

Predictors of and reasons for refusal to participate in a digitally supported remote maintenance pulmonary rehabilitation programme

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Abstract

Objective:

The study aimed to assess the predictors and the reasons for refusal to participate in a digitally supported remote maintenance pulmonary rehabilitation programme (M-PRP). Methods: Patients contacted to integrate a 12-month M-PRP were assessed for clinical and sociodemographic characteristics and completed a series of 11 questionnaires including digital literacy (MDPQ-16), personality traits (BFI-10) and reasons for refusal.

Results:

Of the 136 patients included, 78 accepted the M-PRP and 58 refused (43%). The likelihood of refusal was associated with low forced expiratory volume in 1s (FEV_1), body mass index, neuroticism (BFI-10) and MDPQ-16. Main reasons for refusal were programme constraints (47%), intention to continue physical activity alone (45%), and lack of information technologies (IT) equipment (29%).

Conclusion:

Digital M-PRP rejection is a common problem. Disease severity and technology issues are main barriers. Particular attention should be paid to patients who state they intend to continue on their own, given conflicting literature data.

Introduction

Pulmonary rehabilitation (PR) is a cornerstone of the management of chronic obstructive pulmonary disease (COPD), leading to improvements in daily symptoms, exercise capacity, health status and survival, while also decreasing hospitalisation rates.^{1–3} Unfortunately, the effects of PR are not sustainable in the long term. Indeed, most of the improvements observed following a PR programme are lost in the following year,^{4–6} primarily due to the limited impact of PR on physical activity levels.⁴

To overcome these limitations, maintenance PR programmes (M-PRPs) have emerged in recent years, with heterogeneous modalities (centre-based outpatient support, direct home visits, remote support with digital interventions or hybrid modalities) and durations (6–36 months after the initial PR).^{7–15} Recent systematic reviews and meta-analyses have provided evidence of their overall effectiveness in maintaining benefits after an initial PR programme, with no evidence to support one format over another.^{16–18} Nevertheless, in terms of large-scale deployment, remote M-PRPs with telehealth services appear to be the most affordable and scalable option.¹⁹ In a context of continuous increased tension on health services, telehealth services offers the potential to limit the travel of healthcare professionals compared to face-to-face, home-based programmes, but also to gather several patients at the same time with limited travel costs allowing them to stay in their own homes and, importantly, to increase access to care and convenience.²⁰ This last point could be viewed as an important advantage in proposing long-term management and facilitating long-term improvement in health behaviour.¹⁹ However, the development of digital health also involves several obstacles that remain to be explored, such as data protection issues and digital literacy.^{21,22} More importantly, while digital interventions offer the potential to increase access to health, it also raises a potential inclusivity problem.^{19,21,22} Worryingly, individuals without internet access are more likely to be older and to reside in socioeconomically disadvantaged communities, which are also common features of populations where COPD is more prevalent.¹⁹ All of these limitations can lead to a lack of acceptability of digital health interventions in some patients, which has been associated with high refusal rates in digital health trials.^{23,24}

Unfortunately, the prevalence of refusal in digitally supported remote M-PRP remains difficult to estimate. Of the 6 previous studies that have trailed such programmes in COPD, only two have reported refusal rates.^{12,13,25–28} Both reported low participation rates, with refusal rates of almost 50% among eligible patients.^{27,28} These findings are particularly problematic insofar as a low participation rate is likely to affect the external validity of a study, and therefore the generalisability of its results.²⁹ More importantly, none of the above studies were interested in investigating the reasons for refusal and the characteristics of the refusers. Understanding who these patients are is crucial, both in terms of identifying ways to increase participation in remote M-PRPs and in defining other appropriate support solutions for these patients.

