Chronic Respiratory Disease Questionnaire (CRQ-SAS): Analysis of psychometric properties

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ABSTRACT

Introduction. The Chronic Respiratory Disease Questionnaire Self-Administered Standardized (CRQ-SAS) format is used to assess health-related quality of life in different languages and adult populations, but it has not been validated in adolescents. This study analyzes the psychometric properties of the CRQ-SAS in a sample of adolescent patients with chronic respiratory disease and correlates them to anxiety and depression.

Method. In relation to the CRQ-SAS psychometric properties, exploratory and confirmatory factor analyses were done to assess the instrument's reliability and validity. Correlations and multiple linear regressions with the Hospital Anxiety and Depression Scale were done to assess the relation with anxiety and depression. The mean difference was estimated based on sociodemographic outcome measures.

Results. The CRQ-SAS was administered to 280 children and adolescents with chronic respiratory disease aged 9-18 years (mean = 12.02), with a similar male-female distribution. The original 4-factor structure was maintained; 3 items were removed from the original scale and a new 17-item version was obtained. This showed adequate psychometric properties and discriminant validity. The dyspnea and emotional functioning domains better predicted anxiety and depression. Lastly, scales were obtained for the interpretation of health-related quality of life scores.

Conclusions. This questionnaire, which has been previously used in the adult population, may be an adequate instrument to assess health-related quality of life in adolescent patients with chronic respiratory disease.

Key words: *CRQ-SAS, health-related quality of life, chronic respiratory disease, adolescent, psychometry.*

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INTRODUCTION

At present, according to the World Health Organization (WHO),[1] hundreds of millions of people suffer the consequences of chronic respiratory disease (CRD). In fact, approximately 235 million people suffer asthma; 64 million people, chronic obstructive pulmonary disease (COPD); and millions more, other CRDs, which often go undiagnosed.[1]

In Spain, according to the National Statistics Institute (Instituto Nacional de Estadística, INE), lower respiratory tract diseases were the fifth most common cause of death, and the third among men.[2] It could be stated that CRDs account for approximately 12 % of all deaths and for 4.2 % of deaths among children younger than 15 years.[2] The most prevalent CRD in childhood and adolescence is asthma,[1,3] which affects 5-14 % of adolescents aged 13-14 years in Spain;[4] males have twice the risk for CRD at this age than females.[4]

CRDs are highly disabling, therefore causing a negative impact on health-related quality of life (HRQoL). HRQoL has been defined as a "multidimensional construct that comprises an individual's physical, psychological and social well-being as perceived by such individual."[5] In CRDs, HRQoL instruments are used as indicators of treatment success because they demonstrate disease interference with daily life and the level of adaptation to disease based on several functioning areas (social, emotional or physical). It has been observed that, in adolescents, a poor respiratory symptom control could lead to a greater HRQoL deterioration[6] due

to interference with daily life activities. Likewise, it increases concern for a new crisis and school absenteeism rates.[7] As age advances, HRQoL decreases.[8]

A HRQoL-related outcome measure in pediatric chronic conditions are the emotional symptoms caused by disease. As a result, it has been observed that, in this type of patients, anxiety[9] or depression[10] may reduce their HRQoL.

Studies have suggested the need to use specific HRQoL measures.[11] Different instruments have been implemented to assess HRQoL; some may be generally applied to any type of disease (the Nottingham Health Profile or the SF-36),[12] while others focus on specific diseases, such as the St. George's Respiratory Questionnaire (SGRQ).[13] The most common instrument used in CRD patients is the Chronic Respiratory Disease Questionnaire (CRQ),[14] developed for COPD patients.[14] The effectiveness of the CRQ has been demonstrated in a large variety of studies,[15-17] but mainly in the adult population,[17,18] not in adolescents. The Spanish version of the CRQ[14] was translated and validated for its use in the German and Latin American populations, and some items were removed for its subsequent application.[15,17] In spite of the adequate psychometric properties of the CRQ,[15,19] the original questionnaire depended on an interviewer; for this reason, the Chronic Respiratory Disease Questionnaire Self-Administered Standardized (CRQ-SAS) format[18] has been recently developed and validated in different languages[15,17,20,21] for the adult population,[22-24] and can be administered more easily and rapidly.

