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Original article

Influence of DISC behavioral profile on the short- and long-term outcomes of home-based pulmonary rehabilitation in patients with chronic obstructive pulmonary disease

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ABSTRACT

Introduction. – Pulmonary rehabilitation (PR) programs are commonly prescribed for patients with severe respiratory disorders, but little is known about how the patient's personality traits influence PR outcomes. We analyzed the response of patients with chronic obstructive pulmonary disease (COPD) to a home-based PR program according to their predominant behavioral profiles using the Dominance – Influence – Steadiness – Conscientiousness (DISC) tool.
Methods. – This was a retrospective observational study of 335 COPD patients referred by their pulmonologists between January 2010 and December 2015. The DISC behavioral profile was determined at the beginning of the program. Patients received individual supervised sessions at home once a week for 8 weeks, which consisted of exercise training and psychosocial, motivational, and educational support, all tailored to the participant's DISC profile. Exercise tolerance (6-minute stepper test, 6MST), anxiety and depression (Hospital anxiety and depression scale, HADS), and quality of life (Visual simplified respiratory questionnaire, VSRQ) were evaluated immediately before and after the PR program (T0 and T2, respectively) and then 6 and 12 months later (T8 and T14, respectively). Responders were defined as patients who exhibited at least minimal clinically important differences (improvements) from baseline.
Results. – Of the 335 COPD patients, 102 (30.4%), 98 (29.3%), 82 (24.5%), and 53 (15.8%) were classified as having predominant D, I, S, and C behavioral traits, respectively. All four patient groups showed significantly ($P < 0.01$) improved performance in the 6MST, HADS, and VSRQ evaluations at T2 ($n = 300$), T8 ($n = 262$), and T14 ($n = 231$) compared with T0, and the proportion of responders in all groups at T8 and T14 was high (~60%). The percentage of responders differed significantly between groups only at T2, when the S group contained fewer responders on the HADS anxiety subscale. Most patients who did not complete the study were classified as D type (42/102, 41.2%), followed by I (28/98, 28.6%), S (22/82, 26.8%), and C (12/53, 22.6%) types.
Conclusion. – The personality profile of COPD patients influenced their adherence to, but not their benefit from, a home-based PR program. The high proportion of patients in all personality groups showing significant improvements in outcomes supports a personalized approach to the design of PR programs.

1. Introduction

Patients with chronic obstructive pulmonary disease (COPD) have been proven to benefit from pulmonary rehabilitation (PR) programs in both out-patient and home-based settings. PR increases physical ability, improves exercise tolerance and quality of life, and reduces dyspnea, frequency of exacerbations and hospitalization, and care costs [1–3]. However, nearly all studies to date, which included PR programs of 4 to 12 weeks duration, found that the benefits are not sustained and tend to be lost within

Abbreviations: 6MST, 6-Minute stepper test; COPD, Chronic obstructive pulmonary disease; FEV_1, Forced expiratory volume in 1s; FVC, Forced vital capacity; HADS, Hospital Anxiety and Depression Scale; MCID, Minimal clinically important difference; PR, Pulmonary rehabilitation; QOL, Quality of life; VSRQ, Visual Simplified Respiratory Questionnaire.

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12 to 18 months after completion of the PR program [4–9]. Thus, there is a need to understand the physical and behavioral factors that impact the long-term success (≥ 12 months) of PR programs in patients with chronic respiratory diseases.

To our knowledge, the impact of the COPD patient's personality/behavioral profile on the success of PR has not been previously analyzed. It seems reasonable to assume that the patient's predominant personality/behavioral traits will influence their communication with caregivers (e.g., clinicians, physical therapists, home support) and their adherence to the program. Ineffective patient–caregiver communication not only increases the risk of non- adherence to therapeutic instructions, which is a major cause of complications among many patient populations, but also increases re-hospitalizations, relapses, and adverse events, and jeopardizes patient safety [10–12]. It is up to healthcare professionals to adapt to build the trust and therapeutic alliance necessary for patient adherence [13–15]. This communication skill is neglected in medical and paramedical training [15–17] and varies according to the caregiver's behavior or personality, but it can be improved by specific training [13–18].

