

**Safety, Feasibility and Effectiveness of the remotely delivered Pulmonary Hypertension And Home-Based (PHAHB) Physical Activity intervention**

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## Early View

Original research article

# Safety, Feasibility and Effectiveness of the remotely delivered *Pulmonary Hypertension And Home-Based (PHAHB) Physical Activity* intervention

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Safety, Feasibility and Effectiveness of the remotely delivered *Pulmonary Hypertension And Home-Based (PHAHB) Physical Activity* intervention

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## **Take home message**

The PHAHB exercise trial demonstrates that an entirely remotely delivered exercise intervention is safe and feasible and, displays preliminary effectiveness for improving physical function, physical activity levels and quality of life in adults with PH.

## **Abstract**

**Background:** Pulmonary hypertension (PH) is a heterogeneous condition, associated with a high symptom burden and a substantial loss of exercise capacity. Despite prior safety concerns regarding physical exertion, exercise training as a supportive therapy is now recommended for PH patients. Currently, most programs are hospital-based, which limits accessibility. There is a need to provide alternative approaches for physical activity engagement for PH patients. The aim of this research was to develop, implement and evaluate the safety, feasibility, and effectiveness of home-based physical activity intervention for PH.

**Methods:** An entirely remotely delivered home-based exercise intervention underpinned by behaviour change theory and informed by end-users, was assessed using a single-arm feasibility study design. Participants (n=19; 80% female) with a mean ( $\pm$ SD) age of  $49.9\pm 15.9$  y with a diagnosis of PH undertook a 10-week, home-based exercise intervention with induction training, support materials, telecommunication support, health coaching, exercise training, and assessments, all remotely delivered. Training involved respiratory training along with a combination of aerobic and resistance exercises.

**Results:** The intervention was deemed safe as no adverse events were reported. A high level of feasibility was demonstrated as the protocol was implemented as intended, sustained a high level of engagement and adherence and was well accepted by participants in terms of enjoyment and utility. There was a significant improvement in functional capacity, physical activity, exercise self-efficacy and quality of life (QoL), between baseline and post-training.

**Conclusion:** The study demonstrates that an entirely remotely delivered home-based exercise program is safe, feasible and effective in improving functional capacity, physical activity, and QoL in PH patients.

#### **Conflict of Interest statement**

B. Kehoe institution has received grant funding for the submitted research from Actelion Pharmaceuticals; received grant funding from National Cancer Control Programme and Irish Research Council, outside of the work submitted. N. Moyna institution has received grant funding for the submitted research from Actelion Pharmaceuticals; received grants from Enterprise Ireland and Health Service Executive, outside of the submitted work; received consulting fees from Irish Health Life, outside of the submitted work. B. McCullagh has received honoraria and speaker's fees from Janssen Pharmaceuticals, outside the submitted work; and received travel support from Janssen Pharmaceuticals, outside the submitted work. S. Gaine institution has received grant funding for the submitted research from Actelion Pharmaceuticals; received honoraria and speaker's fees from MSD and Janssen

Pharmaceuticals, outside the submitted work; received travel support from MSD and Janssen Pharmaceuticals, outside the submitted work; participated in a DSMB for United Therapeutics and Janssen Pharmaceuticals; and has received consulting fees from or Altavant, Gossamer Bio, Janssen and MSD outside the submitted work. All other authors have nothing to disclose.

## Introduction

Pulmonary Hypertension (PH) affects approximately 1% of the global population and is characterized by progressive dyspnoea and fatigue leading to a reduction in functional capacity (FC) and quality of life (QoL). Insufficient physical activity in patients with PH further compromises aerobic capacity, hemodynamic function, and the odds of survival [1,2]. In contrast, exercise training improves exercise capacity and QoL [3–5].

To date, most PH exercise training studies have utilized the Heidelberg model [6] which involves an intensive 3-week in-patient induction phase, with a continued multimodality, monitored outpatient period for 12 weeks. Exercise involving a combination of aerobic and resistance training along with respiratory training is undertaken at least 5 days a week. Despite demonstrating significant improvements in exercise capacity, muscle function, QoL and pulmonary haemodynamics, the Heidelberg model is resource intensive and unlikely to be scalable [7]. Furthermore, most PH units are located in large urban centres and are not necessarily accessible to patients living in remote, rural areas.

