

# Validation of the Spanish Activity Questionnaire in COPD (SAQ-COPD) in Patients with Chronic Obstructive Pulmonary Disease

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**Purpose:** The Spanish Activity Questionnaire in COPD (SAQ-COPD) is a short, simple physical activity (PA) measurement instrument for patients with chronic obstructive pulmonary disease (COPD). In this study, we analyzed its validity and sensitivity to change.

**Methods:** Prospective scale validation study. An accelerometer (DynaPort MoveMonitor<sup>®</sup>) and the Yale Physical Activity Survey (YPAS) were used as reference standards. The analyses examined the criterion validity (Spearman correlations), internal consistency (Cronbach's alpha), factorial structure, test-retest reliability (intraclass correlation coefficient, ICC), sensitivity to change and receiver operating characteristic (ROC) curve to classify patients with low PA.

**Results:** A total of 300 patients diagnosed with COPD were analyzed (73% males, mean age  $66 \pm 8$  years, 40.3% with severe airflow limitation). Cronbach's alpha was 0.60 and Spearman's correlations with accelerometer measurements of PA [number of steps, metabolic equivalents (MET), physical activity level (PAL)] and YPAS ranged from 0.37 to 0.53 (all  $p < 0.001$ ). ICC was 0.69 (95% CI 0.61–0.74) and the area under the ROC curve to identify low PA was 0.65 (95% confidence interval: 0.58–0.73). Significant variations in SAQ-COPD scores were found between groups defined by YPAS for change.

**Conclusion:** The SAQ-COPD questionnaire is a valid instrument for classifying PA in patients with COPD. Correlations with other instruments provide criterion validity and also demonstrate good sensitivity to change.

**Keywords:** physical activity, chronic obstructive pulmonary disease, SAQ-COPD, validity, reliability

## Introduction

Research conducted in the last decade on physical activity (PA) has positioned it as a key factor in the course of chronic obstructive pulmonary disease (COPD).<sup>1</sup> It is therefore increasingly necessary to assess the role played by pathophysiological abnormalities derived from the disease and psychological, behavioral, cultural, and social factors in the eventual decrease in PA in patients with COPD.<sup>2,3</sup>

It is known that COPD patients have lower PA levels than healthy individuals of the same age.<sup>4</sup> This decrease in activity begins in the early stages of disease,<sup>5</sup> even before the onset of dyspnea,<sup>6</sup> and is a predictor of poor prognosis, including hospitalizations, mortality<sup>7,8</sup> and health-related quality of life.<sup>9</sup> Fortunately, the lack of PA in patients with COPD is a potentially treatable condition that constitutes an important therapeutic goal.<sup>3</sup> Therefore, current research focuses on optimizing its identification for the promotion of both pharmacological and non-pharmacological therapeutic interventions.

PA in COPD can be quantified by specific monitors and questionnaires. Although objective measures of the amount and frequency of activity recorded by pedometers or accelerometers are increasingly rigorous, they are limited for capturing the multifactorial nature of PA, the symptoms experienced by patients while they are active, or patient

adaptation mechanisms to overcome their limitations.<sup>10</sup> In addition, they are relatively expensive and difficult to use in daily practice.<sup>11</sup> In contrast, questionnaires based on subjective patient perception and recall measures allow patients to be categorized according to their PA level,<sup>12</sup> but have limitations for evaluating activity patterns or detecting small changes in daily PA.<sup>13</sup> In other words, they can classify PA but do not adequately rate or quantify it. Monitors and questionnaires are therefore complementary instruments, and it has been proposed to create and validate hybrid instruments, which combine a questionnaire and activity monitors,<sup>13</sup> as these have shown valid and reliable results in different clinical situations, as well as their capacity to respond to pharmacological and non-pharmacological interventions.<sup>14</sup>

However, clinical practice requires simple, accessible, and easily applicable tools that allow a comprehensive assessment of PA in patients with COPD, based on total activity, amount and difficulty. One of the limitations for the use of PA questionnaires is that there are no standardized instruments sensitive to the low-intensity activities typical of patients with chronic respiratory diseases. Tools sensitive to changes in activity in these patients are therefore needed to assess therapeutic interventions and be feasible for use in all health-care settings.<sup>15</sup>

With this objective, a multidisciplinary panel of pulmonologists and primary care, sports medicine and rehabilitation physicians developed a PA questionnaire for patients with COPD called SAQ-COPD (Spanish Physical Activity in COPD).<sup>16</sup> This questionnaire aims to quantify the PA performed and to explore its main limiting factors and the patient's attitude to it. To assess its usefulness in clinical practice, the purpose of this study was to perform the initial validation of the SAQ-COPD questionnaire in patients with COPD, using as reference elements the objective measurement of PA by an accelerometer and another questionnaire previously validated in this disease.