Research on human emotions conducted in 1928 by Marston led to the proposal that human behavior can largely be classified into four types: Dominance (D), Influence (I), Steadiness (S), and Conscientiousness (C), and while all four traits may be present in an individual, one trait is particularly dominant [19]. Since that time, a formal DISC assessment tool has been developed that queries various aspects of the individual's behavior, such as how they respond to challenges, rules, and procedures, how they influence others, and how they prefer to pace their activity [20]. At present, the DISC tool is used mainly by human resource departments to assist in hiring decisions [21], and to our knowledge, it has not previously been employed in a clinical context.

We hypothesized that understanding a patient's personality/behavioral type may not only improve communication between the patient and caregiver but also allow PR programs to be modified to best suit the patient's predominant personality type. To begin to test this hypothesis, we performed a retrospective observational study to compare the influence of DISC type on the short-, medium-, and long-term benefits (2, 8, and 14 months, respectively) of a brief (2 months, 8 visits) home-based PR program in COPD patients. The psychosocial and motivational aspects and the exercise training components of the program were tailored and adjusted according to each participant's DISC profile. The primary objective of the study was to determine the influence of DISC type on the effects of PR on exercise tolerance, anxiety, depression, and quality of life. The secondary objectives were to compare between DISC types the proportion of patients who displayed clinically significant responses to PR and the proportion who failed to complete the study.

2. Methods

2.1. Patients and study design

This was a retrospective analysis of data collected in real time from COPD patients undergoing the home-based PR program. Approval for the use of the data was obtained from the Committee for the evaluation of observational research protocols of the french language pulmonary society (CEPRO 2017-007). All patients provided written informed consent. The study population included 335 patients in Northern France who were referred by their pulmonologist to receive home-based PR between October 2010 and December 2015. Patients had no severe exacerbations in the preceding 4 weeks. Patients with bronchopulmonary cancer, dementia, uncontrolled psychiatric illness, neurological sequelae, or osteoarticular pathology that prevented physical activity were excluded. The prescribing physician was responsible for the diagnosis and assessment of COPD and co-morbidities, treatments (other than PR), validation of the absence of cardiovascular contraindications to exercise training, and determination of the target heart rate for re-training, as described in detail previously [22].

2.2. PR program

The home-based PR program has been described in detail [23]. Patients underwent an initial assessment at home before starting the program to identify problems, assess individual needs and motivations, and determine the DISC type. The PR team then designed individualized programs, which consisted of exercise training (endurance training starting with 10-minute sessions; shorter for the most severely ill patients), physical activity recovery (warm-up and stretching exercises), peripheral muscle reinforcement (three upper and lower limb muscle strengthening exercises), psychosocial and motivational support, and therapeutic education, as previously described [23]. Sessions were conducted once weekly (~90 minutes per session) for 8 weeks under the direct supervision of a PR team member. After that, patients were encouraged to continue independently on the other days of the week according to their personalized action plan. Follow-up visits were restricted to the planned evaluations immediately after the program (T2) and 6 (T8) and 12 (T14) months later; otherwise, patients continued with their normal therapeutic routines.

2.3. Behavioral assessments

All members of the PR team received initial and ongoing training in the behavioral approach of the DISC tool, and determined their own profile to enable them to better understand how to adapt their communication/interaction style according to the patient's profile [20]. In brief, the DISC tool consists of 13 objective observable characteristics for each profile (Additional Table S1), with at least seven key traits needed to assign the predominant personality profile [24]. The behaviors considered preferred or avoidable for each DISC profile are shown in Additional Table S2 [24]. The transdisciplinary PR team then met to reach consensus on the patient's predominant profile, discuss the medical records, and design the optimal PR program (including exercise training, motivational and psychosocial aspects) on an individual basis. For example, an appropriate slogan for patients with Dominance profiles could be "do it now" or "get straight to the point". Therefore, the communication style for this group was direct and concise, and the D type-specific PR program was designed to integrate challenges, to be performed in a short time, and to have rapidly obtainable objectifiable results.

