ORIGINAL RESEARCH

Management of COPD, equal treatment across age, gender, and social situation? A register study

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Abstract: Chronic obstructive pulmonary disease (COPD) is a progressive chronic disease where treatment decisions should be based on disease severity and also should be equally distributed across age, gender, and social situation. The aim of this study was to determine to what extent patients with COPD are offered evidence-based interventions and how the interventions are distributed across demographic and clinical factors in the sample. Baseline registrations of demographic, disease-related, and management-related variables of 7,810 patients in the Swedish National Airway Register are presented. One-third of the patients were current smokers. Patient-reported dyspnea and health-related quality of life were more deteriorated in elderly patients and patients living alone. Only 34% of currently smoking patients participated in the smoking cessation programs, and 22% of all patients were enrolled in any patient education program, with women taking part in them more than men. Less than 20% of the patients had any contact with physiotherapists or dieticians, with women having more contact than men. Men had more comorbidities than women, except for depression and osteoporosis. Women were more often given pharmacological treatments. With increasing severity of dyspnea, participation in patient education programs was more common. Dietician contact was more common in those with lower body mass index and more severe COPD stage. Both dietician contact and physiotherapist contact increased with deteriorated health-related quality of life, dyspnea, and increased exacerbation frequency. The present study showed that COPD management is mostly equally distributed across demographic characteristics. Only a minority of the patients in the present study had interdisciplinary team contacts. Thus, this data shows that the practical implementation of structured guidelines for treatment of COPD varies, to some extent, with regard to age and gender. Also, disease characteristics influence guideline implementation for each individual patient. Quality registers have the strength to follow-up on compliance with guidelines and show whether an intervention needs to be adapted prior to implementation in health care practice.

Keywords: COPD, quality register, treatments, socioeconomic status, lung

Background

Chronic obstructive pulmonary disease (COPD) is a progressive illness that, in advanced condition, has limited survival and severe health changes that demand preventive and alleviating measures to reduce the impact of exacerbations.[1] COPD is unevenly distributed in the population, as people of the lowest socioeconomic status who have COPD are more likely to experience poor health outcomes than those of the highest socioeconomic status with COPD.[2] Smoking, the main cause of the disease, is also related to socioeconomic status.[3] There are also gender differences: women with COPD are more likely to report the prevalence and higher intensity of dyspnea;[4,5] women have lower prevalence of cardiovascular comorbidity and diabetes mellitus;

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and osteoporosis and depression are more common in women.[4] In a study exploring gender differences in the use of diagnostic tools and nonmedical treatment, it was found that a minority of patients had undergone spirometry tests, women had them done less often than men, but more smoking cessation advice was given to women.[5] Deterioration in health-related quality of life (HRQOL) has been associated with severity of COPD and increasing age.[6] With increasing age, the risk of exacerbations is increased,[7–9] and naturally, a fatal outcome is more common.[9,10]

The negative influence of progression of the disease is highly significant in patients, which necessitates the development of both pharmacological and nonpharmacological evidence-based management strategies. Of the nonpharmacological treatments, patient education has been shown to have an effect on the number of general practitioner visits, patient satisfaction,[11] hospital admissions, and HRQOL.[12] Pulmonary rehabilitation improves both dyspnea and exercise capacity,[13] reduces the number of hospitalizations, and decreases mortality.[14] Therefore, physiotherapists play an important role in the management of COPD.[15] Other effective nonpharmacological interventions for patients are dietician consultation for patients with low body mass index (BMI) and smoking cessation programs for smokers. Pharmacological treatments in severe COPD should include long-acting anticholinergics and/or long-acting β_2-adrenoceptor agonists and/or a combination of long-acting β_2-adrenoceptor agonists and inhaled corticosteroids.[16] Despite the existing research, the distribution of disease manifestations and treatments must be further explored in larger samples of COPD patients. The distribution of treatments across sociodemographic characteristics, such as age, gender, and social situation and disease severity, needs to be explored.

Clinical quality registers could be used to observe the course of the disease in real life, in order to understand variations in treatment and outcomes[17] and whether the treatments are equally distributed. The Swedish National Airway Register was introduced in 2009 in Sweden and in 2012, the model was transformed to include asthma also. The present study used the first register, before transformation, and included 7,810 patients from 240 units. A majority of the registrations were made in two counties, both of which are populated areas. COPD is defined in the register by the Global initiative for chronic Obstructive Lung Disease definition, ie, with the spirometric criterion for airflow limitation that remains with a postbronchodilator ratio of forced expiratory volume in 1 second (FEV$_1$)/forced vital capacity of <0.70.[16] Registered

items are demographic and clinical variables and appropriate interventions. The aim of the present study was to determine to what extent patients with COPD are offered evidence-based interventions and how the interventions are distributed across demographic and clinical factors in the sample.

