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Increased prevalence of chronic obstructive pulmonary disease in a general population

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KEYWORDS
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Summary
Background: Prevalence of COPD is increasing worldwide, and there is need for regularly updated estimates of COPD prevalence and risk factors.
Methods: In the Norwegian Hordaland County Cohort Study (HCCS), 1664 subjects aged 35–90 yrs answered questionnaires and performed spirometry in 2003–05. We estimated COPD prevalence and analysed risk factors for COPD with logistic regression.
Results: In a previous study phase, prevalence of GOLD-defined COPD was 7%. Eight years later, corresponding prevalence was 14%. Seventy % of the subjects experienced respiratory symptoms. Only 1 out of 4 had a physician's diagnosis. Significant risk factors for COPD were sex, age, smoking habits and pack-years. Men had 1.7 (OR, 95% CI 1.2, 2.3) higher odds for COPD than women. Subjects above 65 yrs had 10.3 (OR, 95% CI 6.4, 16.5) times higher odds for COPD than subjects below 40 yrs. Heavy smokers had 4.2 (OR, 95% CI 2.6, 6.7) times higher odds for COPD than subjects with <10 pack-years. When compared with the previous study phase, age and smoking status had roughly the same associations with COPD prevalence. Educational level and male gender, on the other hand, had less effect on COPD prevalence in 2005 than in 1997, while pack years were more important in 2005 than in 1997.
Conclusions: Prevalence of GOLD defined COPD has increased from 7% to 14% in nine years. Although the risk factors remain the same, the strength of associations vary. There is still substantial under diagnosis in COPD, and better disease awareness and diagnostic routines are needed.

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Introduction

The public has become increasingly aware of chronic obstructive pulmonary disease (COPD) during recent years. At the same time, COPD has become increasingly more prevalent across the world, and it is now estimated to be the fourth leading cause of death worldwide.[1]

COPD is a progressive disease characterized by persistent airflow limitation and an enhanced inflammatory response in the airways and the lungs to noxious particles or gases.[2] The most common symptoms are dyspnea, chronic cough and chronic sputum production. Spirometry is required to diagnose COPD patients according to international guidelines.[2,3] The disease usually exhibits a slow progression and COPD patients consequently often wait for many years before seeking medical advice, dismissing early symptoms as smokers cough, lack of general fitness, or simply part of the ageing process. As a result, the disease is widely under diagnosed, despite the large prevalence of symptoms affecting a substantial number of people in their everyday activities.[4–7]

Active cigarette smoking is by far the most important cause of this disease. But also passive smoking, occupational exposure to airborne agents, air pollution and poor indoor climate are important COPD risk factors.[2,8–11] In addition, other risk factors that have a more complex association with disease development and prognosis than direct inhalation are of relevance – such as socioeconomic status, nutrition, physical activity and mental well-being.[12–18]

International reports and guidelines unanimously state that the prevalence of COPD is increasing worldwide.[2,19] Thus, there is need for regularly updates of prevalence estimates in general populations to keep track of this worrying development. The COPD prevalence estimates that have been used in Norway for official reports and health care planning are based on a general population that was examined in 1996–97.[20] Based on the 1996 situation, COPD prevalence was estimated to be 7% in Norwegian adults, ranging from less than 3% in never-smokers to more than 17% in ever-smokers who had smoked more than 20 pack years. The 1996 prevalence was based on COPD defined according to the Global Initiative of Chronic Obstructive Lung Disease (GOLD) as a fixed ratio of forced expiratory volume in one second (FEV1) over forced vital capacity (FVC) < 0.7. Although the GOLD guidelines still advocate the fixed ratio for practical reasons, it is a fact that the FEV1/FVC declines with age and thus risks over diagnosing COPD in the elderly. Consequently the definition of COPD as a ratio less than lower limit of normal has been recommended as a replacement for the fixed ratio, among others by the American Thoracic Society and European Respiratory Society.[21–23]

The aim of the present study was to update prevalence estimates of COPD in a general adult population in Norway, and to examine differences in both disease prevalence and risk factor associations across time. In addition, we wanted to assess the degree of under diagnosis among COPD subjects, and the presence of respiratory symptoms in spirometry-defined COPD cases.

