

Substantial need for early diagnosis, rehabilitation and treatment of chronic obstructive pulmonary disease

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ABSTRACT

INTRODUCTION: Our goal was to estimate the number of individuals with chronic obstructive pulmonary disease (COPD) in the Capital Region of Denmark and the need of resources required to implement the regional management programme for COPD.

MATERIAL AND METHODS: We examined a total of 45,970 participants from the Copenhagen General Population Study (CGPS) using spirometry and a questionnaire.

RESULTS: The prevalence of spirometrically defined COPD among individuals older than 40 years of age was 15%, corresponding to 120,000 citizens in the Region. The number of individuals with moderate COPD (forced expiratory volume in one second (FEV₁): 50-80% of predicted value) was estimated to approx. 51,000 (6.4%), whereas at least 10,000 (1.3%) were expected to have severe or very severe COPD (FEV₁ < 50% of predicted value). Our estimates indicate that more than 26,000 individuals with moderate, severe or very severe COPD in the Region are smokers and that more than 19,000 qualify for physical training. We estimated that approx. 4,000 individuals with severe COPD were not treated with any inhaled medication.

CONCLUSION: The Capital Region of Denmark needs to allocate substantial resources into early detection, rehabilitation and medical treatment of individuals with COPD in order to comply with the intentions of the Region's own management programme for COPD.

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The prevalence of chronic obstructive pulmonary disease (COPD) in Denmark is among the highest in the world [1, 2]. Consequently, The Danish Board of Health and the Danish Regions have initiated programmes in order to stop this unfavourable trend and improve the care for COPD patients in Denmark and established a continuous monitoring of the quality of COPD care through the National Indicator Project (NIP) for COPD (NIP-COPD) [3-5]. The COPD programme for the Capital Region of Denmark focuses on early detection, smoking

cessation, correct medical treatment and rehabilitation [4]. The programme is multidisciplinary and involves all three sectors responsible for the delivery of health services in Denmark: General practice, hospitals and municipalities. However, there are at present no data describing the scale of the need for these interventions, i.e. the number of individuals with COPD, who need help to stop smoking or need pulmonary rehabilitation, nutritional intervention and medical treatment.

The aim of this study was to estimate the number of individuals with COPD in the Capital Region of Denmark, which has approx. 1.6 million inhabitants, corresponding to approx. 30% of the Danish population. In addition, we wanted to estimate the number of individuals with COPD who need relevant medical intervention, including the need for early diagnosis. We also describe the pattern of contacts with hospitals for individuals with COPD and their use of inhaled medications.

MATERIAL AND METHODS

Study population

In the present study we used data from a large and ongoing population-based study, the Copenhagen General Population Study (CGPS) [6, 7]. This study includes subjects from the Northern and Western suburbs of Copenhagen. The aim of the study is to enroll more than 100,000 individuals, but for our purpose, we included the first approx. 45,000 individuals who had been examined in the period from 1 November 2003 to 31 December 2008. A representative sample of subjects older than 20 years of age was drawn from the Danish Civil Registration System and invited to participate in the study. Our analyses included in total 45,970 individuals, who underwent the relevant examinations. The response rate was approx. 48%. The participants answered a questionnaire on life style characteristics, symptoms and diseases and underwent a physical examination including spirometry with measurements of forced expiratory volume in one second (FEV₁) and forced vital capacity (FVC). Spirometry was assessed using the Vitalograph spirometer in the first 14,624 participants of the CGPS, whereas in the remaining participants an EasyOne spirometer was used

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TABLE 1

Individuals with chronic obstructive pulmonary disease in the Copenhagen General Population Study according to age and severity of chronic obstructive pulmonary disease. Values represent n (%).

| | No COPD | GOLD 1 mild | GOLD 2 moderate | GOLD 3 severe | GOLD 4 very severe |
|-------------|---------------|----------------|--------------------|------------------|-----------------------|
| 40-59 years | 22,804 (91.6) | 1,076 (4.3) | 893 (3.6) | 108 (0.4) | 11 (0.0) |
| 60-79 years | 14,952 (79.2) | 1,779 (9.4) | 1,750 (9.3) | 354 (1.9) | 51 (0.3) |
| 80+ years | 1,412 (64.4) | 414 (18.9) | 292 (13.3) | 69 (3.1) | 5 (0.2) |
| All | 39,168 (85.2) | 3,269 (7.1) | 2,935 (6.4) | 531 (1.2) | 67 (0.1) |

COPD = chronic obstructive pulmonary disease.