Many factors are likely to explain a potentially high refusal rate in remote M-PRPs, apart from obvious aspects related to computer use (digital literacy, internet access, etc.). Refusal to participate in a rehabilitation programme for various chronic conditions was associated with socio-demographic factors such as older age and disease severity, having a low income and living alone.^{30–33} The likelihood of refusing rehabilitation was also predicted by several other factors such as certain personality traits of patients (high conscientiousness), low perceived life expectancy, fear of side effects, doubts about efficacy, a lack of desire to live

longer and patient preferences (programs perceived as too constraining, perceived lack of relevance with regards to patient's needs, other priorities to manage...).^{30–33} Additional psychological factors such as fear of failure are worth considering, given its potential influence on disengagement as a maladaptive self-protective strategy.³⁴ Another potential factor could be related to patients' health knowledge, also known as health literacy, given its relationship with access to care.³⁵ These different factors provide some initial clues as to why M-PRPs might be rejected. However, the results may not be generalizable to the extent that the factors presented above come from very different contexts (not M-PRP). Indeed, unlike the studies presented above, the patients who refuse an M-PRP are patients who initially accept an initial program (i.e., the rehabilitation program) but then refuse the remainder of the program (i.e., the maintenance program).

A better understanding of patients who refuse M-PRPs is thus essential, both to better define the widespread use of these models and to identify ways to better support these patients. Therefore, the aim of this exploratory study was to examine the predictors and reasons for refusal to participate in a digitally supported remote M-PRP.

Methods

Study design

Prospective observational study.

Participants

Participants were recruited during an inpatient stay at one of the two PR centres, Cliniques du Souffle La Solane (Osséja, France) and La Vallonie (Lodève, France). Eligible patients were all those contacted between February and November 2023 during their inpatient PR stay to integrate a 12-month M-PRP with a digital platform and videoconference follow-up (RCT m-Rehab-COPD, NCT04550741). The inclusion criteria for the m-Rehab-COPD study were patients with a medical diagnosis of COPD and a post-bronchodilator forced expiratory volume in one second (FEV1) over forced vital capacity (VFC) below the lower limit of normal, aged between 40 and 78 years, and carrying out a PR stay in a PR centre. The main exclusion criteria for the m-Rehab-COPD study were contraindications to exercise training and unstable cardiovascular disease. Additional non-inclusion criteria for the current study were individuals who do not speak, understand or read French, patients suffering from a neurodegenerative disease that limits the ability to complete questionnaires (e.g., Alzheimer's or Parkinson's disease) and patients suffering from the following psychiatric diseases: bipolar disorder, schizophrenia, psychosis or personality disorder.

The protocol was approved by an independent French ethics committee (CPP Sud-Est I, reference number: 2022-A01337-36) and complied with the principles of the Declaration of Helsinki for human experimentation.

