Factors associated with low-level physical activity in elderly patients with chronic obstructive pulmonary disease

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Background/Aims: In patients with chronic obstructive pulmonary disease (COPD), the extent of physical activity (PA) is correlated with disease severity and prognosis. However, factors associated with low-level PA in elderly COPD patients are not known. We assessed the levels of PA and clinical factors associated with low-level of PA in elderly COPD patients.

Methods: This was a secondary analysis of a multicenter, prospective study of 245 patients with COPD. Among them, 160 patients with 65 years or more were included. Three PA groups were defined with respect to daily activity time (low, moderate, and high). Health related quality of life (HRQL) was measured using St. George’s respiratory questionnaire (SGRQ) and 36-item short-form health survey. Anxiety and depression status were assessed employing the hospital anxiety and depression scale (HADS). Multivariate logistic regression was performed to identify independent predictors of low-level PA in elderly COPD patients.

Results: Of all the 160 patients, 103 (64.4%) engaged in low-level PA. Upon univariate analysis, a decreased exercise capacity (6-minute walk test < 250 m), an increased dyspnea (the modified medical research council [MMRC] dyspnea scale ≥ 2), a decreased HRQL (total SGRQ score), and a presence of depression (HADS-D ≥ 8) were significantly associated with low-level PA. Upon multivariate analysis, an MMRC grade ≥ 2 (hazard ratio [HR], 2.550; p = 0.034), and HADS-D ≥ 8 (HR, 2.076; p = 0.045) were independently associated with low-level PA in elderly COPD patients.

Conclusions: Two-thirds of elderly patients with COPD reported low-level of PA. More severe dyspnea and a presence of depression were independently associated with low-level PA in elderly COPD patients.

Keywords: Pulmonary disease, chronic obstructive; Aged; Dyspnea; Depression
in terms of all of ventilatory mechanics, pulmonary gas exchange, cardiac function, and other systemic features [5]. Although COPD treatments including bronchodilators, glucocorticoids, and oxygenation increase life expectancy, the interval between the onset of disability and death is thus extended. Elderly patients with COPD are frequently impaired in terms of their social life and functional capacity [6].

The level of physical activity (PA) in patients with COPD is lower than that in healthy age-matched controls [7]. One previous study found that more physically active patients with COPD exhibited better functional status in terms of the diffusing capacity of lung carbon monoxide and expiratory muscle strength as well as lower-level systemic inflammation [8]. In addition, high-level PA reduces both the number of hospital admissions caused by COPD exacerbation as well as the mortality rate [9]. Risk factors associated with low-level PA in patients with COPD have been reported in several studies [10,11]. Because most works were cross-sectional in nature, it has not been possible to draw causal inferences from the established associations [12]. In addition, most studies included middle-aged patients, and factors associated with low-level PA in elderly patients with COPD were not emphasized. Therefore, the aims of the present study were to assess PA levels in elderly patients with COPD and identify clinical factors associated with low-level PA in such patients.

**METHODS**

**Patients and study design**

This was a secondary analysis of data from a multi-center prospective cross-sectional study conducted from March 2010 to November 2010 [13]. In total, 249 patients with COPD of varying severity were recruited from six institutions. Of these, 160 patients aged ≥ 65 years were included in the present study. Clinically unstable patients (i.e., those requiring changes in medication dose or frequency, exhibiting disease exacerbation, or who had been admitted to hospital in the preceding 6 weeks) were excluded. The study protocol was approved by the Institutional Ethics Committee of Pusan National University Hospital, and written informed consent was obtained from all patients.

**Data collection**

The following data were collected from patient records: age, sex, educational level, marital status, smoking status (current-, ex-, or never-smoker), and cumulative smoking history (pack-years). Body mass index was calculated as weight in kilograms divided by height in meters squared. All patients underwent lung function testing and completed a questionnaire. In terms of PA, the frequency and duration of walking or other exercise, such as bicycling, gardening, stretching, aerobics, dancing, climbing, swimming, soccer, tennis, and jogging, were explored. Patients who exercised for < 30 minutes per day comprised the low-level PA group; the high-level PA group comprised those who exercised for ≥ 60 minutes per day.

