Journal of Statistics on Health Decision

EXTENDED ABSTRACT

A27 Behaviour of the one-minute sit-to-stand test during six months in people with COPD

Jorge Cabral[1,2], Vera Afreixo[1,3], Vânia Rocha[2,4], Sara Souto-Miranda[2,4],Alda Marques[2,4]

[1]Department of Mathematics, University of Aveiro, Aveiro, Portugal
[2]Respiratory Research and Rehabilitation Laboratory (Lab3R), School of Health Sciences (ESSUA), University of Aveiro, Aveiro, Portugal
[3]Center for Research & Development in Mathematics and Applications (CIDMA), University of Aveiro, Aveiro, Portugal
[4]Institute of Biomedicine (iBiMED), School of Health Sciences, University of Aveiro, Aveiro, Portugal

Introduction

Chronic obstructive pulmonary disease (COPD) is a common, progressive and treatable disease that is characterized by persistent respiratory symptoms and airflow limitation [1]. One of the most frequent impacts of COPD on daily life is decreased functional status which includes struggling to perform basic, work and leisure activities [2]. Although, functional status is highly meaningful to people with COPD, this outcome has been overlooked [3]. Numerous field tests might be used to assess functional status [4], yet the one-minute sit-to-stand test (1minSTS) has shown to be a simple test that mimics the common activity of sitting/standing from a chair which is essential to maintain independence among the elderly [5]. Additionally, it is a valid and responsive measure that might be easily performed for follow-up assessment of people with COPD [4]. In fact, regular assessment of people with COPD is essential [1] and this study hypothesise that the 1minSTS might be an important indicator of functional status over time in people with COPD.

Thus, this study aimed to describe the 1minSTS behaviour over a six-month period and explore the factors influencing this behaviour in people with COPD.

Methods

Study design and participants

Data from an observational study including people with stable COPD was retrospectively analysed. Individuals were eligible if diagnosed with COPD [1] and clinically stable over the previous month (no acute exacerbations). Individuals with other respiratory diseases, signs of cognitive impairment or presence of a significant or unstable cardiovascular, neurological or musculoskeletal disease were excluded.

Data collection

Sociodemographic, anthropometric and clinical data were first collected with a structured questionnaire to characterise the sample. Spirometry was used to assess lung function [6]. Severity of comorbid diseases was scored according to the Charlson Comorbidity Index (CCI) [7]. Activity-related dyspnoea was assessed with the modified British medical research council dyspnoea questionnaire (mMRC) [8,9] and the impact of the disease with the COPD Assessment Test (CAT) [10,11].

Functional status was assessed with the 1minSTS which consists of sitting and standing from a 46-48 cm height chair as many times as possible for one minute [4,13]. A change of 3 repetitions was used as minimum clinically important difference (MCID) [13]. All data were collected at baseline and 1minSTS was repeated monthly up to six months.

Data analysis

Variables were summarized according to their nature. Linear-mixed effect models (LMM) with random intercepts and slopes were applied to assess the mean change in the number of repetitions of the 1minSTS [14,15]. A backward elimination with single terms deletion and keeping time was performed [16]. P-values were computed based on conditional F-tests with Kenward-Roger approximation [17]. Two-sided $P<0.05$ was considered statistically significant.

Results

A total of 149 participants with COPD were included. Participants mean age was 67.5 (±9.0) years, most were men (83.9%), slightly overweight (BMI=26.8 kg/m2), former smokers (73.8%), presented severe airflow obstruction (49.0 [38.0;70.0]), 3 to 4 comorbidities (53%), were not under PR effect (72.5%)

Keywords:
COPD; Functional Status; One-Minute Sit-To-Stand; Follow-up

Corresponding author:
Alda Marques
amarques@ua.pt

Conflict of interest:
The authors declare no conflict of interests.

First published: 22JUN2021

and the median of 1minSTS was 26 [21;30] repetitions. Further detailed baseline characteristics are presented in Table 1.

Table 1 - Baseline characteristics (n=149).

