# Made available by Hasselt University Library in https://documentserver.uhasselt.be

Short-term effects of home-based pulmonary rehabilitation during outpatient-managed exacerbations of COPD: a randomised controlled trial Peer-reviewed author version

Machado, A; Dias, C; Paixao, C; Gonçalves, AP; BURTIN, Chris & Marques, A (2024) Short-term effects of home-based pulmonary rehabilitation during outpatient-managed exacerbations of COPD: a randomised controlled trial. In: Thorax, 80 (4), p. 218 -226.

DOI: 10.1136/thorax-2024-221760 Handle: http://hdl.handle.net/1942/45893

2		
3	1	Short-term effects of home-based pulmonary rehabilitation during outpatient-managed
4	2	exacerbations of COPD: a randomized controlled trial
5	- 2	
6 7	3	Ana Machada 12345 Ciptia Dias 12 Cátia Daivão 123 Antónia Dadra Canachuach Chris Durtin 45
/ 8	4	Ana Machado
9	5	Alda Marques <sup>1,2</sup>
10	6	
11	7	<sup>1</sup> Lab3R – Respiratory Research and Rehabilitation Laboratory, School of Health Sciences,
12	8	University of Aveiro (ESSUA), Aveiro, Portugal
13	9	<sup>2</sup> iBiMED – Institute of Biomedicine, Department of Medical Sciences, University of Aveiro,
14 15	10	Aveiro, Portugal
15	11	<sup>3</sup> Department of Medical Sciences, University of Aveiro, Aveiro, Portugal
17	12	4Debabilitation Descarch Conter (DEVAL). Eaculty of Debabilitation Sciences, Llosselt University
18	12	Renabilitation Research Center (REVAL), Faculty of Renabilitation Sciences, Hasselt University,
19	13	Diepenbeek, Belgium
20	14	<sup>5</sup> Biomedical Research Institute (BIOMED), Hasselt University, Diepenbeek, Belgium
21	15	<sup>6</sup> Emergency Department, Centro Hospitalar Universitário de Santo António, Porto, Portugal
22	16	
23 24	17	Corresponding Author: Alda Marques, PT, MSc, PhD, Senior Lecturer, Lab 3R – Respiratory
25	18	Research and Rehabilitation Laboratory. School of Health Sciences (ESSUA) and Institute of
26	19	Biomedicine (iBiMED) University of Aveiro, Agras do Crasto – Campus Universitário de Santiago
27	20	Edifício 20, 2810, 102 Avoiro, Bortugal, Email: amarguos@ua.nt; Tolonhono; 002E1224272462
28	20	Editicio So, Solo-195 Aveiro, Portugal, Email, amarques@ua.pt, Telephone. 00551254572462
29	21	
30 31	22	
32	23	Previous presentations: Part of this work has been presented at the European Respiratory
33	24	Congress 2023, in Milan, as an oral communication.
34	25	
35 36	26	Word count: 3981
37	27	Abstract count: 250
38	28	Tables: 4
39 40	29	Figures: 2
40 41	30	References: 40
42	21	
43	27	
44	32	
45 46	55	
40 47	34	
48		
49		
50		
51		
52		
53 54		
55		
56		
57		
58		
59		
60		

Thorax

2		
3 4	1	Abstract
4 5	2	Background: Uncertainty exists about the beneficial effects of delivering pulmonary
6 7	3	rehabilitation (PR) during exacerbations of chronic obstructive pulmonary disease (ECOPD). This
8	4	study explored the short-term effects and self-reported impact of a home-based PR programme
9 10	5	for people with outpatient-managed ECOPD.
11 12	6	Methods: We conducted a mixed-methods randomized controlled trial in people with
13	7	outpatient-managed ECOPD. Participants were randomly assigned to the control (CG, i.e., usual
14	8	care) or experimental (EG, i.e., usual care and 3-weeks home-based PR) group within 48h of the
16 17	9	diagnosis (baseline). Assessments were performed at baseline and after 3-weeks (post). The
18 10	10	COPD assessment test (CAT) was the primary outcome. Secondary outcomes included measures
19 20	11	of symptoms and functional capacity. After PR, interviews were conducted. Analyses were
21 22	12	performed using (non-)parametric mixed ANOVAs, deductive thematic analysis and narrative
23	13	integration through joint displays.
24 25	14	<b>Results:</b> Fifty participants with outpatient-managed ECOPD (78% male, 70 $\pm$ 11yrs, FEV <sub>1</sub>
26 27	15	47.4±16.4%pred) were included. Significant greater improvements in the EG compared to the
28	16	CG were found for the CAT (EG $\Delta$ -12.5 $\pm$ 7.2 vs. CG $\Delta$ -5.9 $\pm$ 7.2, p=0.002) and 12/13 other secondary
29 30	17	outcome measures. A positive self-perceived impact of PR was found on symptoms, control of
31 32	18	daily life, health, mental status and empowerment. No adverse events were reported.
33 34	19	Conclusions: A 3-weeks home-based PR programme is safe, meaningful and more effective than
34 35	20	just standard medication in improving symptoms, functional capacity and health status,
36 37	21	outcomes often associated with poor prognosis. This highlights the role of PR in improving the
38 30	22	recovery process during outpatient-managed ECOPD, and might contribute to a better prognosis
40	23	in these individuals.
41 42	24	Clinical trial registration: NCT03751670
43 44	25	
45	26	<b>Keywords:</b> pulmonary rehabilitation; early rehabilitation; acute exacerbation; person-centred;
46 47	27	impact of disease
48 ⊿q	28	
50	29	
51 52		
53 54		
55		
56 57		
58 59		
60		

# 1 Key messages

# 2 What is already known on this topic

Pulmonary rehabilitation (PR) is a cornerstone intervention for the management of people with
stable chronic obstructive pulmonary disease (COPD) (evidence level A) and has beneficial
effects in patients following hospitalization for exacerbation of COPD (ECOPD) (evidence level

6 B).

# 7 What this study adds

A 3-weeks home-based PR programme delivered concurrently with pharmacotherapy for people
undergoing outpatient management of ECOPD (i.e., ECOPD that do not required hospitalization,
representing more than 80% of all ECOPD) is safe, more effective than just pharmacological
treatment, and results in positive short-term effects and self-perceived impact on symptoms,
physical activity, activities of daily living, functional capacity and health status.

# 13 How this study might affect research, practice or policy

This is the first randomized controlled trial exploring the role of PR delivered concurrently with pharmacotherapy for people with outpatient-managed ECOPD. Our study provides a significant contribution for healthcare professionals to improve the care of people with outpatientmanaged ECOPD, with a safe and patient-meaningful intervention. The PR programme implemented in this study can be translated readily into clinical practice.

Reviewony

#### Introduction

The clinical trajectory of chronic obstructive pulmonary disease (COPD) is frequently punctuated by exacerbations (ECOPD), which are defined as events characterized by increased dyspnoea and/or cough and sputum that worsens over less than 14 days, and can be managed in an inpatient (severe ECOPD) or outpatient (mild to moderate ECOPD) setting.<sup>[1]</sup> These events have a negative impact on health status and disease progression, leading to worsening of symptoms, accelerated lung function decline, and impaired muscle strength, exercise performance, physical activity levels and quality of life, that often do not fully recover.<sup>[1, 2]</sup> Moreover, ECOPD increase individuals' susceptibility for further exacerbations, other acute events, hospitalizations and death.<sup>[1]</sup> The goals of treatment for ECOPD are, therefore, to minimize the negative impact of these events and prevent their recurrence.<sup>[1]</sup>

Pulmonary rehabilitation (PR) is a cornerstone intervention for the management of people with stable COPD, which has shown to i) improve exercise capacity, muscle strength and health-related quality of life, ii) reduce symptoms, hospitalizations and unscheduled healthcare visits, and iii) enhance self-management and self-efficacy.<sup>[1, 3]</sup> These are common and persistent treatable traits presented by people with ECOPD, hence, given the benefits of PR in these traits, it seems logical to also consider PR as a management strategy for ECOPD. In fact, the current Global Initiative for Chronic Obstructive Lung Disease (GOLD) guideline shows an evidence level B for PR after hospitalization for ECOPD,<sup>[1]</sup> however, studies focused in people with ECOPD who do not need hospital admission are lacking.<sup>[4]</sup> These outpatient-managed ECOPD represent more than 80% of all exacerbations and have a huge negative impact on people's lives; yet, they are treated with pharmacotherapy alone.<sup>[1, 5]</sup> Our previous pilot study showed promising results of PR in the management of people with outpatient-managed ECOPD on symptoms, vital signs, quadriceps muscle strength and impact of the disease,<sup>[6]</sup> but randomized controlled trials with larger samples are warranted.

This study explored the short-term effects and self-reported impact of a home-based PR programme among people with outpatient-managed ECOPD. We hypothesise that by adding PR to the current usual care (pharmacotherapy) for people with outpatient-managed ECOPD we will improve symptoms and impact of the disease, preserve or enhance functional status and have a positive self-perceived impact.

#### Material and methods

#### Study design and ethics

A randomized controlled trial (NCT03751670) with a convergent mixed-methods design (QUAN+QUAL) was conducted among people with outpatient-managed ECOPD between October 2019 and February 2023. Participants were randomly assigned to the control (CG, i.e., usual care) or experimental (EG, i.e., usual care plus PR) groups during the initial visit, prior to the collection of any baseline measures, in an 1:1 ratio, using sealed opaque envelopes. These envelopes were prepared before starting the recruitment process by using a web-based sequence generator (https://www.graphpad.com/quickcalcs/randomize1.cfm). The nature of the intervention and limited staff precluded blinding of participants, treating physiotherapists and assessors.

Approval for this study was obtained from the ethical committees of Centro Hospitalar do Baixo Vouga (15.23.2020), Centro Hospitalar Universitário de Santo António (2020.023: 018-DEFI/019-CE), Centro Hospitalar Vila Nova de Gaia/Espinho (127/2019-1), Unidade Local de Saúde de Matosinhos (73/CE/JAS) and Unidade Investigação em Ciências da Saúde: Enfermagem (P618-10/2019). All participants provided written informed consent before any data collection. This study is reported according to the consolidated standards of reporting trials (CONSORT), consolidated criteria for reporting qualitative research (COREQ) and good reporting of a mixed methods study (GRAMMS) guidelines.<sup>[7-9]</sup>

#### 17 Participants

People with outpatient-managed ECOPD were consecutively recruited, via their treating physicians, from the Pulmonology and Emergency departments of hospitals in the North and Centre regions of Portugal (more details in the supplementary material). The inclusion criteria were: i) previous diagnosis of COPD according to the GOLD criteria (confirmed by spirometry)<sup>[1]</sup>; ii) current diagnosis of ECOPD, defined as an acute worsening of respiratory symptoms that resulted in additional therapy (i.e., any escalation of the COPD treatment, such as, intensification or change of the bronchodilator regime, antibiotics, oral corticosteroids)<sup>[10]</sup>; iii) included within 48h of the ECOPD diagnosis; and iv) able to provide informed consent. Exclusion criteria included: i) need for hospitalization to manage the current ECOPD; ii) history of an acute cardiac or respiratory condition in the previous month; iii) unstable cardiovascular disease; iv) presence of musculoskeletal or neuromuscular impairments that precluded the ability to perform the assessments or intervention; v) signs of cognitive impairment; vi) current neoplasia; and vii) any therapeutical intervention in addition to usual care.

54 31

# 32 Interventions

The usual care intervention consisted of conventional medical treatment (i.e., pharmacotherapy
and medical advice). The home-based PR programme was delivered in fully supervised sessions,
on an 1:1 basis, and consisted of two sessions per week (approximately 60min/session), for 3

#### Thorax

weeks, composed of exercise training, breathing control and retraining, airway clearance techniques, education and psychosocial support.<sup>[4, 6]</sup> Exercise training included step training and strength training focused on the upper limbs, lower limbs and trunk, performed with free weights or individuals' own bodyweight, either in a sitting or standing position, depending on their condition. Education and psychosocial support was delivered in every session thorough talks/coaching, flyers and the demonstration of practical strategies. Sessions were delivered by physiotherapists with experience in respiratory interventions (AM or CD) following a standard protocol, which is described in detail in the supplementary material according to the Consensus on Exercise Reporting Template (CERT) guidelines.<sup>[11]</sup> A multidisciplinary team composed by physicians, nurses, social workers, psychologists and nutritionists was available to provide additional support, according to participants' needs, and contributed to the education and psychosocial support component of this intervention. Patients in both groups received a verbal general encouragement to be physically active.

### 15 Data collection

Participants were assessed at home, by trained physiotherapists (AM or CD), within 48h of thediagnosis of ECOPD (baseline) and 3 weeks after (post).

Sociodemographic (age, sex), anthropometric (height and weight to compute body mass index [BMI]) and general clinical data (smoking habits, self-reported number of exacerbations and hospitalizations in the past year, medication and comorbidities [self-reported and from medical records], use of long-term oxygen therapy and non-invasive ventilation) were collected. The severity of comorbid diseases was recorded and scored according to the Charlson comorbidity index (CCI).<sup>[12]</sup> The most recent lung function assessment and GOLD classification (i.e., grade and group)<sup>[1]</sup> were retrieved from the medical file. At post assessment, the number of self-reported ECOPD-related unscheduled healthcare visits during the 3-weeks study time was retrieved.

