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SOCIOECONOMIC RISK FACTORS FOR LUNG FUNCTION DECLINE IN A GENERAL POPULATION

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ABSTRACT

Aim: To examine gender-specific associations between different aspects of socioeconomic status (SES) (educational level, occupational status, income) and lung function in a general adult population.

Materials and methods: In the Hordaland County Cohort Study, 1644 subjects aged 26-82 yrs at baseline answered questionnaires and performed post-bronchodilator spirometry both in 1996-97 and in 2003-06. We performed adjusted linear regression analysis on the effect of SES on decline in FEV_1, FVC and FEV_1/FVC.

Results: Mean annual decline in FEV_1 from baseline to follow-up was 57 mL (SE 1.3) and 48 mL (SE 1.0) for men and women, respectively ($p<0.01$). Men had a larger decline in FVC than women, while women had a larger decline in FEV_1/FVC ($p<0.05$). Lower education and low occupational status were associated with larger male lung function decline ($p<0.05$). SES did not affect female lung function decline. However, marital status was a significant predictor; unmarried women had less decline than both married and widowed women in both FEV_1 (adjusted mean annual difference 8 mL and 16 mL) and FVC (adjusted mean annual difference 8 mL and 18 mL) ($p <0.05$).

Conclusion: Low SES was associated with increased lung function decline in men. For women, marital status was more important.

Abstract word count: 200 words

Key words: epidemiology asthma/COPD, respiratory function, risk factor, spirometry.

INTRODUCTION

Low socioeconomic status (SES) is inversely related to burden of illness and mortality rates from many diseases, such as coronary heart disease, different types of cancer and respiratory diseases (1-3). The joint guidelines from the American Thoracic Society (ATS) and the European Respiratory Society (ERS) present SES as a risk factor for chronic obstructive pulmonary disease (COPD) along with other known factors such as smoking, environmental pollution and occupational exposure to dust or gas (4).

Several studies have shown that there is an association between low SES and impaired lung function (2, 5-9). This association is significant also after adjusting for common confounders like smoking habits and occupational exposures. It is likely that low SES is associated with further lifestyle factors that have a negative effect on lung function, such as air pollution, unhealthy diet, passive smoking and indoor climate (10-12).

SES is a multidimensional concept consisting of at least educational level, income and occupational status (13). Little is known with regard to how associations between SES and pulmonary health differ over time and between men and women. Of the few longitudinal studies with FEV_1 as outcome, one study analyzed hospital admissions (2), one study examined lung function decline of young adults only (6), one study had only male participants (8), and one study analyzed mortality (9). More information on aspects of SES and on gender differences may bring us closer to an understanding of the underlying mechanisms in the associations between SES and pulmonary health. Also marital status is an important aspect when examining such gender differences in morbidity (13). It has been suggested that marriage may have different health effects for women and men, in that marriage protects men more than women from both overall and cause-specific mortality (14). Thus, it is important to adjust for marital status when examining the relationship between SES and pulmonary health.

The main objective of the present study was to examine gender-specific associations between different aspects of socioeconomic status and lung function decline in a general adult population. Aspects of SES analyzed in this study were income, educational level and occupational status.

METHODS

The present study is based on data from the first (1996-97) and second (2003-06) follow-up surveys in the Hordaland County Cohort Study (HCCS) (15-17). Briefly, the HCCS initially comprised 3181 participants from Bergen and 11 surrounding municipalities in 1985, of whom 2358 performed acceptable spirometry in 1996-97. Of these subjects 2250 were residing in Hordaland and were invited to a follow-up in 2003-6. Altogether 74% (1664/2250) of those invited performed an acceptable spirometry. Predictors for loss to follow-up were low educational level and low income for women, and low income and being married or divorced for men (Table E1). In the remainder of this paper, the 1996-97 survey will be referred to as "baseline", and the 2003-06 survey will be referred to as "follow-up". Informed consent was obtained from each participant prior to each study phase, and the study was approved by the Regional Committee of Medical Research Ethics.

Both surveys included extensive questionnaires and clinical examinations. Additional detail on the spirometric tests is provided in an online data supplement. The highest forced vital capacity (FVC) and forced expiratory volume in one second (FEV_1) values of three trials were used in the analyses. Annual decline in FEV_1, FVC and FEV_1/FVC was defined as the highest

1996-97 measurement minus the highest 2003-06 measurement, divided by follow-up time. Mean follow-up time was 6.8 yrs with standard deviation (SD) 0.7 yrs.

Subjects were classified as persistent never-smokers, persistent ex-smokers, quitters, beginners and persistent smokers according to self-reported daily smoking habits in 1996-97 and 2003-06. All other covariates analyzed in the present study were registered at baseline. Standing height without shoes was measured to the nearest centimetre at the clinical examination. One pack year was defined as 20 cigarettes a day for 1 year. Marital status was linked from the national tax registry, and was categorized into married, unmarried, widowed and divorced.

