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Relevance of multidimensional dyspnea assessment in the context of pulmonary rehabilitation

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Virginie Molinier[1], Espérance Moine[1], Pauline Caille[1,2], Nathalie Fernandes[3], François Alexandre[1] and Nelly Heraud[1]

Abstract

Objectives: While dyspnea is the main symptom in chronic obstructive pulmonary disease (COPD), it is often inadequately evaluated in pulmonary rehabilitation (PR), as it is typically measured using only the impact dimension (ID). However, dyspnea is a multidimensional construct including perception (PD) and emotional (ED) domains. Our work aimed to study the complementarity of dyspnea dimensions and their respective ability to identify different evolutions during PR. **Methods:** 145 people with COPD attending PR were included in this retrospective study. Dyspnea scores from the modified Medical Research Council scale (ID) and the Multidimensional Dyspnea Profile questionnaire (PD/ED), exercise capacity, quality of life at the start (T1) and the end of PR (T2) were collected from existing databases/medical files. The evolution of each dyspnea dimension was evaluated using the delta score between T2–T1. PR response was defined using the minimal clinically important difference. **Results:** Our results show that each dyspnea dimension was associated with different health-outcomes. Positive correlations were found between PD-ED at baseline and between their T2-T1 delta score ($\rho = 0.51$; $\rho = 0.41$ respectively, $p < .01$), but there was no significant correlation between ID-PD or -ED ($p > .05$). 51% of the patients did not respond on ID, but 85% of them nonetheless responded on either PD or ED. Finally, 92% of patients responded on at least one dimension after PR. **Discussion:** Our study emphasizes the significance of assessing each dimension of dyspnea independently and complementary, as dimensions are associated with different elements and evolve differently under PR effects. This approach is crucial to identifying weak points and allows professionals to focus on program elements that most effectively address the specific dimension causing problems.

Key words
Dyspnea, chronic obstructive pulmonary disease, pulmonary rehabilitation, response

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Introduction

Dyspnea is the most prevalent symptom encountered in people with chronic obstructive pulmonary disease (COPD), regardless of disease severity.[1] It has a major impact on daily life, notably correlated with health behaviours,[2] and it is associated with diverse health outcomes, such as health-related quality of life (HRQoL), psychological status, and the risk of hospitalization and mortality.[3,4]

Reducing dyspnea is a central objective of pulmonary rehabilitation (PR). However, dyspnea is often poorly

[1]Direction de la Recherche clinique et de l'Innovation en Santé, Clariane, Lodève, France
[2]Department of Sports Sciences, University of Rennes, Rennes, France
[3]Clinique du Souffle La Vallonie, Inicea, Lodève, France

Corresponding author:
Virginie Molinier, Direction de la Recherche clinique et de l'Innovation en Santé, Clariane, 800 Avenue Joseph Vallot, Lodève 34700, France.
Email: virginie.molinier@clariane.fr

evaluated because it is generally assessed with the impact dimension (ID), which reflects the way that dyspnea affects functional ability, employment, HRQoL, and health status. For example, in reference texts with the highest level of evidence on which the recommendations are based, the efficacy of PR on dyspnea has been studied based solely on data from the ID.[5] Furthermore, dyspnea patients who do not respond are frequently encountered in PR (60% in the literature),[6] but this non-response has only been assessed through the ID in previous studies. This approach consisting of focusing on the dyspnea ID to conclude regarding the overall effects of PR on dyspnea may be somewhat restrictive.

Indeed, dyspnea is a multidimensional complex construct integrating two other dimensions: the perception domain (PD), which reflects how dyspnea symptoms intensity is perceived during breathing, and the emotional domain (ED), which reflects how distressed breathing feels.[7–10] To date, no study has investigated the benefit of an exhaustive approach in the evaluation of dyspnea and consequently the complementarity of the three dyspnea dimensions in PR. While studies have demonstrated that the PD and ED are modified by PR,[11,12] thus suggesting the relevance to assessing them, nothing is known about their added-value compared with assessment of the ID alone. In other words, it would be useful to assess whether, during PR, the PD and ED improve jointly with the ID or not, and whether the non-responding patients are the same for all dimensions.

