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Socioeconomic circumstances and incidence of chronic obstructive pulmonary disease (COPD) in an urban population in Sweden

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ABSTRACT

The association between socioeconomic circumstances and incidence of chronic obstructive pulmonary disease (COPD) was investigated in an urban population in Sweden. The study included all 40–89 year-old inhabitants in Malmö, Sweden ($N = 117,479$) without previous hospitalization due to COPD, who were followed over 14 years for COPD related hospital admissions. The Malmö Preventive Project (MPP) cohort ($n = 27,358$) with information on biological and lifestyle factors was also used to study the association between socioeconomic circumstances and COPD. The Swedish hospital discharge register was used to record incidence of COPD hospitalizations. A total of 2,877 individuals (47.5% men) were discharged from hospital with COPD as the primary diagnosis during follow-up in Malmö. Low annual income (hazard ratio (HR): 2.23; 95%CI: 1.97–2.53, $P < 0.001$) and rented (vs. self-owned) housing (HR: 1.41; 1.30–1.52, $P < 0.001$) were associated with a higher risk for COPD. In addition, compared to married subjects, divorced (HR: 1.61; 1.46–1.78, $P < 0.001$) and widowed (HR: 1.30; 1.16–1.46, $P < 0.001$) individuals had an increased risk for hospitalization due to COPD. Low income, low occupation and being divorced or widowed were similarly associated with COPD in the MPP cohort, after adjustments for smoking, FEV_1, BMI, age and sex. However, socioeconomic circumstances were not associated with COPD in analyses restricted to never smokers. Low socioeconomic circumstances were associated with an increased risk of COPD after adjustments for biological and lifestyle risk factors including smoking status. However, this relationship was not significant in those who never smoked.

Introduction

Chronic obstructive pulmonary disease (COPD) is a major public health concern and cause of chronic morbidity and mortality worldwide (1–3). It is expected to become the third leading cause of death by 2030 (4). In Sweden, the estimated prevalence of COPD diagnosed by physicians is 5–10% (5). The major risk factors for COPD are smoking, environmental air pollutants and aging, but other risk factors such as genetic and hereditary factors also play a role (3, 6–10).

Several studies have reported that low socioeconomic status are important determinants for prevalence and severity of COPD and impaired respiratory health (11–14). According to an international survey, socioeconomic disparity is an independent risk factor for COPD even in countries where healthcare services are free and universal (13). A Finnish nationwide population-based study found that low education level was the main risk factor for COPD and low household-income was a main risk factor for asthma (15). A Danish study also showed a significant association between education and income with admission to hospital for COPD (16). A study in Sweden reported that age, smoking, lower educational level, along with a history of tuberculosis were associated with the prevalence of COPD (12).

Although previous studies have been conducted on COPD and its association with socioeconomic circumstances, these studies have followed different study designs using different confounding factors. The primary aim of this study is to investigate the association between measures of socioeconomic circumstances and incidence of COPD in a total population sample of 40–89 year old men and women from Malmö, Sweden. A secondary aim is to study to what extent the socioeconomic gradient in COPD could be explained by smoking and other risk factors in a large population-based cohort from the same city.

Methods

Study population and follow up

A total of 118,134 subjects, aged 40–89 years, were registered as residents in the city of Malmö in November 1, 1990. After excluding subjects with history of hospitalization due to COPD ($n = 655$) before November 1, 1990, the study population consist of 117,479 subjects. Baseline information was retrieved from the National Swedish Census Data ("Folk- och bostadsräkning, FoB") in 1990, which included mailed self-administered questionnaires and data from other

population registers (17). Information on income was retrieved from assessment of taxes in 1991. Country of birth and marital status were from the Swedish total population register. Occupation and housing conditions were based on self-reported questionnaires. The overall response rate of the questionnaire was 97.5%. information on migration and deaths during the follow-up period was from the Swedish total population register and the Swedish Cause of Death Register. Individuals with a primary hospital discharge diagnosis of COPD were retrieved by record linkage with the Swedish Hospital Discharge Register (18). The diagnosis of COPD was made according to International Classification of Diseases, ICD 8 (codes 490, 491, 492), ICD 9 (codes 490–492, 496) and ICD 10 (codes J40-44).

All subjects were followed-up from November 1, 1990, until first diagnosis of COPD, emigration, death or the end of follow-up on Dec. 31, 2007. This study was approved by the Lund University Ethics review Committee (LU 78-02 and 2009/46).