Age, *years*, mean (SD)		67.5 (9.0)
Sex	Female	24 (16.1)
	Male	125 (83.9)
BMI, *kg/m²*, mean (SD)		26.8 (4.6)
Smoking Status	Never	20 (13.4)
	Former	110 (73.8)
	Current	19 (12.8)
Pack-years, median [IQR]		42.0 [15.0;75.0]
Under PR Effect during follow-up	No	108 (72.5)
	Yes	41 (27.5)
CCI, *score*	1-2	31 (20.8)
	3-4	79 (53.0)
	>=5	39 (26.2)
AECOPD, *in the previous year*	0	106 (71.1)
	1	19 (12.8)
	>1	24 (16.1)
mMRC, *points*, median [IQR]		2 [1.0,3.0]
FEV_1, *% predicted*, median [IQR]		49.0 [38.0;70.0]
FEV_1/FVC, *%*, median [IQR]		53.0 [40.0;63.0]
FEV_1	1	25 (16.8)
	2	47 (31.5)
	3	59 (39.6)
	4	18 (12.1)
CAT, *points,* median [IQR]		12.0 [8.0,18.0]
GOLD CAT, *stage*	A	49 (32.9)
	B	72 (48.3)
	C	2 (1.3)
	D	26 (17.5)
1minSTS, repetitions, median [IQR]		26.0 [21.0;30.0]

Note: Data presented as n (%), unless otherwise stated. COPD, Chronic Obstructive Pulmonary Disease; GOLD, Global Initiative for Chronic Obstructive Lung Disease; BMI, Body Mass Index; PR, Pulmonary Rehabilitation; CCI, Charlson Comorbidity Index; mMRC, Modified Medical Council Dyspnoea Scale; CAT, COPD Assessment Test; AECOPD, Acute Exacerbation of COPD; 1minSTS, One-Minute Sit-To-Stand Test; FEV1, Forced Expiratory Volume in 1 Second; FVC, Forced Vital Capacity; SD, Standard deviation; IQR, Interquartile range.

An increase of the number of repetitions performed over time was observed reaching a median of 30.0 [24.0;37.5] repetitions at assessment 5 (A5) (Figure 1a). Specifically, an increase of 3.8 repetitions after 195 days was predicted (Figure 1b).

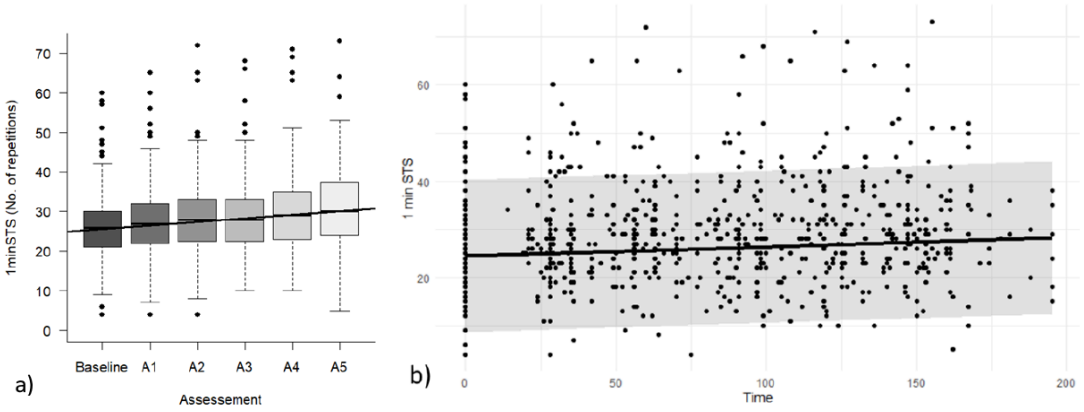

Figure 1 - Description of the number of repetitions performed in the one-minute sit-to-stand (1minSTS) over time by participants with chronic obstructive pulmonary disease (n=149). (a) In the left panel, time was considered as a categorical variable, corresponding to the number of assessments; (b) in the right panel, time was defined as the number of days between baseline and follow-up assessments, predicted values are represented by a black line, 95% confidence intervals by a grey band and observed values by dots.

Table 2 shows the results of the LMM including time and participant as random effects. The model's total explanatory power was substantial (conditional R2 = 0.92). The effect of time was positive and statistically significant [0.09 (0.04; 0.13)]. Females [-4.68 (-8.20; -1.18)], older participants [-0.55 (-0.77; -0.34)], with higher BMI [-0.55 (-0.81; -0.28)], higher pack-years [-0.03 (-0.06; -0.00)], higher scores of mMRC [-2.04 (-3.25; -0.83)] and lower FEV1%predicted [0.07 (0.07; 0.13)] showed a lower number of

repetitions globally. The interaction effect of time on age and on pack-years was negative and statistically significant [-8.60E-4 (-1.48E-3; -2.40E-4) and -1.70E-4 (-3.00E-4; -5.00E-5), respectively].