Procedures and data collection

Firstly, all patients who were eligible for the M-PRP RCT study received standardised written and oral information detailing the proposed M-PRP programme. After deciding whether or not to participate in the M-PRP RCT study, all eligible patients, whether they had accepted or not, were informed that they would be contacted by another investigator to participate in a secondary study. Patients who agreed to be contacted were then met in-person within 48 h by a study investigator for an information visit, which took place in their room or a dedicated office within the clinic. After being informed of the aims of the research and their rights, patients who gave oral consent were enrolled in the current study (written consent was not required for such a non-interventional research as referred to in paragraph 2 of Article L1122-1 of the Public Health Code, in accordance with French legislation). Pre-PR (i.e. at PR admission) anthropometric data, medical diagnosis, comorbidities, oxygen treatment and classic baseline PR assessments such as COPD severity by postbronchodilator plethysmography (FEV1, FEV1/FVC), dyspnea level by modified Medical Research Council (mMRC) questionnaire and exercise capacity by distance in the 6-min walk test (6MWD) were retrieved from the patient's medical record. Patients were then asked to answer a series of socio-demographic questions about their marital status, household composition, annual household income, living environment, educational level, and status and socio-professional category. Their previous experience of pulmonary rehabilitation (number of previous PR stay) and smoking status were also recorded. Finally, patients were asked to complete a series of 11 questionnaires. The total time taken to complete all the questionnaires was approximately 40 min. In the absence of existing literature on predictors of refusal of M-PRP, the target outcomes and associated questionnaires were defined based on a literature review of related topics, such as predictors of refusal of rehabilitation and treatment for various chronic conditions^{30–33} (see introduction section for further details). Perceived health status was assessed with the generic self-rated scale in one question³⁶ (higher score indicates better health status) and with the specific COPD assessment test (CAT) questionnaire (higher score indicates lower health status).³⁷ The level of illness acceptance was assessed with the acceptance of illness scale (AIS), with lower score indicating lower acceptance of illness.³⁸ Health literacy and digital literacy were assessed with the European Health literacy survey in 16 questions (EHLS-16)³⁹ and the Mobile device proficiency questionnaire in 16 questions (MDPQ-16),⁴⁰ respectively, with higher scores indicating higher literacy. Intention to engage in physical activity was assessed with the stage of change for physical activity scale.⁴¹ Fear of failure was assessed with the Performance Failure Appraisal Inventory questionnaire (PFAI), with higher score indicating higher fear of failure.⁴² Personality traits, which represent relatively enduring patterns of thoughts, feelings, and behaviors as defined in the Five-Factor Model,⁴³ were assessed with the 10-item Big Five Inventory (BFI-10).⁴⁴ These traits include Neuroticism (i.e., the propensity to experience distress and to feel negative emotions), Extraversion (i.e., the tendency to experience positive emotions and to be sociable), Openness to experience (i.e., the tendency to be curious and unconventional), Agreeableness (i.e., the propensity to be altruistic and accommodating), and Conscientiousness (i.e., the tendency to self-discipline and responsibility), with higher scores representing a higher level on the trait. Anxiety and depression levels were assessed with the Hospital and Anxiety Depression scale (HADS), with higher scores indicating higher symptoms.⁴⁵ Perceived life expectancy was assessed via a non-validated questionnaire, across the single question proposed by Rothman et al.³³: ““If you had to guess, how long do you think that you might have to live?”. Last, the level of comprehension of the M-PRP m-Rehab-COPD was assessed across a multiple-choice questionnaire specifically developed for the study and comprising 3 questions with 4 possible answers at each time. Furthermore, the

patients who refused the M-PRP were asked to answer an additional question regarding the reasons for refusal. They were offered a total of 16 potential reasons for refusal and asked to mark the appropriate one(s) on the list provided. The proposed reasons were based on the results of the study by Flink et al.⁴⁶ and the advice of a panel of experts specialising in pulmonary rehabilitation. Patients were also given the opportunity to formulate a free reason if it was not one of the 16 suggested reasons. They could give as many reasons as they wanted.

Statistical and data analyses

All statistical analyses were performed using JASP (version 0.18.2), unless specified otherwise.

The main clinical characteristics between patients who accepted remote M-PRP (acceptors) and those who refused (refusers) were compared using chi-squared, unpaired t-tests for parametric data or the non-parametric Mann-Whitney U test, as appropriate.

Predictors of risk of refusal were assessed using logistic regression, with group as the dependent variable (acceptors or refusers). We followed the methodology presented by El Sanharawi et al.⁴⁷ First, univariate logistic regressions were performed on each of the parameters of interest: age, gender, smoking status, weight, height, body mass index (BMI), plethysmography data, oxygen treatment, dyspnea, exercise capacity, marital status, household composition, annual household income, living environment, educational level, socio-professional status and category, number of previous PR stays, and scores on each of the study questionnaires (self-rated health, CAT, AIS, EHLS-16, MDPQ-16, stage of change for physical activity scale, PFAI, BFI-10, perceived life expectancy, HADS and comprehension of the M-PRP). Next, variables showing a significant association with refusal to participate in the M-PRP ($p < 0.05$) or not showing a significant association but with $p < 0.2$ were selected as variables of interest to be included in the multivariate logistic regression.⁴⁷ Prior to conducting the multivariate analysis, the absence of colinearity between the selected variables was checked and those with a variance inflation factor >2.5 were excluded from the model.⁴⁸ Multivariable logistic regression analysis was then performed with the remaining variables to identify independent risk factors associated with refusal of the remote M-PRP.