Assessment of mood was analyzed by the Hospital anxiety and depression scale (HADS) [25], which comprises 14 items (7 each for anxiety and depression), each scored on a 0–3 scale (0–21 minimum–maximum sub-scores; lower is better). The validated minimal clinically significant difference (MCID) for the anxiety and depression sub-scores is 1.5 points [26]. Quality of life was assessed with the Visual simplified respiratory questionnaire (VSRQ) which consists of 8 questions on a scale from 0 to 10 (0–80; higher is better), and has a validated MCID of 3.4 points [27]. Exercise tolerance was assessed with the 6-minute stepper test (6MST) [28], for which 40 strokes is the validated MCID [29]. Patients were considered "PR responders" if they showed improved test scores of at least the MCID between T0 and T2, T8, or T14.

2.4. Statistical analysis

Categorical variables are expressed as frequencies and percentages, and continuous variables are expressed as means and

standard deviation (SD). Normality of distribution was checked graphically and using the Shapiro–Wilk test. The proportion of responders for each DISC group was compared using a Chi^2 test, with appropriate post hoc tests when Chi^2 was significant. Changes in study outcomes over time (6MST strokes, HADS scores and subscores, and VSRQ score) were assessed using a linear mixed model with time as a fixed effect and patient as a random effect. When the time effect was significant, post hoc tests were performed to compare the baseline value and each follow-up assessment. Normality of the model residuals was checked for each outcome. Changes in study outcomes according to behavioral profile were assessed by including a time interaction term in a linear mixed model. All analyses were performed using a two-tailed test with an alpha level of 0.05. Statistical analyses were performed using R version 3.5.3.

3. Results

The clinical and functional characteristics of the 335 COPD patients who participated in the home-based PR program are detailed in Table 1. Approximately equal numbers of patients were classified as D ($n = 102$, 30.4%) and I ($n = 98$, 29.3%) types, while fewer were S ($n = 82$, 24.5%) and C ($n = 53$, 15.8%) types. The mean age of the cohort was 64.1 years (SD 11.2 years) and most of the patients were men (66.9%). In addition, most patients (77%) had severe disease (GOLD stages III and IV), and most (62.7%) were being treated with long-term oxygen therapy and/or non-invasive ventilation and/or continuous positive airway pressure. There were no significant differences between the four groups for any of the parameters shown in Table 1.

A total of 104 patients (31.0%) did not complete the 14-month study, with approximately equal numbers dropping out at T2 ($n = 35$), T8 ($n = 38$), and T14 ($n = 31$; Fig. 1). The proportion of dropouts in each group was highest for D (42/102,41.2%) followed by I (28/98, 28.6%), S (22/82, 26.8%), and C (12/53, 22.6%). However, these differences were not statistically significant ($p = 0.055$). The same pattern was observed at T2, T8, and T14. The major reasons for leaving the PR program differed for patients with each DISC type. For group D, they were refusal to attend the visit ($n = 11$), death ($n = 9$), and exacerbation ($n = 10$); for group I, refusal to attend the visit ($n = 8$); for group S, lost to follow up ($n = 8$); and for group C, death ($n = 3$).

Patients in all four groups showed significant improvements in exercise tolerance (6MST stroke number), anxiety and depression (HADS score), and quality of life (VSRQ score) ($P < 0.01$) at the end of the PR program (T2) and, for the most part, these benefits were sustained for 6 and 12 months after completion of the program (T8 and T14) (Fig. 2). To evaluate the degree to which the behavioral profile influenced the outcomes of the program, we determined the percentage of patients in each group who achieved ≥ MCID improvements in each assessment, using previously identified MCID values. As shown in Fig. 3, patients in each group showed ≥ MCID in anxiety, depression, VSRQ, and 6MST scores at all time points with the exception of T2, when the proportion of patients with improved anxiety scores was significantly lower for the S group (32%) compared with the other groups. In contrast, the percentage of responders in all groups was high (~60%) at T8 and T14 and did not differ significantly between groups.