Malmö Preventive Project Cohort (MPP)

MPP is a primary prevention project started at the Medical Clinic in Malmö University Hospital in the early 1970s with an aim to detect high-risk individuals and offer preventive interventions (19–21). Approximately 71% of the invited people participated in the screening program (22,444 men and 10,902 women), age range 21–61years old (20). The screening program included a physical examination, laboratory tests and a computer-based questionnaire. Height was measured in meters without shoes. Weight measurements were taken in light indoor clothing. BMI was calculated (weight/height^2 (kg/m^2)) and stratified into four groups: ≤ 18.5 (under weight), 18.5–24.9 (normal), 25–29.9 (overweight) and >30 (obese). Smoking status was categorized into three groups: current smokers, former smokers or never-smokers.

Forced expiratory volume in 1 second (FEV$_1$) was measured using a Spirotron apparatus (Drägerwerk AG, Lübeck, Germany), while the subjects were in a standing position without nose clips, by specially trained nurses. The questionnaires included family history and lifestyle factors such as smoking status. Incidence of COPD was defined as cases with a discharge diagnosis of COPD (490–492, 496 (ICD-9) or J40–J44 (ICD-10)) as one of the first three listed diagnoses from inpatient and outpatient registers or on the death register (22).

All participants in the study were followed from the baseline examination until a discharge diagnosis of COPD, emigration from Sweden, death or December 31, 2013, whichever came first. The screening programs were approved and funded by the Health Service Authority in Malmö. After excluding prevalent cases of COPD ($n = 126$) and participants with missing values, the final study cohort comprised of 27,358 participants.

Socioeconomic circumstances

Socioeconomic indicators used for the analysis were total annual income, occupation, housing status, marital status,

and country of birth. The total annual income 1990 (in Swedish Kronor (SEK)) was divided into four quartiles. In November 1, 1990, $1 corresponded to 5.62 SEK. Housing status was also taken into account since annual income may not fully reflect the socioeconomic differences among people, i.e. retired people or individuals with low income in a high income household. Housing status was grouped into self-owned house or apartment or rented properties. The low occupation group was comprised of unskilled manual workers, skilled manual workers and low level non-manual workers; the middle occupation group comprised of medium level non-manual workers; the high occupation group comprised of high level non-manual workers; the "own company" group comprised of participants who were company owners and finally a group that comprised of early retired or unemployed individuals along with farmers (and 'others'). Marital status was categorized into married, single, divorced, or widowed. Country of birth was divided into Swedish or foreign born.

Statistics

Characteristics of the Malmö inhabitants aged 40–89 years and MPP cohort participants at baseline were presented as means ± standard deviation (SD) or percentages based on incident COPD or not. Correlations between socioeconomic variables and risk factors on incidence of COPD were assessed using Pearson's correlation coefficients. Hazard ratios (HR), with 95% confidence interval (CI) were calculated using Cox' proportional hazards regression models to assess the relationship between socioeconomic status and incidence of COPD. HRs were adjusted for baseline age and sex. For MPP cohort, additional adjustments were made for BMI, FEV$_1$ and smoking status in model 2. Interaction terms were added to the multivariate model to assess possible interaction between socioeconomic circumstances and other risk factors on incident COPD. The Kaplan–Meier curve was used to illustrate the relationship between socioeconomic circumstances and the incidence of COPD in the MPP cohort. All statistical analyses were performed using SPSS statistics software version 22.

Results

Baseline characteristics

Baseline characteristics for 40–89-years-old subjects living in Malmö, Sweden, in 1990 and the participants in the MPP cohort are presented in Table 1.

Incidence of COPD in relation to socioeconomic circumstances

During a mean follow-up of 13.5 ± 5.3 years, a total of 2,877 individuals (47.5% men) were discharged from hospital with first-ever COPD as the primary diagnosis. The associations between incidence of COPD and socioeconomic circumstances were presented in Table 2. Low annual income in quartile (Q) 1 and Q2 ((HR: 2.10; 95% CI: 1.83–2.40, $P < 0.001$

Table 1. Characteristics of the Malmö inhabitants aged 40–89 years and MPP cohort participants.