GOLD = Global Initiative for Chronic Obstructive Lung Disease.

TABLE 2

Estimated number of individuals with chronic obstructive pulmonary disease in the Capital Region of Denmark according to age and chronic obstructive pulmonary disease severity. Values represent numbers of individuals.

| | No COPD | GOLD 1 mild | GOLD 2 moderate | GOLD 3 severe | GOLD 4 very severe |
|-------------|---------|----------------|--------------------|------------------|-----------------------|
| 40-59 years | 405,015 | 19,193 | 15,950 | 1,929 | 192 |
| 60-79 years | 223,615 | 26,603 | 26,212 | 5,314 | 766 |
| 80+ years | 43,991 | 12,684 | 8,824 | 2,145 | 161 |
| All | 672,621 | 58,480 | 50,986 | 9,389 | 1,119 |

COPD = chronic obstructive pulmonary disease.

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[8]. Only pre-bronchodilator measurements were available.

Individuals with COPD were identified according to international COPD guidelines, based on $FEV_1/FVC < 0.7$ [9]. The severity of COPD was defined according to the Global Initiative for Chronic Obstructive Lung Disease (GOLD) criteria using the level of FEV_1 in percent of the predicted value ($FEV_1\%$ pred.):

GOLD1: Mild COPD: $FEV_1\%$ pred. ≥ 80

GOLD2: Moderate COPD: $80 > FEV_1\%$ pred. ≥ 50

GOLD3: Severe COPD: $50 > FEV_1\%$ pred. ≥ 30

GOLD4: Very severe COPD: $30 > FEV_1\%$ pred.

Based on the prevalence and severity of airflow limitation, smoking, dyspnoea (3 or higher on the Medical Research Council (MRC) scale [9], low ($< 20 \text{ kg/m}^2$) and high body mass index (BMI) ($> 30 \text{ kg/m}^2$) and taking into account the distribution of the population in the Capital Region of Denmark, we estimated the numbers of individuals with COPD in the Region who according to guidelines would benefit from smoking cessation, pulmonary rehabilitation, nutritional intervention and treatment with inhaled medication.

For each individual, we defined an observation window of two years (one year before and one year after the examination date) and analyzed the use of inhaled medications and contacts with the Region's hos-

pitals during this period. This was done by using the unique personal civil registration number assigned to all Danish inhabitants and by linking our database to two national registries: The Danish National Patient Registry covering all hospital contacts in Denmark [10] and the Danish Registry of Medicinal Product Statistics, which contains information on all prescriptions dispensed in all Danish pharmacies [11]. We identified the relevant medications using the Anatomic Therapeutic Chemical (ATC) code [12]. The following variables were retrieved for each participant and normalized to an observation period of one year: Number of visits at the Region's casualty departments, number of visits at outpatient clinics, number of admissions to hospital (both because of COPD and because of other diagnoses) and the information on purchase of inhaled medication for lung disease (short- and long-acting bronchodilators, inhaled corticosteroids or combinations of these medications).

From the Danish National Patient Registry, we identified hospital admissions with a discharge diagnosis of COPD (International Classification of Diseases 10th edition: DJ41-44).

The CGPS is approved by the local ethical scientific committee (H-KF-01-144/01).

Statistical analysis

With information from Statistics Denmark about age, sex, and regional composition of the whole Danish population, we were able to extrapolate our findings from the CGPS to both the Capital Region of Denmark and the whole Danish population (both above the age of 40). This was done by multiplying the age-, sex-, and region-specific population sizes with the corresponding prevalences. An unadjusted Poisson regression was used to compare admission rates.

Trial registration: not relevant.

RESULTS

The distribution of COPD in our study sample according to age and severity of COPD is shown in **Table 1**. Based on this distribution, we estimated the number of individuals with COPD in the Capital Region of Denmark (**Table 2**). The results show that more than 60,000 citizens are expected to have clinically significant COPD (GOLD stage 2-4) and more than 10,000 have severe or very severe COPD (GOLD stage 3+4).

In our sample, the prevalence of current smoking differed between men and women with COPD. Among subjects with mild COPD, the current smoking prevalence was 34% in men and 26% in women ($p < 0.0001$). However, in participants with more severe COPD (GOLD 2-4), this trend was almost reversed, as more women (50%) than men (44%) were smokers ($p = 0.09$). The

prevalence of smoking in different subgroups of COPD yielded an estimate of approx. 26,000 citizens with clinically significant COPD (GOLD 2-4) in the Capital Region of Denmark who are active smokers.