The primary outcome was impact of the disease assessed with the COPD assessment test (CAT). This outcome measure presents robust measurement properties during ECOPD and is recommended by the GOLD.<sup>[1]</sup> The CAT total score ranges from 0 to 40, with higher scores indicating higher impact. Minimal clinical important differences (MCID) of 2-3 points for hospitalization due to ECOPD and 3-weeks PR have been reported.<sup>[13]</sup>

31 Secondary patient-reported outcome measures included the brief physical activity assessment
 32 tool for physical activity level,<sup>[14]</sup> the modified Medical Research Council dyspnoea questionnaire
 33 for activity-related dyspnoea,<sup>[1]</sup> the London chest activity of daily living for dyspnoea during
 34 activities of daily living,<sup>[15]</sup> the cough and sputum assessment questionnaire (CASA-Q) for
 35 symptoms of cough and sputum and their impact,<sup>[16]</sup> and the functional assessment of chronic

illness therapy-fatigue and checklist individual strength-fatigue (8 items) for symptoms of
 fatigue.<sup>[17]</sup>

Secondary outcomes related to functional capacity were handgrip strength measured on the
dominant side with a hand dynamometer (Jamar 12-0241 Lite, Fabrication Enterprises Inc.,
White Plains, NY, USA),<sup>[18]</sup> biceps and quadriceps isometric muscle strength measured on the
dominant side with a handheld dynamometer (microFET2, Hoggan Health, The best Salt Lake
City, Utah, USA),<sup>[19]</sup> the short physical performance battery (i.e., standing balance, 4-meters gait
speed, 5-repetitions sit-to-stand test),<sup>[20]</sup> the 1-minute sit-to-stand test (1-minSTS)<sup>[21]</sup> and the
Chester step test (CST).<sup>[22]</sup>

At the post assessment, short, semi-structured, individual face-to-face interviews were conducted with the EG aiming to explore their perspectives and self-reported impact of the PR programme. A semi-structured interview guide with open-ended questions (see supplementary material) was developed informed by the literature, previous experience of the team and an experienced qualitative researcher. It was used to ensure that the topics under investigation were covered in a consistent manner but allowing flexibility. Interviews were audio recorded (Olympus digital voice recorder WS-750m) and transcribed verbatim. All interviews were anonymized by assigning pseudonyms to participants. Details on research team and reflexivity, and on rigor and trustworthiness are provided in the supplementary file.

# 20 <u>Data analysis</u>

A sample size calculation was performed based on the estimated partial eta squared for the mixed ANOVA of the primary outcome (CAT) obtained in a previous pilot study.<sup>[6]</sup> Assuming a 30-35% dropout rate,<sup>[23]</sup> it was estimated that 50 patients with outpatient-managed ECOPD would be needed to detect a moderate effect (f=0.30)<sup>[6]</sup> with 80% power, at the 5% significance level.

The quantitative data were analysed per protocol since only two dropouts (CG) occurred (less than 10% missing data). Descriptive statistics were used to describe the sample and the normality of data was explored with the Kolmogorov-Smirnoff test. Comparisons within (i.e., baseline vs. post) and between groups and group\*time interaction were explored with parametric and non-parametric mixed analysis of variance (ANOVAs), accordingly. Group\*time interactions were further explored using analysis of covariance (ANCOVA) to control for age, sex, BMI, smoking status and comorbidities (CCI total score). Statistical analyses were performed using IBM SPSS Statistics version 28.0 (IBM Corporation, Armonk, NY, USA) and RStudio 2022.12.0 (Posit PBC, Boston, MA, USA). The level of significance was set at 0.05. Data are Page 11 of 71

1 2

# Thorax

3	
4	
5	
6	
7	
, 0	
0	
9	
10	
11	
12	
13	
14	
15	
16	
17	
18	
19	
20	
21	
22	
23	
24	
25	
26	
27	
28	
29	
30	
31	
32	
32	
31	
35	
36	
50 27	
2/	
38	
39	
40	
41	
42	
43	
44	
45	
46	
47	
48	
49	
50	
51	
52	
53	
54	
55	
56	
57	
58	
59	
60	

presented as mean±standard deviation, mean (95% confidence interval), median [interquartile
 range] or number (percentage).

3 Qualitative data were analysed using deductive thematic analysis since there were preconceived 4 themes expected to be found (i.e., impact of the PR programme, opinions regarding the PR 5 programme) which the research team wished to investigate while still maintaining flexibility to allow for generation of new themes.<sup>[24]</sup> The six-step procedure of Braun and Clarke was 6 7 followed.<sup>[24]</sup> First, two researchers (AM and CP) familiarized themselves with the data by reading 8 and rereading the transcriptions before starting the coding process; independently organized 9 units of text under each code, creating additional codes if new issues were identified; and 10 organized the codes in themes and subthemes by combining the codes with similar or related 11 ideas. Then, the research team reviewed the data coded under each theme/subtheme, 12 contributed to the appropriate naming and definition of the themes, and produced the report. 13 The initial themes and subthemes found independently were compared between researchers 14 (AM and CP) and, in case of disagreement, consensus was reached by discussion. Analysis of the 15 transcripts was conducted using the Web Qualitative Data Analysis (WebQDA, Oliveira de 16 Azeméis, Portugal) software. Representative quotes were included to support the interpretation 17 of the identified themes and subthemes.

Quantitative and qualitative data were first analysed separately, in a parallel process, and
afterwards merged for integration of both methods in the final interpretation of the results,
using a narrative integration with contiguous approach and integration through joint displays.

21

28 29

30

# 22 Results

One-hundred and seventy-six people were referred for participation in the study. From these,
67 were randomized to either the EG or the CG and 50 participants with outpatient-managed
ECOPD (78% male, 70±11 years, FEV<sub>1</sub> 47.4±16.4%pred) were included in the analysis (Fig. 1). An
inaccurate or unconfirmed diagnosis of COPD or ECOPD was found in 36 of the referred
individuals.

### Please insert Figure 1 here.

Participants' baseline characteristics are summarized in tables 1 and 2. They all experienced a moderate ECOPD, according to GOLD classification.<sup>[1]</sup> Twenty-two participants in the EG completed the full PR programme (i.e., 6/6 sessions, 100% adherence), 1 completed 5/6 sessions and 1 completed 4/6 sessions. No adverse events were reported. One participant in the EG did not perform the interview due to hearing difficulties.

2				
3 ⊿	1			
5	2	Please insert Tables 1 and 2 here.		
6 7	3			
8	4	Significantly greater improvements were found in the EG compared to the CG for the CAT [EG $\Delta$		
9 10	5	-12.5 (-15.4; -9.5) vs. CG $\Delta$ -5.8 (-8.7; -3), p=0.002) and all secondary outcome measures, besides		
11 12	6	the CASA-Q sputum scores and the 1-minSTS (Table 3). After correcting the analysis for age, sex,		
13 14	7	BMI, smoking status and CCI total score, all differences remained significant (p<0.05) except for		
14	8	the CASA-Q scores, 1-minSTS %predicted and CST.		
16 17	9	At post assessment, the EG presented significant improvements in all outcome measures, while		
18 10	10	the CG only improved on the CAT, CASA-Q and CST. During the study period, a smaller number		
19 20	11	of ECOPD-related unscheduled healthcare visits were observed in the EG [0 (0; 0)] compared to		
21 22	12	the CG [0 (0; 2)] (p=0.025).		
23	13			
24 25	14	Please insert Table 3 here.		
26 27	15			
28	16	From the qualitative interviews, three main themes were identified: impact of the PR		
30	17	programme, thoughts about the PR programme, and (lack of) motivation to continue the PR		
31 32	18	programme (Table 4). The full list of themes, subthemes and interview quotations can be found		
33 34	19	in the supplementary material.		
35	20			
36 37	21	Please insert Table 4 here.		
38 39	22			
40	23	Participants described an overall positive impact of the PR programme, with a specific positive		
41 42	24	impact on symptoms, control of daily life, health, mental status and empowerment:		
43 44	25	"I am more stable regarding my problems of breathing, shortness of breath, everything.		
45	26	I felt a difference in my symptoms for better, for better. For what I could not do, God		
46 47	27	forbid!"		
48 49	28	Feedback on the design & setting of the programme, the exercises & support materials used,		
50	29	and the support received from healthcare professionals was also positive. Although most		
51 52	30	participants valued the home-based setting, one participant would appreciate a setting with		
53 54	31	more equipment available. Participants also mentioned the need for a longer PR programme.		
55	32	No suggestions of improvements for the PR programme were given. Education & breathing		
56 57	33	techniques were components highly valued by participants to support them in regaining control:		
58 59	34	"The main thing was to know the breathing techniques. If I would know that before, I		
60	35	would have done it long ago. There was no need of feeling as bad as I was feeling, right.		

### Thorax

2		
3	1	That was a really important thing. () The breathing was the main thing. Now I do it, I
4 5	2	do it. And with the acapella also and so. In the morning and at night. () This was the
6 7	3	main thing, to have clean lungs."
8	4	Conflicting ideas concerning motivation to continue the PR programme emerged, with some
9 10	5	participants feeling they are able to continue the programme alone, while others acknowledged
11 12	6	the importance of continuing PR but do not feel able to do it by themselves:
13	7	"It was important to keep doing it to feel the difference in my conditioning. To feel the
14 15	8	difference in my conditioning, to see if I would decide to start moving alone, walk around
16 17	9	outside. But I am not seeing it happen. () I just lack the will. I lack the will."
18	10	
19 20	11	The integration of the quantitative and qualitative results through a joint display is shown in
21 22	12	figure 2. Findings from both types of data are confirmatory of each other, i.e., positive short-
23	13	term effects of the PR programme on physical activity, symptoms, activities of daily living,
24 25	14	functional capacity and health status, and a positive self-perceived impact in the same domains.
26 27	15	
28	16	Please insert Figure 2 here.
29 30	17	
31 32	18	Discussion
33	19	This study showed that a 3-weeks home-based PR programme in people with outpatient-
34 35	20	managed ECOPD is safe and more effective than pharmacological treatment alone in reducing
36 37	21	impact of the disease, improving symptoms, physical activity levels and functional capacity, and
38	22	reducing ECOPD-related unscheduled healthcare utilization. Moreover, a positive self-perceived
39 40	23	impact of PR was found on symptoms, control of daily life, health, mental status and
41 42	24	empowerment.
43	25	In line with previous literature, <sup>[2, 25]</sup> individuals receiving just pharmacological treatment
44 45	26	presented some recovery, however this was limited to the CAT, CASA-Q and CST. It is known
46 47	27	that ECOPD are heterogeneous events in terms of presentation and trajectory of recovery, with
48	28	different parameters taking different times to recover and often persistent impairments being
49 50	29	sustained. <sup>[2, 26, 27]</sup> Hence, pharmacological treatment is likely insufficient for individuals to
51 52	30	achieve (full) recovery.
53	31	High impact of the disease measured with the CAT has been linked to hospital readmission.
54 55	32	ECOPD recurrence and mortality up to 6 months after hospitalization for ECOPD, hence, poor
56 57	33	prognosis. <sup>[28]</sup> Moreover, an association between change in the CAT score and change in systemic
58	34	inflammation following ECOPD has been shown. <sup>[29]</sup> with low levels of recovery in the CAT (<4
59 60	35	points) being associated with treatment failure $[30]$ In this study. PR resulted in a good level of
	55	

improvement in the CAT, which was two times superior to the improvement obtained with
 pharmacological treatment alone and exceeded the available MCID<sup>[13]</sup> by 4-6 fold. This result
 emphasizes the important role of PR in the recovery process of people with outpatient-managed
 ECOPD, potentially contributing to a better prognosis in these individuals.

Significant improvements after PR were also found in symptoms, physical activity levels and functional capacity, always at least two-fold greater than the CG. In fact, the 3-weeks home-based PR programme led to improvements similar or up to 6 fold superior to the available MCID for 6-12-weeks PR in stable COPD.<sup>[31-33]</sup> These improvements are particularly important due to the known relationship between worse symptoms, physical activity and functional capacity with higher risk of ECOPD, hospitalizations and mortality.<sup>[34, 35]</sup> Nevertheless, the short programme duration and lack of follow-up assessments hinders the possibility of exploring potential long-term effects of PR on these outcomes. Phone call follow-ups are being conducted to assess any potential role of PR in the prognosis of these individuals.

People with outpatient-managed ECOPD have mentioned symptoms as their main concern during ECOPD and, thus, symptoms relief as one of their main needs.<sup>[5]</sup> Limitations in activities of daily living and negative psychological, emotional, social and physiological impacts have also been reported, along with the need to be able to walk.<sup>[5]</sup> By leading to a positive self-perceived impact on symptoms, activities of daily living, functional capacity, mental and health status, this home-based PR programme was able to target the main needs of these individuals, showing that PR is not only safe but also meaningful for people with outpatient-managed ECOPD.

Participants mentioned the need for a longer PR programme and, despite the positive impact found on empowerment, not all individuals felt able to continue the PR programme alone after its completion. This home-based PR programme might, therefore, be seen as a rapid access programme to provide a bridge between the exacerbation period and the enrollment in a conventional stable PR programme.<sup>[36]</sup> In fact, these individuals are likely to be good candidates for referral to conventional PR as some of the commonly reported barriers to adherence (e.g., lack of perceived benefits, comorbidities and disabilities, perception of being too unwell to do it)<sup>[37]</sup> are already overcome. Primary care centers were mentioned as a potential setting to continue PR due to their proximity to people's homes. 

Finally, participants highlighted the importance of education and breathing techniques to help
 Them regaining control of daily life, reinforcing previous findings that PR programmes for people
 with ECOPD should include exercise training, breathing techniques, and education and
 psychosocial support.<sup>[4, 5]</sup>

35 <u>Methodological considerations</u>

Page 15 of 71

conclusions.

