

# Socioeconomic Variations in Use of Prescription Medicines for COPD: A Register-Based Study

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**BACKGROUND:** The purpose of this study was to examine socioeconomic variations in the use of prescription medicines among elderly subjects with COPD. **METHODS:** Data from the Danish national administrative registers were used. The study population included 1,365 individuals >60 y old residing in the Municipality of Copenhagen and diagnosed with COPD in a hospital setting in 2007. Logistic regression analysis was applied to examine the associations between the use of all prescription medicines for obstructive pulmonary diseases and the use of long-acting bronchodilators, in subject groups of different socioeconomic position. **RESULTS:** The study demonstrated that approximately 90% of subjects with COPD purchased at least one prescription medicine for obstructive pulmonary diseases, whereas approximately 50% purchased a long-acting bronchodilator. Medicine use did not vary according to educational status or personal wealth. **CONCLUSIONS:** There were no systematic socioeconomic differences in the use of relevant prescription medicines in elderly subjects diagnosed with COPD in hospital settings in Copenhagen. However, our findings indicate a gap between guideline recommendations and observed use of long-acting bronchodilators and hence suboptimal quality of treatment in the elderly COPD population. *Key words:* COPD; medicine; bronchodilators; elderly; socioeconomic factors; registries; Denmark. [Respir Care 2016;61(7):943–949. © 2016 Daedalus Enterprises]

## Introduction

COPD is one of the most common and disabling chronic diseases, entailing poor health-related quality of life and high costs to society. The estimated COPD prevalence among individuals 35 y of age or older in developed countries ranges from 5 to 19%, with the majority being in the vicinity of 10%; in Denmark, it is 17.4%.<sup>1</sup>

COPD is an incurable disease. Lifestyle changes, such as smoking cessation and physical exercise, alongside treatments to relieve the symptoms, delay the progress of the disease and improve the individual's ability to stay active as well as prevent exacerbations and treat complications.<sup>2</sup> The main COPD treatments include medication therapy and pulmonary rehabilitation. As outlined in the Danish national guidelines and the Global Initiative for Chronic Obstructive Lung Disease (GOLD) 2011 strategy document, medication therapy should depend on the severity of symptoms and include short-acting bronchodilators for mild disease stages, additional long-acting bronchodilators for

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moderate disease stages, and additional inhaled corticosteroids (ICS) for severe and very severe disease stages.<sup>3</sup> All guidelines recommend long-acting bronchodilators, both  $\beta_2$  agonist (LABA) and anticholinergics (long-acting muscarinic antagonists) as baseline therapy for moderate to severe COPD stages in the clinically stable phase.<sup>4</sup>

Research on medication treatment of COPD has intensified during the past decades, and it has been shown that, if adequate, medicines efficiently prevent disease exacerbations, decrease the need for hospitalization, improve quality of life, and save health-care expenditures.<sup>5,6</sup> Clinical trials have shown that both types of long-acting bronchodilators and LABA in combinations with ICS prevented exacerbations in subjects at risk, with relative risk reductions averaging 14–27% for each of these drugs relative to placebo. It has been suggested that a triple combination of ICS-LABA plus a long-acting muscarinic antagonist may provide additional benefit, although the results of various studies to date have been heterogeneous.<sup>7</sup> Quality of life and lung function were best improved on combination inhalers (ICS-LABA) and least on ICS alone at 6 and at 12 months.<sup>8</sup>

Most chronic diseases are unequally prevalent among different socioeconomic status groups of the population. Usually, this is found independent of whether education, occupation, employment status, or income and wealth are used as a measure of socioeconomic position.<sup>9</sup> To a large extent, this phenomenon is caused by socially differentiated exposure and vulnerability. Also, the reverse effect of poor health and disease on educational attainment, the possibility of earning a good income, and the chances of acquiring a secure job with good opportunities for the future plays an important role in the association between health and socioeconomic status.<sup>10</sup>

When prevalence and burden of diseases in general, and of COPD in particular, are distributed unequally between various socioeconomic groups, relevant medicines of high quality should be distributed with at least the same frequency to individuals of various socioeconomic position.<sup>11,12</sup> However, the variations in medicine use in subjects with COPD from different socioeconomic status groups have not been explored. Only one study looked at the use of tiotropium, a new generation long-acting bronchodilator, and found that those subjects who were in a better socioeconomic situation used more of the medicine.<sup>13</sup>

The purpose of this study was to examine socioeconomic variations in the use of prescription medicines in elderly subjects with COPD diagnosed in a hospital setting. We investigated the use of all medicines for obstructive pulmonary diseases and the use of long-acting bronchodilators in subject groups of different wealth and education levels. We chose to focus on long-acting bronchodilators as an effective medicine recommended by the

## QUICK LOOK

### Current knowledge

Prevalence and burden of COPD is distributed unequally between various socioeconomic status groups. Because adequate COPD medication treatment efficiently prevents exacerbations, decreases the need for hospitalization, improves quality of life, and saves health-care expenditures, relevant medicines should be distributed with at least the same frequency to individuals with COPD from various socioeconomic status groups.

