Life-Space Mobility of Subjects With COPD on Long-Term Oxygen Therapy Delivered by Non-Portable Devices

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BACKGROUND: Mobility is human body movement in all its forms, including bed-to-chair transfer, walking, daily tasks, participating in work and social functions, exercising, and using public transport. The mobility of people living with COPD is affected negatively by the disease symptoms. However, limited data are available on the life-space mobility in people with COPD on long-term oxygen therapy (LTOT). This study aimed to explore the life-space mobility in subjects with COPD on LTOT and verify whether life-space mobility is associated with comorbidities and symptoms, activity in daily life, exercise capacity performance, and quality of life. METHODS: This cross-sectional study enrolled 61 subjects with COPD on LTOT (73.0 ± 8.8 y, FEV_1 41.7 ± 16.0% predicted, on LTOT for 2.8 ± 3.3 y). Life-space mobility (Life-Space Assessment), LTOT usage time, comorbidities (Charlson comorbidity index), need for support from a caregiver, exercise capacity (6-min step test), dyspnea (modified Medical Research Council scale), activities of daily living (ADLs, Katz scale), and health-related quality of life (EuroQol 5-Dimension Questionnaire) were assessed. RESULTS: Mobility restriction was identified in 90% of participants. Life-space mobility was negatively associated with the number of comorbidities ($r_s = -0.31$, $P = .02$), dyspnea symptom ($r_s = -0.60$, $P < .001$), and positively associated with basic ADLs performance ($r_s = 0.59$, $P < .001$) and exercise capacity ($r_s = 0.49$, $P < .001$). Dyspnea and exercise capacity were independent predictors of vital space mobility. CONCLUSIONS: Subjects with COPD on LTOT had limited life-space mobility. Interventions to reduce dyspnea and improve exercise capacity should be prioritized to increase this population's domestic and community mobility. *Key words: lung diseases; COPD; oxygen inhalation therapy; mobility limitation; dyspnea; exercise tolerance*. [Respir Care 2023;68(2):208–216. © 2023 Daedalus Enterprises]

Introduction

The main international guidelines recommend the use of long-term oxygen therapy (LTOT) in the presence of hypoxemia at rest, or the presence of pulmonary hypertension, cor pulmonale, or polycythemia, to correct hypoxemia, increase survival, and reduce the incidence of complications and hospitalizations.[1,2]

Despite the indisputable benefits of correcting chronic hypoxemia, LTOT can also culminate in deleterious effects, such as physical inactivity and restriction of mobility. Subjects on LTOT had a reduced level of domestic activity compared with healthy controls and subjects with COPD of the same severity who were not on LTOT[3]; however, the time spent away from home was not evaluated. Furthermore, LTOT offered by non-portable devices is directly related to lower levels of daily physical activity.[4] Despite the perception of LTOT users and the inferences on the restriction of mobility from measures of daily physical activity, the mobility in the living space from inside the home to places outside town is yet to be determined.[3-5]

Life-space mobility involves a spectrum of the individual's mobility, from the most dependent in which the individual needs the help of another person and is restricted to the room where they sleep to the level of independence in which the individual travels to another city without restriction.[6] The Life-Space Assessment (LSA) has been used to evaluate mobility in individuals with different neurological conditions;[7,8] older adults;[9,10] and individuals with musculoskeletal conditions,[11] peripheral arterial disease,[12] coronary artery disease,[13] and COPD (non-LTOT users).[14,15] In individuals with COPD not using LTOT, LSA scores can distinguish reduced mobility and predict exacerbation and were directly associated with exercise capacity and quality of life as well as inversely associated with symptoms of dyspnea and depression.[14,15]

This study aimed to investigate the life-space mobility in subjects with COPD on LTOT and verify whether life-space mobility is associated with comorbidities and symptoms, activity in daily life, exercise capacity performance, and quality of life. We hypothesized that subjects with COPD on LTOT with non-portable oxygen delivery devices show lower life-space mobility, and this would be associated with the presence of more comorbidities and symptoms, poor activity in daily life, exercise capacity performance, and quality of life.