The main objective of this study was to analyze the psychometric properties of the CRQ-SAS for its use in the pediatric population. The specific objectives of this study were to analyze its reliability and validity in pediatric patients with CRD, assess the relation with anxiety and depression, analyze the differences in HRQoL based on sociodemographic outcome measures, and obtain scales for score interpretation.

METHODS

Design

This was a cross-sectional, single-pass study. The SPSS software (version 24.0), the structural equation modeling software (version 6.3), and the FACTOR software[25] were used for the exploratory factor analysis (EFA) and the confirmatory factor analysis (CFA). The EFA was done in line with the process recommended by Lloret-Segura.[26]

Item properties were analyzed based on item-total correlation coefficients and variations in Cronbach's alpha coefficients, if items were removed. Psychometric properties were tested using an EFA and a CFA. The latter was used to validate the scales' factor structure based on Satorra-Bentler's goodness of fit and maximum likelihood estimation (MLE). The suitability of the CFA was tested using Satorra-Bentler's robust correction and χ^2 significance (S-B χ^2).[27] Adequacy of goodness-of-fit indices were tested using the comparative fit index (CFI) and the incremental fit index (IFI); values ≥ 0.90 were considered adequate.[28] Finally, the root mean square error of approximation (RMSEA) was included in the sample; the score had to be ≤ 0.08.[28] Predictive validity was assessed using Pearson's correlations and multiple linear regressions with the Hospital Anxiety and Depression Scale to analyze discriminant validity. The mean difference in relation to sociodemographic outcome measures was estimated using t tests for independent samples.

Instruments

Chronic Respiratory Disease Questionnaire Self-Administered Standardized (CRQ-SAS).[20] This instrument is made up of 20 items grouped into 4 domains[20] (dyspnea, fatigue, emotional functioning and disease control). Items are grouped as follows: for dyspnea, items 1-5; for fatigue, items 8, 11, 15, 17; for emotional functioning, items 6, 9, 12, 14, 16, 18, 20; and, finally, for disease control, items 7, 10, 13, 19. A 7-point Likert-like scale was used for answers, where 1 means maximal involvement and 7, no involvement at all. Prior studies have shown its adequate psychometric properties.[15,17,20]

Hospital Anxiety and Depression Scale.[29] This is a 14-item Likert scale used to assess the cognitive symptoms of anxiety and depression. Each item is rated as per a 4-point frequency scale, from 0 to 3. A higher score indicates a higher level of anxiety and depression symptoms. Prior studies have observed its adequate psychometric properties.[30]

Ethical aspects

The study was approved by the Ethics Committee of Universidad de Valencia and the committee of the participating hospital. Data were collected between July 2015 and December 2017, once informed consents were signed by legal tutors and patients had given their assent.

RESULTS

Participants were pediatric patients with CRD aged 9-18 years (mean = 12.02, standard deviation [SD] = 2.44); 52.1 % were males. The sample was made up of 280 participants seen at the Unit of Pediatric Pulmonology: 53.2 % (n = 149) had asthma; 8.9 % (n = 25), cystic fibrosis; 10 % (n = 28), obliterative bronchiolitis; 4.3 % (n = 12), primary ciliary dyskinesia; and 23.7 % (n = 66), other CRDs (e.g., alpha-1 antitrypsin deficiency, bronchiectasis, recurrent pneumonia, among others).

Item and reliability analysis

The instrument was made up of 20 items grouped in 4 domains. After analyzing items, the reliability analysis suggested the removal of items 1 and 9 to increase the alpha of their corresponding factors and the overall domain (*Table 1*). In general, all domains showed acceptable coefficients, except for dyspnea, which was below 0.70.

