

Development and Validation of the AdT-Physio Scale: A Tool to Assess Adherence and Perception of Physical Therapist Intervention in Patients With Cystic Fibrosis

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Objective. The purpose of this study was to develop a scale to measure patient adherence to physical therapist intervention and to report psychometric properties in patients with cystic fibrosis (CF).

Methods. This observational, multicenter, qualitative, and cross-sectional study was divided into 2 phases: development of scale items (content validity) and assessment of psychometric properties (construct validity, reliability, and convergent/discriminant validity). Recruited were 121 patients with CF (aged ≥ 16 years). Sociodemographic characteristics, lung function testing, Coping with Stress Self-Efficacy, brief Coping Orientation to Problems Experienced inventory, and the scale of Adherence to Treatment of Physiotherapy (AdT-Physio) scale were evaluated.

Results. The final version of the AdT-Physio scale consists of 15 items distributed across 2 subscales: compliance and beliefs about treatment/therapist. The scale showed high internal consistency (Cronbach $\alpha = .897$; 95% CI = 0.868–0.922) and subscales above 0.800. The 2-factor confirmatory factor analysis model fitted the data reasonably well: $\chi^2(76) = 111.96$, comparative fit index = 0.982, Tucker-Lewis index = 0.978, root mean square error of approximation = 0.063, 95% CI = 0.036 to 0.086, and weighted root mean square residual = 0.720. No floor or ceiling effects were identified. There was a positive, significant, and moderate-low magnitude correlation with the total Coping Orientation to Problems Experienced inventory ($r = .360$) and Coping with Stress Self-Efficacy subscale efficacy expectations scores ($r = .304$). For discriminant validity, there was a positive, significant, and moderate correlation between the total and the age of the patients ($r = .354$).

Conclusions. The AdT-Physio scale is psychometrically valid and reliable for use in the clinic for the assessment of adherence to physical therapy in patients with CF.

Impact. Ultimately, the authors propose this documentary instrument to assess the evaluation of the therapeutic alliance in a valid and objective manner. The AdT-Physio scale provides us with a greater degree of understanding of the problems behind noncompliance with treatment to advance person-centered decisions in physical therapy and thereby enhance the effectiveness of care.

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[del Corral T, La Touche R, Cebrià i Iranzo MA, Olmos R, Blanco-Royano F, López-de-Uralde-Villanueva I. Development and validation of the AdT-physio scale: a tool to assess adherence and perception of physical therapist intervention in patients with cystic fibrosis. *Phys Ther*. 2020;100:2063–2074.]

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Published Ahead of Print:

August 5, 2020

Accepted: June 22, 2020

Submitted: December 2, 2019



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Cystic fibrosis (CF) is a life-limiting autosomal recessive disorder that affects the lungs, pancreas, liver, and intestine. In the last 50 years, medical and technological advances have increased the life expectancy of patients with CF, primarily through early diagnosis, improved health care, and the expanded range of treatment options. Daily CF management requires a complex, costly, and time-consuming regimen of therapies, typically consisting of chest physical therapy and exercise to clear secretions from the lungs, enzymes/vitamin supplements to ensure adequate nutrition, and oral and nebulized medication to assist lung function.¹ Adherence plays an important role in optimizing the outcomes of many treatment and preventive regimens in chronic illness; however, adhering to this regimen can be very difficult, given an adult treatment can amount to a median of 7 therapies totaling 108 minutes daily.²

The level of adherence to the medical regimen by patients with CF is variable.^{3–5} For example, a Spanish sample has reported the highest compliance for digestive treatment (88.2%) and respiratory medication (61.8%), with the lowest compliance for physical therapy (41.2%) and nutritional supplementation (59%).⁵ Chest physical therapy adherence, in particular, is generally reported to be poor (40%–55%).^{2,4–8} Reasons for adherence problems in patients with CF have been explored in various studies, reporting that treatment-related factors (the duration and the complexity of the treatment) and cognitive factors (worry, believing there is no need for treatment, and the low degree of confidence in medical practitioners) are important determinants of adherence.^{3,5,9} Also, the treatment adherence can fluctuate over time given that factors such as age have been shown to be associated with a reduction in adherence to treatment.⁹

The study outcomes on adherence to therapy in patients with CF have relied on subjective measures, including the use of parent and child self-reports (questionnaires and 5-point scales) and diary data,^{2–5,7,8,10} as well as objective measures, such as counting empty vials, reviewing prescription refill history, and using electronic monitoring technology.^{8,11} The majority of these studies used self-report questionnaires, and no information is provided on their psychometric properties. Only Oermann et al¹² had developed and validated an instrument measuring patient satisfaction with chest physical therapy. There are no published measures appropriate for adherence to CF treatment¹³; thus, it is difficult for physical therapists to determine the impact of their therapy on health status or to weigh the cost/benefit ratio. Furthermore, contrary to actual clinical outcomes, a large proportion of patients with CF believe that the practice of physical therapy does not produce beneficial effects,^{14,15} sometimes replacing physical therapy with exercise.^{5,16} This aspect highlights the importance of taking into account not only the beliefs of the physical therapist but also those of the patient

about their treatment/therapist, when prescribing a treatment.^{15,17} To our knowledge, however, the available self-report questionnaires to measure adherence are focused on compliance or on the patient's satisfaction; they do not address the adherence construct according to the various factors that affect compliance as described in the literature.⁹ Thus, it is necessary to develop some useful and objective measures that provide detailed, qualitative information that explores adherence to chest physical therapy from the perspective of compliance and patients' beliefs (including motivation, satisfaction, and expectations) about their treatment/physical therapist.

