

# Cognitive function and living situation in COPD: is there a relationship with self-management and quality of life?

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**Background:** Cognitive impairment is increasingly being found to be a common comorbidity in chronic obstructive pulmonary disease (COPD). This study sought to understand the relationship of comprehensively measured cognitive function with COPD severity, quality of life, living situation, health care utilization, and self-management abilities.

**Methods:** Subjects with COPD were recruited from the outpatient pulmonary clinic. Cognitive function was assessed using the Montreal Cognitive Assessment (MOCA). Self-management abilities were measured using the Self Management Ability Score 30. Quality of life was measured using the Chronic Respiratory Disease Questionnaire. Pearson correlation was used to assess the bivariate association of the MOCA with other study measures. Multivariate analysis was completed to understand the interaction of the MOCA and living situation on COPD outcomes of hospitalization, quality of life, and self-management ability.

**Results:** This study included 100 participants of mean age 70±9.4 years (63% male, 37% female) with COPD (mean FEV<sub>1</sub> [forced expiratory volume in 1 second] percentage predicted 40.4±16.7). Mean MOCA score was 23.8±3.9 with 63% of patients having mild cognitive impairment. The MOCA was negatively correlated with age ( $r=-0.28$ ,  $P=0.005$ ) and positively correlated with education ( $r=+0.24$ ,  $P=0.012$ ). There was no significant correlation between cognitive function and exacerbations, emergency room (ER) visits, or hospitalizations. There was no association between the MOCA score and self-management abilities or quality of life. We tested the interaction of living situation and the MOCA with self-management abilities and found statistical significance ( $P=0.017$ ), indicating that individuals living alone with higher cognitive function report lower self-management abilities.

**Conclusion:** Cognitive impairment in COPD does not appear to be meaningfully associated with COPD severity, health outcomes, or self-management abilities. The routine screening for cognitive impairment due to a diagnosis of COPD may not be indicated. Living alone significantly affects the interaction between self-management abilities and cognitive function.

**Keywords:** COPD, cognitive impairment, self-management ability

## Introduction

Cognitive impairment is increasingly being found to be a common comorbidity in chronic obstructive pulmonary disease (COPD).<sup>1-3</sup> The Mayo Clinic Study of Aging has demonstrated that patients with COPD have an increased risk of mild cognitive impairment.<sup>3</sup> The Cardiovascular Health Study found that patients with coexisting COPD and cognitive impairment have increased respiratory-related and all-cause hospitalization compared to those with COPD or cognitive impairment alone.<sup>4</sup> A more recent study found that patients with a recent exacerbation of the disease had worse cognitive function compared to stable COPD or controls.<sup>5</sup> In fact, 57% of those

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with exacerbation were in the impaired range, with 20% considered to have a pathologic loss in processing speed.<sup>5</sup> A number of the patients with mild-to-severe cognitive impairment were discharged home without the impairment being recognized, demonstrating that significant impairment can easily be missed by the medical community.

Self-management is increasingly considered a meaningful outcome in COPD. Efforts have been made to investigate patient self-management in COPD as early treatment of exacerbations has been found to improve time to recovery, quality of life, and reduced risk of hospitalization.<sup>6</sup> A recent study testing a self-management intervention in COPD reported that the participants who followed the self-management plan had a reduced risk of hospital readmission were younger and were less likely to live alone compared to those who did not follow the plan.<sup>7</sup> This study suggests that not only is patient engagement with health care critical to make an impact on outcomes but also that age and living situation are important factors for that engagement. Any analysis of self-management may need to adjust for those important covariants. It is not clear if cognitive impairment could be a barrier to learning self-management as cognitive impairment is more common in the elderly and executive function deficits are commonly seen.<sup>1</sup> The latter is a research question that we wanted to address.

This study sought to understand the relationship of comprehensively measured cognitive function with COPD severity, quality of life, living situation, health care utilization, and self-management abilities.

## Methods

The study was conducted from August 18, 2013, through May 7, 2014. Subjects with COPD were recruited from the outpatient pulmonary clinic at the Mayo Clinic, Rochester, MN, USA. Eligibility criteria are: 1) diagnosis of COPD based on the Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2011 guidelines;<sup>8</sup> 2) age  $\geq 18$  years; 3) able to complete questionnaires in English; and 4) pulmonary function testing within the last 12 months. Subjects were excluded if they were: 1) unable to provide informed consent or 2) could not complete the cognitive function assessment due to vision loss or inability to speak. Participants completed the cognitive function assessment without assistance but were allowed to be assisted by family or friends to complete the additional questionnaires.

