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

(Short title: SES, asthma and chronic bronchitis, ECRHS II)

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ABSTRACT

We 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.

We studied prospectively asthma and chronic bronchitis 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 (POR=1.9; 95%CI 1.4-2.8) and occupational class (POR=1.8; 95%CI 1.2-2.7). Incident bronchitis also increased with low educational level (RR=2.8; 95%CI 1.5-5.4). Prevalent and incident asthma with no atopy was associated with low educational level. Subjects in the low occupational class (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

Introduction

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 regards to definitions and measurement of asthma and SES. Not only are there difficulties in defining asthma [5], but also, 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 the last twenty years [8, 9]. Additionally, differing patterns have been observed by SES in the prevalence of atopic and non-atopic 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 including: smoking [12]; exposure to environmental tobacco smoke (ETS) [13]; mould or mildew in the home [14]; allergen sensitisation [15] and; 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]. 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. Ten years later the ECRHS II study was undertaken 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 socioeconomic status based on measures of occupational class and educational level and the prevalence and incidence of asthma (with and without atopy) and chronic bronchitis.

Methods

Study population

The ECRHS sampling framework includes a random and a symptomatic sample and details have been described elsewhere [17,18]. ECRHS I subjects were aged 20-44 years and randomly selected from the general population in centres from throughout Europe, the United States, 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 at the 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 ECRHS 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 (higher skill level) was used. The categories were: I)

managers and professionals (non-manual) for major groups 1 and 2; II) technicians and associate professionals for major group 3; III) other non-manual for major groups 4 and 5; IV) skilled manual for major groups 6 and 7; V) semi-skilled or unskilled manual for major groups 8 and 9 and; VI) unclassifiable or unknown. Occupational class group VI comprised any person 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 years of completed full-time study. To enable comparability of education level between countries, we constructed country-specific tertiles to provide a relative educational level measure, thus, 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) [3]. 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 at least 3 months during the previous year [20]. We excluded discordant responses (n=871), i.e. subjects reporting either only chronic cough or only chronic phlegm but not both at ECRHS II. 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. 1,743 subjects were excluded who reported any of the following symptoms: current asthma; shortness of breath or; wheeze (with no cold) at the time of ECRHS I. A further 1,604 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 by 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. 1,796 subjects were excluded who responded ‘yes’ to having cough or phlegm at ECRHS I. Discordant responses given to the questions on cough and phlegm (n=470) were excluded in addition to respondents from Tartu (N=178) and Bordeaux (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 numbered from 0-6 [7]. The items were: 1) breathless while wheezing in the last 12 months; 2) woken with a feeling of chest tightness in the last 12 months; 3) attack of shortness of breath at rest in the last 12 months; 4) attack of shortness of breath after exercise in the last 12 months; 5) woken by attack of shortness of breath in the last 12 months and; 6) ever asthma. These analyses were conducted in those subjects reporting none of the six asthma symptoms at baseline (n=5,924).

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 prevalence of asthma (with atopy and with no atopy) and chronic bronchitis at ECRHS II, cumulative incidence of asthma (with atopy and with no atopy), cumulative incidence of chronic bronchitis between ECRHS I and II, and 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) was calculated as weight in kilograms divided by the square of height in metres [21].

Information on smoking status was obtained at each ECRHS survey. Participants were divided into categories of 'non-smokers', 'ex-smokers' and 'current smokers'. To assess levels of environmental tobacco smoke (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

All data was analysed using STATA 8.0 (2002). Prevalence odds ratios (POR) were calculated for the prevalence estimates [23] and risk ratios (RR) for the cumulative incidence estimates 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 age 5 years, mould or mildew in the home during the last 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 (IRR), after adjusting for score at baseline.

Interaction terms were included to determine if the associations of occupational class and educational level with health outcomes were the same in men and women. 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 0.65 for occupational class). Thus, the results are presented with men and women 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. 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.