The 16 suggested reasons for refusing the remote M-PRP were analysed quantitatively. In order to facilitate interpretation, a thematic grouping was made for items that were very similar in terms of information. This reduction in the number of categories was made possible by grouping: (i) the three items around the theme of physical activity into a single item called 'doing PA alone', (ii) the three items around the theme of the programme barriers into the category 'programme constraints', and (iii) the two items around the theme of the relevance of the programme into the category 'not suitable'. The remaining items were analysed as a category, resulting in a total of 11 response categories for analysis. The free reasons given by patients were classified into these 11 categories. Multiple responses were inspected paired by paired with a co-occurrence matrix and a co-occurrence network, using R software (version 4.3.2) and the R package "igraph".⁴⁹

Data are presented as mean and standard deviation (SD). The alpha risk was set at 5%.

Results

Patient characteristics

The flowchart of the study is presented [Figure 1](#). During February and November 2023, 180 consecutive patients were contacted to integrate the M-PRP, with an acceptance rate of 51%. Among them, 78 acceptors and 58 refusers were included in the current study, leading to a total of 136 patients. Main clinical characteristics are provided [Table 1](#). Compared to the acceptors, the refusers were lighter, had a lower FEV₁, a lower FEV₁/FVC, a lower walking distance and a higher mMRC score. An exhaustive presentation of the study population on each questionnaire is provided in the [Supplemental table S1](#).

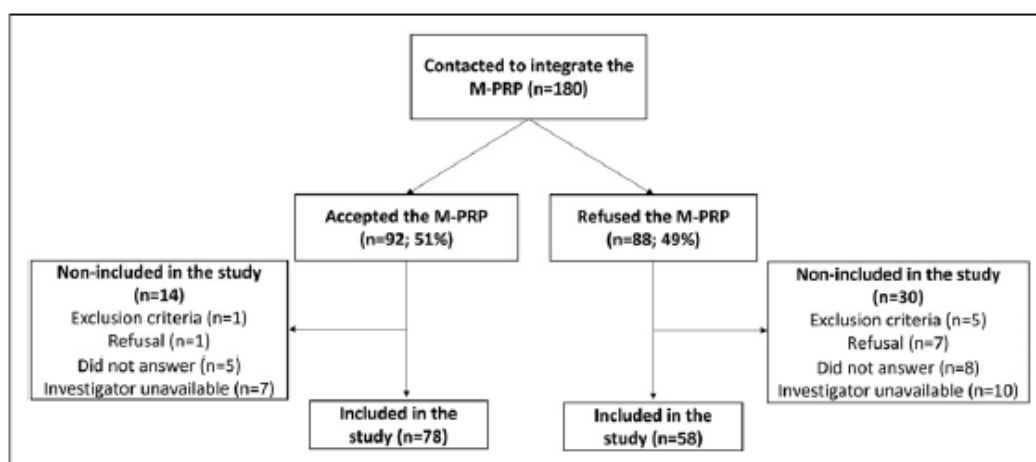


Figure 1. Flowchart of the study. M-PRP: maintenance pulmonary rehabilitation programme.

Table 1. Clinical characteristics comparisons between the acceptors and the refusers of the digitally supported remote M-PRP.

	Acceptors n = 78	Refusers n = 58	p-value
Anthropometric parameters			
Gender, M/F	37/41	24/34	0.48
Age, yrs	63.3 (6.93)	65.2 (6.63)	0.11
Weight, kg	76.8 (21.8)	68.5 (16.5)	<0.05
BMI, kg.m ⁻²	27.4 (6.91)	25.7 (6.03)	0.13
Pulmonary parameters			
FEV ₁ , L	1.62 (0.64)	1.19 (0.54)	<0.001
FEV ₁ , % pred.	62.6 (21.4)	50.2 (21)	<0.01
FEV ₁ /FVC	0.55 (0.12)	0.50 (0.13)	<0.05
Comorbidities			
Metabolic disease, n (%)	28 (36%)	23 (40%)	0.65
Cardiovascular disease, n (%)	38 (49%)	33 (57%)	0.35
Musculo-skeletal disease, n (%)	12 (15%)	13 (22%)	0.31
Other comorbidities, n (%)	46 (59%)	30 (52%)	0.35
Baseline PR outcomes			
mMRC score	1.82 (0.98)	2.22 (1.02)	<0.05
6MWD, m	464.3 (119)	412.3 (114.9)	<0.05
CAT score	18.8 (6.82)	17.51 (6.59)	0.28
Smoking status			
Actual smokers, n (%)	25 (32%)	10 (17%)	0.05

