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Socioeconomic status, asthma and chronic bronchitis in a large community-based study

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ABSTRACT: **The present study investigated the relationship between socioeconomic status, using measures of occupational class and education level, and the prevalence and incidence of asthma (with and without atopy) and chronic bronchitis using data from the European Community Respiratory Health Survey (ECRHS).**

Asthma and chronic bronchitis were studied prospectively within the ECRHS (n=9,023). Incidence analyses comprised subjects with no history of asthma or bronchitis at baseline. Asthma symptoms were also assessed as a continuous score.

Bronchitis risk was associated with low educational level (prevalence odds ratio (POR) 1.9; 95% confidence interval (CI) 1.4–2.8) and occupational class (1.8; 1.2–2.7). Incident bronchitis also increased with low educational level (risk ratio (RR) 2.8; 95%CI 1.5–5.4). Prevalent and incident asthma with no atopy were associated with low educational level. Subjects in the low occupational class (incident risk ratio (IRR) 1.4; 95%CI 1.2–1.7) and education group (IRR 1.3; 95% CI 1.1–1.6) had higher mean asthma scores than those in higher socioeconomic groups.

Lower educational level was associated with increased risk of prevalent and incident chronic bronchitis and asthma with no atopy. Lower socioeconomic groups tended to have a higher prevalence and incidence of asthma, particularly higher mean asthma scores. Adjustment for variables associated with asthma and bronchitis explained little of the observed health differences by socioeconomic status.

KEYWORDS: **Asthma, atopy, bronchitis, socioeconomic status**

The relationships between socioeconomic status (SES) and asthma prevalence and incidence are not well understood. Previous studies in adults have reported no association [1, 2], while others have reported an increased asthma prevalence with lower SES [3, 4]. Some of the inconsistencies may be due to a lack of standardisation between studies, particularly with regard to definitions and measurement of asthma and SES. Not only are there difficulties in defining asthma [5], but in addition the relationship between asthma prevalence and incidence is not easy to disentangle [6, 7]. Furthermore, as with other chronic conditions such as diabetes and coronary heart disease, asthma may have shifted from being more prevalent among the affluent to becoming a condition more strongly associated with poverty in recent years [8, 9]. Additionally, differing patterns of SES have been observed in the prevalence of atopic and nonatopic asthma [10, 11].

In general, little is known about the pathways and mechanisms by which SES affects respiratory disease in adults. A number of risk factors that may be involved in the interrelationship between SES and asthma and chronic bronchitis have been identified: 1) smoking [12]; 2) exposure to environmental tobacco smoke (ETS) [13]; 3) mould or mildew in the home [14]; 4) allergen sensitisation [15]; and 5) obesity [16]. Some of these factors, *e.g.* tobacco smoke [12], show a stronger association with chronic bronchitis than with asthma.

The European Community Respiratory Health Survey (ECRHS) previously examined the relationship between SES and asthma prevalence [3].

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An increased asthma prevalence amongst lower socioeconomic groups was observed at the individual level, with education also being a determinant of asthma risk at the centre level. The ECRHS II study was undertaken 10 yrs later to assess changes over time in the prevalence and incidence of asthma and associated respiratory symptoms. The objective of the current analysis was to investigate the relationship between SES, based on measures of occupational class and educational level, with the prevalence and incidence of asthma (with and without atopy) and chronic bronchitis.

METHODS

Study population

The ECRHS sampling framework includes a random and asymptomatic sample. Details have been described elsewhere [17, 18]. ECRHS I subjects were 20–44 yrs of age and randomly selected from the general population in centres from throughout Europe, the USA, Australia and New Zealand during 1991–1993. All participants completing ECRHS I were invited to take part in a follow-up study, ECRHS II, during 1999–2001. The study population for the current analyses comprises those subjects who participated in both surveys and had occupational information collected in ECRHS II (28 centres from 13 countries).

SES was based on the subject's occupation and education level. Occupational class was derived from the longest-held job during the follow-up period between ECRHS I and II. Categories were based on the major group classification, using the first digit of the International Standard Classification of Occupations (ISCO) [19]. If a subject held multiple jobs for the same time duration during the follow-up period, then the lower ISCO category (*i.e.* higher skill level) was used. The categories were: I for managers and professionals (nonmanual) of major groups 1 and 2; II for technicians and associate professionals of major group 3; III for other nonmanual workers of major groups 4 and 5; IV for skilled manual workers of major groups 6 and 7; V for semi-skilled or unskilled manual workers of major groups 8 and 9; and VI for unclassifiable or unknown. Occupational class group VI comprised any individual not occupationally active during follow-up or who could not be assigned an ISCO code. Each occupational class is presented in table 1 describing the study population but, thereafter, classes IV and V were combined for the analyses.