The aim of this study was to develop a scale to measure patients' adherence to physical therapy treatment and also to report psychometric properties (reliability and validity) in patients with CF. Validation and evaluation of their performance could contribute to a better understanding of nonadherence to physical therapy and to the development of new strategies to improve adherence to treatment.

Methods

The study was performed in 3 phases aimed at evaluating the internal and external validity of the instrument. Specifically, the first 2 phases comprised the development of scale items, item reduction, and a pilot test (content validity); the third phase aimed to assess the psychometric properties (construct validity, reliability, and convergent/discriminant validity) of the scale developed, following the general recommendation for CONsensus-based Standards for the selection of health Measurements INstruments guidelines.¹⁸ The process of scale development and content validity are presented in the [Supplementary Material](#).

Phase 3: Evaluation of Measurement Properties

Procedure. To perform this phase of the research, a multicenter, qualitative, observational and cross-sectional study was designed. This study included patients from CF associations in Madrid and Valencia, Spain, between 2014 and 2019 who were recruited using a method of consecutive sampling by convenience. To capture the real-life scenario of patients with CF, the only selection criteria established were as follows: patients with CF diagnosis, at least 16 years of age, no lung transplantation, and able to understand the questionnaires used. The study was conducted in accordance with the Declaration of Helsinki. All the study participants and/or their legal guardians signed an informed consent, and the study protocol was approved by the local independent ethics committee of the Centre for Advanced University Studies La Salle (CSEULS-PI-028/2013).

All patients who agreed to participate in the study, after completing a form related to sociodemographic characteristics and indicators of lung functioning (forced

spirometry report obtained from the medical record carried out in the last month), completed the self-reported questionnaires in random order.

Scale of Adherence to Treatment of Physical Therapy (AdT-Physio) (originally proposed version). The AdT-Physio scale consists of a total of 20 items aimed at evaluating adherence to physical therapy. To assess various aspects of adherence more specifically, the scale itself comprises 3 subscales: (1) compliance (items 2, 5, 7, 8, 11, 14, 16, 18, 19, and 20); (2) treatment expectations (items 1, 3, 6, 9, 13, 15, and 17); and (3) perception of the physical therapist (items 4, 10, and 12). The items are scored on a 1- or 4-point Likert-type scale (total disagreement, some disagreement, some agreement, or totally agree). All items are formulated directly/positively, except 11 and 14, which are inverse items. The total score is obtained by adding all the item scores; thus, the final value can range between 20 and 80. Higher values indicate better patient adherence to physical therapy.

Coping With Stress Self-Efficacy Scale. Perceived stress self-efficacy was assessed with the Escala de Autoeficacia para el Afrontamiento del Estrés (EAEAE), the validated Spanish version of the Coping with Stress Self-Efficacy scale, an 8-item assessment of personal resources for coping with challenges and threats in an effective and competent manner.¹⁹ The EAEAE shows appropriate reliability in its complete form as well as in its 2 subscales of efficacy expectations and outcome expectations.¹⁹ Patients were asked to rate on a 5-point scale, from completely disagree to completely agree, the extent to which they believe they could perform behaviors important to adaptive coping to handle the situation and to regulate emotion in various relevant life spheres. The total score is obtained by adding all the item scores; thus, the final value can range between 8 and 40. Higher scores indicate greater confidence in personal stress management resources.

Brief Coping Orientation to Problems Experienced (COPE) inventory. Levels of coping were assessed by the Spanish version of the brief Coping Orientation to Problems Experienced inventory, named COPE-28, a brief coping assessment that evaluates the various known responses relevant to effective or ineffective coping.²⁰ It is an inventory of 28 items answered on an ordinal Likert scale of 4 alternative answers, from 0 ("I never do this") to 3 ("I always do this"), with intermediate scores. The COPE-28 is made up of 4 subscales, all with adequate internal consistency (cognitive coping [Cronbach α = .74], social support coping [Cronbach α = .74], coping blockage [Cronbach α = .71], and spiritual coping [Cronbach α = .80]).²⁰ Scores were created by summing the ratings for each item, with the final result ranging from 0 to 84. Higher scores indicate a greater ability to cope with stress.