The severity of dyspnea was assessed using the modified medical research council (MMRC) scale. Patients with MMRC scores of ≥ 2 were regarded as having more severe symptoms. The 6-minute walk test was performed (the total distance walked over 6 minutes was recorded). Health related quality of life (HRQL) was measured using the St. George's respiratory questionnaire (SGRQ), which is a standardized self-administered airway disease-specific instrument [14]. Validated translations of the standard SGRQ questionnaire featuring three domains (symptoms, activities, and impacts) were used [15]. Scores on the SGRQ range from 0 (no disturbance in health-related quality of life) to 100. Health status was assessed using the 36-item short-form health survey (SF-36). The SF-36 contains 36 items that measure health in each of eight multi-item dimensions and explores functional status, well-being, and overall self-evaluation of health [16,17]. For each dimension, the item scores are coded, summed, and transformed to yield a final score ranging from 0 (worst health) to 100 (best health) [16]. Depression and anxiety symptoms were recorded using the hospital anxiety and depression scale (HADS) [18,19], which comprises seven-item anxiety and depression subscales. The scores range from 0 to 21 for both HADS-anxiety (HADS-A) and HADS-depression (HADS-D). A score of 0 to 7 on either subscale is regarded as being within the normal range, and a score of ≥ 8 indicates the probable presence of a mood disorder [20].

**Statistical analysis**

Continuous data are expressed as mean ± standard de-
iation (SD) and categorical data as numbers with percentages. Analysis of variance and the Kruskal-Wallis test were used to compare normally and non-normally distributed continuous variables, respectively, and the chi-squared or Fisher exact test (for small numbers) were used to compare categorical variables. Comparison with \( p \) values of \(< 0.1\) on univariate analysis were included in multivariate logistic regression analysis to identify factors associated with low-level PA. Backward elimination was performed to eliminate any predictor for which the \( p \) value in the multivariate model exceeded 0.05. All statistical analyses were performed using SPSS version 18.0 (SPSS Inc., Chicago, IL, USA), with the two-tailed significance level set at 0.05.

### RESULTS

#### Patients characteristics and comparison of clinical data by PA status

In total, 160 patients were included. Table 1 shows their characteristics. Of all patients, 149 (93.1%) were male, and the mean patient age was 71.8 ± 4.5 years. The mean time since COPD diagnosis was 104.6 ± 128.6 months. Of all patients, 25 lived alone and 137 were unemployed (15.6% and 85.6%, respectively). The most common co-morbidities were hypertension (36 patients, 22.5%) and diabetes (14, 8.8%). The mean numbers of admission and emergency room visits over the previous year were 1.2 ± 0.7 and 1.6 ± 1.1, respectively.

The mean daily walking time was 31.4 ± 47.3 minutes for all patients, of whom 64.4% exhibited low-level PA (<