Educational level was based on age of the subject at completion of full-time study. To enable comparability of education level between countries, country-specific tertiles were constructed to provide a relative educational level measure, therefore, the cut-points for each country are different. Tertiles of education level were categorised as high (reference category), medium and low.

The prevalence analyses included 9,023 subjects (response rate 59%; fig. 1). Current asthma was defined as at least one of the following factors in the previous 12 months: 1) having an asthma attack; 2) woken by an attack of shortness of breath; or 3) currently using asthma medication [17]. Atopic status was determined by blood sample measurement of immunoglobulin (Ig)E and defined as specific sensitisation to at least one of the following common allergens: *Dermatophagoides pteronyssinus, Cladosporium herbarum,* cat or Timothy-grass (specific IgE >0.35 KU·L^{-1}) [3]. A total of 169 subjects who did not have complete information on asthma status and 1,889 subjects with missing information on atopic status were excluded, leaving 6,965 subjects in the asthma prevalence analyses.

Prevalent bronchitis was defined as the presence of both cough and phlegm on most days for $\geqslant 3$ months during the previous year [20]. Discordant responses (n=871), *i.e.* subjects reporting at ECRHS II either only chronic cough or only chronic phlegm but not both, were excluded. No subjects reported both chronic cough and chronic phlegm in Tartu (Estonia), so this centre was excluded from the analysis (n=259), leaving 7,915 subjects.

The cumulative incidence of asthma was defined as the proportion of subjects without asthma symptoms at ECRHS I who subsequently reported asthma symptoms at ECRHS II. In total, 1,743 subjects were excluded after reporting any of the following symptoms: current asthma and/or shortness of breath or wheeze (with no cold) at the time of ECRHS I. A further 1,604 subjects were excluded due to missing data on atopic status, leaving 5,645 subjects in the incident asthma analyses. Both the asthma prevalence and incidence analyses were stratified according to atopic status.

The cumulative incidence ratio for chronic bronchitis was calculated based on the proportion of subjects having neither cough nor phlegm at ECRHS I who then reported having both symptoms at ECRHS II. A total of 1,796 subjects were excluded who responded ''yes'' to having cough or phlegm at ECRHS I. Subjects with discordant responses to the questions on cough and phlegm (n=470) were excluded, in addition to respondents from Tartu (n=178) and Bordeaux, France (n=124), where there were no incident cases of bronchitis reported for the follow-up period, leaving 6,455 participants.

In the incidence analyses, responses to six questions on asthma symptoms were combined into an asthma score ranging 0–6 [7]. The items were: 1) breathless while wheezing in the previous 12 months; 2) waking with a feeling of chest tightness in the previous 12 months; 3) attack of shortness of breath at rest in the previous 12 months; 4) attack of shortness of breath after exercise in the previous 12 months; 5) waking by attack of shortness of breath in the previous 12 months; and 6) the presence of asthma ever. These analyses were conducted in those subjects (n=5,924) reporting none of the six asthma symptoms at baseline.

Study variables

All subjects provided information on asthma, bronchitis, respiratory symptoms, allergic conditions, lifestyle and environment *via* an interviewer-administered questionnaire previously validated in ECRHS I [17]. Outcome measures were: 1) prevalence of asthma (with and without atopy) and chronic bronchitis at ECRHS II; 2) cumulative incidence of asthma (with and without atopy) between ECRHS I and II; 3) cumulative incidence of chronic bronchitis between ECRHS I and II; and 4) asthma score at ECRHS II.

Objective measurements of the subject's height and weight were obtained in both the ECRHS I and II questionnaires [21]. Body mass index (BMI, kg·m^{-2}) was calculated as weight (in kg) divided by the square of height (in m) [21].

