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# The role of personality traits in inpatient pulmonary rehabilitation response in patients with chronic obstructive pulmonary disease

Pauline Caille, François Alexandre, Virginie Molinier, Nelly Heraud

## ► To cite this version:

Pauline Caille, François Alexandre, Virginie Molinier, Nelly Heraud. The role of personality traits in inpatient pulmonary rehabilitation response in patients with chronic obstructive pulmonary disease. *Respiratory Medicine*, 2021, 190, pp.106680. 10.1016/j.rmed.2021.106680 . hal-03583755

**HAL Id: hal-03583755**

<https://imt-mines-ales.hal.science/hal-03583755v1>

Submitted on 5 Jan 2024

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1 **Short title:** Personality and pulmonary rehabilitation

2

3 **Title:** The role of personality traits in inpatient pulmonary rehabilitation response in patients  
4 with Chronic Obstructive Pulmonary Disease

5

6 **Authors:** Pauline Caille\*<sup>1,2,3,4</sup>, François Alexandre<sup>3,4</sup>, Virginie Molinier<sup>3,4</sup>, Nelly Heraud<sup>3,4</sup>

7

8

9 **Affiliations:**

10 1. Clinique du Souffle La Vallonie – Korian, Lodève, France

11 2. Euromov Digital Health in Motion, University of Montpellier, IMT Mines Ales, Montpellier  
12 France

13 3. Direction de la recherche clinique et de l'innovation en Santé – Korian, Lodève, France

14 4. GCS CIPS, Lodève, France

15

16 \* Correspondence :

17 Euromov Digital Health in Motion, University of Montpellier, IMT Mines Ales, UFR STAPS,  
18 700, Avenue du Pic St Loup, 34090 Montpellier, France

19 E-mail: [caillepau@gmail.com](mailto:caillepau@gmail.com)

20 Phone number : +33 6.46.04.78.47

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## 27 **Highlights**

- 28 • A high level of openness to experiences might be a risk factor of non-response to  
29 pulmonary rehabilitation on health-related quality of life in persons with COPD
- 30 • Neuroticism, extraversion, conscientiousness and agreeableness were not associated  
31 with inpatient pulmonary rehabilitation effectiveness.
- 32 • Considering personality traits could be interesting for treatment individualization and  
33 optimization.

## 34 **Summary**

35 **Background:** The effectiveness of pulmonary rehabilitation (PR) is a critical issue for chronic  
36 obstructive pulmonary disease (COPD) patients. However, PR response is marked by a strong  
37 heterogeneity, partially unexplained to date. We hypothesized that personality traits defined by  
38 the Five-Factor Model could modulate the effect of inpatient-PR. **Objective:** The aim was to  
39 assess the associations between these five personality traits and PR outcomes. **Methods:** 74  
40 persons with COPD admitted for a 5-week inpatient PR program had a personality assessment  
41 at the start of the program (T1). Exercise capacity, quality of life, sensory and affective dyspnea  
42 dimensions were assessed at T1 and at the end of the program (T2). Their evolution was  
43 evaluated using the delta score between T2 and T1. PR response was defined using the minimal  
44 clinically important change score for each of them. A composite response was established  
45 distinguishing the poor responders' group, made of patients who responded to 0, 1 or 2  
46 parameters and the good responders' group, with patients who responded on 3 or 4 indicators.  
47 **Results:** Logistic regressions analyses highlighted that those with a high level of openness  
48 [OR=0.36, 95% CI=0.15 – 0.74, p<.01] were less likely to respond on quality of life, controlling  
49 for socio-demographic factors and the severity of the disease. **Conclusion:** This study shows  
50 that the investigation of the personality constitutes an interesting perspective for better  
51 understanding the interindividual differences observed between patients in the PR response.  
52 Tailoring clinical intervention to the patient's personality could be a promising prospect for  
53 optimizing PR effectiveness.

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55

56 **Keywords:** Five Factor Model, Personality, Pulmonary rehabilitation, Respiratory Diseases,  
57 Response, Therapeutic Outcomes

58

## 59 **Introduction**

60 Pulmonary rehabilitation (PR), the reference treatment for people with chronic respiratory  
61 diseases (CRDs), is a comprehensive and multidisciplinary intervention aiming to improve both  
62 the physical and psychological health of patients, as well as specific symptoms of the disease  
63 [1]. Despite a large body of research demonstrating that PR generates numerous bio-psycho-  
64 social benefits [2-4], it reported a significant heterogeneity in PR response [5-8]. Overall, these  
65 studies highlighted that between one-third to one-half of patients enrolled in a PR program  
66 exhibited no clinically significant improvement at the end of the PR program on various clinical  
67 outcomes including exercise capacity and quality of life [5,8]. Given the key role of PR in CRDs  
68 management, the identification of factors associated with PR outcomes has been widely  
69 investigated in the literature [9-12]. However, the understanding of this PR response  
70 heterogeneity remains incomplete, particularly since most studies were essentially limited to  
71 investigating the influence of intrinsic parameters (e.g., forced expiratory volume in 1 second  
72 at the beginning of the program). Yet, extrinsic factors, such as therapeutic environment, and  
73 above all the way patients interact with it, could also notably influence PR effectiveness. This  
74 could be particularly relevant in the specific context of inpatient PR, characterized by i) a  
75 rupture with the patient's home environment lasting several weeks, ii) being confronted with  
76 new social rules and norms and iii) a new community life with other people suffering from  
77 CRD's and a variety of healthcare professionals. All patients, depending on their psychological  
78 predispositions, might adapt differently to a PR environment and thus, might not gain the same  
79 benefits from the therapeutic care management. For example, introvert patients could have  
80 greater difficulties progressing correctly in collective activities whereas, extroverts could  
81 benefit more from activities providing opportunities for social interaction. Thus, the  
82 heterogeneity observed in PR response could partly be the reflection of this adequation between  
83 PR environment and one's tendency to act, think and feel, i.e. personality traits. According to  
84 the Five Factor Model [13,14], personality is made of five dimensions present in varying  
85 degrees in individuals and influencing their behavior and life experiences [15]. These five traits  
86 include Neuroticism (i.e., tendency to be emotionally unstable and stressed), Extraversion (i.e.,  
87 tendency to be optimistic and dynamic), Openness to experience (i.e., tendency to look for new  
88 experiences), Agreeableness (i.e., tendency to be altruistic) and Conscientiousness (i.e.,  
89 tendency to be self-disciplined). Previous studies showed that these personality traits were  
90 associated with some PR-specific environmental elements. For example, personality was  
91 associated with the development of therapeutic alliance [16], quantity and quality of social  
92 interpersonal interactions [17], respecting authority [18] and assimilation of cultural social