Statistical Analysis

Two researchers were involved in the analysis (I.L.-U.-V. and R.O.). Before the exploratory factor analyses were conducted, we calculated the Cronbach α coefficient for the entire scale and the adjusted item-test correlations. To determine whether Pearson's correlation matrix was factorizable, we used Barlett's test and the Kaiser-Meyer-Olkin (KMO) test. Due to the categorical metric of the items (4 categories in a Likert scale) and because the kurtosis and asymmetry showed non-normality, the exploratory factor analysis was estimated with a weighted least squares method. We used the weighted least squares mean and variance adjusted estimation method using Mplus software 7.11.²¹ To retain the correct number of factors, we used parallel analysis (Psych-R program) with the polychoric correlation matrix,²² and we used the following goodness of fit indices: comparative fit index (CFI) and Tucker-Lewis index (TLI) as comparative fit indices, root mean square error of approximation (RMSEA) as a parsimony fit index, and the χ^2 and standardized root mean square residual (SRMR) as absolute fit indices. To determine an acceptable model fit, we used Hu and Bentler criteria (TLI and CFI $\geq$ 0.95, RMSEA $\leq$ 0.06, and SRMR $\leq$ 0.08).²³ Finally, the geomin oblique rotation method was applied.

After an acceptable factor solution was found, a confirmatory factor analysis (CFA) was performed to validate our exploratory and preliminary solution. The CFA was performed with the same sample due to the difficulty of recruiting large sample sizes of patients with CF. However, the model was not exactly the same as the previous one (ie, the exploratory factor solution) because we adjusted a congeneric factor solution; that is, each of the scale items loaded only in 1 factor (all factor cross-loadings were fixed to zero). Modification indices were calculated to detect local mis-specified areas of the model not sensitive to the overall goodness-of-fit indices previously mentioned.²⁴

The floor/ceiling effect was evaluated to determine the degree of discrimination between various levels of adherence presented by the instrument: the percentage of patients obtaining the minimum or maximum possible scores on the AdT-Physio scale. If at least 15% of patients achieved the minimum/maximum score, the floor/ceiling effect was considered to be present.²⁵

Finally, we used other theoretically related measures to determine convergent and discriminant validity by using product-moment Pearson's correlation coefficient and by examining and discussing the direction and size of these correlations (convergent and discriminant validity). Specifically, convergent validity was assessed using the correlation between the AdT-Physio scale and the scales of coping/self-efficacy to stress (EAEAE and COPE-28). In the absence of validated scales to evaluate adherence to

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Table 1.
Anthropometric Characteristics, Pulmonary Function, and Scores Obtained on the Self-Reported Scales^a

Variables	Mean (SD)	Range (Min–Max)
Age (y)	29.39 (11.04)	16–62
Height (cm)	164.92 (9.3)	142–187
Weight (kg)	57.9 (10.63)	37–85.5
Lung function		
FVC (%)	82.33 (15.7)	39–114
FEV ₁ (%)	64.95 (20.48)	21–107.4
FEV ₁ /FVC	67.82 (15.33)	33–116
AdT-Physio (Final version, 14 items)		
Compliance	24.3 (5.87)	11–32
Beliefs about treatment/therapist	21.1 (2.98)	6–24
Total scale score	45.4 (7.86)	17–56
COPE-28		
Cognitive coping	13.84 (2.85)	7–22
Social support coping	10.68 (3.44)	1–18
Coping blockage	10.67 (4.28)	0–28
Spiritual coping	1.27 (1.91)	0–6
Total scale score	41.07 (8.22)	22–69
EAEAE		
Outcome expectations	12.03 (2.74)	5–20
Efficacy expectations	14.72 (2.52)	8–20
Total scale score	26.75 (4.16)	15–38

^aAdT-Physio = scale of Adherence to Treatment of Physiotherapy; COPE-28 = Coping Orientation to Problems Experienced-28; EAEAE = Spanish version of the Coping with Stress Self-Efficacy scale; FVC = forced vital capacity; FEV₁ = forced expiratory volume at the first second.

physical therapy, we chose variables related to coping/self-efficacy to stress because patients with CF have high levels of anxiety/depression.²⁶ Thus, patients with better stress management will have a better quality of life and probably better adherence to treatment. Discriminant validity was evaluated by the association of the AdT-Physio scale with age and with lung function because both variables are linked in the literature.⁹

Results

Initially, a total of 142 potential participants were contacted, of whom 21 were not included in the study: 6 had lung transplantation and 15 refused to participate. Thus, the final sample consisted of 121 patients with CF (58 men and 63 women), with a mean age of 29.39 ± 11.04 years and with a marked obstructive pulmonary function pattern. The average time to complete the AdT-Physio scale was 146 ± 25 seconds, with a response rate of 100%. Table 1 presents the anthropometric characteristics, pulmonary function, and scores obtained on the 3 self-reported scales of the included patients with CF.