4. Discussion

In this retrospective observational study of 335 patients with COPD, we aimed to determine whether and how the short-, medium-, and long-term benefits of a brief home-based PR program were influenced by the patients' DISC behavioral profiles. Importantly, there were no significant differences in the clinicopathological parameters between the DISC groups at baseline. There were three major findings of the study. First, all four patient groups showed significant improvements in all outcome measures at the end of the PR program, and they were maintained for at least 12 months thereafter. Second, the percentage of patients in each group showing at least MCID improvements in exercise tolerance, mood, and quality of life did not vary significantly between groups. Finally, the majority of patients who discontinued the study were in the D and I groups, which together accounted for ~70% of dropouts.

Although we are not aware of comparable studies using the DISC tool, several studies have analyzed the impact of personality type on health using the Five factors model (FFM) of behavioral profiling [30–34]. In a group of 168 COPD patients, the personality traits conscientiousness, agreeableness, and neuroticism (which is not explicitly represented in the DISC model) were associated with quality of life, anxiety, and depression [33]. Another study using the FFM tool found that the adherence of COPD patients to a drug treatment regimen correlated negatively in patients with dominant neuroticism personalities and positively in those with agreeableness and conscientiousness traits [34].

Our results are consistent with many studies demonstrating the beneficial effects of home-based PR programs for COPD patients

Table 1
Characteristics of patients at baseline stratified by DISC behavior profile.

		DISC profile			
Variable	All patients	Group D	Group I	Group S	Group C
Patient number[a]	332	102 (30.7)	98 (29.5)	80 (24.1)	52 (15.7)
Age (years)	64.1 ± 11.2	65.7 ± 10.6	65.2 ± 11.1	59.8 ± 11.4	65.9 ± 10.9
BMI (kg/m^2)	27.2 ± 7.7	26.3 ± 7.6	28.3 ± 7.7	27.6 ± 8.4	26.4 ± 6.4
Sex, male	224 (67.5)	64 (62.7)	69 (70.4)	43 (53.7)	48 (92.3)
FEV_1 (% predicted)	40.4 ± 17.0	38.2 ± 17.1	40.5 ± 16.2	42.1 ± 16.4	42.5 ± 19.1
FEV_1/FVC (% predicted)	51.2 ± 14.4	50.9 ± 13.0	50.6 ± 14.1	52 ± 14.4	51.6 ± 17.9
LTOT	210 (63.2)	72 (70.6)	62 (63.3)	43 (53.7)	33 (63.5)
NIV	108 (32.5)	33 (32.4)	31 (31.6)	28 (35)	16 (30.8)
CPAP	22 (6.6)	7 (6.9)	9 (9.2)	3 (3.7)	3 (5.8)
6MST (strokes)	312.2 ± 160.3	290.9 ± 164.7	304.5 ± 150.3	341.5 ± 163.5	319.7 ± 164.1
VSRQ score	31.3 ± 15.6	30.4 ± 15	31.3 ± 15.9	31.8 ± 16.6	32.0 ± 15.1
HADS total score	17.6 ± 7.6	18.2 ± 8.0	17.5 ± 7.1	17.6 ± 8.3	16.9 ± 6.7
Anxiety score	9.6 ± 4.5	9.8 ± 4.4	9.9 ± 4.4	9.4 ± 5.0	8.9 ± 3.8
Depression score	8.1 ± 4.2	8.8 ± 4.4	7.6 ± 4.1	8.1 ± 4.2	8.0 ± 4.0

D: Dominance; I: Influence; S: Steadiness; C: Conscientiousness. 6MST: 6-minute stepper test; BMI: body mass index; CPAP: continuous positive airway pressure; FEV_1: forced expiratory volume in 1 second; FVC: forced vital capacity; HADS: Hospital anxiety and depression scale, LTOT: long-term oxygen therapy; NIV: noninvasive ventilation, VSRQ: Visual simplified respiratory questionnaire.