Table 2 - Factors associated with the number of repetitions of one-minute sit-to-stand test in people with COPD (n=149).

Factors	1MinSTS (n=149)			
	Estimates	CI 95%	p	df
(Intercept)	77.56	[62.40; 92.71]	<0.001	140.70
Sex [Female]	-4.69	[-8.20; -1.18]	0.009	140.59
Age	-0.56	[-0.77; -0.34]	<0.001	141.39
BMI	-0.55	[-0.81; -0.28]	<0.001	139.05
Pack-years	-0.03	[-0.06; -0.00]	0.033	142.38
CCI [Moderate (3-4)]	4.80	[0.71; 8.89]	0.022	139.13
CCI [Severe (>=5)]	3.57	[-2.15; 9.28]	0.219	140.26
mMRC	-2.04	[-3.25; -0.83]	0.001	140.34
FEV1 % of predicted	0.07	[0.07; 0.14]	0.021	139.75
Time	0.09	[0.04; 0.13]	<0.001	132.41
Age*Time	-8.60E-4	[-1.48E-3; -2.40E-4]	0.007	134.32
Pack-years*Time	-1.70E-4	[-3.00E-4; -5.00E-5]	0.006	133.37
Random Effects				
σ^2	0.08			
τ_{00}	$0.53_{Participant}$			
τ_{11}	$0.01_{Participant.Time}$			
ρ_{01}	$0.64_{Participant}$			
ICC	0.87			
Observations	755			
Marginal R^2 / Conditional R^2	0.408 / 0.922			

1minSTS, One-Minute Sit-To-Stand Test; CI, Confidence Interval approximated by Kenward-Roger method; p, p value approximated by Kenward-Roger method; df, degrees of freedom approximated by Kenward-Roger method; BMI, Body Mass Index; CCI, Charlson Comorbidity Index; mMRC, Modified Medical Council Dyspnoea Scale; FEV_1 % of predicted, percentage of the predicted Forced Expiratory Volume in 1 Second; σ^2, residual variance; τ, random effect standard deviation; ρ, correlation between intercept and slope; ICC, intraclass correlation coefficient; R^2, coefficient of determination [18]. * indicates "interaction with".

Discussion

The clinically significant differences found in our study between the last assessment and the baseline suggest that monitoring patients with COPD monthly could benefit their functional status. Further studies with larger samples and control groups are needed to strengthen our findings.

Additionally, this study identified numerous explanatory factors of the 1minSTS behaviour. For instance, older participants or/and participants that were heavy smokers were expected to increase less, or eventually even decrease their number of repetitions when compared with younger participants or/and participants with low smoking load. This information is important to guide clinical decisions aiming to improve functional status of people with COPD. Future studies should explore the added benefit of monitoring the disease progression with meaningful outcomes.

The strengths of our study include the high explanatory power of the LMM computed.

Limitations of this study include the absence of a control group.

In sum, this study showed the potential of the 1minSTS to assess functional status over time in people with COPD and clarified the individual related factors of the 1minSTS behaviour.

Ethics committee and informed consent

Five independent Ethics Committees (Centro Hospitalar do Médio Ave ref. 09/2016 and 10/2018; Unidade Local de Saúde de Matosinhos ref. 10/CES/JAS 17/02/2017 and 73/CE/JAS 12/10/2018; Centro Hospitalar Baixo Vouga ref. 777638 and 086892; Hospital Distrital da Figueira da Foz ref. 1807/2017 and 27/05/2019; Administração Regional de Saúde do Centro ref. 64/2016 and 85/2018) approved the study. Written informed consent was obtained from all participants before data collection. Data protection was ensured by the National Committee for Data Protection (no. 7295/2016) and followed the General Data Protection Regulation.

Acknowledgements

This work was funded by Programa Operacional de Competitividade e Internacionalização – POCI, through Fundo Europeu de Desenvolvimento Regional - FEDER (POCI-01-0145-FEDER-007628 and POCI-01-0145-FEDER-028806), Fundação para a Ciência e Tecnologia (PTDC/DTP-PIC/2284/2014 and PTDC/SAU-SER/28806/2017) and under projects UIDB/04501/2020 and UIDB/04106/2020.