#### Thorax

This study has some strengths and limitations that need to be acknowledged. First, to our

knowledge, this is the first randomized controlled trial exploring the role of PR in the recovery

process of people being actively managed as outpatients for ECOPD. A major strength of this

study is its mixed-methods design. Using both quantitative and qualitative data allowed a more

comprehensive understanding of the role of PR, while maximizing the strengths and minimizing

the weaknesses of each type of data. Moreover, findings from both types of data were

confirmatory of each other, which increased results' credibility. The most well-established

guidelines to report quantitative (CONSORT), qualitative (COREQ) and mixed-methods studies

(GRAMMS), and exercise interventions (CERT) were followed. The PR programme was delivered

always by the same two physiotherapists (AM & CD) and followed a structured and detailed

intervention protocol (Supplementary material), which ensured consistency and reproducibility

among participants. The nature of the intervention makes it impossible to blind participants and

those delivering PR, hence, psychological and placebo effects cannot be excluded and are not

possible to quantify. Nevertheless, PR led to considerable improvements in all outcome

measures, always superior to the CG, thus it is likely that a true physiological effect contributed

to the observed improvements. Moreover, similar benefits with short interventions have been

found in hospitalized patients with ECOPD<sup>[38]</sup> and critically ill patients with COPD in intensive

care.<sup>[39]</sup> Another limitation is the lack of blinding of assessors, which may introduce bias to the

results. Nevertheless, patient-reported outcomes were completed by the participants

themselves, without direct input from the assessors, and the measures of functional capacity

followed standardized protocols that do not place subjective requirements on the assessor. The

interviews were mostly conducted by the treating physiotherapist, which might also introduce

bias, however, a semi-structured interview guide with open-ended questions was used to

ensure that the topics were covered in a consistent manner, without inducing pre-defined

responses. Our population was mostly composed by men which might limit the generalization

of our findings to all people with COPD, especially women. Additionally, our sample includes a

low percentage of individuals from GOLD grade 4 and on long-term oxygen therapy or non-

invasive ventilation, hence it is uncertain whether the benefits of this short-term PR programme

would be as substantial in individuals with more severe disease. Lastly, the interviews were

conducted in Portuguese, thus, the translation process might have influenced the findings,

particularly regarding the use of colloquial expressions or proverbs. We believe to have

minimized this limitation by having a bilingual speaker revising the main themes, quotes and

35 Implications for future practice and research

Our study provides a significant contribution for healthcare professionals to improve the care of people with outpatient-managed ECOPD, with a safe and patient-meaningful intervention. We envision the broad implementation of our PR programme by real-world primary care healthcare professionals, both in primary care centres and individuals' homes (depending on individual needs and barriers to participation in PR), to further explore the evidence of PR in people with outpatient-managed ECOPD and increase access and awareness to this key intervention. Although primary care has been recognized as the most inclusive, equitable and cost-effective setting by the World Health Organization,<sup>[40]</sup> and the PR protocol developed is possible to be used even in low resources, some implementation challenges are expected in different health systems. First, the establishment of a direct PR referral pathway from both the emergency department and primary care providers is recommended, which requires training and increased awareness for PR among these physicians, and might require the reconfiguration of the health system. The broad implementation of PR can impose some challenges in sites with limited or less experienced staff, resulting in access disparities and the need of hiring and/or training more healthcare professionals. Lack or limited insurance coverage can also be problematic in some health systems, hence new specific reimbursement policies might be required. Further adequately designed multicentric pragmatic randomized controlled trials are needed to build up the evidence of PR in people with outpatient-managed ECOPD, and implementation trials and a cost-effectiveness analysis are warranted. These could strengthen the work with policymakers and other relevant stakeholders to advocate for integration and coverage of PR in this context. Moreover, by improving the recovery process of people with outpatient-managed ECOPD, PR showed potential to contribute to a better prognosis in these individuals. Longitudinal studies exploring the mid- and long-term effects of PR in people with outpatient-managed ECOPD are now needed. Approximately 20% of the individuals referred to this study had an inaccurate diagnosis of COPD/ECOPD, thus, the diagnostic criteria for COPD/ECOPD must be implemented with more rigor. Lastly, the benefits obtained with this PR programme could only be compared with MCID established for PR in stable COPD. Specific MCID for PR in ECOPD are needed to better understand the clinically significance of these findings.

#### 30 Conclusions

A 3-weeks home-based PR programme in people with outpatient-managed ECOPD is safe, more
 effective than just pharmacological treatment, and results in positive short-term effects and
 self-perceived impact on symptoms, physical activity, activities of daily living, functional capacity
 and health status, outcomes often associated with poor prognosis. This highlights the role of PR
 in improving the recovery process during outpatient-managed ECOPD and, in turn, in potentially

Thorax

2	
3	1
4 5	2
6 7	3
8	4
9 10	5
11 12	6
13	7
14 15	8
16 17	9
18	10 11
19 20	12
21 22	13
23 24	14
25	15
26 27	16
28 29	17
30 31	18
32	19
33 34	20
35 36	21
37	22
38 39	23
40 41	24
42	25 26
43 44	20
45	28
46	29
47 48	30
49	32
50	33
52	34
53	35
54 55	30 27
56	38
57	39
58 50	40
59	

contributing to a better prognosis in these individuals. A longitudinal study, exploring the mid and long-term effects of this PR programme, is being conducted to verify this hypothesis.

**Funding:** This work was funded by Fundação para a Ciência e a Tecnologia (FCT) under the PhD grants SFRH/BD/147200/2019 & COVID/BD/153335/2023. This work was also supported under the project UIDB/04501/2020. Cátia Paixão (PhD grants SFRH/BD/148741/2019 & COVID/BD/153477/2023) is funded by FCT.

Declarations of interest: None.

Acknowledgments: The authors would like to acknowledge the support of all patients who
 agreed to participate in this study and their families. We also want to thank all the institutions,
 clinicians and staff involved in the recruitment process.

Authors contributions: AM, CB and ASM were responsible for project conceptualization and administration, and funding acquisition. AM and CD contributed to data acquisition. APG assessed participants for eligibility criteria and referred them to the study. AM and CP performed data analysis and all authors contributed to data interpretation. AM drafted the manuscript. All authors critically revised the manuscript, ensured accuracy and integrity of the work, approved the final version to be published, and agreed to be accountable for all aspects of the work. AM and ASM are responsible for the overall content as guarantors.

# 23 References

The Global Initiative for Chronic Obstructive Lung Disease. Global Strategy for the
 Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease 2023
 [Available from: <u>https://goldcopd.org/2023-gold-report-2/</u>.

Machado A, Barusso M, De Brandt J, Quadflieg K, Haesevoets S, Daenen M, et al.
 Impact of acute exacerbations of COPD on patients' health status beyond pulmonary function:
 A scoping review. Pulmonology. 2022. <u>https://doi.org/10.1016/j.pulmoe.2022.04.004</u>

Rochester CL, Vogiatzis I, Holland AE, Lareau SC, Marciniuk DD, Puhan MA, et al. An
 official American Thoracic Society/European Respiratory Society policy statement: enhancing
 implementation, use, and delivery of pulmonary rehabilitation. Am J Respir Crit Care Med.
 2015;192(11):1373-86. <u>https://doi.org/10.1164/rccm.201510-1966ST</u>

Machado A, Silva PM, Afreixo V, Caneiras C, Burtin C, Marques A. Design of pulmonary
 rehabilitation programmes during acute exacerbations of COPD: a systematic review and
 network meta-analysis. Eur Respir Rev. 2020;29(158).

37 <u>https://doi.org/10.1183/16000617.0039-2020</u>

38 5. Machado A, Almeida S, Burtin C, Marques A. Giving voice to people–experiences
39 during mild to moderate acute exacerbations of COPD. Chronic Obstr Pulm Dis. 2022:2.
40 <u>https://doi.org/10.15326/jcopdf.2022.0283</u>

3	1	6. Machado A, Oliveira A, Valente C, Burtin C, Marques A. Effects of a community-based
4	2	pulmonary rehabilitation programme during acute exacerbations of chronic obstructive
5	3	pulmonary disease–A quasi-experimental pilot study. Pulmonology. 2020;26(1):27-38.
6	4	https://doi.org/10.1016/i.pulmoe.2019.05.004
/	5	7. Jungueira DR. Zorzela L. Golder S. Loke Y. Gagnier JJ. Julious SA. et al. CONSORT Harms
8	6	2022 statement explanation and elaboration: undated guideline for the reporting of harms in
9 10	7	randomised trials BML 2022;281:e072725 https://doi.org/10.1126/hmi-2022-072725
10	0	Tong A. Sainshury D. Craig I. Consolidated criteria for reporting qualitative research
17	0	6. Tong A, Samsbury P, Craig J. Consolidated criteria for reporting qualitative research
12	10	(COREQ): a 32-item checklist for interviews and focus groups. Int J Qual Health Care.
14	10	2007;19(6):349-57. https://doi.org/10.1093/intqnc/mzm042
15	11	9. O'Cathain A, Murphy E, Nicholl J. The quality of mixed methods studies in health
16	12	services research. J Health Serv Res Policy. 2008;13(2):92-8.
17	13	<u>https://doi.org/10.1258/jhsrp.2007.007074</u>
18	14	10. The Global Initiative for Chronic Obstructive Lung Disease. Global Strategy for the
19	15	Diagnosis, Management, and Prevention of Chronic Obstructive Pulmonary Disease 2022
20	16	[Available from: https://goldcopd.org/2022-gold-reports-2/.
21	17	11. Slade SC, Dionne CE, Underwood M, Buchbinder R, Beck B, Bennell K, et al. Consensus
22	18	on exercise reporting template (CERT): modified Delphi study. Physical therapy.
23	19	2016:96(10):1514-24, https://doi.org/10.2522/nti.20150668
24	20	12 Charlson ME Pompei P Ales KL MacKenzie CR A new method of classifying prognostic
25	21	comorbidity in longitudinal studies: development and validation. I Chronic Dis. 1987;40(5):373-
26	21	22 https://doi.org/10.1016/0021.0691/97/00171.9
27	22	<ul> <li>Alma II. Da Jana C. Tailizianni J. Canderman D. Kaaka J. Van der Malan T. Clinically.</li> </ul>
28	25	13. Alma π, De Jong C, Tsinglahmi I, Sanderman R, Kocks J, Van der Molen T. Clinically
29	24	relevant differences in COPD health status: systematic review and triangulation. Eur Respir J.
30	25	2018;52(3). https://doi.org/10.1183/13993003.00412-2018
31 22	26	14. Marshall AL, Smith BJ, Bauman AE, Kaur S. Reliability and validity of a brief physical
32 22	27	activity assessment for use by family doctors. Br J Sports Med. 2005;39(5):294-7.
31	28	http://dx.doi.org/10.1136/bjsm.2004.013771
35	29	15. Garrod R, Bestall J, Paul E, Wedzicha J, Jones P. Development and validation of a
36	30	standardized measure of activity of daily living in patients with severe COPD: the London Chest
37	31	Activity of Daily Living scale (LCADL). Respir Med. 2000;94(6):589-96.
38	32	https://doi.org/10.1053/rmed.2000.0786
39	33	16. Crawford B, Monz B, Hohlfeld J, Roche N, Rubin B, Magnussen H, et al. Development
40	34	and validation of a cough and sputum assessment questionnaire. Respir Med.
41	35	2008:102(11):1545-55, https://doi.org/10.1016/j.rmed.2008.06.009
42	36	17 Al-Shair K Muellerova H Vorke L Rennard SL Wouters EE Hanania NA et al. Examining
43	37	fatigue in COPD: development, validity and reliability of a modified version of EACIT-E scale
44	20	Health Qual Life Outcomes, 2012:10(1):1.8, https://doi.org/10.1186/1477.7525.10.100
45	20	12 Fors F. Clinical Assessment Decommandations   American Society of Land Therapists
46	59	18. Fess E. Clinical Assessment Recommendations   American Society of Hand Therapists
47	40	(ASHT). Chicago; 1992.
48	41	19. Bohannon RW. Reference values for extremity muscle strength obtained by hand-held
49	42	dynamometry from adults aged 20 to 79 years. Arch Phys Med Rehabil. 1997;78(1):26-32.
50 F 1	43	https://doi.org/10.1016/S0003-9993(97)90005-8
51	44	20. Bernabeu-Mora R, Medina-Mirapeix F, Llamazares-Herrán E, García-Guillamón G,
52 52	45	Giménez-Giménez LM, Sánchez-Nieto JM. The short physical performance battery is a
55	46	discriminative tool for identifying patients with COPD at risk of disability. Int J Chron Obstruct
55	47	Pulmon Dis. 2015:2619-26. <u>https://doi.org/10.2147/COPD.S94377</u>
56	48	21. Crook S, Büsching G, Schultz K, Lehbert N, Jelusic D, Keusch S, et al. A multicentre
57	49	validation of the 1-min sit-to-stand test in patients with COPD. Eur Respir J. 2017:49(3).
58	50	https://doi.org/10.1183/13993003.01871-2016
59	20	
60		