Malmö inhabitants (N = 117,479)

	Incident COPD (n = 2,877)	Non-COPD (n = 114,602)	p value
Age (mean ± SD)	65.7 ± 10.3	60.9 ± 3.3	<0.001
Age groups (%)			
40–49	7.8	26.1	
50–59	19.1	21.0	
60–69	34.9	23.0	
70–79	29.7	19.9	
80–89	8.5	9.9	
Sex (%)			<0.001
Women	52.5	55.4	
Men	47.5	44.6	
Annual income (SEK) (mean ± SD)	1091.6 ± 639.4	1316.9 ± 1969.3	<0.001
Income groups (mean ± SD)			
Q1	473.4 ± 170.0	434.0 ± 190.6	
Q2	933.9 ± 137.5	940.4 ± 140.4	
Q3	1379.2 ± 130.3	1396.7 ± 132.9	
Q4	2223.7 ± 735.1	2476.7 ± 3606.7	
Housing status (%)			<0.001
Self-owned	46.8	55.7	
Rented	49.7	40.3	
Others	3.5	4.0	
Marital status (%)			<0.001
Single	11.2	13.7	
Married	48.7	54.9	
Divorced	22.3	16.8	
Widowed	17.9	14.6	
Country of birth (%)			0.764
Swedish born	84.1	84.3	
Foreign born	15.9	15.7	

MPP (n = 27,358)

	Incident COPD (n = 2,294)	Non-COPD (n = 25,064)	p value
Age (mean ± SD)	47.0 ± 6.7	44.4 ± 7.2	<0.001
Age groups (%)			
<40	29.9	17.8	
40–50	53.3	56.4	
>50	16.7	25.9	
Sex (%)			<0.001
Women	32.0	26.8	
Men	68.0	73.2	
Occupation (%)			<0.001
Low	70.7	61.6	
Middle	12.1	18.0	
High	5.4	10.4	
Own company	6.7	7.0	
Retired and others	5.1	3.0	
Annual income (SEK) (mean ± SD) income groups (mean ± SD)	1000.8 ± 511.6	1127.4727.1	<0.001
Q1	497.5 ± 223.8	479.2 ± 235.6	
Q2	919.4 ± 70.4	824.2 ± 69.9	
Q3	1138.8 ± 68.9	1144.2 ± 69.4	
Q4	1693.4 ± 659.7	1804.2 ± 1018.7	
Marital status (%)			<0.001
Single	10.2	13.6	
Divorced	19.3	12.8	
Widowed	2.9	1.8	
Married	67.7	71.7	
Country of birth (%)			0.649
Swedish born	84.9	85.2	
Foreign born	15.1	14.8	
Smoking status (%)			<.001
Never smoker	9.9	37.3	
Former smoker	9.5	18.1	
Current smoker	80.6	44.6	
BMI (mean ± SD)	24.2 ± 3.8	24.4 ± 3.5	<0.001
BMI groups (%)			
<18.5	3.7	1.8	
18.5–24.9	58.9	58.6	
25–29.9	30.1	33.0	
>30	7.3	6.7	
Forced Expiratory volume in 1 sec (FEV_1) (mean ± SD)	2.7 ± 0.9	3.3 ± 0.8	<0.001

Values expressed are means ± standard deviation (SD) or percentages.

Table 2. Incidence of COPD in relation to socioeconomic circumstances and other risk factors among the Malmö inhabitants aged 40–89 years (N = 117,479).

	Incident COPD		
	N of COPD(per 1,000 p-y)	HR^a(95% CI)	p value
Annual income			
Q4	400 (0.88)	Reference	
Q3	704 (1.64)	1.70 (1.50–1.92)	<0.001
Q2	957 (2.58)	2.23 (1.97–2.53)	<0.001
Q1	816 (2.45)	2.10 (1.83–2.40)	<0.001
Housing status			
Self-owned	1,345 (1.48)	Reference	
Rented	1,430 (2.30)	1.41 (1.30–1.52)	<0.001
Marital status			
Married	1,400 (1.53)	Reference	
Single	322 (1.47)	1.06 (0.94–1.21)	0.342
Divorced	641 (2.28)	1.61 (1.46–1.78)	<0.001
Widowed	514 (3.01)	1.30 (1.16–1.46)	<0.001
Country of birth			
Sweden	2,419 (1.83)	Reference	
Foreign born	458 (1.72)	1.02 (0.92–1.13)	0.686
Age group			
40–49	224 (0.43)	Reference	
50–59	549 (1.44)	3.51 (3.00–4.11)	<0.001
60–69	1,005 (2.64)	6.30 (5.43–7.31)	<0.001
70–79	855 (3.62)	8.65 (7.40–10.12)	<0.001
80–89	244 (3.31)	8.19 (6.71–9.99)	<0.001
Sex			
Women	1,510 (1.71)	Reference	
Men	1,367 (1.94)	1.73 (1.60–1.88)	<0.001