TABLE 1 Characteristics of participants in the European Community Respiratory Health Survey II (1999–2001)[#]

Individual variables	Subjects	Range by centre %
Sex		
Male	3412 (49.0)	41.3–54.4
Female	3553 (51.0)	45.6–58.7
Age yrs	43.0±7.1	39.2–46.7
BMI kg·m^{-2}		
<20	390 (5.7)	1.1–12.3
≥20–<25	3096 (45.6)	31.3–60.9
≥25–<30	2429 (35.8)	25.8–45.3
≥30	879 (12.9)	3.1–29.8
Family history of asthma	808 (11.6)	5.7–19.2
Smoking status		
Never-smoker	2927 (42.0)	30.2–60.7
Former smoker	1945 (27.9)	6.5–40.7
Current smoker	2027 (29.1)	11.9–48.2
Exposure to ETS	2637 (38.0)	18.9–78.2
Siblings		
0	690 (9.9)	0.9–21.3
1	2121 (30.5)	12.3–48.7
≥2	4134 (59.5)	31.4–79.8
Respiratory infections before 5 yrs of age	689 (9.9)	2.2–16.3
Rhinitis	2051 (29.5)	11.1–43.0
High occupational exposure to biological or mineral dust, gas or fumes	991 (14.6)	5.0–27.6
Mould or mildew in home in previous 12 months	1166 (16.7)	2.2–40.7
Outcome variables		
Asthma	725 (10.4)	4.9–15.9
With atopy	372 (5.3)	1.3–11.8
Without atopy	353 (5.1)	2.2–9.7
Atopy without asthma	1646 (23.6)	13.4–33.9
No asthma nor atopy	4594 (66.0)	52.6–81.7
Chronic bronchitis[¶]	247 (3.0)	0.0–8.5
Asthma score	0.66±1.2	0.36–0.96
Socioeconomic status measures		
Occupational class[+]		
I	2096 (30.1)	15.1–49.7
II	1246 (17.9)	7.5–28.2
III	1791 (25.7)	15.5–40.2
IV	695 (10.0)	2.2–18.5
V	655 (9.4)	2.8–19.0
VI	482 (6.9)	1.3–17.5
Educational level (country-specific tertiles)		
High	1883 (28.4)	17.8–37.3
Medium	2101 (31.7)	10.9–48.0
Low	2650 (39.9)	29.5–63.8

Data are presented as n (%) or mean±SD, unless otherwise stated. BMI: body mass index; ETS: environmental tobacco smoke. #: only subjects with serum immunoglobulin E measurements were included (n=6,965); ¶: chronic bronchitis category (n=7,915); +: I for managers and professionals, II for technicians and associate professionals, III for other nonmanual workers, IV for skilled manual workers, V for semi-skilled/unskilled manual workers and VI for unclassifiable/unknown.

Information on smoking status was obtained at each ECRHS survey. Participants were divided into three categories: nonsmokers, ex-smokers and current smokers. To assess levels of ETS, participants were asked about regular exposure to cigarette smoke in the previous 12 months. Rhinitis was classified using the question: ''Do you have any nasal allergies, including hay fever?'' Occupational exposures were defined as exposure to biological dusts, mineral dusts, gases or fumes during the follow-up period [22] and classified as none, low or high exposure.

Statistical methods

Prevalence odds ratios (POR) were calculated for the prevalence estimates [23] and risk ratios (RR) for the cumulative