Material and methods

Study population

This study is based on the second follow-up survey in the Hordaland County Cohort study (HCCS) in 2003–2005 (Fig. 1). Initially, the HCCS comprised 3181 participants from Bergen and 11 surrounding municipalities in 1985, of whom 2358 performed acceptable spirometry in the first follow-up in 1996–97 (74%).[24] Of these, 2250 subjects who still lived in Hordaland County in 2003–05 were invited to the second follow-up. Altogether 74% ($n = 1664$), aged 35–90 yrs, of those invited performed an acceptable spirometry. Reasons for loss to follow-up have been described in detail previously.[14]

Data collection

The study included extensive questionnaires and clinical examinations. Respiratory symptoms (cough and dyspnea), exposure of occupational dust and gas, educational level and smoking habits were registered using self-administered questionnaires. Occupational dust and gas exposure were defined as an affirmative answer to the question "Have you ever had a work place with much dust or gas in the air?". Smoking habits were classified as never smokers, current smokers and ex-smokers. One pack-year was defined as 20 cigarettes a day for 1 year. Educational level was classified into primary, secondary and university. Height and weight were registered, and body mass index (BMI) was calculated based on WHO guidelines.

FVC and FEV1 were measured according to the American Thoracic Society standards with a Vitalograph 2160

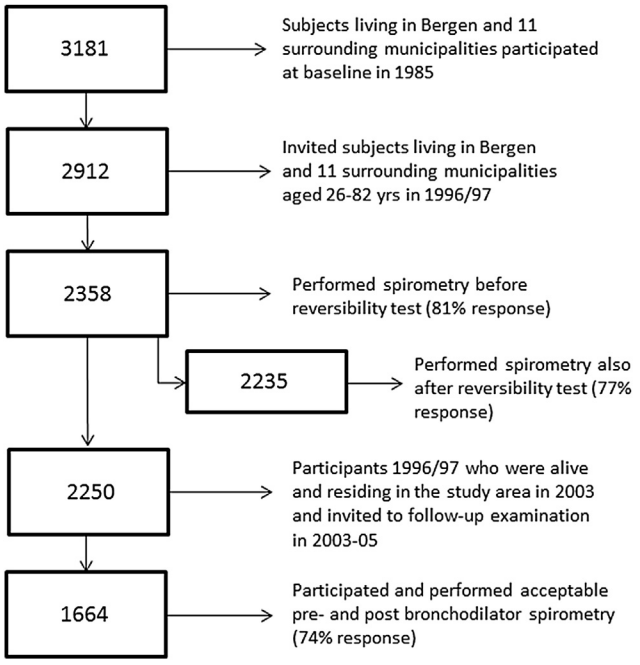

Figure 1 Flow chart of invited and participants in the Hordaland County cohort from first study phase in 1985 to last study phase in 2003–05.

spirometer (Vitalograph Ltd, Maids Moreton, UK) before and after inhalation of a total of 0.4 mg salbutamol powder. In the previous study phase in 1996–97, a Gould 2100 spirometer was used, and 0.3 mg salbutamol was administered.[20] The study engineers were trained by experienced personnel in both study phases. COPD was defined according to the GOLD guidelines as post-bronchodilator FEV1/FVC <0.7 for the main analyses.[2] In addition, we also analysed COPD in 2003–05 defined as FEV1/FVC < lower limit of normal, using recent European reference equations [25]

Informed consent was obtained from each participant. The study was approved by The Regional Committee of Medical Research Ethics (Bergen, Norway).

Statistical analyses

All analyses were performed using Stata 12 (StataCorp. LP, College Station, TX). *P*-values below 0.05 were considered statistical significant. Prevalence of GOLD-defined COPD was calculated using mean estimations with 95% confidence intervals. Logistic regression analysis were used to evaluate the association between a number of potential risk factors of COPD (sex, age, smoking habits, pack-years, BMI, educational level and occupational exposure) and COPD. Significant variables in the univariate analysis were included in the multivariate model. Attributable fractions (PAF) were calculated using the Stata command punaf with 95% confidence intervals.