| Table 1. Characteristics according to the degree of physical activity |
|-------------------------------------------------|
| Parameter                                      | Total (n = 160) | Low (n = 103) | Moderate (n = 26) | High (n = 31) | \( p \) value |
| Age, yr                                        | 71.8 ± 4.5      | 71.6 ± 4.5    | 71.7 ± 4.4        | 72.2 ± 4.7    | 0.833        |
| Male sex                                       | 149 (93.1)      | 93 (90.3)     | 25 (96.2)         | 31 (100)      | 0.136        |
| Smoking                                        |                |               |                   |               |              |
| Non-smoker                                     | 10 (6.3)        | 8 (7.8)       | 1 (3.8)           | 1 (3.2)       | 0.266        |
| Former smoker                                  | 119 (74.4)      | 79 (76.7)     | 16 (61.5)         | 24 (77.4)     |              |
| Current smoker                                 | 31 (19.4)       | 16 (15.5)     | 9 (34.6)          | 6 (19.4)      |              |
| Pack-years                                     | 43.8 ± 28.0     | 45.0 ± 29.6   | 44.0 ± 23.1       | 40.0 ± 27.2   | 0.692        |
| Spirometry values                              |                |               |                   |               |              |
| FVC, L                                         | 2.8 ± 0.9       | 2.77 ± 0.90   | 2.83 ± 0.85       | 2.82 ± 0.73   | 0.920        |
| FEV\(_1\), L                                   | 1.5 ± 0.6       | 1.41 ± 0.57   | 1.51 ± 0.57       | 1.63 ± 0.51   | 0.156        |
| FEV\(_1\) % predicted                          | 57.8 ± 21.4     | 55.3 ± 22.0   | 59.6 ± 21.9       | 61.4 ± 18.2   | 0.321        |
| FEV\(_1\)/FVC                                   | 53.6 ± 14.3     | 51.7 ± 13.9   | 54.8 ± 15.5       | 58.8 ± 13.3   | 0.045        |
| BMI, kg/m\(^2\)                                 | 21.9 ± 3.1      | 21.8 ± 3.3    | 22.3 ± 2.6        | 21.9 ± 3.0    | 0.807        |
| Dyspnea (MMRC scale)                           |                |               |                   |               |              |
| \( 0–1 \)                                      | 111 (69.4)      | 63 (61.2)     | 22 (84.6)         | 26 (81.9)     | 0.010        |
| \( \geq 2 \)                                   | 49 (30.6)       | 40 (38.8)     | 4 (15.4)          | 5 (16.1)      |              |
| 6MWD, m                                        | 324.2 ± 85.6    | 310.6 ± 90.5  | 342.2 ± 75.2      | 354.3 ± 66.5  | 0.022        |
| BODE index score                               | 3.2 ± 2.4       | 3.7 ± 2.5     | 2.6 ± 2.0         | 2.3 ± 1.8     | 0.005        |
| Biomarker                                      |                |               |                   |               |              |
| CRP                                           | 0.7 ± 1.6       | 0.6 ± 1.1     | 1.2 ± 2.7         | 0.5 ± 1.5     | 0.162        |
| Fibrinogen                                     | 360.9 ± 112.2   | 355.5 ± 112.3 | 382.2 ± 103.1     | 360.4 ± 120.7 | 0.561        |

Values are presented as mean ± SD or number (%).

FVC, forced vital capacity; FEV\(_1\), forced expiratory volume in 1 second; BMI, body mass index; MMRC, modified medical research council; 6MWD, 6-minute walk distance; BODE, body mass index, degree of airway obstruction, dyspnea, and exercise capacity; CRP, C-reactive protein.
30 min/day), 16.3% moderate-level PA (30 to 60 min/day), and 19.4% high-level PA (≥ 60 min/day). Table 1 compares the clinical characteristics among the three groups. Upon univariate analysis, a decreased exercise capacity in the 6-minute walk test and an increased dyspnea score (MMRC ≥ 2) were significantly associated with low-level PA (p < 0.1). The severity of COPD (derived using the BODE [body mass index, degree of airway obstruction, dyspnea, and exercise capacity] index) was inversely related to PA. Indices of lung function, such as forced expiratory volume in 1 second (FEV₁), did not differ significantly among the three groups.

Questionnaire scores
Table 2 shows the relationships of PA with HRQL, health status, and psychosocial factors. Patients with low-levels of PA tended to have a reduced HRQL (high total SGRQ scores) and poor health (low SF-36 scores). Additionally, the proportions of patients with anxiety (HADS-A score of ≥ 8) and depression (HADS-D score of ≥ 8) were higher in patients with low-level PA.

