The ability of the Rehabilitation Complexity Scale to capture the burden of care and disability in patients with respiratory diseases admitted for in-hospital rehabilitation: a pilot study

The Rehabilitation Complexity Scale for respiratory patients - Italian network*

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Abstract

The aim of this pilot retrospective study was to test the Rehabilitation Complexity Scale (RCS-E v13) in patients from 15 Italian pulmonary rehabilitation (PR) units and correlate it to the most used clinical and functional outcome measures. At admission and discharge, clinical data [comorbidities with the Cumulative Illness Rating Scale, Barthel Index (BI), Barthel Index Dyspnea (BI-d), Chronic Obstructive Pulmonary Disease (COPD) Assessment Test (CAT), and 6-minute walking test (6MWT)] were collected, and RCS-E v13 total score was calculated. A total of 219 patients [30.6% COPD, 43.4% chronic respiratory failure (CRF), and 26% with invasive ventilation (IV)], aged 69.9 (11.2) years, were considered. RCS-E v13 at admission [8.63 (1.69), 11.06 (2.50), 16.56 (2.97)], and at discharge [0.84 (1.02), 2.19 (1.5), 7.09 (1.47)] for COPD, CRF, and IV, respectively, were statistically differed among groups (analysis of variance p≤0.0001). RCS-E v13 total score strongly negatively correlated with 6MWT [rho = -0.7305 (-07883; -0.6598)] and BI [rho = - 0.6989 (-0.7626; - 0.6217)], while it correlated weakly with CAT [rho = 0.2939 (0.1601; 0.4170)] and BI-d [rho = 0.3512 (0.2243; 0.4663)]. Change in-RCS-E v13 total score [mean change of -8.70; 95% confidence interval (CI) -9.00; -8.40)] as in all single RCS-E v13 items [care -0.59 (95% CI -0.69, -0.48); risk -0.56 (95% CI -0.78;-0.46); nursing needs -2.11 (95% CI -2.22;-2.01); medical needs -2.29 (95% CI -2.39;-2.18); therapy disciplines -1.45 (95% CI -1.57; -1.33); therapy intensity -2.00 (95% CI -2.07; -1,93); equipment -0.23(95% CI -0.30; -0.16)] was found significant after PR. The RCS-E v13 application for patients with respiratory diseases is feasible and highlights a huge difference among different conditions. Its application seems to present an important care burden and relation with motor disability and effort tolerance but a lower relation with dyspnea during activities of daily living, comorbidities, and disease impact. A more robust sample and prospective analysis on the usefulness of the RSC-E v13 in patients with respiratory diseases during rehabilitation are welcomed.

Introduction

Among the various disability scales used in the field of rehabilitation, the British Society of Rehabilitation Medicine has introduced the Rehabilitation Complexity Scale (RCS), specifically designed for patients with motor disabilities, both neurological and orthopedic [1,2]. The most recent version of this scale is RCS-E v13, which stands for the Extended version [3].

Translated in several languages, the Italian RCS-E v13 is

available [4]. It has been tested and demonstrated to be a useful tool for assessing the burden of care, clinical complexity, and rehabilitation needs in neurologic, orthopedic, and cardiologic patients [5].

To enhance the appropriateness of admission to hospital rehabilitation pathways, review the adequacy of hospital reimbursements, and update and share evaluation systems for assessing patient complexity, the Italian Ministry of Health has recently recommended the widespread use of RCS-E v13. This tool proves to be a suitable tool for measuring care needs and rehabilitation complexity, considering the intensity and level of skills required in nursing, medical, therapeutic, and appropriate care [6].

To the best of our knowledge, RCS-E v13 has never been tested in patients admitted to respiratory rehabilitation programs.

In the present study, the investigators aimed to achieve two objectives: first, to test the application of the RCS-E v13 scale to patients admitted to rehabilitation in 15 Italian pulmonary rehabilitation units, and second, to correlate the RCS-E v13 scale with the most widely used clinical and functional measures evaluated in the respiratory field.