1		
2		
3	1	22. de Camargo AA, Justino T, de Andrade CHS, Malaguti C, Dal Corso S. Chester step test
4	2	in patients with COPD: reliability and correlation with pulmonary function test results. Respir
5	3	Care, 2011:56(7):995-1001, https://doi.org/10.4187/respcare.01047
6	4	23. Garrod R. Marshall I. Barley F. Jones P. Predictors of success and failure in pulmonary
7	5	rehabilitation Fur Respir L 2006:27(4):788-94
8	6	https://doi.org/10.1183/09031936.06.00130605
9 10	7	24 Braun V. Clarke V. Using thematic analysis in nsychology. Qual Res Psychol
10	2 2	24. Braun v, clarke v. Osing menatic analysis in psychology. Quarkes r sychol. 2006.2(2).77-101 https://doi.org/10.1101/1/178088706gp06302
12	0	2000,5(2).77-101. <u>https://doi.org/10.1191/14780887004p0050a</u> 25 Debler CC Merrow AS Bouchel P. Farah MH. Maizouh AM, Wilson MF, et al.
13	10	25. Doblet CC, Moltow AS, Beuscher B, Falah MH, Majzoub AM, Wilson ME, et al.
14	10	diseases a systematic review with meta analysis. Annals of internal medicine, 2020;172(6):412
15	11	22. https://doi.org/10.7226/M10.2007
16	12	22. <u>nttps://doi.org/10.7326/M19-3007</u>
17	13	26. Spruit MA, Franssen FM, Rutten EP, Wopereis S, Wouters EF, Vanfleteren LE. A new
18	14	perspective on COPD exacerbations: monitoring impact by measuring physical, psychological
19	15	and social resilience. Eur Respiratory Soc; 2016. p. 1024-7.
20	16	27. Oliveira A, Afreixo V, Marques A. Enhancing our understanding of the time course of
21	17	acute exacerbations of COPD managed on an outpatient basis. Int J Chron Obstruct Pulmon
22	18	Dis. 2018;13:3759-66. <u>https://doi.org/10.2147/copd.s175890</u>
23	19	28. Zhao Y-f, Jiang Y-p, Zhou L-f, Wu X-I. The value of assessment tests in patients with
24 25	20	acute exacerbation of chronic obstructive pulmonary disease. Am J Med Sci. 2014;347(5):393-
25	21	9. https://doi.org/10.1097/MAJ.0b013e31829a63b1
20	22	29. Tu Y-H, Zhang Y, Fei G-H. Utility of the CAT in the therapy assessment of COPD
28	23	exacerbations in China. BMC Pulm Med. 2014;14(1):1-8. https://doi.org/10.1186/1471-2466-
29	24	14-42
30	25	30. García-Sidro P, Naval E, Rivera CM, Bonnin-Vilaplana M, Garcia-Rivero JL, Herrejón A,
31	26	et al. The CAT (COPD Assessment Test) guestionnaire as a predictor of the evolution of severe
32	27	COPD exacerbations, Respir Med. 2015:109(12):1546-52.
33	28	https://doi.org/10.1016/i.rmed.2015.10.011
34	29	31. Rebelo P. Oliveira A. Andrade I. Valente C. Marques A. Minimal clinically important
35	30	differences for nationt-reported outcome measures of fatigue in nations with COPD following
30 27	31	nulmonary rehabilitation Chest 2020:158(2):550-61
3/ 20	32	https://doi.org/10.1016/i.chest 2020/130(2).550 01.
30	22	32 Rebelo P. Oliveira A. Paixão C. Valente C. Andrade I. Marques A. Minimal clinically
40	27	important differences for nationt reported outcome measures of sough and sputum in
41	34 2E	nation to with COPD, let I Chron Obstruct Dulmon Dis 2020-201 12
42	35	patients with COPD. Int J Chron Obstruct Pulmon Dis. 2020;201-12.
43	30	<u>Allps://doi.org/10.214//COPD.5219480</u>
44	37	33. Stoπels AA, De Brandt J, Meys R, Van Hees HW, Vaes AW, Klijn P, et al. Short physical
45	38	performance battery: response to pulmonary renabilitation and minimal important difference
46	39	estimates in patients with chronic obstructive pulmonary disease. Arch Phys Med Rehabil.
47	40	2021;102(12):2377-84. e5. <u>https://doi.org/10.1016/j.apmr.2021.05.011</u>
48	41	34. Machado A, Marques A, Burtin C. Extra-pulmonary manifestations of COPD and the
49	42	role of pulmonary rehabilitation: a symptom-centered approach. Expert Rev Respir Med.
50	43	2021;15(1):131-42. https://doi.org/10.1080/17476348.2021.1854737
51	44	35. Medina-Mirapeix F, Valera-Novella E, Morera-Balaguer J, Bernabeu-Mora R. Prognostic
52 53	45	value of the five-repetition sit-to-stand test for mortality in people with chronic obstructive
54	46	pulmonary disease. Ann Phys Rehabil Med. 2022;65(5):101598.
55	47	https://doi.org/10.1016/j.rehab.2021.101598
56	48	36. Oliveira A, Quach S, Alsubheen S, Dasouki S, Walker J, Brooks D, et al. Rapid access
57	49	rehabilitation after exacerbations of COPD-a qualitative study. Respir Med. 2021;186:106532.
58	50	https://doi.org/10.1016/j.rmed.2021.106532
59	51	37. Janaudis-Ferreira T, Tansey CM, Harrison SL, Beaurepaire CE, Goodridge D, Bourbeau J.
60	52	et al. A qualitative study to inform a more acceptable pulmonary rehabilitation program after

https://mc.manuscriptcentral.com/thorax

3	1	acute exacerbation of chronic obstructive pulmonary disease. Ann Am Thorac Soc.
4	2	2019;16(9):1158-64. https://doi.org/10.1513/AnnalsATS.201812-854OC
5	3	38. Moecke DP. Zhu K. Gill J. Brar S. Petlitsvna P. Kirkham A. et al. Safety and efficacy of
6	4	inpatient pulmonary rehabilitation for patients hospitalized with an acute exacerbation of
/	5	chronic obstructive pulmonary disease: systematic review and meta-analyses. Ann Am Thorac
8	6	Soc $2023 \cdot 20(2) \cdot 307 \cdot 19$ https://doi.org/10.1513/AppalsATS.202206-5450C
9	7	20 Shaahan L. Abdeen A. Saleh HM. Mahran SA. Farghaly S. Farly rehabilitation program
10 11	, 0	and weaping outcomes in critically ill chronic obstructed airway disease patients: a randomized
17	0	trial. The Equation Journal of Pronchology 2022;16(1):22, https://doi.org/10.1196/c12169
13	9 10	
14	10	<u>022-00128-8</u>
15	11	40. World Health Organization. Primary health care2023. Available from:
16	12	https://www.who.int/news-room/fact-sheets/detail/primary-health-care.
17	13	
18	14	
19		
20		
21		
22		
23		
25		
26		
27		
28		
29		
30		
31		
33		
34		
35		
36		
37		
38 20		
39 40		
41		
42		
43		
44		
45		
46		
47 48		
49		
50		
51		
52		
53		
54		
55 56		
50 57		
58		
59		
60		

#### **List of Figures**

Figure 1 – Consolidated standards of reporting trials (CONSORT) flow diagram of participants through the study. COPD, chronic obstructive pulmonary disease; ECOPD, exacerbation of COPD; PR, pulmonary rehabilitation.

Figure 2 – Joint display presenting the integration of quantitative and qualitative data. Data are presented as median change [1<sup>st</sup> quartile; 3<sup>rd</sup> quartile] and represent the results obtained in the experimental group. is, um asse. is questionne. j = fatigue scale; Imp, ed Medical Research Cou. it muscle strength; SPPB, shoi 1-minSTS, 1-minute sit-to-stand test; BMS, biceps muscle strength; BPAAT, brief physical activity assessment tool; CASA-Q, cough and sputum assessment questionnaire; CAT, COPD assessment test; CIS-8, checklist individual strength 8-itens questionnaire; CST, Chester step test; FACIT-F, Functional assessment of chronic illness therapy – fatigue scale; Imp, impact subscore; LCADL, London chest activity of daily living scale; mMRC, modified Medical Research Council dyspnoea questionnaire; PR, pulmonary rehabilitation; QMS, quadriceps muscle strength; SPPB, short physical performance battery; Sym, symptoms subscore.

https://mc.manuscriptcentral.com/thorax

- 1 Table 1 Sociodemographic, anthropometric and general clinical characteristics of participants with an
- 2 exacerbation of chronic obstructive pulmonary disease (n=50).

	Experimental group	Control group
	(n=24)	(n=26)
Sex (male), n (%)	22 (91.7%)	17 (65.4%)
Age, years	72.5 ± 9.8	67.1 ± 11.1
Body mass index, kg/m <sup>2</sup>	24.9 ± 4.6	25 ± 4
Lung function (stable)		
FEV <sub>1</sub> , %predicted	48.7 ± 15.3	46.4 ± 17.5
FVC, %predicted	70.1 ± 15.3	69.7 ± 17.3
GOLD grade (stable), n (%)		
1	2 (8.3%)	0 (0%)
2	8 (33.3%)	10 (38.5%)
3	10 (41.7%)	11 (42.3%)
4	4 (16.7%)	5 (19.2%)
GOLD group (stable), n (%)		
A	3 (18.8%)	2 (13.3%)
В	6 (37.5%)	6 (40%)
E	7 (43.8%)	7 (46.7%)
Smoking status		
Never smoker	2 (8.3%)	2 (7.7%)
Current smoker	5 (20.8%)	13 (50%)
Former smoker	17 (70.8%)	11 (42.3%)
Pack-years	52.8 ± 42.1	42.3 ± 29.2
Nº hospitalizations last year	0 [0; 0.5]	0 [0; 1]
Nº hospitalizations due to ECOPD last year	0 [0; 0.5]	0 [0; 0]
Nº ECOPD last year	1 [0; 1]	2 [1; 3]
Long-term oxygen therapy	2 (8.3%)	6 (23.1%)
Non-invasive ventilation	2 (8.3%)	5 (19.2%)
Charlson comorbidity index, total score	4.5 [4; 5]	4 [3; 5]
Comorbidities, n (%)		
Diabetes	5 (20.8%)	4 (15.4%)
Dyslipidaemia	12 (50%)	8 (30.8%)
Controlled arterial hypertension	15 (62.5%)	13 (50%)
Arrythmia	4 (16.7%)	5 (19.2%)
Peripheral vascular disease	4 (16.7%)	5 (19.2%)
Heart failure	3 (12.5%)	1 (3.8%)
Other cardiovascular disease	7 (29.2%)	12 (46.2%)
Anxiety	2 (8.3%)	5 (19.2%)
Depression	2 (8.3%)	4 (15.4%)
Medication (stable), n (%)		
SABA	5 (20.8%)	6 (23.1%)
SAMA	4 (16.7%)	3 (11.5%)
LABA	2 (8.3%)	0 (0%)
LAMA	7 (29.2%)	3 (11.5%)
ICS	4 (16.7%)	3 (11.5%)
LABA+LAMA	10 (41.7%)	12 (46.2%)
Triple therapy	3 (12.5%)	7 (26.9%)
IVIEGICATION (ECOPD), N (%)		
SABA	11 (45.8%)	16 (61.5%)
SAMA	10 (41./%)	14 (53.8%)
Antibiotic	13 (54.2%)	
	1/ (/U.8%) 7 (20, 20%)	19 (73.1%)
iviucolytic	/ (29.2%)	9 (34.6%)

3 Data are presented as mean±standard deviation, median [1<sup>st</sup> quartile; 3<sup>rd</sup> quartile] or number

4 (percentage), unless stated otherwise.

# Thorax

- 1 Table 2 Baseline characteristics (primary and secondary outcomes) of participants with an exacerbation
- 2 of chronic obstructive pulmonary disease (n=50).

	Experimental group	Control group
	(n=24)	(n=26)
BPAAT, total score	0 [0; 0]	0 [0; 0]
mMRC, grade	3 [2; 3]	2 [2; 3]
CAT, total score	23.1 ± 7.1	23.2 ± 7.1
LCADL, total score	23 [17.5; 39]	24.5 [19; 39]
LCADL, % score	45.2 [35.9; 57,3]	39.3 [31.4; 56]
FACIT-F, total score	30 [22; 34]	25 [21; 34]
CASA-Q, score		
Cough symptoms	37.8 ± 28.8	47.4 ± 29.3
Cough impact	44.5 ± 23.1	52.3 ± 29.5
Sputum symptoms	29.2 [8.3; 58.3]	29.2 [16.7; 66.7]
Sputum impact	56.4 ± 29.8	52.1 ± 30.5
CIS-8, total score	44.5 [39; 50.5]	46 [38; 52]
Handgrip strength, kg	23.3 ± 10.1	25.2 ± 10.5
Handgrip strength, %pred	71.1 ± 27.2	79.3 ± 25
Biceps muscle strength, kgf	15 ± 4.3	16.9 ± 5
Biceps muscle strength, %pred	65.2 ± 17.1	81.4 ± 20.3
Quadriceps muscle strength, kgf	22 ± 6	23.4 ± 7.3
Quadriceps muscle strength, %pred	67 ± 15.7	72 ± 22.4
5-repetitions sit-to-stand test, s	12.4 [11; 17.3]	11.3 [7.7; 17.1]
SPPB, total score	9 [7.5; 10]	9 [8; 11]
1-minute sit-to-stand test, repetitions	17.3 ± 6	17.9 ± 9.4
1-minute sit-to-stand test, %pred	50 [41.4; 66.2]	49.3 [35.3; 64]
Chester step test, nº of steps	14 [6.5; 31.5]	30 [16; 42]

Data are presented as mean±standard deviation or median [1<sup>st</sup> quartile; 3<sup>rd</sup> quartile], unless stated
 otherwise.

5 BPAAT, brief physical activity assessment tool; CASA-Q, cough and sputum assessment questionnaire;

6 CAT, COPD assessment test; CIS-8, checklist individual strength 8-itens questionnaire; COPD, chronic

7 obstructive pulmonary disease; FACIT-F, Functional assessment of chronic illness therapy – fatigue scale;

8 LCADL, London chest activity of daily living scale; mMRC, modified Medical Research Council dyspnoea

9 questionnaire; SPPB, short physical performance battery.

1 Table 3 – Effects of a 3-weeks home-based pulmonary rehabilitation programme during exacerbations of

2 chronic obstructive pulmonary disease (n=50).

	•		
	Experimental group (n=24)	Control group (n=26)	Group*Time
	Mean Δ (95% CI)	Mean Δ (95% CI)	Interaction
BPAAT, total score	3.5 (2.7; 4.3)*	-0.4 (-1.2; 0.3)	<0.001
mMRC, grade	-0.5 (-0.8; -0.3)*	0 (-0.3; 0.3)	0.006
CAT, total score	-12.5 (-15.4; -9.5)*	-5.8 (-8.7; -3)*	0.002
LCADL, total score	-5.4 (-8.1; -2.7)*	0.1 (-2.5; 2.7)	0.006
LCADL, % score	-9.1 (-13.1; -5.2)*	0 (-3.8; 3.9)	0.001
FACIT-F, total score	11.2 (8.3; 14.1)*	3.4 (0.6; 6.2)	0.001
CASA-Q, score			
Cough symptoms	46.7 (33.4; 60)*	23.1 (10.3; 35.9)*	0.006
Cough impact	43.8 (32.2; 55.4)*	23.7 (12.5; 34.8)*	0.047
Sputum symptoms	46.5 (32.3; 60.8)*	31.1 (17.4; 44.8)*	0.081
Sputum impact	36.6 (23.6; 49.5)*	28.7 (16.2; 41.1)*	0.948
CIS-8, total score	-11.8 (-15.8; -7.8)*	-4.3 (-8.2; -0.5)	0.003
Handgrip strength, kg	2.1 (0.9; 3.3)*	-0.5 (-1.8; 0.7)	0.003
Handgrip strength, %pred	6.9 (3; 10.7)*	-1.4 (-5.4; 2.6)	0.004
Biceps muscle strength, kgf 🦯 🔀	2.3 (1.1; 3.5)*	-0.1 (-1.2; 1.1)	0.004
Biceps muscle strength, %pred	10.4 (5; 15.8)*	-0.5 (-6.1; 5)	0.006
Quadriceps muscle strength, kgf	3.9 (2; 5.9)*	-0.4 (-1.7; 0.9)	<0.001
Quadriceps muscle strength, %pred	12.4 (6.5; 18.2)*	-1.3 (-5.3; 2.8)	<0.001
5-repetitions sit-to-stand test, s	-2.6 (-5.1; -0.2)*	-0.4 (-2.7; 1.8)	0.002
SPPB, total score	1.4 (0.8; 2)*	0.6 (-0.1; 1.2)	0.049
1-minute sit-to-stand test, repetitions	4.4 (2.5; 6.3)*	2 (0.3; 3.8)	0.061
1-minute sit-to-stand test, %pred	13. <mark>7 (7.8</mark> ; 19.7)*	7.1 (0.8; 13.4)	0.086
Chester step test, nº of steps	23.4 (6.2; 40.5)*	11.6 (1; 22.3)*	0.047
N <sup>o</sup> ECOPD-related unscheduled healthcare visits (at Post)	0 (0; 0)	0 (0; 2)	0.025ª

Data are presented as mean (95% confidence interval), unless stated otherwise. Bold denotes a significant
 group\*time interaction. Mean Δ, mean change Post-Baseline. \*significant time effect (baseline vs. post);
 <sup>a</sup>p-value from Mann-Whitney U test.