In addition to referring to distinct theoretical concepts, the three dyspnea dimensions are also associated with different health outcomes: while the ID is associated with exercise tolerance (e.g., the six-minute walking-test) and forced expiratory volume in 1 second (FEV_1)[13,14]; the PD and ED are associated with physical and mental parameters of anxiety, respectively.[15] Consequently, it is very likely that the latter are complementary and do not evolve in the same manner (i.e., qualitatively versus quantitatively) for people with COPD during PR.

The lack of a tool that enables the simultaneous evaluation of all three dyspnea dimensions may account for the fact that the three dimensions are rarely assessed simultaneously[16] and that no study has ever examined the response to PR on the dimensions simultaneously. In fact, only the two dimensions—ED and PD—[12,16] can be evaluated on questionnaires that support a multidimensional approach to dyspnea, such as the Multidimensional Dyspnea Profile questionnaire (MDP)[18] and the DYSPNEA-12.[17] ID is not allowed to be assessed in these forms. This may provide a barrier to a thorough assessment of dyspnea in research, especially in light of the lack of actual study on the complementarity of the three dimensions. Therefore, by utilizing the mMRC scale and the MDP questionnaire, this study aimed to enhance knowledge of the specificities and complementarity of the three dimensions of dyspnea during a PR program.

Methods

Study design and participants

The eligible data came from research databases of three studies that received regulatory approval: "DYSPNEMO-2", independent French ethics committee – CPP-Ouest III 2019-A00874-53; "PERS-ADHE – CPP-Ouest IV 2018-A03141-54."; and "PROMOD" – CPP-IDF7 2019-A00582-55. These three databases all contained a measurement of the Multidimensional Dyspnea Profile (MDP) score before and after PR, thus their reuse allowed having to carry out a new study to be avoided. DYSPNEMO-2 was an interventional trial including two groups: (1) the experimental group including people with COPD attending for a PR program and following hypnosis treatment and (2) the control group including people with COPD only attending for a conventional PR program. Only data from patients belonging to the control group (with no hypnosis intervention) were retrieved. These patients simply had additional evaluations including the MDP questionnaire during a PR. PERS-ADHE and PROMOD are both observational studies that took place during a PR program, leading to no change in patient care. They only included additional evaluations (including MDP) in addition to classical support, and therefore, without influence on the PR program and its effects.

In accordance with the European regulation on data protection (GDPR) and the French regulation on the reuse of data for research purposes (reference methodology 004, CNIL), all patients received individual information on the reuse of their data for this study and were offered the opportunity to refuse to it.

To compile our database, we included data from patients enrolled in these studies with the following characteristics: men and women (1) having a confirmed diagnosis of COPD (Tiffeneau ratio <0.70 assessed with plethysmography and confirmed by a medical doctor during a medical consultation), (2) admitted to the Clinique "La Vallonie" or the Clinique "Les Clarines" for a PR program, and (3) not receiving any other specific intervention apart from the PR. To complete our database, we retrieved clinical data such as the modified Medical Research Council (mMRC) scores and HRQoL scores in the computerized medical records of the patients.

Pulmonary rehabilitation program

Patients underwent a multidisciplinary and individualized inpatient rehabilitation in accordance with the statements for PR program.[17] The four-week standardized inpatient PR

program was performed 3 h/day for 5 days/week. It included a mean of 26 individualized endurance training sessions of 45 min each combining endurance training with ergocycle, treadmill, and ground-based walking at an intensity close to the ventilation threshold. The target heart rate (HR) was previously determined during a cardiopulmonary exercise testing (CPET) as the HR where the ventilation threshold was reached. The training power (or walking speed for ground-based walking) is adapted as the patient progresses, adjusting the intensity to maintain the target HR. The program also comprised 12 individualized resistance training sessions of 45 min each. Each resistance training session included 4 exercises: 2 exercises targeting the muscles of the lower limbs and 2 exercises targeting the muscles of the upper limbs. Patients were asked to work at a level of perceived exertion of 5-6 on 10, thanks to the correspondence established between perceived effort intensity and actual effort intensity.[18] Through resistance training sessions, as soon as the patient's perceived exertion is less than 5/10, the workload is increased to stay within the target. Finally, an individual educational diagnosis was also carried out at the entry of PR to individually define the patient's needs. Thus, beyond a common educational program including relaxation therapy (8 h in total), breathing therapy (8 h in total), group and individual education sessions (15 h in average, mainly including dyspnea management, nutrition counselling, psychological support, and smoking cessation support), additional sessions specifically targeting some issues (smoking cessation, nutrition) could be offered to the patient if necessary.

