The effect of educational level on the incidence of asthma and respiratory symptoms

Tomas M.L. Eagan,*, Amund Gulsvik, Geir E. Eide, Per S. Bakke

Summary Few studies have examined the impact of socioeconomic status on the incidence of asthma and respiratory symptoms. Between 1985 and 1996/97, we conducted an 11-years community cohort study with 2819 subjects, aged 15–70 years at baseline, in Western Norway. We examined the cumulative incidence of asthma and respiratory symptoms by educational level (primary, secondary, and university), as well as estimating the odds ratios (ORs) of educational level on the incidences, after adjustment for sex, age, hay fever, smoking habits, pack years, and occupational exposure. For all respiratory symptoms, the incidences decreased with increasing educational level. The cumulative incidence of asthma was 5.3%, 4.1%, and 1.8%, respectively, for those with a primary educational level, secondary educational level, and university level. Subjects with a primary educational level had adjusted ORs (95% CI) from 1.4 (0.9, 2.3) for the incidence of chronic cough to 2.5 (1.6, 4.0) for the incidence of dyspnea grade 2, compared to those with a university level education. The adjusted OR (95% CI) for the incidence of asthma was 2.1 (1.01, 4.4) in subjects with a primary educational level, and 2.0 (1.04, 3.6) in subjects with a secondary educational level, compared to subjects with a university educational level. In conclusion, subjects with a lower educational level had a higher risk of developing asthma and respiratory symptoms, after adjustment for sex, age, hay fever, smoking, and occupational exposure.

Introduction Lower socioeconomic status is consistently associated with poorer health, measured both by morbidity and mortality. Several cross-sectional studies have observed an association of a lower socioeconomic status with an increased prevalence of asthma or respiratory symptoms. However, the effect of socioeconomic status on the incidence of adult asthma is largely unknown. In the Coronary Artery Risk Development in Young Adults (CARDIA) study with 4547 participants from four cities in the US, Beckett et al. reported on possible predictors of both baseline prevalence and incidence of asthma. In the CARDIA study, lower educational level was associated with an increase both in prevalence and incidence of asthma in young adults, after adjustment for sex, age, race, and study center. For the age groups above 30, there are no published data from a general population on the effect of socioeconomic status on the incidence of asthma or respiratory symptoms.
The Hordaland County Cohort Study is a large community cohort study in Western Norway, conducted between 1985 and 1997. Using educational level as an indicator of socioeconomic status, we investigated whether educational level was an independent risk factor for the incidence of asthma and respiratory symptoms in adults, after adjustment for the potential confounders: sex, age, hay fever, smoking, and occupational exposure.

Methods

Study population

The baseline survey was conducted in 1985. A random sample of the population in the city of Bergen and 11 surrounding municipalities, aged 15–70 years, was mailed a questionnaire with 40 questions regarding respiratory health, smoking habits, allergies, and occupational exposures. Of 3786 subjects, 3370 (89 percent) replied after a maximum of two postal reminders. The procedure of the sampling and data collection has been described previously.

Within the 11 years of follow-up, 189 subjects were deceased, leaving 3181 subjects eligible for the follow-up survey, which started in September 1996. The new questionnaire added questions regarding education, passive smoking, family history, and indoor exposures, consisting of a total of 58 questions. Due to the inclusion of a voluntary examination, the follow-up lasted till May 1997. Altogether, 2819 subjects (89 percent) completed the questionnaire, after a maximum of two reminder letters and one telephone reminder. The procedure of data collection at follow-up has also been previously described.

The questionnaires

The subjects were asked at follow-up about their highest attained education, by four categories: (1) former primary school or present 9-year compulsory school; (2) continuation school, “folk-high school” (1-year people’s college), bible school, or the like; (3) lower or upper secondary school, or technical school; (4) college or university. In the present analyses, categories (2) and (3) were combined, so that educational level was modeled as a variable with three categories, labeled ‘primary’, ‘secondary’, and ‘university’.

At baseline, the subjects were asked whether they had ever had hay fever, and this question was used as an indicator of atopy.

The subjects were asked about their smoking history both at baseline and follow-up, with questions regarding smoking type, amount, and length of their habit. One pack-year was defined as having smoked 20 cigarettes per day for 1 year, or having smoked 50 g of pipe tobacco per week for 1 year. At baseline and follow-up, the subjects were asked whether they had ever been exposed to dust or fumes at their workplace, and this was used as an indicator of occupational exposure.