An alternative and pragmatic approach, found to be as effective as a supervised exercise program in cardiac rehabilitation, is a home-based model of delivery [8]. Home-based exercise interventions have the potential to mitigate commonly reported barriers to participation in centre-based programs, such as time constraints, access to facilities, transportation issues, parking and cost [9]. A recent study reported a preference among PH patients for home-based physical activity programs, with appropriate support and monitoring [10,11]. The few studies that have examined the beneficial effects of home-based programs

in PH have found them to be safe and effective in improving functional capacity and QoL [12–14].

The use of telehealth in conjunction with wearable technology, and evidence-based behavioural change techniques, provides a low-cost and scalable solution to exercise training promotion in PH, that is likely to be sustainable and foster long-term behaviour change. Research of remote programs in other chronic respiratory diseases appears to be largely beneficial in improving clinical outcomes [15]. To our knowledge, no previous research has examined the feasibility and effectiveness of a home-based physical activity intervention that is delivered entirely remotely in PH patients.

The *Pulmonary Hypertension And Home-Based* (PHAHB) intervention is a novel patient-centered, theoretically informed and remotely delivered physical activity program for PH patients. The primary aim of the PHAHB trial was to assess the safety and feasibility of the intervention. The secondary aim was to assess the effects of PHAHB on physical function, physical activity, sedentary behaviour, fatigue, QoL, and exercise self-efficacy.

## **Methods**

This study employed a single group, pre-post-intervention design. Participants were recruited from the National Pulmonary Hypertension Unit at the Mater Misericordiae University Hospital, Dublin, Ireland. Eligible participants were invited to participate during their routine 3/6-month clinic visit commencing in February 2020. The study adhered to the Standard Protocol Items: Recommendations for Interventional Trials Reporting Template (SPIRIT) [16] and template for intervention description and replication (TIDieR) [17]. Ethical



approval was obtained from the Mater Misericordiae Institutional Review Board REF:1/378/2032 and Dublin City University Research Ethics DCUREC/2018/246. Trial registration ISRCTN83783446.

Eligibility criteria included adults  $\geq 18$  years with formal diagnosis of PH (WHO Groups I and IV) by right heart catheterisation with mean pulmonary arterial pressure (mPAP)  $\geq 25$  mmHg and resting pulmonary capillary wedge pressure (PCWP)  $\leq 15$  mmHg, on optimized conventional PH therapy and clinically stable with no medication changes in the 2 months prior to enrolment. A detailed list of exclusion criteria had been detailed previously [18]. Written informed consent was obtained prior to participation.

To date, exercise training interventions for PH have not been underpinned by behavioural change theory despite calls for the use of theory in the implementation of interventions [19]. The PHAHB intervention was underpinned by social cognitive theory [20] and associated behavioural change techniques found to be effective for increasing physical activity including instruction on how to perform behaviour, setting graded tasks, goal-setting, self-monitoring and adding objects to the environment [21,22]. In addition, the intervention was end-user informed through qualitative research exploring patients attitudes towards physical activity, exercise preferences and desired support needs [10,11].

## **Intervention**

The full study protocol for the PHAHB intervention has been previously described [18]. Briefly, participants completed a 10-week patient-centered, home-based physical activity intervention. All assessments and components of the study intervention were completed remotely. Participants were in regular contact with the researcher via telecommunication

technologies. The multi-component physical activity intervention included three 1:1 60-90min induction sessions, five 30 min health coaching sessions (with a focus on goal setting, action planning, feedback on performance, review of goals, problem solving) and an individualized exercise training program. Participants were provided with a stationary bike (NordicTrack GX 2.7U), exercise videos, a specifically designed physical activity manual and log-book and, Fitbit Charge 3 for self-monitoring. Participants were also provided with an automatic blood pressure monitor (Beurer BM44), finger pulse oximeter (SafeHeart SpO<sub>2</sub>monitor) and real time single lead electrocardiography/heart rate/respiratory rate monitor (Frontier X, UK) for assessment purposes.

The exercise training involved a combination aerobic, resistance and respiratory training. Individualized exercise plans were agreed based on a shared decision-making process between the clinical exercise physiologist and the participant during bi-weekly individual health-coaching sessions. The modified 10-point, Borg rating of perceived exertion (RPE) scale [23] was used to regulate exercise intensity. Participants aimed to achieve an initial RPE of 3 (moderate), with progression to an RPE of 4 (somewhat hard), if manageable.