93 norms [19]. Personality traits were also associated with treatment observance and compliance  
94 [20-22], effectiveness of non-pharmacological interventions [23], and participation to  
95 rehabilitation activities [24]. Moreover, the association between personality traits and physical  
96 activity has been established [25,26]. Thus, these studies suggested that personality traits, given  
97 their relationships with PR elements, could influence the way patients adapt to a PR  
98 environment. In fact, personality could become an explanatory psychological factor for  
99 interindividual differences observed in PR response. This is why, we hypothesized that  
100 personality traits could be associated with the effectiveness of inpatient-PR. Therefore, the  
101 objective of the present study was to investigate associations between the five personality traits  
102 and PR response in persons with chronic obstructive pulmonary disease.

103

## 104 **Material and methods**

### 105 *Ethics approval*

106 The study protocol was approved by an independent French ethics committee (CPP Ouest IV  
107 Nantes, reference number: 2018-A03141-54, 03/04/2019). The present study abided by the  
108 principles of the Declaration of Helsinki for human experimentation of 1975, revised in 2000.

109

### 110 *Data accessibility*

111 Individual values for all supporting data are available upon request.

112

### 113 *Participants and procedure*

114 Patients were recruited during a 5-week inpatient PR program at the “Clinique du Souffle La  
115 Vallonie” (Lodève, France), between April 2019 and January 2020. Patients were eligible for  
116 the study if they: 1) had a validated diagnosis of chronic obstructive pulmonary disease  
117 (COPD), 2) were older than 18 years old and 3) had healthcare coverage. Patients were not  
118 included in the study if they were unable to respond to paper-based questionnaires and/or if  
119 they had a mental disorder that could affect their judgment. Eligible participants were invited  
120 to participate in this study during an inclusion visit (T0) that took place during the first two  
121 days of the program. No intervention or incentive was provided to encourage study  
122 participation. In accordance with the regulations governing research displayed in 3 ° of article  
123 L.1121-1 of the French public health code concerning non interventional studies based only on  
124 questionnaires or interviews, a declaration of non-opposition to participating in the study was  
125 collected from all participants before inclusion. Patients were recruited on a voluntary basis,  
126 after medical advice and checking all criteria mentioned above. Patients enrolled in the study

127 were assessed twice, during the first week (T1) and at the end of the last week of the PR program  
128 (T2). The mean time interval between T1 and T2 was 25 days (Standard deviation = 5 days).

129

### 130 **Pulmonary rehabilitation**

131 The inpatient PR program was conducted following recommendations of the American  
132 Thoracic and European Respiratory societies [1]. The program was carried out over 5 weeks.  
133 Patients received a complete clinical evaluation (clinical assessment, respiratory function  
134 measures at rest by plethysmography, blood gas test, and body composition) and benefited from  
135 30 to 40 sessions of exercise training including endurance training (average of 7h/wk.) and  
136 resistance training both for upper and lower limbs (average of 2h/wk.). Exercises focused on  
137 balance, coordination, flexibility and posture. Furthermore, collective relaxation sessions (on  
138 average 4 hours / week) were also offered. In addition, participants had access to group  
139 therapeutic education sessions (e.g., pain and dyspnea self-management, smoking cessation,  
140 behavioral change, physical activity planning...) and nutrition, psychological and nursing  
141 support in individual sessions (average of 3 hours / wk.). Average PR duration in our sample  
142 was 35 days (SD=4 days).

143

### 144 *Measures*

#### 145 **Personality traits**

146 Personality traits of the Five-Factor model were measured at T1 using the French version of the  
147 Big Five Inventory (BFI-Fr) [27]. Participants were asked whether they agreed or disagreed  
148 with 45 descriptive statements using a 5-point Likert scale, ranging from 1 (*strongly disagree*)  
149 to 5 (*strongly agree*). Eight items assessed the level of extraversion (e.g., "*I see myself as*  
150 *someone who is sociable*") and neuroticism (e.g., "*I see myself as someone one who is easily*  
151 *anxious*") in participants. Nine items measured the level of conscientiousness (e.g., "*I see myself*  
152 *as someone who is effective in his work*"). Finally, answers on ten items assessed the level of  
153 openness to experiences, (e.g., "*I see myself as someone creative, full of original ideas*"), as  
154 well as agreeableness (e.g., "*I see myself as someone who is naturally forgiving*"). A high score  
155 in a specific trait indicates a high level on that trait. In the sample, Cronbach alphas, measuring  
156 the internal consistency of the 5 scales, were .77 for neuroticism, .73 for extraversion, .85 for  
157 openness, .68 for agreeableness, and .65 for conscientiousness.

