Comorbidity Clusters and Healthcare Use in Individuals With COPD

Nanna Sklander Hansen, Lars Ängquist, Peter Lange, and Ramune Jacobsen

BACKGROUND: Individuals who share the same comorbidity profile are usually similar with regard to their disease severity, use of health care, and clinical outcomes. The identification of comorbidity clusters therefore bears prognostic information. The objective of this study was to identify and characterize comorbidity clusters in individuals with COPD in Denmark. METHODS: Data from the Danish national registers were used. The study population included all individuals ≥16 y old who lived in the Danish Capital Region on January 1, 2012, and were diagnosed with COPD (*N* = 70,274). Comorbid chronic conditions were identified using diagnostic algorithms. A 2-step cluster analysis was performed. RESULTS: 81% of subjects with COPD had chronic comorbidities; the most common was hypertension (47.6%), and the least common was anxiety (0.1%). Three comorbidity clusters were identified. Cluster 1 contained 16% of the studied individuals with COPD, with all having heart disease in addition to the remaining comorbidities. Cluster 2 contained 30% of the studied individuals with COPD, of whom approximately 1 in 3 suffered from allergies, while the rest had no comorbidities. Cluster 3 contained 54% of the studied individuals with COPD, where all comorbidities but heart disease were represented. Cluster 1 contained the highest proportion of individuals over the age of 65 y, as well as the individuals with the lowest education. After adjusting for sociodemographic characteristics, individuals in Cluster 1 had the highest rates of hospitalizations and bed days. CONCLUSIONS: The presence of heart disease in individuals with COPD is a strong prognostic factor for socioeconomic and health vulnerability. *Key words: COPD; comorbidity; epidemiology; hospitalization; Denmark; registers.* [Respir Care 2020;65(8):1120–1127. © 2020 Daedalus Enterprises]

Introduction

COPD is a chronic disease characterized by an exaggerated inflammatory response in the lungs, which causes progressive and irreversible obstruction of the airways and destruction of the alveoli.[1,2] According to the World Health Organization, COPD was responsible for 3.17 million deaths in 2015, making COPD the fourth leading cause of death globally (http://www.who.int/mediacentre/factsheets/fs310/en; *accessed March 6, 2018*). In Denmark, COPD prevalence is among the highest in the Western countries: it has been estimated that approximately 400,000 of the 5.8 million Danish population have spirometrically defined COPD.[3] Danish women and men have, respectively, a 3.3 and 1.7 times higher risk of dying from COPD compared to the average European citizen.[4]

COPD is often associated with other comorbid chronic conditions.[5] A case-control study reported that individuals with COPD had, on average, 3.7 comorbidities compared to 1.8 comorbidities in individuals without COPD.[6] COPD

Ms Hansen and Dr Lange are affiliated with the Department of Public Health, University of Copenhagen, Copenhagen, Denmark. Dr Ängquist is affiliated with the Novo Nordisk Foundation Center for Basic Metabolic Research, University of Copenhagen, Copenhagen, Denmark. Dr Lange is affiliated with the Medical Department, Herlev-Gentofte Hospital, Hellerup, Denmark. Dr Jacobsen is affiliated with the Department of Pharmacy, University of Copenhagen, Copenhagen, Denmark.

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Correspondence: Ramune Jacobsen PhD, Department of Pharmacy, Research Group for Social and Clinical Pharmacy, University of Copenhagen, Universitetsparken 2, 4th floor, Copenhagen, Denmark. E-mail: ramune.jacobsen@sund.ku.dk.

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comorbidities included cardiovascular and cerebrovascular diseases, diabetes mellitus, lung cancer, osteoporosis, muscle weakness, depression, and anxiety.[5,7] Comorbidities contributed to a decrease in health status and functional performance, as well as an increase in health care utilization and mortality.[5,7,8] Furthermore, comorbid conditions may develop with certain patterns and thus can occur in so-called clusters.[9] Individuals who share the same comorbidity profile or fall into the same comorbidity cluster are usually similar with regard to their disease severity, clinical outcomes, and treatments.[8]

Comorbidity cluster analysis in individuals with COPD is an emerging research area. The identification of the type of cluster can yield prognostic information on individuals' health status and health care utilization.[8,10] In this study we aimed to identify comorbidity clusters and their frequencies in individuals with COPD in Denmark and to characterize individuals from different comorbidity clusters in terms of sociodemographics and health care utilization.