For educational level, there was large variation by country, for example, in the United Kingdom, only 5% of participants were in the 'high' education group compared with 55% and 52% in the United States and Norway respectively (data not shown). We assessed heterogeneity 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) and found no heterogeneity for either the medium (*p* for heterogeneity=0.76) or low (*p* for heterogeneity=0.93) education categories.

Table 2 presents the PORs for asthma (with atopy and with no 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 and low occupational group.

We examined treatment and health care utilisation among asthmatics (data not shown) and found no differences by occupational class. By educational level, there were some small non-significant differences seen, for example, asthmatics in the low education group were less likely to have been prescribed medicines for their breathing (OR=0.77, 95%CI 0.51-1.2) or to have seen a doctor (OR=0.72, 95%CI 0.50-1.03) compared to those in the high education group.

Cumulative incidence

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

As with the prevalence analyses, we 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. We 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. The *p* values for heterogeneity were 0.18 and 0.52 for the medium and low education groups respectively.

Generally, there were no large differences 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 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 to the high education group (p=0.008). Sensitisation to all of the allergens examined was highest in occupational class I with the reverse pattern seen with educational level where sensitisation was increased amongst those in the lower education groups.

Table 4 shows the cumulative incidence ratios for asthma (with atopy and with no 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 with no 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 2.83; 95%CI 1.48-5.41) educational level. The low

occupational class group had a 43% higher mean 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 we adjusted the asthma score for bronchitis, we 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

We 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 ten-year follow-up period between ECRHS I and ECRHS 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 socioeconomic status.

Some [3, 4] but not all [1, 25] studies have reported an increased risk of asthma with lower socioeconomic status. 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-points applied across the whole ECRHS study population. In the current analyses we have calculated tertiles specific for each country to provide a relative measure of educational level and minimise problems associated with educational levels having different 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 incident risk ratios in these analyses we found no association with occupational class and asthma risk, but an effect was seen when we analysed asthma symptoms 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 suggests that misclassification of asthma status at baseline may explain the absence of an association between asthma incidence and occupational class when the incident risk ratio measure was used.

Our 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. They found an increased risk of bronchitis, but not asthma, in those with a low social position compared to 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 from 25%-80% across the participating centres and thus the potential for selection bias must be acknowledged. There were no differences between responders and non-responders by sex, but subjects from a high occupational class were more likely to respond (63%) than those from a low occupational class (57%). Respondents with asthma were slightly more likely to participate than those without asthma (62% vs 60% respectively); the reverse pattern was seen for chronic bronchitis with a higher proportion of respondents reporting no bronchitis at baseline (60%) compared to those with bronchitis (56%). 22% of subjects were excluded due to missing data on atopy. We 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 we found no significant difference 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 hyper-responsiveness [31]. The overall effect of this type of misclassification would be to underestimate the true association of asthma or bronchitis with SES. We included several potential explanatory factors in the fully adjusted models including obesity, respiratory infections in childhood, exposure to allergens, smoking and exposure to environmental tobacco smoke 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, you would expect the risk associations to reduce with widening confidence intervals. However,

there were no dramatic changes seen in either the risk estimates or confidence intervals between the minimally and fully adjusted models, for example, 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 more than 10%.

In conclusion, this study identified lower educational level to be associated with an increased risk of prevalent and incident chronic bronchitis and 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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Table 1: Characteristics of study participants ECRHS II (1999-2001) (N=6965)¥