Exploratory Factor Analysis

We calculated the Cronbach α coefficient for the entire scale ($\alpha = .895$) and the adjusted item-test correlations (average item-test correlations = .533). Items 6, 11, and 19 were excluded because they showed low item-test correlations ($<.400$) and because the alpha coefficient increased when removing them from the scale. The KMO showed an excellent data suite for factor analysis (KMO = .914). Also, Barlett's test rejected the identity matrix null hypothesis: $\chi^2 (136) = 1031.24$, $P < .001$. A parallel analysis with the polychoric correlation matrix suggested retaining 2 factors. The first empirical eigenvalues (8.28 and 1.97, respectively) were higher than the simulated eigenvalues (2.07 and 1.71, respectively). The goodness-of-fit indices showed that the 2-factor model fit well with the data: $\chi^2 (103) = 136.18$, $P = .016$, CFI = 0.966, TLI = 0.955, RMSEA = 0.052, 95% CI = 0.024 to 0.074, and SRMR = 0.042. Thus, all the criteria converged on the 2-factor solution (Tab. 2).

Factor 1 explains items 1, 2, 5, 7, 8, 14, 16, 17, 18, and 20; the theoretical contents of these items refer to compliance with therapy. In all these items, factor loadings were

Table 2.
Exploratory Factor Analysis Solution

Item	Factor 1	Factor 2
1. Realizar mi tratamiento de fisioterapia en casa hace que me sienta mejor. <i>Performing my physical therapy at home makes me feel better.</i>	.536 ^a	.324 ^a
2. Realizo los ejercicios según la prescripción del fisioterapeuta. <i>I perform the exercises according to the physical therapist's instructions.</i>	.665 ^a	.151
3. El tratamiento de fisioterapia que estoy realizando está bien estructurado. <i>The physical therapy I'm performing is well structured.</i>	.194	.483 ^a
4. Seguir las pautas indicadas por el fisioterapeuta hace que mi salud mejore. <i>Following the regimens indicated by the physical therapist improves my health.</i>	.244	.589 ^a
5. Realizo los ejercicios terapéuticos en el horario que el fisioterapeuta me lo ha indicado. <i>I perform the therapeutic exercises at the times indicated by the physical therapist.</i>	.745 ^a	-.012
6. El tratamiento de fisioterapia en casa es dinámico y poco rutinario. <i>The physical therapy at home is dynamic and not routine.</i>	-	-
7. El tiempo que dedico al tratamiento de fisioterapia es adecuado. <i>The time I dedicate to physical therapy is appropriate.</i>	.806 ^a	.046
8. Cumpla las indicaciones del fisioterapeuta relacionadas con los cambios de hábitos y conductas. <i>I follow the physical therapist's instructions regarding changes in habits and behaviors.</i>	.702 ^a	.132
9. El tratamiento de fisioterapia en casa es fácil de cumplir. <i>Physical therapy at home is easy to accomplish.</i>	.318 ^a	.360 ^a
10. La motivación que el fisioterapeuta me ofrece para que realice los ejercicios es adecuada. <i>The motivation provided by my physical therapist to perform the exercises is appropriate.</i>	.129	.556 ^a
11. En ocasiones me olvido de realizar los ejercicios. <i>I sometimes forget to perform the exercises.</i>	-	-
12. Las pautas e indicaciones que el fisioterapeuta me ha dado son adecuadas para mi problema. <i>The regimens and indications provided by the physical therapist are appropriate for my issue.</i>	-.071	.738 ^a
13. El tratamiento de fisioterapia se adapta bien a mis necesidades. <i>Physical therapy fits my needs well.</i>	-.009	.785 ^a
14. Realizo el tratamiento de fisioterapia solamente cuando me encuentro peor. <i>I perform the physical therapy only when I feel bad.</i>	.584 ^a	-.130
15. La exigencia de los ejercicios pautados es adecuada para mi problema. <i>The thoroughness of the prescribed exercises is appropriate for my condition.</i>	.066	.646 ^a
16. Aunque me siento mejor sigo realizando los ejercicios pautados. <i>Even when I feel better, I keep performing the prescribed exercises.</i>	.849 ^a	.004
17. Otros tratamientos no sustituyen los beneficios de la fisioterapia para mi problema. <i>Other treatments do not replace the benefits of physical therapy for my condition.</i>	.317 ^a	.175
18. Puedo cumplir el tratamiento sin supervisión de otras personas de mi entorno. <i>I can do the treatment without supervision from other individuals in my surroundings.</i>	.502 ^a	-.080
19. Utilizo alguna estrategia o recordatorio para realizar el tratamiento de fisioterapia prescrito. <i>I use a strategy or reminder to perform the prescribed physical therapy.</i>	-	-
20. Aunque me sienta indispuesto sigo realizando los ejercicios pautados. <i>Even when I do not feel like it, I keep performing the prescribed exercises.</i>	.886 ^a	-.125
Correlation	.511 ^a	

^a = $P < .05$; $N = 121$; Weighted least square mean and variance adjusted estimation method.

always $>.500$ (except item 17, which did not initially belong to this factor). Factor 2 explains items 3, 4, 9, 10, 12, 13, and 15 (and partially explains item 1, given its loading was $.324$, significantly different from zero). Factor loadings were $>.500$ except in item 3 ($.483$) and item 9 ($.360$). Factor 2 encompasses the 2 theoretically proposed constructors of expectations about treatment and perception of the physical therapist; thus, it was decided to call this factor belief about treatment/therapist.