Methods

Study Design and Participants

This was a cross-sectional study reported according to STROBE recommendations.[16] Data were collected between January 2019–March 2020. This study was approved by the ethics committee of the Federal University of Juiz de Fora Hospital, Brazil (No. 3084871). Participants gave written informed consent. A convenience sample of users with COPD registered on a public long-term home oxygen therapy program were enrolled in this study. Home visits were scheduled for assessment of the eligible participants. Inclusion criteria were diagnosis of COPD-based spirometry ($FEV_1/FVC < 0.7$)[17] and subjects who remained on oxygen use criteria after 3 months of the last exacerbation of the initial prescription. Exclusion criteria were refusal to participate; cognitive or physical function impairment that could affect study assessments including neurodegenerative diseases, neurological motor alterations due to stroke (eg, hemiplegia, hemiparesis), and severe osteoarthritis; being hospitalized due to an exacerbation within the last 3 months; having completed or being in a pulmonary rehabilitation program in the last 6 months; or loss of contact.

QUICK LOOK

Current knowledge

Mobility is the ability to move between places as desired, it is movement in all its forms. Long-term oxygen therapy (LTOT) provided by non-portable devices affects mobility in people with COPD. In general, the devices are heavy and constrain the user, making the individual less mobile. However, most of these patients are prescribed oxygen from 15–18 hours a day so that they can spend a few hours without the device and, therefore, be able to mobilize in their living space during this period.

What this paper contributes to our knowledge

For people with COPD on LTOT delivered by non-portable devices, greater mobility was associated with fewer comorbidities and disease symptoms and better performance in activities of daily living and exercise capacity. Dyspnea and exercise capacity were independent predictors of mobility in the living space of this population. Interventions aimed at reducing dyspnea and improving exercise capacity, such as pulmonary rehabilitation, can contribute to improving mobility in people with COPD on LTOT delivered by non-portable devices.

Outcomes and Procedures

Our primary outcome was the subject's life-space mobility. Secondary outcome variables included limitation due to dyspnea, comorbidity index, independence in basic activities of daily living (ADLs), health-related quality of life, and exercise capacity. All assessments were performed by previously trained researchers during a single home visit. In addition, a standardized form was used for a sociodemographic survey on social history, health conditions, need for caregiver support, LTOT usage, and prescription. Arterial blood gases were obtained by a public long-term home oxygen therapy program on a date close to the home visit.

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Life-Space Mobility

Life-space mobility was assessed using the LSA from the survey of sites visited by the participants in the past 4 weeks, including the frequency and level of independence of movement. It is a validated instrument, and has adequate reliability and internal consistency, in addition to good interpretability.[18] A score of 0 indicates room restriction, and a score of 120 indicates that the person travels to other cities frequently and independently; scores $\leq$ 60 indicate mobility restriction[6,10] (see related supplementary materials at http://www.rcjournal.com).

Secondary Outcomes

Dyspnea was evaluated using the modified Medical Research Council (mMRC) scale.[19] The comorbidities were registered by the Charlson comorbidity index. The overall index is obtained by combining the clinical conditions with an age-related score. The higher the index, the greater the chance of death of the patient.[20]

The basic ADLs were assessed using the Katz scale.[21] Its interpretation is made according to the number of functions such as bathing, dressing, going to the bathroom, transferring, continence, and feeding in which the patient performs independently: 6 = independent, 4 = moderate dependence, $\leq$ 2 = very dependent.[21]

The EuroQoL-5D (EQ-5D) health-related quality-of-life instrument includes 3 levels of severity for each of the 5 dimensions. Its index is a continuous variable where 1 represents full health and 0 is equivalent to death. This instrument also has a visual analog scale, the EuroQoL Visual Analog Scale, using which the participant rates their health status on a scale of 0 (worst possible health condition) to 100 (best possible health condition).[22-24]

The exercise capacity and exercise-induced desaturation were assessed using the 6-min step test (6MST).[25] The test was self-paced, and participants were told to go up and down as many steps as possible for the duration of the test. Guidelines of the American Thoracic Society for the 6-min walk test were followed, using the same encouraging phrases, monitoring, and safety criteria.[25] The number of steps performed was used as a measure of exercise capacity. Exercise-induced oxygen desaturation was considered when there was a 4% drop in the baseline S_{pO_2} value or a drop below 88%. The need for an increase in oxygen delivery during exercise was recorded. The percentage of the predicted number of steps was based on normative values.[26]