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#### 161 **Sociodemographic, anthropometric and clinical characteristics**

162 Collected demographics included self-reported age (in years), sex (coded 0 for men and 1 for  
163 women) and education (in years). Anthropometric data included height (cm), weight (kg),  
164 which led to calculating the body mass index (BMI) ( $\text{kg}\cdot\text{m}^{-2}$ ). Deprivation was measured using  
165 the EPICES (Evaluation of Deprivation and Inequalities in Health Examination Centers) score  
166 [28], calculated from weighted scoring of answers to 11 questions pertaining, for example, to  
167 health insurance, home ownership, financial situation. The final EPICES score ranged from 0  
168 to 100. Clinical characteristics included pulmonary and cognitive function assessments.  
169 Regarding pulmonary function assessment, forced expiratory volume at the first second of  
170 maximum expiration ( $\text{FEV}_1$ ), its predicted value ( $\text{FEV}_1\% \text{ pred}$ ) and Tiffeneau index ( $\text{FEV}_1 /$   
171  $\text{FVC}$ ) were measured with a plethysmograph (V6200 Autobox, SensorMedics Corp., Yorba  
172 Linda, CA, USA). Cognitive impairment was assessed with the Montreal Cognitive Assessment  
173 (MoCA) test [29]. A score above or equal to 26 on a 0–30-point scale was considered normal.  
174 All of these variables were assessed at T1.

175

### 176 **Exercise capacity**

177 Exercise capacity was assessed at T1 and at T2 with a 6-minute walking test (6MWT) at the  
178 start and at the end of PR, respectively. In accordance with good clinical practices and the  
179 guidelines of the American Thoracic Society [1] patients were instructed to walk as far as  
180 possible in 6 minutes, in a 30-meter corridor.

181

### 182 **Quality of life**

183 Health-related quality of life was measured at T1 and at T2 with the short French self-reported  
184 questionnaire VQ11, specific to COPD [30]. This questionnaire includes 11 items related to  
185 feelings experienced in dealing with consequences of the disease. Each participant indicated  
186 the intensity experienced for each feeling on a scale ranging from 1 (not at all) to 5 (extremely).  
187 This questionnaire enables the calculation of the overall health-related quality of life score and  
188 3 sub-dimensions: functional, psychological and relational scores. The VQ11 score ranges from  
189 11 to 55 and a low global score ( $< 22$ ) indicates a better health-related quality of life.

190

### 191 **Dyspnea**

192 Dyspnea was assessed at T1 and at T2 using the French version of the "Multidimensional  
193 dyspnea profile" questionnaire (MDP) [31-33]. The MDP consists of 11 items evaluated on an  
194 analog scale ranging from 0 (*not felt*) to 10 (*strongly felt*). This questionnaire evaluates 3  
195 subdomains of dyspnea. The first item (A1) assesses the immediate unpleasantness of the

196 dyspnea. Then, five items (SQ) measure sensations linked to dyspnea, both in terms of quality  
197 and intensity. The last five items (A2) assess emotions arising from experiencing dyspnea, in  
198 terms of quality and intensity. From these scores, two components of dyspnea can be calculated:  
199 the sensory dimension (MDP-SD) of dyspnea, corresponding to the sum of the 5 items from the  
200 SQ, and affective dimension (MDP-AD) of dyspnea calculated by adding A1 and A2. To  
201 complete the questionnaire, patients were instructed to focus on the worst episode of dyspnea  
202 experienced over the past two weeks.

203

204 *Effect of pulmonary rehabilitation*

205

### 206 **Evolution of clinical indicators during PR**

207 The effects of respiratory rehabilitation were studied via the evolution of the 6MWT distance  
208 and VQ11, MDP-SD and MDP-AD scores. The evolution of these clinical indicators was  
209 evidenced by the delta calculated by subtracting values at T1 from values at T2. In order to  
210 promote the readability of the results, all values were expressed in absolute values. Therefore,  
211 a positive score denotes an improvement of the parameters while a negative score represents a  
212 deterioration.

213

### 214 **Categorization of COPD patients according to PR response**

- 215 • Responders vs. Non-Responders

216 Responders and non-responders were differentiated using the Minimal Clinically Important  
217 Difference (MCID) available for each indicator in the literature. These MCIDs and associated  
218 reference studies are listed in Table 1.

219

- 220 • Good-Responders vs. Poor-Responders

221 In order to best reflect the multidisciplinary objectives of the PR, a composite response was  
222 defined based on the previous distinctions from the assessment of physical and psychological  
223 indicators. Patients were therefore classified into 2 response profiles: the “poor responders”  
224 group, consisting of patients who only responded on 0, 1 or 2 parameters according to the  
225 respective MCIDs and the “good responders” group, where patients showed a clinically  
226 significant improvement on 3 or 4 indicators.

227

228



229 **Table 1.** Minimal Clinically Important Differences defined for 6MWT, VQ11, MDP-SD and  
 230 MDP-AD.

Indicators		MCIDs	References
6MWT		+ 30 meters	[34,35]
VQ11		- 2 points	[36]
MDP-SD		- 3.02 points	[37]
MDP-AD	A1	- 0.58 point	
	A2	and/or - 2.07 points	

231  
 232 *Data analyses*

233 To test whether the five personality traits were associated with the evolution of clinical  
 234 indicators (i.e., 6MWT, VQ11, MDP-SD, MDP-AD) during PR, multiple linear regression  
 235 analyses were performed, adjusted for relevant demographic and clinical information: age (in  
 236 years), sex (coded as 1 for men and 0 for women), educational attainment (in years), %FEV1,  
 237 MoCA score, EPICES score and value at baseline. For these analyses, we used the lm() function  
 238 of “stats” package in R studio software.