### **Safety and Feasibility**

Safety was assessed by documentation of serious adverse events, which were defined as unintended physical injury resulting from or contributed to by study participation, that required additional monitoring, treatment, or hospitalization, or resulted in death. The feasibility of the intervention was assessed in accordance with guidelines by Bowen et al., [24] and, included the following domains: implementation, demand, acceptability, and practicality. Feasibility outcomes were captured through trial monitoring, researcher field

notes and participant exit questionnaires. Secondary outcomes were assessed remotely at baseline and, after the 10-week intervention (post-training) and included exercise capacity (6-min walk test (6MWT)), lower body strength (30 sec sit-to-stand test (STS)), physical activity levels and sedentary behaviour (using a ActivPAL3 micro accelerometers). In addition, overall level of fatigue (fatigue severity scale), QoL (Cambridge Pulmonary Hypertension Outcome Review (CAMPHOR)) and indices of exercise self-efficacy (including outcome, task, scheduling, recovery and self-regulatory self-efficacy) were also assessed using validated questionnaires as previous described [18].

The 6MWT was administered at home (n=3) or a local community centre (n=17) according to standard guidelines [25] using detailed step-by-step video and written instructions and remotely supervised by the clinical exercise physiologist via telecommunications. Real time heart rate and a single lead ECG were continuously monitored using telemetry (Frontier X). Timing, distance covered, RPE, blood pressure and oxygen saturation (SpO<sub>2</sub>) were measured with the assistance of a family member/friend. The 30 sec STS test was also supervised remotely by the clinical exercise physiologist who provided a demonstration prior to the test. Each participant performed two trials separated by 5 min, with the best score being recorded. ActivPAL micro activity monitors (PAL Technologies, Glasgow, Scotland) were placed on the right thigh and used to assess sedentary behaviour and levels of light, moderate and vigorous intensity physical activity over a 7-day period. The accelerometer along with the questionnaires used to measure fatigue, QoL and indices of exercise self-efficacy were mailed to participants and include a prepaid postage envelope for return.

## **Statistical Analysis**

Statistical analysis was performed using SPSS v27 (IBM, New York, USA). The mean difference between baseline and post-training on efficacy outcomes was compared using a paired samples t-test or a Wilcoxon signed-rank test. A two-way repeated measures (RM) ANOVA was used to compare within group differences in RPE, palpitations, chest pain, fatigue and breathlessness during the 6MWT at baseline and post-training. Significant main effects and interactions were examined using the Bonferroni test. To assess temporal changes in outcome measures, exercise training was divided into three blocks of three weeks each, starting from week two. Mean differences in outcome measures across the three blocks were compared using a one-way RM ANOVA. Significant main effects were probed using the Tukey test. The significant level was set at alpha value of  $p < 0.05$ .

## **Results**

### **Participant Enrolment**

The study recruitment process is shown in figure 1. A total of 103 patients were screened, of which 45 met the study inclusion criteria and 20 enrolled. A recent change in disease targeted therapy or scheduled to begin a new drug therapy during the intervention period were the primary reasons for ineligibility (Figure 1). One participant dropped out of the study due to hospitalization for an illness unrelated to PH or the intervention.

Participants baseline characteristics are summarized in table 1. The sample was 80% female with a mean age of  $49.9 \pm 15.9$ (SD)yrs. Participants resided at an average distance of

105 km from the National Pulmonary Hypertension Unit. Participants were diagnosed with PAH (n=17) or CTEPH (n=3). The majority of PAH was idiopathic.

### **Primary Outcomes**

The intervention was deemed safe as there were no serious or minor adverse events reported during the study. One participant reported a knee injury unrelated to participation in the study. Engagement was high with all participants (n=20) attending the three online induction sessions. The mean duration of the induction and health coaching sessions were  $58 \pm 14$  (SD) min and  $28 \pm 8$  (SD) min respectively. A high proportion (85%) of participants attended the five health coaching sessions and 5% attended each of four, three and two sessions. Mean self-reported adherence to the individually prescribed/agreed resistance training, respiratory training and aerobic training was 91%, 94% and 95%, respectively. Fitbit uptake was high with 85% of participants appropriately syncing their Fitbit data to the Fitbit Health Solutions Dashboard. The Fitbit tracker was the most frequently used support tool, with 84% reporting daily use. Participant compliance to recording their daily exercise was 100%. Almost two-thirds (63%) of participants indicated that they referred to the physical activity manual and 47.3% indicated viewing the exercise videos (via WhatsApp) almost daily.