### What this paper contributes to our knowledge

There were no systematic differences in the use of relevant prescription medicines in various socioeconomic status groups among elderly subjects with COPD diagnosed in a hospital setting in Copenhagen. However, our findings indicate a gap between guideline recommendations and actual use of long-acting bronchodilators and hence suboptimal quality of treatment in the elderly COPD population.

GOLD guidelines for all individuals with COPD in the moderate to severe disease stage. We investigated medicine use in the elderly as the most vulnerable group of subjects with COPD.

## Methods

### Study Population and Data Sources

The study population included all individuals >60 y old in the Municipality of Copenhagen who had contact with a hospital system due to a COPD diagnosis (action diagnosis ICD 10: J44) in 2007. Data were obtained from the Danish National Patient Register.<sup>14</sup> In total, 1,365 individuals met the inclusion criteria (age range 61–101 y). Data on sex, age, and marital status were obtained from the Danish Civil Registration System.<sup>15</sup>

Data on prescription medicine purchases were retrieved on an individual level from the Danish Register of Medicinal Products Statistics.<sup>16</sup> Since 1994, information on all prescription medication sold in Danish community pharmacies has been recorded in the Danish Register of Medicinal Products Statistics. The Register contains information on dispensed prescriptions, including variables at the level of the medicine user, the prescriber, and the pharmacy. Reimbursement-driven record keeping, with automated bar code-based data entry, provides data of high quality. The possibility of linkage through the unique Civil Personal Registration number with other nationwide indi-

vidual-level data sources makes the Danish Register of Medicinal Products Statistics a very powerful pharmacoepidemiological tool. Moreover, the linkage through the unique Civil Personal Registration number enables researchers to identify and follow prescriptions on the individual level over time. Thus, for individuals with permanent residence in Denmark, loss to follow-up is unlikely. In our study, medicines for obstructive airway diseases were defined by the Anatomical Therapeutic Chemical Classification System code R03. Long-acting bronchodilators were defined by the Anatomical Therapeutic Chemical codes R03AC12–R03AC18 (LABA), R03BB04 (long-acting muscarinic antagonist), and R03BB05 (long-acting muscarinic antagonist). The exposure time was calculated from January 1 until December 31, 2007, or until death or emigration during 2007.

Data on the highest completed education level were obtained from the Population Education Register.<sup>17</sup> Education was categorized into 3 levels: basic school, upper secondary/vocational school, and higher education. Personal net wealth (excluding pension fund assets) in 2006 was obtained from the Income Statistics Register and separated into quartiles.<sup>18</sup>

The 17-item Charlson comorbidity index was used to adjust for comorbidity.<sup>19</sup> The Danish National Patient Register was used to identify the first-listed diagnoses for all hospital contacts in 2006.

### Statistical Analyses

Multiple logistic regression in SAS 9.1 (SAS Institute, Cary, North Carolina) was applied to carry out the analyses. The models (with an outcome of use versus non-use of all medicines for obstructive pulmonary diseases as well as use versus non-use of long-acting bronchodilators) and explanatory variables (demographic characteristics and the comorbidity index) were run separately for education and personal wealth. We used separate models for education and personal wealth to estimate the total effect of education and wealth, respectively.

### Ethical Considerations

The Danish Data Protection Agency gave permission for data retrieval and analysis (J. nr. 2009-41-4071). According to Danish law, permission from an ethics committee was not required, since biological material was not used in the present study.