Predictors of low-level PA in elderly patients
We used univariate and multivariate logistic regression models to identify predictors of low-level PA in elderly patients with COPD. Univariate analysis indicated that six factors (MMRC score of ≥ 2, 6-minute walk test result of < 250 m, total SGRQ score, SF-36 physical functioning score, HADS-D score of ≥ 8, and HADS-A score of ≥ 8) should be included in the multivariate model (Table 3). The factors independently associated with low-level PA on multivariate analysis were severe dyspnea (MMRC score of ≥ 2) and depression (HADS-D score of ≥ 8) (Table 4).

DISCUSSION
We explored the clinical factors associated with low-level PA in elderly patients with COPD. The median age of all patients was 71.8 years, and two-thirds reported low-levels of PA. This proportion is higher than those of previous studies that included middle-aged patients [11].

Table 2. Comparison of questionnaire scores according to the physical activity

| Parameter                        | Total (n = 160) | Low (n = 103) | Moderate (n = 26) | High (n = 31) | p value |
|----------------------------------|----------------|--------------|------------------|--------------|---------|
| **SGRQ**                         |                |              |                  |              |         |
| Symptoms domain                  | 35.7 ± 21.2    | 36.7 ± 22.3  | 37.4 ± 16.9      | 31.1 ± 20.9  | 0.400   |
| Activity domain                  | 57.1 ± 25.3    | 61.1 ± 24.1  | 56.5 ± 26.3      | 44.3 ± 24.8  | 0.005   |
| Impact domain                    | 28.7 ± 21.7    | 32.2 ± 22.0  | 26.0 ± 24.5      | 19.5 ± 14.8  | 0.013   |
| Total score                      | 38.5 ± 20.1    | 41.7 ± 20.0  | 37.2 ± 21.4      | 28.9 ± 16.6  | 0.007   |
| **SF-36**                        |                |              |                  |              |         |
| Physical functioning             | 60.4 ± 26.3    | 55.3 ± 26.7  | 62.5 ± 27.8      | 75.7 ± 16.7  | 0.001   |
| Social functioning               | 89.3 ± 21.3    | 86.0 ± 24.4  | 93.8 ± 15.5      | 96.4 ± 9.2   | 0.030   |
| Role physical                    | 53.9 ± 45.5    | 45.6 ± 44.8  | 54.8 ± 45.3      | 80.7 ± 38.6  | 0.001   |
| Role emotional                   | 77.9 ± 39.7    | 71.5 ± 43.1  | 82.1 ± 38.0      | 95.7 ± 18.7  | 0.009   |
| Mental health                    | 66.7 ± 22.9    | 64.5 ± 21.9  | 70.9 ± 24.1      | 70.7 ± 24.5  | 0.245   |
| Vitality (energy/fatigue)        | 39.4 ± 16.4    | 36.9 ± 15.9  | 40.6 ± 15.0      | 46.6 ± 17.4  | 0.013   |
| Pain                             | 85.7 ± 25.0    | 83.2 ± 26.5  | 89.4 ± 21.4      | 90.9 ± 21.8  | 0.230   |
| General health                   | 47.4 ± 24.3    | 45.1 ± 23.9  | 44.4 ± 24.7      | 57.6 ± 23.5  | 0.033   |
| HADS-A                           | 3.9 ± 4.1      | 4.4 ± 4.3    | 3.5 ± 4.4        | 2.6 ± 2.8    | 0.090   |
| HADS-D                           | 6.9 ± 4.1      | 7.7 ± 4.3    | 6.2 ± 3.8        | 5.0 ± 3.2    | 0.005   |
| HADS-A ≥ 8                       | 26 (16.3)      | 21 (20.4)    | 4 (15.4)         | 1 (3.2)      | 0.059   |
| HADS-D ≥ 8                       | 60 (31.3)      | 52 (49.5)    | 8 (30.8)         | 9 (29.0)     | 0.042   |

Values are presented as mean ± SD or number (%).
SGRQ, St. George’s respiratory questionnaire; SF-36, medical outcomes short form-36; HADS-A, hospital anxiety and depression scale-anxiety; HADS-D, hospital anxiety and depression scale-depression.
Previous studies found that relief of exertional dyspnea and exercise intolerance in patients with COPD [21]. In addition, dyspnea was the only symptom predicting variation in functional performance, and oxygen may influence such performance and the dyspnea symptoms per se in patients with COPD [22]. Although COPD treatments have traditionally sought to improve both pathological and physiological parameters, assessment of the response to treatment may be key when it is sought to predict improvements in the daily activities and outcomes of elderly patients.