Researcher field notes provided a detailed account of the feasibility of the intervention from the perspective of the clinical exercise physiologist. With regards to fidelity, each component of the intervention was delivered as per protocol. A quarter of participants required one additional follow-up call (on average  $17 \pm 8$  (SD) min) to assist with Fitbit setup or to address questions related to the exercise program.

The remote-based nature of the intervention delivery presented a number of technical challenges including insufficient internet connectivity and smart phone storage capacity along with synchronization issues. A series of pre-recorded “*how to*” videos produced to assist with Zoom, Fitbit and accelerometer set-up along with instructions for assessment procedures, activity monitoring, 6MWT and questionnaire completion were identified as valued resources.

The induction sessions were deemed feasible by the researcher. They were identified as a key component of the intervention and provided an opportunity for rapport building with the participants. Topics related to safety, the acute effects of exercise, the benefits of exercise, breathing techniques and managing exercise intensity were well received by participants. Discussions with participants regarding potential barriers to program engagement and program goals allowed the researcher to become familiar with their individual support needs and circumstances.

Most participants (79%) found the PHAHB intervention to be “*extremely*” enjoyable or “*quite a bit*” (21%) enjoyable. Health coaching sessions were deemed to be the most helpful (84.2%) component of the intervention, followed by induction sessions and the Fitbit tracker at 78.9% respectively.

### **Secondary Outcomes**

There was a significant increase in the average number of steps taken per day and time spent in light intensity physical activity and moderate-to-vigorous intensity physical activity (Table 2). Self-reported engagement in aerobic training (AT) and resistance training (RT) during each exercise block (B) is summarized in table 3. There was a significant increase

in the weekly number and duration of cycle ergometer session and the mean duration of the walking sessions between B1 and B3. The number of AT sessions (sum of cycle ergometer and walking training) per week and the time per session increased significantly between all three blocks. The mean RPE of the AT sessions increased from  $3.73 \pm 0.47$ (SD) during B1 to  $4.03 \pm 0.44$  (SD) during B3 ( $p=0.017$ ). The mean number of RT sessions and the mean number of sets and repetitions per session increased significantly between B1 and B3. There was no significant difference in the number of respiratory sessions undertaken between any of the three-week blocks.

Performance in the 6MWT improved significantly ( $p=0.000$ ) between baseline and post training (Figure 2) with a mean increase of 72 m (range 34-115m). None of the participants reported chest pain or palpitations pre or post 6MWT at baseline or post-training and the mean SpO<sub>2</sub> value remained constant at 94-95%. Perception of breathlessness and fatigue increased significantly from pre to post 6MWT at both baseline and post-training. There was no interaction effect for perception of breathless and fatigue between baseline and post-training.

There was a significant improvement in the 30-second STS score ( $p=0.000$ ) between baseline and post-training (Figure 2). The average increase was  $8.32 \pm 3.95$  (SD) reps (range 12-25). The difference in both the STS and 6MWD performance score between baseline and post-training were calculated and were found to be positively correlated ( $r=0.75$ ). Each 1 rep increase in STS was associated with a 10.5 m improvement in 6MWD.

Compared to baseline, there was a significant improvement in total CAMPHOR score ( $p=0.019$ ) and symptoms ( $p=0.000$ ) at post-training (Table 3). Although the fatigue severity

score (Table 3) was 6% lower at post training than baseline, it failed to reach statistical significance ( $p=0.09$ ). All measures of self-efficacy improved significantly between baseline and post training (Table 3).

## **Discussion**

The present study found that a novel and entirely distance-based physical activity intervention is safe, feasible and effective in medically stable PH patients. A high safety profile has previously been reported in inpatient [6,26–28] and hybrid models of exercise training [12,29,30]. Participants perceived the program to be practical and reported a high level of satisfaction and enthusiasm as evidenced by the high engagement rates. The study provides preliminary evidence of effectiveness through improvements in physical function, physical activity and QoL.