Statistical Analysis

Life-space mobility from the LSA was dichotomized into presence (score $\leq$ 60) or absence (score $>$ 60) of restriction to mobility. For comparison of between-group differences in the presence or absence of restriction, we used the independent samples *t* tests or Mann-Whitney and chi-square test according to typology and distribution of the variable. Pearson, Spearman, or Kendall correlation coefficients were used, as appropriate, to identify relations between life-space mobility (dependent variable) and dyspnea, comorbidities, ADLs, exercise capacity, and quality of life (independent variables). Results of the univariate analysis determined the variables to be included in a stepwise multiple linear regression analysis examining the relative importance of variables in predicting life-space mobility. Potential predictors of life-space mobility were included in the model if $P < .1$ on univariate analysis. Multicollinearity was checked by inspecting the tolerance values/variance inflation factors (VIFs) and the correlation coefficients among independent variables. The absence of multicollinearity was considered when tolerance values were > 0.1 (VIF < 10) and correlation coefficients below 0.7. Results are presented as the total percentage of variance that could be explained by the regression model (r^2) and β with 95% CI. *P* values $< .05$ were considered significant.

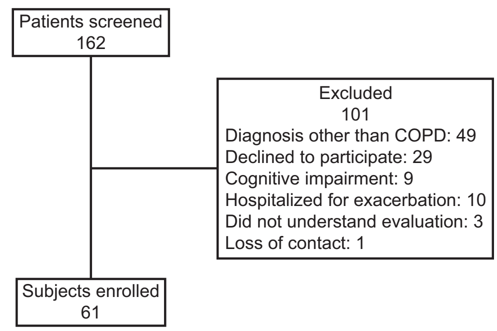

Fig. 1. Flow chart.

Results

A total of 162 LTOT users registered on a public long-term home oxygen therapy program were screened, of which 101 were not included for the following reasons: diagnoses other than COPD ($n = 49$), refused to participate ($n = 29$), cognitive impairment ($n = 9$), hospitalization due to exacerbation ($n = 10$), loss of contact ($n = 1$), and did not understand the study procedures ($n = 3$). Therefore, 61 subjects diagnosed with COPD were enrolled according to eligibility criteria (Fig. 1).

The clinical and sociodemographic characteristics of participants are presented in Table 1. The mean age of participants was 73.0 ± 8.8 y; 56% were female; most of them needed support from a caregiver, and hospitalization for all causes in the last year was identified in 44% of participants. Regarding the type of LTOT device used, 84% of the participants used a concentrator and 16% used cylinders, and all participants used a nasal cannula as the interface. Although participants with stationary cylinders were also provided small gas cylinders by the LTOT dispensation service, it was for rescue purposes only; LTOT users were also instructed to use the small cylinders to attend the appointments in the health services. However, no instructions were provided on the mobility aspects as the small cylinders supplied as they were still burdensome, heavy, not fit for everyday use, and the recharging service was not frequent. Participants presented with moderate COPD (FEV_1 41.7 ± 16.0% predicted) and received oxygen therapy with a dose sufficient to maintain peripheral oxygen saturation at rest ≥ 88% (Table 1).

Subjects with COPD on LTOT showed a reduction in exercise capacity of 49.6 ± 18.7% as predicted in the 6MST. Moreover, 72.1% of the participants experienced oxygen desaturation during this exercise (Table 1). The oxygen flow used during exercise was 2.7 ± 1.2 L/min adjusted according to the participant's prescription during exercise.

Table 1. Sociodemographic and Clinical-Functional Characteristics of the Subjects

Variables	Subjects ($N = 61$)
Female	34 (56)
Age, y	73 ± 8.8
BMI, kg/m^2	26.9 ± 7.2
With caregiver	36 (59)
Hospitalization in last year	27 (44)
Comorbidities, Charlson index	5 (1–14)
Comorbidities	
Cardiovascular condition	35 (57)
Diabetes	14 (23)
Non-metastatic neoplasm	14 (23)
Connective tissue disease	11 (18)
Kidney disease	7 (11)
Hepatic disease	6 (10)
Gastric ulcer	5 (8)
Dyspnea, mMRC	3 (1–4)
Nasal cannula extension, m	6.4 ± 3.9
O_2 flow at rest, L/min	2.2 ± 0.7
O_2 flow at exercise, L/min	2.7 ± 1.2
LTOT duration, y	2.8 ± 3.3
Daily time in LTOT, h	16.1 ± 6.2
P_{aO_2}, mm Hg	68.3 ± 15.8
P_{aCO_2}	44.2 ± 12.0
S_{aO_2}, % rest	89.8 ± 9.5
FEV_1, % predicted	41.7 ± 16.0
Life-space mobility	31 (3–100)
Mobility restriction presence	55 (90.2)
Basic ADLs, Katz index	5 (1–6)
EQ-5D index	0.5 (−0.1 to 1.0)
EQ-VAS	60 (20–100)
6MST, steps	62.4 ± 26.1
6MST, % normality value	49.6 ± 18.7
6MST, ΔS_{aO_2}	12.6 ± 8.1
6MST desaturator	44 (72.1)