QUICK LOOK

Current knowledge

COPD is often associated with other comorbid chronic conditions, which contribute to decreasing health status and functional performance, and increasing utilization of health care and mortality. Comorbidity cluster analysis in individuals with COPD is an emerging research area.

What this paper contributes to our knowledge

We identified 3 comorbidity clusters: 1) all comorbidities including heart disease; 2) no comorbidities apart from allergies; and 3) all comorbidities except for heart disease. After adjusting for sociodemographic characteristics, individuals within the first cluster had the highest rates of hospitalizations and bed days. Heart disease in individuals with COPD may be a prognostic factor for health vulnerability and an indicator of a COPD subpopulation in need of more effective management.

Methods

Data Sources

The eligible study population included all individuals ≥16 y old who lived in the Danish Capital Region on January 1, 2012 ($n = 1,397,173$). We were only interested in those with a COPD diagnosis, and no one <35 y old had COPD. Therefore, our study population consisted of all individuals ≥ 35 y old who lived in the Danish Capital Region and had COPD ($N = 70,274$). The study population and information on sociodemographic factors, medical diagnoses, and health care utilization during the year 2012 was obtained from the Danish national administrative and health registers. In Denmark, as in other Scandinavian countries, all legally residing individuals are registered with a unique 10-digit civil person registration number. Using this number, it is possible to link information from different registers or databases. To construct a data set for our study, data from the following national registers were obtained: the Danish Civil Registrations System,[11] the Danish Education Register maintained by Statistics Denmark,[12] the Danish National Health Services' Register,[13] and the Danish National Patient Register.[14] Using a civil person registration number, individual-level information was merged and placed on a Statistics Denmark server. Remote access to the merged data set was provided to the researchers after Statistics Denmark changed the civil person registration numbers into anonymized identification numbers.

Diagnostic algorithms developed at the Research Center for Prevention and Health at Glostrup University Hospital were used to identify 16 specific chronic conditions diagnosed both in primary and secondary health care sectors.[15] These chronic conditions included COPD, hypertension, allergies, high cholesterol, heart disease, diabetes, long-term use of antidepressants, osteoporosis, osteoarthritis, chronic back pain, cancer, stroke, schizophrenia, joint disease, dementia, and anxiety.

The Capital Region of Denmark granted permission to obtain, merge and analyze data from the Danish registers in an anonymized form (J.no. 2012-58-0004). According to the Danish law, permission from an ethics committee is not required to conduct register data-based studies.

Variables

The ages of subjects in 2012 were grouped into 6 categories (split by birthdays): 35–44, 45–54, 55–64, 65–74, 75–84, and ≥85 y. Education was used to measure socioeconomic status and was based on the highest level of a subject's educational attainment according to 4 categories: primary and lower secondary school; vocational education; undergraduate education; and postgraduate education.[14] We categorized the 11 different kinds of health care services utilized by the study population into 6 categories: total number of contacts with general practitioners; total number of contacts with medical specialists; total number of visits to out-patient clinics in a hospital; total number of visits to the emergency department; total number of hospitalizations; and total number of bed days (ie, days in a hospital bed).