Methods
The Swedish National Airway Register includes demographic and disease- and treatment-related variables. In the present study, the baseline registrations of 7,810 patients are presented. All patients who had been registered were included in the present study. Inclusion criterion was that the patient had at least one registration during the period in which the register was active. All registrations included in the present study concern baseline data. The study was approved by the Ethics Committee at the Department of Medical Ethics in Gothenburg in July 2015 (Dnr: 317-15). All patients were informed and gave their informed consent prior to entering the register.

Hypotheses
Hypotheses were formulated based on the pharmacological and nonpharmacological treatments recommended in COPD care and the assumption that the care should be distributed based on disease severity, irrespective of the sociodemographic factors.

Hypothesis I: Smoking cessation program is equally distributed to smokers across sociodemographic characteristics.
Hypothesis II: Patient education program is equally distributed across sociodemographic characteristics.
Hypothesis III: Dietician consultation is related to a low BMI, irrespective of the sociodemographic factors.
Hypothesis IV: Physiotherapy consultation is more common with deteriorating exercise capacity and increasing dyspnea, irrespective of the sociodemographic factors.

In order to find whether there are differences in the distribution of nonpharmacological and pharmacological treatments, two hypotheses about two pharmacological treatments were formulated.

Hypothesis V: Prescription of long-acting anticholinergics is more common with increasing disease severity measured by FEV$_1$% of the predicted value, dyspnea, and exacerbations, irrespective of the sociodemographic factors.
Hypothesis VI: Prescription of the combination of long-acting β_2-adrenoceptor agonists and inhaled steroids is more common with increasing disease severity measured by FEV$_1$% of the predicted value, dyspnea, and exacerbations, irrespective of the sociodemographic factors.

Variables

Demographic and clinical variables

We included demographic factors such as age, gender, and social situation, divided into "living alone" or "cohabiting", from the Swedish National Airway Register. Clinical variables included obstruction, measured by $FEV_1\%$ of the predicted value, number of exacerbations during the last 12 months before registration, number of hospital admissions due to COPD in the last 12 months before registration, BMI, and comorbidities.

Patient-reported variables

Patient-reported variables were smoking (nonsmokers, quit smoking, or still smoking), exercise capacity, measured by number of days per week with physical activity, and functional dyspnea, measured by the modified Medical Research Council (mMRC) dyspnea scale.[18] The mMRC dyspnea scale is a patient-reported, single-item scale where the severity of dyspnea is reported, ranging from 0 ("not troubled by breathlessness except on strenuous exercise") to 4 ("breathless when dressing or undressing"). HRQOL was measured by the Clinical COPD Questionnaire (CCQ),[19] a patient-rated questionnaire consisting of ten items: one item each about dyspnea at rest and dyspnea during physical activities; two items about how concerned the patient is about dyspnea; one item each about cough and phlegm; and four items about how the dyspnea had limited the patient's physical activities, ie, strenuous physical activities, moderate physical activities, daily activities, and social activities. All items are scored from 0, for "never", to 6, which corresponds to "almost all the time". Mean values of the scores were used and the results are interpreted as follows: 4.0–6.0 means large or very large impact on HRQOL/health status, 2.0–3.9 corresponds to moderate impact on HRQOL, and 0.0–1.9 means none or small impact on HRQOL.

Treatment-related variables

Data about interventions and treatments were retrieved from the Swedish National Airway Register. Participation in a smoking cessation program was included in the analysis for those who reported themselves as still smoking. Patient education program included: lectures to increase knowledge about COPD, medications, and prevention of infection; advice about physical activity, breathing, cough, and relaxation techniques, energy-conserving techniques; and daily life aids. Patient education also included appropriate actions to take during exacerbations, as well as smoking prevention and smoking cessation. Other information collected included if the patient had an established contact with physiotherapists, dieticians, occupational therapists, or social workers, and had received vaccinations against *Streptococcus pneumoniae* and influenza, as well as oxygen treatment. There was no information about the target of the consultations with physiotherapists, dieticians, occupational therapists, or social workers. Data on the following medications were also retrieved from the Swedish National Airway Register: long-acting anticholinergics, inhaled steroids, combination of steroids and long-acting β_2-adrenoceptor agonists, *N*-acetylcysteine, calcium, bisphosphonate, and long-acting β_2-adrenoceptor agonists.