We tested for interactions between sex and all the other potential risk factors for COPD in separate analyses.

Results

Characteristics of the study population are presented in Table 1. Mean age was 55 yrs for women and 54 yrs for men. There was a significant gender difference in smoking habits, pack-years, BMI and occupational exposure to dust and gas. Characteristics of the 1996/97 study population are presented in the Online Supplement, E-Table 1.

The prevalence of GOLD defined COPD was 13.7%, an increase of almost 7% compared with the prevalence in the previous study phase, 1996–7 (Table 2).

There was a higher prevalence of COPD among men than women, 17% and 11%, respectively. However, the prevalence of COPD among women had increased by 175% compared with 1996–97. When COPD was defined by GOLD stages, the prevalence was highest in GOLD stage I and II for both men and women (Fig. 2). The prevalence increased with increasing age and pack-years, and decreased with higher educational level. Approximately 1 out of 4 over 65 years suffered from COPD, but only 1 out of 20 under 50 years. Not surprisingly, never-smokers had a lower prevalence of COPD than ever-smokers. While approximately 1 out of 20 never-smokers had COPD, as many as 1 out of 5 current smokers suffered from COPD. The prevalence of COPD was higher in the underweight group than in the obese group, and higher amongst the subjects who had been exposed to occupational dust and gas than among unexposed, 16% and 12%, respectively.

Proportions of respiratory symptoms in spirometry-defined COPD cases are presented in Fig. 3. Men reported higher prevalence of all types of cough, whereas women reported higher prevalence of dyspnea and attacks of dyspnea. However, the differences were not statistically significant. Approximately 70% of both men and women with COPD experienced one or more symptoms. Only 24% of the GOLD-defined COPD subjects had a physician's diagnosis.

The unadjusted OR showed that sex, age, smoking habits, pack-years, educational level and occupational exposure were significantly associated with COPD (see Online Supplement E-Table 3).

Adjusted odds ratios (OR) for COPD, of both 1996–7 and 2003–05, are presented in Table 3. After adjustment for other significant covariates, subjects older than 65 yrs had 10 times higher odds for COPD than subjects younger than 50 yrs. Current smokers had 5 times higher odds for COPD than never smokers, and those with more than 20 pack-years had 4 times higher odds for COPD than subjects

Table 1 Characteristics of study population by sex of participants in the Hordaland County cohort study 2003–05, $N = 1664$ subjects aged 35–90 yrs.

	Total	Women	Men	*p*-Value#
Age yrs	54.7 (13)	55.1 (13)	54.3 (13)	0.21
Smoking habits				<0.001
Never-smokers	618 (38)	343 (43)	275 (33)	
Ex-smokers	532 (32)	221 (28)	311 (37)	
Current smokers	491 (30)	234 (29)	257 (31)	
Pack-years for ever-smokers				<0.001
1–9	373 (37)	200 (44)	173 (31)	
10–19	303 (30)	140 (31)	163 (29)	
20+	342 (34)	112 (25)	230 (41)	
Body mass index (kg/m^2)				<0.001
<18.5	23 (1)	18 (2)	5 (1)	
18.5–24.9	808 (49)	452 (56)	356 (42)	
25–29.9	624 (38)	238 (30)	386 (45)	
>30	193 (12)	93 (12)	100 (12)	
Educational level				0.85
Primary	242 (15)	114 (14)	128 (15)	
Secondary	945 (57)	461 (57)	484 (57)	
University	476 (28)	235 (29)	241 (28)	
Occupational exposure to gas or dust				<0.001
Yes	710 (43)	211 (26)	499 (59)	
No	935 (57)	589 (74)	346 (41)	
Total	1664	811	853	

Data are presented as mean ± SD (continuous variables) and *n* (%) (categorical variables). #: *p*-values are from the two-group mean comparison test (unpaired *t*-test) for continuous variables and Chi-squared tests for categorical variables.
Information on smoking habits was missing for 13 females and 10 males. Information on pack years was missing for 16 females and 12 males. Information on BMI was missing for 10 females and 6 males. Information on educational level was missing for 1 female. Information on occupational dust exposure was missing for 11 females and 8 males.