[a] Results are expressed as mean ± SD or number (%).

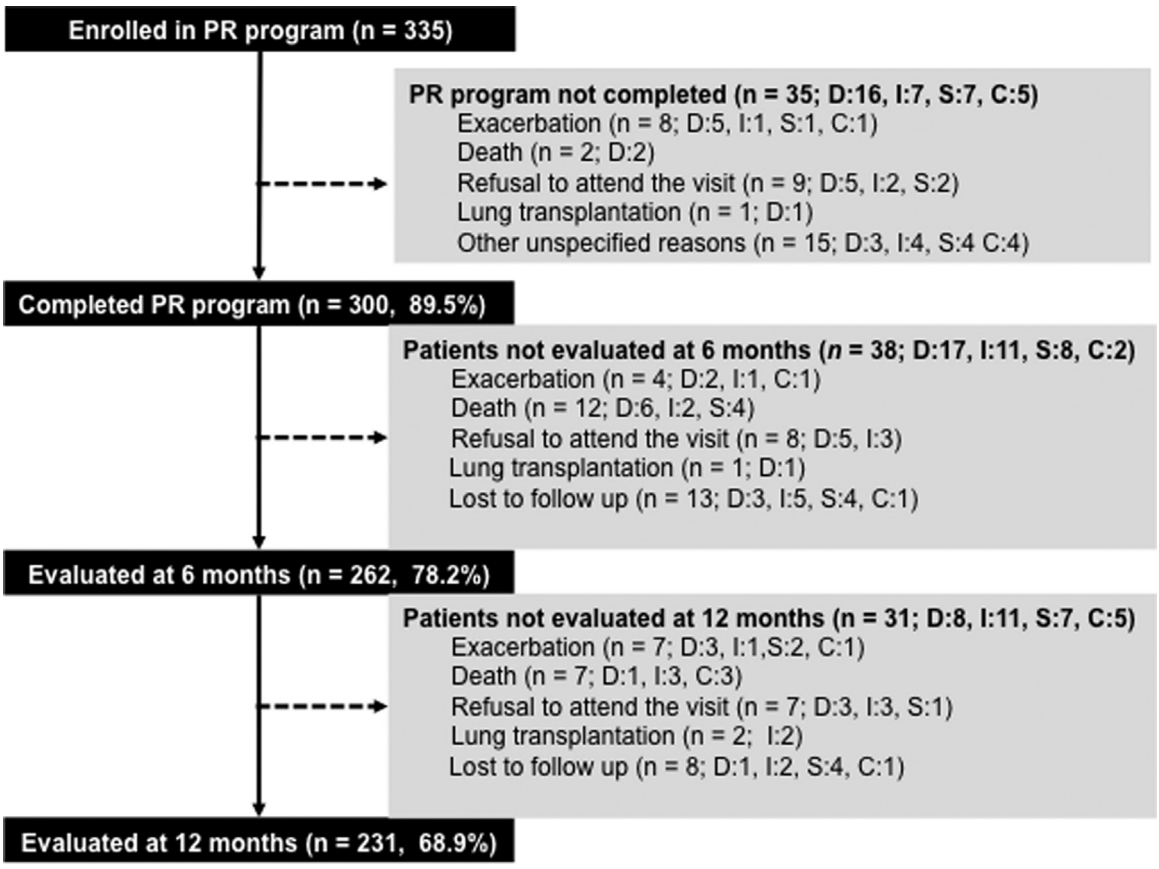

Fig. 1. Flow chart showing patient disposition. D: Dominance; I: Influence; S: Steadiness; C: Conscientiousness.