239 Furthermore, to test associations between the five personality traits and response on  
 240 each clinical indicator, logistic regressions analyses were carried out, adjusted for age, sex,  
 241 educational attainment, %FEV1, MoCA score, EPICES score and score at baseline. For each  
 242 indicator, the responder group was recoded as 1 while the non-responder group was recoded as  
 243 0. For these analyses, we used the glm function of “stats” package in R studio software.

244 Moreover, independent sample t-tests and chi-squared analyses were performed to  
 245 examine baseline differences between responders and non-responders on composite PR  
 246 response regarding socio-demographics, anthropometrics, pulmonary function characteristics  
 247 and clinical indicators. Additional logistic regression analyses were used to test relationships  
 248 between PR composite response and the five personality traits, adjusted for relevant  
 249 demographics and clinical elements: age, sex, education, %FEV1, MoCA score, and the  
 250 EPICES score. For these analyses the "good response" group was recoded as 1 while the "poor  
 251 response" group was recoded as 0. Taking into account the high number of statistical tests  
 252 carried out, we chose to lower the significance level at  $p \leq .01$ , in order to limit the risk of type  
 253 I error. Patients who did not complete the PR program or patients with incomplete data were  
 254 excluded from the analyses. A flowchart is presented in figure 1. For all outcomes, personality  
 255 scores were standardized and analyses were conducted separately for each trait and then with

256 all traits simultaneously within the same model. All statistical tests were carried out with R and  
257 R studio software. The R studio script is available upon request.

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259 **Figure 1.** Flow Chart

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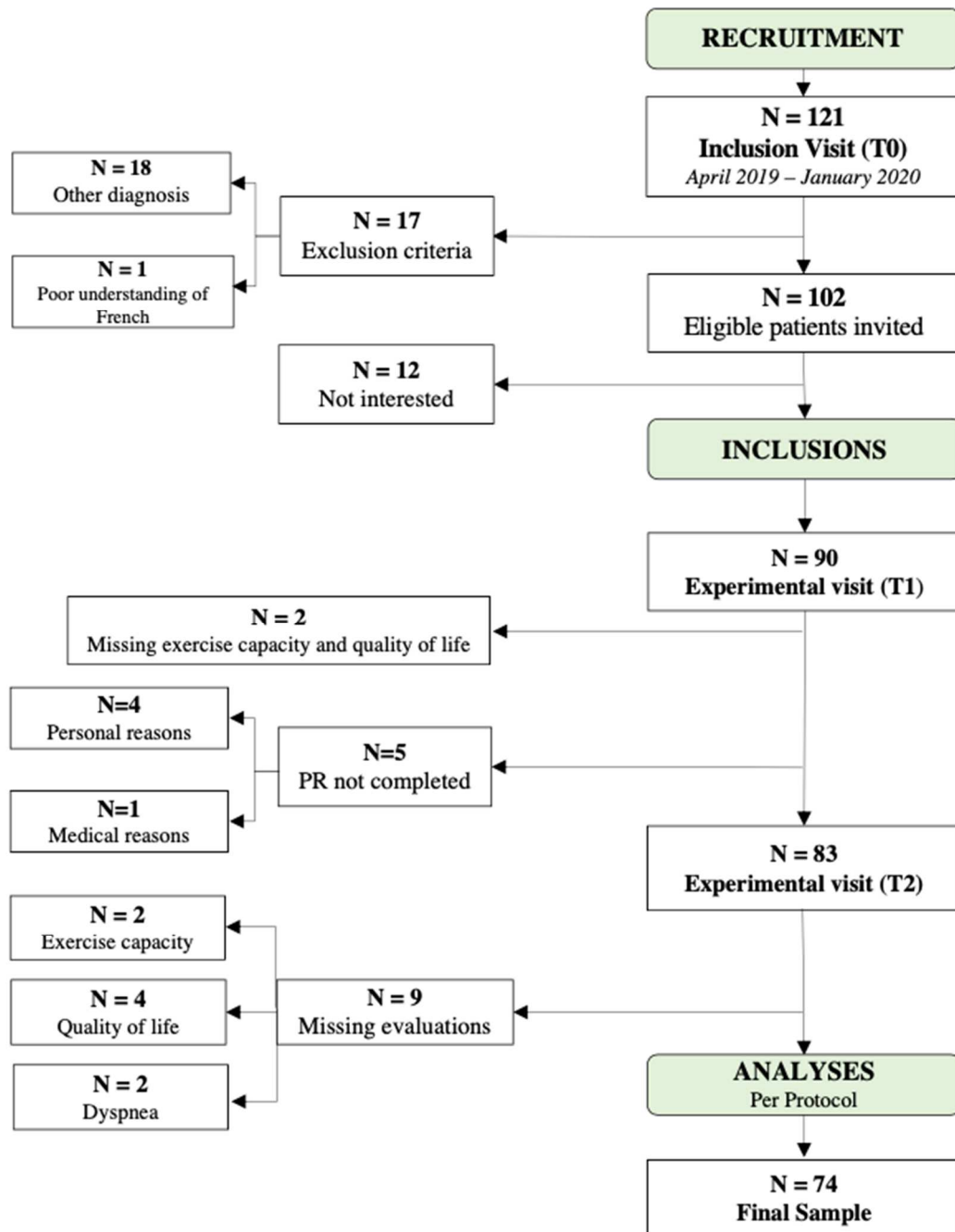
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290 **Results**

291 *Patient characteristics*

292 Among the 121 patients invited to participate in the present study, 102 met the inclusion criteria  
 293 and 90 agreed to participate. Five patients did not complete the rehabilitation program and 11  
 294 patients did not complete all the evaluations. As such, the final sample included 74 persons with  
 295 COPD (Figure 1). Baseline characteristics of participants are reported in Table 2. Values are  
 296 represented by the mean  $\pm$  standard deviation in case of normal distribution (test with Q-Qplot,  
 297 Skewness, Kurtosis), otherwise by the median [lower quartile (LQ)- upper quartile (UQ)].