Table 2 Prevalence estimates with 95% confidence intervals (CI) of GOLD-defined COPD (post-bronchodilator FEV1/FVC<0.7) in a general adult population in 1996–97 and 2003–05 by sex, age, smoking habits, pack years, body mass index, educational level and occupational exposure to dust or gas. *N* = 2235 subjects aged 27–82 yrs in 1996–97 and *N* = 1664 subjects aged 35–90 yrs in 2003–05.

		Prevalence (%) 1996–7 (95% CI)	Prevalence (%) 2003–5 (95% CI)	Increase (%)
Sex	Women	4 (3, 5)	11 (8, 13)	175
	Men	10 (9, 12)	17 (14, 19)	70
Age (yrs)	≤34 yrs	2 (0, 3)	–	–
	35–49 yrs	3 (2, 4)	5 (3, 7)	67
	50–64 yrs	6 (4, 8)	14 (11, 16)	133
	≥65 yrs	20 (17, 24)	28 (24, 33)	40
Smoking habits	Never-smokers	3 (2, 4)	7 (5, 8)	133
	Ex-smokers	11 (9, 14)	16 (13, 19)	45
	Current smokers	9 (7, 11)	20 (16, 23)	122
Pack-yrs for ever-smokers	1–9	5 (3, 7)	8 (5, 11)	60
	10–19	9 (6, 12)	16 (11, 20)	78
	20+	17 (14, 21)	31 (26, 36)	82
BMI	<18.5	13 (0, 27)	17 (2, 33)	31
	18.5–24.9	8 (6, 10)	15 (12, 17)	88
	25–29.9	6 (4, 8)	13 (10, 16)	117
	>30	6 (3, 8)	12 (7, 17)	100
Educational level	Primary	14 (11, 18)	23 (17, 28)	64
	Secondary	6 (5, 7)	14 (12, 17)	133
	University	3 (2, 5)	8 (5, 10)	167
Occupational Exposure	Yes	9 (7, 11)	16 (13, 18)	78
	No	5 (4, 6)	12 (10, 14)	140
Total		7 (6, 8)	14 (12, 15)	100

with under 10 pack-years. However, educational level and occupational exposure were not significantly associated with GOLD-defined COPD in the multivariate analysis. When comparing the results from the present study with corresponding results from the previous study phase, the effect of age on COPD risk is the same in the two time periods. However, the effect of male gender and educational level after adjustment for other risk factors has decreased. Heavy smokers with more than 20 pack years had a higher OR for COPD in the present study than in 1996–97, while

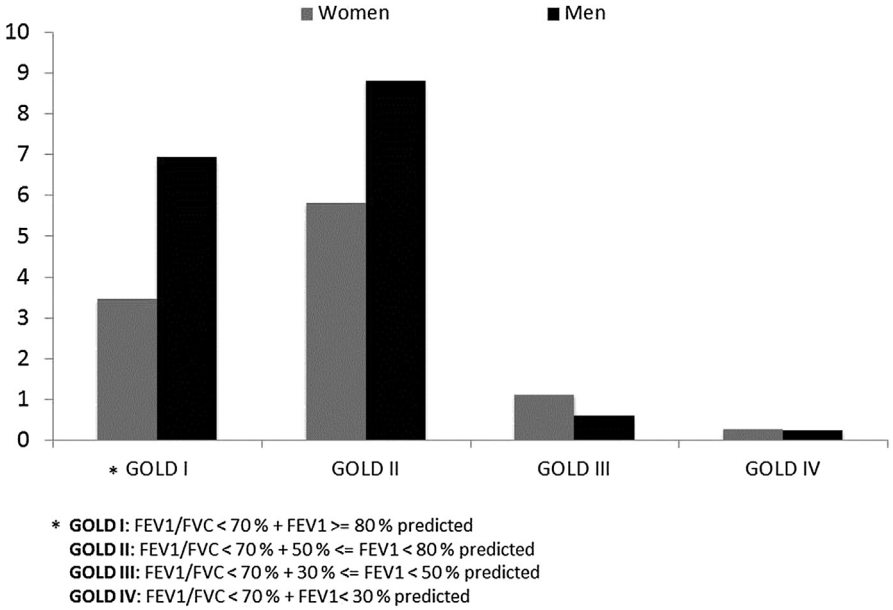

Figure 2 Prevalence of COPD defined by GOLD stages in a general adult population in 2003–05. *N* = 1664 subjects aged 35–90 yrs.

