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Original Article

Predictors of Physical Inactivity in Elderly Patients with Chronic Obstructive Pulmonary Disease☆

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S U M M A R Y

Background: Aging may contribute to decreased physical activity in chronic obstructive pulmonary disease (COPD). We explored the predictors of physical inactivity in older patients with COPD.
Methods: Thirty male patients with clinically stable COPD participated in the study (age 66.9 ± 4.3 years, forced expiratory volume in 1 second [FEV_1, % of predicted] 52.6 ± 24.6%). Patient characteristics were recorded. Pulmonary function testing was performed and disease stage was determined using the Global Initiative for Chronic Obstructive Pulmonary Disease (GOLD) classification system. Maximal inspiratory and expiratory muscle strength and quadriceps muscle strength were determined using a hand-held device. Dyspnea perception was assessed using the modified Medical Research Council (MMRC) scale. Functional capacity was evaluated using a 6-minute walk test (6MWT). Heart rate and oxygen saturation were recorded before and after 6MWT. Physical activity was assessed using the International Physical Activity Questionnaire (IPAQ).
Results: In elderly COPD patients, the IPAQ sitting score was significantly related to 6MWT distance ($r = -0.51$), GOLD stage ($r = 0.52$), paroxysmal nocturnal dyspnea ($r = -0.42$) and orthopnea ($r = -0.50$), MMRC score ($r = 0.40$), FEV_1 ($r = -0.48$), FEV_1/forced vital capacity (FVC) ($r = -0.47$), forced expiratory flow between 25% and 75% of FVC ($r = -0.43$), peak expiratory flow ($r = -0.43$), baseline heart rate ($r = 0.40$), change in heart rate ($r = -0.46$), and baseline oxygen saturation ($r = -0.43$, $p < 0.05$). GOLD stage, change in heart rate, and orthopnea independently predicted the IPAQ sitting score ($R = 0.732$, $R^2 = 0.536$, $F_{(1,24)} = 4.769$, $p = 0.039$).
Conclusion: Disease severity, heart rate response to exercise, and orthopnea are determinants of physical inactivity in elderly COPD.

1. Introduction

Chronic obstructive pulmonary disease (COPD) is characterized by progressive airflow limitation. It is a major cause of morbidity, prevalently affecting older people[1–4]. The severity of COPD increases with advancing age[1]. Comorbidities and hospitalization[5] are common in older patients with COPD[1]. Age-related changes in pulmonary function[6] and a compromised immune system[1] result in high mortality rates[2]. Improvements in COPD management can increase survival despite severe disability and respiratory impairment[7].

Declining mobility is common in elderly individuals and is associated with decreased pulmonary function and respiratory and peripheral muscle strength[6], and adverse health outcomes[8]. Functional exercise capacity is also reduced in elderly patients with COPD[7]. Physiological changes in COPD, including reduced body weight, lean body mass[2], pulmonary function[9], peripheral and respiratory muscle strength[6], and reduced respiratory muscle endurance[10], are factors responsible for progressive impairment of exercise tolerance[1].

In addition to lower physical exercise capacity, physical inactivity during everyday tasks is common in patients with COPD[11].

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The International Physical Activity Questionnaire (IPAQ) is now commonly used in assessment of physical activity since it has acceptable measurement properties[12]. To the best of our knowledge, there is a lack of studies investigating predictors of physical inactivity in elderly patients with COPD. Since spending a large part of the day in a sitting position is considered to be a characteristic of the elderly[13], we used the IPAQ sitting score to determine the level of physical inactivity in elderly patients with COPD. The purpose of this study was to investigate predictors of physical inactivity in COPD patients with advancing age.

2. Methods

2.1. Patients

Thirty elderly male patients with COPD (61–78 years) participated in this study. The diagnosis of COPD by a pulmonologist was based on medical history, current symptoms, and pulmonary function testing following Global Initiative for Chronic Obstructive Pulmonary Disease (GOLD) guidelines[14]. All subjects had stable COPD at the time of the study. Patient characteristics including age, height, weight, time from diagnosis, and smoking history were recorded. Body mass index was calculated as kg/m^2. Subjects who had significant musculoskeletal or cardiovascular conditions were excluded. All subjects provided written consent to participate in the study, which was approved by the Hacettepe University Ethics Committee.