Table 1. Demographic Characteristics of the Population and Prevalence of Comorbidities

	COPD Subjects, *n* (%)	Number of Comorbidities, Median (IQR)	Subjects With Comorbidities, %
All COPD subjects	70,274 (100)	2 (1–3)	81.2
Gender			
Female	40,884 (58.2)	2 (1–3)	83.9
Male	29,390 (41.8)	2 (1–3)	77.5
Age, y			
35–44	8,648 (12.3)	1 (0–1)	57.9
45–54	12,283 (17.5)	1 (0–2)	68.9
55–64	15,566 (22.2)	2 (1–3)	81.0
65–74	17,626 (25.1)	2 (1–4)	88.8
75–84	12,030 (17.1)	3 (2–4)	94.5
> 84	4,121 (5.9)	3 (2–4)	96.7
Educational attainment			
Lower secondary	23,419 (33.3)	2 (1–4)	85.2
Vocational	28,968 (41.2)	2 (1–3)	80.5
Undergraduate	9,811 (14.0)	1 (1–3)	77.7
Postgraduate	5,457 (7.8)	1 (0–2)	72.6
Information missing	2,600 (3.7)	2 (1–4)	85.3

IQR = interquartile range

Statistical Analysis

A 2-step cluster analysis procedure was performed to identify the comorbidity clusters.[16] A cluster analysis, also called a segmentation analysis, attempts to identify structures in the data. Specifically, the analysis attempts to identify homogenous groups of cases from the distribution of the input variables used. The 2-step cluster method is a scalable cluster-analysis algorithm designed to process very large data sets with both continuous and categorical variables. The clustering has 2 steps: first, the method pre-clusters the cases with specific variables (ie, comorbidities in our study) into sub-clusters; then, the method creates clusters from the sub-clusters into the desired or automatically selected number of clusters. In the second step, the 2-step cluster method uses an agglomerative hierarchical clustering to classify the data. The log-likelihood function is used to measure distance in these processes. In this study, we first allowed the program to select the number of clusters automatically, and then we ran sensitivity analysis to select a larger number of clusters to check whether increasing the number of clusters produces better clinically interpretable clusters.

Sociodemographic characteristics were described for the total population and the identified clusters in terms of gender, age, and education, as well as in terms of medians with interquartile ranges for health care contacts, visits, and bed days. Because the health care contacts, visits, and bed days were not normally distributed, Poisson log-linear regression models were run to assess the incidence rate ratios of health care utilization according to the comorbidity clusters. IBM SPSS Statistics 24 (IBM, Armonk, New York) was used for all statistical analyses.

Results

The demographic characteristics of the study population (ie, individuals with COPD in the Danish Capital Region) are presented in Table 1. The mean (SD) age for the study population was 62.8 (14.1) y. The population had a larger proportion of women (58.2%) and people with lower secondary (33.3%) or vocational education (41.2%) compared to people with undergraduate (14.0%) or postgraduate education (7.8%). For 3.7% of the study population, no information about education was available, and these were excluded from regression analyses, although they were included into cluster analyses. The median number of comorbidities was 2; the numbers of comorbidities increased with age. Only 18.8% of the population had no other chronic conditions than COPD. Table 2 presents the 15 specific chronic conditions that comprised the comorbidities in the individuals with COPD. The most common chronic comorbidity was hypertension (47.6%) and the least common comorbidity was anxiety (0.1%).

The results of the automatically selected 3 cluster solution were as follows. In Cluster 1 (n =11,300; 16.1%), individuals had high numbers of all comorbidities, including heart disease. In Cluster 2 (n = 20,744; 29.5%), approximately one third suffered from allergies, whereas the rest had no comorbidities. In Cluster 3 (n = 38,230; 54.4%), individuals had all comorbidities except for

Table 2. Prevalence of the Comorbid Chronic Conditions in the COPD Subject Population

Condition	Prevalence per January 1, 2012
Hypertension	33,452 (47.6)
Heart disease	11,299 (16.1)
Allergies	24,023 (34.2)
High cholesterol	20,403 (29.0)
Diabetes	9,947 (14.2)
Long-term use of antidepressants and/or depression	9,288 (13.2)
Osteoporosis	9,017 (12.8)
Osteoarthritis	6,713 (9.6)
Back pain	5,850 (8.3)
Cancer	5,329 (7.6)
Stroke	3,506 (5.0)
Schizophrenia	1,992 (2.8)
Joint disease	1,613 (2.3)
Dementia	1,348 (1.9)
Anxiety	39 (0.1)

Data are presented as *n* (%).

heart disease. The ratio between the largest and the smallest cluster size was 3.4.