Materials and Methods

This is a multicentric pilot retrospective study; it has been approved by the Maugeri Ethical Committee (Protocol ID: ICS Maugeri 2713 EC, on 16 December 2022). The availability of hospital accesses for respiratory rehabilitation in Italy is decidedly below needs, estimated at 16,000 admissions per year [7]. Centers with acceptable standards (number of patients admitted/year major of 100 patients, adequate case mix, willingness to accept very complex patients coming from intensive care units, availability of assessment tools and rehabilitative service provision according to international guidelines) have been surveyed recently (unpublished data) in a number of no more than 65 hospitals on the whole Italian territory with significant inequality between southern and central Italy compared to northern [8].

In a preliminary screening for the development of the current study, 20 centers met the inclusion criteria, but only 15 responded to the consortium call. The 15 centers participating in this study represent 23% of the Italian hospitals, accounting for 47% of the total annual patient accesses. Consequently, these centers serve as a significant reflection of the Italian healthcare landscape. Of these centers, 10 were located in the northern area (46.4 % of the Italian population) and in particular in the Lombardy region (16.85% of the entire Italian population), 2 in central (19.86 % of the Italian population) and 3 in southern Italy (33.74 % of the Italian population) (Figure 1). Furthermore, among the 15 hospitals, 4 are public hospitals, and 11 are private facilities affiliated with the National Health Service. Specific differences in patient acceptance are characterized by local system rules: some centers only admit patients from acute hospitals, while others also accept patients directly from home.

Inclusion criteria: data from the last 15 patients admitted to rehabilitation in the year 2022 and, according to the three diagnosis-related groups (DRGs) [tracheostomized/ventilated 566/565, 88 chronic respiratory failure (CRF), and 87 chronic obstructive pulmonary disease (COPD)], which were the most representative in the participating centers, were considered.

All patients underwent a period of respiratory rehabilitation as defined by the latest guidelines of the American Thoracic Society/European Respiratory Society [9].

Exclusion criteria were related to death or patient transfer to an acute hospital or discharge with other DRGs.

Demographic and anthropometric data, diagnosis at admission, comorbidities with the Cumulative Illness Rating Scale (CIRS) scale [10], provenience (home or acute hospital) of patients before admission, and days of hospitalization in the rehabilitation unit were recorded.

At admission and discharge, the following scales were collected: Barthel Index (BI) [11], Barthel Index Dyspnea (BI-d) [12], COPD Assessment Test (CAT) [13], and 6-minute walking test (6MWT) [14]. Higher BI and 6MWT values indicated a better clinical condition, whereas higher BI-d, CAT, and RCS-E v13 values represented a worse condition. RCS-E v13 was retrospectively calculated using data from admission and discharge [4]. RCS-E v13 comprises 22 points across 5 domains: basic care, risk, nursing, medical needs, therapy disciplines need, therapy intensity, and equipment needs. RCS-E v13 scores from 0 (indicating no complexity) to 22 (indicating the highest complexity).

Statistical analysis

Summary statistics have been presented as a descriptive analysis of the mean and standard deviation (±1 SD) or median and percentiles (25-75th) for continuous variables and as frequencies for categorical or dichotomous variables. As this is a pilot and retrospective study, we utilized a convenient subjective sample size, consisting of 5 cases for each different main DRG category (invasive ventilation 566/565, 88 CRF, 87 COPD) for each participating unit for a total of 15 cases/unit.

Comparisons for continuous variables were conducted using analysis of variance, while the chi-square test was employed for cat-

Figure 1. Geographical distribution of the 15 Italian participating rehabilitation centers.

egorical or dichotomous variables. Additionally, the Chi-Square Test was used to assess significant differences in the distributions of discrete variables. The Student's *t*-test was used for the pre- to post-comparison between continuous variables (difference between admission and discharge from rehabilitation). At admission, correlations between RCS-E v13 and the standard respiratory and disability scales used during the rehabilitation period (BI, BI-d, CAT, and 6MWT) were performed by Spearman's tests describing rho with the related 95% Confidence Interval (95% CI). For all tests, $p<0.05$ was considered significant.

Results

The data was obtained from 219 patients (30.6% COPD, 43.4% CRF, and 26.0% with invasive ventilation), 122 males (55.7%), aged 69.9 (11.2) years (Table 1). 52.97% of patients were admitted after a serious relapse and hospitalization in an acute facility, after which they were discharged to rehabilitation centers to undergo post-acute programs. This condition showed significant variation across different centers, with 50% being the median value of centers, and acceptance rate from acute hospitals ranged widely from 0% to 100%. The remaining 47.03% of patients were admitted following a severe relapse at home and recruited directly from home during an office visit.