## Methods

This is a prospective, observational, scale validation study conducted between September 2018 and October 2020, involving 13 centers, 11 specialist care centers and 2 primary care centers, in 8 Spanish autonomous communities. The study was approved by the Ethics Committee of the Hospital Universitario La Paz (Madrid), with number of ethical approval PI-3011. All patients gave their written informed consent to participate, complying with the Declaration of Helsinki.

Enrolled patients had a diagnosis of COPD ( $FEV_1/FVC < 0.7$ , smoking history of at least 10 pack-years and chronic respiratory symptoms). Patients were consecutively selected at the participating centers in an attempt to maintain the same proportion of patients in terms of severity of airflow limitation according to the Global Initiative for Chronic Obstructive Lung Disease criteria (GOLD 2017).<sup>17</sup> Main exclusion criteria were presence of limitations, physical handicaps or medical conditions requiring rest, mental or cognitive impairment that prevented completion of the questionnaire, institutionalization, treatment with continuous home oxygen therapy without available portable oxygen concentrators or liquid oxygen, and occurrence of a moderate-to-severe COPD exacerbation in the four weeks before inclusion.

The study was conducted in 6 visits during 6 months of follow-up: visit 1 at day -7 (screening), visit 2 at day 0 (baseline), visit 3 at day 7 (administration of the accelerometer for test-retest), visit 4 at day 14 (test-retest), visit 5 at day 173 (administration of the accelerometer for sensitivity to change) and visit 6 at day 180 (sensitivity to change).

## SAQ-COPD Questionnaire

The expert committee had previously developed the SAQ-COPD questionnaire using a methodology of selection by rounds (Delphi method) with subsequent discussion of the outcome.<sup>16</sup> The SAQ-COPD questionnaire is divided into two blocks. The first block of 4 items measures PA in four categories: low, moderate, intense and inactivity. Each item is rated on a 0 to 5 Likert scale based on the average daily time spent performing the PA represented by each category in the last 7 days. The score for each PA category is obtained by multiplying the Likert scale value by the number of days indicated, with the minimum score ranging from 0 to 35. The total score is the sum of the scores obtained in each category, with a range between 0 and 140. The second block evaluates the profile and the impact only in patients classified as having

low PA in the first block. SAQ-COPD questionnaire was administered by clinician at baseline, at visit 4 after 14 days for test-retest and at visit 6 after 6 months for sensitivity to change.

## SAQ-COPD Validation Tools

### Accelerometer

The DynaPort MoveMonitor<sup>®</sup> accelerometer (McRoberts, B.V Raamweg 43, 2596 HN Den Haag, Netherlands) was used because of its high validity to estimate energy expenditure and discriminate between different walking speeds in patients with COPD.<sup>18</sup>

Patients had to place the accelerometer in the lateral-dorsal region of their waist and use it for 7 consecutive days, with the minimum time of use defined as at least 3 days on which 70% or more of the daytime period was recorded. At 7 days of the accelerometer recording, patients completed the SAQ-COPD,<sup>16</sup> since the questions referring to the previous 7 days coincided with the period of use of this instrument. The number of steps per day, physical activity time (hours/day), intensity (MET-h/day), energy expenditure (kcal), and basal metabolic rate (kcal) were obtained for each patient. Physical Activity Level (PAL) is the relationship between total energy expenditure and basal metabolic rate of accelerometer placement periods. Patients placed the accelerometer during 7 days between the screening and baseline visits, between visits 3 and 4, and between visits 5 and 6. Accelerometer measures were registered at baseline, at visit 4 and at visit 6.

### Yale Physical Activity Survey (YPAS)

The validated Spanish version<sup>19</sup> of the YPAS<sup>20</sup> was used. This questionnaire measures the volume, frequency and intensity of PA in a wide list of activities performed in the past 4 weeks based on the daily time spent in the activity (hours) and energy expenditure in the activity. The 7 questions of the questionnaire, which combine frequency and intensity of activities, provide an activity summary index ranging from 0 to 137, with a cut-off point for discriminating sedentary patients of 51.<sup>19</sup> YPAS questionnaire was administered by the clinician at baseline and at visit 6 after 6 months for sensitivity to change.