Demographic information and health care utilization of the individuals according to comorbidity clusters are presented in Table 3. Cluster 1 included the highest proportion of individuals > 65 y old (77.6%), as well as individuals with lower secondary school or vocational education (81.4%), whereas Cluster 2 had the highest proportion of individuals with undergraduate or postgraduate education (32.5%). There were close to equal proportions of men and women in Cluster 1 and Cluster 2, whereas Cluster 3 had an overrepresentation of women (63.3%). Further, individuals with COPD from Cluster 1 had the highest median numbers of the contacts with general practitioners, out-patient treatment, and emergency department visits, as well as the highest median number of hospitalizations and bed days; individuals in Cluster 2 had the lowest median numbers of all kinds of health care utilization; and individuals in Cluster 3 had the highest median number of contacts with medical specialists.

The cluster-specific patterns of health care utilization remained after adjustment for gender, age, and education, as shown by the results of the regression analyses displayed in Table 4; with the exception of contacts with medical

Table 3. Characteristics of and Health Care Utilization in COPD Comorbidity Clusters

	Cluster 1: All Comorbidities Including Heart Disease	Cluster 2: No Comorbidities Apart From Allergies	Cluster 3: All Comorbidities but Heart Disease
Gender			
Female	5,783 (51.2)	10,916 (52.6)	24,185 (63.3)
Male	5,517 (48.8)	9,828 (47.4)	14,045 (36.7)
Age, y			
35–44	122 (1.1)	6,228 (30.0)	2,298 (6.0)
45–54	609 (5.4)	6,219 (30.0)	5,455 (14.3)
55–64	1,794 (15.9)	4,415 (21.3)	9,357 (24.5)
65–74	3,373 (29.8)	2,793 (13.5)	11,460 (30.0)
75–84	3,708 (32.8)	912 (4.4)	7,410 (19.4)
> 84	1,694 (15.0)	177 (0.9)	2,250 (5.9)
Educational attainment			
Lower secondary	4,844 (42.9)	4,696 (22.6)	13,879 (36.3)
Vocational	4,356 (38.5)	8,765 (42.3)	15,847 (41.5)
Undergraduate	931 (8.2)	3,935 (19.0)	4,945 (12.9)
Postgraduate	437 (3.9)	2,809 (13.5)	2,211 (5.8)
Information missing	732 (6.5)	536 (2.6)	1,348 (3.5)
Health care utilization			
Contacts with general practice during 2012, no.	18 (11–29)	7 (3–2)	13 (8–21)
Contacts with medical specialists during 2012, no.	1 (0–3)	0 (0–2)	1 (0–3)
Visits to out-patient treatment at hospital during 2012, no.	3 (1–9)	0 (0–2)	1 (0–5)
Visits to the emergency department during 2012, no.	0 (0–1)	0 (0–0)	0 (0–0)
Number of hospitalizations during 2012, no.	1 (0–2)	0 (0–0)	0 (0–1)
Number of bed days during 2012, d	1 (0–7)	0 (0–0)	0 (0–1)

Data are presented as *n* (%) or median (interquartile range) for number of items of occurrence (no.) and number of days (d).

Table 4. Adjusted IRRs for Health Care Utilization in COPD Comorbidity Clusters During 2012

