were excluded: one for presenting musculoskeletal disorders and one refused to participate in the study. Thus, 63 participants were randomised. After intervention, 28 participants in the control group and 27 participants in the HBPR group were evaluated, while after the 6 months of follow-up, 18 participants in the control group and 19 participants in the HBPR group were assessed (figure 1). 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 6 months of follow-up.

There no were differences in baseline characteristics of the groups (table 1). The causes of bronchiectasis were idiopathic (35%), recurrent pneumonia (24%), tuberculosis sequelae (8%), gastro-oesophageal reflux

TABLE 1 Baseline characteristics of participants

	Control	HBPR	p-value
Participants	30	33	
Female	18 (60)	16 (48.5)	0.360
Age years	49.27±14.10	44.42±16.16	0.209
BMI kg·m^{-2}	24.02±2.91	23.96±2.56	0.933
MRC score	2.90±0.92	2.48±1.03	0.097
Aetiology			
Idiopathic	15 (50)	7 (21)	
Recurrent pneumonia	6 (20)	9 (27)	
Gastro-oesophageal reflux disease	4 (13)	1 (3)	
Other causes	5 (17)	16 (49)	
MRC score			0.366
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	0.431
Mild/moderate severity	15 (50)/15 (50)	16 (49)/17 (51)	
E-FACED score	2.57±1.19	2.45±1.37	0.730
Mild/moderate severity	24 (80)/6 (20)	26 (79)/7 (21)	0.905
Pseudomonas colonisation	14 (46.7)	10 (30.3)	0.189
FVC L	2.35±0.81	2.59±0.97	0.296
FVC % pred	68.90±20.57	72.30±21.89	0.527
FEV_1 L	1.37±0.56	1.63±0.84	0.151
FEV_1 % pred	51.21±0.56	55.15±27.19	0.535
FEV_1/FVC	59.09±14.30	61.47±16.49	0.542
ISWT m	433.79±145.74	477.40±196.88	0.319
ESWT min	8.22±6.87	8.14±6.90	0.961
MIST total steps	115.92±71.74	141.94±93.89	0.230
Daily steps	6045±2731	7340±4754	0.186
Quadriceps strength kg-force	26.46±12.15	26.52±10.76	0.983

Data are presented as n, n (%) or mean±SD, unless otherwise stated. HBPR: home-based pulmonary rehabilitation; BMI: body mass index; MRC: Medical Research Council dyspnoea scale; FACED: forced expiratory volume in 1 s (FEV_1), age, chronic colonisation by *Pseudomonas aeruginosa*, radiological extension and dyspnoea; E-FACED: FACED criteria plus exacerbation; FVC: forced vital capacity; ISWT: incremental shuttle walk test; ESWT: endurance shuttle walk test; MIST: modified incremental step test.

disease (8%), 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 programme. On average, the HBPR group participants performed 20±0.5 out 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 (mean difference (MD) 87.91 m, 95% CI 32.98–142.85 m; effect size between-group 0.863), but this was not maintained at 6 months. Improvements in time during the ESWT (MD 4.36 s, 95% CI 1.93–6.79 s; effect size 0.967) and MIST (MD 81.35 steps, 95% CI 43.10–119.60 steps, 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 aforementioned parameters were not maintained after 6 months (table 2).

Improvement in peripheral muscle strength was greater in the HBPR group than the control group following rehabilitation in quadriceps strength (MD 5.72 kg-force, 95% CI 1.99–9.45 kg-force; 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 −88.72–2745.61 steps; effect size 0.505) or at 6 months' follow-up (table 2).

In quality of life, the QoL-B questionnaire shows that "physical" (MD 11.44, 95% CI 0.83–22.06; effect size 0.589), "role" (MD 11.52, 95% CI 2.38–20.66; effect size 0.688) and "emotional" (MD 7.15, 95% CI 0.65–13.65; 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).

TABLE 2 Change in clinical differences from baseline to 2 months and follow-up (6 months)

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

Data are presented as mean±SD (95% CI). HBPR: home-based pulmonary rehabilitation; ISWT: incremental shuttle walk test; ESWT: endurance shuttle walk test; MIST: modified incremental step test. *: p<0.05 *versus* baseline; #: p<0.05 between groups; ¶: p<0.05 *versus* end rehabilitation.

Discussion

This is the first clinical trial aiming 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 6 months of follow-up. As expected, no changes were observed in the outcomes studied for the control group. The physical training programme was safe, and no adverse events were recorded. A high adherence to the training frequency was observed among the participants who completed the rehabilitation programme.

TABLE 3 Change in quality of life differences from baseline to 2 months and follow-up (6 months)

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

Data are presented as mean±SD (95% CI). HBPR: home-based pulmonary rehabilitation; QoL-B: Quality of Life Questionnaire Bronchiectasis. *: p<0.05 *versus* baseline; #: p<0.05 *versus* end rehabilitation; ¶: p<0.05 between groups.

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 s) [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 programme 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 6 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 elastic bands was effective in increasing 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 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 of quality of life in bronchiectasis. This is the first study to use 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 demonstrated previously 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 programmes. 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 completed the three weekly sessions 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 programme that requires little space to perform and is easy for the participant to understand. The aerobic exercise was step training, externally paced by sound stimuli, with an individualised cadence, and based on a percentage of the maximum workload obtained from the MIST. Although step training seems be problematic to perform in older populations, people with musculoskeletal limitation and balance issues, we believe that this type of aerobic training for HBPR is an alternative to walking-based programmes because it is not dependent on large and adequate areas of physical space, a common need in HBPR programmes that use walk-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 programme 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 to 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 patients and those in better clinical conditions than the population with bronchiectasis as a whole, 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 analysed by using linear mixed models. Finally, as described in the ClinicalTrials.gov registration, 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 programme was not effective in maintaining improvements after a 6-month follow-up period. Therefore, HBPR can be considered an effective and safe alternative rehabilitation programme to offer individuals with bronchiectasis.

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Conflict of interest: None declared.

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