Confirmatory Factor Analysis

As previously shown in Table 2, 2 items presented factor loading $<.400$: item 9 and item 17. Although neither item compromised model fit indices, they had very low communality; consequently, they were not very reliable observed indicators of their factors. In addition, item 1 is not a congeneric item because it loads onto 2 different factors. This item was also considered problematic because according to its content, it was more related to factor 2 than factor 1; however, its factor loadings were not consistent with this assumption. We thus decided to fit a 2-factor CFA model without these items to retain a congeneric solution (item 9 had another problem because it received significant factor loadings from both factors) and reliable observed indicators. The model fit the data reasonably well: $\chi^2(76) = 111.96$, $P = .0046$, CFI = 0.982, TLI = 0.978, RMSEA = 0.063, 95% CI = 0.036 to 0.086, weighted root mean square residual = 0.720. All standardized factor loadings were $>.500$ and many were $>.700$ (Tab. 3). Thus, the observed indicators were reliable measures of their scales. The correlation between the compliance and beliefs about the treatment/therapist factors was $r = .675$ ($P < .001$), showing a positive and substantive relationship between both subscales (Figure). In other words, patients with greater treatment compliance also had greater confidence/expectations about their physical therapist and/or the efficacy of the intervention. Finally, the internal consistency of the AdT-Physio scale was 0.897 (95% CI = 0.868–0.922), with its 2 subscales showing an internal consistency >0.800 (compliance, 0.891 [95% CI = 0.859–0.918]; and beliefs about the treatment/therapist, 0.827 [95% CI = 0.775–0.871]).

Final Version of AdT-Physio Scale: Floor and Ceiling Effects

The final version of the AdT-Physio scale consisted of a total of 15 items distributed across the 2 subscales as follows: (1) compliance (items 2, 5, 7, 8, 14, 16, 18, and 20); and (2) beliefs about treatment/therapist (items 3, 4, 10, 12, 13, and 15). All the items were formulated directly/positively, except item 14, which was a reverse item. The total score on the final version of the AdT-Physio scale can range from 14 to 56, in which a high score is indicative of better adherence to physical therapy. No floor or ceiling effects were identified for this final version of the scale because none of the patients had the

lowest possible score, and only 4.1% had the highest possible score.

Convergent and Discriminant Validity

The AdT-Physio scale showed a positive, significant, and moderately low magnitude correlation with the total COPE-28 and EAEAE scores (Tab. 4). Specifically, the subscale “compliance” was more related to total COPE-28 ($r = .360$) and its subscales “cognitive coping” ($r = .442$) and “spiritual coping” ($r = .269$). However, the subscale “beliefs about the treatment” showed a greater association with the EAEAE, especially with the subscale “efficacy expectations” ($r = .304$).

With respect to discriminant validity, there was a positive, significant, and moderate correlation between the score obtained in the AdT-Physio scale and the age of the patients with CF ($r = .354$). The forced expiratory volume at the first second (FEV₁) showed an inverse, significant, and small magnitude correlation with the score obtained in the AdT-Physio scale ($r = -.252$). However, only the subscale “compliance” was significantly correlated with the FEV₁ ($r = -.256$).

Discussion

This study describes the methodological process for the creation and subsequent validation of a new self-report instrument that evaluates adherence to physical therapy in patients with CF. In general terms, our results demonstrate that the AdT-Physio scale does not present problems in patient comprehension, it was established on a good theoretical basis, and it is psychometrically valid and reliable for use in the clinic. Thus, in terms of psychometric properties, we can affirm that the AdT-Physio scale meets the recommended minimum standards for patient-centered measures proposed by the International Society for Quality of Life Research.²⁷

Conceptual Model and Confirmation Analysis of Theoretical Construction

The theoretical construct was mainly developed according to the literature related to adherence in patients with CF.^{9,28} It was also strongly influenced by the studies of Higgins et al²⁹ and Bright et al³⁰ in which the concept of commitment in the therapeutic context had been discussed and revised.^{29,30} In contrast to our theoretical model, an exploratory factor analysis showed the presence of 2 factors instead of the 3 that were initially proposed (compliance, expectations about treatment, and perception about the physical therapist). Specifically, the exploratory factorial analysis proposed a fusion of the construct expectations about treatment and perception about the physical therapist into a single factor that we called beliefs about treatment/therapist. Both constructs include aspects related to the patient's satisfaction with the therapeutic approach, to the motivation generated by the therapist to fulfill the tasks, and to the expectations of