## Other Variables of Interest

Sociodemographic, clinical characteristics of patients and main comorbidities were collected at baseline. Responses to CAT (COPD assessment test) questionnaire on health-related quality of life<sup>21</sup> were collected at baseline and at 6 months. At baseline, a 6-minute walk test was performed in duplicate, according to the recommendations of the American Thoracic Society,<sup>22</sup> and the 5-STST (five-repetition sit-to-stand test)<sup>23</sup> that measures the time taken by the patient to rise five times from a chair, thus allowing examination of lower limb function.

## Statistical Analysis

Sociodemographic and clinical characteristics of patients are presented using descriptive statistics. Normally distributed quantitative variables are reported as mean and standard deviation, and qualitative variables as numbers and percentages.

The validation process integrated the analysis of feasibility, validity, reliability and sensitivity to change. For the feasibility analysis, we used the time taken to complete the questionnaire reported in the development study (4.53 min),<sup>16</sup> the percentage of patients with no missing data in the questionnaire, the percentage of patients with no missing data in each dimension, and the variability of responses using the ceiling-floor effect. A ceiling or floor effect was considered when 15% or more responses accumulated at the higher or lower values, respectively.

The validity of the questionnaire was based on: a) concept validity, already analyzed in the opinion of the experts during the creation of the questionnaire;<sup>16</sup> b) criterion validity using the reference standards: accelerometer and YPAS; c) construct validity using the Varimax rotation method to aid responses grouping according to underlying (latent) factors that identify the possible dimensions, and to determine the unidimensionality of the instrument.

The overall internal consistency was assessed with baseline score using Cronbach's alpha statistical method. Test-retest or intra-observer reliability was examined in patients who remained stable between baseline and test-retest visits, considering "stability" as any change lower or equal in absolute value to the standard deviation of the accelerometer

physical activity level (PAL) parameter. The intraclass correlation coefficient (ICC) is presented. Interobserver reliability was obtained using the *t*-test statistic.

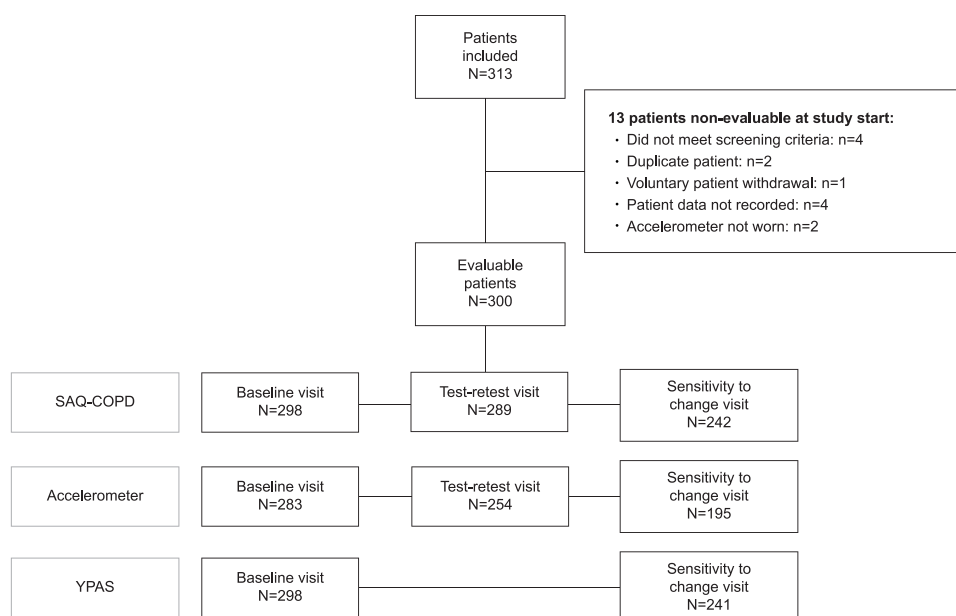
As measures of sensitivity to change, the means in SAQ-COPD score in stable or non-stable patients according to YPAS are presented. Cohen criteria were used to estimate the effect size and quantify the difference in means. Diagnostic sensitivity and specificity to discriminate inactive patients from active patients were obtained by analyzing ROC curves using as reference standards the number of steps and PAL of the accelerometer. The cut-off points chosen to classify the population as inactive or active were 6000 steps and 1.7 PAL, respectively.