2.2. Measurements

2.2.1. Pulmonary function

Pulmonary function was tested using a spirometer (Spirolab; Medical International Research, Rome, Italy). The highest value from at least three technically acceptable maneuvers was expressed as a percentage of the predicted values for forced vital capacity (FVC), forced expiratory volume in 1 second (FEV_1), peak expiratory flow rate (PEF), and forced expiratory flow between 25% and 75% of FVC ($FEF_{25-75\%}$)[15].

2.2.2. Breathlessness

Functional dyspnea was measured using the modified Medical Research Council (MMRC) dyspnea scale[16]. The scale consists of five statements describing respiratory disability from none (score 0) to almost complete incapacity (score 4). The score is the number that best fits the patient's level of activity.

2.2.3. Respiratory muscle strength

Inspiratory (MIP) and expiratory muscle strength (MEP) was measured using a hand-held mouth pressure device (Micro RMP; Micro Medical, Rochester, UK). MIP was measured at residual lung volume, whereas MEP was measured at total lung capacity[10,17].

2.2.4. Peripheral muscle strength

Isometric quadriceps strength was determined using a hand-held dynamometer (PowerTrack Commander II; JTECH Medical, Salt Lake City, UT, USA) from both sides and the mean value was recorded[18].

2.2.5. Exercise capacity

Functional exercise capacity was assessed using a 6-minute walk test (6MWT) (ATS 2002). Heart rate (PF3000 heart rate monitor; Polar Electro, Kempele, Finland), oxygen saturation (KTPS-01 pulse oximeter; KTMed, Seoul, Korea), dyspnea, and fatigue on a 10-point modified Borg scale were recorded before and after the test. Two 6MWT tests at least 30 minutes apart were performed to eliminate any potential learning effect. The test producing the greater distance was used for analysis. The 6MWT results are expressed in meters and percentage of the predicted values[19]. The predicted maximum heart rate was calculated as 220 minus the patient's age to determine the percentage maximum heart rate reached at the end of the 6MWT[20].

2.2.6. Physical activity

The level of physical activity was determined using the Turkish version of the IPAQ. This is a seven-item questionnaire consisting of list of activities, and requests estimates of the duration and frequency for each activity engaged in over the previous 7 days[12]. Scores for moderate and vigorous activities and walking were calculated as the sum of the corresponding item scores in terms of duration multiplied by known metabolic equivalents (METS) per activity. The sitting question is a separate score and is not included in the physical activity score. It represents the level of physical inactivity.

2.2.7. Multidimensional disease severity

Multidimensional disease severity was measured using the BODE index, consisting of airflow obstruction (FEV_1), functional dyspnea (MMRC dyspnea scale), exercise capacity (6MWT), and body mass index[21]. For FEV_1, 6MWT, and MMRC, a score of 1–3 points was recorded; for body mass index, the score was 0 or 1 point. The points for each variable were added to obtain a score ranging from 0 to 10. The BODE index has four severity stages: Stage I (score 0–2), Stage II (score 3–4), Stage III (score 5–7), and Stage IV (score 8–10).

2.3. Statistical analysis

Statistical analysis was performed using Statistical Package for Social Sciences (SPSS) version 15.0 (SPSS Inc., Chicago, IL, USA)[22]. For descriptive analyses, data are presented as mean $\pm$ SD unless otherwise specified. Correlations were assessed using Pearson correlation coefficient analysis. Multiple linear regression was performed using the IPAQ sitting score as the dependent variable and variables significantly related according to the correlation analysis ($p \leq 0.015$) as the independent variables. Probability values of $p < 0.05$ were considered to be statistically significant.

3. Results

The characteristics for the 30 study participants are presented in Table 1. Their mean age was 66.87 ± 4.31 years and the mean FEV_1

Table 1
Anthropometric and functional characteristics for COPD patients.

	Mean ± SD	Range
Age (y)	66.87 ± 4.31	61–78
Body mass index (kg/m^2)	25.53 ± 3.72	17.36–33.98
Time from diagnosis (y)	8.42 ± 6.47	1–30
MMRC	1.73 ± 0.91	0–3
FEV_1 (%)	52.62 ± 24.59	16–104
FVC (%)	68.79 ± 21.74	38–113
FEV_1/FVC	60.74 ± 13.56	33.50–78.60
PEF (%)	57.28 ± 27.28	20–128
$FEF_{25-75\%}$ (%)	30.07 ± 19.99	9–82
Smoking (pack-y)	47.76 ± 27.10	1–110
6MWT distance (m)	497.72 ± 118.28	171–655.6
HR_{max} (%)	72.58 ± 10.78	51.61–99.33
BORG-dyspnea (0–10)	2.23 ± 2.45	0–9
BORG-fatigue (0–10)	2.32 ± 2.37	0–10
MIP (cmH_2O)	86.66 ± 28.23	22–153
MEP (cmH_2O)	132.93 ± 36.98	72–244
SpO_2 (%)	94.37 ± 2.44	89–99
Quadriceps muscle strength (N)	288.48 ± 76.66	107.60–427.50
IPAQ total	1662.16 ± 2370.99	149–12159
IPAQ sitting	583.45 ± 205.29	180–960
BODE index (0–10)	2.59 ± 2.10	0–8

Table 2
Multiple linear regression analysis[a].