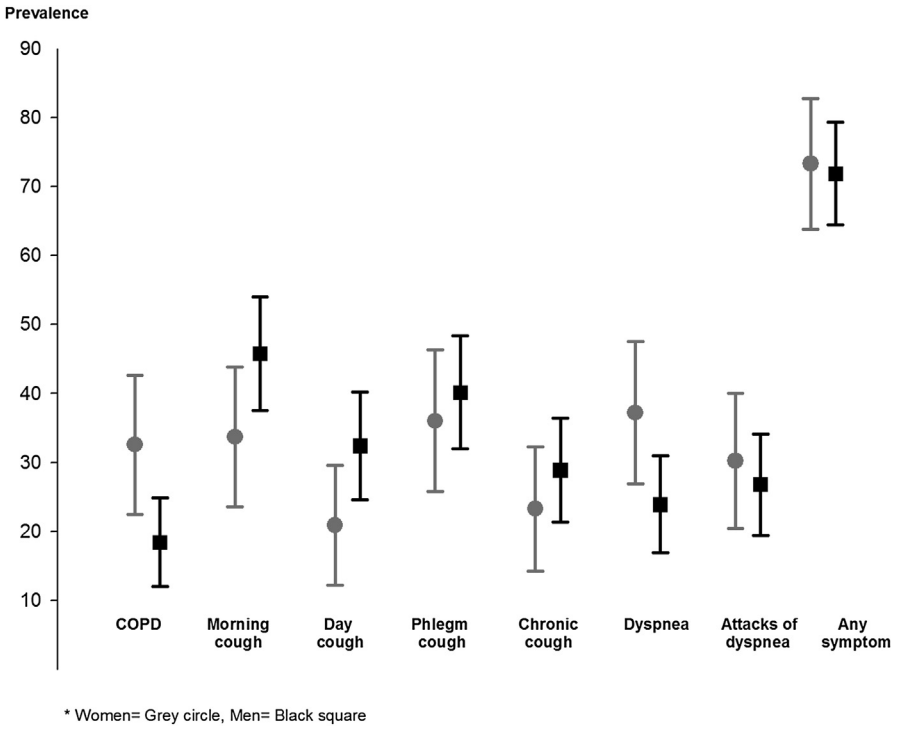

Figure 3 Prevalence of respiratory symptoms in a general adult population in 2003–05. $N = 1664$ subjects aged 35–90 yrs.

ex-smokers had a markedly lower OR for COPD in 2003–05 than in 1996–97.

There was not found any significant interactions between sex and any of the other potential risk factors for COPD. Hence, no stratification for sex was made in the multivariate analyses.

Table 4 presents adjusted population attributable fractions (PAF) with 95% confidence intervals for both 1996/97 and 2003–05 study phases. 74% of COPD among current smokers can be attributed to smoking in 2003–05, which was approximately the same in the previous study phase. 32% of COPD among men can be attributed to male gender in 2003–05, a decline from the previous study phase were 55% of COPD among men was attributed to male gender.

We also analysed COPD defined as <LLN in 2003–05 (E-Tables 2 and 4). Overall prevalence according to this

Table 3 Adjusted odds ratios (OR) with 95% confidence intervals (95%CI) for COPD (post-bronchodilator FEV1/FVC<0.7) in a general adult population in 1996–97 and 2003–05, by sex, age, smoking habits, pack years, educational level and occupational exposure. $N = 2235$ subjects aged 27–82 yrs in 1996–97 and $N = 1664$ subjects aged 35–90 yrs in 2003–05.