## Results

Of 313 patients recruited, 300 were finally evaluated (Figure 1). Table 1 shows the main anthropometric and clinical characteristics. Patients were mainly aged 70–80 years, predominantly male, from urban areas and retired, with moderate comorbidities and moderate-to-severe airflow limitation. Most were in groups A and B of the GOLD classification and were ‘non-exacerbators’.

Patients recorded a mean number of steps per day of  $7108 \pm 4329$ , and the PAL measured using the accelerometer was  $1.7 \pm 0.2$  (Table 2). Using cut-off point 51 for the YPAS activity summary index score,<sup>24</sup> 70.5% of patients were classified as sedentary. According to SAQ-COPD, 77.3% of patients performed at least 30 minutes of low-intensity PA daily and 31.5% performed at least 30 minutes of moderate PA, while only 18.8% performed some type of intense PA on a daily basis (Supplementary Figure 1). A total of 81.2% of patients who did not perform any type of intense PA were in the lowest score range of the intense PA dimension, causing a floor effect. No significant differences were found in mean PAL, MET and daily number of accelerometer steps according to the intense PA category of the SAQ-COPD (Supplementary Table 1).

Internal consistency of the SAQ-COPD total score showed a Cronbach’s alpha of 0.60. Correlations between SAQ-COPD scores and the accelerometer and YPAS ranged from 0.37 to 0.53 (Table 3), with the YPAS activity summary index being the strongest. Supplementary Table 2 shows correlations for baseline scores between accelerometer and YPAS reference standards ranging from 0.21 to 0.38, with the greatest association between the YPAS activity summary index and accelerometer METs. Correlations between accelerometer and YPAS were obtained for follow-up scores ranging from 0.24 to 0.36 (Supplementary Table 3).



**Figure 1** Flow chart.

**Abbreviations:** SAQ-COPD, Spanish Activity Questionnaire in COPD; YPAS, Yale Physical Activity Scale.

**Table I** Sociodemographic and Baseline Clinical Data in the Study Population

Characteristic	Total (n=300)
<b>Sociodemographic data</b>	
Age, years	66.6 ± 8.2
Male	219 (73)
Dependency status	
Lives with another person and is independent	234 (78)
Lives with another person and is dependent on a family member or caregiver	6 (2.0)
Lives alone and is independent	58 (19.3)
Lives alone and is dependent on a family member and/or caregiver	2 (0.7)
Area of residence	
Urban	227 (75.7)
Semi-urban	46 (15.3)
Rural area	27 (9)
Employment status*	
Retired	196 (67.1)
Active	72 (24.7)
Unemployed	24 (8.2)
<b>Clinical data</b>	
BMI, kg/m <sup>2</sup>	27.1 ± 4.5
Frequent comorbidities (>5%)	
Diabetes	29 (9.7)
Myocardial infarction	25 (8.3)
Solid tumor or neoplasm	20 (6.7)
Peripheral arterial disease	18 (6.0)
Smoking habit <sup>†</sup> : active smoker	66 (22.1)
Dyspnea grade (mMRC scale)	217 (72.3)
Grade 0	26 (8.7)
Grade 1	153 (51.0)
Grade 2	96 (32.0)
Grade 3	25 (8.3)
Airflow limitation (according to GOLD)	
Mild	66 (22)
Moderate	113 (37.7)
Severe	121 (40.3)
Type of patient according to GOLD (A, B, C, D)	
Group A: Few symptoms, low risk of exacerbations	134 (44.7)
Group B: More symptoms, low risk of exacerbations	83 (27.7)
Group C: Few symptoms, high risk of exacerbations	35 (11.7)
Group D: More symptoms, high risk of exacerbations	48 (16.0)
Number of exacerbations in the past year	
Moderate	0.6 ± 1.1
Severe	0.2 ± 0.5
Pulmonary function	
Post-bronchodilator FEV <sub>1</sub> (% predicted)	58 ± 21
DLCO (% predicted) <sup>‡</sup>	62 ± 22
FRC (% predicted) <sup>‡</sup>	171.8 ± 37.4
RV (% predicted) <sup>‡</sup>	202.8 ± 61.3
TLC (% predicted) <sup>‡</sup>	123.3 ± 20.0
Distance walked in 6-minute walk test (m) <sup>‡</sup>	443 ± 102
5STS (s) <sup>‡</sup>	11.8 ± 3.6
Impact of COPD on health status (COPD Assessment Test) (score range: 0–40)*	12.2 ± 7.2