Data analysis

Descriptive statistics were used to describe the sample and registered treatments, with mean and standard deviation (SD) calculated for continuous variables. Categorical variables were presented as numbers and percentages for the total sample (N=7,810) and the distribution in the demographic groups, ie, for those below and above the median age of 70 years, for men and women, and for those living alone and those who cohabit. Some registrations were missed, resulting in lower numbers of participants in different variables, ie, missing registrations in any of the demographic or the investigated variables resulted in substantially lower numbers of some variables in Tables 1 and 2. Relationships between dichotomous categorical experience and treatment variables and age, gender, and social situation were analyzed with the Mantel–Haenszel chi-square test. Logistic binary regression analyses were used to analyze the relationships between treatments and selected prerequisites, as defined by the hypotheses, and adjusted for age, gender, and social situation. The treatments used as dependent variables were: participation in a smoking cessation or patient education program, dietician consultations, physiotherapy consultations, medication with long-acting anticholinergic and a combination of steroids and long-acting β_2-adrenoceptor agonists. First, univariable logistic regression analyses were performed with age, gender, social situation, $FEV_1\%$ of the predicted value, BMI, exercise capacity, dyspnea measured by mMRC, HRQOL measured by CCQ, and exacerbations per year as independent variables. Second, independent variables that significantly predicted the dependent variable with $P<0.20$ in the univariable analyses were entered in the multivariable logistic regression analyses with the same dependent variables.

Table I Demographic and clinical characteristics at registration of the total sample and divided by age, gender, and social situation

Demographic variables	Total sample, N=7,810	Age			Gender			Social situation		
		≤70 years n=4,303 (55.1%)	>70 years n=3,507 (44.9%)	P-value	Men n=3,448 (44.1%)	Women n=4,362 (55.9%)	P-value	Living alone n=1,934 (24.8%)	Cohabiting n=3,083 (39.5%)	P-value
Age, mean (SD)	69 (9.1)			<0.001	70.1 (9.4)	68.5 (9.4)	<0.001	70.6 (9.6)	68.9 (9.0)	<0.001
Social situation, n (%)							<0.001			
Living alone	1,934 (38.5)	944 (35.0)	990 (42.6)	<0.001	644 (18.7)	1,290 (29.6)				
Cohabiting	3,083 (61.4)	1,749 (65.0)	1,334 (57.4)		1,647 (47.8)	1,436 (32.9)				