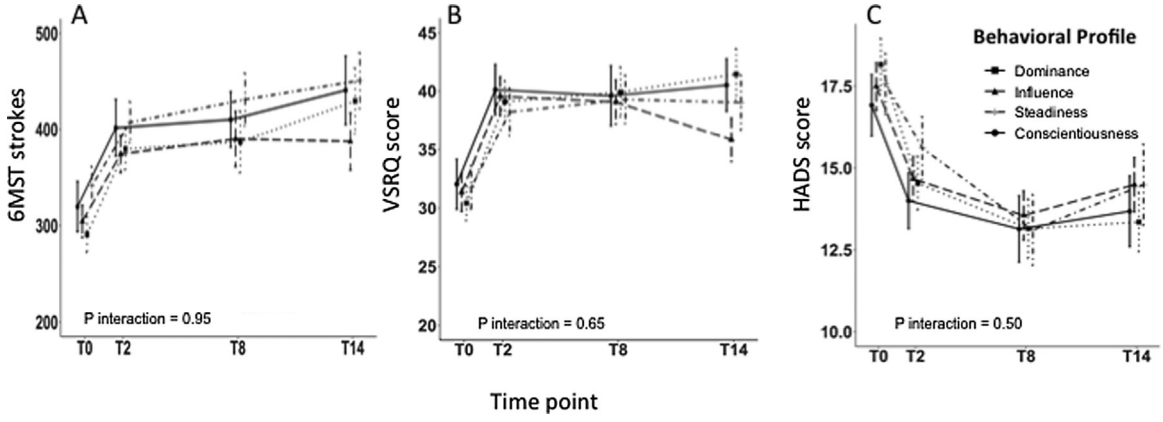

Fig. 2. Change in evaluation scores before and after the PR program stratified by DISC behavior profile. (A–C) Patients were evaluated before (T0) and then at 2 (T2), 8 (T8), and 14 (T14) months after the start of the PR program. A. Exercise tolerance using the number of strokes in the 6-minute stepper test (6MST). B. Quality of life using the Visual Simplified Respiratory Questionnaire (VSRQ). C. Mood using the Hospital Anxiety and Depression Scale (HADS). Data are presented as the mean ± SD. $P_{interaction}$ = *P*-value for the interaction between time and the four groups (i.e., change in the variable with time compared between the four groups). Dominance: squares with dotted lines, Influence: triangles with dashed lines, Steadiness: crosses with dotted/dashed lines; Conscientiousness: circles with solid lines.

[1–3]. However, most studies have found that the benefits tend to wane at later times and are generally lost within 12 to 18 months of the program [4–9,35]. Thus, the main challenge in designing PR programs is in ensuring their sustainability so that quality of life, anxiety, depression, and exercise capacity improvements continue over the long term. Robinson et al. examined the main barriers to continuation of physical activity after a PR program in COPD patients, and they found that a successful relationship with health professionals was one of the keys to success [36]. In a questionnaire-based study, Dibbeit and coworkers interrogated 61 doctors and 470 of their patients and found that the interaction quality was crucial for the success of rehabilitation programs [37]. Indeed, successful communication between caregivers and patients is now well recognized for its beneficial impact on patient satisfaction, treatment adherence, quality of life, pain, anxiety, and depression, as well as the return to work speed [38–40].

An important finding in this study is the high percentage of PR responders for each evaluation parameter at each time point, and its persistence for 12 months after the end of the PR program; indeed, the response was even higher at T14 than at T2. In contrast, Spruit et al. studied COPD patients who underwent a 40-session in-patient PR program, and they found that only 18% of