Measures

Clinical variables. At the start of PR (T1), sex (male or female), age (years), body mass index (BMI in kg/m^2), forced expiratory volume in one second (FEV_1) (liters), and Tiffeneau ratio were reported. At T1 and the end of the PR program (T2), data on exercise capacity (six-minute walking distance (6MWD) scores) were reported. If available, HRQoL data through the VQ11 questionnaire[19] were retrieved from the computerized medical records of the patients. More details regarding the assessment methods can be found elsewhere.[20,21]

Dyspnea. Impact dimension (ID) was evaluated before (T1) and after PR (T2) from mMRC scores. The self-rated mMRC questionnaire is a one-item scale that assesses the degree of disability that breathlessness poses on day-to-day activities, with scores from 0 to 4 (0 = no breathlessness except on strenuous exercise and 4 = too breathless to leave the house, or breathless when dressing/undressing).

Perception (PD) and emotional domains (ED) were evaluated at T1 and at T2 based on the French version of the Multidimensional Dyspnea Profile (MDP) questionnaire.[15,22] The MDP measures PD and ED through the immediate discomfort of breathing (A1), the presence and intensity of five sensory quality items (SQ), and the intensity of five emotional responses (A2) to breathlessness. Each item is rated from 0 to 10 (with higher values for higher levels of dyspnea). PD includes the A1 and SQ scores, and ED includes the A2 scores.[23]

Categorization of people with COPD according to the dyspnea response to PR. The evolution of the dyspnea indicators was evidenced by the delta (Δ) between values assessed at the end of PR (T2) and at baseline (T1). A negative change corresponds to a reduction of dyspnea. For each dyspnea indicator, responders and non-responders were distinguished using the Minimal Clinically Important Difference (MCID) available for each indicator. The MCID is defined as the smallest change in score that patients perceive as beneficial, and it is useful to help the clinical interpretation of health status data, particularly in response to an intervention. A patient was considered as responder on one outcome when their Δ score between the start and the end of PR (T1 and T2) was higher than the MCIDs (>- 1 unit for ID (mMRC),[24] > - 3.02 units for PD (MDP; A1 + SQ) [25] and > - 2.07 units for ED (MDP; A2)[25] (Table 1).

To best reflect the multidimensionality of the dyspnea and to investigate the complementarity of the three dimensions in terms of response, a composite response was defined. Patients were classified into three response profiles: the "Total responders" group corresponded to patients who responded in the three dyspnea dimensions, the "Partial responders" group corresponded to the patients with a clinically significant improvement on one or two dyspnea dimensions, and "Total non-responders" corresponded to the patients who did not respond in any dyspnea dimension.

Statistical analysis

Statistical analyses were performed using Statistica software (StatSoft, Inc., version 6.0, Tulsa, OK, USA). All results are presented as means ± standard deviation (SD) or medians and lower/upper quartiles (LQ/UQ) or as percentages when appropriate. Data were examined for normality using a Shapiro–Wilk test. To examine the effects of PR on the three dimensions of dyspnea, paired sample tests were performed. Student's *t*-tests were used in case of normal distribution, and Wilcoxon tests otherwise. Correlation tests were performed to examine (1) the associations between the three dyspnea dimensions themselves (in baseline or in terms of change) and (2) the links between the three dyspnea dimensions and other clinical parameters. In case of normal distributed data, Pearson's tests were carried out, and Spearman's tests otherwise. Taking into account the number of correlation tests carried out, the significance level

was obtained after Bonferroni's corrections in order to limit the risk of type I error.

Results

Description of the sample and dyspnea characteristics of the population

The final sample comprised 145 patients: 21 (14.4%) from DYSPNEMO-2, 72 (49.7%) from PERSADHE, and 52 (35.9%) from PROMOD. To assess the homogeneity of the three databases, comparisons of clinical parameters at baseline are available in supplemental materials (Supplemental Data 1).