298 **Table 2.** Descriptive characteristics of the sample  
 299

Variables	Mean / Median	Standard Deviation / [LQ-UQ]
<b><i>Demographic and anthropometric</i></b>		
Sex n women (%)	29 (39%)	-
Age (years)	68.39	8.64
BMI (kg.m <sup>2</sup> )	24.10	[20.61 - 28.30]
Education (years)	12.32	3.59
EPICES	22.77	[13.61 - 35.51]
<b><i>Pulmonary Function</i></b>		
FEV <sub>1</sub> (L)	0.95	[0.80 - 1.18]
FEV <sub>1</sub> (% pred)	38.30	[31.00 - 49.75]
FEV <sub>1</sub> /FVC (%)	45.36	[37.93 - 50.81]
GOLD stage I n (%)	6 (8%)	-
GOLD stage II n (%)	14 (19%)	-
GOLD stage III n (%)	37 (50%)	-
GOLD stage IV n (%)	17 (23%)	-
<b><i>Psycho-cognitive variables</i></b>		
MOCA score	25	[23.00 - 27.00]
	Score 26 < n = 50 (68%)	
VQ11	34.30	7.92
MDP-SD	30.59	9.46
MDP-AD	28.50	[19 - 43.75]
<b><i>Exercise capacity</i></b>		
6MWT (in meters)	370.39	85.78
<b><i>Personality traits</i></b>		
Neuroticism	2.58	0.75
Extraversion	3.12	0.68
Openness	3.45	0.76
Agreeableness	4.14	0.46
Conscientiousness	3.84	0.52

Note. **Total N = 74**, **BMI**: body mass index, **FEV<sub>1</sub>**: forced expiratory volume in one second; **FVC**: forced vital capacity; **GOLD**: global initiative for chronic obstructive lung disease

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304 *Evolution of clinical indicators during PR and associations with personality traits*

305 The evolution of each clinical indicators during PR is presented in table 3. The results of  
 306 multiple linear regression analyses performed to test the association between personality traits  
 307 and the evolution of clinical indicators during PR are presented in Table 4. These analyses did  
 308 not highlight any significant association between personality traits and the evolution of exercise  
 309 capacity, quality of life, sensory and affective dyspnea dimensions. Furthermore, no significant  
 310 association was found when all traits were simultaneously entered in the same model (Table  
 311 S1).

312  
 313 **Table 3.** Evolution of clinical indicators during PR

Variables	T1 (Start of PR)	T2 (End of PR)	Δ
	Mean ± Standard Deviation Median [LQ;UQ]		
6MWT	371.43 ± 85.02	409.99 ± 90.75	36.50 [10.50; 61.50]
VQ11	34 [29.25;39.00]	29 [22.00; 34.00]	6 [2.00; 9.75]
MDP-SD	31 [24.00; 38.00]	22 [13.25; 32.00]	8 [1.25; 17]
MDP-AD	28.50 [19.00; 30.45]	17 [11.00; 25.00]	8 [-1.00; 23.50]

**Note.** LQ: lower quartile, UQ: upper quartile  
 Δ : relative difference between T2 and T1 score

314  
 315  
 316 **Table 4.** Summary of multiple regression analyses predicting the evolution of clinical indicators  
 317 during PR from personality traits in baseline

Variables	Δ 6MWT	Δ VQ11	Δ MDP-SD	Δ MDP-AD
β p-values				
Neuroticism	0.08 <sub>ns</sub> p=0.50	-0.01 <sub>ns</sub> p=0.93	-0.12 <sub>ns</sub> p=0.24	-0.12 <sub>ns</sub> p=0.26
Extraversion	-0.08 <sub>ns</sub> p=0.51	-0.06 <sub>ns</sub> p=0.56	0.23 <sub>ns</sub> p=0.02	0.11 <sub>ns</sub> p=0.24
Openness	-0.01 <sub>ns</sub> p=0.92	-0.16 <sub>ns</sub> p=0.12	0.23 <sub>ns</sub> p=0.03	0.16 <sub>ns</sub> p=0.07
Agreeableness	-0.15 <sub>ns</sub> p=0.24	-0.01 <sub>ns</sub> p=0.93	0.07 <sub>ns</sub> p=0.52	0.14 <sub>ns</sub> p=0.15

Conscientiousness	-0.04 <sub>ns</sub> p=0.74	0.06 <sub>ns</sub> p=0.54	0.00 <sub>ns</sub> p=0.96	-0.05 <sub>ns</sub> p=0.55
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**Note.** Adjusted for age, sex, %FEV1, MoCA score, EPICES score, Education and T1 score  
<sub>ns</sub> = not significant according to the significance level defined at p ≤ 0.01

Δ : delta between T2 and T1 score

No significant association was found when all traits were simultaneously entered in the same model.

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320 *Responders vs. Non-Responders and associations with personality traits*

321 According to MCIDs of exercise capacity during the program, 42 (57%) patients were  
 322 categorized as responders, and 32 (43%) as non-responders. For health-related quality of life,  
 323 59 (80%) COPD patients were classified as responders. For dyspnea, 50 (68%) and 58 (78%)  
 324 patients were classified as responders on MDP-SD and MDP-AD respectively.