Abbreviations: BMI, body mass index; FEV₁, forced expiratory volume in 1 s; FVC, forced vital capacity; mMRC, modified medical research council; 6MWD, 6-min walking distance; CAT, COPD assessment test. Data are expressed as mean and SD, unless specified.

Table 2. Results of the multivariate regression analysis to predict the likelihood of refusal.

	OR	95% confidence limits	p-value
Number of previous PR stage	1.12	0.94–1.32	0.2
Age, per yr	0.99	0.93–1.07	0.91
Actual smoker (ref: yes)	0.87	0.29–2.66	0.81
BMI, per kg.m ⁻²	0.92	0.85–0.99	<0.05
FEV ₁ , per L	0.28	0.11–0.74	<0.01
6MWD, per m	1	0.99–1.01	0.84
mMRC score, per unit	1.34	0.75–2.41	0.32
MDPQ-16 score, per unit	0.97	0.94–0.99	<0.05
PFAI score, per unit	0.92	0.8–1.07	0.29
Neuroticism score, per unit	0.52	0.34–0.81	<0.01
Anxiety score, per unit	0.93	0.78–1.11	0.43

Abbreviations: OR, odds ratio; PR, pulmonary rehabilitation; BMI, body mass index; FEV₁, forced expiratory volume in 1 s; 6MWD, 6-min walking distance; mMRC, modified medical research council; MDPQ-16, mobile device proficiency questionnaire-16; PFAI, performance failure appraisal inventory. Any variable associated with a probability value less than 0.20 was accepted in the multivariate logistic regression.

Predictor of refusal

Univariate logistic regression analyses identified 15 variables of interest predicting the likelihood of refusals with $p < 0.2$ (Table S1). After excluding 4 variables of interests because of collinearity (FEV₁/FVC, weight, height and socio-professional status), multivariate regression analysis on the 11 remaining variables showed that the independent predictors of refusal to participate in the remote M-PRP were lower BMI, lower FEV₁, lower mobile device proficiency (MDPQ-16) score and lower levels of neuroticism (Table 2).

Reasons for refusal

The three main reasons for refusing the remote M-PRP were “programme constraints” (47%), “intention to continue physical activity (PA) by other means” (45%) and “lack of IT equipment” (29%) (Figure 2). Other reasons provided were “unavailability for several months” (21%), “programme not suitable” (19%), “not interested” (12%), “refusal to take part in research” (10%), “unable to follow the programme” (9%), “programme perceived as too intrusive” (9%), and “did not understand the programme” (3%). Multiple responses analysis (Figure 2) shows that the most common co-occurrence responses were “programme constraints” with “intention to practice PA by other means”, answered simultaneously by 24% of the sample. Other common co-occurrence responses were “programme constraints” with “programme not suitable” (14% of the sample) and “programme constraints” with “lack of IT equipment” (12% of the sample). All other co-occurrence responses had a prevalence of less than or equal to 10%. The co-occurrence matrix is provided in the supplemental table S2.