Table 3.
Confirmatory Factor Analysis Solution

Item	Factor 1 Compliance	Factor 2 Beliefs About Treatment/Therapist
Item 2 Realizo los ejercicios según la prescripción del fisioterapeuta. <i>I perform the exercises according to the physical therapist's instructions.</i>	.820 ^a	
Item 5 Realizo los ejercicios terapéuticos en el horario que el fisioterapeuta me lo ha indicado. <i>I perform the therapeutic exercises at the times indicated by the physical therapist.</i>	.792 ^a	
Item 7 El tiempo que dedico al tratamiento de fisioterapia es adecuado. <i>The time I dedicate to physical therapy is appropriate.</i>	.876 ^a	
Item 8 Cumpro las indicaciones del fisioterapeuta relacionadas con los cambios de hábitos y conductas. <i>I follow the physical therapist's instructions regarding changes in habits and behaviors.</i>	.826 ^a	
Item 14 Realizo el tratamiento de fisioterapia solamente cuando me encuentro peor. <i>I perform the physical therapy only when I feel bad.</i>	.601 ^a	
Item 16 Aunque me siento mejor sigo realizando los ejercicios pautados. <i>Even when I feel better, I keep performing the prescribed exercises.</i>	.900 ^a	
Item 18 Puedo cumplir el tratamiento sin supervisión de otras personas de mi entorno. <i>I can do the treatment without supervision from other individuals in my surroundings.</i>	.504 ^a	
Item 20 Aunque me sienta indispuesto sigo realizando los ejercicios pautados. <i>Even when I do not feel like it, I keep performing the prescribed exercises.</i>	.856 ^a	
Item 3 El tratamiento de fisioterapia que estoy realizando está bien estructurado. <i>The physical therapy I'm performing is well structured.</i>		.756 ^a
Item 4 Seguir las pautas indicadas por el fisioterapeuta hace que mi salud mejore. <i>Following the regimens indicated by the physical therapist improves my health.</i>		.862 ^a
Item 10 La motivación que el fisioterapeuta me ofrece para que realice los ejercicios es adecuada. <i>The motivation provided by my physical therapist to perform the exercises is appropriate.</i>		.701 ^a
Item 12 Las pautas e indicaciones que el fisioterapeuta me ha dado son adecuadas para mi problema. <i>The regimens and indications provided by the physical therapist are appropriate for my issue.</i>		.750 ^a
Item 13 El tratamiento de fisioterapia se adapta bien a mis necesidades. <i>Physical therapy fits my needs well.</i>		.792 ^a
Item 15 La exigencia de los ejercicios pautados es adecuada para mi problema. <i>The thoroughness of the prescribed exercises is appropriate for my condition.</i>		.779 ^a
Cronbach α	.891	.827

^a = $P < .01$; N = 121; Weighted least square mean and variance adjusted estimation method.

the effectiveness of the treatment. The explanation for fusion could indirectly lie in the concept of therapeutic alliance in which the patient-therapist relationship (eg, interpersonal attributes, attention received, individualization of the treatment) are key determinants in terms of satisfaction with the treatment received³¹ in addition to being able to impact the treatment results due to increased adherence.^{32,33} On the other hand, the factor compliance did not present changes with respect to the proposed theoretical model, probably because it is a simpler construct based on the authority of the health care provider (biomedical knowledge).³⁴

After eliminating items 9 and 17 for having a factor loading $< .400$ and for their low communality, the confirmatory factorial analysis supported the presence of the 2 factors proposed in the exploratory analysis. In fact, the model established in the confirmatory analysis showed a correct statistical fit.²⁴ In addition, the 2 subscales constituting the AdT-Physio scale (compliance and beliefs about the treatment/therapist) showed a strong relationship ($r = .675$). Thus, this finding reinforces studies that have established a strong influence of the patient's beliefs about the treatment/therapist on strict adherence to the prescribed treatment.^{15,17} In fact,