95% CI, 95% confidence interval; BPAAT, brief physical activity assessment tool; CASA-Q, cough and
sputum assessment questionnaire; CAT, COPD assessment test; CIS-8, checklist individual strength 8-itens
questionnaire; ECOPD, exacerbation of chronic obstructive pulmonary disease; FACIT-F, Functional
assessment of chronic illness therapy – fatigue scale; LCADL, London chest activity of daily living scale;
mMRC, modified Medical Research Council dyspnoea questionnaire; SPPB, short physical performance
battery.



**Table 4** – Qualitative themes and subthemes with supporting illustrative quotes of participants with an

2 exacerbation of chronic obstructive pulmonary disease included in the experimental group, at the end of

3 the 3-weeks home-based pulmonary rehabilitation programme.

Theme	Subtheme	Illustrative quote
	Overall impact	I think everything improved. I feel better in everything () I can say, considering how I was, I can even say that I am almost at 100%. Comparing with how I was, how I was feeling lately To my day-to-day, I am better, of course ()
Impact of the PR programme	Symptoms relief Regaining control of daily life	I feel much, much better in comparison with the first day. I had a lot of cough, shortness of breath, and I felt really bad, I didn't feel well at all. I couldn't sleep. Now, at the end of the PR programme, I feel good, I am already able to do the exercises and I don't feel so tired, I am able to breathe much better. () I used to have more difficulties sleeping. There was also the cough, but now it is gone. I improved in all activities, in everything. () Before I couldn't walk much, now I can walk a lot. Now I am able to sweep the stairs up and down. And I know how to yeah, I am now able to do a lot of things that I couldn't do before.
	Health recovery	I felt more stable. I felt with more more, with a bit more health.
	Overcoming isolation, stress and fears	Therefore, the impact this programme have is that I feel more protected because I know what is going on with me and what I will need to do to not get worse. () The impact that it had I think it is more mental, more psychological, because I am better informed ()
	Feeling empowered	Now I got clarified regarding the breathing control. I already have a self- control, minimum, but I already have it. I know that any effort I make, I can sit and control my breathing and it will relieve me faster.
	Design & setting	For me everything was positive. () All the programme, it was adequate and positive. () Hmm, I think there is nothing to change () Everything I did was normal.
	Exercises & support materials	The leaflets are good. Everything was easy to understand, both from reading and from talking with you. The language was easy to understand. () The leaflets I think they are all very explicit in what we need to do.
Thoughts about the PR programme	e Education & breathing techniques to regain control	I think this is a good programme, that in fact everyone who has this health problem should do, because it teaches you, you learn a lot, how to deal with the disease, how to improve your physical condition, basic knowledge and really important for this type of disease, and I think that it was really good. () Because it taught me new information regarding exercise, and many other things, and it taught me a lot.
	Need for a longer programme	Ah if I could have the programme during more time it would be better. I would do more sessions because it is for my own good. Because when someone sees that it is for our own good, we ask for more.
	Support from health professionals	Having a physiotherapist taking care of us, at least one or two times per week, I think it is really good for us.
(Lack of) Motivation to	I can do it alone	To do the exercises at home alone it is really easy! Easy. I do it really easily. I already did some exercises. And I am going to continue doing them. It is for my own good. I have to continue doing them.
continue the PR programme	I can't do it alone	If I am here alone, I can't do anything. () To exercise alone is nothing, nothing. I lack the will to do it. If someone is motivating you, then you will do it.

4 PR, pulmonary rehabilitation.



HEALTH STATUS CAT: △ -12 [-17.5; -6.5] 

Å

ĸ

\$

#### SYMPTOMS

- SYMPTOMS
   The beginning of my respiratory crisis I felt really tired. But with
   this treatment it improved, it improved a lot the tiredness that use
   to feel. (...) The cough decreased. The shortness of breach, if I do
   certain efforts I get tired, but I recover quickly. The sputum also
   decreased, and its colour is lighter."
   mmRC: Δ-0.5 [-1;0] [FACT-F: Δ 12 [5; 14] [CIS-8: Δ-11 [-17.5;-6]
   CAS-Q. Cough: Sym a 50 [29.2; 70.8] [Imp Δ 42.2 [26.6;563]
   CAS-Q.Sputum: Sym Δ 58.3 [37.5; 66.7] [Imp Δ 39.6 [16.7; 52.1]

#### PHYSICAL ACTIVITY

- BPAAT: \$\$ 3 [2: 5.5]

¥ ĥ "(...) I can now do all my errands. And even at home I don't have any problems." Ġ, ECADL: △ -4.5 [-8.5; -2] \* 🖧 🕈 PUNCTIONAL CAPACITY
 ""
 "Now I have strength and I can walk and everything."
 "I feel that I improved a lot now in my physical status, in the walking." Ť Ż . ţ

"I feel that I am stronger now. I have more strength in my legs." 
 Handgrip: Δ 2 [0; 3.5] | BMS Δ 3 [0.4; 3.9] | QMS: Δ 4 [0.5; 7.2]

 SPPB: Δ 1 [1; 2] | 1minSTS: Δ 2 [0.5; 8] | CST: Δ 17.5 [2.5; 30]

404x149mm (118 x 118 DPI)

"Sh	ort-term effects of home-based pulmonary rehabilitation during outpatient-mana	aged
	exacerbations of COPD: a mixed-methods randomized controlled trial	
ŀ	Ana Machado, Cíntia Dias, Cátia Paixão, António Pedro Gonçalves, Chris Burtin, Alda Marqu	es
1. Parti	cipants' recruitment strategies	
2. Inter	vention protocol	
1.1 W	/arm-up exercises	
1.2 St	rength training – Upper limb exercises	1
1.3 St	rength training – Trunk exercises	
1.4 St	rength training – Lower limb exercises	
1.5 St	retch exercises	
3. Semi	-structured interview guide	
4. Rese	arch team and Reflexivity	
5. Rigo	and Trustworthiness	
6. List c	of themes and subthemes	
6.1	Impact of the PR programme	
6.1	.1 Overall impact	
6.1	L.2 Symptoms relief	
6.1	L3 Regaining control of daily life	
6.1		
6.1	1.5 Overcoming isolation, stress and fears	
6.1	L.6 Feeling empowered	
6.2	Thoughts about the PR programme	
6.2	2.1 Design & setting	
6.2	2.2 Exercises & support materials	•••••
6.2	2.3 Education & breathing techniques to regain control	
6.2	2.4 Need for a longer programme	
6.2	2.5 Support from health professionals	
6.3	(Lack of) Motivation to continue the PR programme	••••••
6.3	3.1 I can do it alone	••••••
6.3	3.2 I can't do it alone	

# 1. <u>Participants' recruitment strategies</u>

People with an outpatient-managed exacerbation of chronic obstructive pulmonary disease (ECOPD) were consecutively recruited, via their treating physicians, from the Pulmonology and Emergency departments of four hospitals: Centro Hospitalar do Baixo Vouga, Centro Hospitalar Universitário de Santo António, Centro Hospitalar Vila Nova de Gaia/Espinho and Unidade Local de Saúde de Matosinhos. Due to the specificities of the different services, different strategies were used.

In Centro Hospitalar do Baixo Vouga, Centro Hospitalar Vila Nova de Gaia/Espinho and Unidade Local de Saúde de Matosinhos, pulmonologists identified individuals having an exacerbation through their routine appointments and/or by being present in the emergency department. In these hospitals, pulmonologists addressed the potential participants about the study during their appointments and, in case of acceptance, immediately referred them to the research team.

In Centro Hospitalar Universitário de Santo António (the main recruiting hospital), physicians from internal medicine were involved in identifying people with ECOPD in the emergency department. One leading physician (APG) was identified, who reminded the colleagues about the study and communicated with the research team. In this hospital, some potential participants were identified and invited to participate in the study during their emergency appointment (as mentioned above); in most of the cases, the leading physician (APG) screened the emergency list for individuals that could match the criteria of the study and referred them to the research team.

Treating physicians (in all hospitals) were informed about the study through several meetings between the research team and the physicians' teams. In these meetings, all the details about the study were explained and any doubts clarified. The best communication and recruitment strategies for each site were also discussed. Flyers with the aim of the study, inclusion and exclusion criteria, brief explanation and contacts of the team were provided, as requested by the physicians' teams, to help them remember the study was ongoing and have an easy visualization of the inclusion/exclusion criteria and contacts.

Upon the referral of potential participants, the recruiting member of the research team (AM) immediately contacted them to further explained the study, clarify any doubts and try to ascertain the inclusion/exclusion criteria. In case of participants' acceptance, the initial study visit was scheduled.

# 2. Intervention protocol

Participants in the experimental group received an individualized, fully supervised, home-based pulmonary rehabilitation programme for 3 weeks, 2 sessions/week, in a total of 6 sessions. The programme was adapted from a previously conducted pilot study<sup>[1]</sup> and included exercise training, breathing control and retraining, airway clearance techniques, education and psychosocial support.<sup>[2]</sup> The first session was delivered on the day after the baseline assessment, and the last session was conducted on the day before the post assessment. Each session lasted approximately 60 minutes and was delivered by a physiotherapist with experience in respiratory interventions. Participants' heart rate, peripheral oxygen saturation (SpO<sub>2</sub>) and

#### Thorax

levels of dyspnoea and perceived exertion in the modified Borg scale<sup>[3]</sup> were monitored throughout the sessions to ensure safety and intensity of the training. Table S1 provides a detailed description of the intervention.

Exercise training was prescribed at a moderate intensity, i.e., between 4 and 6 in the modified Borg scale and a target heart rate between 60 and 80% of the maximum heart rate predicted for the age.<sup>[4]</sup> The maximum heart rate was estimated according to the formula: *Heart rate maximum* = 220 - age.<sup>[5]</sup> The Karvonen formula<sup>[6]</sup> was used to compute the target heart rate during training. An effort was made to keep the SpO₂≥90% throughout the sessions. For the strength training, exercises were chosen based on the level of (de)conditioning that the participants presented in the baseline assessment (please see below the full list of exercises that could be used). These exercises were performed using free weights or the participants' bodyweight, according to the type of exercise. For the endurance training, step training (preferably continuous training) was used. The target pace for the step training was computed based on 60-80% of the step cadence (initially set at 60%) of the maximum level achieved in the Chester step test (level 1 -15steps/min; level 2 – 20 steps/min; level 3 – 25 steps/min; level 4 – 30 steps/min; level 5 – 35 steps/min).<sup>[7]</sup> The step from the Chester step test was used for the training and a metronome ensured that the target pace was followed. Participants that showed desaturation (i.e.,  $SpO_2 < 90$ ) during the baseline assessment in the Chester step test and/or 1-minute sit-to-stand test, and/or participants that could not perform continuous training due to intense dyspnoea were selected for interval training.<sup>[4]</sup> The progression of exercise training was performed by increasing the number of exercises, number of sets, number of repetitions and duration of the endurance training, as described in detail in Table S1, and, when applicable, by increasing the difficulty (level) of the exercise and/or the weight of the free weights, always according to participants' levels of dyspnoea and perceived exertion in the modified Borg scale.<sup>[4]</sup>

Airway clearance techniques (i.e., slow inspiratory techniques, slow expiratory techniques, forced expiratory techniques and active cycle of breathing techniques) were chosen accordingly to the findings of lung auscultation and performed according to participants' tolerance.<sup>[8]</sup> Lung auscultation was performed at the beginning of each session and reassessed throughout the session to guide the techniques to be used and the amount of time spent in this component.

The education and psychosocial support component included talks/coaching, flyers<sup>[9, 10]</sup> and the demonstration of practical strategies. Conversations focused on this component were kept throughout the entire sessions and approximately 10 minutes per session were reserved for a more structured approach. In the first 3 sessions, "management of respiratory symptoms", "respiratory system and management of exacerbations" and "exercise" were the mandatory topics discussed. For the remaining sessions, 3 topics were chosen according to participants' specific needs from the following options: "nutrition and sleep", "smoke cessation", "medication and oxygen therapy", "management of stress and anxiety", "resources available in the community", "environmental factors" and "pulmonary rehabilitation programmes". A multidisciplinary team composed by physicians, nurses, social workers, psychologists and nutritionists was

available to provide additional support, according to participants' needs, and contributed to the <text> development of the educational material used. Participants' individual needs were identified by the physiotherapist through conversations and by assessing their living conditions. Any clarification needed with the referring physician was performed directly by the research team as a direct contact was kept. Physicians could then decide if an additional appointment/support was needed. In each session, time was provided to give participants the opportunity to clarify any doubts and ask further questions that they felt were needed. Participants were also encouraged to perform the exercises at home, on the days without session, and to be physically active.