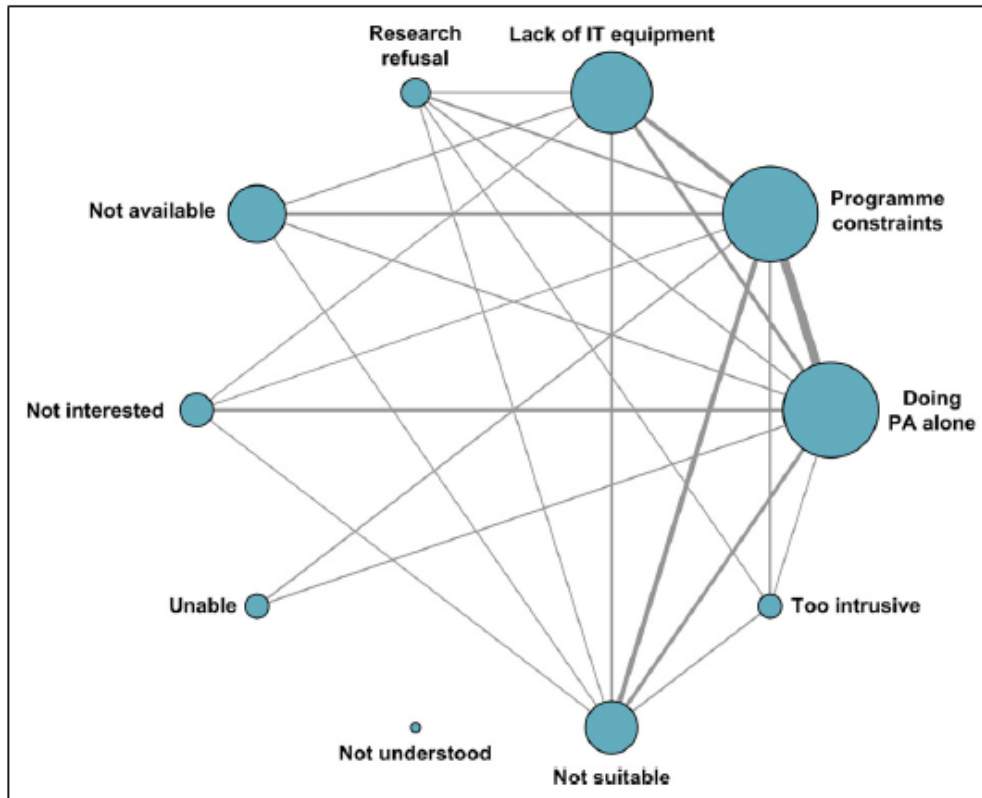


Figure 2. Co-occurrence network of the responses for each category of reason for refusal. The size of each circle indicates the number of times the corresponding answer was cited, and the size of the links indicates the number of times the linked answers were given simultaneously. Co-occurrence threshold was >1. Doing PA alone (grouping items): “I’m already enrolled in another programme” or “I already do enough physical activity at home” or “I plan to do some physical activity on my own at home”. Programme constraints (grouping items): “I don’t have the time to take part in such a programme” or “the programme is too long” or “the programme is too demanding (frequency of interviews, effort required)”. Lack of IT equipment: “I am not equipped (internet, smartphone, computer, etc.) for remote monitoring”. Research Refusal: “I refuse to take part in a clinical research project”. Not available: “I will be absent/unavailable for several months”. Not interested: “I don’t see what such a programme can do for me”, Unable: “I don’t feel able to take part (e.g. too ill)”. Not understood: “I don’t fully understand what it’s all about”. Not suitable (grouping items): “The support offered does not seem to meet my needs” or “I would prefer to be accompanied in a different way to this one”. Too intrusive: “The programme seems too intrusive (daily monitoring of my activities, my state of health)”. The last item “I’m disappointed with my pulmonary rehabilitation stay and don’t want to go any further” was not included in the matrix as it was never provided by any participant.

Discussion

This study sought to identify independent risk factors associated with refusal of a digitally supported remote M-PRP and the main reasons for refusal. We found that almost one in two of the patients contacted refused the programme. Lower BMI, lower FEV1, lower digital literacy (MDPQ-16), and lower levels of neuroticism (BFI-10) were independently associated with greater risk of remote M-PRP refusal. The most common reasons for refusal were programme constraints, intention to continue physical activity after PR by means other than the proposed remote M-PRP, and lack of IT equipment.