The highest completed educational level was classified into: (1) 9 year compulsory school; (2) continuation school, secondary school or technical school; (3) college or university (18). The participants registered their current occupation in self-administered questionnaires. We then recoded the occupations manually into the occupational status categories white-collar high level (for instance scientists, teachers, medical doctors), white-collar medium level (for instance engineers, nurses, pilots) white-collar low level (for instance secretaries, cooks, police officers), blue-collar high-level (skilled manual labour, for instance carpenters, painters, blacksmiths) and blue-collar low level (unskilled manual labour, for instance window cleaners, shop salespersons, waitresses), using the internationally renowned five-category EGP (Eriksson-Goldthorpe Portocarero) scheme (19). People not working for various reasons (the majority of which were retired) were classified as “others”. Income data for each subject were linked from the national tax registry. Annual personal income in 1996-97 was categorized based on population tertiles.

Analyses were performed using Stata 10.0 (20). Initially, we tested for interactions between gender and risk factors for lung function decline. Gender interacted significantly with age and height for FEV_1/FVC decline ($P<0.01$), and borderline significantly ($P<0.05$ but >0.01) with marital status (for FVC decline), income (for FEV_1/FVC decline) and occupational exposure to dust or gas (for FVC decline). We also performed interaction analyses of marital status / SES factors and smoking habits. Smoking interactions involving marital status, educational level and occupational status were not significant for any gender. Only one interaction was significant; male smokers with low income had larger FEV1/FVC decline than male smokers with high income. Interaction analyses of occupational exposure to dust or gas and occupational status with regard to lung function decline, showed no significant interactions. To enable focus on gender-specific associations between different aspects of SES and lung function, the main analyses in our study was stratified by gender. All analyses were adjusted for age, height, smoking habits, occupational exposure to dust or gas and marital status. All p values were two-sided, and values below 0.05 were considered statistically significant. Educational level, occupational status, and income were analyzed as risk factors for decline in FEV_1, FVC and FEV_1/FVC, using linear regression analysis. Gender differences in baseline characteristics as well as in lung function decline were analyzed using two-group mean comparison test (t test) for continuous variables and chi square test for categorical variables. One-way ANOVA with Bonferroni tests was performed to compare mean decline in FEV_1, FVC and FEV_1/FVC in subcategories of education, occupational status and income.

RESULTS

Study population characteristics

Of the 1644 participants in this study, 49% were women (Table 1). Mean age at baseline was 48 yrs (SD 13 yrs), with women being slightly older than men ($p<0.05$). More women than men were never-smokers (44% vs. 33%, respectively, $p<0.01$). Among ever-smokers, women had fewer pack years than men ($p<0.01$). Approximately half of the study population had experienced occupational exposure to dust or gas, although the exposure was much more prevalent among men than women (64% and 31%, respectively, $p<0.01$).

The majority of the population had intermediate education, and there were no significant gender differences in educational level. More men had high occupational status, and more women had low occupational status ($p<0.01$). Mean annual personal income at baseline was 238 000 NOK, significantly higher for men than women ($p<0.01$). A majority of the population was married. Among those who were not married, more men were unmarried and more women were widowed or divorced ($p<0.01$).

Baseline and follow-up lung function by SES factors and marital status

Mean baseline FEV_1/FVC was 81%, with women having a higher ratio than men ($p<0.01$, Table 2). Lower education, low occupational status and low income were all associated with cross-sectional lung function at both baseline and follow-up were for men ($p<0.05$, see Tables E2 and E4 in the online supplement). For women, low occupational status was associated with lower lung function at baseline and at follow-up. In addition, married women had lower FEV_1/FVC ratio than unmarried women at both points in time ($p<0.05$, see Tables E3 and E5 in the online supplement).

Decline in lung function by SES factors and marital status

Mean annual decline in lung function was 52 ml (SE 0.8 ml) FEV_1, 40 ml (SE 1.0 ml) FVC, and 0.55% FEV_1/FVC (SE 0.02%) (Table 2). There were significant gender differences in lung function decline. Men had a larger decline in both FEV_1 and FVC than women, while women on the other hand had a larger decline in FEV_1/FVC ($p<0.01$).

Univariate ANOVA analyses showed no significant associations between socioeconomic risk factors and marital status, and male decline in FEV_1 and FVC. For FEV_1/FVC in men, however, educational level, occupational status and income was associated with larger decline ($p<0.05$, see Table E6 in the online data supplement and Figure 1). Regarding SES, similar univariate results were observed for women (see Table E7 in the online data supplement and Figure 2). There was no association with female decline in FEV_1 or FVC, while both educational level and occupational status were significantly associated with decline in FEV_1/FVC ($p<0.05$). However, in women, marital status was associated with differences in mean FEV_1 and FVC decline ($p<0.05$, see Table E7 in the online data supplement and Figure 2). Unmarried women had less decline in FEV1 and FVC than married and widowed women ($p<0.05$).