 Thorax

	We	ek 1	Week 2
Components	Session 1	Session 2	Session 3
Education &	Dyspnoea relief positions	Respiratory system	Exercise
Psychosocial support	Management of respiratory symptoms	Management of exacerbations	
Breathing control &	Breathing control	Breathing control	Breathing control
retraining	Pursed lips breathing	Deep breathing exercises	Deep breathing exercises
		Pursed lips breathing	Pursed lips breathing + Acapella
Airway clearance	Slow inspiratory & expiratory techniques	Slow inspiratory & expiratory techniques	Slow inspiratory & expiratory techniques
(Note: based on the	Education of part of the ACBT: huffing and	Forced expiratory techniques: huffing and cough	Forced expiratory techniques: huffing and cough
findings from lung	cough	АСВТ	АСВТ
auscultation)			PEP device: Acapella
Exercise	Warm-up:	Warm-up:	Warm-up:
(Note: moderate	Choose <u>4 warm-up exercises</u> focused on the	Choose <u>4 warm-up exercises</u> focused on the	Choose 4 warm-up exercises focused on the
intensity, i.e.,	main muscular groups involved in the strength	main muscular groups involved in the strength	main muscular groups involved in the strength
between 4–6 in the	training, based on participants' level (10 reps	training, based on participants' level (10 reps	training, based on participants' level (10 reps
modified Borg scale	<u>each</u> )	each)	<u>each</u> )
and a target HR	1min step-in place (alternatively, the participant	2min step-in place (alternatively, the participant	3min step-in place (alternatively, the participant
between 60–80% of	might do the step-in place with support on a	might do the step-in place with support on a	might do the step-in place with support on a
the maximum HR	table/chair)	table/chair)	table/chair)
predicted for the			
age, SpO₂≥90%)	Strength training:	Strength training:	Strength training:
	Choose 2 upper limb and 2 lower limb exercises,	Choose <u>2 upper limb exercises</u> , <u>2 lower limb</u>	Choose 2 upper limb exercises, 2 lower limb
	based on participants' level (1-2 sets of 10 reps	exercises and <u>1 trunk exercise</u> , based on	exercises and <u>1 trunk exercise</u> , based on
	<u>each</u> )	participants' level ( <u>1-2 sets of 10 reps each</u> )	participants' level (2 <u>-3 sets of 10 reps each</u> )
	Cool down:	Cool down:	Cool down:
	Choose 4 stretch exercises focused on the main	Choose 5 stretch exercises focused on the main	Choose 5 stretch exercises focused on the main
	muscular groups worked out in the session (2	muscular groups worked out in the session (2	muscular groups worked out in the session (2
	sets of 30s each)	sets of 30s each)	sets of 30s each)

 Table S1 – Detailed description of the intervention. Adapted from Machado et al.<sup>[1]</sup>

	Week 2	We	ek 3
Components	Session 4	Session 5	Session 6
Education &	Choose one of the optional topics, accordingly	Choose one of the optional topics, accordingly	Choose one of the optional topics, accordingly
Psychosocial support	to participants' specific needs	to participants' specific needs	to participants' specific needs
Breathing control &	Breathing control	Breathing control	Breathing control
retraining	Deep breathing exercises	Deep breathing exercises	Deep breathing exercises
	Pursed lips breathing + Acapella	Pursed lips breathing + Acapella	Pursed lips breathing + Acapella
Airway clearance	Slow inspiratory & expiratory techniques	Slow inspiratory & expiratory techniques	Slow inspiratory & expiratory techniques
(Note: based on the	Forced expiratory techniques: huffing and cough	Forced expiratory techniques: huffing and cough	Forced expiratory techniques: huffing and cougl
findings from lung	АСВТ	ACBT	АСВТ
auscultation)	PEP device: Acapella	PEP device: Acapella	PEP device: Acapella
Exercise	Warm-up:	Warm-up:	Warm-up:
(Note: moderate	Choose 4 warm-up exercises focused on the	Choose 4 warm-up exercises focused on the	Choose 4 warm-up exercises focused on the
intensity, i.e.,	main muscular groups involved in the strength	main muscular groups involved in the strength	main muscular groups involved in the strength
between 4–6 in the	training, based on participants' level ( <u>10 reps</u>	training, based on participants' level (10 reps	training, based on participants' level (10 rep
modified Borg scale	<u>each</u> )	each)	<u>each</u> )
and a target HR	<u>1min step-in place</u> (alternatively, the participant	<u>1min step-in place</u> (alternatively, the participant	<u>1min step-in place</u> (alternatively, the participan
between 60–80% of	might do the step-in place with support on a	might do the step-in place with support on a	might do the step-in place with support on a
the maximum HR	table/chair)	table/chair)	table/chair)
predicted for the			
age, SpO₂≥90%, step	Endurance training:	Endurance training:	Endurance training:
pace 60–80% of the	5min of continuous step training (alternatively,	10min of continuous step training (alternatively,	15min of continuous step training (alternatively
maximum level	the participant can perform interval training)	the participant can perform interval training)	the participant can perform interval training)
achieved in the			
Chester step test)	Strength training:	Strength training:	Strength training:
	Choose <u>2 upper limb exercises</u> , <u>2 lower limb</u>	Choose <u>2 upper limb exercises</u> , <u>2 lower limb</u>	Choose 2 upper limb exercises, 2 lower limb
	exercises and <u>1 trunk exercise</u> , based on	exercises and <u>1 trunk exercise</u> , based on	exercises and <u>1 trunk exercise</u> , based or
	participants' level (2-3 sets of 10 reps each)	participants' level (2-3 sets of 15 reps each)	participants' level (2 <u>-3 sets of 15 reps each</u> )
	Cool down:	Cool down:	Cool down:
	Choose <u>5 stretch exercises</u> focused on the main	Choose <u>5 stretch exercises</u> focused on the main	Choose <u>5 stretch exercises</u> focused on the main
	muscular groups worked out in the session (2	muscular groups worked out in the session (2	muscular groups worked out in the session (2
	sets of 30s each)	sets of 30s each)	sets of 30s each)



# 1.1 Warm-up exercises



















2
3
1
4
5
6
7
8
9
10
10
11
12
13
14
15
16
17
17
18
19
20
21
22
22
∠.) ⊃.4
24
25
26
27
28
20
29
30
31
32
33
34
35
26
30
37
38
39
40
41
12
ד∠ ⊿ר
43
44
45
46
47
48
10
49 50
50
51
52
53
54
55
55
50
57
58
59















# 1.3 Strength training – Trunk exercises









# 1.4 Strength training – Lower limb exercises





















### 3. Semi-structured interview guide

**Table S2** – Semi-structured interview guide used with the participants with an exacerbation of chronic obstructive pulmonary disease included in the experimental group, at the end of the 3-weeks home-based pulmonary rehabilitation programme.

### Interview questions

1. Impact (positive or negative) the pulmonary rehabilitation programme had on you.

1.1. Which were the advantages and disadvantages of participating in this programme?

1.2. What are your thoughts about doing rehabilitation during your respiratory crisis?

1.3. Which changes did you feel (e.g., signs, symptoms, quality of life)?

1.4. Which changes did you perceive on adopting or maintaining healthy lifestyles and your general well-being?
 Opinion (positive or negative) regarding the pulmonary rehabilitation programme.

- 3.1 What is your opinion about the number and duration of the sessions, space, equipment and staff?
- 3.2 What do you think regarding the topics discussed during the sessions and the language used?
- 3.3 What are your thoughts about the possibility of replicating these exercises at home?
- 3. Thoughts about how to change or improve the pulmonary rehabilitation programme.

# 4. Research team and Reflexivity

AM, a physiotherapist (PhD student), contacted the participants for the study, led most of the qualitative interviews, transcribed them, and was involved in the analysis. CD, a physiotherapist (MSc), led the remaining qualitative interviews, reviewed the themes and coding, and provided feedback. CP, a physiotherapist (PhD student), reviewed the transcriptions and was involved in the analysis. APG, an internal medicine physician (MSc), reviewed the themes and coding and provided feedback. CB, a physiotherapist (senior researcher), and ASM, a physiotherapist (senior researcher), reviewed the themes and coding and DP.

# 5. <u>Rigor and Trustworthiness</u>

The criteria of credibility, transferability, dependability and confirmability were used to ensure rigor and trustworthiness.<sup>[11]</sup> Credibility was ensured through: i) researcher triangulation, i.e., two researchers analyzed each interview independently and then compared the analysis and agreed on the final themes/subthemes, ii) continuous discussion of the analysis and interpretation of the data with the research team, and iii) presentation of all the representative quotes in the results and supplementary material. Transferability was ensured by describing the characteristics of the researchers, participants, data collection and analysis in detail. Dependability and confirmability were ensured by triangulating the independent analysis of two researchers with different experiences and backgrounds and discussing every step of the process with the research team.

# 6. List of themes and subthemes

Impact of the PR programme

Overall impact Symptoms relief

Regaining control of daily life
Health recovery
Overcoming isolation, stress and fears
Feeling empowered
Thoughts about the PR programme
Design & setting
Exercises & support materials
Education & breathing techniques to regain control
Need for a longer programme
Support from health professionals
(Lack of) Motivation to continue the PR programme
I can do it alone
I can't do it alone
6.1 Impact of the PR programme
6.1.1 Overall impact
It was good to do this PR programme. I felt better than I was before. () I felt better in everything. In
everything, I am better now than I was at beginning. (James)
The PR programme is good. Everyone that can do this, it is good. If someone does this, if they can handle it,
it is good. (James)
For now I am feeling good. () I am much better now! Damn! () I am so much better now! () Now I am
better in everything. (James)
It was really good. I felt better, I improved in everything. I felt a difference in everything. I can't say I improved
in A, B or C, it was in everything. Climbing stairs and everything. (Peter)
It was good. () I feel better, I feel I feel better and better every time. (Oliver)
I feel much better. Since I did these exercises, I feel much better. () I feel better with the help of the exercises
I did. (David)
That's what I am saying, these sessions seem like they fell from the sky. () So let's see I only ask God to
continue more or less as I am now, it isn't very good, but you live by. (David)
I feel good. I am better. (Harry)
This PR programme had a positive impact. The impact was good for me, I think it was really good, really good.
It helped me a lot. () I felt advantages in doing this PR programme. (Michael)
For the rest everything is good. () This is already about 90% better. (Ethan)
It always makes a difference for us. (Neil)
It was good. It was good to do this PR programme. () It was good. (Miles)

The impact of this PR programme was good, it made me better. Positive, it was positive for me, very positive. (...) It helped me a lot. Good advantages, really good. (...) This is good because it nearly cured me. (Brian) I think this was good for me. (Wade) It is positive, it is good. (...) Participating in this PR programme had a lot of advantages. (Rose) This programme had good effects, good effects. It was good. It helps getting better. It helps a lot. (Ted) It improved somethings. (Ted) It was good. It helped, it helped. It helped a lot. (...) It helped making me feel better. (Philip) I feel better, of course I feel better, there is no problem with that. The programme had a positive impact. (Philip) Oh this is really worth it! (...) We do a bit of physiotherapy, of gymnastics. With that we start recovering over time, and it is always good to have these people who take care of us, the patients. Therefore, I think this is really important and good for us; us, the patients. (Fred) This is all really good. (...) Considering the way I was at beginning, I think I am super well now. (Fred) I felt good and I think these programmes should continue, both for myself and for others, for everyone, I hope this continues because this is really good and it is one of the best things we can get. (...) And I would really like this to continue for all patients. (Fred) I felt better, I felt better by doing all these exercises. (Joe) Comparing with how I was in the beginning, I am better now. I am better now. (Joe) It was positive... It was positive. It was good. (...) It is positive. It is positive. (Liam) To me this programme was positive. (Paul) I think it was good. It was good. It relieved me a lot. (...) You can see it. By the way you are giving me instructions, from the beginning to now, there is no comparison possible, there is no comparison possible. (..) I am satisfied. Thank you so much. (...) I have a lot to thank you. (Rick) I am much better! There is no comparison! I cannot compare because the difference is so, so, so big that I am somehow glad that I found you, that you contact me after I have been in the emergency room of the hospital. I had the luck of saying yes. It was a great luck for me. (Thomas) This was good, this was good, it is always good. This is good. (John) Well, I think, I think it is not worse, I think we feel better. That is not the question. Everything, all these exercises are always to improve not to worsen. (John) Well, now I didn't feel it, I will feel it. I know that we feel it, in the future we will feel it, that is how it is. I know that it is like that. (John) I think everything is good. I think everything improved. I feel better in everything, in everything. (...) I can say, considering how I was, I can even say that I am almost at 100%. Comparing with how I was, how I was feeling lately... To my day-to-day, I am better, of course, I already said everything, I already said everything. I already said everything, I am better in everything. (Mary) I feel that I improved a lot, I recovered a lot. (...) (Mary)

2	6.1.2 Symptoms relief
3 4	My symptoms are much better since I started doing the exercises. () The cough improved, the sputum also
5	and the shortness of breath also. (Peter)
7	I am more stable regarding my problems of breathing, shortness of breath, everything. I felt a difference in
8 9	my symptoms for better, for better. For what I could not do, God forbid! (Oliver)
10 11	I feel better in everything. My breathing, the exercises I did, I feel better in that. () The cough and the
12	sputum improved a lot. (David)
13 14	The breathing is good. (Harry)
15 16	The sputum is almost gone. The tiredness is nothing as before. () It improved, of course it got better! I
17	almost didn't breathe! I felt like there was something that would barely let me breathe. Just to go to there
18 19	to the market I barely could do it. <i>(Ethan)</i>
20 21	I feel that my lungs are clean, I go to bed and I don't have problems. Now I don't have cough nor anything
22	when I go to sleep. () My symptoms are relieved. (Ethan)
23 24	I improved in somethings. My symptoms of cough and sputum improved. (Miles)
25 26	My symptoms improved a lot! They improved a lot! () I had a really though shortness of breath, and also
27	cough, and automatically it all disappeared. It was great. (Brian)
28 29	My symptoms improved a lot. I don't feel nor have so much cough the sputum I am able to take it out, and
30 31	before I couldn't, I was not able to remove the sputum before and now I can. And I don't feel so much
32	shortness of breath, nor so much tiredness. (Rose)
33 34	The tiredness improved. (Ted)
35 36	Now I don't have any symptoms, lately I am not having any symptoms. The programme relieved them. (Ted)
37 38	My cough improved. It is better. (Philip)
39	Hmm, regarding the breathing, I started breathing better. () Now I know how to breathe better. () (Fred)
40 41	The cough and the shortness of breath improved. I am better. (Rick)
42 43	I realized that my symptoms got better. I improved a bit. I got better. I gradually got better. (Liam)
44	At the beginning of my respiratory crisis I felt really tired. But with this treatment it improved, it improved a
45 46	lot the tiredness that I use to feel. () The cough decreased. The shortness of breath, if I do certain efforts I
47 48	get tired, but I recover quickly. The sputum also decreased, and its colour is lighter. (Paul)
49	Oh I felt good. I felt good and, practically for example, my breathing, now I breathe better I feel good, I
50 51	feel really good! For me it is positive. (Dan)
52 53	I am simply saying that the breathing was a problem, and it is something that for me now is good. (Dan)
54	It relieved my system of control of breathing. (Rick)
55 56	I feel much, much better in comparison with the first day. I had a lot of cough, shortness of breath, and I felt
57 58	really bad, I didn't feel well at all. I couldn't sleep. Now, at the end of the PR programme, I feel good, I am
59	already able to do the exercises and I don't feel so tired, I am able to breathe much better. () I used to have
00	more difficulties sleeping. There was also the cough, but now it is gone. (Thomas)