The extensive design process of the PHAHB intervention is likely to have positively influenced adherence rates. A novel aspect of the PHAHB intervention was the focus on physical activity behaviour change and the utilization of evidence based behaviour change techniques to enhance intervention effectiveness. It has been shown that physical activity interventions that combine behaviour change techniques such as self-monitoring, goal setting, providing feedback on performance, adding object to the environment and review of behaviour goals [31] illicit greater effectiveness. The individualised approach to exercise training planning and progression using shared decision-making guided by the clinical exercise physiologist has not been reported in previous PH studies. Empowering individuals to engage in the decision-making process and to self-regulate their physical activity is likely to foster the



development of more autonomous forms of motivation, a central element to increasing participation and enjoyment levels [32] and promoting adherence to exercise [33].

Performance in the 6MWT has previously been shown to strongly correlate with daily physical activity levels, right atrial pressure, and prognosis in PH [34]. All participants in the current study improved their 6MWD. The average improvement in the 6MWT of 72m is similar to a recent 6-month home-based intervention which included 17 PH participants who engaged in an aerobic training and respiratory training rehabilitation program [14] and is at the upper end of the range reported for PH patients following participating in centre-based exercise training programs (53 to 72m) [4,35,36]. Ten of the participants who achieved a 6MWD <440m at baseline achieved a score  $\geq$ 440m post-training as recommended by the ESC-ERS risk stratification as treatment goal for PH patients [37].

Our study also contributes to the literature in terms of physical activity outcomes in PH. To our knowledge, no previous work has focused on physical activity behaviour change as an important outcome in physical activity interventions despite preliminary evidence indicating that physical activity and sedentary behaviour may have unique influences on survival in this cohort [2,38]. The PHAHB intervention increased moderate-to-vigorous physical activity by 154% and reduced sedentary behaviour by 11%. Given the recent evidence indicating that physical activity needs to be of at least moderate intensity to significantly improve 6MWD and QoL in individuals with PH [38], the present findings are encouraging from a clinical perspective. The 17% increase in light intensity physical activity (1.5-2.9 METs), which primarily involves activities of daily living, may also provide an important therapeutic target, particularly for sedentary/insufficiently active populations [39].

The improvements in QOL were similar to those recently reported in PH patients following one year of medical treatment [40]. The significant change in CAMPHOR symptoms domain may potentially influence patients' ability to engage in physical activity and activities of daily living. It is encouraging that the majority of participants were close to attaining the recommended minimal important clinical difference values [40] following the relatively brief PHAHB intervention.

The manner in which the intervention was remotely monitored and assessed has potential implications for the broader feasibility and scalability of this pragmatic approach. Importantly, participants did not incur any financial cost during the program, and no travel was involved. The unit cost for the intervention equipment (wearable trackers, cycle ergometer, print material) was approximately €270. Participants safely completed baseline and follow-up assessments remotely, with no major issues reported. The adoption of remote assessment/monitoring in clinical practice may help to improve patient care.

### **Strengths and limitation**

A major strength of this study was the systematic, iterative approach taken to develop the intervention, which was evidence-based, underpinned by behaviour change techniques, and informed by end-users. The study included a national sample of PH patients with a broad range in ages. However, only three men participated in the study, which may limit the generalisability of the study findings in terms of gender. Other study limitations included the absence of control group and the small sample size. This was however planned as a pilot study with the primary aim of establishing the safety and feasibility of the intervention to

inform a larger-scale evaluation using a randomised control trial (RCT). Finally, remote monitoring is open to potential bias that could affect the accuracy and reliability of the data.

## **Conclusion**

The PHAHB trial demonstrates that a novel remotely delivered physical activity intervention is safe and feasible and, with preliminary effectiveness for improving physical function, physical activity levels and QoL in PH. The PHAHB model holds promise for the adoption of home-base delivery models among the wider PH population. Further research in the form of larger scale RCTs is needed to confirm these findings.