	Contacts With General Practice	Contacts With Private Medical Specialists	Visits to Out-Patient Treatment at Hospital	Visits to the Emergency Department	Number of Hospitalizations	Number of Bed Days
Cluster						
1: All comorbidities including heart disease	1.30 (1.30–1.31)	0.90 (0.88–0.91)	1.73 (1.72–1.75)	1.60 (1.55–1.65)	1.75 (1.72–1.79)	1.81 (1.79–1.82)
2: No comorbidities apart from allergies	0.58 (0.58–0.59)	0.65 (0.64–0.66)	0.45 (0.45–0.46)	0.60 (0.57–0.62)	0.46 (0.45–0.48)	0.37 (0.37–0.38)
3: All comorbidities but heart disease	1	1	1	1	1	1
Gender						
Female	1.21 (1.21–1.22)	1.22 (1.20–1.23)	0.94 (0.93–0.94)	0.85 (0.83–0.87)	0.92 (0.90–0.93)	0.86 (0.85–0.87)
Male	1	1	1	1	1	1
Age, y						
35–44	0.83 (0.82–0.84)	1.01 (0.98–1.04)	1.15 (1.13–1.18)	0.96 (0.89–1.03)	0.56 (0.53–0.59)	0.38 (0.37–0.39)
45–54	0.82 (0.81–0.83)	1.10 (1.06–1.13)	1.16 (1.13–1.18)	0.88 (0.83–0.94)	0.58 (0.56–0.61)	0.45 (0.44–0.46)
55–64	0.84 (0.84–0.85)	1.07 (1.04–1.10)	1.36 (1.33–1.38)	0.77 (0.73–0.82)	0.68 (0.65–0.70)	0.56 (0.55–0.56)
65–74	0.88 (0.87–0.89)	1.21 (1.18–1.24)	1.53 (1.50–1.56)	0.73 (0.69–0.77)	0.79 (0.76–0.82)	0.73 (0.72–0.74)
75–84	0.97 (0.96–0.98)	1.19 (1.15–1.22)	1.38 (1.36–1.41)	0.88 (0.83–0.93)	0.97 (0.94–1.00)	0.98 (0.96–0.99)
> 84	1	1	1	1	1	1
Educational attainment						
Lower secondary	1.32 (1.31–1.33)	0.79 (0.77–0.81)	1.07 (1.05–1.09)	1.77 (1.65–1.89)	1.67 (1.59–1.74)	1.49 (1.46–1.53)
Vocational	1.23 (1.22–1.24)	0.89 (0.87–0.91)	1.08 (1.06–1.09)	1.45 (1.36–1.56)	1.38 (1.32–1.45)	1.25 (1.23–1.28)
Undergraduate	1.16 (1.15–1.17)	1.01 (0.99–1.04)	1.04 (1.02–1.06)	1.31 (1.22–1.42)	1.16 (1.10–1.22)	1.09 (1.06–1.11)
Postgraduate	1	1	1	1	1	1

Data are presented as IRR (95% CI).
IRR = incidence rate ratio

specialists, individuals with COPD from Cluster 1 had the highest health care utilization, whereas those from Cluster 2 had the lowest. For instance, individuals from Cluster 1 had approximately 80% more (adjusted incidence rate ratio 1.81 (95% CI 1.79–1.82), and individuals from Cluster 2 had approximately 60% less bed days (adjusted incidence rate ratio 0.37, 95% CI 0.37–0.38) compared to those in Cluster 3.

Sensitivity analysis with the selected 4-cluster solution resulted in splitting one of the 3 clusters (Cluster 3) into 2 clusters, one with a slightly higher representation of diabetes and hypertension, and the other with a slightly higher representation of musculoskeletal conditions; the ratio between the largest and smallest cluster size then was reduced to 2.1. The 2 additional clusters were not predictive with respect to health care utilization.

Discussion

Our study identified and described 3 comorbidity clusters in individuals with COPD. The subjects in the first cluster had high numbers of comorbidities including heart disease, were the oldest, had the lowest level of educational attainment, and utilized health care much more intensively than the subjects in the other 2 clusters. Subjects in the second cluster had no comorbidities except for allergies, were the youngest, had the highest level of educational attainment, and had the lowest health care utilization. The subjects in the third cluster had all kinds of comorbidities except for heart disease, were overrepresented by women, and had the highest number of contact with medical specialists.