325 Logistic regression analyses revealed a significant association between openness and  
 326 VQ11 response. Specifically, this result suggested that a high level of openness [OR = 0.36;  
 327 95% confidence interval (CI) = 0.15 – 0.74] was associated with a lesser likelihood of  
 328 responding on the VQ11 (Table 5). This relation did not remain significant when all traits were  
 329 simultaneously entered into the adjusted logistic regression model (Table 6). No association  
 330 between personality traits and 6MWT, MDP-SD and MDP-AD responses were found.

331

332 **Table 5.** Summary of logistic regression analyses predicting clinical indicators response from  
 333 personality traits in baseline

Variables	Response to 6MWT	Response to VQ11	Response to MDP-SD	Response to MDP-AD
	<i>Odd Ratios 95% CI p-values</i>			
Neuroticism	0.99 <sub>ns</sub> (0.59-1.69) p=0.97	1.01 <sub>ns</sub> (0.51-2.08) p=0.97	0.71 <sub>ns</sub> (0.37-1.29) p=0.26	0.67 <sub>ns</sub> (0.30-1.47) p=0.32
Extraversion	0.57 <sub>ns</sub> (0.30-0.99) p=0.06	0.69 <sub>ns</sub> (0.33-1.33) p=0.29	1.86 <sub>ns</sub> (0.98-3.77) p=0.07	1.35 <sub>ns</sub> (0.64-2.96) p=0.44
Openness	1.08 <sub>ns</sub> (0.65-1.82) p=0.76	<b>0.36*</b> <b>(0.15-0.74)</b>	2.11 <sub>ns</sub> (1.10-4.50) p=0.03	2.69 <sub>ns</sub> (1.27-6.81) p=0.02
Agreeableness	0.96 <sub>ns</sub> (0.54-1.66) p=0.88	0.98 <sub>ns</sub> (0.50-1.87) p=0.94	1.72 <sub>ns</sub> (0.91-3.45) p=0.10	2.45 <sub>ns</sub> (1.11-6.27) p=0.04
Conscientiousness	0.78 <sub>ns</sub> (0.46-1.29) p=0.34	0.59 <sub>ns</sub> (0.30-1.07) p=0.09	1.79 <sub>ns</sub> (0.95-3.60) p=0.08	1.78 <sub>ns</sub> (0.95-3.63) p=0.09

**Note.** Coefficients are standardized regression coefficients. 95% confidence intervals are in parentheses. Adjusted for age, sex%,FEV1, MoCA score, EPICES score, Education and T1 score  
 \*  $p < .01$ , *ns* = not significant according to the significance level defined at  $p \leq .01$

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**Table 6.** Summary of logistic regression analyses predicting clinical indicators response from the five personality traits included in the same regression model

Variables	Response to 6MWT	Response to VQ11	Response to MDP-SD	Response to MDP-AD
	<i>Odd Ratios 95% CI p-values</i>			
Neuroticism	0.83 <sub>ns</sub> (0.43-1.57) <i>p</i> =0.55	0.49 <sub>ns</sub> (0.17-1.31) <i>p</i> =0.17	1.32 <sub>ns</sub> (0.58-3.27) <i>p</i> =0.51	1.38 <sub>ns</sub> (0.49-4.50) <i>p</i> =0.56
Extraversion	0.49 <sub>ns</sub> (0.24-0.91) <i>p</i> =0.03	0.91 <sub>ns</sub> (0.39-2.11) <i>p</i> =0.82	1.75 <sub>ns</sub> (0.80- 4.16) <i>p</i> =0.18	1.48 <sub>ns</sub> (0.55-4.61) <i>p</i> =0.46
Openness	1.44 <sub>ns</sub> (0.78-2.77) <i>p</i> =0.25	0.26 <sub>ns</sub> (0.07-0.68) <i>p</i> =0.02	1.53 <sub>ns</sub> (0.71- 3.58) <i>p</i> =0.29	2.19 <sub>ns</sub> (0.93-6.14) <i>p</i> =0.10
Agreeableness	0.81 <sub>ns</sub> (0.41-1.55) <i>p</i> =0.53	1.30 <sub>ns</sub> (0.54-3.20) <i>p</i> =0.55	1.76 <sub>ns</sub> (0.8- 4.23) <i>p</i> =0.17	2.41 <sub>ns</sub> (0.92-8.14) <i>p</i> =0.10
Conscientiousness	0.75 <sub>ns</sub> (0.42-1.30) <i>p</i> =0.31	0.60 <sub>ns</sub> (0.28-1.22) <i>p</i> =0.16	1.35 <sub>ns</sub> (0.67-2.85) <i>p</i> =0.41	1.19 <sub>ns</sub> (0.53-2.75) <i>p</i> =0.67

**Note.** Coefficients are standardized regression coefficients. 95% confidence intervals are in parentheses. Adjusted for age, sex%,FEV1, MoCA score, EPICES score, Education and T1 score  
*ns* = not significant according to the significance level defined at  $p \leq .01$

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*Good Responders vs. Poor Responders and associations with personality traits*

Based on the composite response criteria defined in this study, 47 (62%) patients were classified as good responders and 27 (38%) as poor responders. Descriptive statistics for each group are presented in Table 7.

The independent sample t-tests and chi-squared performed to compare baseline characteristics between each group did not reveal any significant difference on socio-demographic, anthropometric, pulmonary function, and exercise capacity variables (Table 7). Regarding psycho-cognitive variables, good responders had significantly higher scores on the MDP-AD [ $M_{\text{goodresponders}} = 33$  [21.50 - 46.50] versus  $M_{\text{poorresponders}} = 22$  [14.50 – 28.50];  $W(72) = 405.5$ ,  $p = <.01$ ], indicating a poorer affective dimension of dyspnea at baseline (Table 7).

349 Logistic regressions did not unveil a significant association between personality traits  
 350 and PR composite response (Table 8). No significant association was found when all traits were  
 351 simultaneously entered in the same model (Table S2).