Instrument's validity analysis

After analyzing the psychometric properties of the items, the instrument's internal validity was established using the EFA and the CFA. Before performing the analyses, data adequacy was determined using the Kaiser-Meyer-Olkin (KMO) measure and Bartlett's sphericity test. The KMO showed an adequate value (KMO = 0.85), as well as Bartlett's sphericity test ($\chi^2 = 1667.83$, df = 190; $p \leq 0.001$), so the EFA and the CFA were performed.

a) Exploratory factor analysis

It was estimated based on the original scale. After applying it in a fixed manner to the 4 domains, it was necessary to remove those items whose saturation was below 0.40 or higher in more than 1 factor; therefore, 4 items were removed (1, 8, 11, 17). Such factor resolution showed adequate fit indices (RMSEA = 0.02, CFI = 0.98). The explained variance for the 4 domains was 59.78 %.

TABLE 1. *Item and reliability analysis*

	M	DT	rjx	α-x	A	K
Dyspnea: α = 0.45; α (leaving out item CRQ-SAS1) = 0.60; CR = 0.63; CI = (0.53-0.67)						
CRQ-SAS1	5.85	2.24	0.14	0.60	-1.94	2.29
CRQ-SAS2	6.79	0.87	0.27	0.40	-5.13	28.92
CRQ-SAS3	6.72	0.80	0.42	0.34	-2.97	9.23
CRQ-SAS4	6.58	1.25	0.36	0.32	-3.70	14.74
CRQ-SAS5	5.26	1.53	0.26	0.38	-0.78	0.08
Fatigue: α = 0.73; CR = 0.72; CI = (0.68-0.77)						
CRQ-SAS8	4.87	1.56	0.46	0.71	-0.77	-0.12
CRQ-SAS11	5.64	1.23	0.54	0.66	-0.87	0.12
CRQ-SAS15	5.78	1.18	0.52	0.67	-0.82	-0.01
CRQ-SAS17	5.53	1.48	0.57	0.63	-0.93	0.03
Emotional functioning: α = 0.80; α (leaving out item 9) = 0.81; CR = 0.82; CI = (0.78-0.84)						
CRQ-SAS6	5.26	1.53	0.59	0.77	-0.78	0.08
CRQ-SAS9	5.87	1.46	0.36	0.81	-1.04	0.12
CRQ-SAS12	5.76	1.32	0.68	0.75	-0.83	0.12
CRQ-SAS14	4.97	1.65	0.54	0.78	-0.48	-0.97
CRQ-SAS16	5.90	1.24	0.60	0.77	-1.07	0.72
CRQ-SAS18	5.71	1.09	0.50	0.78	-1.18	2.63
CRQ-SAS20	5.23	1.54	0.56	0.76	-0.74	-0.20
Disease control: α = 0.68; CR = 0.69; CI = (0.62-0.73))						
CRQ-SAS7	6.26	1.25	0.47	0.63	-1.83	3.01
CRQ-SAS10	5.47	1.74	0.53	0.58	-1.04	-0.05
CRQ-SAS13	4.97	1.94	0.50	0.61	-0.67	-0.81
CRQ-SAS19	6.16	1.18	0.44	0.65	-1.53	2.13
HRQoL: α = 0.84; α (leaving out items 1 and 9) = 0.85; CR = 0.88; CI = (0.82-0.87)						

M: mean; SD: standard deviation; rjx: item-total correlation; α-x: Cronbach's alpha if the item is removed; A: asymmetry; K: kurtosis; CR: compound reliability; CI: confidence interval for Cronbach's alpha; HRQoL: health-related quality of life; CRQ-SAS: Chronic Respiratory Disease Questionnaire Self-Administered Standardized.

b) Confirmatory factor analysis

After applying the EFA recommendations, the CFA was performed. The goodness-of-fit indices for the 4-factor resolution in the 20-item version were inadequate. Therefore, items with factor loading problems, ≤ 0.30 score, were removed, thus resulting in a significantly improved model once 3 items (1, 9, 13) were removed (*Table 2*). The same procedure was repeated for the single factor resolution, the same number of items was removed, and the model was deemed inadequate. The results showed that the 4-factor resolution was the better option. Finally, a short 17-item version of the questionnaire was obtained (*Table 3*).