Clinical variables	Mean (SD)	Mean (SD)	Mean (SD)		Mean (SD)	Mean (SD)		Mean (SD)	Mean (SD)	
FEV$_1$% of the predicted value	50.3 (20.1)	51.2 (22.1)	49.2 (17.1)	<0.001	50.6 (23.1)	50.0 (17.2)	0.236	47.6 (16.7)	50.4 (17.1)	<0.001
Exacerbations, last 12 months before registration	0.78 (1.4)	0.77 (1.3)	0.80 (1.5)	0.416	0.68 (1.3)	0.87 (1.5)	<0.001	0.83 (1.3)	0.78 (1.5)	0.257
Hospital admissions, last 12 months before registration	0.23 (0.8)	0.17 (0.6)	0.31 (1.0)	<0.001	0.21 (0.8)	0.26 (0.8)	0.010	0.33 (1.0)	0.23 (0.9)	<0.001
BMI	26.0 (5.6)	26.3 (5.9)	25.7 (5.2)	<0.001	26.3 (5.2)	25.8 (5.9)	<0.001	25.5 (5.7)	26.1 (5.3)	0.003
Comorbidity	n (%)	n (%)	n (%)		n (%)	n (%)		n (%)	n (%)	
Heart failure	761 (9.7)	232 (5.4)	529 (15.1)	<0.001	409 (11.9)	352 (8.1)	<0.001	241 (12.5)	296 (9.6)	<0.001
Ischemic heart disease	1,199 (15.3)	481 (11.2)	718 (20.5)	<0.001	712 (20.6)	487 (11.2)	<0.001	312 (16.1)	472 (15.3)	0.060
Stroke	405 (5.2)	171 (4.0)	234 (6.7)	<0.001	231 (6.7)	174 (4.0)	<0.001	109 (5.6)	156 (5.1)	0.031
Hypertension	3,136 (40.2)	1,519 (35.3)	1,617 (46.1)	<0.001	1,403 (40.7)	1,733 (39.7)	0.387	771 (39.9)	1,254 (40.7)	0.815
Atrial fibrillation	600 (7.7)	179 (4.2)	421 (12.0)	<0.001	344 (10.0)	256 (5.9)	<0.001	154 (8.0)	251 (8.1)	0.372
Diabetes	894 (11.4)	446 (10.4)	448 (12.8)	0.001	481 (14.0)	413 (9.5)	<0.001	216 (11.2)	374 (12.1)	0.791
Osteoporosis	749 (9.6)	308 (7.2)	441 (12.6)	<0.001	124 (3.6)	625 (14.3)	<0.001	251 (13.0)	267 (8.7)	<0.001
Depression/anxiety	1,136 (14.5)	708 (16.5)	431 (12.3)	<0.001	327 (9.5)	812 (18.6)	<0.001	360 (18.6)	396 (12.8)	<0.001
α1-Antitrypsin deficit	46 (0.6)	34 (0.8)	12 (0.3)	0.016	14 (0.4)	32 (0.7)	0.067	13 (0.7)	15 (0.5)	0.552
Sleep apnea	141 (1.8)	100 (2.3)	41 (1.2)	<0.001	78 (2.3)	63 (1.4)	0.004	33 (1.7)	59 (1.9)	0.316
Patient-reported variables	n (%)	n (%)	n (%)		n (%)	n (%)		n (%)	n (%)	
Smoking:				<0.001			0.497			0.050
Nonsmoker	295 (3.8)	77 (1.8)	218 (6.4)		89 (2.6)	206 (4.8)		67 (3.5)	94 (3.1)	
Have quit smoking	4,648 (60.1)	2,274 (53.7)	2,374 (69.4)		2,156 (63.7)	2,492 (58.4)		1,101 (57.4)	2,014 (65.8)	
Still smoking	2,706 (35.4)	1,880 (44.4)	826 (24.2)		1,140 (33.7)	1,566 (36.7)		749 (39.1)	952 (31.1)	
Exercise capacity (days per week)	Mean (SD) 3.3 (2.8)	Mean (SD) 3.5 (2.8)	Mean (SD) 3.0 (1.3)	<0.001	Mean (SD) 3.4 (2.8)	Mean (SD) 3.2 (2.8)	0.030	Mean (SD) 3.2 (2.8)	Mean (SD) 3.4 (2.8)	0.098
Functional dyspnea, (mMRC)	1.88 (1.2)	1.67 (1.2)	2.14 (1.3)	<0.001	1.84 (1.3)	1.91 (1.2)	0.028	2.13 (1.3)	1.80 (1.2)	<0.001
Quality of life (CCQ)	1.8 (1.2)	1.8 (1.2)	1.9 (1.1)	<0.001	1.8 (1.1)	1.8 (1.2)	0.782	2.0 (1.2)	1.8 (1.2)	<0.001