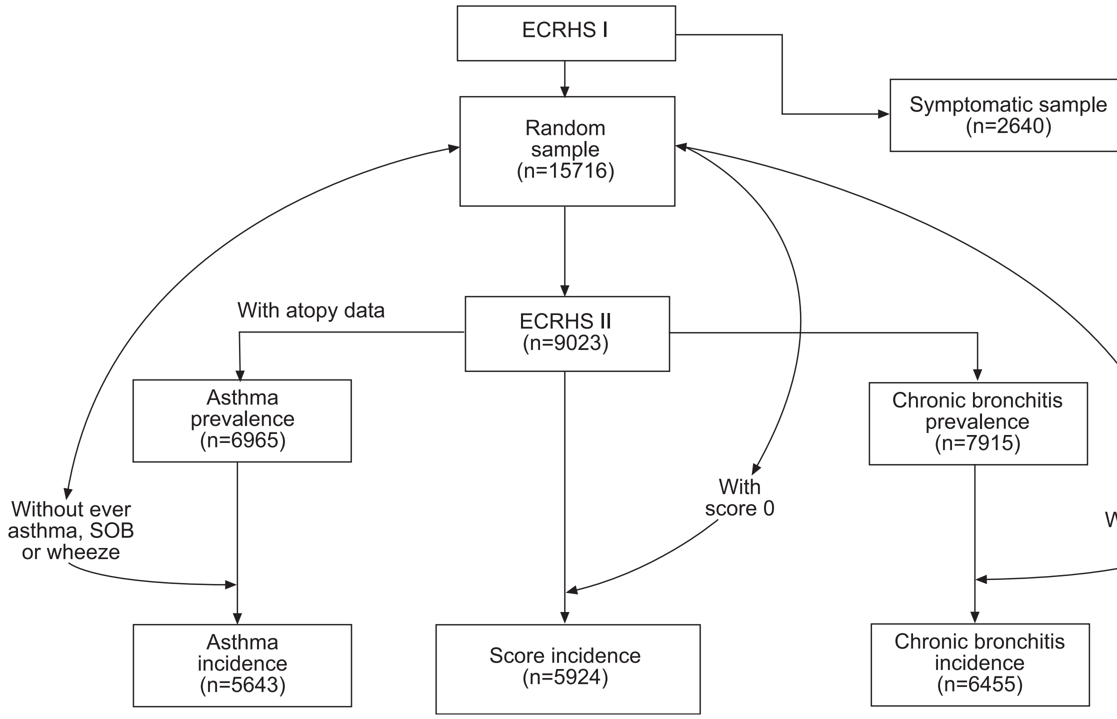

FIGURE 1. Selection of the study population for the European Community Respiratory Health Survey (ECRHS) II socioeconomic status, asthma and chronic bronchitis study. SOB: shortness of breath.

incidence estimates. They were adjusted for age, sex and centre in the initial analyses; and for age, sex, country, BMI, family history of asthma, number of siblings, ETS, smoking status, rhinitis, respiratory infections before 5 yrs of age, mould or mildew in the home during the previous 12 months and high exposure to occupational pollutants in the fully adjusted models, as with previous ECRHS analyses [13, 24]. PORs were calculated using logistic regression and RRs using log–binomial regression. Tests for heterogeneity were assessed using meta-analysis while interaction terms were tested using likelihood ratio tests. Asthma score was analysed using a negative binomial regression model which models the ratio of score averages (*i.e.* incident risk ratio (IRR)) after adjusting for score at baseline.

Interaction terms were included to determine whether the associations of occupational class and educational level with health outcomes were the same in males and females. The interaction terms for educational level and occupational class were not significant (p=0.21 and p=0.18, respectively) for either asthma or bronchitis (p=0.52 for educational level and p=0.65 for occupational class). Thus, the results are presented with the data for males and females combined.

RESULTS

Prevalence

Table 1 presents the characteristics of the study population. The overall prevalence of asthma was 10.4% (5.3% with atopy and 5.1% without atopy). The mean asthma score for the study population was 0.66. The prevalence of chronic bronchitis was 3.0%.

Almost one third of subjects belonged to occupational class I (managers and professionals) ranging from 15% in Verona (Italy) to 49% in Paris (France). Approximately 6.9% of subjects were unclassified. Of these, 44% were housepersons and 30% were currently employed but without an occupational ISCO code. The remainder were distributed amongst the unemployed, in poor health, retired or student categories.

Heterogeneity was assessed in the association between education level and asthma prevalence by measuring the prevalence of asthma against the percentage of low or medium educational level by country (adjusted for age, sex and centre). No heterogeneity was found for either the medium (p=0.76 for heterogeneity) or low (p=0.93 for heterogeneity) education categories.

Table 2 presents the PORs for asthma (with and without atopy) and bronchitis in the minimally adjusted and fully adjusted models. There was a statistically significant increased risk of bronchitis in the low occupational group and with medium and low educational level, which were both also associated with an increased risk of asthma with no atopy. There was little change seen in the risk estimates in the fully adjusted model; however, the results were no longer statistically significant for bronchitis risk in the low occupational group.

Treatment and healthcare utilisation among asthmatics (data not shown) were examined and no differences were found according to occupational class. With regard to educational level, some small nonsignificant differences were observed, *e.g.* asthmatics in the low education group were less likely to have been prescribed medicines for their breathing (OR 0.77; 95% confidence interval (CI) 0.51–1.2) or to have seen a doctor (OR 0.72; 95% CI 0.50–1.03) compared with those in the high education group.