^{a}Model including age, sex, marital status, annual income, housing status and country of birth P-y: person-years; HR: hazard ratio; CI: confidence interval.

and HR: 2.23; 1.97–2.53, P < 0.001, respectively) were associated with higher risks for COPD. Individuals with rented housing (HR: 1.41; CI: 1.30–1.52, P < 0.001) had higher COPD risk compared to living in self-owned property. Compared to married individuals, divorced (HR: 1.61; CI: 1.46–1.78, P < 0.001) and widowed (HR: 1.30; CI: 1.16–1.46, P < 0.001) individuals had increased risk for hospitalization due to COPD. There was no significant difference in incidence of COPD between Swedish or foreign-born individuals.

For MPP, there were a total of 2,294 subjects (1,561 men (68%) and 733 women (32%)) with a discharge diagnosis of COPD as one of the first three listed diagnoses, during a mean follow-up of 29 years. In the model adjusted for age and sex, subjects with low occupation (HR: 1.82; CI: 1.49–2.12, p < 0.001), divorced individuals (HR: 1.71; CI: 1.46–2.02, P < 0.001), and subjects with low income (HR: 1.62; CI: 1.40–1.89, P < 0.001) had increased risk for COPD (Table 3, Figures 1, and 2). These relationships were reduced, but remained significant after additional adjustments for smoking status, BMI and FEV$_1$. There was no significant difference for COPD risk between Swedish or foreign-born individuals. There was no significant interaction between socioeconomic circumstances and other risk factors on incidence of COPD.

In addition, we performed separate analyses of never smokers, former smokers and current smokers, with adjustment for all other covariates in MPP cohort. There were 227 individuals who developed COPD among 9,582 never-smokers during the follow-up. No significant association between socioeconomic circumstances and COPD was found in this group: HR for Low occupation (HR: 1.13; CI: 0.67–1.90,

p = 0.64), low income in Q1 (HR: 1.41; CI: 0.89–2.25, p = 0.146) and divorced (HR: 0.92; CI: 0.65–1.48, P = 0.918).

There were 218 COPD events among 4,760 former smokers during the follow-up. Divorced subjects (HR: 1.70; CI: 1.15–2.50, P = 0.007) had a higher COPD risk in the analysis of former smokers. Among 13,017 current smokers, 1,849 individuals had an incident COPD hospitalization. Low occupation (HR: 1.34; CI: 1.07–1.68, p = 0.012), low income in Q1 (HR: 1.33; CI: 1.12–1.57, p = 0.001) or Q2 (HR: 1.18; CI: 1.01–1.37, P = 0.043) and divorced or widowed marital status (HR: 1.38; CI: 1.22–1.55, P < 0.001 and HR: 1.48; CI: 1.14–1.94, P = 0.004, respectively) were associated with a higher risk for COPD.

Discussion

In this study of an urban population, lower socioeconomic circumstances such as low occupational status, low income and being divorced were significantly associated with an increased risk of COPD hospitalizations. The relationships remained significant after adjustments for lifestyle and biological factors including smoking status. This relationship was mainly observed in smokers and no significant relationship between socioeconomic circumstances and COPD was found in those who never smoked.

According to our results, low occupational status, low income and being divorced were associated with a higher incidence rate and risk of COPD, which were in line with previous studies that have shown associations between low socioeconomic circumstances and risk for COPD (15, 23–25). Country of birth was not associated with risk for COPD in our study, while other studies showed significant relationships between ethnicity and respiratory health outcomes (11, 26). However, there are many differences between immigrant populations, for example, with respect to education, reason for emigration and life style habits in home countries.