Few previous studies have analyzed comorbidity clusters in individuals with COPD. Vanfleteren et al[8] studied 255 individuals with COPD recruited in a clinical setting in the Netherlands, and identified 5 clusters: subjects with few comorbidities; subjects with cardiovascular comorbidities; cachectic subjects; subjects with metabolic comorbidities; and subjects with psychological comorbidities. Another study by Chubachi et al[10] also identified 5 comorbidity clusters among a cohort of 445 Japanese subjects with COPD, where the disease was confirmed spirometrically: those with few comorbidities; those with malignant comorbidities; those with metabolic and cardiovascular comorbidities; those with gastroesophageal reflux disease and psychological comorbidities; and those who were underweight and anemic. The cluster with no comorbidities but allergies and the cluster including heart disease identified in our study resemble respective clusters in the studies by Vanfleteren et al[8] and Chubachi et al.[10] Moreover, of the 2 additional clusters identified in our sensitivity analysis, the cluster characterized by high prevalence of metabolic comorbidities resembles cluster 4 in the study by Vanfleteren et al.[8] The number of clusters was higher in the other studies because, after investigating the health care utilization characteristics of the individuals in the identified clusters, we decided to report the 3-cluster solution where the clusters also appeared distinct with respect to these characteristics. There may also be other reasons for the discrepancy in cluster numbers between our study and the other studies. First, the number and definition of the recorded chronic conditions in the studies were different. Vanfleteren et al[8] investigated the clustering of 13 comorbidities, identified based on the peer-reviewed English literature;[8] Chubachi et al[10] focused on 19 comorbidities that were diagnosed through objective examination, review of prescription history and clinical records, and self-report. In our study, 15 chronic conditions besides COPD were identified using diagnostic algorithms and data from the Danish administrative and medical registers. It is difficult to say how the differences in primary data have affected the final results of the cluster analyses in the 3 studies.

Another potential reason for the different numbers of clusters in the previous studies compared to our study could be related to the severity of COPD disease in the studied subjects. COPD is categorized into 4 Global Initiative for Chronic Obstructive Lung Disease (GOLD) stages based on the severity of air-flow limitation defined spirometically.[1] The study by Vanfleteren et al[8] only included individuals with moderate to very severe COPD (GOLD stages 2–4); the study by Chubachi et al[10] also included individuals with mild COPD (GOLD stages 1–4). In our study, information about GOLD stage was not available, but presumably we had a whole spectrum of disease severity stages represented because individuals with COPD diagnosed in both primary and secondary health care sectors were included. On the other hand, because Chubachi et al[10] and Vanfleteren et al[8] included and excluded GOLD stage 1 subjects, respectively, and both studies still identified 5 clusters, it is doubtful that COPD disease severity in the studied populations had a crucial impact on the number of clusters identified.

Finally, the reason for identifying different numbers of comorbidity clusters in our study compared to the previous studies could be the statistical methods used for cluster analyses. The 2 previous studies involved a hierarchical cluster analysis,[8,10] whereas we used a 2-step cluster analysis due to computational infeasibility of a hierarchical cluster analysis on a very large data set. The 2-step cluster analysis, which starts by assigning the cases to pre-clusters and then continues with making clusters out of the pre-clusters using hierarchical clustering, is more likely to result in a lower number of clusters compared to when hierarchical clustering is applied from the very start. The 2-step clustering technique has been recommended for use with large data sets.[16]

Concerning the sociodemographic characteristics of individuals with COPD in the different clusters in our study, the picture generally reflects the situation revealed in previous multimorbidity research. Studies on multimorbidity have reported that the prevalence of multimorbidity increases with age and that people with lower socioeconomic status (either assessed from educational attainment level or by the level of deprivation in the area where the individual lives) have a higher prevalence of multimorbidity than people with high socioeconomic status.[17-20] Accordingly, in our study, the cluster with all comorbidities including heart disease included the oldest and least educated individuals with COPD, and the cluster with no comorbidities but allergies had the youngest and best educated subjects. Furthermore, prevalence of multimorbidity is usually higher among women than among men.[18,19] Our results support this because there was a substantially greater representation of women (63.3% vs 36.7%) in the cluster with all comorbidities except from heart disease (Cluster 3). In the cluster with all comorbidities including heart disease (Cluster 1), the proportions of women and men were almost equal (51.2% vs 48.8%). Considering that the total study population had a larger proportion of women (58.2%), seeing equal proportion of men and women in Cluster 1 reflects the fact that men suffer from heart disease more often than women.[21]