I feel my breathing is better, the tiredness also (...) (Mary)

# 6.1.3 Regaining control of daily life

I improved in all activities, in everything. (...) Before I couldn't walk much, now I can walk a lot. Now I am able to sweep the stairs up and down. And I know how to... yeah, I am now able to do a lot of things that I couldn't do before. (*Peter*)

Now I am still climbing the stairs, walking and I will keep cycling and helping my wife cleaning the house. (...) Before, sometimes I wanted to walk or go with my wife and carry some groceries from the supermarket and I couldn't. But now, now I can do that and even more. (...) Now I have strength and I can walk and everything. (Peter)

I wasn't able to climb the stairs. I used to get tired for everything and nothing. By bending down, I would lose my balance, as it happened in the hospital... I was grabbing a paper and I fell. And many other things. And now I am doing it little by little, better. (...) I am able to go to my garden and do some work, during half an hour or 15 minutes, for as long as I can take it... (*Oliver*)

I feel a difference in walking, climbing stairs. I feel better since I started doing the exercises. (...) Now I can live a normal life. Those things that are possible for me to do. Cooking. Cleaning the house is done by my daughters. I cook, eat, drink, sleep and do some hobbies, that's it. (*David*)

Now I do things better. More, more easily. (...) On a daily basis I now manage to do more, more things. (*Harry*) Now I am able to walk back from there... I am already able to do all that walk. I can now do all my errands. And even at home I don't have any problems. (*Ethan*)

This makes a difference in the old man, here in the old man, because we improve our conditioning... (Neil) I also improved a bit when I need to make some efforts. And in things related with that. (Miles)

I feel that I improved a lot now in my physical status, in the walking. (...) In everyday life, for example, I had difficulties and now I don't. I have less difficulties. Walking and everything. (*Ted*)

I am now a bit more active. This helped, this helped. Before I had difficulties, now this helped me a bit.

Walking, I already feel better. Before I could only walk a little bit, now I can walk more. (Ted)

My ability for the home activities improved a bit. I got better, but only a bit. (*Philip*)

I feel that I am stronger now. I have more strength in my legs. (Philip)

(...) Hmm, I feel, so, I feel with more capacity to move, to do different movements, in comparison to how I was before. (....) I walk better (...) (*Fred*)

(...) and now I am able, every now and then, of walking more than before... (Paul)

I feel better in my daily activities. Much, much better! (Dan)

As for the effort, doing efforts also eased a bit (...) (Rick)

(...) being able to grab an object in my hand and take it, take it to another place, a bit further, before that's something I couldn't do anymore, now I am able to do it, although it is a light object, even a light one, before I couldn't take it, I had to stop on the way and put it down. Now I can go and grab something with my arm,

#### Thorax

and I am already able to bring something a bit heavier with me. I am now able to climb the stairs, even if I

only have 3	steps, but now I can do it, I need to hold on to the railing, but now I am able to climb the stairs
see a recov	ery. (Mary)
6.1.4	Health recovery
I felt more	stable. I felt with more more, with a bit more health. <i>(Oliver)</i>
The breathi	ing helps a bit. I feel more stable. (Oliver)
The PR pro	gramme contributed for the stability in my life () (Michael)
I only have	good things to say about this PR programme. I was fortunate enough to be part of this programn
and it will c	ertainly do me a lot of good for the rest of my life. God will tell. (Thomas)
Because if	I wouldn't have done this programme, all these things throughout these years that I have th
disease, l w	rould already be death. (John)
I feel more	quality of life. (Brian)
My quality	of life is much better now! <i>(Rose)</i>
It changed,	my quality of life improved. (Philip)
During this	time I have been home doing these exercises, this is really good, I feel I am really at the rig
point. I felt	really good, much better. (Fred)
I think this	improved my life for the future. It was good. ( <i>Liam</i> )
For me you	wouldn't leave my home. I loved to do this programme, this treatment. I feel that I really ne
this. I really	need it and I hope God's will is that the clinic will send you, you or another colleague, to help r
living for ar	nother year or two. (Paul)
Oh I really	feel that my quality of life improved! () Everything. I feel really good! I feel, I feel really goo
(Dan)	
6.1.5	Overcoming isolation, stress and fears

With the exercises I don't even feel stress, I don't, I don't even think. I am busy, so I don't even think. (Oliver) Ah, just by having company, just having company is already enough for someone to feel happy. (David) Therefore, the impact this programme have is that I feel more protected because I know what is going on with me and what I will need to do to not get worse. (...) The impact that it had I think it is more mental, more psychological, because I am better informed (...) (Wade)

I started understanding. And for me it is good to know that it only depends on me, it is really good, psychologically it is good for me. Because, if it wasn't like this, I would feel much sicker just by knowing that I had a problem and I could do nothing to make it better, or that my life expectancy was really reduced, I would be much more worried. (*Wade*)

(...) We start to feel more like going out, going for walks, spending some time with friends, we are not so tied to the house. (*Fred*)

You were able to give me some moral because this is a disease that I have for many years... (Paul)

So, my biggest problem from some time ago is not just the respiratory part. But it was the respiratory part that made me go to the hospital, to the emergency. Because I was, I wasn't feeling well at all, I lost my appetite. I wasn't able to eat anything, nothing, nothing. And after a few days I could, after the Physiotherapist has been here. (*Thomas*)

I think that the breathing techniques relax me, I can't be sure. But I think they relax me, I think they relax me because I stopped having negative thoughts when I go to bed and when I wake up. And it was since I started doing those, is it by chance? I don't know. I stopped having those thoughts. *(Thomas)* 

I improved a bit. Because the physiotherapist used to come in the afternoon, and we would spend here a good time doing the exercises, and afterwards I would feel like going for a walk. Why? I don't know. Maybe it is related with the exercises, maybe it is related with the personality of the physiotherapist, I don't know. *(Thomas)* 

### 6.1.6 Feeling empowered

When I see that I am in a more distressed mode, I sit in dyspnoea relief position and take the bronchodilator SOS, 2 puffs, wait a bit, breathe in, breathe out, to relieve more, exactly how it relieved more now. That's how life is. *(David)* 

It was also good for understanding, how can I explain it, the amount of time I can have of more effort or less effort, to see the quality of oxygen that I have, how I can manage my effort. (*Miles*)

I learned. For example, in case I feel more tired, I learned how to breath. Hmm, so if I am doing something I can stop, positioned myself in a certain way and then breathe in and breathe out before I restart. *(Miles)* Regarding the current moment, after the physiotherapist, after I did these sessions, I now have more knowledge about my problem, throughout the physiotherapist that informed me about it, the positive and the negative regarding my problem. I familiarized myself more with the disease I have. I am coming to terms with the problem I have and what is in its origin, and what I should do to not make it worse, or to at least try to stop it. And, therefore, the impact it has is positive because today I am more aware of what I should and shouldn't do to not make my health status worse. (...) And, therefore, I feel more protected, I feel more informed, and it has a really, really positive impact for me because I understand what is going on with me. *(Wade)* 

So, we learn how to breathe. (Fred)

(...) We begin to have more autonomy in ourselves. (...) Hmm, when walking we already feel better, we already know when we should stop and when we should continue. (...) We are able to manage our efforts better. (...) I am now able to manage my efforts better (...) (*Fred*)

Now I got clarified regarding the breathing control. I already have a self-control, minimum, but I already have it. I know that any effort I make, I can sit and control my breathing and it will relieve me faster. (*Rick*)

# Thorax

	6.2 Thoughts about the PR programme
	6.2.1 Design & setting
One	e hour, one hour per session is good. Two times per week is enough. (James)
For	me the programme is excellent. Score one hundred percent good. (Peter)
l th	ink the sessions are fine like this. (Harry)
l th	ink the number of sessions is adequate, it is an adequate number. (Michael)
l th	ink two sessions per week it is good. () One hour per session is good, it is good like this. (Neil)
lt w	yould also work in the primary care centre. Of course, we go to the primary care centre, stay there half an
οι	r or so, it would work. In the hospital would already be too far. The primary care centre would be more
acc	essible. (Neil)
The	e duration of the sessions is adequate, it is. (Miles)
The	e number and duration of the sessions was good, good, good. It was, it was. Considerable even. () For
me	the programme is good like this. (Brian)
The	number and duration of the sessions was good. (Rose)
One	e hour per session is good, it is enough. And 3 weeks is also good. I would do the sessions again, in the
san	ne way. <i>(Ted)</i>
The	e programme was adequate. It went well, it went well. (Philip)
For	me I think is enough, one hour per day, it is enough, we don't need more because we also can't do a lot
of e	ffort. We are limited to a certain amount of effort, everyone in their situation but in my situation, I think
in n	ny situation it is good. One hour per day is ideal. <i>(Fred)</i>
Oh,	if we would have a gym at home, it would be better. But not everyone has the possibility to have those
ma	chines and also the conditions of the homes sometimes do not allow it. But I think it is good like this.
(Fre	ed)
Oh	if we had those gym machines it would always help a bit more, isn't it? (Fred)
Yes	, in the primary care centre or in the hospital it would always be possible. And it would be better because
the	re we would have things that we don't have at home. More equipment. And do other types of exercises
tha	t we can't do at home. (Fred)
The	e duration of the sessions is positive. (Liam)
For	me everything was positive. () All the programme, it was adequate and positive. () Hmm, I think there
is n	othing to change, everything was normal. Everything I did was normal. (Dan)
l th	ink the sessions are good. Hmm, maybe more than one hour per session, or, or instead of for example
two	times per week, do it three times per week. Maybe, I think. (Rick)
And	to be able to do it at home it is much easier because we don't have to travel, it is always much easier.
(Joł	nn)

Home-based PR during ECOPD, Machado et al. 2024 https://mc.manuscriptcentral.com/thorax

### 6.2.2 Exercises & support materials

The exercises are possible to do at home, I can continue doing them alone. (...) And the leaflets are easy to understand. (*James*)

The exercises, for now, for now they are good. I am able to do the exercises that we have been doing. (...) And the leaflets are all good. (*Peter*)

The exercises are not difficult. It is all normal, it is all normal. (David)

The exercises are easy to do at home alone. (...) They are easy to do because everything is really well explained, thus, I think it is easy to do them. And all the education as well. (*Michael*)

The language in the leaflets is easy. It is an easy language, it is an easy language, it is a matter of the person to dedicate himself, learn, read, and it is a language that is accessible to people with more culture or less culture, more education or less education. I think it is an easy language and accessible to people with less education, because it is written in a way that we can read perfectly, any person can read it. *(Michael)* 

In terms of education, I think we discussed everything. (Ethan)

The exercises are easy to continue doing them. They are easy. (...) (Neil)

The leaflets are good. Everything was easy to understand, both from reading and from talking with you. The language was easy to understand. (...) The leaflets I think they are all very explicit in what we need to do. (*Miles*)

The language of the leaflets is easy to understand. Easy, really easy. Only those who don't want to know, for those who don't want to know it isn't easy. But it is easy to understand what is written there. (*Brian*) The programme has a meaning, it is not for no reason that you use all these devices, because I have a lot of respect for everyone's profession, and it is not for no reason that every exercise I do the physiotherapist is always monitoring my heart rate and those things, therefore it has a meaning, you are the ones studying that, you are the ones working in the field, and I respect and have always respected everyone's profession, and for sure that will help you defining it better, maybe the problem I have and many others, so that one day others, maybe my children, or my grandchildren, maybe this problem becomes smaller and smaller. (*Wade*) The content of the leaflets is important, for sure it is. (...) And if I would have any doubt I would always ask. (*Wade*)

I was able to easily understand the content of the leaflets. (Rose)

The leaflets I thought they were good. I could understand them well. (Philip)

The exercises are really easy to do at home, we don't need anything special, we can use some water bottles for the free weights... Hmm, a small stool can be used to go up and down steps. And then we have the rest to maintain our gymnastics with the raise arms and legs, we can do everything inside our home and without spending many or any cash. (*Fred*)

I could understand the leaflets. (...) There was nothing missing in the programme. There was nothing missing. (*Liam*)

#### Thorax

The language of the leaflets is adequate. (...) All the information that is in the leaflets, I was able to understand everything. And everything that you explained to me I was also able to understand. And it is not in vain because I read everything, everything, everything. (*Paul*)

The exercises are really useful, really useful, amazing. (Rick)

So, what I have been doing in the programme up to now and the exercises that the physiotherapist told me to do, I felt some days good, some days a bit less good, depending on the exercises. But in general, I felt good. And when I wouldn't feel so good, I would tell her. I would tell her, today I am feeling a bit more tired... and she would adjust. I can't say anything else. *(Thomas)* 

The exercises aren't difficult to do. (John)

### 6.2.3 Education & breathing techniques to regain control

I learned new things, new ways of breathing, new exercises... thus, for me it was good, it was positive. (Michael)

It improved me, there was a big improvement, I learned how the sputum can evolve, information that I didn't know and I learned, and for me it was really beneficial and... and very useful I think. I really liked it and I think this was very useful for my disease. (*Michael*)