Then, the relation among the different instrument domains was analyzed using Pearson's correlations. Positive and moderate statistically significant relations were observed among all domains.

The instrument's criterion validity was established based on the determination of the relation between the CRQ-SAS and other constructs suggested in the bibliography. Pearson's correlation coefficient and regression analyses for the different CRQ-SAS and HADS domains were performed (*Table 4*). Correlation coefficients were negative (a lower score indicated a better HRQoL), low or moderate, and significant ($p \leq 0.01$, between -0.19 and -0.64). Correlations between the CRQ-SAS and age were negative and significantly low ($p \leq 0.01$) for *emotional functioning* and for *total* HRQoL, but not significant in relation to the other scales.

Continuing with criterion validity, two multiple regression linear analyses were done; the *anxiety* and *depression* domains were the criterion variables and the different CRQ-SAS factors were predictor variables. The following were the main results of the final models:

a) They predicted *anxiety*, *dyspnea*, and *emotional functioning* in a negative direction (*Figure 1*).
b) *Emotional functioning* predicted *depression* in a negative direction (*Figure 1*).

Mean difference

For the analysis of differences in HRQoL based on sex and age, participants were grouped into preadolescents aged 9-12 years and adolescents aged 12-18 years, similar to what was done in other studies.[7] No difference was observed in any of the domains in terms of sex; however, age showed differences among the domains: *fatigue* ($t_{205} = 2.79$, $p \leq 0.01$, $d = 0.34$), *emotional functioning* ($t_{206} = 2.63$, $p \leq 0.01$, $d = 0.38$), and *total* HRQoL ($t_{196} = 2.15$, $p \leq 0.05$, $d = 0.27$). Preadolescents showed higher HRQoL levels in terms of *fatigue*, *emotional functioning*, and *total* HRQoL.

Percentiles to interpret health-related quality of life in pediatric pulmonology patients

Finally, after completing the analysis of the CRQ-SAS psychometric properties, a reference table with scales was developed to facilitate the interpretation of data obtained in this study (*Table 5*).

DISCUSSION

The presence of a CRD in adolescence has a negative impact on a patient's HRQoL.[6,7] The results indicate that the CRQ-SAS, a questionnaire that is widely used to assess HRQoL in CRD[22-24] in several countries,[15,17,21] is valid and reliable for its use in adolescents with CRD.

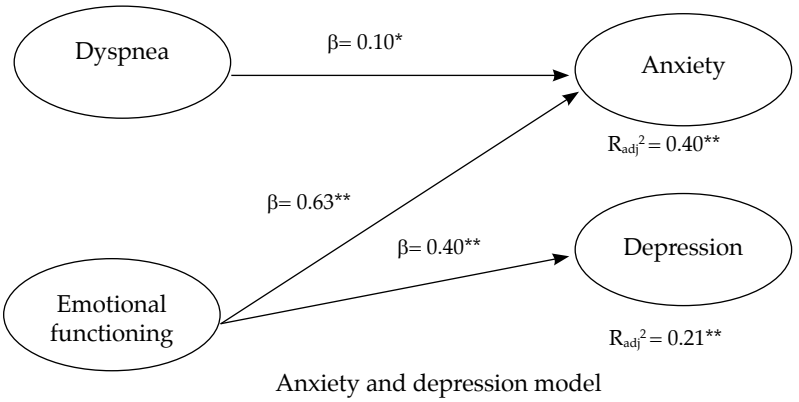
After analyzing its psychometric properties, the number of items was reduced, thus obtaining the version presented in this study. This short version contains 17 items distributed into 4 factors, as suggested in the original scale.[20] Both reliability and validity results suggest adequate psychometric properties. Reliability results are adequate and similar to those observed in previous studies in adults.[17,19] The fit indices obtained with the CFA indicate that