Individual variables	No.	%	Range (%) by centre
Males	3,412	49.0	41.3-54.4
Females	3,553	51.0	45.6-58.7
Age (mean, SD)	43.0	7.1	39.2-46.7
Body mass index (BMI)			
<20	390	5.7	1.1-12.3
20≤BMI<25	3,096	45.6	31.3-60.9
25≤BMI<30	2,429	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	2,927	42.0	30.2-60.7
Former smoker	1,945	27.9	6.5-40.7
Current smoker	2,027	29.1	11.9-48.2
Exposure to ETS	2,637	38.0	18.9-78.2
No. of siblings			
0	690	9.9	0.9-21.3
1	2,121	30.5	12.3-48.7
≥2	4,134	59.5	31.4-79.8
Respiratory infections before age 5 yrs	689	9.9	2.2-16.3
Rhinitis	2,051	29.5	11.1-43.0
High occupational exposure to biologic, mineral dust, gas or fumes	991	14.6	5.0-27.6
Mould or mildew in home in last 12 months	1,166	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
With no atopy	353	5.1	2.2-9.7
Atopy without asthma	1,646	23.6	13.4-33.9
No asthma, no atopy	4,594	66.0	52.6-81.7
Chronic bronchitis®	247	3.0	0.0-8.5
Asthma score (mean, SD)	0.66	1.2	0.36-0.96
Socioeconomic status measures			
Occupational class*			
I	2,096	30.1	15.1-49.7
II	1,246	17.9	7.5-28.2
III	1,791	25.7	15.5-40.2
IV	695	10.0	2.2-18.5
V	655	9.4	2.8-19.0
Unclassified	482	6.9	1.3-17.5
Educational level (country-specific tertiles)			
High	1,883	28.4	17.8-37.3
Medium	2,101	31.7	10.9-48.0
Low	2,650	39.9	29.5-63.8

¥ Only subjects with serum IgE included

® Chronic bronchitis category n=7915

* I, managers and professionals; II, technicians and associate professionals; III, other non-manual; IV, skilled manual; V, semi-skilled/unskilled manual; VI, unclassifiable/unknown

Table 2: Prevalence odds ratios (and 95% CIs)ϕ of asthma (with or without atopy) and chronic bronchitis in ECRHS II participants by occupational class and education level

	Asthma (n=6965¥)		Asthma with atopy (n=2018)		Asthma with no atopy (n=4947)		Chronic Bronchitis (n=7915+)	
	RR	95% CI	RR	95%CI	RR	95% CI	RR	95%CI
Minimal adjusted ϕ								
OC* = I[1]	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
Unclassified	1.37	1.00-1.88	1.07	0.67-1.72	1.55	1.00-2.41	1.62	0.97-2.69
Educ=High								
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 ♣								
OC* = I[1]	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
Unclassified	1.25	0.84-1.86	1.16	0.63-2.14	1.28	0.75-2.19	1.24	0.56-2.75
Educ=High	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

* OC / Occupational class - I, managers and professionals; II, technicians and associate professionals; III, other non-manual; IV, skilled manual; V, semi-skilled/unskilled manual; VI, unclassifiable/unknown.

ϕ Prevalence odds ratios (POR), adjusted for age, sex and centre

♣ Prevalence odds ratios (POR), adjusted for age, sex, country, BMI, family history of asthma, number of siblings, exposure to ETS, smoking status, respiratory infections before age 5 yrs, mould or mildew in the home last 12 months, rhinitis and high occupational exposure to pollutants

[1]Reference category

+ Excludes Tartu centre

¥ Only subjects with serum IgE included (except bronchitis category)

Table 3: Cumulative incidence of respiratory symptoms and sensitisation n (%) and asthma score (mean) by occupational class and education level between ECRHS I (1991-1992) and ECRHS II (1999-2001)[¥]

Variables	Occupational class* n (%)						Education n (%)			
	I	II	III	IV-V	Unclassified	$p^{ώ}$	High	Medium	Low	$p^{ώ}$
Asthma symptoms										
Breathless while wheezing in last 12 months	1.4	1.1	1.4	1.6	0.5	*<0.001*	1.5	1.6	2.9	*0.004*
Woken with chest tightness in last 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 while at rest in last 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 last 12 months	3.9	2.5	4.5	3.2	1.2	*0.001*	3.6	4.2	7.3	*<0.001*
Woken by attack of shortness of breath in last 12 months	0.9	0.7	1.0	0.6	0.4	*0.071*	0.9	1.3	1.6	*0.345*
Ever asthma	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*[e]	0.28	0.29	0.38	*<0.001*[e]
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										
Sensitized to *dermatophagoides pteronyssinus*	4.4	2.5	2.8	2.8	1.1	*0.009*	3.9	4.6	4.6	*0.028*
Sensitized to cat	2.1	1.5	1.5	1.2	0.4	*0.186*	2.0	2.2	2.3	*0.308*
Sensitized to grass	4.4	2.9	3.4	2.7	0.9	*0.265*	4.5	4.5	5.0	*0.034*
Sensitized to *cladosporium herbarium*	0.3	0.1	0.1	0.2	0.04	*0.509*	0.2	0.2	0.3	*0.592*