All clinical characteristics, measured at admission and discharge, were different among the three DRGs considered, being the patients in the invasive ventilation group the most disabled, symptomatic, and critical, while those in the COPD group were the less compromised.

Figure 2a shows all single subitems of the RCS-E v13 at admission: time spent by the physiotherapists, medical and nurse needs were the most compromised items. All the RCS-E v13 items decreased significantly after rehabilitation [change in care score -0.59 (95% CI -0.69, -0.48); change in risk score -0.56 (95% CI -0.78;-0.46); change in skilled nursing needs score -2.11 (95% CI -2.22;-2.01); change in medical needs score -2.29 (95% CI -2.39;-2.18); change in therapy disciplines score -1.45 (95% CI -1.57; -1.33); change in therapy intensity score -2.00 (95%IC -2.07; -1.93); change in equipment score -0.23(95% CI -0.30; -0.16)]. Figure 2b shows the total RCS-E v13 score in the entire group was moderately impaired at admission but decreased at the end of the rehabilitation program with a mean change of -8.70 (95% CI -9.00; -8.40).

At admission and discharge, patients coming from acute hospitals showed statistically higher RCS-E v13 values [(13.21 (3.99) and 3.94 (2.93), p=0.001)] compared to those from home setting [(10.06 (2.96) and 2.01 (2.28)]. Additionally, RCS-E v13 scores varied significantly among the three DRGs (Table 2): the invasive ventilation group exhibited higher needs, whereas the COPD group demonstrated lower needs. Figure 3 describes Spearman's correlation between RCS v13 and 6MWT, BI-d, CAT, and BI.

Table 1. Anthropometrics and clinical characteristics of included patients at admission and discharge.

	Overall (n=219)	COPD (n=67)	CRF (n=95)	Tracheostomized/ ventilated (n=57)	p
Age, years	69.86 (11.23) 72 (65-78)	72.54 (9.17) 73 (66-80)	72.18 (8.58) 74 (68-78)	62.84 (14.14) 67 (53-74)	**<0.0001** **(#; &)**
Male, n (%)	122 (55.7)	40 (59.7)	48 (50.5)	34 (59.7)	0.413
Length of Stay, d	27.41 (13.25) 25 (20-33)	23.51 (9.67) 22 (19-28)	25.95 (12.08) 24 (20-30)	34.42 (16.03) 35 (21-47)	**<0.0001** **(#; &)**
Hospital provenience, n (%)	116 (52.97)	19 (28.36)	52 (54.74)	45 (78.95)	**<0.0001**
CIRS 1, score	2.56 (1.32) (1.7-3.0)	2.61 (1.7) 2.2 (1.6-3.0)	2.52 (1.34) 2.1 (1.7-2.5)	2.57 (1.12) 2.2 (1.8-3.5)	0.8956
6MWT on admission, meters	153 (156.52) 139 (0-278)	280.55 (133.42) 285 (200-370)	153 (137.67) 147 (0-220)	3.07 (15.46) 0 (0-0)	**<0.0001** **(*; #; &)**
Not able to perform 6MWT, n (%)	86 (39.27)	4 (5.97)	28 (29.47)	54 (94.74)	**<0.0001**
6MWT on discharge, meters	205.74 (167.92) 200 (0-340)	317.12 (146.08) 330 (225-417)	219.02 (152.18) 225 (105-320)	52.7 (82.24) 0 (0-105)	**<0.0001** **(*; #; &)**
Not able to perform 6MWT, n (%)	60 (27.40)	4 (5.97)	19 (20)	37 (64.91)	**<0.0001**
CAT on admission, score	24.81(7.11) 25 (21-29)	22.24 (8.33) 21 (17.8-27.5)	24.86 (6.7) 25 (22-28)	27.83 (4.73) 25 (25-30)	**0.0001** **(*; #; &)**
CAT on discharge, score	17.62 (7.14) 18 (14-21.8)	15.73 (8.41) 15.5 (10.5-22)	17.04 (6.38) 18 (13-20)	20.98 (5.60) 18 (18-22.8)	**0.0002** **(#; &)**
BI score, on admission	59.37 (34.86) 65 (25-94)	84.19 (8.13) 91 (66-100)	66.12 (27.84) 74 (44-90)	18.96 (23.82) 12 (0-27.5)	**<0.0001** **(*; #; &)**
BI score, on discharge	72.60 (30.07) 84 (59-100)	90.94 (13.63) 98 (88-100)	77.21 (25.38) 85 (65-100)	43.37 (30.2) 47 (20-70)	**<0.0001** **(*; #; &)**
BI-d score, on admission	41.95 (22.65) 42 (27-54)	30.82 (16.56) 28 (17-40)	41.85 (20.71) 43 (29-54)	56.21 (24.92) 46 (46-73)	**<0.0001** **(*; #; &)**
BI-d, on discharge	25.67 (19.34) 24 (10-34)	17.75 (13.92) 15 (8-28)	27.09 (20.59) 24 (11-36)	33.11 (19.65) 28 (26-37)	**<0.0001** **(*; #)**