Sample characteristics at baseline are reported in Table 2. The sample had a median age of 66.2 ± 8.4 years and comprised 83 males and 62 females with a mean BMI of 26.1 ± 7.0. The 6MWD was 387.4 ± 102.8 meters on average. The mean VQ11 score (n = 133) was 34.3 ± 7.8. For dyspnea dimensions, the median scores were 3[2–4] for ID, 38 [30–47] for PD, and 20.0 [11–35] for ED.

A positive significant association was found between PD and ED (Spearman's coefficient ρ = 0.51; $p < .05$). No significant associations were found between ID and PD (ρ = 0.11; $p > .05$) and ID and ED (ρ = 0.14; $p > .05$).

Table 1. Minimal clinically differences defined for mMRC and MDP.

DYSPNEA ITEM score	MCIDs	References
ID (mMRC)	−1 unit	[24]
PD (MDP; A1+SQ)	−3.02 units	[25]
ED (MDP; A2)	−2.07 units	[25]

Notes. MDP: Multidimensional Dyspnea Profile, mMRC: modified Medical Research Council, ID: Impact dimension, PD: Perception Domain, ED: Emotional domain, A1: immediate discomfort of breathing, SQ: intensity of five sensory quality items, and A2: intensity of five emotional responses to breathlessness.

Effects of pulmonary rehabilitation on the three dimensions of dyspnea

Evolution of dyspnea dimensions. All three dyspnea dimensions scores decreased significantly (all $p < .001$) (Table 3). A significant positive association was found between ΔPD and ΔED through PR (Spearman's coefficient ρ = 0.41; $p < .01$). No significant associations were found between ΔID and ΔPD (ρ = 0.14; $p > .05$) or ΔED (ρ = 0.10; $p > .05$).

Response/non-response for each dyspnea dimension. Details are provided in Figure 1. Out of the 145 patients, 74 were non-responders on ID (51%) versus 71 responders (49%). Among the 74 non-responders on ID, 63 were responders on either PD or ED (85%). Conversely, among the 71 responders on ID, 8 patients were non-responders on ED (11.3%), 9 were non-responders on PD (12.7%), and 12 did not respond on the PD not the ED (16.9%). In the entire sample, 42 patients (29%) were total responders, 92 patients (63.4%) were partial responders, and 11 patients (7.6%) were total non-responders.

Table 2. Sample characteristics (n = 145).

Variables	Mean/Median	Standard Deviation/[LQ-UQ]
Anthropometric parameters		
Sex (female) *n* (%)	62 (42.8%)	-
Age (years)	66.2	8.4
BMI (kg/m^2)	26.1	7
Pulmonary function (n = 143)		
FEV_1 (L) (n = 175)	1.04	[0.79–1.38]
FEV_1 (% predicted)	42	[31–56]
FEV_1/FVC (%)	45.9	[39.5–55.1]
Exercise capacity		
6MWD (m)	387.4	102.8
Health-related quality of life (n = 133)		
VQ11 total score	34.3	7.8
Dyspnea		
Impact dimension (ID)	3	[2–4]
Perception domain (PD)	38	[30–47]
Emotional domain (ED)	20	[11–35]

Data are presented as means (standard deviation) or medians [LQ–UQ]. BMI, body mass index; FEV1, forced expiratory volume in one second; FEV1/FVC (forced vital capacity), Tiffeneau index; 6MWD, 6-min walking distance; LQ, lower quartile; UQ, upper quartile; VQ11, health-related quality of life.

Table 3. Evolution of the three dyspnea dimensions scores between the beginning and the end of the pulmonary rehabilitation (PR).

	T1	T2	ΔT2-T1
		Median [LQ–UQ]	
Impact dimension mMRC score	3 [2–4]	1 [1–3]	0 [−2–0]***
Perception domain (SQ + A1)	38 [30–47]	28 [2–4]	−9 [−21–0]***
Item "Immediate unpleasantness" (A1)	8 [6–9]	6 [4–7]	−1 [−3–0]***
Sensory items total (SQ)	30 [24–39]	22 [13–33]	−7 [−17–0]***
Item "Breathing work/effort"	6 [5–8]	5 [3–7]	−1 [−4–1]***
Item "Air hunger"	8 [6–8]	5 [2–7]	−2 [−4–0]***
Item "Chest tightness"	6 [3–8]	2 [0–6]	−2 [−4–0]***
Item Mental effort"	7 [4–8]	5 [2–7]	−1 [−3–1]***
Item "Breathing a lot"	7 [4–8]	5 [3–7]	−1 [−4–0]***
Emotional domain *(A2)*	20 [11–35]	8 [1–19]	−9 [−19–-1]***
Item "Depression"	3 [0–7]	0 [0–3]	−1 [−4–0]***
Item "Anxiety"	5 [2–8]	1 [0–4]	−2 [−5–0]***
Item "Frustration"	6 [2–9]	3 [0–6]	−2 [−5–0]***
Item "Anger"	4 [0–8]	1 [0–5]	−1 [−5–0]***
Item "Fear"	3 [0–8]	0 [0–3]	−1 [−5–0]***