Multivariate analysis of lung function decline by SES factors

Gender-specific linear regression analysis of lung function decline by socioeconomic factors and marital status, with adjustment for baseline lung function, age, height, smoking habits, and occupational exposure to dust or gas, showed significant associations between lung function decline and SES for men but not women (Tables 3 and 4).

Men with lower education and with blue-collar low level occupations had 9 and 13 ml higher mean annual decline in FEV_1 than men with white-collar high level occupations, respectively (p-values 0.05 and <0.01). With regard to FVC, men with lower education and blue-collar low-level occupations had 19 ml and 13 ml more mean annual decline than men with higher education and white-collar high level occupations, respectively (p-values <0.01 and 0.02).

Compared with unmarried women, married and widowed women had 8 ml and 16 ml more mean annual decline in FEV_1, respectively (p-values 0.02 and <0.01, Table 4). Also with FVC, married and widowed women had 7 ml and 16 ml more mean annual decline than their unmarried counterparts (p values 0.06 and 0.01).

DISCUSSION

The present study examined gender-specific associations between different aspects of socioeconomic status and lung function in a general adult population. We found that low SES was associated with increased lung function decline in men. For women marital status was more important than SES.

The main strengths of our study were a longitudinal study design and a large sample size, allowing for multivariate analyses of changes in lung function over time. Furthermore, we do not have reason to suspect non-response bias or that the estimates will not be representative for the general population. A previous study of the same cohort have shown that although there were more middle-aged subjects in paid employment among responders in 1996-97 than among non-responders, they did not differ with regard to prevalence of respiratory symptoms (21). Furthermore, from baseline to follow-up the annual decline in FEV1 was 52 ml in this study population (48 ml in women and 57 ml in men). This is in accordance with another study from the same geographical area, where the annual decline in FEV1 was in average 53 ml in a general male population (22).

A limitation of this study was loss to follow-up. As much as 25% of the participants in 1996-97 who were invited to the follow-up examination in 2003-06, did not participate. Neither baseline lung function, age, height, occupational exposure to dust or gas, or smoking habits was associated with loss to follow-up. Significant predictors for loss to follow-up were low educational level and low income for women, and low income and being married or divorced for men (Table E1). Interestingly, this was quite the opposite of the analyses in Tables 3 and 4, where SES predicted accelerated lung function decline for men but not women. One could speculate that in general, healthier people are more likely to participate in follow-up studies of lung function. Perhaps if all the invited subjects in this study had participated in the follow-up study, SES would have predicted lung function decline with comparable significance in both men and women.

A limitation of most studies focusing on repeated measures is the potential pitfall of regression to the mean. In general, when observing repeated measurements in the same subject, relatively high (or relatively low) observations are likely to be followed by less extreme ones nearer the subject's true mean (23). The effect of regression to the mean increases with larger measurement variability. One way to reduce this problem is to use two or more baseline measurements. In our study, lung function both at baseline and follow-up was measured three times, and measurement variability at both points in time were controlled using the ATS spirometry criteria ensuring a reproducibility of the two highest measurements within 200 ml (24). To further check for presence of regression to the mean, we initially plotted lung function decline against baseline lung function (results not shown). There was not markedly more decline at the tails of the baseline measurements than in the middle, suggesting that regression to the mean was not an important problem in our study.

The adjusted association between low SES and decline in lung function for men confirms the results from previous studies (2, 7-9, 18, 25-26). However, most of these studies have been cross-sectional. One of the few longitudinal studies that have examined associations between low SES and lung function decline over time is the American CARDIA study. The authors observed that for subjects aged 18-30 yrs at baseline, pulmonary function declined earlier and faster for individuals with low childhood SES than for individuals with high childhood SES (6). Similarly, in a study of middle-aged Japanese-American men from the Honolulu Heart Program, Burchfiel and co-workers found that non-smokers with lower education experienced more rapid decline in FEV_1 than non-smokers with higher education (8).

The associations between SES and lung function decline could be confounded by smoking. Smoking could also affect the observed gender differences in the present study. During the last 50 years smoking has migrated its way down the SES categories from being a fashionable habit for the wealthy to becoming a working class habit. Smoking has also changed across gender, from being a predominantly male habit to increasingly include women (27). However, in the present study we adjusted all multivariate analyses for smoking habits from baseline to follow-up, thus minimizing the danger of confounding by smoking. Interaction analyses showed no significant interactions between marital status and smoking, between educational level and smoking, or between occupational status and smoking for any gender. For women, there was no significant interaction between income and smoking either, but for men, smokers with low income had larger decline in FEV1/FVC than smokers with high income. However, income was the SES predictor that was not associated with lung function decline in the main analyses (Table 3). Thus, this finding does not imply that the associations between SES and lung function decline is mediated by the powerful effect of smoking on lung function.