## **Acknowledgements**

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Table 1 Participants baseline clinical characteristics

Clinical Characteristics	Baseline
Gender (Male:Female)	4:16
Age (y)	49.90 ± 15.87
Height (m)	166.56 ± 10.40
Weight (kg)	79.14 ± 21.97
BMI (kg.m <sup>2</sup> )	28.31 ± 6.42
Distance from NPHU (km)	104.69 ± 109.15
PH specific diagnosis	
IPAH	10(50)
CTD-PAH	4(20)
IPAH-CCB	2(10)
CTEPH	3(15)
Other	1(5)
Duration of diagnosis (years)	6 ± 4.40
NYHA functional class	
1	3(15)
2	12(60)
3	5(25)
Risk stratification	
Low	10(50)
Intermediate	10(50)
Comorbidities	
Yes	19(95)
No	1(5)
Medication combination treatment	
None	2(10)
Monotherapy	2(10)
Double Combination	8(40)
Triple Combination	8(40)
PH targeted drugs	
Phosphodiesterase 5 - inhibitors	18(90)
Endothelin receptor antagonists	16(80)
Prostaglandin 12	10(50)
Pre-syncope	
None	14(70)
Syncope	6(30)
Unknown	1(5)
Clinical signs of RHF	
Yes	1(5)
No	19(95)
Respiratory rate (bpm)	17.50 ± 1.05
Blood profile	
Hb (g/dl)	14.01 ± 1.86
BNP (ng/L)	138.58 ± 161.94

Continuous variables are presented as mean ± standard deviation. Categorical variables are n (%). BMI: Body mass index; NPHU: National pulmonary hypertension unit; PH: Pulmonary Hypertension; IPAH: Idiopathic Pulmonary Arterial Hypertension; CTD – PAH: Connective tissue

disease associated PAH; IPAH- CCB: IPAH calcium channel blocker responder; CTEPH: Chronic Thromboembolic Pulmonary Hypertension; NYHA: New York Association; RHF: Right heart failure; Hb: Hemoglobin; BNP: Brain natriuretic peptide .

Table 2 Self-reported exercise training

Variable	Exercise Blocks			P values		
	Block 1 (Weeks 2-4)	Block 2 (Weeks 5-7)	Block 3 (Week 8-10)	B1 vs. B2	B1 vs. B3	B2 vs.B3
Cycle ergometer sessions/wk (n)	1.7 ± 1.07	2.42 ± 0.99	2.56 ± 1.10	.063	<b>.014*</b>	.992
Cycle ergometer time/wk (min)	21.98 ± 17.29	40.29 ± 26.91	33.87 ± 33.87	<b>.014*</b>	<b>.002*</b>	<b>.010*</b>
Walking sessions/wk (n)	1.82 ± 1.17	1.98 ± 1.38	2.00 ± 1.24	1.00	1.00	1.00
Walking time/wk (min)	42.91 ± 34.88	54.66 ± 44.51	66.98 ± 51.28	.102	0.01	.220
Aerobic training sessions/wk (n)	3.56 ± 1.24	4.40 ± 1.88	4.56 ± 1.55	<b>.043*</b>	<b>.004*</b>	1.00
Aerobic training time/wk (min)	64.89 ± 37.13	94.96 ± 60.32	117.40 ± 65.23	<b>.002*</b>	<b>.000*</b>	<b>.002*</b>
Aerobic training RPE	3.73± 0.47	3.85 ± 0.52	4.03 ± 0.44	.555	<b>.017</b>	.318
Resistance training sessions/wk (n)	2.14 ± 0.64	2.43 ± 0.83	2.56 ± 0.68	.092	<b>.017*</b>	.092
Resistance training sets/session (n)	2.43 ± 0.47	2.75 ± 0.38	2.94± 0.22	<b>.053*</b>	<b>.001*</b>	.070
Resistance training sets/wk (n)	5.42 ± 1.97	7.05 ± 2.66	7.59 ± 2.20	<b>.002*</b>	<b>.000*</b>	<b>.002*</b>
Resistance training reps/session	9.61 ± 1.71	10.98 ± 2.07	12.29 ± 1.45	<b>.002*</b>	<b>.000*</b>	<b>.008*</b>
Resistance training reps/wk (n)	55.36 ± 24.54	82.45 ± 36.66	95.28± 33.98	<b>.000*</b>	<b>.000*</b>	<b>.004*</b>
Resistance training exercises/session (n)	4.21 ± 0.53	4.92 ± 0.97	5.71± 0.98	<b>.004*</b>	<b>.000*</b>	<b>.000*</b>