Data are presented as medians [LQ–UQ]. LQ: lower quartile, UQ: upper quartile, SD: standard deviation, ΔT2-T1: Change between T2 and T1, mMRC: modified Medical Research Council, A1: immediate discomfort of breathing, SQ: intensity of five sensory quality items, A2: intensity of five emotional responses to breathlessness, T1: start of PR, T2: end of PR. ***: p-value <.001.

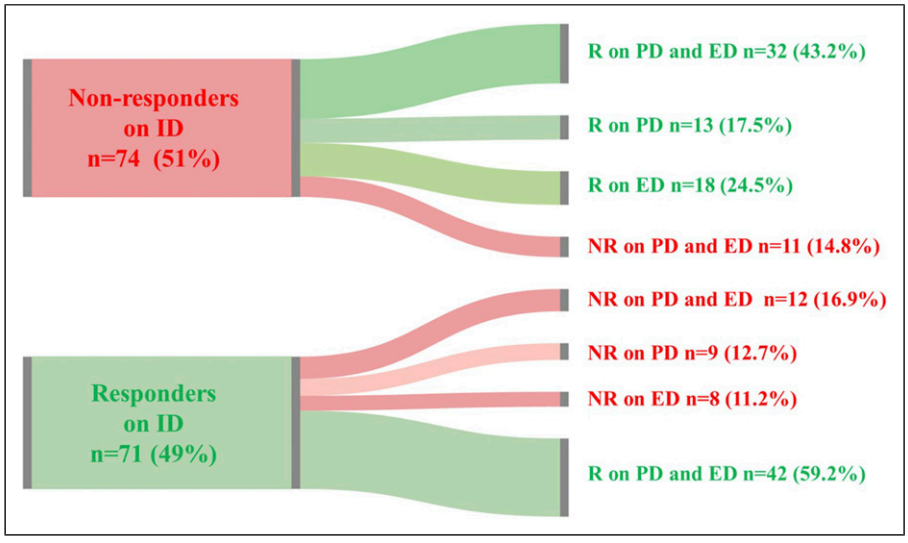

Figure 1. Distribution of responders and non-responders on PD and ED according to dyspnea response on ID. Green color: responders, red color: non-responders. ID: Impact dimension, PD: Perception domain, ED: Emotional domain, R: Responders, NR: Non-responders.

Associations between dyspnea dimensions and clinical parameters

At baseline, ID score was significantly and negatively associated with FEV_1 (Spearman's coefficient $\rho = -0.33$; $p < .01$) and baseline 6MWD ($\rho = -0.51$; $p < .01$) (Table 4). PD score was significantly associated with age ($\rho = -0.23$; $p < .01$), baseline VQ11 score ($\rho = 0.24$; $p < .01$), and ΔVQ11 score ($\rho = 0.27$; $p < .01$). ED score was significantly and positively associated with baseline VQ11 score ($\rho = 0.40$; $p < .01$) (Table 4).

In terms of changes, ΔID and ΔPD were significantly and positively associated with ΔVQ11 ($\rho = 0.42$; $\rho = 0.28$ respectively; $p < .05$) (Table 5).

Table 4. Association between dyspnea scores at baseline and clinical parameters.

	Clinical parameters						
Dyspnea dimensions	Age	BMI	FEV1	6MWD baseline	VQ11 baseline	Δ6MWD	ΔVQ11
Impact dimension (ID)	0.02	0.07	**−0.33***	**−0.51***	0.17	−0.04	0.01
Perception domain (PD)	**−0.23***	−0.09	−0.16	−0.13	**0.24***	−0.05	**−0.27***
Emotional domain (ED)	−0.16	−0.03	−0.11	−0.20	**0.40***	0.03	−0.11

BMI, body mass index; FEV1, forced expiratory volume in one second; 6MWD, 6-min walking distance; VQ11, health-related quality of life; Δ: Change between (T2-T1). NB: Bold numbers with * are significant correlation coefficients (p < .01- Bonferroni's corrections).