## Ethics

This study was approved by the Mayo Institutional Review Board Minimal Risk Committee IRB 12-006156, and written

informed consent was obtained from all patients. This study was conducted in accordance with the amended Declaration of Helsinki.

## Assessments

### Cognitive function assessment

The Montreal Cognitive Assessment (MOCA) is a screening tool for cognitive impairment. It is a 30-point test that assesses short-term memory, visuospatial ability, executive function, verbal abstraction, phonemic fluency, attention, concentration, and language.<sup>9,10</sup> The MOCA has a high internal consistency with a Cronbach's  $\alpha$  of 0.83.<sup>9</sup> The MOCA has a sensitivity of 90% and specificity of 100% for identifying mild cognitive impairment when a cutoff of  $<26$  is used.<sup>9</sup> This test has a high retest reliability with a mean change of  $0.9 \pm 2.5$  points and a retest correlation of 0.92,  $P < 0.001$ .<sup>9</sup>

### Self-management ability

The Self-Management Ability Score 30 (SMAS-30) is a 30-item questionnaire validated in COPD and other chronic diseases that measures self-management ability. The score assesses the six core self-management abilities: taking initiatives, investment behavior, variety, multifunctionality, self-efficacy, and positive frame of mind.<sup>11</sup> This scale has a high internal consistency with a Cronbach's  $\alpha$  of 0.91.<sup>12</sup> The intraclass correlation is 0.76, indicating good reproducibility.<sup>12</sup> Higher scores indicate higher self-management abilities.<sup>13</sup>

### General survey

The general survey contains four items addressing the following: 1) smoking status; 2) COPD exacerbations; 3) hospitalizations for respiratory and nonrespiratory causes; and 4) ER/urgent care visits for respiratory and nonrespiratory causes. Exacerbations, hospitalizations, and emergency room (ER)/urgent care visits were confirmed when possible in the Mayo Medical Record for local patients. Data regarding living situation, comorbidities, and activities of daily living were also obtained from the medical record as they are part of the current visit questionnaire used for all patients at the Mayo Clinic.

### Pulmonary function testing

All patients included in the study had pulmonary function testing completed within the last 12 months in the outpatient pulmonary function lab. The severity of the airflow limitation was classified based on the GOLD criteria.<sup>14</sup>

### Gait speed

The 4 m gait speed was assessed as a measure of exercise capacity and frailty.<sup>15</sup> A gait speed  $<0.8$  m/s has been associated with frailty.<sup>16</sup>

The 4 m gait speed was measured at the patient's usual pace in an unobstructed clinic hallway. Each walk was performed with a 2 m rolling start where the participants are already walking as they enter the measuring area. Canes, walkers, and supplemental oxygen were used if the patient normally used the equipment in daily activity. Two cones were placed 8 m apart, and then an automated timing system was set up 2 m after the first cone and 2 m before the second cone. We used the Dual Beam Wireless Infrared Timing System (TracTronix, Lenexa, KS, USA).

### Depression screen

The Patient Health Questionnaire-2 is a validated two-item depression-screening questionnaire.<sup>17</sup> The test has an internal consistency of  $\alpha = 0.83$  as assessed by Cronbach's  $\alpha$ .<sup>17</sup> A Patient Health Questionnaire-2 score of  $\geq 3$  has a sensitivity of 87% and a specificity of 78% for major depressive disorder and a sensitivity of 79% and a specificity of 86% for any depressive disorder.<sup>17</sup>

### Quality of life

Chronic Respiratory Disease Questionnaire (CRQ) self-administered with the standardized dyspnea domain is a valid, reliable, and responsive instrument for the assessment of short-term quality of life change in patients with COPD exacerbations.<sup>18</sup> Higher scores imply better self-reported disease-specific quality of life.<sup>18</sup> The fatigue, emotion, and mastery domains have high internal reliability ( $\alpha = 0.71$ – $0.88$ ) as well as a high test–retest reliability ( $P > 0.90$ ).<sup>19</sup> The dyspnea domain has a lower internal reliability ( $\alpha = 0.53$ ) and a test–retest reliability of  $P = 0.73$ .<sup>19</sup>

### Dyspnea

The Modified Medical Research Council Dyspnea scale is a five-item tool used to assess dyspnea in patients with COPD.<sup>20</sup> Interobserver agreement is high for this scale with a weighted kappa of 0.92.<sup>21</sup>