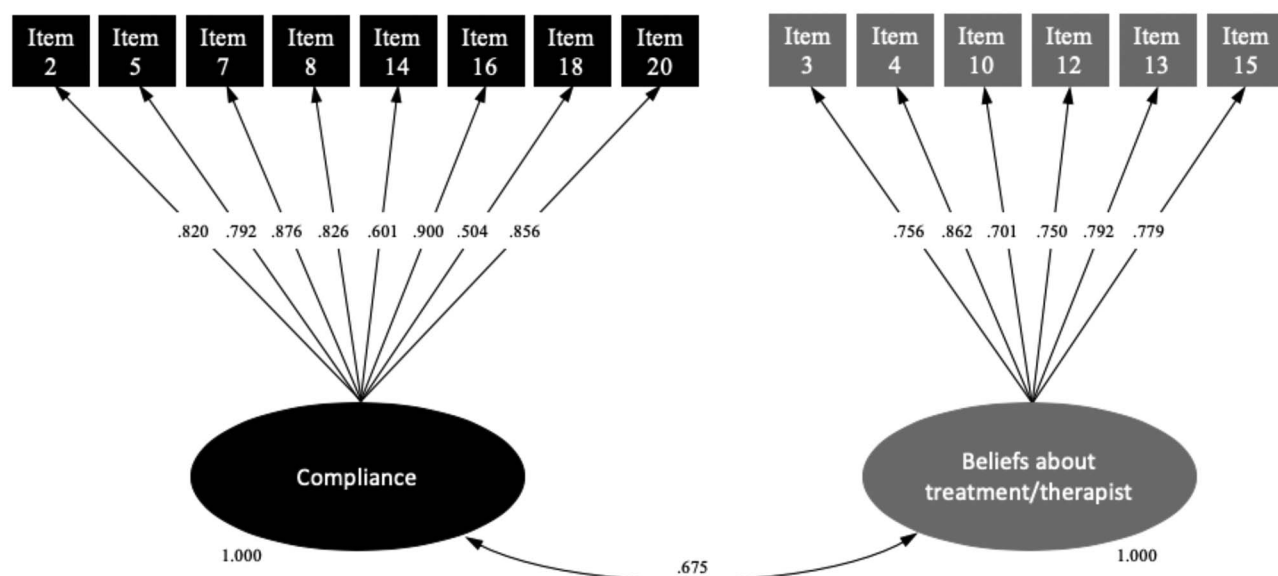


Figure.
Structural equation modeling for the final version of AdT-Physio scale.

Table 4.
Convergent and Discriminant Validity of the AdT-Physio Scale^a

Variables	AdT-Physio Scale		
	Total Score	Compliance	Beliefs About Treatment/Therapist
Convergent validity			
COPE-28			
Cognitive coping	0.454 ^b	0.442 ^b	0.328 ^b
Social support coping	0.147	0.152	0.089
Coping blockage	0.055	0.062	0.023
Spiritual coping	0.282 ^b	0.269 ^b	0.214 ^b
Total scale score	0.365 ^b	0.360 ^b	0.255 ^b
EAEAE			
Outcome expectations	0.009	0.003	0.029
Efficacy expectations	0.311 ^b	0.262 ^b	0.304 ^b
Total scale score	0.200 ^b	0.157	0.203 ^b
Discriminant validity			
Age (y)	0.354 ^b	0.323 ^b	0.298 ^b
FEV ₁ (%)	-0.252 ^b	-0.256 ^b	-0.163

^a AdT-Physio = scale of Adherence to Treatment of Physiotherapy; COPE-28 = Coping Orientation to Problems Experienced-28; EAEAE = Spanish version of the Coping with Stress Self-Efficacy scale; FEV₁ = forced expiratory volume at the first second.

^b Statistically significant.

along the same lines as our results, previous studies have reported a close relationship between satisfaction with treatment and the degree of compliance with the prescribed treatment.^{33,35,36}

Internal Consistency

The internal consistency shown for both the AdT-Physio scale (Cronbach $\alpha = .897$) and their subscales (compliance, Cronbach $\alpha = .891$; and beliefs about the treatment/therapist, Cronbach $\alpha = .827$) was adequate. To the authors' knowledge, there are no validated questionnaires that assess a theoretical construct similar to ours.⁹ In fact, the few reports available in the literature that also measure adherence among patients with CF and other pathologies did not analyze internal consistency or had psychometric deficits; thus, they can be considered low quality.^{3,37–39} However, there are currently questionnaires that evaluate aspects similar to the subconstructs proposed in the AdT-Physio scale that show an internal consistency similar to our results. For example, in the study by Oermann et al,¹² satisfaction with chest physical therapy treatment in patients with CF was evaluated by use of a questionnaire, demonstrating good internal consistency for the instrument (Cronbach $\alpha = .87$). Adequate results have also been observed in various instruments used to measure exercise adherence in the therapeutic context of musculoskeletal pathology, such as the Hopkins Rehabilitation Engagement Rating Scale (Cronbach $\alpha = .91$),⁴⁰ Injury Rehabilitation Overadherence (Cronbach $\alpha = .76$),⁴¹ the Sport Injury Rehabilitation Adherence Scale (Cronbach α range = 0.82–0.8),⁴² and the redevelopment and validation of the Rehabilitation Adherence Questionnaire (Cronbach α range = .79–.87).⁴³

Understanding the AdT-Physio Scale and Floor and Ceiling Effects

Regarding the responses, specifically in the section on response rate analysis, it was observed that 100% of the items were answered. The good response rate could be due to the appropriate wording of the items and the good understanding shown by the patients; however, it could also be due to the small number of items that comprise the instrument. Consistent with this hypothesis, a meta-analysis developed by Rolstad et al⁴⁴ found an association between response rate and questionnaire length, observing a lower response rate in longer questionnaires.

The content validity could be considered adequate given a qualitative phase was performed for the creation of the instrument and its comprehension was verified, rigorously following the guidelines established by Patrick et al.⁴⁵ In addition, reinforcing the good content validity of the AdT-Physio scale, no floor/ceiling effect of the instrument was observed given neither of these effects was present in