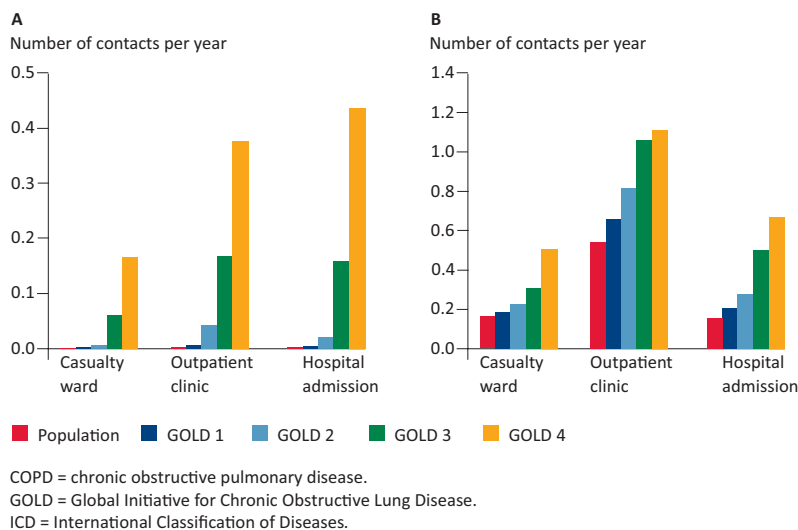
We defined the need for pulmonary rehabilitation similarly to the definition of The Danish Board of Health as spirometrically defined COPD together with dyspnoea equal to or higher than three on the MRC dyspnoea scale [3]. **Table 3** shows both the prevalence of MRC ≥ 3 and the estimated number of citizens with COPD in the Capital Region of Denmark, i.e. subjects that qualify for pulmonary rehabilitation. As expected, the percentage of individuals suited for rehabilitation increased with increasing severity of COPD, resulting in more than 83% in the most severe group. Our estimates for the Capital Region of Denmark suggest that among those with severe and very severe COPD, there are more than 6,000 individuals who qualify for pulmonary rehabilitation with physical training according to COPD guidelines.

We defined the threshold for the need for nutritional intervention in COPD as a BMI below 20 kg/m² and a BMI above 30 kg/m². The percentages of underweight individuals increased with increasing severity of COPD from 4.4% in mild disease, 6.3% in moderate, 10.2% in severe and 19.4% in very severe COPD. This gave an estimate of more than 4,400 individuals in the Region with underweight and clinically significant COPD. With regard to obesity (BMI > 30 kg/m²), there was no clear relationship with the severity of COPD. We estimated that more than 10,000 individuals with clinically significant COPD (GOLD 2-4) in the Capital Region of Copenhagen are obese.

The frequency of treatment with inhaled medication in different GOLD groups was 7.3% in mild disease, 21.8% in moderate, 57.2% in severe and 86.1% in very severe COPD. This means that more than 40% of individ-

FIGURE 1

Annual contacts with hospitals according to chronic obstructive pulmonary disease severity. **A.** COPD related contacts per year (ICD-10: DJ41-DJ44). **B.** All contacts per year (ICD-10: DA00-D299).



uals with severe and very severe COPD are not on any inhaled medication. Taking into account the population distribution in the Capital Region of Copenhagen, this corresponds to more than 4,000 individuals in the Region.

Finally, we analyzed the pattern of contacts with the Region's hospitals in relation to the severity of COPD according to GOLD criteria. The left part of **Figure 1** shows the annual contact pattern due to COPD according to the GOLD stage. The frequency of all three types of hospital contacts rose significantly with increasing COPD stage ($p < 0.0001$ for all comparisons). A similar pattern was seen with regard to contacts with hospitals due to all somatic diseases (right part of Figure 1). In general, individuals with severe or very severe COPD had more than twice as high contact rates as individuals without COPD; e.g. for hospital admissions more than 0.5 admission per year versus less than 0.2 admissions per year.