### Disease severity

Disease severity was assessed using the age-dyspnea-obstruction (ADO) index and the GOLD severity classification. The ADO index is a recognized marker of disease severity in COPD as a predictor of the 3-year mortality risk.<sup>22</sup> The scoring range of the ADO was 0–14 with 14 being the

highest risk.<sup>22</sup> The GOLD severity classification determines disease severity based on the degree of obstruction.<sup>8</sup>

### Statistical analysis

Data are summarized using mean  $\pm$  standard deviation for continuous variables and number (%) for nominal variables. The objective of the current study was to assess the relationship of cognitive function (MOCA) with COPD severity, outcomes, quality of life, and self-management abilities. The Pearson product–moment correlation was used to assess the bivariate association of MOCA with other study measures. In order to test the hypothesis that the association of cognitive function with COPD outcomes (exacerbations, ER visits, hospitalizations), quality of life (CRQ total score), or self-management abilities (SMAS total score) differed for participants who were living alone versus those who were not, a series of multivariable analyses were performed. For these analyses, MOCA score and living situation were the explanatory variables of interest. Age and [forced expiratory volume in 1 second] were included as covariates. The MOCA-by-living situation interaction was included in the model to test whether the association of the MOCA with the given outcome was dependent on living status. If the MOCA-by-living situation interaction was found to be statistically significant, supplemental analyses were performed to assess the association of the MOCA with the given outcome separately for those who lived alone versus those who did not. In all cases, two-tailed tests were used with  $P$ -values  $\leq 0.05$  used to denote statistical significance.

### Results

This study included 100 participants (63% male, 37% female) with COPD based on GOLD criteria (2% I-mild, 27% II-moderate, 41% III-severe, and 29% IV-very severe). The mean  $\pm$  standard deviation cognitive function score, as assessed by the MOCA, was  $23.8 \pm 3.9$ , with 63% of patients scoring below the cutoff of 26, which previous studies have shown to be consistent with mild cognitive impairment.<sup>9</sup> A cutoff of 22 has been found to be more specific for mild cognitive impairment, and 24% of the patients in this study had MOCA scores  $< 22$ . Two patients were diagnosed with dementia after enrollment. These patients had not been hospitalized for COPD in the past year.

Additional baseline characteristics of the study participants are tabulated in Table 1 along with the bivariate correlation of each characteristic with MOCA score. The mean SMAS total score was  $64.1 \pm 10.9$  on a scale of 0–100 with higher scores being associated with higher self-management ability. The mean CRQ score was  $4.7 \pm 1.2$  on a seven-point

**Table 1** Patient characteristics

Characteristics	Number	Mean $\pm$ SD	Correlation with MOCA	
			$r^*$	P-value
Age, years	100	70.0 $\pm$ 9.4	-0.28	0.005
Male	100	63 (63%)	#	0.112
Lives alone	100	24 (24%)	#	0.752
Education, years	100	13.3 $\pm$ 2.3	+0.24	0.012
MOCA	100	23.8 $\pm$ 3.9	-	-
FEV <sub>1</sub> , % predicted	99	40.4 $\pm$ 16.7	+0.06	0.584
Gait speed, m/s	70	1.1 $\pm$ 0.2	+0.32	0.008
mMRC dyspnea scale	100	2.2 $\pm$ 1.2	-0.05	0.605
ADO index	99	8.8 $\pm$ 2.4	-0.27	0.005
Depression screening (PHQ-2)	100	1.3 $\pm$ 1.7	+0.08	0.428
CRQ	87			
Dyspnea		5.1 $\pm$ 1.5	+0.08	0.440
Fatigue		3.9 $\pm$ 1.4	-0.05	0.668
Emotion		4.8 $\pm$ 1.2	+0.16	0.135
Mastery		4.9 $\pm$ 1.5	-0.04	0.714
CRQ – total score		4.7 $\pm$ 1.2	+0.04	0.693
SMAS-30	99			
Taking initiatives		65.9 $\pm$ 15.5	-0.08	0.429
Investment behavior		59.5 $\pm$ 15.0	-0.08	0.438
Variety		41.6 $\pm$ 14.6	+0.00	0.998
Multifunctionality		69.0 $\pm$ 11.8	+0.02	0.845
Self-efficacy		84.3 $\pm$ 13.4	-0.00	0.981
Positive frame of mind		64.2 $\pm$ 17.7	+0.06	0.551
SMAS – total score		64.1 $\pm$ 10.9	-0.02	0.862
Exacerbations in last year	100		+0.04	0.717
0		44		
1		21		
2		15		
3 or more		20		
ER visits for breathing problems in last year	100		+0.06	0.564
0		62		
1		19		
2		11		
3 or more		8		
Hospitalization for breathing problems in last year	100		-0.04	0.661
0		72		
1		18		
2		11		
3 or more		3		

**Notes:** \*Pearson product-moment correlation coefficient; #the mean  $\pm$  SD MOCA score was 23.3 $\pm$ 4.2 for males and 24.6 $\pm$ 3.4 for females (*t*-test, *P*=0.112). For patients who lived alone, the mean  $\pm$  SD MOCA score was 24.2 $\pm$ 3.8; for those who did not live alone, the mean  $\pm$  SD MOCA score was 23.9 $\pm$ 3.9 (*t*-test, *P*=0.752).