Supplemental analyses (Tables E6 and E7) showed associations between cigarette smoking and FEV_1 and FEV_1/FVC, but not between smoking and FVC. Although smoking is a predictor for both restrictive and obstructive pulmonary disease, it is by far a more important predictor for obstruction than restriction. FEV1 is more sensitive to obstruction than FVC, and consequently also the ratio is affected by smoking.

One could hypothesise that the effect of occupational status on lung function decline was mediated by occupational exposure to airborne agents. One would perhaps expect jobs with lower status to be more prone to occupational exposure to dust or gas. However, although the two parameters are associated with each other, interaction analyses performed initially showed no interaction between exposure and status on decline in FEV1, FVC or FEV1/FVC for any gender.

Of the three SES aspects, income was only significantly associated with male FEV_1/FVC decline, not with FEV_1 or FVC separately. This is in contrast with what certain previous studies have found (28). Differences in income are relatively small in Norway compared with many other countries. In the present study, baseline income for men varied from 130000 NOK (14300 €) on the 10^{th} percentile to 450000 (49400 €) on the 90^{th} percentile (results not shown). However, the weak association between income and pulmonary morbidity may also be explained by other mechanisms than egalitarianism. Results from the British Household Panel Survey suggest that economics matters less than for instance marital status and psychological distress with regard to longevity (29).

In this study population, SES affected lung function among men but not women. Several studies have shown that SES is a significant predictor for impaired lung function for both men and women (2, 7). However, it has also been shown that although SES is a significant risk factor for disease among both sexes, low individual SES affects men more than women (18, 30). A possible explanation for the lack of association between SES and female lung function in our study could be that the women's socioeconomic status will be linked to their husband's social position, at least among the elderly (30). Information on household income rather than personal income, and information on partner's education and occupation could shed some light on this hypothesis.

Another noteworthy result from the present study was that married women and widows had a larger lung function decline than unmarried women, even after adjusting for all potential confounders including age. One could hypothesize that a non-linear association between lung function decline and age could be a confounder for the results in the present study, since the age adjustment performed here was linear. The estimates for the youngest (unmarried women) and oldest (widows) could have been affected by a linear age adjustment to give an unrealistically minimized lung function decline for the unmarried and a corresponding maximized lung function decline for the widows. However, additional analyses where we adjusted for age^2 did not alter any of the estimates (results not shown).

The significant association between marital status and female lung function decline was based on marital status in 1996-97. Perhaps the results would be affected by taking into consideration those who changed their marital status during the study period. To examine this possibility further, we performed additional analyses where we included changes in marital status from baseline to follow-up instead of simple baseline marital status. This did not change any of the results (results not shown).

The finding that married women had larger lung function declines than unmarried women contrasts with results from previous studies, showing that marriage has a beneficial health effect on for instance physical functioning and hospital admissions (31, 32). However, previous research is not entirely consistent; a Dutch study showed that adults who had never been married had lower health care utilization than those who were married (33). Joung and co-workers furthermore reported from the GLOBE study that people who live alone have higher morbidity rates than those who live with a partner (34). Following this line of reasoning, a high degree of unmarried cohabitation could have influenced our results. This would potentially affect the younger age segments, where unmarried cohabitation is more common. Unfortunately, we do not have information in the present study on the proportions of unmarried women in the study population who were single or cohabitants. An alternative explanation for the negative marriage effect could be passive smoking, since women have traditionally experienced more passive smoking than men. However, additional analyses where we adjusted for passive smoking reported at baseline did not change the marital status estimates (results not shown).

Finally, to further investigate the associations between SES, marital status and lung function, we also performed alternative multivariate analyses with baseline lung function and follow-up lung function as outcomes instead of lung function decline (tables E2-E5 in online supplement). This was done to check if associations remained the same in a cross-sectional perspective. Interestingly, the results were mainly the same for men, but altered somewhat for women. Low occupational status was a significant predictor for low lung function in the cross-sectional analyses. Being married was associated with lower FEV_1/FVC but not FEV_1 and FVC. These findings may suggest that marital status in an epidemiological perspective gains importance with increasing time, and may be a "slow-acting" risk factor for female pulmonary health, but more studies are needed to elaborate on this.

To conclude, this study confirms the notion that socioeconomic status is an independent and important risk factor for decline in lung function, at least among men. Future studies should examine more closely the associations between SES and marital status, and pulmonary health among women. The "healthy marriage effect" may have exceptions, especially among women.