more than 15% of the 121 patients with CF who were evaluated.²⁵

Convergent and Discriminant Validity

The analysis of the convergent validity showed a positive low-moderate correlation between the AdT-Physio scale and the COPE-28 and EAEAE scales. Cognitive coping showed the greatest association with adherence to physical therapy. Reinforcing the validity of the content of the AdT-Physio scale, there are studies supporting a link between adherence to treatment and coping through cognitive aspects (evaluated in this subscale of COPE-28) such as acceptance, optimism, and active coping.^{46,47} In addition, as in previous studies, our results showed that patients with greater spiritual/religious coping present a greater degree of adherence.^{48–50} On the other hand, adherence also slightly correlated with the self-efficacy of coping with stress, especially with the subscale efficacy expectations. Possibly, as with adherence to pharmacological treatment for CF,⁵¹ expectations and beliefs about treatment influenced adherence. Finally, with respect to discriminant validity, adherence to treatment was greater in older patients with CF. This finding is supported by previous literature reporting a lower degree of adherence in adolescents compared with young adults.^{52–54} In addition, patients with CF with more impaired lung function (FEV₁) had higher adherence to treatment. This finding reinforces the discriminant validity of the AdT-Physio scale, as lung function has been proposed as a marker of adherence to treatment in previous studies conducted in patients with CF.^{9,28,55} However, it is important to note that our results may provide additional information, as they show how the subscale “compliance” may be more relevant than the subscale “beliefs about the treatment/therapist” in the relationship between lung function and treatment adherence. In this way, motivated by fear, patients can achieve strict compliance to treatment with the aim of minimizing deterioration and/or progression of lung involvement. However, the correlation between lung function and adherence to treatment (although significant) was poor, so these interpretations should be taken with caution.

Clinical Implications and Limitations

The evidence shows the importance of adherence to treatment to improve the patient's clinical condition and reduce the costs of managing CF.⁹ To our knowledge, the AdT-Physio scale, as reported in the literature, is currently the best documentary instrument available to assess adherence in a valid and objective manner by paper administration mode. In addition, the AdT-Physio scale evaluates various relevant aspects in the process of adherence to treatment, including not only compliance in the strictest sense but also the patient's beliefs about the treatment/therapist.^{15,17,56} This last theoretical constructor could allow the partial and indirect evaluation of the

degree of therapeutic alliance.²⁹ In this way, the AdT-Physio scale, in addition to being useful for determining adherence to treatment, provides us with a greater degree of understanding of the problems behind noncompliance with treatment. For example, the detection of a very low score in the beliefs subscale would indicate that we must modify certain aspects or the approach to treatment to improve these beliefs and therefore the adherence to the treatment. As a strength of the study, we have facilitated the translation and retrotranslation of the AdT-Physio scale following the criteria established by Wild et al.⁵⁷ We hope that future studies will perform the cross-cultural validation of the scale, evaluating its psychometric properties among English speakers. In this way, more clinicians could benefit from the use of this new tool in an attempt to understand and improve the efficacy of and adherence to various interventions.⁵⁸

This study has some limitations. First, CFA was performed on the same sample due to the difficulty of recruiting large samples from patients with CF. However, the model used was very conservative in an attempt to overcome this limitation. Second, the evaluation of adherence by self-report could be questionable given an overestimation of the adherence to pharmacological treatment using this type of instrument has been reported.^{8, 8,59} In any case, the self-report appears to be the only way to evaluate adherence to treatment from a global perspective that includes the patient's beliefs about the intervention/therapist. Additionally, the AdT-Physio scale could be used in conjunction with more objective and/or less memory-biased treatment adherence measures (eg, specialized airway clearance devices or patient-report apps that collect data in real time). This would provide a more comprehensive assessment of treatment adherence, which is critical in the clinical setting, and especially in the research setting, because these more objective measures are generally more costly and/or burdensome to patients. Third, given there are currently no instruments available to evaluate adherence to treatment,⁹ convergent validity was evaluated by using theoretical constructors related to adherence,²⁶ which could have influenced the results.⁶⁰ Finally, it is important to mention that this study only evaluated the validity of the psychometric properties of the AdT-Physio scale in patients with CF aged 16 years of age or older. Thus, the AdT-Physio scale would require adaptation for use by either parent- or self-report in children and adolescents younger than 16 years of age.

The AdT-Physio scale is a valid and reliable tool for assessing the adherence to chest physical therapy in patients with CF. Based on the findings of this study, the AdT-Physio scale could be used in clinical practice and in additional research studies to evaluate adherence to treatment. Future studies are warranted to evaluate the psychometric properties of the AdT-Physio scale in other languages as well as when the scale is applied in other clinical entities.

Author Contributions and Acknowledgments

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The authors thank all of the patients, physicians (Dr López Andreu, Dr Cortell Aznar, Unidad de Fibrosis Quística del Hospital Universitari i Politècnic La Fe, Valencia [SPAIN], and Dra. M^a Teresa Martínez, Unidad de Fibrosis Quística del Hospital Universitario 12 de Octubre, Madrid), the physical therapist (Nuria Cañas de Dios), and the psychologist (Beatriz Monfort Gil) who participated in this study.

Ethics Approval

This study was approved by the local ethics committee of the Center for Advanced Studies University La Salle, Madrid, Spain (CSEULS-PI-028/2013).

Funding

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Disclosures

The authors completed the ICMJE Form for Disclosure of Potential Conflicts of Interest and reported no conflicts of interest. The authors certify that they have no affiliations with or financial involvement in any organization or entity with a direct financial interest in the subject matter or materials discussed in the article.

<https://doi.org/10.1093/ptj/pzaa136>

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