* Occupational class - I, managers and professionals; II, technicians and associate professionals; III, other non-manual; IV, skilled manual; V, semi-skilled/unskilled manual; VI, unclassifiable/unknown.

¥ Only subjects with serum IgE included (except bronchitis category)

[ώ] *p*-value from chi square test for association with categorical variables.

[e] *p*-value from likelihood ratio test for asthma score.

Table 4: Cumulative incidence ratios (and 95% CI) of asthma (with or without atopy) bronchitis and asthma score (IRR) for ECRHS II participants by occupational class and education level

	Asthma (n=5645¥)		Asthma with atopy (n=1406)		Asthma with no atopy (n=4239)		Asthma score (n=5924[e])		Bronchitis (n=6455+)	
	RR	95% CI	RR	95%CI	RR	95% CI	IRR	95%CI	RR	95%CI
Minimally adjusted ϕ										
OC* = I[1]	1		1		1		1		1	
II	1.23	0.90-1.67	1.47	0.88-2.47	1.16	0.74-1.81	1.36	1.12-1.64	1.72	0.87-3.41
III	1.18	0.89-1.57	1.13	0.67-1.91	1.20	0.81-1.78	1.40	1.18-1.67	1.97	1.04-3.74
IV-V	1.11	0.81-1.52	0.81	0.44-1.50	1.23	0.83-1.83	1.43	1.19-1.73	1.95	0.98-3.88
Unclassified	1.05	0.72-1.56	1.48	0.75-2.92	1.31	0.76-2.27	1.32	1.04-1.67	2.20	0.97-4.96
Educ=High	1		1		1		1		1	
Medium	1.21	0.89-1.65	0.91	0.57-1.47	1.44	0.95-2.17	1.08	0.92-1.28	2.15	1.10-4.23
Low	1.32	0.99-1.77	1.13	0.72-1.78	1.53	1.04-2.25	1.33	1.14-1.56	2.83	1.48-5.41
Fully adjusted ♣										
OC* = I[1]	1		1		1		1		1	
II	1.25	0.90-1.73	1.52	0.91-2.56	1.16	0.74-1.82	1.33	1.09-1.62	1.50	0.75-3.03
III	1.08	0.80-1.47	1.23	0.73-2.08	1.20	0.81-1.78	1.38	1.15-1.66	1.52	0.77-3.01
IV-V	1.05	0.69-1.60	0.76	0.35-1.63	1.37	0.79-2.39	1.40	1.09-1.80	1.37	0.55-3.42
Unclassified	1.01	0.61-1.70	1.36	0.57-3.25	1.26	0.66-2.42	1.36	0.98-1.89	2.23	0.78-6.34
Educ=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	1.11	0.93-1.33	2.13	1.02-4.45
Low	1.40	1.03-1.89	1.36	0.85-2.17	1.50	1.00-2.25	1.31	1.10-1.56	2.49	1.21-5.13

* OC / Occupational class - I, managers and professionals; II, technicians and associate professionals; III, other non-manual; IV, skilled manual; V, semi-skilled/unskilled manual; VI, unclassifiable/unknown.