		Adjusted OR 1996–97 (95%CI)	Adjusted OR 2003–05 (95%CI)
Sex	Women	1	1
	Men	3.1 (2.1, 4.8)	1.7 (1.2, 2.3)
Age (yrs)	35–49 yrs	1	1
	50–64 yrs	2.4 (1.3, 4.2)	3.3 (2.2, 5.2)
	≥65 yrs	10.9 (6.4, 18.6)	10.3 (6.4, 16.5)
Smoking habits	Never-smokers	1	1
	Ex-smokers	3.6 (2.1, 6.2)	2.4 (1.6, 3.6)
	Current smokers	4.2 (2.4, 7.5)	5.2 (3.3, 8.1)
Pack-years for ever-smokers	1–9	1	1
	10–19	1.6 (0.9, 3.1)	2.3 (1.4, 3.8)
	20+	2.7 (1.5, 4.9)	4.2 (2.6, 6.7)
Educational level	Primary	2.6 (1.4, 5.3)	1.5 (0.9, 2.4)
	Secondary	1.5 (0.8, 2.7)	1.4 (0.9, 2.1)
	University	1	1
Occupational Exposure	Yes	1.2 (0.8, 1.8)	1.1 (0.8, 1.5)
	No	1	1

Covariates were all significant in univariate analyses, and are adjusted for each other in the multivariate models.

Table 4 Adjusted population attributable fractions (PAF) with 95% confidence intervals (95%CI) for COPD (post-bronchodilator FEV1/FVC < 0.7) in a general adult population in 1996–97 and 2003–05, by sex, age, smoking habits, pack years, educational level and occupational exposure. $N = 2235$ subjects aged 27–82 yrs in 1996–97 and $N = 1664$ subjects aged 35–90 yrs in 2003–05.

		Adjusted PAF 1996–97 (95%CI)	Adjusted PAF 2003–05 (95%CI)
Sex	Women	Ref	Ref
	Men	55% (35%, 69%)	32% (12%, 47%)
Age (yrs)	35–49 yrs	Ref	Ref
	50–64 yrs	55% (24%, 73%)	65% (49%, 77%)
	≥65 yrs	87% (79%, 92%)	85% (78%, 90%)
Smoking habits	Never-smokers	Ref	Ref
	Ex-smokers	63% (39%, 77%)	50% (29%, 65%)
	Current smokers	75% (59%, 85%)	74% (62%, 82%)
Pack-years for ever-smokers	1–9	Ref	Ref
	10–19	33% (−11%, 59%)	49% (21%, 66%)
	20+	53% (26%, 70%)	66% (50%, 76%)
Educational level	Primary	47% (9%, 69%)	23% (−11%, 47%)
	Secondary	16% (−42%, 51%)	24% (−6%, 45%)
	University	Ref	Ref
Occupational Exposure	Yes	14% (−18%, 37%)	4% (−23%, 25%)
	No	Ref	Ref

definition was 8.7%. Compared with GOLD-defined COPD, LLN-defined COPD were more pronounced among the youngest age group, and less prevalent among men and participants over 65 yrs. ORs for risk factors were comparable regardless of COPD definition, apart from for age and male gender, which affected GOLD-defined COPD substantially more than LLN-defined COPD.

Discussion

The updated Norwegian prevalence estimate of spirometry-defined COPD is approximately 14%, twice as high as eight years earlier. The risk factors for COPD remain the same over time, but the strengths of the associations vary. While educational level and male gender had less effect on COPD prevalence in 2005 than in 1997, pack years were more important in 2005 than in 1997. Almost one out of three ever-smokers with more than 20 pack years suffers from COPD according to the present study. Three in four COPD cases among current smokers were due to smoking. The degree of under diagnosis is substantial. Less than 1 out of 5 of the GOLD defined COPD cases in this study has a relevant clinical diagnosis, even though a vast majority of them reports one or more respiratory symptoms.

The present study defined COPD according to post-bronchodilator spirometry. We also analysed the prevalence of pre bronchodilator test FEV1/FVC < 0.7 (results not shown). The overall prevalence was 21%, which is 7% higher than the results of the post bronchodilator test. Johannessen et al.[20] investigated this in more detail for the previous study phase in 1996/97 and found similar results. Especially more young never smokers would be included as COPD cases when using pre bronchodilator prevalence results.