Notes: N=7,810. Some registrations were missed, which resulted in lower number of participants in some of the variables.
Abbreviations: BMI, body mass index; CCQ, Clinical COPD Questionnaire; FEV$_1$, forced expiratory volume in 1 second; mMRC, modified Medical Research Council; SD, standard deviation.

Table 2 Treatments at registration for the patients by age, gender, and social situation*

Treatments	Total sample n (%) (N=7,810)	Age			Gender			Social situation		
		≤70 years n=4,303 (55.1%) n (%)	>70 years n=3,507 (44.9%) n (%)	P-value	Men n=3,448 (44.1%) n (%)	Women n=4,362 (55.9%) n (%)	P-value	Living alone n=1,934 (38.5%) n (%)	Cohabiting n=3,083 (61.4%) n (%)	P-value
Still smokers (n=2,706)										
Participated in SCP	924 (34.1)	713 (40.3)	211 (27.8)	<0.001	368 (34.7)	556 (37.8)	0.109	299 (41.8)	324 (35.9)	0.016
Participation in patient education program	1,725 (22.1)	962 (22.4)	763 (21.8)	0.977	687 (21.5)	1,038 (25.9)	<0.001	446 (24.8)	724 (24.8)	0.973
Contact with:										
Physiotherapist	1,522 (19.5)	813 (18.9)	709 (20.2)	0.081	572 (17.3)	950 (22.8)	<0.001	485 (25.6)	592 (19.6)	<0.001
Dietician	843 (10.8)	416 (9.7)	427 (12.2)	<0.001	300 (9.1)	543 (13.0)	<0.001	307 (16.2)	334 (11.0)	<0.001
Occupational therapist	539 (6.9)	253 (5.9)	286 (8.2)	<0.001	184 (5.6)	355 (8.6)	<0.001	197 (10.6)	204 (6.8)	<0.001
Social worker	337 (4.3)	204 (4.7)	133 (3.8)	0.053	100 (3.1)	237 (5.8)	<0.001	120 (6.4)	123 (4.1)	<0.001
Vaccinated against:										
Pneumococcus	2,978 (38.1)	1,456 (42.3)	1,522 (56.8)	<0.001	1,224 (45.5)	1,754 (51.1)	<0.001	796 (51.3)	1,242 (49.4)	0.248
Influenza	3,934 (50.4)	1,847 (52.9)	2,087 (71.7)	<0.001	1,706 (60.3)	2,228 (62.3)	0.097	1,006 (62.0)	1,712 (64.7)	0.075
Oxygen treatment at home	169 (2.2)	67 (1.6)	102 (3.0)	<0.001	61 (1.8)	108 (2.6)	0.030	56 (2.9)	77 (2.5)	0.401
Medication:										
Long-acting anticholinergics	4,414 (56.5)	2,294 (54.9)	2,120 (62.6)	<0.001	1,887 (56.4)	2,527 (59.9)	0.002	1,188 (62.1)	1,760 (59.7)	0.003
Inhaled steroids	1,003 (12.8)	536 (12.9)	467 (13.8)	0.230	412 (12.3)	591 (14.1)	0.027	239 (12.5)	411 (13.5)	0.287
Combination of long-acting β_2-Adrenoceptor agonists and inhaled steroids	3,860 (49.4)	2,007 (48.1)	1,853 (54.7)	<0.001	1,646 (49.3)	2,214 (52.5)	0.006	1,087 (56.7)	1,557 (51.1)	<0.001
N-acetylcysteine	2,014 (25.8)	1,005 (24.2)	1,009 (30.0)	<0.001	873 (26.2)	1,141 (27.2)	0.308	600 (31.4)	848 (27.9)	0.008
Calcium	882 (11.3)	395 (9.7)	487 (14.8)	<0.001	184 (5.6)	698 (17.0)	<0.001	306 (16.4)	341 (11.4)	<0.001
Bisphosphonate	422 (5.4)	186 (4.5)	236 (6.7)	<0.001	86 (2.6)	336 (8.2)	<0.001	132 (7.1)	175 (5.9)	0.078
β_2-Adrenoceptor agonists long acting	1,079 (13.8)	545 (13.1)	534 (15.8)	<0.001	451 (13.5)	628 (15.0)	0.075	278 (14.6)	438 (14.4)	0.885

Note: *Some registrations were missed, which resulted in lower number of participants in some of the variables.
Abbreviation: SCP, smoking cessation programs.

As the total sample was large and many comparisons were made, only those P-values <0.001 were regarded as significant.

Results

Demographic and clinical characteristics

Demographic and clinical characteristics of the patients are presented in Table 1. According to the Global initiative for chronic Obstructive Lung Disease staging,[16] the majority of the patients (48%) were diagnosed with moderate COPD (50% ≤FEV_1, <80% predicted). Seven percent of the patients were diagnosed with mild COPD (FEV_1 ≥80% predicted), 35% with severe COPD (30% ≤FEV_1, <50% predicted), and 10% with severe COPD (FEV_1 <30% predicted). Men had more comorbidities than women, except for osteoporosis and depression/anxiety. Heart failure, osteoporosis, and depression were more frequently reported by those living alone. Younger people and men had higher BMI. People below 71 years of age were more commonly current smokers. Median exercise capacity was three days a week.

Dyspnea and HRQOL

The median subjectively rated dyspnea degree, according to the mMRC, was two, corresponding to "becoming breathless when walking on flat ground at the same speed as a person of the same age". Those living alone had higher levels of self-rated dyspnea than those who were cohabiting. Median HRQOL, according to CCQ, was 1.6, which corresponds to "little or no impact on HRQOL". Older people had worse HRQOL and worse dyspnea and less exercise capacity than younger people (Table 1).

Treatments

Hypotheses I and II: smoking cessation and education programs

The registered treatments are presented in Table 2. Of the current smokers, a minority (34%) participated in a smoking cessation program. In the multivariable analyses, no factors were related to a changed odds ratio for participation in a smoking cessation program (Table 3). Of the total sample, 22% had participated in patient education programs, with women participating to a larger extent (Table 2). Worse dyspnea was the only significant variable that increased the odds of participation in patient education (Table 3).

Hypotheses III and IV: physiotherapist and dietician contacts

Physiotherapy was the most common paramedic consultation. Being a woman and living alone were the factors associated with an increased possibility of having contact with a physiotherapist. Increasing age, being a woman, and living alone were the factors associated with an increased possibility of having contact with a dietician.