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353 **Table 7.** Patient characteristics according to Poor or Good Responder Profile  
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Variables	Poor responders n = 27	Good responders n = 47	p-values
<b>Demographic and anthropometric variables</b>			
Sex n(% women)	10 (37%)	19 (40%)	.77ns
Age (years)	69.11 ± 10.85	67.98 ± 7.18	.63ns
BMI (kg.m <sup>2</sup> )	24.31 [19.35-27.15]	23.89 [21.33-28.45]	.68ns
Education (in years)	12.09 ± 3.90	12.45 ± 3.43	.70ns
EPICES score	22.48 [13.61-29.97]	23.07 [13.61-39.64]	.48ns
<b>Pulmonary Function variables</b>			
FEV <sub>1</sub> (L/min)	0.95 [0.74-1.14]	0.95 [0.82 -1.92]	.78ns
FEV <sub>1</sub> (% pred)	37 [31-48.50]	40 [30 -50.02]	.78ns
FEV <sub>1</sub> /FVC (%)	45.65 [35.36-51.75]	45.26 [39.51-50.31]	.84ns
GOLD stage I n (%)	1 (2%)	3 (6%)	.42ns
GOLD stage II n (%)	5 (26%)	19 (21%)	-
GOLD stage III n (%)	16 (46%)	59 (45%)	-
GOLD stage IV n (%)	5 (26%)	19 (28%)	-
<b>Psycho-cognitive variables</b>			
MOCA score	25.19 ± 2.80	24.85 ± 3.02	.63ns
VQ11	32.22 ± 7.95	35.49 ± 7.74	.09ns
MDP-SD	28[23.50 -32.50]	34[26.50-39]	.03ns
MDP-AD	22[14.50 -28.50]	33[21.50-46.50]	.01*
<b>Exercise capacity</b>			
6MWT (in meters)	381.07 ± 71.24	365.89 ± 92.29	.43ns
<b>Note.</b> BMI: body mass index, FEV <sub>1</sub> : forced expiratory volume in one second; FVC: forced vital capacity; TLC: total lung capacity; GOLD: global initiative for chronic obstructive lung disease * p < .01, ns = not significant according to the significance level defined at p ≤.01			

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357 **Table 8.** Summary of logistic regression analyses predicting PR composite response from  
 358 personality traits at baseline

Variables	Response to PR (Poor Responders = 0 and Good Responders = 1)		
	Odds Ratios	95% CI	p-values
Neuroticism	1.15ns	(0.70-1.94)	p=0.57

Extraversion	0.87 $ns$ (0.51-1.45) $p=0.59$
Openness	1.26 $ns$ (0.77-2.12) $p=0.37$
Agreeableness	1.17 $ns$ (0.68-2.01) $P=0.57$
Conscientiousness	1.09 $ns$ (0.66-1.78) $p=0.74$

**Note.** Coefficients are standardized regression coefficients. 95% confidence intervals are in parentheses. Adjusted for age, sex, %FEV1, MoCA score, EPICES score and Education  
 $ns$  = not significant according to the significance level defined at  $p \leq 0.01$   
No significant association was found when all traits were simultaneously entered in the same model.

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## 360 Discussion

361 The objective of the present study was to assess, for the first time, relationships between  
362 personality traits, as defined by the Five-Factor Model, and effectiveness of inpatient-PR on  
363 exercise tolerance, quality of life and dyspnea in persons with COPD. Consistent with our  
364 hypothesis, this study shows that personality traits are likely to modulate the effectiveness of  
365 the therapeutic intervention. In particular, a high level of openness to experience was associated  
366 with a lesser likelihood of responding to PR on quality of life. No association was found  
367 between the other traits and PR outcomes. In addition, none of the traits were associated with  
368 PR composite response.

369 Thus, our study suggests that openness to experiences could be a risk factor for non-  
370 response to PR on quality of life. This result was unexpected because most studies that  
371 identified links between openness and therapeutic intervention effectiveness usually reported  
372 that this trait was a protective factor [38-40]. For example, a high level of openness increases  
373 the benefits from a nonpharmacological breathlessness intervention in persons with  
374 intrathoracic cancer [39]. In addition, it was positively associated with intervention  
375 effectiveness for cognitive impairment in older adults [40] and with decreased depression  
376 severity upon treatment completion [38]. Regarding quality of life, the few studies that  
377 investigated the relationship with openness to experiences following a clinical intervention  
378 reported inconsistent results. For example, while a high level of openness was significantly



379 associated with a poorer quality of life 6 months after breast reconstruction [41], no association  
380 was evidenced in women with Breast Cancer 1 and 2 mutations, after risk-reducing salpingo-  
381 oophorectomy [42]. This lack of consensus might be explained by the fact that these  
382 associations could be related to contextual factors. Indeed, our results can partly be interpreted  
383 in light of the very specific context of inpatient-PR, which could interfere with the  
384 psychological needs of these individuals. For example, the highly supervised environment of  
385 inpatient PR imposes some restrictions (i.e., monitored outings and visits, strict daily  
386 schedule...), which do not align with the personal values of independence in thoughts and  
387 actions of individuals with a high level of openness [43]. Moreover, repeating the same  
388 activities during a 5-week period could create a routine, lacking stimulation for those  
389 individuals constantly looking for new and unusual experiences [14]. Therefore, the poor match  
390 between the openness trait and inpatient-PR environment specificities could interfere with the  
391 effectiveness of the therapeutic intervention. To test the validity of this hypothesis, it could be  
392 interesting to identify whether these associations between openness and PR response would be  
393 similar in the context of more independent therapeutic modalities such as outpatient or home-  
394 based program.