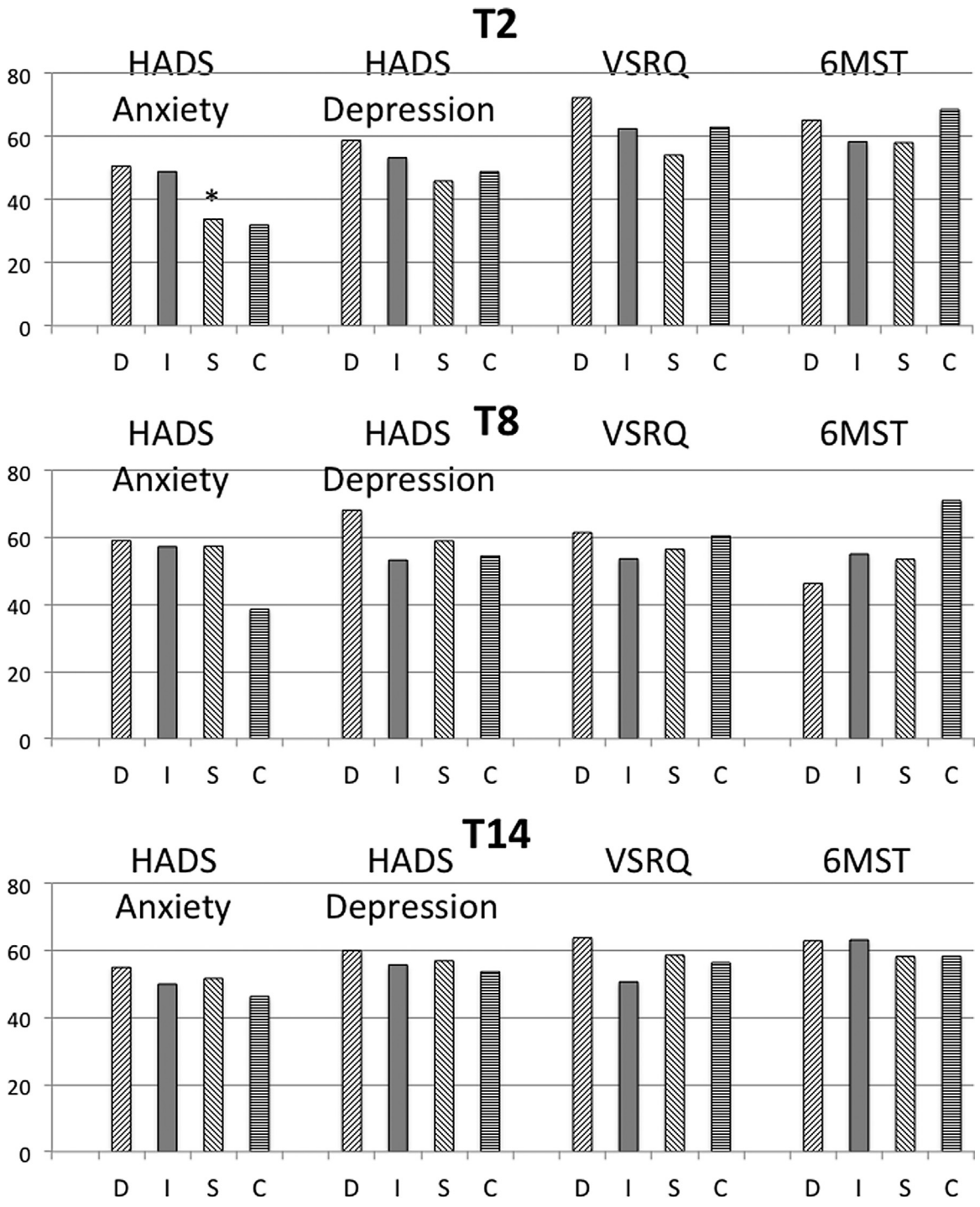

Fig. 3. Percentage of patients with each DISC behavior profile who responded to PR. Data are presented as the percentage of patients who responded to PR, with response defined as a change of ≥ MCID for the indicated assessments at 2 (T2), 8 (T8), and 14 (T14) months compared with the start of the PR program. D: Dominance, I: Influence, S: Steadiness, C: Conscientiousness. 6MST: 6-minute stepper test; MCID: minimal clinically important difference; VSRQ: Visual Simplified Respiratory Questionnaire. *$p < 0.05$ vs. group D.

patients were "very good responders" (defined as at least 1 × MCID improvement in exercise capacity and quality of life) and 35% were "good responders" (defined as at least 1× MCID improvement in one parameter) [41]. However, the authors stressed that the use of only two outcome measures did not capture the "clinical complexity of PR patients". This "complexity" seems likely to include relational and psychological aspects (e.g., personality, communication, motivation, disease acceptance), supporting the need for a holistic approach to PR [42–45].