Data are presented as mean ± SD, median (minimum-maximum), or *n* (%).
BMI = body mass index
mMRC = Modified Medical Research Council scale
LTOT = long-term oxygen therapy
S_{aO_2} = arterial oxy-hemoglobin saturation
ΔS_{aO_2} = δ (difference) arterial oxy-hemoglobin saturation
ADLs = activities of daily living
EQ-5D = EuroQol 5-Dimension Questionnaire
EQ-VAS = EuroQol Visual Analog Scale
6MST = 6-min step test

Life-Space Mobility

The median LSA indicated an important restriction of mobility 31 (3–100) as evidenced by LSA scores below the cutoff point of 60 (Table 1 and Fig. 2). The majority of participants with mobility restriction had a caregiver (90.1% vs 9.8%, $P = .002$), presented more symptoms of dyspnea (mMRC 3 [1–4] vs 2 [1–3], $P = .034$), and worse quality of life (EQ-5D score 0.4 [−0.1 to 1.0] vs 0.9 [0.4–1.0], $P = .002$) compared to participants without mobility restriction (Table 2).

Mobility was inversely correlated with the symptom of dyspnea ($r_s = -0.60$, $P < .001$) and with the number of comorbidities ($r_s = -0.31$, $P = .02$). It was also directly correlated with the level of basic ADLs performed on Katz scale ($r_s = 0.59$, $P < .001$), exercise capacity on the 6MST ($r_s = 0.49$, $P < .001$), and quality of life on the EQ-5D index ($r_s = 0.38$, $P = .003$) (Fig. 3). There was no correlation of life-space mobility with age ($r_s = -0.24$, $P = .60$), BMI ($r_s = -0.008$, $P = .95$), number of hospitalizations in the last year ($r_s = 0.18$, $P = .17$), and exercise desaturation ($r_s = -0.16$, $P = .27$).

Factors Influencing Life-Space Mobility

The stepwise multiple linear regression model included the variables that showed significant correlations with mobility in the living space. However, only dyspnea and exercise capacity were shown to be significant independent predictors of life-space mobility (Table 3). These independent variables explained 43% of the variance in life-space mobility ($F [2.43] = 15.990$, $P < .001$; $r^2 = 0.43$).

Post Hoc Power Analysis

The effect size found was a large (0.99) estimate based on the variation explained by the coefficient of determination (r^2).

Discussion

This study set out to quantify the life-space mobility of subjects with COPD receiving home-based LTOT