ACKNOWLEDGMENTS

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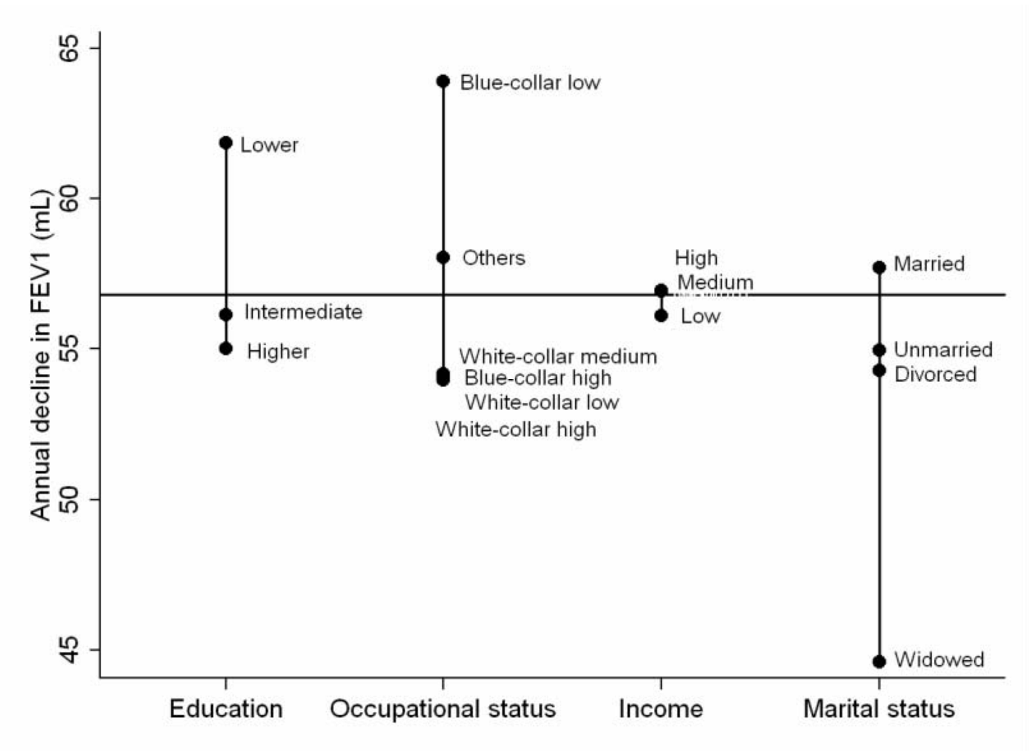
FIGURE LEGENDS

Figure 1. Mean Annual Decline in FEV_1 and FEV_1/FVC Among Men in the Hordaland County Cohort Study 1996-97 to 2003-06, by Educational Level, Occupational Status, Income and Marital Status. N=834. Horizontal line is male total population mean.

Figure 2. Mean Annual Decline in FEV_1 and FEV_1/FVC Among Women in the Hordaland County Cohort Study 1996-97 to 2003-06, by Educational Level, Occupational Status, Income and Marital Status. N=810. Horizontal line is female total population mean.

SOCIOECONOMIC RISK FACTORS FOR LUNG FUNCTION DECLINE IN A GENERAL POPULATION - FIGURES

Figure 1.