A First important result is that almost half patients approached (49%) refused to be included in a remote M-PRP. This result confirms the high refusal rates that were expected from previous studies of similar programmes, but which were not specifically designed to investigate this,^{27,28} or were unable to report it.^{12,13,25,26} The scale of this Figure also

highlights the importance of examining the profiles of these patients. Furthermore, it calls into question the external validity of previous studies of the effectiveness of M-PRP that did not report the number of refusals. At least two conclusions can be drawn from this concern. First, the results of trials on remote M-PRP should not be generalised and should only be applied to the specific population of patients who accepted the programme. Secondly, the high refusal rate shows that remote M-PRP cannot be a universal model, as it is acceptable for at most half of all patients.

Refusal of remote M-PRP was independently associated with lower FEV1 and BMI, two indicators of severity in COPD patients. Indeed, low BMI has been associated with an increased risk of exacerbations⁵⁰ and mortality.⁵¹ The fact that the most severe COPD patients were more likely to refuse the programme is particularly consistent with previous findings in the literature. For example, refusal of various telehealth programmes has been associated with greater disease severity in COPD²⁴ or in other chronic diseases such as heart failure.⁵² Higher disease perception has also been described as a barrier to the acceptance of pulmonary rehabilitation programmes or the adoption of digital health technologies by COPD patients.^{31,53} Overall, our results suggest that remote M-PRP may be more appropriate for patients with less severe COPD, and that other kind of support may be needed for the most severe population.

Another consistent finding is the negative relationship between lower digital literacy (MDPQ-16 score) and greater likelihood of refusal. Given these results, improving digital literacy may be a way to increase the uptake of remote M-PRP and therefore the number of patients who are likely to benefit from this type of support. In this regard, a recent study showed that a digital literacy training programme can improve digital literacy even in very old individuals, with an increase in MDPQ-16 score of more than 60%.⁵⁴ The addition of a digital literacy training programme during pulmonary rehabilitation is therefore an interesting perspective to improve access to remote M-PRP in COPD patients. It is also important to note that lack of IT equipment was one of the main reasons for refusal. Thus, and more generally, it seems clear from our study that improving digital equity (both proficiency and access to IT) should be a priority before implementing a digital programme on a large scale in the COPD population.

Our study also reported a negative association between neuroticism and the likelihood of refusing the remote M-PRP. This association indicates that the patients most likely to accept the programme are those with high levels of neuroticism. These results are in line with previous data in the literature showing that patients with high levels of neuroticism are more likely to seek out healthcare resources.^{55–57} This phenomenon may be related to the fact that patients with high levels of neuroticism are prone to hypervigilance and are more sensitive to threats.^{58,59} In addition, although not verifiable, it is quite conceivable that the context of the PR programme, where health promotion is ubiquitous, may have contributed to activate patients' vigilance and threat perception in relation to the risks associated with harmful health behaviours, leading to healthier behaviours, such as accepting a M-PRP, among those with the highest levels of neuroticism. This hypothesis could be related to the concept of "healthy neuroticism", suggesting that although usually associated with poor outcomes, high neuroticism may be protective in some contexts.^{60,61} Another possible explanation may also lie in the existing association between neuroticism and PA levels. Indeed, patients with low levels of neuroticism generally tend to have higher PA levels.⁶² This possibility is consistent with one of the main reasons for refusal reported by patients, which is the intention to engage in PA by means other than the M-PRP. Future studies are needed to verify PA levels at home after PR in patients with the lowest levels of neuroticism, or in those who declare their

intention to continue PA alone after the PR stay. These studies are all the more important as previous studies have shown that the intention to practice PA and the actual practice of PA after rehabilitation are not correlated in COPD.⁶³

In addition to predictors of refusal, our study also identified “programme constraints” as one of the main reasons for refusing the remote M-PRP. This finding is interesting in that digitally supported remote M-PRP is a setting that is thought to minimise constraints compared to the other main M-PRP settings (such as centre-based outpatient support or direct home visits). In particular, it would have been interesting to look more closely at patients’ responses to see whether the constraints of the programme were more related to the maintenance programme itself or to the fact that it was delivered digitally. Unfortunately, the list-based format we chose to investigate the reasons for refusal, although having the advantage of being able to interview a large number of people, is not appropriate to achieve this aim.