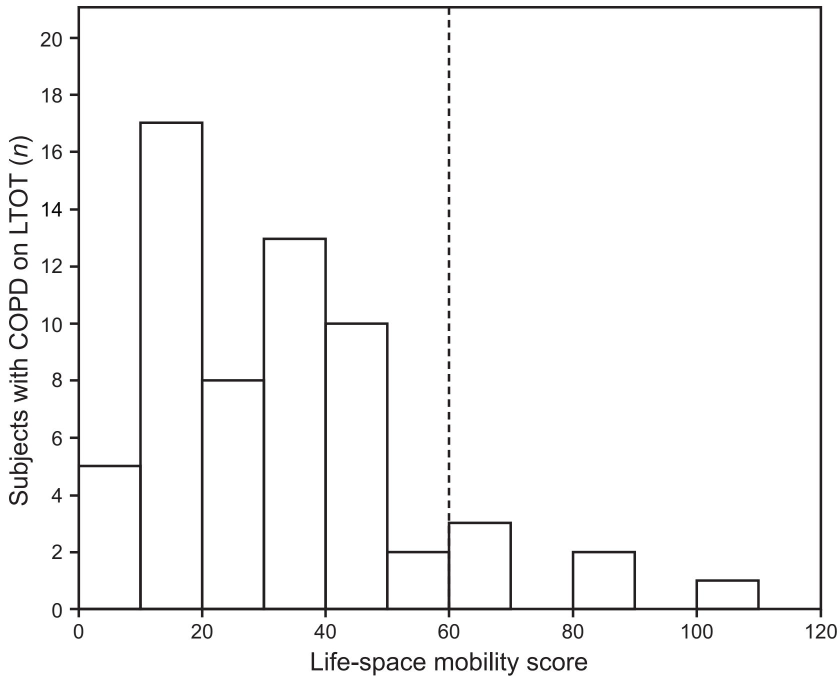

Fig. 2. Distribution of life-space mobility among subjects with COPD on long-term oxygen therapy. The vertical dotted line dichotomizes the mobility restriction of 60 cutoff scores. LTOT = long-term oxygen therapy.

Table 2. Comparison of Variables Between Participants With and No Mobility Restrictions

Variables	Mobility Restriction ($n = 55$)	No Mobility Restrictions ($n = 6$)	P
Age, y	73.1 ± 9.2	72.1 ± 4.2	.80
BMI, kg/m^2	26.7 ± 7.3	28.9 ± 7.6	.53
With caregiver	55 (90.2)	6 (9.8)	.03
Comorbidities, Charlson index	5 (1–14)	5 (2–10)	.92
Dyspnea, mMRC	3 (1–4)	2 (1–3)	.034
Daily time in LTOT, h	15.1 ± 6.7	8.6 ± 3.2	.02
P_{aO_2}, mm Hg	66.3 ± 17.9	63.7 ± 12.2	.80
P_{aCO_2}	43.7 ± 11.7	50.3 ± 17.7	.37
S_{aO_2}, %	89.8 ± 9.8	90.0 ± 5.3	.98
FEV_1, % predicted	41.0 ± 15.4	48.1 ± 20.8	.31
Basic ADLs, Katz index	5 (1–6)	6 (5–6)	.08
6MST, steps	60.3 ± 26.3	77.3 ± 22.0	.14
6MST, ΔS_{aO_2}	12.8 ± 8.3	11.5 ± 6.3	.72
EQ-5D index	0.4 (−0.1 to 1.0)	0.9 (0.4–1.0)	.002
EQ-VAS	60 (20–100)	70 (50–80)	.60

Data are presented as mean ± SD, median (minimum-maximum), or *n* (%).
BMI = body mass index
mMRC = Modified Medical Research Council scale
LTOT = long-term oxygen therapy
S_{aO_2} = arterial oxy-hemoglobin saturation
$\Delta S_{aO_2} = \delta$ (difference) arterial oxy-hemoglobin saturation
ADLs = activities of daily living
6MST = 6-min step test
EQ-5D = EuroQol 5-Dimension Questionnaire
EQ-VAS = EuroQol Visual Analog Scale