Continuous variables are presented as mean ± SD. Aerobic training = sum of number of cycle ergometer and walking sessions; n = number; min = minutes; RPE =rate of perceive exertion; wk = week; B = blocks;\* = statistically significant results p = < 0.05

Table 3 Secondary outcome measures at baseline and post-training

Outcome	Time		p – value
	Baseline	Post-Training	
6MWD (m)	380.34.65 ± 72	451.05 ± 76.55	<b>0.001</b>
30 STS (reps)	10.05 ± 2.89	18.32 ± 3.95	<b>0.001</b>
Sleep duration (h)	9.43± 1.58	9.92 ± 1.57	<b>0.004</b>
Fatigue	44.89 ± 17.68	42.26 ± 15.30	0.089
<b>PA and Sedentary Behaviour</b>			
Sedentary waking (h)	10.14 ± 1.84	9.10 ± 1.56	<b>0.001</b>
Standing (h)	3.21 ± 1.18	3.54 ± 1.38	0.078
Stepping (h)	1.18 ± 0.60	1.58 ± 0.72	<b>0.000</b>
LIPA (h)	1.02 ± 0.46	1.18 ± 0.50	<b>0.008</b>
MVPA (h)	0.15 ± 0.16	0.39 ± 0.30	<b>0.000</b>
<b>Quality of Life</b>			
CAMPHOR total score	30.26 ± 16.64	25.89 ± 18.51	<b>0.019</b>
CAMPHOR QoL	10.21± 7.50	8.79 ± 7.547	<b>0.032</b>
CAMPHOR activity	7.68 ± 4.110	8.32 ± 4.85	0.259
CAMPHOR symptoms	12.37 ± 6.80	8.79 ± 7.08	<b>0.000</b>
<b>Exercise Self-Efficacy</b>			
Outcome self-efficacy	4.68 ± 0.52	4.89 ± 0.47	<b>0.034</b>
Task self-efficacy	7.63 ± 1.53	8.46 ± 1.19	<b>0.000</b>
Scheduling self-efficacy	7.81 ± 1.65	8.69 ± 1.28	<b>0.001</b>
Recovery/coping self-efficacy	7.10 ± 1.91	8.52 ± 1.37	<b>0.000</b>
Self- regulatory exercise self-efficacy	7.72 ± 1.55	8.57 ± 1.21	<b>0.001</b>

Variables are presented as mean ± SD. 6MWD: 6 min walk distance; STS: Sit to stand; PA: Physical activity; LIPA: Light intensity physical activity; MVPA: moderate to vigorous physical activity ; CAMPHOR: Cambridge pulmonary hypertension outcome review; QoL: Quality of life.

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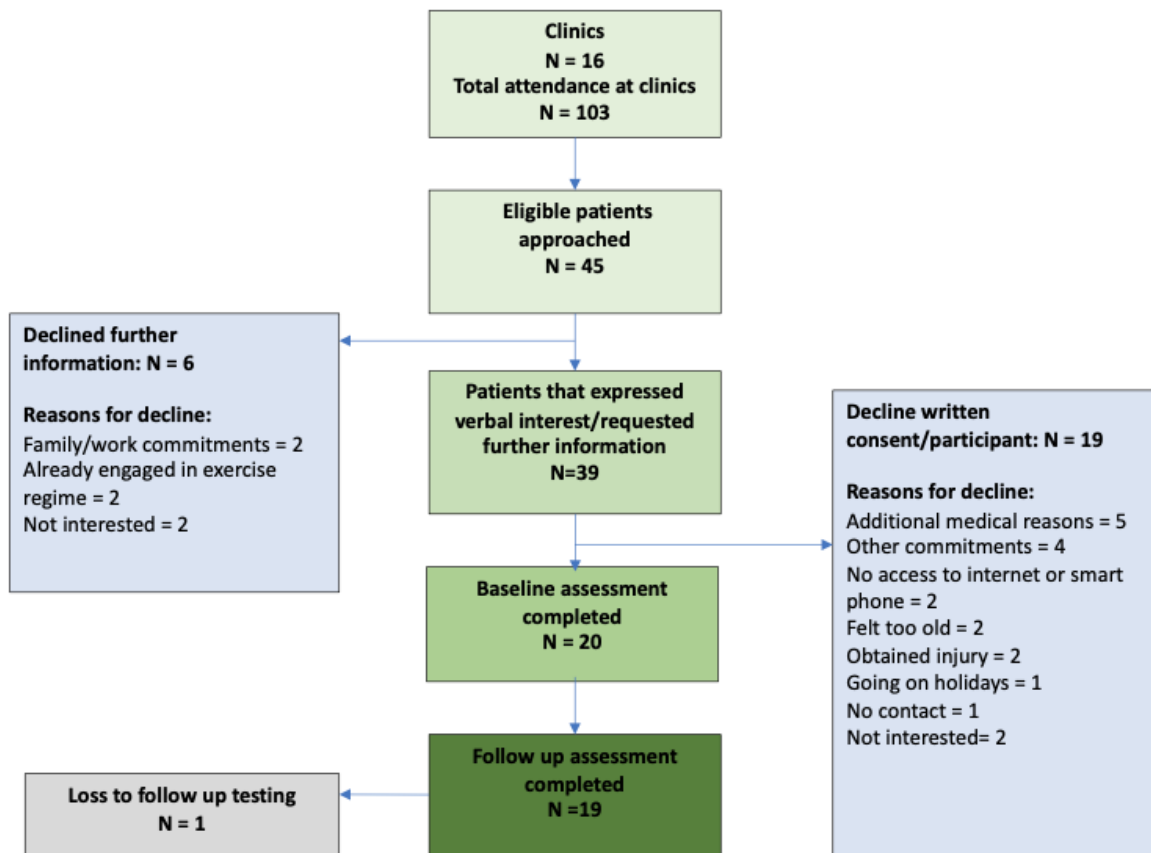