### Results

Table 1 presents the main characteristics of the study population. Tables 2 and 3 present the percentages of medicine non-users in each socioeconomic status group

Table 1. Characteristics of Study Population

Characteristics	n (%) of Subjects
Access to prescription medicines	
All medicines for obstructive pulmonary diseases	1,208 (88.5)
Long-acting bronchodilators	705 (51.6)
Sex	
Men	506 (37.1)
Women	859 (62.9)
Age	
61–69 y	294 (21.5)
70–79 y	608 (44.5)
80–101 y	463 (33.9)
Marital status	
Married	409 (30.0)
Divorced	493 (35.1)
Widowed	377 (27.6)
Unmarried	84 (6.2)
Missing information	2 (0.1)
Highest completed education	
Basic school	719 (52.7)
Upper secondary or vocational school	360 (26.4)
Higher education	94 (6.9)
Missing information	192 (13.3)
Charlson comorbidity index	
1	1,007 (73.8)
2	199 (14.6)
≥3	159 (11.6)
Total	1,365 (100.0)

and the results of the logistic regression models investigating the association between socioeconomic characteristics and the use of medicines for obstructive pulmonary diseases as well as the use of long-acting bronchodilators, respectively. Regression model 1 is for education, and model 2 is for net wealth. According to the results presented in the tables, education and net wealth were not associated with medicine non-use, whereas subjects' age, sex, marital status, and comorbidities were. Subjects ≥80 y old were more likely to not use the medicines than younger ones; males were more likely to not use the medicines than women; divorced, widowed, or unmarried subjects were more likely than married individuals to not use the medicines; and subjects with the most comorbidities were more likely to not use the medicines than subjects with fewer comorbidities.

### Discussion

In our study, we observed that during a year, almost 90% of subjects with COPD purchased a COPD medicine, whereas only about 50% purchased any long-acting bronchodilator (Table 1). The national guidelines from the National Board of Health for COPD, which are

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Table 2. Percentage of Those Who Did Not Purchase a Prescription of Medicines for Obstructive Pulmonary Diseases According to Demographic and Socioeconomic Factors and Results of Multiple Logistic Regression Analyses

Characteristics	Percentage	Model 1: Education Level			Model 2: Net Wealth		
		OR	95% CI	P	OR	95% CI	P
Sex				<.001			.01
Men	14.0	1.98	1.33–2.96		1.57	1.09–2.26	
Women	10.0	Reference	Reference		Reference	Reference	
Age				.048			<.001
≤69 y	11.2	Reference	Reference		Reference	Reference	
70–79 y	8.4	0.80	0.49–1.30		0.85	0.53–1.37	
≥80 y	15.1	1.39	0.82–2.34		1.66	1.01–2.72	
Marital status				.048			.02
Married	9.1	Reference	Reference		Reference	Reference	
Divorced	11.1	1.37	0.82–2.31		1.55	0.95–2.53	
Widowed	11.6	1.53	0.91–2.57		1.40	0.87–2.25	
Unmarried	20.2	2.60	1.31–5.16		2.76	1.45–5.27	
Charlson comorbidity index				.08			.01
1	9.7	Reference	Reference		Reference	Reference	
2	15.1	1.39	0.83–2.33		1.59	1.01–2.49	
≥3	16.4	1.75	1.04–2.95		1.84	1.14–2.98	
Education				.84	ND	ND	
Basic school	10.4	Reference	Reference				
Upper secondary or vocational school	10.8	0.98	0.65–1.50				
Higher education	12.8	1.21	0.62–2.36				
Net wealth		ND	ND				.40
Lowest quartile	12.0				Reference	Reference	
Middle-low quartile	9.1				0.68	0.41–1.14	
Middle-high quartile	13.2				1.01	0.63–1.63	
Highest quartile	10.8				0.88	0.54–1.45	

Medicines for obstructive airway diseases were defined by the Anatomical Therapeutic Chemical Classification System codes R03.

OR = odds ratio

ND = no data

in line with the international GOLD guidelines, recommend that patients with moderate, severe, and very severe COPD, who are usually diagnosed in a hospital setting, should be treated with long-acting bronchodilators.<sup>20</sup> Thus, we observed a gap between guideline recommendations and actual use of long-acting bronchodilators in elderly subjects with COPD, which indicated suboptimal quality of treatment.

We further aimed to investigate whether different educational levels and the level of personal wealth were associated with the use of prescription medicines for COPD. Our results indicated that there were no systematic socioeconomic differences in the use of relevant COPD medicines in primary care; neither education nor personal wealth were associated with the use of prescription medicines. The Danish health-care and medicine reimbursement system can be mentioned among the explanatory factors behind our results. The Danish health-care system is predominantly public, financed mainly by local and national taxes. Access to hospitals and general practitioners is free of charge for all residents; dental care, pharmaceuticals,