In a multivariable analysis adjusted for age, gender, and social situation, an increasing possibility for having contact with a dietician or a physiotherapist was related to lower FEV_1% of the predicted value, higher levels of dyspnea, worse HRQOL, and higher number of exacerbations. Lower BMI was also a positive factor for having contact with a dietician (Table 3).

Hypotheses V and VI: pharmacological treatments

Patients of increasing age were, to a larger extent, prescribed long-acting anticholinergics and a combination of steroids and long-acting β_2-adrenoceptor agonists. The likelihood of being prescribed long-acting anticholinergics increased with low FEV_1% of the predicted value and higher levels of dyspnea (Table 4). The likelihood of being prescribed a combination of inhaled corticosteroids and long-acting β_2-adrenoceptor agonists increased with low FEV_1%, increased level of dyspnea, worse HRQOL, and an increased exacerbation rate (Table 4).

Discussion

The present study shows that patients with COPD are not a homogenous group and that there are differences in disease expressions as well as in treatments related to demographic characteristics. These differences could have various explanations, such as different characteristics of the disease or differences in prescriptions of treatment across age, gender, and social situation. Nonpharmacological treatments were only used by a minority of the patients, and could, if prescribed and utilized to larger extent, have the potential to increase the effectiveness of COPD treatment.

With regard to disease characteristics, more men than women were diagnosed with comorbidities, except for osteoporosis and depression/anxiety, which occurred more frequently in women, which was also reported by Aryal et al.[4] Differences in comorbidity profile were also found by Kilic et al,[20] who reported that women, to a larger extent, had sleep disorder, chronic kidney disease, anemia, and gastroesophageal reflux disease.[20] The present study, as in the study by Kilic et al,[20] showed that women experienced significantly more exacerbations. However, the increase of exacerbations in relation to higher age, found in other studies,[7,9] was not found in this sample. The most probable explanation for the difference is that the selection criteria of the patients were different in these studies. Our patient register is dominated

Table 3 Logistic binary regression analysis with nonpharmacological treatments, ie, participation in smoking cessation program or patient education, contact with dietician or physiotherapist

Independent variables	Smoking cessation program (only smokers)		Patient education program		Dietician		Physiotherapist	
	Univariable OR (95% CI), P-value	Multivariable OR (95% CI), P-value	Univariable OR (95% CI), P-value	Multivariable OR (95% CI), P-value	Univariable OR (95% CI), P-value	Multivariable OR (95% CI), P-value	Univariable OR (95% CI), P-value	Multivariable OR (95% CI), P-value
Constant		3.73, P=0.027		0.31*		0.77, P=0.768		0.57, P=0.20
Age, divided by 10 years	0.76 (0.69, 0.83)*	0.78 (0.66, 0.93), P=0.005	1.00 (0.94, 1.06), P=0.972		1.20 (1.11, 1.30)*		1.07 (1.00, 1.14), P=0.034	
Gender (1= man, 2= woman)	1.14 (0.97, 1.35), P=0.109		1.28 (1.15, 1.43)*		1.50 (1.29, 1.74)*	1.40 (1.04, 1.88), P=0.028	1.41 (1.25, 1.58)*	
Social situation (0= living alone, 1= cohabiting)	0.78 (0.64, 0.96), P=0.016	0.71 (0.52, 0.96), P=0.028	1.00 (0.88, 1.15), P=0.973		0.64 (0.54, 0.76)*		0.71 (0.62, 0.81)*	0.80 (0.64, 0.98), P=0.035
FEV$_1$ % of the predicted value	1.00 (0.99, 1.00), P=0.17		0.99 (0.98, 0.99)*	0.99 (0.99, 1.00), P=0.002	0.96 (0.95, 0.96)*	0.98 (0.97, 0.99)*	0.97 (0.96, 0.97)*	0.97 (0.97, 0.98)*
BMI	1.01 (1.00, 1.03), P=0.187		0.99 (0.98, 1.00), P=0.120		0.88 (0.87, 0.90)*	0.90 (0.87, 0.92)*	0.99 (0.98, 1.00), P=0.041	
Exercise capacity	1.02 (0.99, 1.06), P=0.146		0.98 (0.96, 1.00), P=0.136		0.92 (0.89, 0.95)*		0.97 (0.94, 0.99), P=0.002	
Quality of life (CCQ) (0–6)	1.14 (1.05, 1.24), P=0.002		1.18 (1.12, 1.25)*		1.72 (1.60, 1.83)*	1.36 (1.17, 1.59)*	1.46 (1.38, 1.54)*	
Dyspnea (mMRC) (0–4)	1.11 (1.03, 1.19), P=0.006		1.23 (1.17, 1.28)*	1.17 (1.09, 1.26)*	1.88 (1.76, 2.00)*	1.47 (1.26, 1.72)*	1.58 (1.50, 1.66)*	1.32 (1.20, 1.44)*
Exacerbations per year	1.07 (1.00, 1.14), P=0.05		1.13 (1.08, 1.17)*	1.064 (1.01, 1.12), P=0.020	1.33 (1.27, 1.38)*	1.16 (1.07, 1.24)*	1.30 (1.25, 1.36)*	1.12 (1.06, 1.20)*
Test								
Area under the curve		0.578		0.585		0.797		0.706