**Abbreviations:** SD, standard deviation; MOCA, Montreal Cognitive Assessment; mMRC, modified Medical Research Council; ADO, age-dyspnea-obstruction; PHQ-2, two-item depression-screening questionnaire; CRQ, Chronic Respiratory Disease Questionnaire; SMAS-30, Self-Management Ability Score 30; ER, emergency room; FEV<sub>1</sub>, forced expiratory volume in 1 second.

scale with higher scores indicating better health-related quality of life. MOCA score was found to be negatively correlated with age ( $r=-0.28$ ,  $P=0.005$ ) and positively correlated with education ( $r=+0.24$ ,  $P=0.012$ ). MOCA score was also found to be positively correlated with gait speed ( $r=+0.32$ ,  $P=0.008$ ) and negatively correlated with the ADO index ( $r=-0.27$ ,  $P=0.005$ ). From a multivariable analysis adjusting for age, there was still evidence suggesting that gait speed was increased with higher MOCA scores (slope

estimate =+0.02 m/s change in gait speed per one unit increase in MOCA,  $P=0.034$ ). After adjusting for age, the association between the MOCA score and the ADO index was no longer statistically significant ( $P=0.175$ ).

There was no significant bivariate correlation between cognitive function and the number of exacerbations, ER visits, or hospitalizations in the previous year. There was also no significant correlation between the MOCA score and the total SMAS or any of the self-management domains as

seen in Table 1. Similarly, there was no significant bivariate correlation between the MOCA score and quality of life as measured by the CRQ.

A series of multivariable analyses were performed to assess whether the relationship of cognitive function with COPD outcomes and self-management was dependent on living situation. From these analyses, there was no significant evidence of a two-way interaction between the MOCA score and living situation for the number of exacerbations in the previous year ( $P=0.604$ ), the number of ER visits for breathing problems in the previous year ( $P=0.784$ ), or the number of hospitalizations for breathing problems in the previous year ( $P=0.144$ ). However, for SMAS total score and CRQ total score, the MOCA-by-living status interaction was found to be statistically significant ( $P=0.017$  and  $P=0.040$ , respectively) indicating that the association of cognitive function with self-management and quality of life depends upon whether or not the individual is living alone. Supplemental analyses assessing the association of cognitive function with SMAS and CRQ scales were performed separately for those who were living alone and not living alone. Among those who lived alone, higher MOCA was associated with higher quality of life (CRQ) and lower self-management (SMAS), Table 2. Among those who did not live alone, there was no evidence that cognitive function was associated with quality of life or self-management.

## Discussion

This study evaluated cognitive function in COPD patients in the outpatient clinic, and we found no association between

cognitive function and important COPD outcomes: quality of life and health care utilization. There has been ongoing interest in the study of cognitive impairment as it has been found to be prevalent in the COPD population. We had postulated that the prevalence of cognitive impairment in this group might explain the difficulty that some COPD patients have managing their disease. We found no univariate association with cognitive function and health care utilization, quality of life, or self-management abilities. The strongest associations with cognitive function seem to be age and educational level, which are known factors that impact cognitive function. There was a mild correlation with the ADO index, a predictor of 3-year mortality risk. However, the latter is likely secondary to the age component of the score rather than a true association for severity of disease. Current literature has been very limited in the exploration of barriers to self-management and the impact of cognitive function. This study suggests that, although many COPD patients have some degree of cognitive impairment, it is not severe enough to impact health care utilization, self-management abilities, or quality of life in most patients.