DISCUSSION

This is the first study focusing on the need for health intervention for individuals with COPD in Denmark. Based on a study sample of more than 45,000 individuals, we estimate that more than 120,000 individuals in the Capital Region of Copenhagen have COPD. This estimate is based on an examination of people living in a relatively prosperous suburban area of greater Copenhagen. As the prevalence of COPD increases with decreasing social status [13], we expect that the prevalence of COPD and hence also our estimates of the total number of affected individuals would have been even



TABLE 3

Percentage prevalence of dyspnoea equal to or higher than three on the Medical Research Council scale and the estimated number of citizens with chronic obstructive pulmonary disease in the Capital Region of Denmark with these characteristics, i.e. subjects that qualify for pulmonary rehabilitation.

| | GOLD 1 mild | GOLD 2 moderate | GOLD 3 severe | GOLD 4 very severe |
|-------------|----------------|--------------------|------------------|-----------------------|
| 40-59 years | 3.9 722 | 15.0 2,348 | 47.7 927 | 72.7 140 |
| 60-79 years | 8.8 2,344 | 25.5 6,673 | 54.5 2,893 | 84.0 644 |
| 80+ years | 24.2 3,191 | 43.0 3,782 | 69.6 1,535 | 100 161 |
| All | 9.2 6,257 | 24.0 12,804 | 55.1 5,356 | 83.3 945 |

GOLD = Global Initiative for Chronic Obstructive Lung Disease.



Early mobilization during admission for chronic obstructive pulmonary disease is important.

higher if we had studied less affluent areas of the Capital Region of Denmark [14]. In addition, our estimates are based on responders only (i.e. approx. 50% of the invited) and this is also likely to underestimate the true prevalence. On the other hand, the lack of post-bronchodilatory measurements in our spirometry tends to give higher estimates in our calculations, not least because we are likely to include a group of individuals with asthma into our COPD population [9]. However, taking this into account, we still think that our projections are likely to underestimate rather than overestimate the true number of individuals with COPD.

If we expand our estimates to the whole of Denmark, which has a population of 5.5 million of inhabitants, we find that approx. 417,000 Danes have COPD. This number consist of 203,000 individuals with mild COPD (GOLD 1), 177,000 with moderate COPD (GOLD 2), 33,000 with severe COPD (GOLD 3) and 4,000 with very severe COPD (GOLD 4). This estimate is very close to the estimate of approx. 430,000 Danes with COPD reported in the study of Løkke et al based on the 4th examination of The Copenhagen City Heart Study conducted in the years 2001-2003 [1]. The latter study enrolled individuals living in the inner city of Copenhagen.

In our study, we tried to identify the target population for the COPD programme for the Capital Region of Copenhagen [4]. The main interventions described in this programme comprise early detection of COPD by means of spirometry, help to achieve smoking cessation, physical training as part of pulmonary rehabilitation, correct medical treatment and nutritional intervention in those undernourished and obese. Our estimates of the number of citizens qualifying for these interventions are remarkably high. Especially the fact that many subjects may be undiagnosed and thus not treated is alarm-

ing, but actually in keeping with findings from another Danish study covering the northern part of Jutland [15]. This is the most likely explanation for the fact that 40% of individuals with severe and very severe COPD (GOLD 3 and 4) are not on any inhaled medication. Also the fact that there are approx. 16,000 individuals in the age group 40-59 years with moderate COPD is disturbing. These individuals are very likely to progress to severe and very severe COPD as they become older. There is therefore an urgent need for diagnosis in these individuals in order to undertake relevant action to prevent further disease progression. The Danish society should consider a broader approach such as awareness campaigns to promote lung health and make spirometry as popular and accessible as blood pressure measurements [16]. The fact that population projections in the Capital Region of Copenhagen indicate that within few decades the individuals older than 65 years of age will count approx. 400,000 in the Region compared with 200,000 in year 2000 is also a factor that should be considered when planning future health care for COPD patients.

As expected, the use of hospital services among individuals with COPD, especially among those with severe disease, is very high and increases with the severity of COPD (Figure 1). Our estimates based on the present population sample are, in fact, in keeping with the actual figures that have been reported in the Danish NIP-COPD [5]. The NIP project, which is based on compulsory reports to The Danish National Patient Registry by all Danish hospitals, shows that in the Capital Region of Denmark in the year 2010, the hospitals had been in contact with approx. 1,100 subjects with very severe COPD (GOLD 4). In fact, this estimate is quite close to our estimate of 1,119 individuals with very severe COPD in the region (Table 2).

In conclusion, we report that more than 60,000 out of the 1.6 million inhabitants of the Capital Region of Denmark have spirometrically defined and clinically relevant COPD, corresponding to approx. 8% of the population older than 40 years of age. Although there may be a discrepancy between the presence of spirometrically defined COPD and the individual perception of a treatment need, our results indicate a substantial need for resources in order to implement the goals regarding early detection of COPD, smoking cessation, pulmonary rehabilitation and correct medical treatment.

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CONFLICTS OF INTEREST: Disclosure forms provided by the authors are available with the full text of this article at www.danmedj.dk.

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