The results of previous research that associated multimorbidity with increased utilization of health care are also reflected in our study: individuals with COPD with no comorbidities but allergies (Cluster 2) utilized the health care system less than those having more comorbidities.[22,23] Additionally, we noted that subjects with COPD and all comorbidities including heart disease had much higher use of health care compared to subjects with COPD without heart disease. Heart disease thus greatly increased the number of contacts with general practitioners, visits to outpatient treatment and the emergency department, as well as the numbers of hospitalizations and numbers of bed days. Interestingly, subjects with COPD and other comorbidities except for heart disease had the highest utilization of medical specialists. The reason for this may be related to the fact that heart disease presents a serious threat to an individual's life, and thus individuals with heart disease are referred by general practitioners directly to hospital care, bypassing medical specialists. Indeed, in Denmark, medical specialists practice in private community based settings, and for more serious disease cases, in outpatients clinics in a hospital.[24] It is also possible that individuals with COPD and heart disease are often admitted to hospitals via the emergency department which is in line with results indicating that emergency service utilization for cardiovascular conditions is higher compared to other conditions, such as diabetes.[25]

A distinguishing feature of our study is the use of the 2-step cluster-analysis technique. This technique has been used in other similar studies,[26-28] but the 2 previously conducted studies on COPD comorbidity clusters used hierarchical cluster analysis.[8,10] The latter technique was computationally infeasible in our study due to the large sample size, so we chose the simpler clustering technique, which, nevertheless, was able to distinguish clinically important clusters of individuals with COPD. Our results point out an obvious burden of heart comorbidities, which stands out from all the other comorbidities, in individuals with COPD, thus supporting a body of research encouraging to deeper investigate relationship between respiratory and cardiovascular diseases.[29]

The strength of this study is the use of data from the Danish national administrative and health registers, which are recognized to have good reliability and validity and thus are used extensively for research purposes.[30] This is a large-scale study including all individuals with COPD in the Danish Capital Region in 2012. The use of diagnostic algorithms instead of diagnosis codes to identify chronic conditions in the study can be seen both as a strength and limitation. It is a strength because the algorithms capture subjects from the primary health care sector, which doesn't report diagnosis codes to the Danish national registers.[15,30] This can be viewed as a limitation, however, because algorithms do not always capture all individuals with chronic conditions such as rheumatoid arthritis, osteoarthritis, back conditions, lung diseases, mental health disorders (eg, anxiety), and allergies.[15] It is therefore possible that the prevalence of comorbidities in our study is underestimated. Furthermore, the use of diagnostic algorithms bears a certain risk of misdiagnosis, particularly between COPD and asthma.[31] Thus, the number of individuals with COPD in our study could have been biased by individuals with asthma, especially in the younger age groups. The use of Poisson regression to analyze the numbers of bed days may also be seen as a potential limitation, as one of the underlying assumptions for using Poisson regression is that the outcome episodes must be independent; being in a hospital bed on a particular day depends on being in this bed the previous day. Finally, the limitations include lack of information about the COPD disease severity (GOLD stages) and missing information on education for 3.7% of the study population. Even though COPD disease severity may not be a determining factor for the number of COPD comorbidity clusters, as revealed in the comparison of the studies by Vanfleteren et al[8] and Chubachi et al,[10] having full information on COPD disease severity could have added more credibility to our findings.

Conclusions

Up to 80% of individuals with COPD have comorbidities. Among individuals with COPD, the cluster with comorbidities including heart disease represented the most socioeconomically vulnerable and most often hospitalized subgroup. Thus, presence of heart disease in individuals with COPD is a prognostic factor for socioeconomic and health vulnerability and, relatedly, an indicator of the COPD subpopulation with a need for more effective management.

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