Figure 1. Flow diagram summarizing the study recruitment process

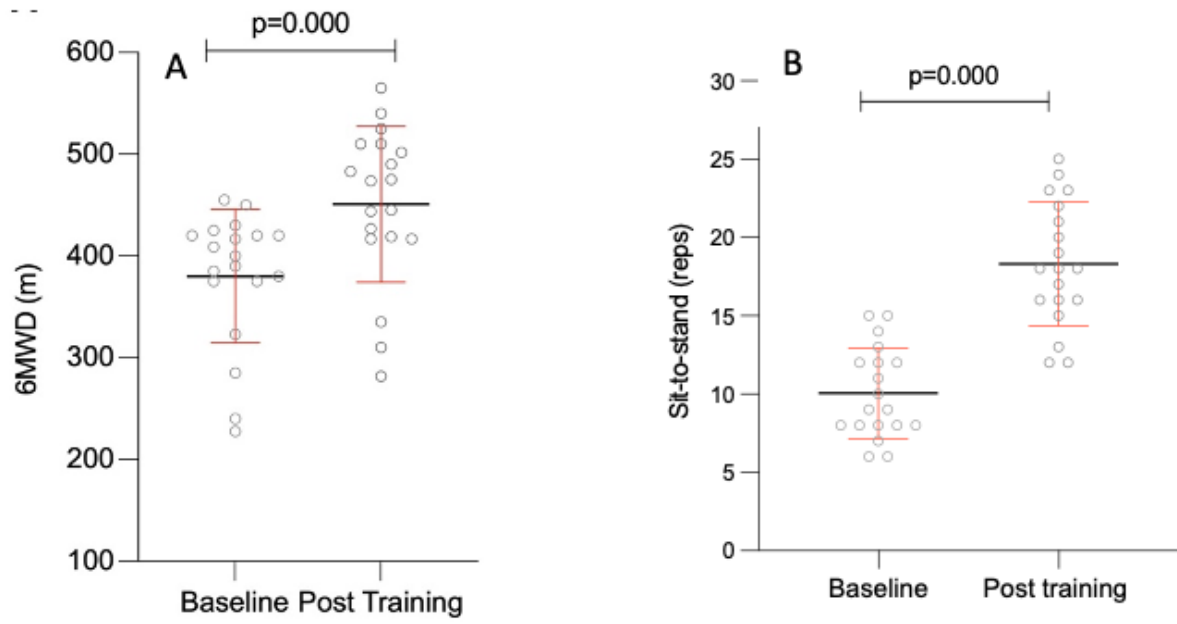


Figure 2. (A) 6MWD and (B) 30-sec sit-to-stand performance at baseline and post training