**Notes:** Data are expressed as mean ± SD and n (%). \*Missing data: employment status (n=8); smoking habit (n=1); TLC (n=197); FRC (n=198); RV (n=197); CAT score (n=2); <sup>‡</sup>N analyzed: DLCO, n=152; 6-minute walk test, n=207; 5STS, n=292. <sup>†</sup>Values expressed according to their theoretical value using the 2021 Global Lung Initiative (GLI) reference values (Hall et al. *Eur Respir J.* 2021).

**Abbreviations:** 5STS, five-repetition sit-to-stand test; CAT, COPD assessment test; DLCO, diffusion capacity of the lung; FEV<sub>1</sub>, forced expiratory volume in one second; FRC, functional residual capacity; FVC, forced vital capacity; GOLD, Global Initiative for Chronic Obstructive Lung Disease; mMRC, modified dyspnea scale of the Medical Research Council; RV, residual volume.

**Table 2** Estimation of Daily PA in the Study Population

	Total (n=300)
<i>Physical activity of accelerometer (DynaPort MoveMonitor®)*</i>	
Number of steps (n/day)	7108 ± 4329
MET in activity (MET-h/day)	1.4 ± 0.17
Physical activity level (PAL)	1.7 ± 0.19
<i>YPAS physical activity</i>	
Time in any activity (h/week) *	32.5 ± 24.2
Energy expenditure in activity (kcal/week) * <sup>‡</sup>	8482 ± 6678
Physical activity summary index*	43.1 ± 23.4
<i>SAQ-COPD physical activity*</i>	
Low PA dimension	20.5 ± 9.3
Moderate PA dimension	14.9 ± 12.3
Intense PA dimension	2.6 ± 7.1
Inactivity dimension	17.3 ± 7.8
Total	55.3 ± 25.3

**Notes:** Data are expressed as mean ± SD. \*Missing data: physical activity of the accelerometer (n=17); YPAS time in any activity (n=4); YPAS energy expenditure (n=4); YPAS physical activity summary index (n=2); SAQ-COPD physical activity (n=2). <sup>‡</sup>Value calculated by multiplying the number of hours spent on each activity by the corresponding metabolic equivalents for each activity (MET) (Ainsworth, BE et al. *Med Sci Sports Exerc.* 2021) by patient weight.

**Abbreviations:** PA, physical activity SAQ-COPD, Spanish Activity Questionnaire in COPD; TLC, total lung capacity; YPAS, Yale Physical Activity Survey.

**Table 3** Correlation Between SAQ-COPD and Accelerometer PA Measurements and YPAS

	Accelerometer			YPAS		
	Number of steps (n/day)	MET in activity	PAL	Time in activity (hr/wk)	Energy expenditure in activity (kcal/wk)	Physical activity summary index
<b>SAQ-COPD Questionnaire</b>	0.39**	0.45**	0.37**	0.42**	0.48**	0.53**

**Note:** Spearman correlation coefficient. \*\*p < 0.001.

**Abbreviations:** MET, metabolic equivalents; PA, physical activity; PAL, physical activity level; SAQ-COPD, Spanish Activity Questionnaire in COPD.

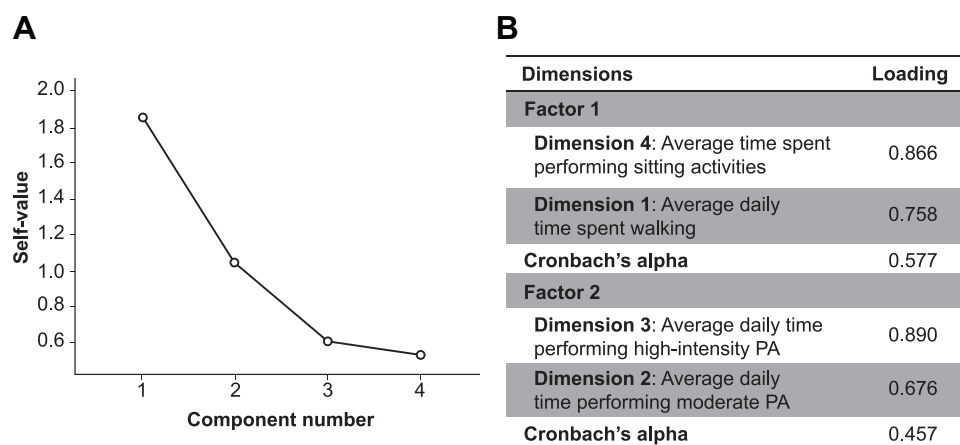
Analysis of construct validity found 2 factors with a cumulative variance explanation exceeding 70% (Figure 2). Cronbach's alpha analysis on these two factors did not improve the value of the 4 dimensions taken together. The test-retest reliability for the total score and the different dimensions are shown in Table 4.