ϕ Asthma and bronchitis incidence risk ratios (RR) and ratio of asthma score averages (IRR) adjusted for age, sex and centre

♣ Asthma and bronchitis incidence risk ratios (RR) and ratio of asthma score averages (IRR) adjusted for age, sex, country, BMI, family history of asthma, number of siblings, exposure to ETS, smoking status, respiratory infections before age 5 yrs, mould or mildew in the home last 12 months, rhinitis and high occupational exposure to pollutants

[1] Reference category

+ Excludes Tartu and Bordeaux centres

¥ Only subjects with serum IgE included (except bronchitis category)

[e] Includes only people with asthma score=0 at baseline

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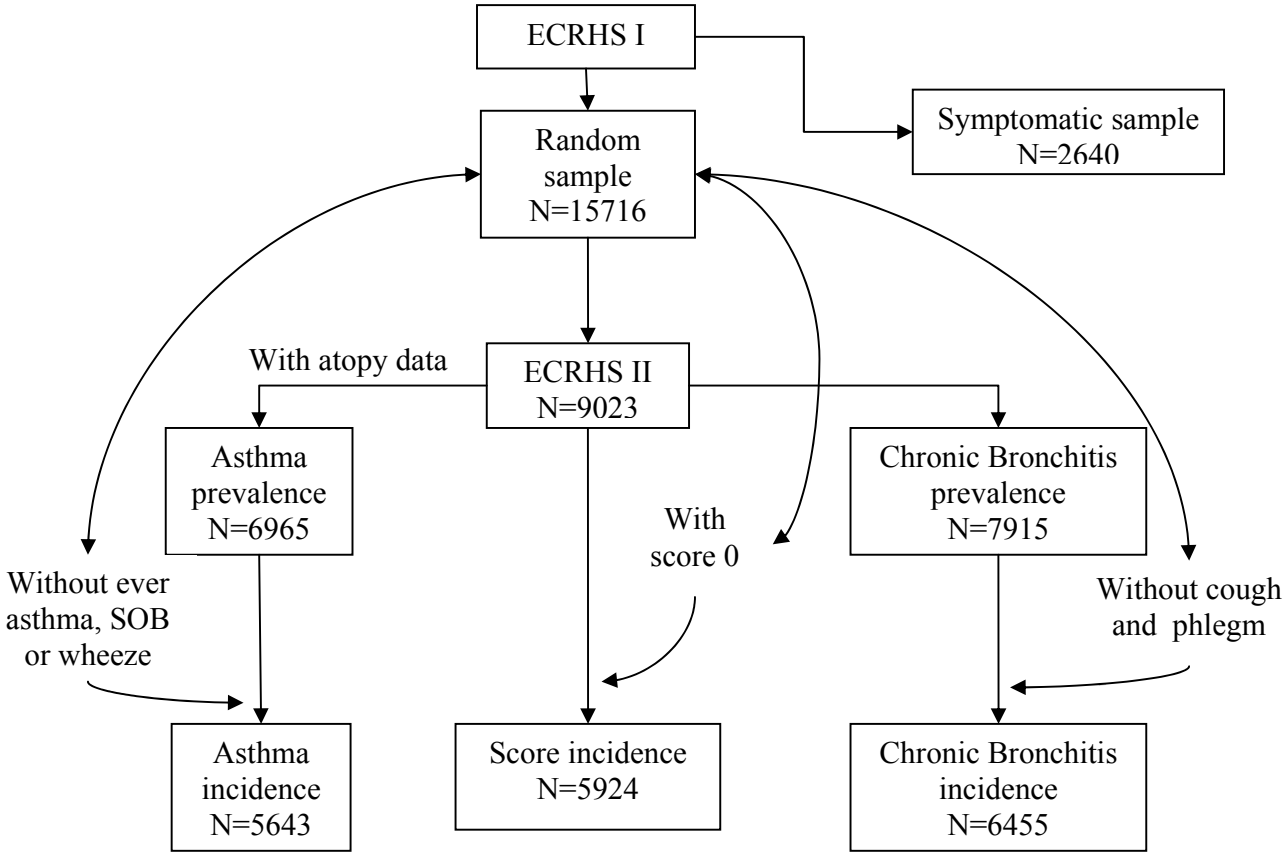

Figure 1: Selection of the study population for the ECRHS II socioeconomic status, asthma and chronic bronchitis study.