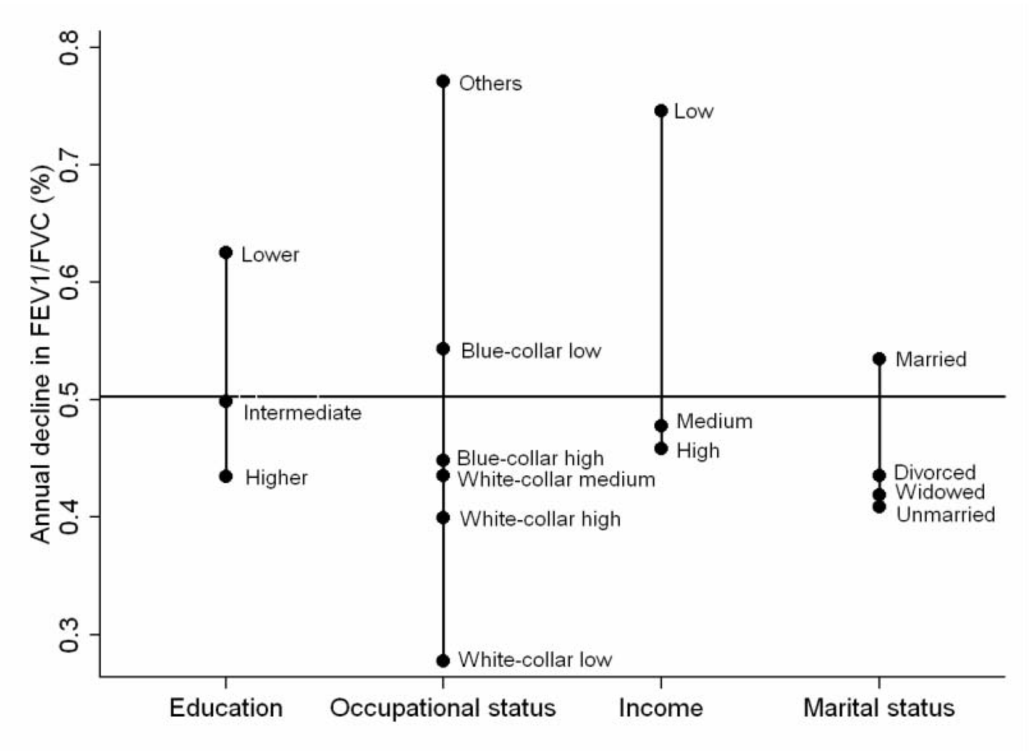
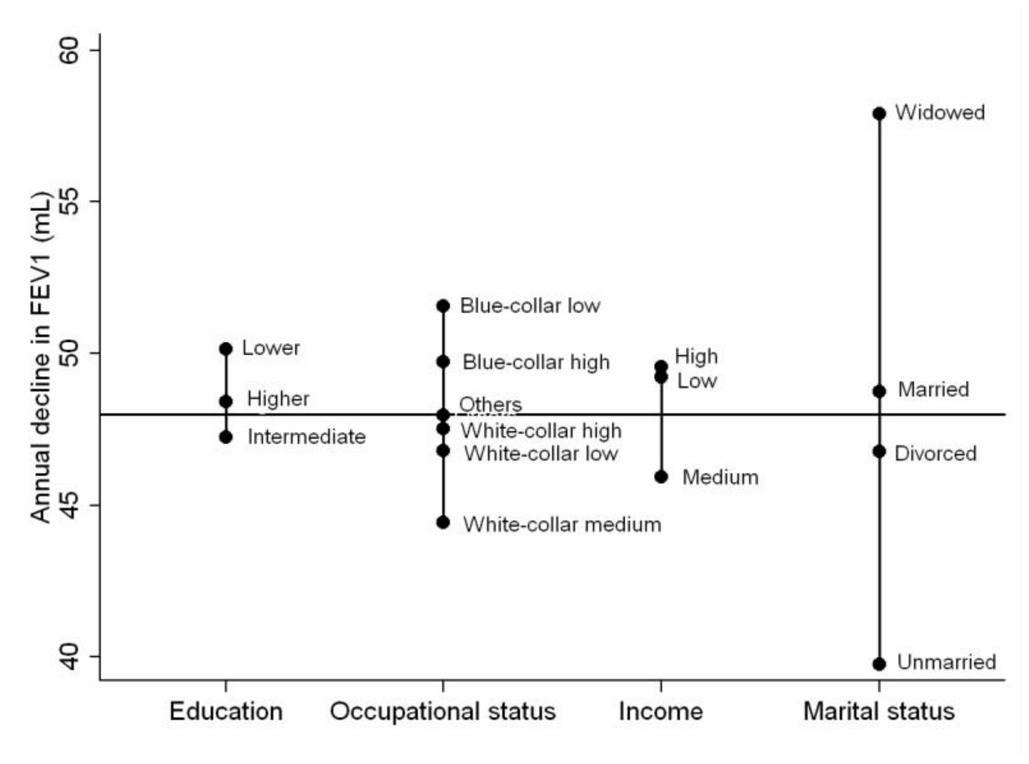
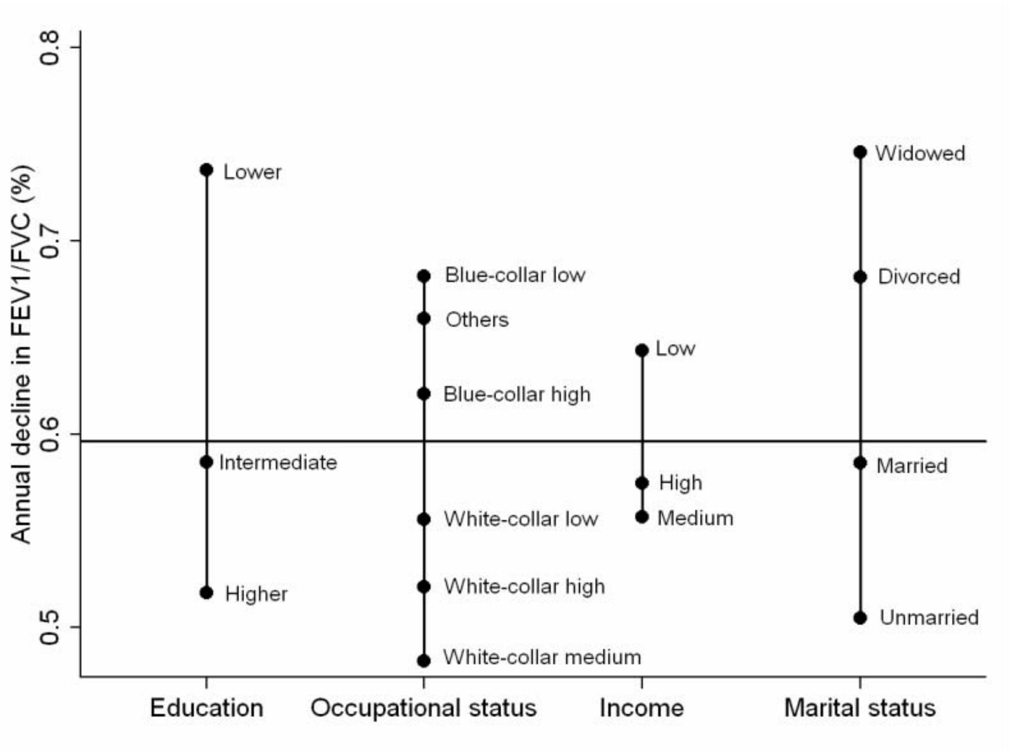