Communication effectiveness depends not only on the health professional's skills in communicating such encouragement but also on the patient's manner of perceiving/interpreting it, which will be personality dependent. By proposing a set of verbal and nonverbal communication references, the DISC tool may assist caregivers in identifying how best to communicate and encourage beneficial health changes in their patients (Additional Tables S1 and S2). For example, patients with Dominance and Influence profiles generally prefer a faster rate of change, while Steadiness and

Conscientiousness types prefer slower changes [24]. In support of this, we found a steady increase in the percentage of patients in the S and C groups with improved anxiety and depression scores between T2, T8, and T14, whereas the percentage of responders in D group was relatively high at T2 and remained so at later times.

In our study, refusal to attend the follow-up visit accounted for about a third of the dropouts in both the D and I groups. COPD patients with a Dominance profile are less likely than others to attend follow-up visits, possibly because they need to dominate new clinical situations and do not need the team's presence to make progress. Influence types might be less motivated due to the lack of novelty in the follow-up actions (Additional Tables S1 and S2); therefore, Influence-type patients might benefit from reinforcement of educational and motivational aspects of a program after the first follow-up visit (between 6 and 12 months). Interestingly, refusal to attend the visits was particularly common among the Steadiness patients; this type may have more difficulty in "saying no" and therefore preferred not to answer the appointment calls (i.e., lost to follow-up). Patients with Conscientiousness behavior had the lowest dropout rates overall and most frequently attended the long-term appointments, reflecting their more rigorous approach to health care.

There were some limitations to this study. First, classification bias was possible for patients who scored high on two similar DISC profiles. To avoid this bias, PR team members received training to standardize their approach to patients with each DISC profile. Second, this was a monocentric retrospective observational study. Further multicenter studies will be needed to confirm these results and extrapolate them to other patient groups and PR programs. Finally, many other factors, in addition to the patients' DISC profiles, will influence their long-term adherence to favorable health behaviors. Some of these will relate to the patients' personality (e.g., non-acceptance of the disease, lack of motivation, mistaken beliefs about health, anxiety, and depression), circumstances (e.g., socioeconomic status), and treatment (e.g., drugs, devices), while others will relate to the caregivers (e.g., technical approach to illness, lack of empathy, communication difficulties, time constraints). Understanding these factors and integrating them into the overall approach to the treatment of COPD patients should help in the design of adaptable PR programs in terms of exercise type, frequency, and/or duration, as well as motivational and educational aspects, by specialized teams of PR professionals.

5. Conclusion

The results of this study indicate that the behavioral/personality profile of COPD patients, as measured using the DISC tool, can influence the adherence to a home-based PR program, but does not affect the benefits obtained. The finding that a high proportion of all personality groups showed significant improvements in long-term outcomes supports the beneficial effects of a personalized and adaptable home-based PR program. Further integration of the personality type into the program design might also improve patient adherence to the program.

Author contributions

JMG, LCD, and BW had full access to all data and take responsibility for the integrity of the data and the accuracy of data analysis, including and especially any adverse effects. JMG, LCD, AC, MVB, GT, OLR, and BW contributed substantially to the study design, data analysis and interpretation, and writing of the manuscript.

Disclosure of interest

JMG received financial support unrelated to the submitted work from VitalAire, Astra-Zeneca, Chiesi, Roche and Boehringer Ingelheim. OLR received financial and non-financial support from AstraZeneca, Boehringer Ingelheim, Chiesi, Lilly, and Novartis; and non-financial support from GlaxoSmithKline, MundiPharma, Pfizer, Teva, Santélys Association, Vertex, and VitalAire, all for services unrelated to the submitted work. BW received financial support from VitalAire, Roche, and Boehringer Ingelheim for services unrelated to the submitted work. The other authors declare that they have no competing interest.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at https://doi.org/10.1016/j.resmer.2019.12.001.

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