The prevalence estimate from the present study is in accordance with other recent prevalence studies of spirometry-defined COPD, such as the Burden of Obstructive Lung Disease study (BOLD).[19] In Sweden, estimates from the BOLD study indicated that 16% of the adult population suffered from COPD.[26] A study from Copenhagen indicated that Danish COPD prevalence exceeds 17%.[27] A report from the Northern Ireland Cost and Epidemiology of Chronic Obstructive Pulmonary Disease (NICECOPD) study stated that the prevalence of GOLD-defined COPD stage 2 or more severe was 6.3% in a general population aged 40–69 yrs.[28] In our study, prevalence of GOLD-defined COPD stage 2 or worse was 8.4% which is in accordance with the NICECOPD estimates given the higher age range in our study. Most other studies confirm that COPD prevalence is increasing, although a recent Spanish study in fact reported a decrease in COPD prevalence from 1997 to 2007.[6]

The results of this study is based only on the results of lung function tests, and not including a thorough medical examination as is appropriate when diagnosing COPD. Therefore it could be argued that the use of COPD is not appropriate. We have nevertheless chosen to use the COPD term in this study because it is in line with international guidelines and other epidemiology studies.

Since most other contemporary prevalence studies have similar estimates as the present study, there is little reason to believe that the current prevalence estimate is an overestimation. Consequently, the most striking with our results is that GOLD-defined COPD prevalence is twice as high as the prevalence estimate that has been in used in Norway until now; 14% versus 7%.[20] There are several plausible explanations for this large discrepancy.

Firstly, there is a substantial age difference in the two study populations. The study population is basically the same in the two studies. The age range was 26–82 yrs in the former study, while it was 35–90 yrs in the latter. Since COPD is closely related to age and is very rare among subjects below 40 yrs of age, the population is more proper for COPD estimates in the second than in the first follow-up. From this perspective, the present COPD estimate is likely to be more realistic than the previous Norwegian COPD estimate.

To examine if the differences in Norwegian prevalence estimates from 7% in the first HCCS follow-up to 14% in the second follow-up is in fact a result of an ageing study population, we compared COPD prevalence in the two time periods across population characteristics such as gender, age groups, smoking habits and educational level, as mentioned in the results from Table 2. The prevalence was higher across all categories in 2003–05 when compared with 1996–97, even across age categories. Also, when estimating the COPD prevalence within the same age range (35–82 yrs) in the two time periods, additional analyses showed that COPD prevalence in 1996–97 was 8.2% and COPD prevalence in 2003–05 was 13% (results not shown). These estimates suggest that the higher COPD prevalence estimates in the present study compared to the previous

Norwegian prevalence study reflect an actual increase in prevalence, and that it is not only due to different age structure in the population.

An explanation for the increased prevalence compared to earlier estimates could be methodological. The present study is the second follow-up of the Hordaland County Cohort Study, and the same cohort has been followed for as much as 20 years. Although this is considered a substantial strength of the study in many contexts, it could be viewed as a limitation in the present study since we focus on cross-sectional disease prevalence in a general population. Loss to follow-up could potentially bias the estimates. However, a previous report showed that loss to follow-up in the present study was not associated with baseline lung function, age, height, occupational exposure to airborne agents or smoking habits. Only low socioeconomic status was a predictor for non-response in this study.[14] To check if the participants in our study in 2003–05 were a less healthy sample than the participants in the previous study phase in 1996–97, we also compared the 1996 COPD prevalence for all participants within the age range 35–82 yrs with the 1996 COPD prevalence for only those participants within the age range 35–82 yrs who also participated in the follow-up in 2003. Total 1996 prevalence in the age range 35–82 yrs was 8.2% (95% CI 6.9, 9.4) while 1996 prevalence for those who also participated in the follow-up was actually lower: 5.2% (95% CI 3.9, 6.4) (results not shown). We therefore do not find it likely that the study population in the second HCCS follow-up was systematically less healthy than the study population in the first HCCS follow-up.