Annual decline in FEV1/FVC (%)
0.3
0.4
0.5
0.6
0.7
0.8
Lower
Intermediate
Higher
Others
Blue-collar low
Blue-collar high
White-collar medium
White-collar high
White-collar low
Low
Medium
High
Married
Divorced
Widowed
Unmarried
Education
Occupational status
Income
Marital status

Figure 2.


Annual decline in FEV1 (mL)
40
45
50
55
60
Lower
Higher
Intermediate
Blue-collar low
Blue-collar high
Others
White-collar high
White-collar low
White-collar medium
High
Low
Medium
Widowed
Married
Divorced
Unmarried
Education
Occupational status
Income
Marital status


Annual decline in FEV1/FVC (%)
0.8
0.7
0.6
0.5
Lower
Intermediate
Higher
Blue-collar low
Others
Blue-collar high
White-collar low
White-collar high
White-collar medium
Low
High
Medium
Widowed
Divorced
Married
Unmarried
Education
Occupational status
Income
Marital status

TABLES

Table 1. Baseline Characteristics by Gender of Participants in the First and Second Follow-up in the Hordaland County Cohort Study, N = 1644 Subjects who Answered Questionnaires and Performed Post-Bronchodilator Spirometry at Both Baseline in 1996-97 and Follow-Up in 2003-06.

	Total	Women	Men	p-value*
Age (yrs), mean (SD)	48.0 (13.3)	48.7 (13.4)	47.4 (13.1)	0.039
Height (m), mean (SD)	1.72 (0.09)	1.65 (0.06)	1.78 (0.07)	<0.001
Smoking habits from baseline to follow-up [†]				<0.001
Persistent never-smokers, n (%)	607 (37)	336 (42)	271 (33)	
Persistent ex-smokers, n (%)	383 (24)	153 (19)	230 (28)	
Quitters, n (%)	156 (10)	78 (10)	78 (9)	
Beginners, n (%)	50 (3)	26 (3)	24 (3)	
Persistent smokers, n (%)	426 (26)	203 (26)	223 (27)	
Occupational dust exposure, n (%)[§]	769 (48)	248 (31)	521 (64)	<0.001
Educational level [‖]				0.468
Lower education, n (%)	252 (15)	129 (16)	123 (15)	
Intermediate education, n (%)	974 (60)	484 (60)	490 (59)	
Higher education, n (%)	409 (25)	191 (24)	218 (26)	

Occupational status **				<0.001
White-collar high level, n (%)	209 (13)	40 (5)	169 (20)	
White-collar medium level, n (%)	333 (20)	186 (23)	147 (18)	
White-collar low level, n (%)	199 (12)	167 (20)	32 (4)	
Blue-collar high level, n (%)	187 (12)	15 (2)	172 (21)	
Blue-collar low level, n (%)	414 (25)	243 (30)	171 (20)	
Others ††, n (%)	298 (18)	159 (20)	139 (17)	
Income (NOK*1 000), mean (SD)	238 (400)	176 (103)	299 (546)	
Income				<0.001
Low income, n (%)	454 (28)	340 (42)	114 (14)	
Medium income, n (%)	558 (34)	316 (39)	242 (29)	
High income, n (%)	632 (38)	154 (19)	478 (57)	
Marital status				<0.001
Unmarried, n (%)	261 (16)	111 (14)	150 (18)	
Married, n (%)	1160 (71)	550 (68)	610 (73)	
Widowed, n (%)	69 (4)	61 (7)	8 (1)	
Divorced, n (%)	154 (9)	88 (11)	66 (8)	
Total, n	1644	810	834	

[*] P-values are from two-group mean comparison test (t test) for continuous variables and chi square tests for categorical variables.

[†] Information on smoking habits from baseline to follow-up was missing for 14 women and 8 men.

[§] Information on occupational dust exposure was missing for 39 subjects (19 men and 20 women)

[||] Information on educational level was missing for 9 subjects (3 men and 6 women).

** Information on occupational status was missing for 4 women.

†† Others in occupational status comprise students (27), subjects not working (245) and subjects not classifiable for other reasons (26).