Depression is more prevalent in patients with COPD than in those with other medical conditions [23]. Although the true prevalence of depression in elderly patients with COPD is unclear, several studies have reported that the level was high (>40%) [24,25]. In our study, the prevalence was 43.1%, which is similar to that of previous studies. We assessed clinical depression using the HADS, which is a valid and reliable self-rating scale measuring anxiety and depression in both hospital and community settings [19]. In the original study, the cut-off scores for possible and probable depression were 7/8 and 10/11, respectively [19]. In our study, possible (HADS-D score of 8 to 10) and probable (HADS-D score of ≥11) depression were evident in 36 patients (22.5%) and 33 (20.6%), respectively. We used a score of 8 as the depression threshold because possible or subthreshold depression is also known to be an independent predictor of physical disability and impaired HRQL [25]. In most studies, the optimal balance between sensitivity and specificity was evident when caseness was defined by a score of ≥8 on the HADS-D.

Unfortunately, little is known about the mechanism that depression develops in elderly patients with COPD. Very few studies have explored structural brain pathology or cognitive dysfunction specifically in such patients. Magnetic resonance imaging-based quantitative assessment of brain pathology affords direct evidence of psychological and mood changes [26]. Age-related disease-specific processes, including hypoxia and inflammatory changes, compromise the integrity of the frontostriatal pathways, amygdala, and hippocampus, increasing the vulnerability of elderly patients with COPD to depression [27]. In our study, depression was independently associated with low-level of PA. Because this study is the cross-sectional study, it does not allow establishment of

Table 3. Factors associated with low degree of physical activity by univariate analysis

| Factor                          | HR (95% CI)     | p value |
|---------------------------------|-----------------|---------|
| MMRC scale (≥ 2)                | 3.386 (1.499–7.648) | 0.003   |
| 6MWD (< 250 m)                  | 4.474 (1.476–13.566) | 0.008   |
| SGRQ total score               | 1.024 (1.006–1.043) | 0.008   |
| SF-36 physical functioning   | 0.977 (0.964–0.991) | 0.001   |
| HADS-A ≥ 8                     | 2.663 (1.946–7.500) | 0.064   |
| HADS-D ≥ 8                     | 2.399 (1.208–4.766) | 0.012   |

HR, hazard ratio; CI, confidence interval; MMRC, modified medical research council; 6MWD, 6-minute walk distance; SGRQ, St. George’s respiratory questionnaire; SF-36, medical outcomes short form-36; HADS-A, hospital anxiety and depression scale-anxiety; HADS-D, hospital anxiety and depression scale-depression.

Table 4. Factors associated with low degree of physical activity by multivariate analysis

| Factor                          | HR (95% CI)     | p value |
|---------------------------------|-----------------|---------|
| MMRC scale (≥ 2)                | 2.550 (1.075–6.049) | 0.034   |
| 6MWD (< 250 m)                  | 2.697 (1.823–8.741) | 0.098   |
| HADS-D ≥ 8                      | 2.076 (1.018–4.241) | 0.045   |

HR, hazard ratio; CI, confidence interval; MMRC, modified medical research council; 6MWD, 6-minute walk distance; HADS-D, hospital anxiety and depression scale-depression.

Our principal findings were that dyspnea severity and depression were independently associated with low-level PA in elderly patients with COPD. Although several studies have sought to identify predictors of low-level PA in patients with COPD [8,10,11], few have specifically examined clinical factors influencing PA in elderly patients. Therefore, this is the first study to analyze PA patterns and predictors of low-level PA in elderly patients with COPD.