The wording of the questions on asthma and respiratory symptoms are given in the Appendix A.

Statistical analysis

The cumulative incidence was defined as the proportion of subjects not having a symptom or asthma at baseline who developed the symptom or asthma at follow-up. A chi-square test was used to assess the univariate associations between the cumulative incidences and sex, age, hay fever, smoking habits, pack years, dust or fumes exposure before baseline, and educational level at follow-up. For each symptom or asthma, a logistic regression model was used to estimate the adjusted odds ratios (ORs). Smoking habits were defined as never, ex, or current smoking in 1985, and pack years were modeled as a separate, continuous variable. By this procedure only smoking up until baseline was taken into account, making sure the exposure occurred before the outcome. However, we also performed additional analyses taking into account smoking (modeled as never-never, non-current, current-current, current-ex, ex-ex smoking), and dust or fumes exposure, all the way through follow-up, to see if this altered the relationship between educational level and the incidence of asthma or the symptoms.

We tested for all first-order interactions between educational level and the confounders sex, age, hay fever, smoking habits, pack years, and previous dust or fumes exposure, with a significance level of 0.05. All analyses were conducted with Stata 8.0.

Results

Sex, age, hay fever, smoking habits, pack years, and previous occupational exposure varied with educational level, as shown in Table 1. The subjects with the highest education were more likely to be male, younger, never-smokers, and without previous occupational dust or fumes exposure (Table 1).
The cumulative 11-year incidences of asthma and the respiratory symptoms are given in Table 2. For asthma and all symptoms except wheezing, the incidence was significantly higher among the subjects with the lowest level of education (Table 2).

After adjustment for sex, age, hay fever, smoking habits, pack years, and occupational exposure, the ORs for the incidence of asthma and respiratory symptoms varied by educational level as shown in Table 3. Subjects with a primary educational level had a higher adjusted OR for developing all symptoms and asthma, compared to subjects with a university educational level. This reached statistical significance for asthma and all symptoms except phlegm cough and chronic cough (Table 3). Subjects with a secondary educational level showed a similar trend of increased risk of respiratory symptoms and asthma, except for wheezing, in comparison with subjects with a university educational level.

Adjusting for hay fever, smoking, and occupational exposure had a relatively small effect on the relationship between educational level and the incidences of respiratory symptoms and asthma (Table 4).

Adjusting for smoking or dust or fumes exposure until follow-up did not overtly alter the ORs for the effect of educational level to the incidences of asthma and the symptoms (data not shown).

No first-order interactions between educational level and the other factors examined were significant ($P > 0.05$). However, to further examine possible interactions, separate analyses were conducted on both sexes, and for the age-groups younger and older than 40 years. There was a trend that lower educational level was more

### Table 1: Characteristics of the Hordaland Study cohort, according to educational level.

<table>
<thead>
<tr>
<th></th>
<th>Primary (n = 501)</th>
<th>Secondary (n = 1536)</th>
<th>University (n = 720)</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sex (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td>0.009</td>
</tr>
<tr>
<td>Women</td>
<td>55.7</td>
<td>52.9</td>
<td>47.4</td>
<td></td>
</tr>
<tr>
<td>Men</td>
<td>44.3</td>
<td>47.1</td>
<td>52.6</td>
<td></td>
</tr>
<tr>
<td><strong>Age in 1985, mean (SD)</strong></td>
<td>46.3 (16.5)</td>
<td>38.0 (14.5)</td>
<td>31.8 (11.9)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Hay fever before 1985 (%)</strong></td>
<td>7.8</td>
<td>9.9</td>
<td>13.1</td>
<td>0.008</td>
</tr>
<tr>
<td><strong>Smoking habits in 1985 (%)</strong></td>
<td>32.5</td>
<td>38.6</td>
<td>54.8</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Never</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ex</td>
<td>19.7</td>
<td>20.1</td>
<td>18.4</td>
<td></td>
</tr>
<tr>
<td>Current</td>
<td>47.8</td>
<td>41.4</td>
<td>26.8</td>
<td></td>
</tr>
<tr>
<td><strong>Smoking load, median pack years (interquartile range)</strong></td>
<td>16.5 (16.5)</td>
<td>12.3 (14.3)</td>
<td>8.3 (12.5)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td><strong>Exposure to dust or fumes before 1985 (%)</strong></td>
<td>31.9</td>
<td>31.9</td>
<td>18.3</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

*P-Values calculated with chi-square for sex, hay fever, smoking habits, dust or fumes exposure, and Kruskal–Wallis test for age and pack years.