Table 5. Association between changes in dyspnea dimensions and clinical parameters at baseline or in terms of evolution.

	Clinical parameters						
Dyspnea dimensions	Age	BMI	FEV1	6MWD baseline	VQ11 baseline	Δ6MWD	ΔVQ11
Δ impact dimension (ID)	0.06	0.02	−0.07	0	−0.16	−0.1	**0.42***
Δ perception domain (PD)	0.09	0.03	−0.05	0.01	0.07	−0.15	**0.28***
Δ emotional domain (ED)	0.15	−0.07	−0.05	0.07	−0.05	−0.14	0.16

BMI, body mass index; FEV1, forced expiratory volume in one second; 6MWD, 6-min walking distance; VQ11, health-related quality of life; Δ: Change between (T2–T1).
NB: Bold numbers with * are significant correlation coefficients ($p < .01$- Bonferroni's corrections).

Effects of pulmonary rehabilitation on other outcomes

PR outcomes, 6MWD and VQ11 scores, significantly improved during PR (T2 mean 6MWD = 432.3 ± 105 m, $p < .001$ and T2 mean VQ11 = 27.9 ± 7.8 $p < .001$ respectively).

Discussion

To better understand the complementarity between the three dyspnea dimensions and their evolutions during a pulmonary rehabilitation (PR) program, we examined (1) the associations of each dyspnea dimension with other clinical parameters, (2) the relationship between the three dyspnea dimensions themselves, and (3) the effect of the PR on each dyspnea dimension on average and through individual responses. Our major findings show that each dyspnea dimension was associated with different health outcomes. Additionally, the ID was not linked to the PD or ED during the PR program, either at baseline or in terms of changes. Moreover, while all the dyspnea dimension scores decreased significantly on average, patients had varied dyspnea responses to the PR. Specifically, only 49% of the patients responded to the PR in terms of the ID, but 92% of the patients responded to at least one dyspnea dimension after the PR program.

In this study, we investigated the association between dyspnea dimensions and health outcomes during a PR program. Our findings indicate that at baseline, dyspnea dimensions are not associated with the same clinical parameters. The ID was negatively related to respiratory parameters and exercise tolerance, while the PD and ED were positively associated with the HRQoL, and the PD was also negatively associated with age. These results are partially consistent with previous studies. Indeed, the association found in our study between the ID, exercise tolerance, and respiratory function has already been identified previously.[13,14,26,27] However, some studies have also described a relationship between the ID and the HRQoL not found here.[28,29] This may be linked to the different questionnaire used to assess the HRQoL in our study (VQ11).[19] On the other hand, in line with previous work,[15] our study showed that the HRQoL was associated with the PD and ED. Beyond the baseline associations, the Δ scores of each dyspnea dimension after PR were also correlated with different clinical parameters. Indeed, ΔHRQoL was associated with ΔPD but not with ΔED. Taken together, these results support the notion that dyspnea is a complex phenomenon in which distinct theoretical concepts are linked to each dimension.[8]

In the current study, we also found different associations between the three dyspnea dimensions. We observed that ID was not associated with the two other dimensions (PD and ED) either at baseline or in terms of evolution. However, there was a consistent correlation between PD and ED at baseline and in terms of evolution.[11] This result reinforces our previous conclusion related to the complementarity of dyspnea dimensions through two crucial points. Firstly, only assessing ID (whether at the start or during the program) provides an incomplete evaluation of dyspnea as ID is

completely independent of the other two dimensions. This can consequently result in a significant loss of information. Secondly, although the significant correlations between PD and ED indicate a bona fide conceptual connection between them, their moderate size effect (0.41 at baseline and 0.50 in terms of change) confirms that they are not interchangeable, thus underlying the importance of evaluating both dimensions during PR. Altogether, our results clearly demonstrate the relevance of individually assessing each dyspnea dimension in PR.