and some other services (eg, physiotherapy) require a co-payment. In 2002, the Danish Government released a public health policy document titled “Health throughout life: the targets and strategies for public health policy of the Government of Denmark 2002–2010,” placing a special focus on efforts to reduce the major preventable diseases, particularly type 2 diabetes, cardiovascular diseases, preventable cancers, musculoskeletal disorders, mental disorders, asthma, allergy, and COPD. According to the disease management plan for COPD, developed following the government policy document, smokers or ex-smokers >35 y of age who have one or more pulmonary symptoms should be examined by their general practitioner. After diagnosis of COPD, the severity of the disease should be assessed and regularly followed up in yearly controls. Based on the severity of the COPD, the general practitioner should decide whether to take on the individual’s case or to refer him/her to a pulmonary specialist in the out-patient department in a hospital. Accordingly, the general practitioner or a pulmonologist will prescribe medicines for COPD. In the case of exacerbations, the individual will be hospi-

Table 3. Percentage of Those Who Did Purchase a Prescription of a Long-Acting Bronchodilator According to Demographic and Socioeconomic Factors and Results of Multiple Logistic Regression Analyses

Characteristics	Percentage	Model 1			Model 2		
		OR	95% CI	P	OR	95% CI	P
Sex				.02			.12
Men	54.2	1.37	1.06–1.77		1.20	0.95–1.52	
Women	50.2	Reference	Reference		Reference	Reference	
Age				.048			<.001
≤69 y	49.0	Reference	Reference		Reference	Reference	
70–79 y	47.4	0.96	0.72–1.29		1.00	0.75–1.32	
≥80 y	59.0	1.37	0.97–1.92		1.56	1.14–2.15	
Marital status				.16			.13
Married	48.4	Reference	Reference		Reference	Reference	
Divorced	49.9	1.19	0.88–1.62		1.16	0.86–1.55	
Widowed	53.8	1.32	0.97–1.80		1.20	0.90–1.60	
Unmarried	61.9	1.19	0.88–1.62		1.77	1.09–2.88	
Charlson comorbidity index				.39			.22
1	50.2	Reference	Reference		Reference	Reference	
2	55.8	1.14	0.81–1.60		1.22	0.89–1.66	
≥3	56.0	1.26	0.88–1.81		1.28	0.91–1.80	
Education				.30	ND	ND	
Basic school	51.9	Reference	Reference				
Upper secondary or vocational school	47.8	0.83	0.64–1.07				
Higher education	47.9	0.83	0.54–1.29				
Net wealth		ND	ND				.73
Lowest quartile	51.9				Reference	Reference	
Middle-low quartile	50.4				0.87	0.64–1.19	
Middle-high quartile	54.0				0.99	0.72–1.35	
Highest quartile	50.3				0.88	0.64–1.20	

Anatomical Therapeutic Chemical Classification System codes R03AC12–R03AC18, R03BB04, and R03BB05.

OR = odds ratio

ND = no data

talized to receive care where all medicines and procedures are free of charge.<sup>21</sup> With regard to the reimbursement of prescription medicines in primary care, the Danish system is complex. Many prescription medicines in Denmark are covered by general reimbursement (ie, patients receive reimbursement automatically). The general reimbursement sum depends on an annual personal expenditure on reimbursable medicines before deduction of reimbursement. For example, people spending >3,280 Danish kroner (~440 euros) per year on medicines, receive 85% reimbursement. Subjects with COPD may also receive individual reimbursement for the chronically ill. According to the rules for individual reimbursement for the chronically ill, people spending >17,738 Danish kroner (2,377 euros)/y on medicines receive 100% reimbursement. In some cases (eg, for pensioners of limited means), a subsidy for medicines from the municipality of residence can also be provided. The Danish regions pay for general and individual reimbursement as well as for the medicines used in hospitals.<sup>22</sup>

We used personal wealth as an indicator for economic situation. Personal wealth reflects the economic situation among the elderly better than does income. Moreover, wealth could be interpreted as an indication of a lifelong accumulation of financial resources, healthy living, and success. In this process, the association between wealth and health is probably circularly caused and reinforced. On one hand, a good position (and maybe fortune inherited or gained) leads to accumulation of further wealth and other resources, which helps in managing and coping with the disease without the use of medicines. Conversely, disease and poor health lessen the chances to obtain education and earn a good living, which therefore does not enable the accumulation of a fortune but results in the spending of any fortune one might have. Findings regarding the prime relevance of wealth as a proxy measure for economic position have been reported earlier in studies on health in aging populations.<sup>23</sup> In addition, we also conducted analyses with personal income and found no differences in medicine



use between the subjects of various incomes (data not shown).