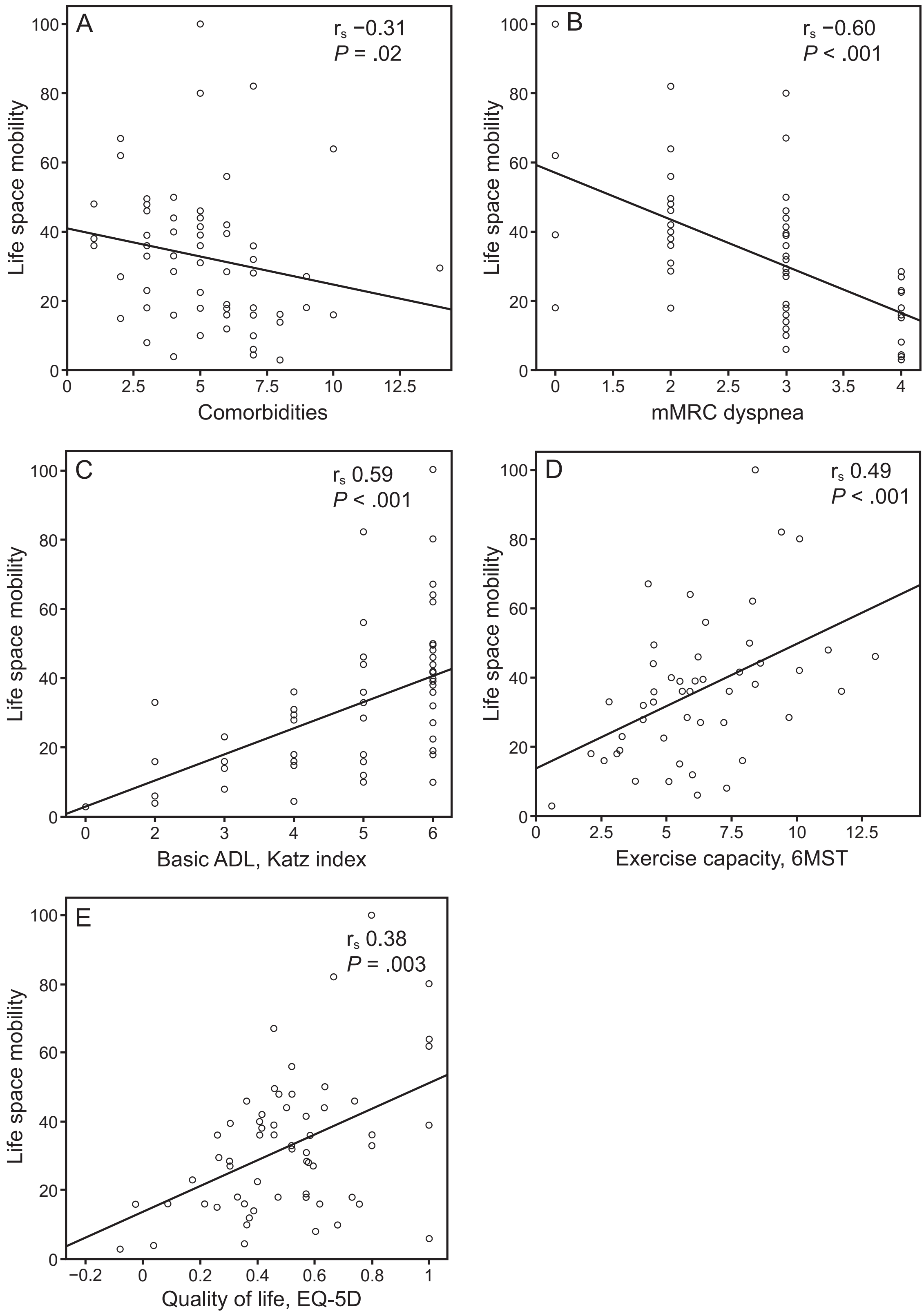

Fig. 3. Correlations between life-space mobility and comorbidities (A), Modified Medical Research Council dyspnea (B), basic activities of daily living (C), exercise capacity via 6-min step test (D), and health-related quality of life measured by EuroQoL 5-Dimension Questionnaire (E). mMRC = Modified Medical Research Council; ADLs = activities of daily living; 6MST = 6-min step test; EQ-5D = EuroQoL 5 Dimension Questionnaire; r_s = Spearman correlation coefficient.

Table 3. Stepwise Multiple Linear Regression Model for Mobility Life-Space

Variables	Unstandardized Coefficient (B)	95% CI	P	Standardized Coefficient (β)
Constant	57.33	31.48–83.18	< .001	
Dyspnea (mMRC)	−12.62	−19.06 to −6.17	< .001	−0.493
6MST	0.22	0.02–0.42	.031	0.279

mMRC = Modified Medical Research Council
6MST= 6-min step test

delivered by non-portable devices and to identify the associations between life-space mobility and relevant clinical and functional variables. The LSA was able to identify that the majority of LTOT users had restricted in their life-space mobility, and mobility was negatively related to dyspnea symptoms and number of comorbidities and positively related to the level of basic ADLs, exercise capacity, and health-related quality of life. Further, dyspnea and exercise capacity are important factors that could explain the life-space mobility in people with COPD on LTOT.

Optimal mobility is characterized by the confidence and ability to go as desired, including timing and method of travel. Mobility is movement in all its forms, from transferring from bed to chair, walking, completing daily tasks, walking for leisure, engaging in work and social roles, exercising, driving a car, and using public transport.[6] Our sample showed a high prevalence of restricted mobility (90%) compared to individuals with COPD not receiving LTOT, who have a prevalence of restriction around 50%.[14,15]