TABLE 2 Prevalence odds ratios (POR) of asthma (with or without atopy) and chronic bronchitis in European Community Respiratory Health Survey II participants by occupational class and education level

	POR (95%CI)			
	Asthma	Asthma with atopy	Asthma without atopy	Chronic bronchitis
Subjects n	6965#	2018	4947	7915¶
Minimally adjusted+				
Occupational class§				
Iƒ	1	1	1	1
II	1.16 (0.91–1.47)	1.15 (0.82–1.60)	1.10 (0.77–1.57)	1.43 (0.94–2.17)
III	1.26 (1.01–1.56)	1.15 (0.83–1.60)	1.44 (1.06–1.95)	1.71 (1.17–2.51)
IV–V	1.07 (0.83–1.36)	0.91 (0.63–1.30)	1.26 (0.89–1.79)	1.84 (1.23–2.74)
VI	1.37 (1.00–1.88)	1.07 (0.67–1.72)	1.55 (1.00–2.41)	1.62 (0.97–2.69)
Educational level				
Highƒ	1	1	1	1
Medium	1.02 (0.82–1.26)	0.74 (0.54–1.00)	1.39 (1.01–1.93)	1.54 (1.05–2.25)
Low	1.19 (0.93–1.43)	0.93 (0.70–1.25)	1.70 (1.26–2.29)	1.93 (1.35–2.76)
Fully adjusted##				
Occupational class§				
Iƒ	1	1	1	1
II	1.13 (0.88–1.42)	1.08 (0.75–1.54)	1.13 (0.78–1.65)	1.43 (0.91–2.23
III	1.25 (0.99–1.57)	1.22 (0.87–1.72)	1.34 (0.97–1.85)	1.53 (1.01–2.34)
IV–V	1.08 (0.78–1.48)	0.91 (0.57–1.46)	1.20 (0.77–1.88)	1.66 (0.96–2.87)
VI	1.25 (0.84–1.86)	1.16 (0.63–2.14)	1.28 (0.75–2.19)	1.24 (0.56–2.75)
Educational level				
Highƒ	1	1	1	1
Medium	1.02 (0.81–1.28)	0.75 (0.53–1.05)	1.40 (1.00–1.97)	1.59 (1.04–2.42)
Low	1.20 (0.95–1.52)	1.10 (0.79–1.52)	1.55 (1.18–2.14)	1.66 (1.10–2.50)

CI: confidence interval. #: Only subjects with serum immunoglobulin E measurements were included (except bronchitis category); ¶: excludes Tartu (Estonia) centre; +: for age, sex and centre; §: I for managers and professionals, II for technicians and associate professionals, III for other nonmanual workers, IV for skilled manual workers, V for semi-skilled/unskilled manual workers and VI for unclassifiable/unknown; ƒ: reference category; ##: for age, sex, country, body mass index, family history of asthma, number of siblings, exposure to environmental tobacco smoke, smoking status, respiratory infections before 5 yrs of age, mould or mildew in the home in the previous 12 months, rhinitis and high occupational exposure to pollutants.

Cumulative incidence

There were 298 new cases of asthma identified between ECRHS I and II, corresponding to a cumulative incidence of 5.3% over the 10-yr follow-up period. For the analyses of incident chronic bronchitis, 87 new cases were reported, corresponding to a cumulative incidence of 1.3% for the follow-up period.

As with the prevalence analyses, the present authors modelled effect estimates for heterogeneity to assess the association between asthma incidence and education group at the country level. For the medium educational and low educational levels there was no heterogeneity ($p=0.97$ and $p=0.72$, respectively) with asthma incidence. The present authors also assessed heterogeneity in the association between bronchitis and education group at the regional level (due to small numbers in some countries) composed of Scandinavia, Central Europe, Southern Europe and English-speaking countries. p-Values for heterogeneity were 0.18 and 0.52 for the medium and low education groups, respectively.

Generally, no large differences were observed for cumulative incidence of respiratory symptoms by occupational class (table 3). Differences in cumulative incidence by educational level were more pronounced than for occupational class, with breathless while wheezing ($p=0.004$), waking with chest tightness ($p=0.032$) and attacks of shortness of breath after exercise ($p<0.001$) being more common in those individuals with a low educational level. The mean asthma score was highest in the low education group ($p<0.001$). The low education group had an increased incidence of bronchitis compared with the high education group ($p=0.008$). Sensitisation to all of the allergens examined was highest in occupational class I, with the reverse pattern observed for educational level, where sensitisation was increased amongst those in the lower education groups.