Table 2. Baseline values and annual decline in post-bronchodilator lung function by gender, mean and standard error (SE). N = 1644.

	Total	Women	Men	p-value*
Baseline FEV1 (L), mean	3.42 (0.02)	2.88 (0.02)	3.95 (0.03)	<0.001
Baseline FVC (L), mean	4.23 (0.03)	3.51 (0.02)	4.94 (0.03)	<0.001
Baseline FEV1/FVC (%), mean	81 (0.2)	82 (0.2)	80 (0.2)	<0.001
FEV1 decline (ml), mean	52 (0.8)	48 (1.0)	57 (1.3)	<0.001
FVC decline (ml) , mean	40 (1.0)	36 (1.2)	44 (1.7)	<0.001
FEV1/FVC decline (%), mean	0.55 (0.02)	0.60 (0.02)	0.50 (0.02)	0.003

Abbreviations: FEV1, forced expiratory volume in one second; FVC, forced vital capacity.

* P-values are from two-group mean comparison test (t test) for continuous variables.

Table 3. Linear regression analyses of annual decline in FEV_1, FVC and FEV_1/FVC among men in the Hordaland County Cohort Study 1996-97 to 2003-06, by baseline educational level, occupational status, income and marital status. All analyses are adjusted for baseline lung function, age, height, occupational exposure to dust or gas, and smoking habits from baseline to follow-up. N = 834.

	FEV_1 decline (ml), parameter estimate (p)	FVC decline (ml), parameter estimate (p)	FEV_1/FVC decline (%), parameter estimate (p)
Educational level			
Higher education	0	0	0
Intermediate education	2.1 (0.519)	5.2 (0.201)	-0.05 (0.300)
Lower education	9.4 (0.048)*	19.3 (0.001) *	-0.10 (0.151)
Occupational status			
White-collar high level	0	0	0
White-collar medium level	-0.7 (0.880)	-1.4 (0.790)	0.05 (0.476)
White-collar low level	-0.3 (0.970)	2.7 (0.766)	-0.06 (0.610)
Blue-collar high level	1.8 (0.672)	-1.3 (0.814)	0.03 (0.594)
Blue-collar low level	13.3 (0.002) *	12.8 (0.017) *	0.08 (0.205)
Others	3.8 (0.462)	1.4 (0.819)	0.14 (0.061)
Income			
High income	0	0	0
Medium income	-0.8 (0.806)	-0.3 (0.937)	-0.02 (0.685)
Low income	-0.2 (0.969)	-1.4 (0.789)	0.10 (0.115)

Marital status			
Unmarried	0	0	0
Married	-0.1 (0.972)	-3.2 (0.502)	-0.00 (0.954)
Widowed	-12.4 (0.420)	2.5 (0.891)	-0.34 (0.125)
Divorced	-5.0 (0.397)	-4.0 (0.577)	-0.13 (0.132)

Abbreviations: FEV1, forced expiratory volume in one second; FVC, forced vital capacity.

* $P < 0.05$.

Table 4. Linear regression analyses of annual decline in FEV_1, FVC and FEV_1/FVC among women in the Hordaland County Cohort Study 1996-97 to 2003-06, by baseline educational level, occupational status, income and marital status. All analyses are adjusted for baseline lung function, age, height, occupational exposure to dust or gas, and smoking habits from baseline to follow-up. N = 810.

	FEV_1 decline (ml), parameter estimate (p)	FVC decline (ml), parameter estimate (p)	FEV_1/FVC decline (%), parameter estimate (p)
Educational level			
Higher education	0	0	0
Intermediate education	-2.6 (0.319)	-3.0 (0.314)	0.00 (0.974)
Lower education	1.0 (0.782)	-1.3 (0.750)	0.10 (0.226)
Occupational status			
White-collar high level	0	0	0
White-collar medium level	-3.9 (0.468)	-0.6 (0.917)	-0.05 (0.696)
White-collar low level	-0.6 (0.909)	0.4 (0.954)	0.06 (0.615)
Blue-collar high level	3.6 (0.697)	1.4 (0.898)	0.15 (0.477)
Blue-collar low level	3.1 (0.551)	3.2 (0.599)	0.11 (0.338)
Others	-3.3 (0.557)	1.2 (0.855)	0.01 (0.929)
Income			
High income	0	0	0
Medium income	-2.3 (0.430)	-0.5 (0.876)	-0.02 (0.816)
Low income	-0.8 (0.799)	0.0 (0.995)	0.03 (0.641)

Marital status			
Unmarried	0	0	0
Married	7.8 (0.017) *	7.0 (0.059)	0.05 (0.479)
Widowed	15.5 (0.004) *	16.2 (0.009) *	0.10 (0.406)
Divorced	5.0 (0.262)	3.0 (0.560)	0.09 (0.340)

Abbreviations: FEV1, forced expiratory volume in one second; FVC, forced vital capacity.

* $P < 0.05$.