Note: *P<0.001.
Abbreviations: BMI, body mass index; CCQ, Clinical COPD Questionnaire; CI, confidence interval; FEV$_1$, forced expiratory volume in 1 second; mMRC, modified Medical Research Council; OR, odds ratio.

Table 4 Logistic binary regression analysis with pharmacological treatments, ie, prescriptions of long-acting anticholinergics and a combination of steroids and long-acting β_2-adrenoceptor agonists as dependent variables

Independent variables	Prescription of long-acting anticholinergics		Prescription of a combination of long-acting β_2-adrenoceptor agonists and inhaled steroids	
	Univariable	Multivariable	Univariable	Multivariable
	OR (95% CI), *P*-value	OR (95% CI)	OR (95% CI), *P*-value	OR (95% CI)
Constant		1.61, *P*=0.008		1.58, *P*=0.007
Age, divided in 10 years	1.25 (1.19, 1.32)*		1.19 (1.13, 1.24)*	
Gender (1= man, 2= woman)	1.16 (1.05, 1.27), *P*=0.002		1.14 (1.04, 1.24), *P*=0.006	
Social situation (0= living alone, 1= cohabiting)	0.84 (0.74, 0.94), *P*=0.003		0.80 (0.71, 0.90)*	
FEV$_1$% of the predicted value	0.98 (0.97, 0.98)*	0.99 (0.98, 0.99)*	0.97 (0.97, 0.97)*	0.98 (0.97, 0.98)*
BMI	0.99 (0.98, 1.00), *P*=0.121		1.00 (0.99, 1.01), *P*=0.709	
Exercise capacity	1.00 (0.98, 1.02), *P*=0.766		0.99 (0.97, 1.00), *P*=0.985	
Quality of life (CCQ)	1.35 (1.28, 1.42)*		1.56 (1.48, 1.64)*	1.19 (1.09, 1.30)*
Dyspnea (mMRC)	1.46 (1.40, 1.52)*	1.30 (1.20, 1.40)*	1.56 (1.50, 1.63)*	1.22 (1.13, 1.33)*
Exacerbations per year	1.18 (1.13, 1.23)*	1.08 (1.01, 1.15), *P*=0.026	1.38 (1.32, 1.45)*	1.16 (1.08, 1.24)*
Test				
Area under the curve		0.658		0.694

Note: *P<0.001

Abbreviations: BMI, body mass index; CCQ, Clinical COPD Questionnaire; CI, confidence interval; FEV$_1$, forced expiratory volume in 1 second; mMRC, modified Medical Research Council; OR, odds ratio.

by patients from primary care, and a substantial part of our patients were in the early stages of the disease.

Regarding variation in the prescription of interventions, there were some differences between men and women in the reported treatments (Table 2), in that more women participated in patient education programs, had contacts with physiotherapists, occupational therapists, dietician, and social workers, were vaccinated, and received more pharmacological interventions. Although women have earlier been found to have a longer diagnostic delay and increased difficulties of reaching a physician,[21] there are no consistent findings of gender differences in treatments in the earlier studies,[22] as we found in the present study. An explanation of the gender differences could be an inherent difference in the appreciation of, for example, rehabilitation efforts. The sociodemographic differences did not remain in the multivariable analysis and the first and the second hypotheses were supported, in that there were no sociodemographic differences in participation in smoking cessation or patient education programs. The national guidelines for evidence-based COPD management, published in Sweden in 2015[23] by the National Board of Health and Welfare, state that patient education and smoking cessation support should be offered with high priority to all patients with COPD. Therefore, it is

reassuring that these nonpharmacological interventions are equally distributed across sociodemographic factors.