*Among current- or ex-smokers.

### Table 2: The cumulative 11-years incidence of respiratory symptoms and asthma by educational level.

<table>
<thead>
<tr>
<th></th>
<th>Primary (n = 501)</th>
<th>Secondary (n = 1536)</th>
<th>University (n = 720)</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Symptoms</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Morning cough</td>
<td>20.4</td>
<td>17.7</td>
<td>10.3</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Phlegm cough</td>
<td>20.0</td>
<td>17.6</td>
<td>12.3</td>
<td>0.003</td>
</tr>
<tr>
<td>Chronic cough</td>
<td>11.5</td>
<td>9.5</td>
<td>6.2</td>
<td>0.006</td>
</tr>
<tr>
<td>Dyspnea grade 2</td>
<td>19.4</td>
<td>12.4</td>
<td>5.7</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Attacks of dyspnea</td>
<td>13.9</td>
<td>10.8</td>
<td>7.2</td>
<td>0.001</td>
</tr>
<tr>
<td>Wheezing</td>
<td>18.3</td>
<td>14.0</td>
<td>13.6</td>
<td>0.080</td>
</tr>
<tr>
<td><strong>Asthma</strong></td>
<td>5.3</td>
<td>4.1</td>
<td>1.8</td>
<td>0.004</td>
</tr>
</tbody>
</table>

*Calculated by chi-square test.
strongly related to the incidence of asthma in women than in men. However, the confidence intervals were wide and overlapping, so this should be interpreted with caution. For the incidence of respiratory symptoms no such trend was observed. We therefore conclude that there were no significant sex differences on the effects of educational level to the incidence of asthma and respiratory symptoms, in this study population. In the separate analyses on subjects younger and older than 40 years, there were no overt differences in the relationships of educational level to the incidences of asthma and respiratory symptoms.

### Discussion

The cumulative incidence of asthma and all examined symptoms was highest in the subjects with the lowest attained educational level. After adjustment for sex, age, hay fever, smoking, and occupational exposure, educational level was a significant risk factor for the incidence of asthma and all symptoms except phlegm cough and chronic cough. The risk of asthma incidence was approximately doubled in subjects with a primary or secondary educational level, compared to subjects with a university educational level.
The strength of the current study is its longitudinal design with a large community sample, wide age-span, and high response rate. However, there are some methodological considerations. Firstly, the most common indicators used for measurement of socioeconomic status are income level, occupation, and educational level. Educational level measures one aspect of socioeconomic status and we cannot rule out that the results would have been different with another measure. Possibly, a more ideal measure would be one that took into account several aspects, for example both educational level and working class. In older women, social status could be dependent on the social standing of their husbands, information to which we did not have access.

Secondly, the length of mandatory schooling in Norway has changed over the last 50 years. Shorter lengths of education 40 years ago could correspond to a higher educational level than would be the case today. This was adjusted for by asking the subjects at what type of school or educational institution they finished their highest degree, by the categories as was explained in the methods section. In doing so, for instance those with 7 years of primary school in 1960 will be categorized with subjects who completed 9 years of primary school in 1980. However, we should still caution that educational level may not measure socioeconomic status the same way today that it did 50 years ago.

Finally, educational level at follow-up was used, thus using a predictor variable collected from the study phase after the incident event. However, at baseline, the youngest study subjects were 15 years old, and could not have achieved more education than equivalent to 'primary level'. At follow-up, the youngest subjects were 26 years old, and thus likely to have achieved a university level education, if that were to be their 'highest attained education'.