Women appeared to use medicines, both all of the medicines for obstructive airway diseases and long-acting bronchodilators, more often than men (Tables 2 and 3). Marital status was associated with medicine use, so that being married had a positive impact on the use of long-acting bronchodilators compared with being divorced, widowed, or unmarried (Table 3). To be married indicates a stable and supportive social relation, which has been found to be related to adherent use of different medication types.<sup>24</sup> Surprisingly, the oldest age group ( $\geq 80$  y) and the groups with more comorbidities used medicines less often than the younger groups and the groups with fewer comorbidities, respectively (Tables 2 and 3). We expected that age and poorer general health would reduce general functional capacity, increase disease severity, and therefore require more intensive medicine use. The reasons why the oldest subjects used medicines less often than younger ones are not clear. We speculated that older subjects might have been spending more time in hospitals, where they might have been receiving their medicines, which are not registered at the individual level in the Danish Register of Medicinal Products Statistics; however, analyses adjusted for the frequency and length of hospital stays showed essentially the same results as our main analyses. We further speculated that elderly subjects more often resided in nursing homes, but the Danish Register of Medicinal Products Statistics, unlike prescription registers in other countries, does contain individual-level information on prescriptions dispensed to residents of long-term care institutions, such as nursing homes. Therefore, it is likely that elderly subjects with COPD in Copenhagen actually did not purchase any medication for their disease more often than younger ones, and this is a problem that requires further investigation.

A couple of studies from Denmark have previously described the Danish COPD population.<sup>25,26</sup> The distributions of prevalence of COPD according to age groups in our study and the other Danish studies were similar (see supplementary Table 1 at <http://www.rcjournal.com>).

### Limitations of the Study

Several methodological considerations of the study have to be mentioned. First, the medicines in the prescription registry, from where we retrieved our data, were the medicines dispensed in community pharmacies and hence did not include any medicines dispensed in hospitals. The sensitivity analysis, including COPD-specific hospital days in regression models, did not reveal any changes in the estimates, thus providing support to the conclusions being independent of the medicines used during COPD hospitalization(s). Second, in our analyses, we did not adjust for

COPD disease severity. Disease severity in subjects with COPD is determined by their lung function. The information on lung function started being reported to the National Patient Registry from 2008 only for out-patients with COPD.<sup>27</sup> We used data from 2007; moreover, we analyzed both in- and out-patients. Thus, data on disease severity in our study were not available. Nevertheless, all patients with COPD of moderate to severe disease stages according to GOLD guidelines (ie, the subjects in our study) are recommended treatment with long-acting bronchodilators besides other medications for COPD, regardless of COPD disease stage. We reported analyses of medication use versus non-use as well as long-acting bronchodilator use versus non-use (ie, dichotomous outcomes not required to be adjusted for disease severity). We also conducted linear regression analyses to see whether the amount of all medicines as well as long-acting bronchodilators depended on socioeconomic characteristics. The amount of medicines used, however, does depend on disease stage; therefore, the analyses ideally should be adjusted for disease severity. Because the information on the latter was not available, adjustment was not possible. However, our analyses did not reveal any differences in the amount of all medicines, as well as the amount of long-acting bronchodilators, used in the subject groups with different education, whereas those with larger net wealth used smaller amounts of medicines than those with less wealth (supplementary Table 2).

Finally, a limitation of the study was that approximately 13% of our population did not have information available on education. This is due to the fact that Danish administrative registers only contain information on education for individuals born since 1921. Consequently, individuals in our study who in 2007 were  $\geq 86$  y old had no information on education and were excluded from the relevant analyses.

### Implications of the Study

It has been demonstrated that only about 50% of the COPD population in Denmark received evidence-based care as recommended in the national guidelines.<sup>20</sup> The chronic care model has been envisioned as a possible solution to encourage high-quality chronic disease care.<sup>28</sup> A systematic literature review of the effects of using the chronic care model to support care in the COPD population concluded that  $\geq 2$  of 4 groups of management practices (ie, self-management, delivery system design, decision support, and clinical information system) need to be implemented for that reason.<sup>29</sup> Moreover, improving care in COPD patients might be linked to changing the care system.<sup>30</sup> In this context, the findings of our study point out the groups of elderly subjects with COPD (namely very old, divorced, widowed or unmarried, and men) who

should be considered when trying to improve (ie, implement new or change existing) practices of chronic care.

### Conclusions

Our study could not identify any systematic socioeconomic barriers to the use of pulmonary prescription medications in elderly subjects with COPD in Copenhagen. However, our findings indicate a gap between guideline recommendations and actual use of long-acting bronchodilators and hence suboptimal quality of treatment in the elderly COPD population.

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