The mean change in SAQ-COPD total score from baseline to follow-up was 18.6±15.9. Statistically significant differences in SAQ-COPD score change were observed between groups defined by the change in YPAS PA as “stable” (17.0±14.4) and “non-stable” (22.9±18.6); (p = 0.05).

Figure 3A shows that the area under the ROC curve (AUC) between PA according to SAQ-COPD and inactivity according to PAL in the accelerometer was 0.66 (95% CI: 0.58–0.74; p < 0.001). Figure 3B shows that the AUC between PA by SAQ-COPD score and inactivity by steps number was 0.65 (95% CI: 0.57–0.73; p < 0.001). ROC curve identified that having less than 61.5 points on SAQ-COPD classifies the patient as inactive with a specificity of 53.1% (95% CI: 42.7% to 63.4%) and a sensitivity of 72.9% (95% CI: 62.9% to 81.5%) for the threshold established by the number of steps, and a sensitivity of 72.9% (95% CI: 63.5% to 81.0%) and a specificity of 56.5% (95% CI: 45.3% to 67.2%) for PAL.

Supplementary Table 4 shows the conditioning factors reported by “inactive” patients for not performing PA according to the SAQ-COPD. “Shortness of breath” is the symptom that slowed down activity the most, though it accounts for only 17–19% of cases. Leg discomfort, either fatigue or pain, was a limiting factor in 9.2% and 8.5% of





**Figure 2** (A) Sedimentation of the SAQ-COPD factorial analysis; (B) factorial analysis of the SAQ-COPD dimensions.  
**Abbreviations:** SAQ-COPD, Spanish Activity Questionnaire in COPD.

patients, respectively. Only the impact of not performing PA on social life and patient dependence positively correlated with their health-related quality of life assessed by CAT, though with Spearman coefficients of 0.31 and 0.34, respectively;  $p < 0.001$  (Table 5).

## Discussion

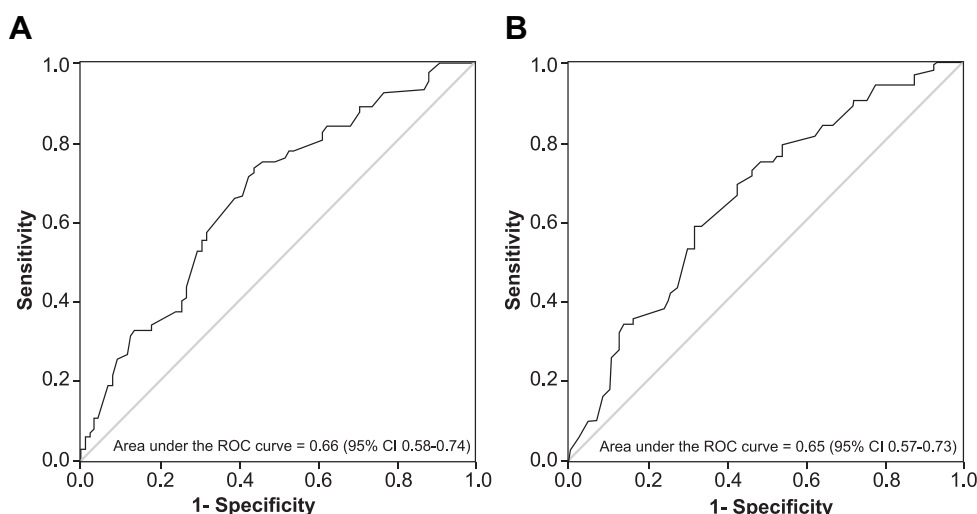
This is the first study to examine the validity of the SAQ-COPD questionnaire to discriminate patients with COPD according to the intensity of their PA and to identify inactive individuals by comparison with the accelerometer and YPAS reference standards. Overall, the results, in a sample of 300 COPD patients, show moderate validity and good sensitivity to change.