Our study sought to further explore the association of self-management abilities with cognitive function to determine the relationship in a subset of patients. While we found no association between self-management abilities and cognitive function using univariate analysis, we did find an association when the analysis was adjusted by living situation. The Glasgow Supported Self-management trial has previously demonstrated that patients who live alone are less likely to

**Table 2** Association of MOCA score with CRQ and SMAS scales according to living situation\*

	Does not live alone			Lives alone		
	Estimate	SE	P-value	Estimate	SE	P-value
<b>CRQ</b>						
CRQ – total	-0.02	(0.04)	0.682	+0.15	(0.07)	0.040
Dyspnea	-0.01	(0.04)	0.867	+0.25	(0.07)	0.002
Fatigue	-0.06	(0.04)	0.216	+0.06	(0.09)	0.470
Emotion	+0.03	(0.04)	0.460	+0.17	(0.08)	0.053
Mastery	-0.03	(0.05)	0.548	+0.14	(0.08)	0.095
<b>SMAS</b>						
SMAS – total	+0.40	(0.32)	0.218	-1.67	(0.75)	0.038
Taking initiatives	-0.02	(0.46)	0.971	-1.17	(1.08)	0.292
Investment behavior	+0.39	(0.47)	0.412	-2.11	(0.79)	0.016
Variety	+0.96	(0.44)	0.031	-2.21	(0.74)	0.008
Multifunctionality	+0.36	(0.37)	0.335	-1.55	(0.80)	0.068
Self-efficacy	+0.27	(0.42)	0.531	-1.37	(0.83)	0.116
Positive frame of mind	+0.42	(0.56)	0.448	-1.58	(1.08)	0.163

**Notes:** \*Analyses were performed separately for those who lived alone and those who did not live alone by using multiple linear regression to assess the association of the MOCA score with the given scale score after adjusting for patient age and percentage of predicted FEV<sub>1</sub>. Findings are summarized by presenting the estimated regression coefficient for the MOCA score along with the corresponding standard error (SE) and P-value.

**Abbreviations:** MOCA, Montreal Cognitive Assessment; CRQ, Chronic Respiratory Disease Questionnaire; SMAS, Self-Management Ability Score; FEV<sub>1</sub>, forced expiratory volume in 1 second.

follow a self-management plan.<sup>7</sup> Another qualitative study found that COPD patients spontaneously developed self-care activities but experienced difficulties with self-care if family was not supportive.<sup>23</sup> In patients who were living alone, higher cognitive function was associated with lower patient-reported self-management abilities. In patients living with a spouse, domestic partner, or family, higher cognitive function was associated with higher patient-reported self-management abilities. The reason for these differences is not clear but living situation appears to be a strong driver for the patient's perception of their ability to manage his/her disease. We speculate that the patients living alone with higher cognitive function may be more aware of their limitations due to COPD in the context of no household help and are more frustrated or depressed as a result. On the contrary, patients with better cognitive function have better self-management abilities. Our findings are very novel and ignite the need for further research regarding social support for this population.

This study did not find a relationship between health care utilization and either cognitive function or self-management abilities. Our study included patients with all severities of COPD with similar educational levels; hence, we feel this population is representative of the general COPD population being seen in the outpatient pulmonary clinic. Several patients had recurrent exacerbations and/or hospitalizations. In our previous work using the digit symbol substitution test to evaluate cognitive function, we found that only patients with two or more hospitalizations in the past year had low digit symbol substitution test scores, indicating lower cognitive function. This study suggested that only COPD patients with overall poor health status had significant cognitive impairment. Our current study continues to support the finding that cognitive impairment in COPD patients is not severe enough to impact health outcomes in the majority of COPD patients. Mild cognitive impairment is a risk factor for progression to dementia but the US Preventive Services Task Force is not currently recommending screening for cognitive impairment.<sup>24</sup> Based on our findings, we cannot recommend cognitive function screening in the outpatient pulmonary clinic for COPD patients.

## Limitations

Our study does have limitations. As this is a cross-sectional study, we were unable to test if the deterioration in cognitive abilities has an impact in significant outcomes or if there is a phenotype of COPD that may predict a rapid decline

of cognitive abilities. Sample size may be a limitation in the study. While we believe we did not miss any large or clinically meaningful association, a larger study may be able to pick up smaller associations.

## Conclusion

Cognitive impairment in COPD does not appear to be independently associated with COPD severity, health outcomes, or self-management abilities. The routine screening for cognitive impairment due to a diagnosis of COPD may not be indicated. Living alone significantly affects the interaction between self-management abilities and cognitive function.

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## Author contributions

Dr Dulohery contributed to study design, data collection, data analysis, and writing of the manuscript. Mr Schroeder contributed to the data analysis and writing of the manuscript. Dr Benzo (guarantor) contributed to the design of the study, data collection, data analysis, and writing of the manuscript. Dr Benzo takes responsibility for the content of the manuscript, including the data and analysis. All authors contributed toward data analysis, drafting and critically revising the paper and agree to be accountable for all aspects of the work.

## Disclosure

The authors report no conflicts of interest in this work.

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