More than 90% of the individuals who developed COPD in MPP cohort were former or current smokers. When we stratified the individuals by smoking status, the associations between socioeconomic circumstances and COPD were seen mainly among the smokers. It should be acknowledged, though, that there was no significant interaction between smoking and socioeconomic factors and the statistical power was smaller in the analysis of never smokers. One obvious question is whether the relationship between low socioeconomic circumstances and COPD hospitalizations can be explained by increased rates of smoking in these groups. The relationship between socioeconomic circumstances and COPD could be a result of different smoking habits in smokers from different social classes and residual confounding from smoking therefore cannot be excluded. However, it is also possible that other COPD risk factors such as exposure to environmental or occupational air pollutants contribute to the relationship between social class and COPD in smokers (27, 28). It is possible that smokers with low socioeconomic circumstances on average consume more cigarettes and quit smoking less often than smokers from high

Table 3. Incidence of COPD in the MPP cohort in relation to socioeconomic circumstances and other risk factors ($n = 27,358$).

		Incident COPD			
		Model 1[a]		Model 2[b]	
	N of COPD (per 1,000 p-y)	HR (95% CI)	p value	HR (95% CI)	p value
Occupation					
High	124 (1.48)	Reference		Reference	
Middle	278 (1.89)	1.23 (0.99–1.52)	0.056	1.13 (0.91–1.40)	0.268
Low	1,621 (3.30)	1.82 (1.49–2.12)	<0.001	1.35 (1.11–1.65)	0.003
Own company	153 (2.68)	1.40 (1.09–1.80)	0.007	1.21 (0.94–1.55)	0.134
Retired and others	118 (5.57)	2.36 (1.79–3.11)	<0.001	1.58 (1.20–2.07)	0.001
Annual income					
Q4	418 (1.85)	Reference		Reference	
Q3	571 (2.66)	1.20 (1.05–1.38)	0.006	1.06 (0.92–1.21)	0.360
Q2	681 (3.55)	1.53 (1.33–1.76)	<0.001	1.17 (1.01–1.34)	0.031
Q1	624 (3.74)	1.62 (1.40–1.89)	<0.001	1.29 (1.11–1.50)	0.001
Marital status					
Married	1,552 (2.67)	Reference		Reference	
Single	233 (2.16)	1.01 (0.88–1.16)	0.855	0.96 (0.83–1.10)	0.562
Divorced	442 (4.49)	1.71 (1.46–2.02)	<0.001	1.41 (1.27–1.58)	<0.001
Widowed	67 (5.17)	1.59 (1.20–2.11)	0.001	1.38 (1.07–1.77)	0.013
Country of birth					
Sweden	1,947 (2.84)	Reference		Reference	
Foreign born	347 (3.03)	0.99 (0.88–1.12)	0.964	0.93 (0.82–1.04)	0.183
Age group					
<40	408 (1.59)	Reference		Reference	
40–50	1,293 (3.02)	2.14 (1.91–2.39)	<0.001	1.53 (1.36–1.72)	<0.001
≥50	525 (5.06)	4.47 (3.82–5.24)	<0.001	2.71 (2.31–3.19)	<0.001
Sex					
Women	733 (3.53)	Reference		Reference	
Men	1,561 (2.64)	1.31 (1.15–1.49)	<0.001	1.50 (1.29–1.74)	<0.001
BMI					
18.5–24.9	1,333 (2.8)	–	–	Reference	
<18.5	126 (5.05)	–	–	1.45 (1.16–1.81)	<0.001
25–29.9	668 (2.63)	–	–	0.91 (0.83–1.01)	0.060
>30	167 (3.54)	–	–	1.06 (0.90–1.24)	0.238
FEV1	–	–	–	0.36 (0.34–0.38)	<0.001
Smoking status					
Never smoker	227 (0.76)	–	–	Reference	
Former smoker	218 (1.53)	–	–	1.61 (1.34–1.94)	<0.001
Current smoker	1,849 (5.12)	–	–	5.65 (4.91–6.50)	<0.001

[a]Model 1 including age, sex, occupation, marital status, annual income and country of birth.
[b]Model 2 including age, sex, occupation, marital status, annual income, country of birth, plus BMI, forced expiratory volume in 1 second and smoking status.
P-y: person-years; HR: hazard ratio; CI: confidence interval; FEV1: Forced Expiratory volume in 1 second.

socioeconomic groups (29, 30). Moreover, exposure to occupational dust, fumes, and toxic substances in the workplace are also more common in low socioeconomic groups (31). Therefore, the increased risk for COPD among the smokers with low socioeconomic circumstances might reflect an increased susceptibility for exposure to smoking in these individuals. Other factors such as indoor and outdoor air pollutants, crowding, poor nutrition, slower intrauterine growth of lung function or increased occurrence of childhood respiratory infections are other potential explanations of the socioeconomic differences in COPD (3, 6).