Internal consistency of the SAQ-COPD total score was moderate as were correlations between SAQ-COPD score and accelerometer measurements and YPAS. Our findings are similar to those obtained in the validation study of YPAS in COPD patients showing correlations with the accelerometer between 0.30 and 0.48 in somewhat older individuals than our patients.<sup>24</sup> The criterion validity correlations obtained for SAQ-COPD are similar to those previously achieved between the questionnaires PASE (Physical Activity Survey for the Elderly) (0.23–0.59), YPAS (0.23–0.61) and CHAMPS (Community Healthy Activities Seniors) (0.26–0.46), with three very different validation measures: activity monitoring, performance tests (EPESE index and 6-minute walk) and other self-reported measures (SF-36) in healthy elderly subjects.<sup>25</sup> In this regard, it should be noted that both in our study and those mentioned above, correlations between subjective measures were higher than those seen with objective measures of activity, which reinforces the idea that self-reported PA tends to be overestimated.<sup>26</sup>

**Table 4** Test-Retest Reliability of the SAQ-COPD Questionnaire in Patients with COPD

SAQ-COPD	Test-Retest Reliability ICC (95% CI)
Low PA dimension	0.70 (0.62–0.75)
Moderate PA dimension	0.55 (0.45–0.62)
Intense PA dimension	0.65 (0.57–0.72)
Inactivity dimension	0.62 (0.54–0.69)
Total score	0.68 (0.61–0.74)

**Abbreviations:** CI, confidence interval; ICC, intraclass correlation coefficient; SAQ-COPD, Spanish Activity Questionnaire in COPD.



**Figure 3** ROC curves. Predictive ability of the SAQ-COPD questionnaire to identify physical inactivity with respect to physical activity level or PAL criteria (**A**) and number of steps (**B**) provided by the accelerometer.

**Abbreviations:** ROC, receiver-operating characteristic.

Correlations between YPAS and accelerometer were lower than values observed in the YPAS validation study in COPD.<sup>24</sup> However, as in that study, we found the highest correlation coefficient between the activity summary index of the questionnaire and the accelerometer steps, which are the most accepted measurements for each instrument.<sup>27</sup> The highest correlation coefficient for SAQ-COPD score was observed for the accelerometer MET rather than for the daily number of steps even though the former has a greater precision for quantifying movement than for estimating energy expenditure. This is particularly well known in populations such as ours, where low-intensity PA is performed (eg, walking slowly).<sup>27</sup> Therefore, correlation coefficients could be increased with validity measures that clearly reflect the low-intensity PA.

This study also found no differences in the number of steps, PAL and MET measured by the accelerometer in the different categories of intense PA according to the SAQ-COPD. Although this may be more related to the small number of patients present in some of the categories than to the precision of the accelerometer to quantify PA, it is again shown that self-reported perception and direct measurement may differ. Interestingly, studies categorizing PA by intensity level (low, moderate, or intense) show greater differences between self-reporting and objective measurement in intense category levels.<sup>28</sup>

To discriminate inactive patients with COPD, the accepted cut-off points for healthy individuals and those with the disease were used.<sup>29,30</sup> The analysis showed that the cut-off point with the best diagnostic precision for SAQ-COPD was 61.5. The ROC curve shows that SAQ-COPD discriminates 66.6% of patients with inactive COPD. This value, while not

**Table 5** Correlation Between SAQ-COPD and CAT Impact Measure in Patients with Low PA

	Score: CAT
<b>“Impact” dimension of SAQ-COPD questionnaire</b>	
Lack of activity worsens my disease	0.122
Lack of activity prevents me from having more social life	0.309**
Lack of activity makes me more dependent on others	0.341**
If I did more activity I would be in a better mood/have more energy	0.098
When I compare myself to other people of my age, I think my physical activity is similar to theirs	−0.197*

**Notes:** \*\* $p < 0.001$ ; \* $p < 0.05$ .

**Abbreviations:** PA, physical activity; CAT, COPD Assessment Test; SAQ-COPD, Spanish Activity Questionnaire in COPD.



high, could be considered useful in the early identification of inactivity in COPD patients. Sensitivity and specificity indices are moderate, which requires us to consider SAQ-COPD as a tool with a moderate level of precision.