	R	R^2	Univariate analysis	*B*	β
GOLD stage	0.517	0.268	0.268	98.053	0.434
Heart rate change	0.666	0.444	0.176	−5.486	−0.336
Orthopnea	0.732	0.536	0.092	−140.289	−0.321

[a] Dependent variable, IPAQ sitting score; independent variables (if $p \le 0.015$), GOLD stage, change in heart rate during 6MWT, and orthopnea. $R^2 = 0.536$, $F_{(1,24)}$=4.769, $p = 0.039$, constant = 721.259.

was 52.62 ± 24.59%. The patient distribution by GOLD stage was as follows: five (16.7%) patients in Stage I, nine (30%) patients in Stage II, 12 (40%) patients in Stage III, and three (10%) patients in Stage IV. According to multidimensional staging (BODE index), 17 patients were in Stage I, seven in Stage II, four in Stage III, and one in Stage IV. Twenty-seven (90%) patients had dyspnea and 24 (80%) had fatigue at rest. Five (16.7%) patients had paroxysmal nocturnal dyspnea and nine (30%) had orthopnea. Nine (30%) patients were inactive, 17 (57%) were minimally active, and three (10%) were sufficiently active (Table 2).

The IPAQ total score was significantly related to MMRC ($r = -0.38$, $p = 0.043$), FEV_1 ($r = 0.39$, $p = 0.039$), and FVC ($r = 0.39$, $p = 0.039$). The IPAQ moderate activity score was 140.00 ± 261.00 METs/minute (0–1200 METs/minute) and it was significantly correlated with FEV_1 ($r = 0.43$, $p = 0.022$), $FEF_{25-75\%}$ ($r = 0.49$, $p = 0.009$), and PEF ($r = 0.58$, $p = 0.001$). The mean IPAQ walking score was 997.98 ± 913.57 METs/minute (132–2772 METs/minute). It was significantly associated with MMRC ($r = -0.48$, $p = 0.008$), FEV_1/FVC ($r = 0.47$, $p = 0.012$), and exercise fatigue perception ($r = -0.44$, $p = 0.016$).

In elderly COPD patients, the IPAQ sitting score was significantly related to 6MWT distance ($r = -0.51$, $p = 0.004$), GOLD stage ($r = 0.52$, $p = 0.005$), paroxysmal nocturnal dyspnea ($r = -0.42$, $p = 0.023$) and orthopnea ($r = -0.50$, $p = 0.006$), MMRC score ($r = 0.40$, $p = 0.031$), FEV_1 ($r = -0.48$, $p = 0.009$), FEV_1/FVC ($r = -0.47$, $p = 0.012$), $FEF_{25-75\%}$ ($r = -0.43$, $p = 0.021$), PEF ($r = -0.43$, $p = 0.021$), baseline heart rate ($r = 0.40$, $p = 0.032$), change in heart rate during 6MWT ($r = -0.46$, $p = 0.012$), and resting SpO_2 ($r = -0.43$, $p = 0.020$). GOLD stage (Fig. 1), change in heart rate during 6MWT, and orthopnea independently predicted the IPAQ sitting score ($R = 0.732$, $R^2 = 0.536$, $F_{(1,24)} = 4.769$, $p = 0.039$).

4. Discussion

The main finding of this study is that GOLD stage, orthopnea, and change in heart rate during 6MWT independently predicted the level of physical inactivity in elderly patients with COPD. These three variables together explained 54% of the variance in physical inactivity in elderly COPD.

COPD is characterized by airflow limitation that is progressive and not fully reversible[14]. There are also some significant extrapulmonary effects that may contribute to disease severity[14]. The GOLD staging system reflects the classification of disease severity. We found that disease severity according to GOLD stage made an individual contribution to the level of physical inactivity in elderly patients with COPD and explained 27% of the variance in daily inactivity. An association between physical activity and disease severity was observed in a previous study[23]. We found that the amount of physical inactivity (sitting time) increased with disease severity. An interaction with age could be extrapolated from this observation, as both physical inactivity and disease severity increase with age[23].