Table 4 shows the cumulative incidence ratios for asthma (with and without atopy), chronic bronchitis and the average asthma score ratio. In the analyses adjusted only for sex, centre and age, there were no consistent patterns observed for asthma incidence by occupational class. Asthma without atopy was significantly associated with low educational level (RR 1.53; 95% CI 1.04–2.25). There was a statistically significant increased risk of incident bronchitis with both medium (RR 2.15; 95% CI 1.10–4.23) and low (RR 2.831; 95% CI 1.48–5.41) educational level. The low occupational class group had a 43%

TABLE 3 Cumulative incidence of respiratory symptoms and sensitisation and asthma score by occupational class and education level between European Community Respiratory Health Survey I (1991–1992) and II (1999–2001)[#]

Variable	Occupational class[¶]						Education			
	I	II	III	IV–V	VI	p-value[+]	High	Medium	Low	p-value[+]
Asthma symptom										
Breathless while wheezing in previous 12 months	1.4	1.1	1.4	1.6	0.5	<0.001	1.5	1.6	2.9	0.004
Waking with chest tightness in previous 12 months	2.5	1.6	2.3	1.8	0.8	0.306	2.3	2.5	3.9	0.032
Attack of shortness of breath at rest in previous 12 months	0.9	0.6	1.1	0.6	0.4	0.141	1.0	1.0	1.6	0.248
Attack of shortness of breath after exercise in previous 12 months	3.9	2.5	4.5	3.2	1.2	0.001	3.6	4.2	7.3	<0.001
Waking due to attack of shortness of breath in previous 12 months	0.9	0.7	1.0	0.6	0.4	0.071	0.9	1.3	1.6	0.345
Asthma ever	1.0	0.8	1.0	0.7	0.3	0.553	1.1	1.2	1.7	0.428
Asthma score mean	0.24	0.36	0.36	0.35	0.38	<0.001[§]	0.28	0.29	0.38	<0.001[§]
Asthma	1.3	1.0	1.5	0.9	0.5	0.062	1.2	1.7	2.4	0.087
Other symptoms										
Bronchitis	0.2	0.3	0.4	0.3	0.2	0.148	0.2	0.5	0.7	0.008
Sensitisation										
Dermatophagoides pteronyssinus	4.4	2.5	2.8	2.8	1.1	0.009	3.9	4.6	4.6	0.028
Cat	2.1	1.5	1.5	1.2	0.4	0.186	2.0	2.2	2.3	0.308
Grass	4.4	2.9	3.4	2.7	0.9	0.265	4.5	4.5	5.0	0.034
Cladosporium herbarium	0.3	0.1	0.1	0.2	0.04	0.509	0.2	0.2	0.3	0.592

Data are presented as % of new cases, unless otherwise stated. #: Only subjects with serum immunoglobulin E measurements were included (except bronchitis category); ¶: I for managers and professionals, II for technicians and associate professionals, III for other nonmanual workes, IV for skilled manual workers, V for semi-skilled/unskilled manual workers and VI for unclassifiable/unknown; +: from Chi-squared test for association with categorical variables; §: p-value from likelihood ratio test for asthma score.

higher mean asthma score ($p<0.001$) than the high occupational class group, and the low education group a 33% higher mean asthma score ($p<0.001$) than the high education group. Asthma score stratified by atopic status showed a similar pattern to that seen for asthma symptoms. When the asthma score for bronchitis was adjusted, it was found that bronchitis was highly correlated with the score ($p<0.001$) but this did not markedly change the asthma score risk estimates, which remained statistically significant. In the fully adjusted model, there was little change to the risk estimates for asthma score for both occupational class and educational level. Asthma (RR 1.40; 95% CI 1.03–1.89) and specifically, asthma with no atopy (RR 1.50; 95% CI 1.00–2.25) was significantly associated with low educational level. Bronchitis risk remained significant in both the medium and low education groups.

DISCUSSION

The present authors examined the prevalence of respiratory symptoms in ECRHS II and the cumulative incidence of respiratory symptoms in relation to occupational class and educational level in the 10-yr follow-up period between ECRHS I and II. Prevalent bronchitis was increased in low occupational classes, while low educational level was associated with an increased risk of both prevalent and incident bronchitis. Lower socioeconomic groups tended to have a higher prevalence (particularly for asthma with no atopy) and incidence of asthma, with higher mean asthma scores. Known risk factors for asthma and chronic bronchitis explained only a small part of the observed differences by SES.