SAQ-COPD questionnaire shows a test-retest reliability of 0.68, a moderate ICC given that in general for reliability to be considered good it should have exceeded 0.75.<sup>31</sup> However, in the specific case of the assessment of PA instruments, 0.70 has been suggested as a sufficient cut-off point to consider reliability as acceptable.<sup>32,33</sup> Based on this, test-retest reliability for SAQ-COPD total score can be considered acceptable. To date, and since this is the first validation study, we cannot compare this result to previous ICC values for SAQ-COPD, but the test-retest reliability of YPAS (0.59) and CHAMPS (0.64) for detecting sedentary behavior in elderly patients is lower than reported here.<sup>34</sup>

The observed floor effect would subtract discriminatory capacity from the intense PA dimension but does not invalidate the results. The exploratory factor analysis shows an explanation of 70% of the total variance by two main factors, indicating that the questions of each factor measure internally the same concept. This floor effect of the intense PA dimension was predictable. That is, it was expected that patients would not perform intense PA, but when designing the study, it was considered that a questionnaire designed to assess changes in activity should also contain this item.

Apart from the validation results, it should be noted that mood, external conditioning factors and family obligations had little impact on our patients with COPD when performing PA. These results contrast with previously published data showing behavioral and social factors as ‘conditioning factors’ of PA. In fact, lack of time and motivation, particularly in sedentary patients with COPD, appear to be among the most limiting factors in other populations.<sup>35</sup> This could be an explanation for the low correlation that other authors have obtained between PA (“patient can and wants to do it”) and stress tests (“patient can do it”).<sup>35</sup> Cultural and lifestyle factors undoubtedly influence these differences.

The results of this study also show that our patients with COPD, mostly with moderate-to-severe airflow limitation, usually perform low-to-moderate intensity PA, which does not necessarily have to be less effective. Indeed, participation in a PA equivalent to walking for at least 2 hours per week has been associated with a 30%–40% reduction in the risk of COPD-related hospital admission and mortality.<sup>36</sup> In our study, 77.3% of patients reported walking at least 30 minutes daily and 31.5% met the PA recommendations for adult patients of engaging in moderate activity of  $\geq 30$  minutes on at least 5 days per week.<sup>37</sup>

The weak correlation we found between the impact measure for patients with low-intensity PA according to SAQ-COPD and CAT questionnaires can be explained in part by the impact of the disease shown by patients on their wellbeing and daily life according to the total CAT score.<sup>21</sup>

SAQ-COPD measures have also demonstrated sensitivity to change after 6 months. This is an important consideration when selecting an instrument to measure the results of a PA intervention.<sup>38</sup> Our literature review indicates that SAQ-COPD is the only PA questionnaire specific for patients with COPD that has assessed sensitivity to change.

A limitation of this study is that time in a sedentary lifestyle has been considered as “inactivity” because, although both concepts are strongly correlated, they are different domains with their particularities and determinants,<sup>39</sup> so that both may or may not be present in the same individual.<sup>39</sup> In fact, 40% of patients spend 21%–42% of the day in sedentary activities - this finding being much lower than reported in healthy adults<sup>40</sup> and other series of COPD patients with similar airflow limitation (62.6%).<sup>39</sup> Additionally, this study did not explore the effect that certain covariates, such as biological sex, may have on physical activity. Also, during recruitment of study sample, patients were stratified exclusively by severity of airflow limitation and not by dyspnea, so none of the patients evaluated had mMRC 4 dyspnea, which could limit the generalization of results to the most symptomatic patients. Another potential limitation is having considered the same time in PA for all intensity levels when activity variability is greater in less severe COPD, and activity is mainly limited from GOLD stage II.<sup>41</sup> The low representation of patients with mild obstruction in our study is due to their poor representation in clinics, probably because of the existing underdiagnosis and the lack of primary care centers at recruitment. In the interpretation of the results, patient loss over the follow-up in each of the instruments analyzed also cannot be completely disregarded.

## Conclusion

The SAQ-COPD questionnaire is an instrument with acceptable psychometric results, good internal consistency, and acceptable predictive validity. It is an easy-to-use tool that could be incorporated into clinical practice in the near future along with validated tools to identify inactive COPD patients and promote healthy interventions. However, future studies and routine administration of the current SAQ-COPD questionnaire in standard clinical practice will help refine the current model.

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## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically review the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and all agree to be accountable for all aspects of the work.

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