TABLE 2. *Fit indices of the confirmatory factor analysis for four factor resolutions and single factor resolution*

Model	S-B-χ2	df	p	S-B χ²/df	CFI	IFI	RMSEA
CRQ-SAS 20 items (4 factors)	311.94	164	< 0.000	1.90	0.85	0.85	0.06 (0.05-0.07)
CRQ-SAS 20 items (1 factor)	456.86	110	< 0.000	2.69	0.71	0.71	0.08 (0.07-0.09)
CRQ-SAS 17 items (4 factors, leaving out items 1, 13, 9)	164.86	113	< 0.000	1.46	0.93	0.93	0.04 (0.02-0.05)
CRQ-SAS 17 items (1 factor, leaving out items 1, 13, 9)	318.82	119	< 0.000	2.68	0.74	0.75	0.08 (0.07-0.09)

S-B χ^2: Satorra-Bentler χ^2; df: degree of freedom; S-B χ^2/df: ratio between S-B χ^2 and df; CFI: comparative fit index; IFI: incremental fit index; RMSEA: root mean square error of approximation; CRQ-SAS: Chronic Respiratory Disease Questionnaire Self-Administered Standardized.

FIGURE 1. *HADS domain prediction as per CRQ-SAS domains*



* Significance level $p \leq 0.05$.
** Significance level $p \leq 0.01$.

TABLE 3. *Short version of the Chronic Respiratory Disease Questionnaire Self-Administered Standardized with selected items*

Short version of the Chronic Respiratory Disease Questionnaire Self-Administered Standardized (CRQ-SAS 17)	
Factor 1: DYSPNEA	Taking care of your basic needs, such as bathing, showering, eating, or dressing (item 2)
	Walking (item 3)
	Performing chores, such as housework, shopping or grocery shopping (item 4)
	Participating in social activities, such as meeting with family, friends (item 5)
Factor 2: EMOTIONAL FUNCTIONING	How much of the time have you felt frustrated or impatient? (item 6)
	How much of the time did you feel upset, worried, or depressed? (item 12)
	How much of the time did you feel relaxed and free of tension? (item 14)
	How much of the time have you felt discouraged or down in the dumps? (item 16)
	How happy, satisfied, or pleased have you been with your personal life? (item 18)
	How often have you felt restless, tense, or uptight? (item 20)
Factor 3: DISEASE CONTROL	How often did you have a feeling of fear or panic when you had difficulty getting your breath? (item 7)
	How much of the time did you feel very confident and sure that you could deal with your respiratory problem? (item 10)
	How often did you feel upset or scared when you had difficulty getting your breath? (item 19)
Factor 4: FATIGUE	How tired have you felt? (item 8)
	How much energy have you had? (item 11)
	How often have you felt low in energy? (item 15)
	How often have you felt worn out or sluggish? (item 17)

CRQ-SAS: Chronic Respiratory Disease Questionnaire Self-Administered Standardized.

TABLE 4. *Correlations among the domains of the Chronic Respiratory Disease Questionnaire Self-Administered Standardized and the Hospital Anxiety and Depression Scale*

CRQ-SAS domains	**HADS**			**AGE**
	Anxiety	**Depression**	**Emotional distress**	
Dyspnea	-0.23**	-0.19**	-0.23**	-0.10
Emotional functioning	-0.63**	-0.45**	-0.64**	-0.17**
Disease control	-0.31**	-0.23**	-0.32**	0.10
Fatigue	-0.34**	-0.29**	-0.37**	-0.11
HRQoL	-0.56**	-0.43**	-0.58**	-0.12**

Note: *$p \leq 0.05$, **$p \leq 0.01$
HADS: Hospital Anxiety and Depression Scale; CRQ-SAS: Chronic Respiratory Disease Questionnaire Self-Administered Standardized; HRQoL: health-related quality of life.

the proposed 4-factor model has an adequate fit. As suggested in prior studies,[21,22,24] some items show an erroneous factor loading and may result repetitive; therefore, in our study, 3 items were removed from the original scale.