The guidelines[23] further recommend different types of interventions concurrently, such as support from an interprofessional team with physiotherapy and dietician contact. Only 11% of the registered patients had dietician contact, and it was found that patients with lower BMI and deteriorating disease were more likely to have dietician contact. This, to some extent, supports the third hypothesis that dietician consultation is related to BMI, independent of sociodemographics. According to the European Society for Clinical Nutrition and Metabolism guidelines, nutrition is important for COPD patients and should, in combination with exercise and pharmacological therapy, increase the nutritional status.[24]

Only 20% of the patients had contact with a physiotherapist, which is too low, according to the recommendation in the current guidelines which states that patients with deteriorated physical capacity should be offered fitness training. The mean days of exercise in the sample was slightly above three days a week, across age, gender, and social situation. Contact with a physiotherapist was predicted by increased dyspnea and higher exacerbation frequency, but not by deteriorated exercise capacity, which means that the fourth hypothesis, which assumed that physiotherapy contact should

be more common with deteriorating exercise capacity, was not supported. This indicates that deteriorated illness, with increasing dyspnea, is the main trigger of physiotherapy consultation. The physiotherapy consultation is part of pulmonary rehabilitation, with the potential to improve both dyspnea and exercise capacity.[13] In the guidelines,[23] it was stated that health care professionals should identify patients with deteriorated physical capacity with a 6-minute walking test and offer fitness training, individually or in a group, which could be a good way to improve the implementation of training and rehabilitation in the management of COPD.

The Swedish Medical Products Agency has published the recommendations for medical treatment offered to patients with COPD and dyspnea, measured by the mMRC[18] ≥ 2.0 and CCQ[19] ≥ 1.0, which includes long-acting anticholinergics or a combination of long-acting anticholinergics and long-acting β_2-adrenoceptor agonists. If the patients also have exacerbations, long-acting β_2-adrenoceptor agonists combined with inhaled steroids is a starting option.[25] Prescription of long-acting anticholinergics was more common in patients with lower $FEV_1\%$ and increased dyspnea, which was the fifth hypothesis and is in accordance with the recommendations. Prescription of a combination of long-acting β_2-adrenoceptor agonists and inhaled corticosteroids was more common in patients with low $FEV_1\%$, deteriorated HRQOL, increased dyspnea, and increased exacerbation frequency, supporting hypothesis VI, which states that a combination of long-acting β_2-adrenoceptor agonists and inhaled steroids is prescribed commonly with increasing disease severity as measured by $FEV_1\%$ of the predicted value, dyspnea, and exacerbations, irrespective of the sociodemographic factors.

There were differences in clinically measured and patient-reported variables and in comorbidity between older and younger patients, men and women, and those living alone and those cohabiting; however, the triggering factors for prescriptions of pharmacological treatment seem to be deteriorated illness, uninfluenced by demographic factors. The results also imply that the pharmacological treatments were, to a larger extent, following the newly formulated guidelines, in contrast to the recommended nonpharmacological interventions. However, the present study shows that both pharmacological and nonpharmacological treatments were prescribed according to the severity of the disease, irrespective of age, gender, and social situation.

Methodological considerations

A comprehensively completed register provides the opportunity to compare management and outcomes in a real-life situation.[17] To obtain evidence for an intervention, evidence-based medicine mostly employs randomized controlled trials or meta-analyses, which provide highly stringent results of the efficacy of an intervention. However, the stringency in the trial situation might not always be possible in an encounter with the real-life situation of a patient. Using a quality register has the potential to generate knowledge about the effects of interventions on large populations.[26] Sometimes, epidemiological studies can provide this type of information. The reverse, however, is that epidemiology tends to underestimate the effects of disease management in the more severely ill patients. Thus, although not comprehensive in either geographical coverage or inclusion of all patients in each health care center, the register could give information on what is possible in the real patient encounter and provides the possibility to adhere to guidelines.

Limitations of our study include its retrospective approach. In order to improve generalization of the register, it is important to obtain comprehensive registration across all regions and all health care centers dealing with COPD in the country. Also, a better representation of the early stages of COPD following a better diagnostic effort will further improve the generalization of a register such as ours.

Conclusion

The present study showed that although there were differences between both disease expressions and management across demographic characteristics, treatments are mainly related to disease severity. Only a minority of the patients in the present study participated in interventions from the interdisciplinary team. Therefore, there is a great potential for improvement to keep up with the current national guidelines and use pharmacological and nonpharmacological interventions concurrently. Quality registers have the strength to follow-up on compliance with guidelines and, to some extent, also evaluate the important factors in guideline implementation.

Disclosure

The authors report no conflicts of interest in this work.

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