Changes in heart rate during exercise reflect responses of the sympathetic nervous system to increased metabolic demands[24]. In a previous study, we showed that there is chronotropic incompetence to maximal exercise in patients with COPD, mainly because of dyspnea[25]. In the present study, we used 6MWT to detect changes in heart rate since it is a measure of the submaximal sustainable exercise capacity[25] and is related to physical activity levels in COPD[11]. Changes in heart rate during 6MWT explained 18% of the variance in physical inactivity in our patients. This finding indicates that nonphysiological heart responses to exercise in COPD[26] may be responsible for the increased physical inactivity in elderly patients with COPD.

Patients with COPD often experience an increased sensation of breathlessness in supine compared to sitting positions[27]. Increased inspiratory resistive work is thought to be responsible for orthopnea in COPD patients[28]. In our study, orthopnea explained 9% of the variance in physical inactivity. Since the BODE index was significantly related to orthopnea (r = −0.46, $p = 0.012$), its presence in elderly patients with COPD may reflect higher multidimensional disease severity.

There are few data on factors affecting sitting (sedentary) behaviors. COPD patients spend only 6 ± 4% of the day in walking[11]. In our study, although 6MWT was correlated with the IPAQ sitting score, it was not an independent contributor to physical inactivity. Pitta et al found that 6MWT is the best indicator of physical activity in COPD using activity monitors[29]. In our elderly patients, we used activity recall for 7 days (IPAQ), and the discrepancy in the results may be due to differences in methodology. Susceptibility to misplacement and the high cost of accelerometers[29] were the main limitations for the use of these devices to monitor physical inactivity in our elderly patients. Validated questionnaires such as the IPAQ are inexpensive, easy to administer, and readily applicable for measuring all kinds of habitual activity. However, they are based on self-reports and hence are subject to both over- and underestimation of physical activity levels[29].

Physical inactivity may simply reflect disease severity. Physical inactivity is a risk factor for pulmonary rehabilitation programs. Participation in a pulmonary rehabilitation program of at least a moderate physical activity level may offer protection from worsening disability in elderly COPD patients[30].

Proximal nocturnal dyspnea, the MMRC dyspnea score, $FEF_{25-75\%}$ and PEF, baseline heart rate, and resting SpO_2 did not meet the criteria for inclusion, and their independent contribution was not calculated. The decrease in physical activity estimated in elderly patients with COPD does not depend merely on the severity of airflow limitation. We found no contribution of respiratory and peripheral muscle strength or body composition to physical inactivity.

We used a stepwise procedure to select medical and sociodemographic variables in the model explaining variance in physical inactivity. This approach ensured a conservative estimate of the

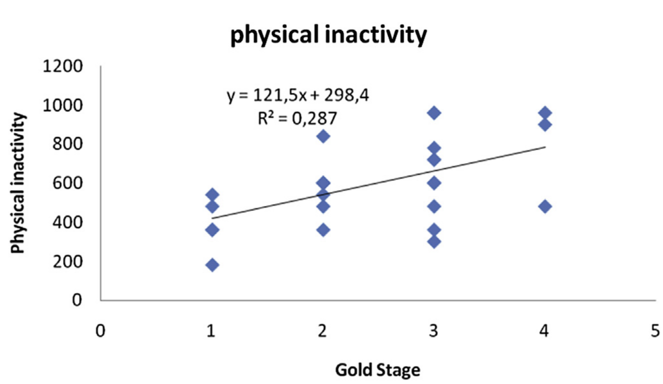

Fig. 1. Regression analysis between physical inactivity and GOLD stage.

unique contribution of demographic, physiological, physical, and neurological factors in predicting physical inactivity, and limited the type 1 error associated with multiple comparisons.

4.1. Study limitations

Several limitations of our study should be noted. The lack of instrument validation for quantitative measures is a major limitation. The IPAQ places little emphasis on assessing very low to moderate levels of physical activity and short-term activities of less than 10 minutes in duration. However, we measured physical inactivity (sitting score) using the IPAQ questionnaire.

5. Conclusion

In conclusion, GOLD stage, change in heart rate during exercise, and orthopnea are determinants of physical inactivity in elderly COPD. Disease severity, chronotropic response, and positional changes increased inspiratory resistive work caused by physical inactivity. This information might facilitate physical activity management in patients with COPD.

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