Study limitations

In order to investigate the reasons for refusals and the characteristics of patients who had previously declined a care programme, it was crucial to minimize the number of refusals in our study. Unfortunately, despite our best efforts to include as many people as possible, we lost almost twice as many patients among those who had refused the programme as among those who had accepted it (30 vs 14). In addition, we had more refusals among those who had already refused to take part in the trial (7 vs 1). So, it is very likely that we did not survey the whole population, and there is probably a sub-profile of patients who refused to take part in the programme who also refused to take part in our questionnaire study.

Another potential limitation is that this study was conducted from an M-PRP in a clinical research context. Therefore, the results obtained may have been influenced by the clinical research setting and may not be a perfect reflection of real life in the context of an M-PRP in everyday practice. For example, the refusal of certain patients could have been influenced by the fear of not being drawn into the desired group, which may have led to an overestimation of the percentage of refusals in a real-life situation. Nevertheless, it is important to emphasise that refusal to participate in the remote M-PRP was rarely motivated by refusal to participate in a research study ($n = 6$, 10%). More importantly, no patient (0%) reported refusal to participate in research as the sole reason for refusal, which was always associated with one or more other reasons for refusal (data not shown). It is therefore unlikely that the fact that this programme took place in a research context led to a significant overestimation of the number of patients who refused the remote M-PRP.

In addition to the potential influence on the number of refusals, it is also important to note that the fact that this study was part of a larger RCT may have influenced respondents’ answers. Indeed, by the time patients were asked to answer the questions in this study, those who had accepted the larger RCT had already been randomised to it and therefore knew whether they were in the experimental or control group, which may have influenced certain responses, for example in relation to potential disappointment at being in the control group.

It is important to note that no sample size calculation was carried out for this study. We simply sought to interview as many people as possible in order to obtain the largest possible sample.

A final limitation is that of the 12 questionnaires in the study, 3 non-validated questionnaires were used. The first, a single question on perceived life expectancy, was used as proposed previously by Rothman et al.³³ and because there is no equivalent. The other two were a multiple-choice questionnaire on the level of comprehension of the M-PRP, and a question on reasons for refusal. For these two questionnaires, the non-validated use was constrained by the fact that they were very specific to the study and for which there is no equivalent nor probable need for future use in other studies.

Conclusion

Approximately half of the patients asked to participate in remote M-PRP agreed to do so. Higher disease severity, lower digital literacy and lower levels of neuroticism independently predicted greater likelihood of refusal. Although the predictors that emerged make it possible to identify ways of improving access to these programmes, such as digital training, our results also suggest that they are not relevant for certain patients, with the intention to exercise by means other than M-PRP being a common reason for refusal. Furthermore, other main reasons for refusal cited by patients, such as lack of IT equipment or programme constraints, highlight the fact that remote M-PRP cannot be a universal solution, as it excludes many patients. Hence, while this type of programme may be effective for those who participate, our study highlights the importance of not overlooking the many excluded patients and the need to find solutions to either remove possible barriers, identify alternative formats that may be better suited to them, or ensure that they do not require post-PR support.

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Ethical statement

Ethical approval

The protocol was approved by an independent French ethics committee (CPP Sud-Est I, reference number: 2022-A01337-36) and complied with the principles of the Declaration of Helsinki for human experimentation.

Informed consent

Participants were required to give verbal informed consent prior to their participation in the study, in accordance with French legislation, which stipulates that written consent is not required for non-interventional research referred to in paragraph 3° of article L. 1121-1 (https://www.legifrance.gouv.fr/codes/article_lc/LEGIARTI000032722892).

Author contributions

FA, VM, EM, SK and NH conceived and designed the study. FA, VM, EM, AV, GC, AC, and VG performed the data acquisition. FA, VM and SK analyzed the data, and FA, VM, EM, SK, FB, MH and NH interpreted the data. FA drafted the manuscript. All authors have read and approved the final manuscript.

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Declaration of conflicting interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: MH, FB and NH are members of the “m-Rehab” consortium, which is the owner of the rights to the m-Rehab digital solution. Other authors declared no other potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

Data Availability Statement

Data are available upon request by mailing to the corresponding author.

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