I think this is a good programme, that in fact everyone who has this health problem should do, because it teaches you, you learn a lot, how to deal with the disease, how to improve your physical condition, basic knowledge and really important for this type of disease, and I think that it was really good. (...) Because it taught me new information regarding exercise, and many other things, and it taught me a lot. (*Michael*)

The education, at least to me, it was really good, the person was really accessible, very understanding, the physiotherapist was very calm and patient, and I could really understand the physiotherapist and do, and follow with rigor what she was teaching me, and I took everything really seriously, to me it was really important. (*Michael*)

The main thing was to know the breathing techniques. If I would know that before, I would have done it long ago. There was no need of feeling as bad as I was feeling, right. That was a really important thing. (...) The breathing was the main thing. Now I do it, I do it. And with the acapella also and so. In the morning and at night. (...) This was the main thing, to have clean lungs. *(Ethan)* 

The content of the leaflets was very important. It helped me a lot. And I am following all the information, I am following the programme you left me. (*Brian*)

Now I have, physiotherapist, I have the conscience that... I am better informed about my problem, because I didn't know it and because the physiotherapist really made me see the problem I have exactly as it is, with the complains that I decided to mention. And, therefore, the impact this programme have is that I feel more protected because I know what is going on with me and what I will need to do to not get worse. (...) and now I am aware of the state I am in, that is not, I feel it is not, it is not so severe if I stop smoking and I exercise. (*Wade*)

Now, since the physiotherapist said it relies on me and that I can still live some time with some quality of life, that makes me very happy, to know it depends on me. Stop smoking, exercise, be careful with my food, but that I was always because there are a lot of things I don't like to eat, so. (...) but, to me it is good to know it depends on me. (*Wade*)

In addition to being more informed, in addition to knowing that I am still in a phase that I can fight, at least to not make it worse, to try to stabilize it, and that it depends on me, it was really good for me (...) (Wade) Because this that happened was also new for me, and the little I know, that is already a lot, it was through the physiotherapist, through the questions she asked me, and everything that I already read, not having read much, but mostly through everything the physiotherapist already transmitted to me. (Wade)

So, more important things, this thing, the acapella, it made it easier for me. From now, I already know how I am going to talk with my doctor, you already gave me certain information that I didn't know, and that from now on I will maybe have a bit more priority. *(Rick)* 

Just in the morning, I leave the bed a bit more in trouble, I drink a bit of water because I always drink water, I do the breathing techniques and after a bit, done, I am already relieved. The sputum is out. (*Rick*) This week I will start Reading the leaflets because I like to read. I will start reading all of this, from the beginning to the end, theme by theme... because there are a lot of things that I need to know. (*Rick*) The instructions you gave me, according to what I saw. I believe it was a very useful process. For selfmanagement, for... regarding these personal procedures, the food, I think it is... the breathing also, what can happen... I think it is really useful. (*Rick*)

The acapella. It is something that makes me feel really good, and that I liked and like because the sleep seems to me to come more quickly, and I feel I breath better and I don't wake up with troubles breathing. Does it have anything to do with the acapella? I think so, because before using it I didn't, no, no, no, I didn't feel so well. (...) The acapella, for me, it is something that I think is very interesting. *(Thomas)* 

I like to know about the things. (Mary)

#### 6.2.4 Need for a longer programme

I needed more time, more sessions. (James)

If it would be during more time it would be better, obviously. (Peter)

Ah, for now I feel good, but if I could do a few more sessions it would be better for me. (Oliver) Ah if I could have the programme during more time it would be better. I would do more sessions because it is for my own good. Because when someone sees that it is for our own good, we ask for more. (David) For me this programme would be during a longer time, but yeah... it is not possible. (Neil) I would like to do it during more time, more prolonged. (...) For a few more weeks. (...) Needed? Needed, needed it would be for the rest of my life. But, for half a year it wouldn't be bad. (Neil)

#### Thorax

It is just a pity that it is for a short time. (...) this should be, this should be a continuous thing... because, only this time is not enough. (....) it would be good to have it for more time. More time, or paused. But it is like this. (*Rick*)

Ah more than 3 weeks. For sure. I think that, if now I could notice the difference from the first time to now, because there is a difference, there is. Then evidently if there were more sessions, I think I would improve even more. (...) It is just a pity that it was not enough, not enough. (*Rick*)

I would really like and, in fact, I even told it to the physiotherapist, I would like her to come for a little longer. (...) I have no idea for how long. But I know that it would do no harm, on the contrary. But you have your methods and I just have to comply with them. (*Thomas*)

Doing the programme for a longer time I think it could only make me feel good, in two ways. To the respiratory part, which is the main one in this case. And also to the psychological part it could only make me feel better. (*Thomas*)

# 6.2.5 Support from health professionals

(...) The physiotherapist is also of easy communication and, therefore, I thought it was positive and I think I learn some things. (Wade)

First it was good because the physiotherapist is also someone apparently healthy, talks as if we didn't have a really severe problem, that also helps us to not be so scared, to not be afraid, to not worry. And, the physiotherapist is someone that transmits the information well, communicates well, is soft in the way she explains everything, gives us some motivation for the future, and that for me made me feel well, it was really good. (*Wade*)

(...) Having a physiotherapist taking care of us, at least one or two times per week, I think it is really good for us. (...) (Fred)

But then to have a gym at home we always need to have someone that guides us because we don't know anything about gymnastics. (Fred)

I am satisfied with you guys. (Rick)

And, mainly, the person that took care of me is someone extremely competent to do the job she is doing. (Thomas)

With someone that could understand myself and that I could get along with, as it happened with physiotherapist that treated me. She fully understood me and I got along with her perfectly, and she made me, in a certain way, even when I didn't want to, do the sessions, but diplomatically. (*Thomas*)

# 6.3 (Lack of) Motivation to continue the PR programme

6.3.1 I can do it alone

I do the exercises alone. (James)

I think I am going to continue doing the exercises alone. No one is born already knowing how to do this, so we have to try to remember everything we learn in the sessions, and check in the leaflets and ask. (Peter) I go there, I stay there often in the balcony doing some walk-in place, other times doing some exercises with my legs back and forth, back and forth, do some exercise so I don't get rusted. (David) I can continue to do the exercises alone. I can! Both the walking, the gymnastics for the legs, the lower limbs, the arms... open and lift it and everything. I can. (Harry) I always had the will to do these sessions. (...) It is a matter of the person wanting to do it, isn't it, to have the will to do it. (Michael) I think so. I am going to continue doing the exercises, at least to see if it improves a bit. To see if I don't stay like this. Or to see if I don't lose what I already gained. (Ethan) I will try to keep doing some exercises, the things I feel I am able to. (Miles) To do the exercises at home alone it is really easy! Easy. I do it really easily. I already did some exercises. And I am going to continue doing them. It is for my own good. I have to continue doing them. (Brian) I got better, I got better. And because I got better and, in addition, I will continue doing the home exercises that I have there to do, I am going to get even better. Because it will help me even more, right. (Brian) Therefore, I am going to fight to minimize my problem. (...) I think I can do the exercises alone, and even more exercises, more difficult. (Wade) The breathing exercises, those I think I will continue to do. (Rose) I do some of the exercises, some of them. I don't do all of them but I do some, a bit, but I keep doing something. (Ted) Yes, I will continue to do the exercises every day a bit. Every day, a part in the morning and another in the afternoon. That is indispensable to continue in the best shape possible. (Fred) I will continue doing exercise. But now, while the weather is like this with rain, it is what I say, it is more limited. (Joe) I can continue doing the exercises alone. (Liam) I am going to talk with the pulmonologist and ask to integrate the pulmonary rehabilitation programme, I 

just need to wait until March. I need to hold on until March, with the exercises that I have to do, the things you thought me, the things I did, I will try. I will try. I can't say that I am going to do fifty percent, no, I don't know. I will try to do everything more or less as I have been doing, I can go to the stairs outside in the building. I will try to do it. Hmm, until March. And then I am going to talk with the doctor to see if it is possible to integrate the PR programme, she won't tell me no. (Rick)

I will try to keep doing the exercises. I can't tell you that I am going to do one hundred percent or seventy or... I will try to do at least fifty percent to try to rehabilitate myself in the best way possible. (...) It will often all depend on how I wake up. I won't tell you that I will comply because I would lie. I will try to do my best within the things I am able to do, because you know when we are alone... The athletes are athletes and don't

#### Thorax

juggle. Thus, I know the things, I know the responsibility. And I will try to do it because it is for my own good, it is for my own good. (*Rick*)

The exercises are not easy nor difficult, it is a matter of willpower. And I can't tell you about it because I am 79 years old and I don't know how I will feel tomorrow, which will be my willpower. Which will be my willingness to do it. But I think that there are many exercises that I did during the programme that I will keep doing. In fact, there is one that I insist on doing every day at night, the acapella... (...) and thanks to the physiotherapist I do it, and I will continue doing it because I am going to buy one. (...) In a next exacerbation I would request to do these sessions, I wouldn't be waiting for someone to contact me, I would request someone to come and do these sessions like the ones I had. (*Thomas*)

I think some of the exercises I can do them. The ones I can do alone I do them. (Mary)

### 6.3.2 I can't do it alone

I go to where they send me. If I stop doing this, I don't lose the belly. I want to have a stable life, a life that gives me security... to live a few more years. (...) I have a lot of willpower. (...) I think these sessions help. I think they do. I think the sessions help, don't let me stop. (...) But no, no, no. I can't... Alone? I can't do it alone. I lack the will to do it alone. (*Oliver*)

I, I don't feel like doing it alone, I don't... If, if I am at home, I practically forget things. (Oliver)

I don't do it alone, I don't do it. I lack willingness. I am able to go to my garden and do some work, during half an hour or 15 minutes, for as long as I can take it... and then I feel a bit tired and I stop, done. Now doing this, I don't do it. (*Oliver*)

If I am here alone, I can't do anything. (...) To exercise alone is nothing, nothing. I lack the will to do it. If someone is motivating you, then you will do it. In this case it is almost mandatory, isn't it. I must do it. (Neil) It was important to keep doing it to feel the difference in my conditioning. To feel the difference in my conditioning, to see if I would decide to start moving alone, walk around outside. But I am not seeing it happen. (...) I just lack the will. I lack the will. (*Neil*)

I think I won't continue to do the exercises alone. I didn't even check anything from the leaflets yet. (*Rose*) You know, it is hard for us to do this, but afterwards we feel the improvements. (...) Do these sessions, this is good, but we are lazy. But this is good, because then we feel it, we feel the results later. But... sometimes we are lazy. (...) It is a bit hard for us, we are lazy, we don't want to do it, that's the reality. And I already know that, for example, it is really like this, even yesterday, I was tired and felt I wanted to sit, and I was dying to lay down, lay down to rest and so but... But if we want to have benefits, we need to sacrifice ourselves... We need to sacrifice ourselves. But we are always trying to avoid it, trying to see if we can fool the therapist, if we can deceive her... (*John*)

Well, it would be possible to do the exercises alone, but we don't do it. It would be possible, but we don't do it. Because, as you can see, you tell me to do this or to do that, and I do it, but when I feel a bit tired, if no one would be here telling me to do it, insisting that I need to do it, then I would just feel like, okay, too bad I

didn't do it, or I would stop when I am tired and wouldn't do more. It is like this. There is nothing to deceive that it is like this. It is like this and it is typical. It must be me and everyone else. We are all like this, all of us. (...) Okay, oh never mind, tomorrow I will do better, and no, and tomorrow I will do better and, it is for tomorrow, leave it for tomorrow. There is a saying that says, don't leave for tomorrow what can be done today. But it is like this. (*John*)

# 7. <u>References</u>

1. Machado A, Oliveira A, Valente C, Burtin C, Marques A. Effects of a community-based pulmonary rehabilitation programme during acute exacerbations of chronic obstructive pulmonary disease–A quasi-experimental pilot study. Pulmonology. 2020;26(1):27-38. <u>https://doi.org/10.1016/j.pulmoe.2019.05.004</u>

2. Machado A, Silva PM, Afreixo V, Caneiras C, Burtin C, Marques A. Design of pulmonary rehabilitation programmes during acute exacerbations of COPD: a systematic review and network meta-analysis. European Respiratory Review. 2020;29(158). <u>https://doi.org/10.1183/16000617.0039-2020</u>

3. Borg GA. Psychophysical bases of perceived exertion. Medicine & science in sports & exercise. 1982.

4. Gloeckl R, Zwick R, Fürlinger U, Jarosch I, Schneeberger T, Leitl D, et al. Prescribing and adjusting exercise training in chronic respiratory diseases–Expert-based practical recommendations. Pulmonology. 2022. <u>https://doi.org/10.1016/j.pulmoe.2022.09.004</u>

5. Fox III SM, Naughton JP. Physical activity and the prevention of coronary heart disease. Preventive medicine. 1972;1(1-2):92-120. <u>https://doi.org/10.1016/0091-7435(72)90079-5</u>

6. Karvonen MJ. The effects of training on heart rate; a longitudinal study. Ann med exp biol fenn. 1957;35:307-15.

de Camargo AA, Justino T, de Andrade CHS, Malaguti C, Dal Corso S. Chester step test in patients with
 COPD: reliability and correlation with pulmonary function test results. Respiratory care. 2011;56(7):995 1001. <u>https://doi.org/10.4187/respcare.01047</u>

8. Postiaux G. La kinésithérapie respiratoire du poumon profond. Bases mécaniques d'un nouveau paradigme. Revue des maladies respiratoires. 2014;31(6):552-67. http://dx.doi.org/10.1016/j.rmr.2013.11.009

9. Marques A, Oliveira A, Oliveira D. Gerir a infeção respiratória do trato inferior na comunidade: o papel do Fisioterapeuta: Lusodidacta; 2016.

10. Plataforma de Reabilitação Respiratória em Rede Portugal2019 [Available from: http://3r.web.ua.pt/reabilitacao-respiratoria-educacao-apoio/#folhetosinformativos.

11. Lincoln Y, Guba E. Validity trustworthiness and rigor: Quality and the idea of qualitative research. Methodological Issues in Nursing Research. 1985:304-10.