Data are expressed as mean (±1 standard deviation) and median (25-75th percentile). COPD, chronic obstructive pulmonary disease; CRF, chronic respiratory failure; CIRS, Cumulative Illness Rating Scale; 6MWT, 6-minute walking test; CAT, COPD Assessment Test; BI, Barthel Index; BI-d, Barthel Index Dyspnea. p = Fisher's test of one-way analysis of variance. Symbols used to describe significant differences between groups (pairwise comparison with Bonferroni correction) *CRF *vs.* COPD; $^{\#}$tracheostomized/ventilated *vs.* COPD; $^{\&}$tracheostomized/ventilated *vs.* CRF.

Discussion

Validated tools that support referrals to rehabilitation can enhance the admission process, making it more appropriate and shareable. Furthermore, the use of shared instruments not only reduces national variability but also improves clinical appropriateness.

Previous studies have utilized RCS-E v13 to validate the rehabilitation complexity in patients with various rehabilitation needs [4,15].

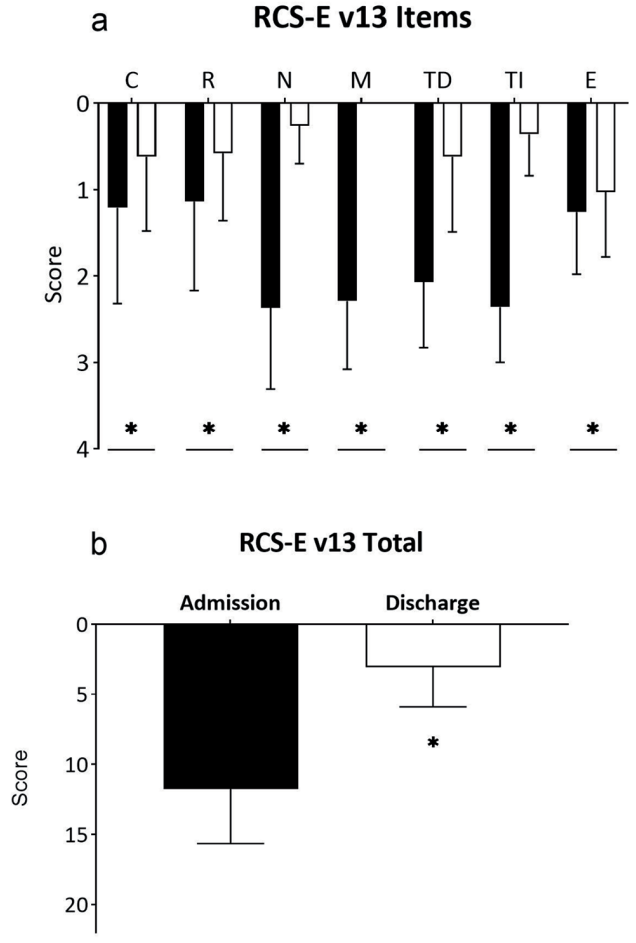

Figure 2. Pre-to-post changes in Rehabilitation Complexity Scale (extended) (RCS-E v13) subitems (a) and total values (b). C, care; R, risk; N, skilled nursing needs; medical needs; TD, therapy disciplines; TI, therapy intensity; E, equipment. The black bar refers to the score at admission and the white bar refers to that at discharge. * p<0.0001.

Version 13 of the Italian RCS-E provides a tool for assessing the burden of care and clinical complexity in rehabilitation settings dedicated to patients with neurologic, orthopedic, and undefined cardiologic conditions [5].