Some [3, 4], but not all [1, 25], studies have reported an increased risk of asthma with lower SES. ECRHS I found an increased prevalence of asthma in low SES groups [3], with the odds ratios being higher than those found in the current analyses. This difference is probably a combination of different sampling, since ECRHS II includes only a subset of ECRHS I, and improved living and working conditions and availability of treatments. It is unlikely that education directly affects the risk of developing respiratory symptoms, but it may capture long-term influences of early-life circumstances on adult health and is a predictor of future employment and income [26].

There are difficulties in the comparability of educational achievement across countries where changes in the education systems within populations and differences in the meanings of various educational categories between populations may vary [27]. Previous ECRHS analyses of SES [3] used tertiles of educational level, based on the age of the subject at completion of full-time study, with the same cut-off points applied across the whole ECRHS study population. In the current analyses, tertiles specific for each country have been calculated to provide a relative measure of educational level and minimise problems associated with educational levels having different

TABLE 4 Cumulative incidence risk ratios (RR) of asthma (with or without atopy) bronchitis and asthma score for European Community Respiratory Health Survey II participants by occupational class and education level

	RR (95% CI)				IRR (95% CI)
	Asthma	Asthma with atopy	Asthma without atopy	Bronchitis	Asthma score
Subjects n	5645[#]	1406	4239	6455[¶]	5924[+]
Minimally adjusted[§]					
Occupational class[ƒ]					
I[##]	1	1	1	1	1
II	1.23 (0.90–1.67)	1.47 (0.88–2.47)	1.16 (0.74–1.81)	1.72 (0.87–3.41)	1.36 (1.12–1.64)
III	1.18 (0.89–1.57)	1.13 (0.67–1.91)	1.20 (0.81–1.78)	1.97 (1.04–3.74)	1.40 (1.18–1.67)
IV–V	1.11 (0.81–1.52)	0.81 (0.44–1.50)	1.23 (0.83–1.83)	1.95 (0.98–3.88)	1.43 (1.19–1.73)
VI	1.05 (0.72–1.56)	1.48 (0.75–2.92)	1.31 (0.76–2.27)	2.20 (0.97–4.96)	1.32 (1.04–1.67)
Educational level					
High[##]	1	1	1		1
Medium	1.21 (0.89–1.65)	0.91 (0.57–1.47)	1.44 (0.95–2.17)	2.15 (1.10–4.23)	1.08 (0.92–1.28)
Low	1.32 (0.99–1.77)	1.13 (0.72–1.78)	1.53 (1.04–2.25)	2.83 (1.48–5.41)	1.33 (1.14–1.56)
Fully adjusted[¶¶]					
Occupational class[ƒ]					
I[##]	1	1	1	1	1
II	1.25 (0.90–1.73)	1.52 (0.91–2.56)	1.16 (0.74–1.82)	1.50 (0.75–3.03)	1.33 (1.09–1.62)
III	1.08 (0.80–1.47)	1.23 (0.73–2.08)	1.20 (0.81–1.78)	1.52 (0.77–3.01)	1.38 (1.15–1.66)
IV–V	1.05 (0.69–1.60)	0.76 (0.35–1.63)	1.37 (0.79–2.39)	1.37 (0.55–3.42)	1.40 (1.09–1.80)
VI	1.01 (0.61–1.70)	1.36 (0.57–3.25)	1.26 (0.66–2.42)	2.23 (0.78–6.34)	1.36 (0.98–1.89)
Educational level					
High[##]	1	1	1	1	1
Medium	1.18 (0.86–1.63)	0.93 (0.56–1.53)	1.37 (0.90–2.09)	2.13 (1.02–4.45)	1.11 (0.93–1.33)
Low	1.40 (1.03–1.89)	1.36 (0.85–2.17)	1.50 (1.00–2.25)	2.49 (1.21–5.13)	1.31 (1.10–1.56)

CI : confidence interval; IRR: incidence RR. [#]: Only subjects with serum immunoglobulin E measurements were included (except bronchitis category). [¶]: excludes Tartu (Estonia) and Bordeaux (France) centres; [+]: includes only people with asthma score 0 at baseline; [§]: for age, sex and centre; [ƒ]: I for managers and professionals, II for technicians and associate professionals, III for other nonmanual workers, IV for skilled manual workers, V for semi-skilled/unskilled manual workers and VI for unclassifiable/unknown; [##]: reference category; [¶¶]: for age, sex, country, body mass index, family history of asthma, number of siblings, exposure to environmental tobacco smoke, smoking status, respiratory infections before 5 yrs of age, mould or mildew in the home in the previous 12 months, rhinitis and high occupational exposure to pollutants.