Studies involving subjects on LTOT and the impact of this therapy have focused mainly on physical activity in daily life among subjects with COPD. Two studies showed lower physical activity levels and exercise capacity in subjects with COPD using LTOT compared with their clinical or healthy control peers; however, these studies did not assess the mobility of these populations in their life spaces.[3,4] On the other hand, 2 qualitative studies have shown the negative perception of the subjects using LTOT on the impact of the use of oxygen supply devices on their mobility, autonomy, and social interaction.[5,27] Our study showed a substantial restriction of mobility in subjects with COPD on LTOT who need support from a caregiver, present more dyspnea symptoms, and lower health-related quality of life. Indeed, the need for support from a caregiver suggests a loss of autonomy and worsened quality of life.[5] All participants in the present study used non-portable oxygen delivery devices. This profile of devices used by the participants corroborates the perception that mobility restriction is related to the device being too heavy, conspicuous, too complicated, or too limiting and/or making the user feel embarrassed, all of which lead to the individual becoming less physically active.[27] The mobility restriction of LTOT users is not inherent only to the use of the non-portable device; because although most of them have a prescription for oxygen use, it is between 15–18 hours a day, and they could spend a few hours without the device, and therefore, they could increase their mobility in space in this period.

Our study showed an inverse correlation between mobility, the number of comorbidities, dyspnea symptoms, and a positive correlation with basic ADLs, exercise capacity, and quality of life. Garcia et al[15] also found an association between life-space mobility and dyspnea and ADLs in individuals with COPD not prescribed with LTOT; however, in contrast to our findings, in their study dyspnea did not remain in the regression model to determine life-space mobility. Dyspnea is multifactorial[28] and arises as a combination of underlying pathologies involving neural pathways and subjective central perception.[29] It is plausible to speculate that people with COPD on LTOT have a greater gas exchange disorder that can elicit a greater perception of dyspnea, added to the deconditioning imposed by the physical restriction caused by the tubing, concentrators, or cylinders, in addition to the stigma of reliant on an oxygen device.

In the present study, both dyspnea and exercise capacity outcomes were able to explain the life-space mobility of subjects on LTOT. These findings suggest initiatives that prioritize effective interventions to improve exercise capacity and decrease dyspnea, including pulmonary rehabilitation and alternative strategies such as home-based programs or telerehabilitation. These alternatives may overpass important barriers to physical displacements and improve the mobility of those on LTOT restricted to their home surroundings. Of note, individuals with COPD perceive their physical condition as unsatisfactory and associated with the limitations imposed by the characteristics of portable oxygen cylinders and concentrators.[5,27] For example, better mobility and quality of life are reported by individuals using liquid oxygen compared to those on cylinders.[5] Individuals' preferences should be taken into consideration during LTOT prescription, particularly its barriers to mobility and use in public and private transportation systems; liquid oxygen devices could be a feasible and accessible alternative for this population.

A strength of this study was to identify the high prevalence of mobility restriction by subjects with COPD who use LTOT delivered by non-portable devices as well as its determinants. And there is an advantage to applying the

LSA, as it is a simple and quick tool that may help the clinician easily identify individuals who can benefit from interventions to reduce mobility restriction. A relevant feature of the LSA is that it identifies how far, how independently, and how frequently a patient can move, allowing therapists to collect information about home and community mobility using a single and inexpensive instrument. In addition, identifying increased dyspnea and low exercise capacity in this population as factors that contribute to low mobility may guide physical therapists to target interventions to improve life-space mobility.

A potential limitation of this study is memory bias. The information collected through the self-report of participants may be compromised by the difficulty of remembering events during the past 4 weeks, particularly in older adults. An alternative is to interview participants in the presence of their spouse or caregiver, who can validate the information reported. We did not perform sampling power calculation either; however, the effect size estimated was large. Another limitation of this study is the difference in the number of participants between the groups with restricted and unrestricted mobility that might have affected the results on between-group comparisons; however, this difference in group samples showed the real prevalence of mobility restriction in patients on LTOT. Whether life-space mobility is associated with dyspnea symptoms and exercise capacity in the same way in LTOT users with different diseases is unknown.

Conclusions

This study identified the high prevalence of mobility restriction in subjects with COPD on LTOT. We found relations among life-space mobility, comorbidities, dyspnea symptoms, basic ADLs, exercise capacity, and quality of life. We also demonstrated that dyspnea and exercise capacity were independent predictors of life-space mobility in this population. The LSA is a simple, quick, and useful tool to include in the framework of evaluation of people with COPD on LTOT, which enables easy identification of those who require interventions that could increase domestic and community mobility.

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