The correlation identified in the present study between widely used respiratory field outcomes and RCS-E v13 is promising, as it can shed light on the relationship between the patient's complexity and their relevant rehabilitation objectives.

The good correlation observed between RSC-E v13 and motor disability (BI) as well as effort intolerance (6MWT) indicates that disability domains are robust indicators of care needs. Conversely, we found a weaker relation between RSC-E v13, comorbidities, symptoms during activities of daily living (ADL), and the impact of the disease. This may be attributed to the fact that RCS-E v13 was originally designed for chronic, long-term hospital patients with neurologic diseases. Indeed, RCS-E v13 focuses on evaluating patients' needs and performance before and after treatment, predicting the time required for motor rehabilitation and the necessary nursing and medical assistance, without accounting for the needs of patients with respiratory diseases such as dyspnea.

Furthermore, not considering breathlessness and its impact could lead to an underestimation of real disability in chronic respiratory diseases. Among the patients, those with COPD received the lowest RCS-E v13 scores, indicating that this group has the lowest clinical complexity and the least burden of care. The findings of the present study also confirmed that tracheostomized/ventilated patients tend to have higher RCS-E v13 scores, which serves as a strong indicator of their care needs, equipment, and the need for physiotherapy. We observed intermediate RCS-E v13 values among patients with CRF, who are typically the most frequently admitted patients in a respiratory hospital-based rehabilitative setting.

As previously demonstrated by Roda *et al*. [5], our study also found that the CIRS 1 score cannot directly measure the patient's rehabilitative needs. These results support the hypothesis that comorbidities *per se*, as indicated by the CIRS 1 score, are not necessarily related to the clinical complexity and disability in patients with respiratory disease.

Limitations and strengths

The main study's limitation is its pilot retrospective nature, which required us to rely solely on patients' health documentation without face-to-face assessments. Additionally, the relatively low sample size, with only 53% of patients admitted from acute hospitals, may limit the generalizability of the findings to more severe patients.

Moreover, while our study provides a valuable cross-section of the Italian rehabilitation reality dedicated to patients with respiratory diseases, it does not represent the entire situation in Italy.

A notable strength of the study is its multicenter approach,

Table 2. Values of Rehabilitation Complexity Scale (extended) score according to different diagnosis-related groups.

	COPD (n=67)	CRF (n=95)	Tracheostomized/ ventilated (n=57)	p
RCS-E v13, on admission	8.63 (1.69) 8 (7-10)	11.06 (2.50) 11 (9-12)	16.56 (2.97) 16 (15-19)	**<0.0001** **(*; #; &)**
RCS-E v13, on discharge	0.84 (1.02) 1 (0-1)	2.19 (1.5) 2 (1-3)	7.09 (1.47) 8 (6-8)	**<0.0001** **(*; #; &)**

Data are expressed as mean (±1 standard deviation) and median (25-75th percentile). COPD, chronic obstructive pulmonary disease; CRF, chronic respiratory failure; RCS-E, Rehabilitation Complexity Scale (extended); DRGs, diagnosis-related groups. p = Fisher's test of one-way analysis of variance. Symbols used to describe significant differences between groups (pairwise comparison with Bonferroni correction) *CRF *vs.* COPD; $^{\#}$invasive ventilation *vs.* COPD; $^{\&}$invasive ventilation *vs.* CRF.