395         The lack of associations with the other traits of the Five-Factor Model in the present  
396 research is surprising since previous studies, investigating the role of personality in chronic  
397 disease [23,44] or mental health [45-47] clinical outcomes, showed that neuroticism [23,44-  
398 47], conscientiousness [44,46,47], extraversion and agreeableness [44,46] were likely to  
399 modulate the effect of therapeutic management. To date, few studies have investigated the  
400 mediating mechanisms underlying which traits could influence response to treatment [48].  
401 However, consistent associations between traits and behaviors that could influence a  
402 therapeutic management, such as adherence to treatment protocol [20,21,49-51] were  
403 identified. Nevertheless, the context of inpatient-PR, given these constraining characteristics  
404 (i.e., supervision by a multitude of healthcare professionals, care setting rules) offers few  
405 opportunities for patients to express their own individual behavioral patterns. Inpatient-PR  
406 could thus constitute a poor environment for the expression of these personality traits. In order  
407 to test this hypothesis, it might be interesting to identify associations between personality traits  
408 and more specific behaviors such as PR program dropout rates, level of engagement in  
409 therapeutic management or participation in sessions. Moreover, future studies should  
410 investigate the associations between personality traits and PR response in management settings  
411 where individual patient behaviors (e.g., therapeutic adherence) are central to the success of the  
412 program such as outpatient-PR or telerehabilitation.

413 In addition to the scientific relevance of improved understanding of psychological  
414 factors that may influence PR effectiveness [52-55], the results could also have practical clinical  
415 implications. Indeed, the association identified in this study represents the first basis for  
416 improving the response on the quality-of-life dimension, which is one of the most important  
417 domains given its association with mortality in persons with COPD [56,57]. Assessing the  
418 openness to experience trait could help clinicians better target individuals less likely to benefit  
419 from the PR intervention on the quality-of-life and thus reinforce prevention for these patients.  
420 With this objective in mind, additional research to determine cut-off scores for this trait, to  
421 detect the most vulnerable patients, would be highly relevant. Moreover, the differential  
422 effectiveness of a PR program according to one's personality emphasizes the importance to  
423 tailor non-pharmacological therapy to individual characteristics. In this perspective, future  
424 studies should help define which are the most suitable PR modalities and contents according to  
425 one's dispositions, including personality traits.

426

#### 427 *Strengths and methodological considerations*

428 The present study has several strengths that include the investigation of PR effectiveness  
429 through both physiological and psychological indicators. Moreover, we analyzed PR effects  
430 using two complementary methodological approaches (evolution versus response). Finally, this  
431 study is one of the few to propose a composite indicator of PR response, which is more  
432 representative of the multiple objectives of this intervention. Some methodological  
433 considerations deserve some special attention. First, for the sake of statistical rigor, we chose  
434 to lower our significance threshold to 0.01. Nevertheless, results that did not express themselves  
435 according to the threshold we imposed may deserve more attention. Replication studies would  
436 be relevant to identify which results would be consistent. Moreover, the validity of MCIDs  
437 [37] used to categorize responders and non-responders on dyspnea dimensions are questionable  
438 since they were not defined after a clinical intervention. However, they were the only MCIDs  
439 available and published to date. Finally, due to the lack of composite indicators in the literature,  
440 the methodology used to categorize good and poor responders, was defined in an arbitrary  
441 manner. Despite this limit, the resulting proportion of responders (62%) and non-responders  
442 (38%) is consistent with previous studies that reported a response rate of over 50% [5,6,8,10].  
443 Furthermore, findings pointing to good responders having lower affective dimension scores  
444 compared with poor responders is in line with previous studies that found a poorer health status  
445 at baseline in good responders, including dyspnea [7,58].

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## 449 **Conclusion**

450 To sum up, identifying the determinants of PR effectiveness represents a major human,  
451 clinical and economic challenge. The present study shows that investigating personality traits  
452 as defined by the Five-Factor Model constitutes an interesting perspective to understand the  
453 heterogeneity observed in PR response. Specifically, our results indicate that high openness is  
454 associated with a lower likelihood of responding to PR on health-related quality of life. Thus,  
455 this study highlights the existence of new psychological factors that could be taken into account  
456 to design new strategies for individualized care pathways. However, additional research is  
457 needed to implement these findings in clinical practice.

458

## 459 **AUTHOR CONTRIBUTIONS**

460 P.C, N.H, V.M and F.A conceived and designed research. P.C performed experiments and  
461 analyzed data. P.C, N.H, V.M and F.A interpreted results of experiments. P.C prepared tables  
462 and drafted manuscript. N.H, F.A and V.M edited and revised manuscript. P.C, N.H, V.M and  
463 F.A approved final version of manuscript.

464

## 465 **ACKNOWLEDGEMENTS**

466 The authors would like to thank the experts of the Korian research committee for their precious  
467 advice. Moreover, the authors kindly thank all the volunteer participants who made this study  
468 possible. Finally, we also gratefully acknowledge the different clinical teams of the Clinique  
469 du Souffle La Vallonie for facilitating the implementation and the organization of this study  
470 within the pulmonary rehabilitation center. The authors also thank Bénédicte Clément  
471 (medical/science translator; EU agreement) for English editing.

472

## 473 **FUNDING**

474 The project was financially supported by the French Agency for Research and Technology  
475 [ANRT, CIFRE 2018/0198]. The sponsor had no influence on the conduct of this study, the  
476 analysis of the data, or the writing of this report.

477

## 478 **DISCLOSURE**

479 The authors declare no conflicts of interest financial or otherwise. The results of this study are  
480 presented clearly, honestly, and without fabrication, falsification, or inappropriate data  
481 manipulation.

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