Of all patients, 30.6% had severe dyspnea (MMRC score of ≥2), which was independently associated with low-level PA. The etiology of dyspnea is multifactorial, but recent mechanistic studies suggest that dynamic lung hyperinflation-induced volume restriction with consequent neuromechanical uncoupling of the respiratory system are associated with exertional dyspnea and exercise intolerance in patients with COPD [21]. Previous studies found that relief of exertional dyspnea and improved exercise endurance following prescription of bronchodilator therapy were correlated with reduced lung hyperinflation [21]. In addition, dyspnea was the only symptom predicting variation in functional performance, and oxygen may influence such performance and the dyspnea symptoms per se in patients with COPD [22]. Although COPD treatments have traditionally sought to improve both pathological and physiological parameters, assessment of the response to treatment may be key when it is sought to predict improvements in the daily activities and outcomes of elderly patients.
causal relationship. However, previous studies reported that disease-specific fears contributed to disability and avoidance of PA in subjects with COPD [28]. In addition, a recent study reported that symptoms of depression were prospectively associated with a reduction in PA 6 months later in COPD patients [29]. Therefore we suggest that the presence of depression could decrease the level of PA. However, no direct association has been yet identified. Further studies are needed.

In our present study, only one of the 69 patients with depression was actually treated for the condition. Undetected and untreated depression reduces compliance with medical treatment, quality-of-life, and overall survival of the elderly [30,31]. Therefore, appropriate screening tools and therapy are required to reduce depressive symptoms and the associated disability in elderly patients with COPD [32]. Treatment of the underlying COPD is of course important, but this is often not enough to achieve remission of depression. Antidepressants, psychotherapy, or both are preferred treatment options for late-life major depression [33]. However, aging influences drug pharmacodynamic responses differently at the various pharmacokinetic stages. When prescribing for elderly patients, careful and specific assessment of drug-related problems is required [34]. In patients with minor depression, nonspecific supportive interventions are acceptable alternatives.

In the present study, we found no significant association between lung function and PA. In several studies that included middle-aged patients with COPD, the FEV₁ and the maximal voluntary ventilation exhibited weak to moderate positive associations with PA [12]. However, only a few studies have explored the relationships between PA and measures of lung function. In elderly patients with COPD, lung function may not correlate with low-level PA.

Our study had several limitations. First, the number of the patients is relatively small in our study. Second, we did not consider clinical differences among elderly patients; for example, we did not subdivide patients into those aged > 80 and 65 to 80 years. Furthermore, the FEV₁/forced vital capacity (FVC) ratio declines with age, and the use of a fixed FEV₁/FVC ratio of 0.7 as the threshold for airway obstruction in the elderly remains controversial. Third, we could not assess etiologic or causal links between the level of PA and dyspnea or depression because of the cross-sectional nature of this analysis. Finally, we used self-reported questionnaire rather than a direct measures, such as accelerometers, to establish the PA level. Although objective measures can provide more accurate way, they are not feasible in routine practice. Several studies have demonstrated the correlation of self-reported walking times per day (patients who walked < 30, 30 to 60, and ≥ 60 minutes) with health-related quality of life and functional status [11].

In conclusion, two-thirds of elderly patients with COPD reported low-level PA. Severe dyspnea and depression were independently associated with this low-level of PA. Further work with larger populations would afford more insight into predictors of low-level PA in elderly patients with COPD.

**KEY MESSAGE**

1. Severe dyspnea and depression are independent risk factor for low-level physical activity (PA) in elderly patients with chronic obstructive pulmonary disease (COPD). Obviously, these clinical factors alone do not explain why the PA level was low. Nevertheless, assessment of dyspnea and symptom control may be the key to increase daily activity in elderly patients with COPD.

2. The application of adequate screening for presence of depression and aggressive treatment for depression could improve the level of PA.

**Conflict of interest**

No potential conflict of interest relevant to this article was reported.

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