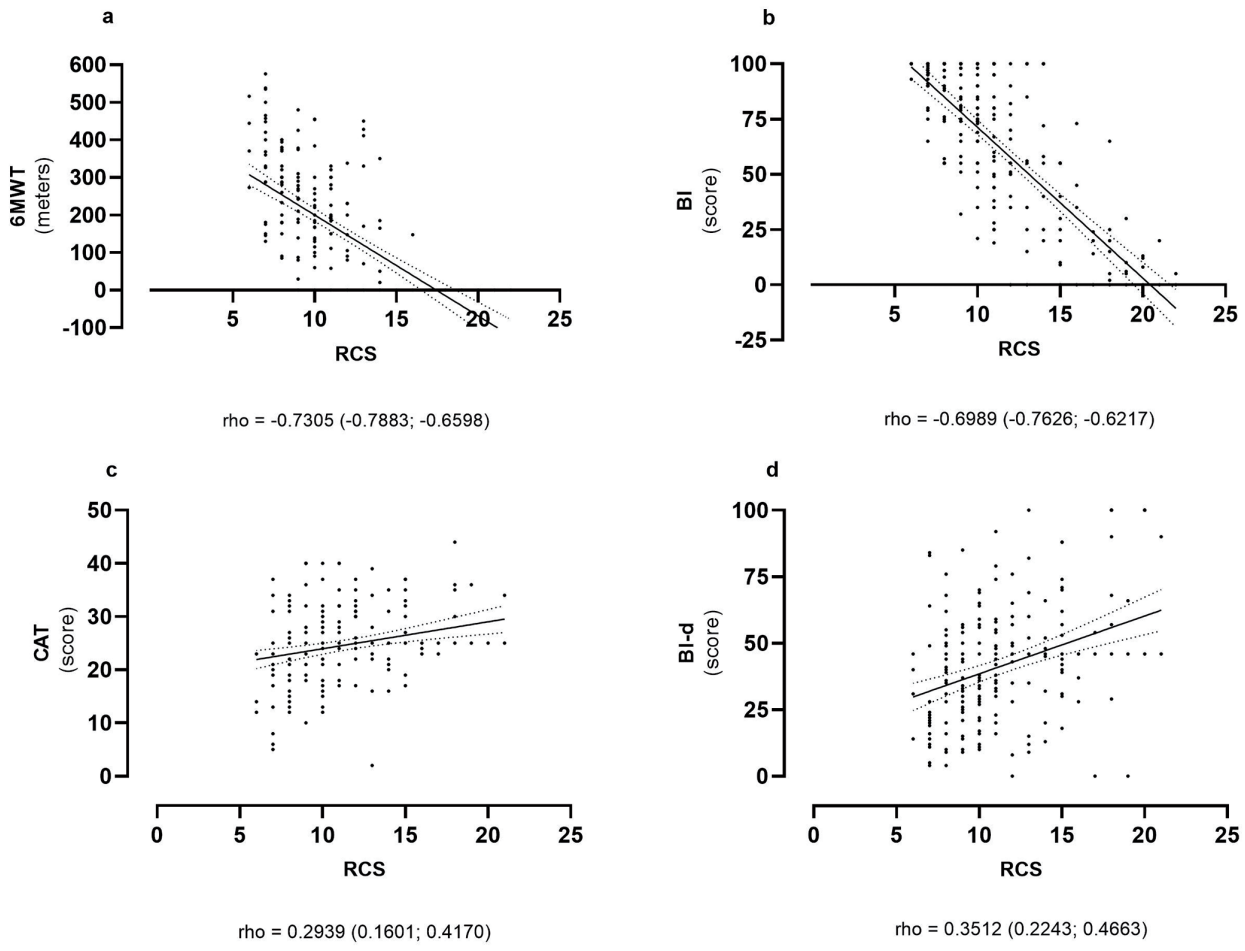

Figure 3. Correlation between Rehabilitation Complexity Scale (RCS) v13 and 6-minute walking test (6MWT) (a), Barthel Index (BI) (b), Chronic Obstructive Pulmonary Disease Assessment Test (CAT) (c) and Barthel Index Dyspnea (Bi-d) (d). Rho = Spearman's test, in brackets is shown 95% confidence interval.

involving patients from different nosological categories where disability and comorbidity do not necessarily align.

To enhance our understanding of disabilities related to respiratory diseases, a multidimensional score, including RSC-E v13 and focusing on effort tolerance and dyspnea during ADL, could be valuable in capturing the diverse aspects of these patients.

Practical implications

Although RCS-E v13 may not be entirely useful for patients with respiratory diseases, this study may provide valuable insights for the Italian Healthcare System (HCS). It sheds light on the utility and limitations of this score, aiding the HCS in patient stratification for optimal utilization of rehabilitation beds, revising reimbursement rates, and assessing necessary rehabilitation resources.

Conclusions

This study suggests the applicability of the RCS-E v13 scale in rehabilitation admissions for patients with respiratory diseases. It suggests i) a huge difference in the burden of care based on different diseases and conditions and ii) a strong correlation with motor disability and effort tolerance but a weaker relation with dyspnea during ADL, comorbidities, and disease impact. Given the pilot nature of this study, future research with a larger and prospective sample is necessary to confirm the utility of RSC-E v13 in the field of respiratory diseases.

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