A relation has been demonstrated between HRQoL and anxiety and depression (criterion validity), which was this study's objective. Thus, regression models suggest that the main predictive outcome measure of anxiety and depression symptoms is *emotional functioning* (feeling anxious, worried), which is consistent with the fact that anxiety and depression have a negative impact on the psychological aspects of HRQoL.[9,10] In addition, dyspnea (shortness of breath while doing daily activities) is a predictor of anxiety, which, in the case of CRD, shows a two-way relation: greater shortness of breath leads to greater anxiety and vice versa. In terms of age, older participants showed a worse quality of life, as suggested by prior studies.[7]

In relation to the third objective of this study, the analysis of the impact of sociodemographic outcome measures on HRQoL showed no differences for sex, whereas it did for age. Adolescents have a worse HRQoL, specifically in the *fatigue* and *emotional functioning* domains. This may be because they have a greater awareness of their disease and the loss of autonomy in relation to medical treatments.[7]

We find the use of this instrument for any type of CRD in the adolescent population innovative because, in general, HRQoL instruments are in English and aimed at the adult population. Although there are other questionnaires related to HRQoL that can be used in our population, they focus on specific diseases, such as asthma or cystic fibrosis. Therefore, it may be useful for any pediatric CRD and is easily administered by individuals themselves, without the help of a trained professional. This reduces the time of administration compared to other questionnaires. Although the data used in our study correspond to a cross-sectional design, this questionnaire may be used in a longitudinal study to observe changes in respiratory rehabilitation or physical therapy techniques in relation to HRQoL.[20]

In spite of the contributions made by this study, it has limitations. First of all, the sampling procedures corresponded to non-probability sampling and, in general, the sample was not representative of all CRDs. Our sample included a higher proportion of patients with bronchial asthma and obliterative bronchiolitis compared to other diseases, which prevents the generalization of outcomes. Further studies with probability sampling and with samples from other countries are required. Although such limitation is common in the studies conducted in this field, the large sample size—larger than in other studies—renders these results a useful initial approach to the study subject matter. Another limitation of this study is the use of self-reports for data collection. Self-reports are frequently used in research but may introduce social desirability bias. Therefore, it would be advisable to use other tools and/or external objective measures (e.g., spirometry or plethysmography values). This study is interesting, especially in relation to the lack of generic HRQoL questionnaires in the pediatric pulmonology bibliography.

CONCLUSION

The CRQ-SAS is a valid and practical instrument to assess HRQoL in patients with CRD. This study provides a short questionnaire

TABLE 5. *Scales based on age for pediatric patients with chronic respiratory disease (n = 280)*

Dyspnea		Emotional functioning		Fatigue		Disease control		HRQoL		Centil
9-12 years old (n = 165)	12-18 years old (n = 114)	9-12 years old (n = 165)	12-18 years old (n = 114)	9-12 years old (n = 165)	12-18 years old (n = 114)	9-12 years old (n = 165)	12-18 years old (n = 114)	9-12 years old (n = 165)	12-18 years old (n = 114)	
7	7	6.67	6.50	6.75	6.58	7	7	6.65	6.62	90
7	7	6.50	6	6.50	6.33	7	7	6.53	6.47	80
7	7	6.17	6	6.25	6.17	6.67	6.67	6.35	6.29	70
7	7	6	5.75	6	5.83	6.67	6.67	6.18	6.12	60
7	7	5.67	5.50	5.75	5.42	6	6.67	6	5.85	50
7	7	5.50	5.25	5.50	5	5.67	6.33	5.76	5.65	40
6.75	6.75	5.17	4.75	5	4.5	5.33	5.67	5.59	5.35	30
6.50	6.50	4.83	4.50	4.75	4.33	5	5	5.35	5.12	20
6	5.88	4.33	3.50	4.50	3.83	4.33	4.67	5.06	4.62	10

HRQoL: health-related quality of life (total score for quality of life).

version that enables to broaden the age range for its implementation and facilitates its administration, even by specialists themselves. ■

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