References

1. Global Strategy for the Diagnosis, Management, and Prevention of Chronic Obstructive Lung Disease: the GOLD science committee report 2021. 2021. https://goldcopd.org/wp-content/uploads/2020/11/GOLD-REPORT-2021-v1.1-25Nov20_WMV.pdf

2. Leidy NK. Functional status and the forward progress of merry-go-rounds: toward a coherent analytical framework. Nurs Res. 1994;43(4):196-202. https://doi.org/10.1097/00006199-199407000-00002
3. Bui KL, Nyberg A, Maltais F, Saey D. Functional Tests in Chronic Obstructive Pulmonary Disease, Part 1: Clinical Relevance and Links to the International Classification of Functioning, Disability, and Health. Ann Am Thorac Soc. 2017 May;14(5):778-784. http://doi.org/10.1513/AnnalsATS.201609-733AS
4. Vaidya T, Chambellan A, de Bisschop C. Sit-to-stand tests for COPD: A literature review. Respiratory medicine. 2017;128:70-77. http://doi.org/10.1016/j.rmed.2017.05.003
5. Vaidya T, de Bisschop C, Beaumont M and others. Is the 1-minute sit-to-stand test a good tool for the evaluation of the impact of pulmonary rehabilitation? Determination of the minimal important difference in COPD. Int J Chron Obstruct Pulmon Dis. 2016;11:2609-2616. http://doi.org/10.2147/COPD.S115439
6. Graham BL, Steenbruggen I, Miller MR and others. Standardization of Spirometry 2019 Update. An Official American Thoracic Society and European Respiratory Society Technical Statement. American journal of respiratory and critical care medicine. 2019;200(8):e70-e88. http://doi.org/10.1164/rccm.201908-1590ST
7. Charlson M, Szatrowski TP, Peterson J, Gold J. Validation of a combined comorbidity index. Journal of clinical epidemiology. 1994;47(11):1245-51. http://doi.org/10.1016/0895-4356(94)90129-5
8. Bestall JC, Paul EA, Garrod R, Garnham R, Jones PW, Wedzicha JA. Usefulness of the Medical Research Council (MRC) dyspnoea scale as a measure of disability in patients with chronic obstructive pulmonary disease. Thorax. 1999;54(7):581-6. http://doi.org/10.1136/thx.54.7.581
9. Crisafulli E, Clini, EM. Measures of dyspnea in pulmonary rehabilitation. Multidisciplinary respiratory medicine. 2010;5(3):202-10. http://doi.org/10.1186/2049-6958-5-3-202
10. George F. Diagnóstico e Tratamento da Doença Pulmonar Obstrutiva Crónica. Direção Geral da Saúde 028/2011:1-15. 2013.
11. Jones PW, Harding G, Berry P, Wilklund I, Chen WH, Leidy NK. Development and first validation of the COPD Assessment Test. The European respiratory journal. 2009;34(3): 648-54. http://doi.org/10.1183/09031936.00102509
12. Ozalevli S, Ozden A, Itil O, Akkoclu A. Comparison of the Sit-to-Stand Test with 6 min walk test in patients with chronic obstructive pulmonary disease. Respiratory medicine. 2007;101(2):286-93. http://doi.org/10.1016/j.rmed.2006.05.007
13. Vaidya T, de Bisschop C, Beaumont M and others. Is the 1-minute sit-to-stand test a good tool for the evaluation of the impact of pulmonary rehabilitation? Determination of the minimal important difference in COPD. International journal of chronic obstructive pulmonary disease. 2016;11:2609-16. http://doi.org/10.2147/COPD.S115439
14. Bates D, Maechler M, Bolker B, Walker S. Fitting Linear Mixed-Effects Models Using lme4. Journal of Statistical Software. 2015;67(1):1-48. http://doi.org/10.18637/jss.v067.i01
15. Kuznetsova A, Brockhoff PB, Christensen RHB. lmerTest Package: Tests in Linear Mixed Effects Models. Journal of Statistical Software. 2017;82(13):1-26. http://doi.org/10.18637/jss.v082.i13
16. Zuur A, Ieno EN, Walker N, Saveliev A, Smith GM. Mixed Effects Models and Extensions in Ecology With R. 2009:121-22. http://doi.org/10.1007/978-0-387-87458-6_1
17. Kenward MG, Roger JH. Small sample inference for fixed effects from restricted maximum likelihood. Biometrics. 1997:983-97. http://doi.org/10.2307/2533558
18. Nakagawa S, Johnson P, Schielzeth H. *The coefficient of determination R2 and intra-class correlation coefficient from generalized linear mixed-effects models revisted and expanded.* J. R. Soc. Interface 14:20170213. http://doi.org/10.1098/rsif.2017.0213