Strengths and limitations

Emigration, vital status and hospitalizations at the end of the follow-up were up-dated by data linkage with national registers on all individuals. In addition, the large number of individuals and events, and the complete and reliable data about the background population add strength to the study. The main limitation for a study with a complete urban population is that it is difficult to collect data on biological and lifestyle factors. Another limitation is a possible under-diagnosis of less severe COPD cases, as subjects with mild COPD are often not diagnosed until quite late during the progression of the disease (32). The outcome of COPD has been recorded by different versions of ICD through the years which might give rise to error. However, since the procedures have been the same for all socioeconomic groups in this study, any systematic bias should be less likely. Smoking rates in Sweden have been declining in Sweden (33–35). Many smokers in this study might have reduced or quit smoking during the follow-up period. It likely many smokers quit smoking during the follow-up period, which if anything would reduce the risk in smokers, and would have biased our results toward the null. We also lack information on pack-years, which could be used to quantify the effects of smoking to establish cut-offs. Other factors that may have changed during the long follow-up periods, such as medication use for milder cases of COPD, could have also reduced the likelihood of severe COPD outcomes which again would have biased the results towards the null. Likewise, we did not take into account any changes that might have occurred such as divorces or new occupations during follow-up. However, the occupation and income levels were assessed when the subjects
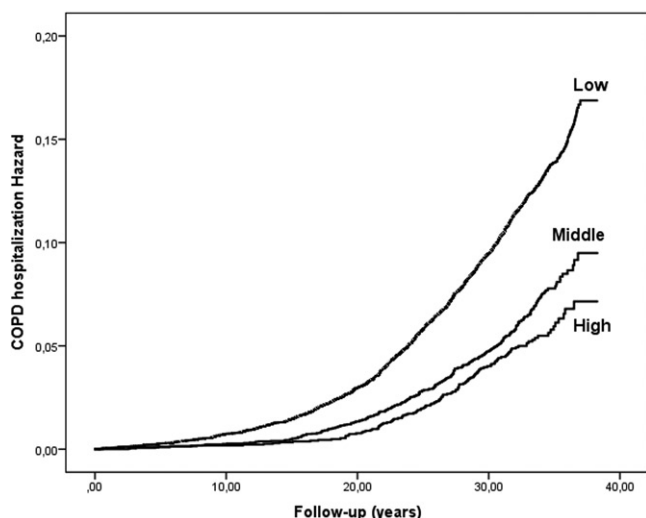
Figure 1. Incidence of hospitalization for COPD in relation to occupation in the MPP cohort.
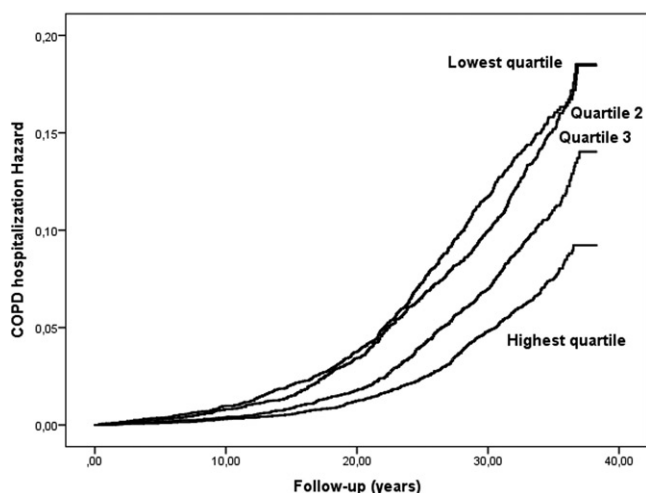

Figure 2. Incidence of hospitalization for COPD in relation to income in the MPP cohort.

were adults above 40 years of age, and substantial changes of an individual's socioeconomic circumstances are less likely above this age. If there were any improvements in socio-economic circumstances from baseline this would again have biased the associations seen toward the null.

Conclusions

Our study showed that low socioeconomic circumstances were significantly associated with an increased risk of COPD. This relationship was mainly observed in smokers and no significant relationship between socioeconomic level and COPD was found in those who never smoked.

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Conflict of interest

None declared.

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