Previous studies have indicated that educational level was associated with an increased risk for asthma and respiratory symptoms in adults. Cross-sectional analyses from the Copenhagen City Heart Study showed an association between educational level and a lower FEV1 and FVC, after adjustment for sex, age, and smoking. This large community study also showed an increased risk for later hospitalization for COPD, with lower educational level. Earlier cross-sectional analyses from Hordaland County indicated a higher risk for asthma and respiratory symptoms with lower education, after adjustment for sex, age, smoking, and occupational exposure. And, in the report from the CARDIA Study Cohort in Minnesota, asthma incidence among 18–30 year olds was higher with lower educational level. There has been a number of prevalence studies on the effect of socioeconomic status on asthma in children. No consistent pattern exists, as some studies showed a negative association (more asthma with lower social class), some a positive association (more asthma with higher social class), and some studies no association at all. These discrepancies could be due to differences in study design, indices of social class, or severity of asthma. Atopy could be a factor, either by an increased allergen exposure in early childhood, or an under-stimulation of the immune system through an overly sterile environment (the hygiene hypothesis). If this were true also in adults, atopy could be a confounding factor.

In the current study, we adjusted for hay fever, smoking and occupational exposure, and still found an association between educational level and respiratory symptoms and asthma. The question about previous dust or fumes exposure may not capture all potentially harmful exposures. Some of the effect of educational level seen in the current study could therefore be due to differences in working exposures. However, the question regarding dust or fumes exposure has been validated against interview-based data on working exposures, and found to have a high specificity.

Possible explanatory factors for the increased incidence of asthma and respiratory symptoms among those with a lower educational level could be an unhealthy diet, lack of exercise, passive smoking, poorer housing conditions, or poorer access to health care.

The Norwegian welfare state ensures health care at low individual cost to the entire population. Thus, it is unlikely that poor access to health care is a major cause of the effect of educational level on asthma and symptoms. The question of previous dust or fumes exposure may not capture all potentially harmful exposures. Some of the effect of educational level seen in the current study could therefore be due to differences in working exposures. However, the question regarding dust or fumes exposure has been validated against interview-based data on working exposures, and found to have a high specificity.

Both a low fish and low fresh fruit intake have been shown to be associated with increased respiratory symptoms and lower lung function, where at least one study was from the same general population as the Hordaland County cohort.

Both prevalence and incidence studies have shown that obesity could be a risk factor for adult asthma, at least in women. Obesity being more frequent in subjects with lower than higher socioeconomic status. In the Nurses Health Study, body mass index (BMI) at baseline and weight gain throughout follow-up was a clear risk factor for asthma incidence, after adjustment for age, race, smoking, birth weight, hysterectomy status, breast feeding, physical activity, and energy intake.

Passive smoking has been shown to be a risk factor for respiratory symptoms and asthma in 1980. However, we should still caution that educational level may not measure socioeconomic status the same way today that it did 50 years ago.

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children. For adults, this is less clear. In a cross-sectional report from the European Community Respiratory Health Survey, passive smoking at the workplace was associated with current asthma, but not passive smoking at home, after adjustment for sex, age, parental smoking, sensitization to allergens, total IgE, and study center. In a cross-sectional study on 4197 never-smokers in Switzerland, passive exposure to smoking was associated with increased risk of wheeze, dyspnea, and self-reported asthma.

Factors associated with poorer housing conditions are lack of central heating, increased exposure to dust mites, and home dampness. Gas stove usage has been associated with an increased risk of respiratory symptoms, but gas stoves are rarely used for cooking in Norway.

In conclusion, this is the first study to show the effects of educational level to the incidence of asthma and respiratory symptoms in a general population with a wide age span. It was found that lower educational level is a risk factor for the incidence of adult asthma, even after adjustment for sex, age, hay fever, smoking and occupational exposures. New community studies with a longitudinal design are necessary to find the factors responsible for the effect of educational level to the incidence of adult asthma and respiratory symptoms.

Appendix A.

The wording of the questions on respiratory symptoms and asthma were identical at baseline and follow-up except for the question regarding wheezing:

1985
Do you usually have phlegm when coughing? [yes, no]
Do you have a cough for 3 months or more altogether during a year? [yes, no]
Are you breathless when you climb two flights of stairs at an ordinary pace? [yes, no] (dyspnea grade 2)
Do you sometimes experience attacks of breathlessness? [yes, no]
Do you ever have wheezing in your chest? [yes, no]
Have you ever been treated by a doctor or have you been hospitalized for asthma? [yes, no, do not know]

1996/97
Have you had wheezing in your chest in the last 12 months? [yes, no]

References
7. StataCorp. Stata Statistical Software, 8.0 ed. College Station, TX: Stata Corporation; 2003.