meanings in different countries, which is only partially solved by adjusting for country. Using tertiles calculated over the whole ECRHS population yielded little difference in the risk estimates; however, the results were less consistent in terms of the direction of the gradient seen between high, medium and lower educational level and increased risk for all respiratory outcome measures compared with the results using country-specific tertiles.

Using IRR in the analyses, no association was found with occupational class and asthma risk, but an effect was seen when asthma symptoms were analysed as a continuous score. With a condition such as asthma, where there is a high prevalence and low incidence, bias due to disease misclassification may be substantial [7]. The higher mean asthma scores with lower occupational class suggest that misclassification of asthma status at baseline may explain the absence of an association between asthma incidence and occupational class when the IRR measure was used.

The present findings are consistent with MONTNÉMERY *et al.* [1] who examined social position as a risk factor for asthma and chronic bronchitis in a random sample of 12,071 adults. MONTNÉMERY *et al.* [1] found an increased risk of bronchitis, but not asthma, in those individuals with a low social position compared with a middle/high social position. Chronic bronchitis has been found to be more consistently associated with lower social class [28] and unemployed people have a higher risk of bronchitis-type symptoms than their employed counterparts [20]. Some of the observed associations with occupationally defined social class may be due to respiratory symptoms caused by occupational exposures [29], although several studies have reported that confounding by occupational exposure does not fully explain this association [30]. A socioeconomic gradient has been reported with smoking, an important risk factor for bronchitis [30]. No statistically significant interaction between either occupational class or educational level and smoking status was found, suggesting that the findings for SES and bronchitis were not dependent on smoking status.

The response rate for the current study was 59%, ranging 25–80%, across the participating centres and thus the potential for selection bias must be acknowledged. There were no differences between responding and nonresponding subjects by sex, but subjects from a high occupational class were more likely to respond (63%) than those from a low occupational class (57%). Responding subjects with asthma were slightly more likely to participate than those without asthma (62 *versus* 60%, respectively). The reverse pattern was seen for chronic bronchitis, with a higher proportion of those responding reporting no bronchitis at baseline (60%) compared with those with bronchitis (56%). In total, 22% of subjects were excluded due to missing data on atopy. The present authors assessed the effect of this by comparing the results among the study population, including those with missing atopy data, and among the population with atopy data. The results did not change, however, as no significant difference was found with occupational class ($p=0.88$) or educational level ($p=0.81$) for those with and without atopy data.

There may have been some misclassification of asthma or bronchitis, as defined by the questionnaire which has been previously validated against bronchial hyperresponsiveness [31]. The overall effect of this type of misclassification would be to underestimate the true association of asthma or bronchitis with SES. Several potential explanatory factors were integrated in the fully adjusted models, including obesity, respiratory infections in childhood, exposure to allergens, smoking and exposure to ETS, which have been identified as being more common among lower SES groups [8, 28]. It is possible that some of these factors may be intermediate variables on the causal pathway between lower SES and asthma or bronchitis, and may be highly correlated with each other. In that case, it would be expected that risk associations would reduce with widening CI. However, there were no dramatic changes seen in either the risk estimates or CI between the minimally and fully adjusted models; *e.g.* the minimally adjusted RR estimate for asthma in the low education group was 1.32 (95% CI 0.99–1.77), which changed to 1.31 (95% CI 0.97–1.77) when BMI was added to the model. Inclusion of any one of the explanatory variables used in the fully adjusted model did not change the minimally adjusted risk estimate by $>10\%$.

In conclusion, the present study identified lower educational level to be associated with an increased risk of prevalent and incident chronic bronchitis and also with an increased risk of prevalent and incident asthma with no atopy. Lower socioeconomic groups had higher mean asthma scores, suggesting that misclassification of asthma status at baseline and follow-up may explain some of the absence of an association between asthma incidence and occupational class in these analyses. Adjusting for potential explanatory variables related to socioeconomic status did not modify much of the association, suggesting that other factors in adult life or in childhood may mediate the occurrence of socioeconomic differences in respiratory disease.

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