The average efficacy of PR on the three dyspnea dimensions reported in the current study is consistent with existing literature on the subject, not only for ID[5,30,31] but also for PD and ED.[12,32,33] As PD and ED are evaluated only very rarely during PR, the lack of reports in the literature on the impact of PR on these two dimensions of dyspnea is surprising. Nevertheless, due to its multidisciplinary nature, PR includes several interventions that are likely to address each of the three dyspnea dimensions.[10,34,35] Physical training, for example, can reverse dysregulation in skeletal muscles and improve their aerobic function, leading to a decrease in lactic acidosis and ventilation requirements.[35] This, in turn, reduces dynamic hyperinflation and the exertional ID. In addition, exercise training can induce dyspnea desensitization, altering neural responses associated with dyspnea and affecting the patient's perception of the symptom (i.e., PD). PR also includes education, self-management, and behaviour change strategies that can help reduce dyspnea by addressing its emotional component (i.e. ED).[10] By developing self-management strategies, promoting positive adaptive behaviors, and reducing dyspnea-related emotional stress, patients can improve their emotional functioning and overall psychological outcomes.[10,36,37]

The heterogeneity of the individual dyspnea responses found in our study further highlights the complementarity of these three dimensions in the PR context. Indeed, firstly, our results showed that not all of the patients responded regarding the three dyspnea dimensions (n = 49, 29% of the total sample), and eight different dyspnea response profiles were observed. Secondly, most of the patients (92%) were responders regarding at least one out of the three dyspnea dimensions. Consequently, partial assessment of dyspnea can lead to erroneous conclusions in terms of the dyspnea response. For example, our results indicate that assessment dyspnea based on the ID alone will only yield a 49% rate of responders. Thus, as the numerous previous works in the literature have limited themselves to a one-dimensional assessment of dyspnea, they have probably underestimated the effectiveness of PR regarding this symptom. Hence, future large studies are needed to re-evaluate the prevalence of dyspnea non-responders to PR in a complete and multidimensional assessment.

This study also presents some clinical perspectives. First of all, our data highlight the importance of an exhaustive assessment of dyspnea during a PR program. Indeed, a such exhaustive assessment will help identify any points of interest and will allow professionals to focus on the contents of the program that are most likely to effectively address the specific dimension causing problems. Furthermore, this study offers the prospect of an even more personalized approach ensuring that each patient receives the right treatment for their unique needs (i.e., the right treatment for the right patient and for the actual problem).

Strengths and methodological considerations

This study has several strengths, such as the exploration of the effectiveness of PR on dyspnea across three dimensions in a large representative sample. However, there are some methodological considerations that warrant special attention. Firstly, the study was retrospective and used data from previous research, which means that these studies were, therefore, not specifically designed to address the question of our study. However, since the data come from studies with different goals and designs, it allows for a broader perspective. The analysis of the three datasets showed that the cohorts are comparable and cover severity levels ranging from stage II to stage IV of the GOLD classification, as usually encountered in PR (Supplemental Data 1), which reinforces the comparability of the datasets and thus the absence of sample bias. A second limitation is that the MCIDs for the perception and emotional domains were not defined after a clinical intervention.[25] However, they are the only available and published MCIDs to date. A third limitation is the use of mMRC scale for assessing the ID response to PR. Indeed, although commonly used by physicians to evaluate the dyspnea improvement after PR and by several authors in research studies,[5,38–40] mMRC demonstration to be responsive to PR is unsure.[41] Therefore, the hypothesis of an underestimation of the ID response rate due to a poor sensitivity of the mMRC scale should not be ruled out. Nevertheless, this does not call into question our results on the need to evaluate dyspnea using a multidimensional approach. One of perspective would be to compare this result with ID responses from another tool assessing impact dyspnea such as the London Chest Activity of Daily Living Scale (LCADL) for example.[42,43]

Conclusion

Our study highlights the importance of considering the three dyspnea dimensions when assessing and following up patients undergoing PR. The three dyspnea dimensions are associated with different clinical parameters, have different relationships with each other, and have different responses to PR. Consequently, the multidimensionality of dyspnea

assessment is a key factor to be taken into account in the context of a multidisciplinary PR program for people with COPD.

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ORCID iDs

Virginie Molinier https://orcid.org/0000-0002-6674-4323
Esperance Moine https://orcid.org/0000-0002-4579-1323

Supplemental Material

Supplemental material for this article is available online.

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