The risk for COPD increased with increasing pack years at both time points but more so in the present study than in 1996. At the same time ex-smokers had higher OR for COPD in 1996 than in 2005. This should be viewed in light of COPD being the result of cumulative exposures over a long time period and the fact that it is a disease with a long latency period. Even if smoking prevalence is now declining in Norway it will still take some decades before this decline is mirrored in a lower COPD prevalence. The result regarding ex-smokers, however, indicates that improvement has started: although the prevalence of COPD among ex-smokers is higher in 2005 than in 1996, the adjusted risk for COPD as measured in odds ratios is lower in 2005 than in 1996. In addition, the general ageing of the world's population leads to an independent increase in COPD; both since age in itself is a risk factor for COPD, and since a longer lifetime gives the individual a longer period of time to be cumulatively exposed to various risk factors.[29]

Numerous epidemiological studies on COPD and obstructive airways symptoms have found that low educational level is an independent risk factor for developing this disease.[13,30–33] In the present study, we found a clear tendency for increasing COPD with decreasing educational level with the prevalence estimates ranging from 5% among those with university education to 17% among those with compulsory education only. However, this tendency was only statistically significant in univariate model (Online Supplement, E-Table 3) and not in the multivariate model. A further inspection of the data showed that the association between educational level and COPD lost statistical significance after adjustment for smoking habits. Substantially more smokers had lower education, and substantially more never-smokers had accomplished university education. In the present study, the effect of education on COPD was thus confounded by smoking habits. This is particularly interesting since the study of the same population 8 years earlier showed a significant association between COPD and education also after adjustment for smoking. Further investigations will be needed to disentangle why education is no longer an independent predictor for COPD in an ageing study population.

The use of fixed ratio criterion (postbronchodilator FEV1/FVC < 0.7) to define COPD has received much criticism during the last years. It has been shown that using such a fixed cut-off results in an underestimation of COPD among younger subjects and an overestimation of COPD among the elderly.[34–37] There is a growing international consensus that FEV1/FVC $<$ lower limit of normal (LLN) should be used to define COPD in epidemiological studies, to help overcome the problems associated with a fixed cut-off.[21–23] To further investigate the COPD prevalence in the general Norwegian population of the present study, we performed additional analysis of LLN-defined COPD prevalence (E-Table 2 and 4). The analysis was based on European reference equations from the Swiss LuftiBus study,[25] and gave a COPD prevalence of 8.7%. This prevalence reduction is in accordance with what others have found. A report from the Swedish part of the BOLD study stated that prevalence decreased from 16% to 10% when changing the fixed cut-off with the lower limit of normal.[26] Furthermore, we found that ORs for increasing age and male gender were the most dependent on COPD definition, both being strongest associated with GOLD-defined COPD.

The large amount of under diagnosis in COPD remains a fact whatever spirometric definition one chooses to implement.[4–7] In the present study, only one out of five men and one out of three women with GOLD-defined COPD had a relevant physician's diagnosis. When examining LLN-defined COPD, on the other hand, 1 out of 4 men with COPD had a relevant physician's diagnosis, while the proportion for women was the same as with GOLD-defined COPD. At the same time, a vast majority of them – more than 70% of subjects with GOLD-defined COPD – reported being affected by respiratory symptoms. Respiratory symptoms are important for predicting long-term clinical outcomes in COPD,[38] and thus under diagnosis among symptomatic subjects is very unfortunate. We still have a long way to go before COPD is properly diagnosed in a primary care setting. A better routine for diagnosing COPD and increased COPD awareness among primary care physicians could greatly improve patient management, since early detection and treatment of COPD patients are of the utmost importance for enhanced lifespan and quality of life in this group of patients.

To conclude, the present study has shown that prevalence of GOLD-defined COPD is 14%, a substantial increase from the last prevalence study 8 years earlier. The risk factors for disease remained the same, but strength of associations varied over time. Regardless, smoking is still the most important risk factor, approximately every third ever-smoker with more than 20 pack-years suffered from COPD. Only a small minority of the COPD subjects had a relevant diagnosis, although a vast majority of them reported respiratory symptoms.

Conflict of interest

The authors declare that they have no conflict of interest.

Appendix A. Supplementary data

Supplementary data related to this article can be found at http://dx.doi.org/10.1016/j.rmed.2013.04.008.

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