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Job titles classified into socioeconomic and occupational groups identify subjects with increased risk for respiratory symptoms independent of occupational exposure to vapour, gas, dust, or fumes

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ABSTRACT

Objectives: To evaluate the ability of three different job title classification systems to identify subjects at risk for respiratory symptoms and asthma by also taking the effect of exposure to vapours, gas, dust, and fumes (VGDF) into account.

Background: Respiratory symptoms and asthma may be caused by occupational factors. There are different ways to classify occupational exposure. In this study, self-reported occupational exposure to vapours, gas, dust and fumes was used as well as job titles classified into occupational and socioeconomic groups according to three different systems.

Design: This was a large population-based study of adults aged 30–69 years in Northern Sweden (n = 9,992, 50% women). Information on job titles, VGDF-exposure, smoking habits, asthma and respiratory symptoms was collected by a postal survey. Job titles were used for classification into socioeconomic and occupational groups based on three classification systems; Socioeconomic classification (SEI), the Nordic Occupations Classification 1983 (NYK), and the Swedish Standard Classification of Occupations 2012 (SSYK). Associations were analysed by multivariable logistic regression.

Results: Occupational exposure to VGDF was a risk factor for all respiratory symptoms and asthma (odds ratios (ORs) 1.3–2.4). Productive cough was associated with the socioeconomic groups of manual workers (ORs 1.5–2.1) and non-manual employees (ORs 1.6–1.9). These groups include occupations such as construction and transportation workers, service workers, nurses, teachers and administration clerks which by the SSYK classification were associated with productive cough (ORs 2.4–3.7). Recurrent wheeze was significantly associated with the SEI group manual workers (ORs 1.5–1.7). After adjustment for also VGDF, productive cough remained significantly associated with the SEI groups manual workers in service and non-manual employees, and the SSYK-occupational groups administration, service, and elementary occupations.

Conclusions: In this cross-sectional study, two of the three different classification systems, SSYK and SEI gave similar results and identified groups with increased risk for respiratory symptoms while NYK did not give conclusive results. Furthermore, several associations were independent of exposure to VGDF indicating that also other job-related factors than VGDF are of importance.

Introduction

It is well established that respiratory symptoms and asthma may be caused by occupational factors [1]. Occupational exposures have been related to adult-onset asthma and work-aggravated asthma, and the population-attributable fraction is estimated at about 15% [2]. Several jobs and occupational exposures are strongly associated with cough, wheeze, and nasal symptoms [3–6], and low socioeconomic status is associated with asthma, cough, and wheeze [7]. In population-based studies, occupational exposure to vapours, gas, dust, and fumes (VGDF) have been shown to increase the risk of asthma [8], respiratory symptoms [9] and rhinorrhea [10].

There are different methods to classify occupational exposure. Most studies in occupational epidemiology are based on specific workforces or exposure to specific agents [3,6,11–13]. In large population-based studies, occupational exposures are commonly assessed by using a job-exposure matrix (JEM) based on job title, or by using a
single-item question of exposures to VGDF. There is no consensus whether the use of a JEM or the use of a VGDF question is the best way of assessing occupational exposure in epidemiological studies [14–16]. While job titles are frequently used to construct a JEM or for classifying socioeconomic status [7], job titles grouped into occupational groups have seldom been analysed as risk factors for respiratory illness.

Throughout the Nordic countries, similar systems based on job titles, are used to classify different occupational groups. The International Standard Classification of Occupations (ISCO) 08 [17] is used as a basis for the current standards of occupation classification in Sweden (SSYK) [18], Norway (STYRK) [19], Denmark (DISCO) [20], and Finland (Ammattiluokitus) [21]. The Icelandic standard (Istarf) [22] is based on a previous, but similar, issue: ISCO 88. The Nordic Classification of Occupations (NYK) [23] is based on ISCO 68, an older system of which the last version was published in 1983 and has since been replaced by SSYK. For socioeconomic status, different classifications systems are used in the Nordic countries. To the best of our knowledge, no previous study has simultaneously evaluated the associations between respiratory health and occupation, socioeconomic status, and occupational exposure in the same population.

In this study, we have used job titles for classification of occupational groups and socioeconomic groups by three different classification systems, and analysed the associations with respiratory symptoms and asthma by also taking exposure to VGDF into account. We hypothesised that the three systems would yield similar results.

**Methods**

**Study population**

This was a large population-based cross-sectional study performed within the epidemiological research program the Obstructive Lung disease In Northern Sweden (OLIN) studies. In 2006, a random sample of the population aged 20–69 years in the county of Norrbotten was invited to a postal questionnaire survey (n = 7,997) and 77% participated. A cohort recruited to a similar survey in 1996 was at the same time in 2006 invited for follow-up, now aged 30–84 years (n = 7,004) and 85% participated. In total, 12,055 (80.4%) responded and the same questionnaire was used in both cohorts [24]. The questionnaire was based on a British Medical Research Council questionnaire but included questions from the US Tucson and ATS questionnaires and has been described previously [25]. The study population in the current study includes all individuals 30–69 years of age (n = 9,992, 50.3% women). The younger and older individuals were excluded since a large portion of them were not professionally active. Of those below 30 years of age, 45% were students or did not report any occupation. The study was approved by the Regional Ethical Review Board of Umeå, Sweden.

**Definitions**

Longest held job title was used to classify occupational groups by two different systems: (1) the Nordic Occupations Classification 1983 (NYK) [23]: Science, humanistic, and artistic work (Science), Health and social work (Healthcare), Administration, clerical, and commercial work (Administration), Agriculture, forestry, and fishery (Agriculture), Mining, quarrying, and petroleum extraction work (Mining), Transportation and communication work (Transportation), Manufacturing and machine maintenance (Manufacturing) Service work (Service), Other and unspecified (Other) including students, professional military personnel and non-classifiable individuals; (2) the Swedish Standard Classification of Occupations 2012 (SSYK) [18]: Occupations requiring advanced level of higher education (Occupations requiring advanced education), Occupations requiring higher education qualifications or equivalent (Occupations requiring higher education), Administration and customer service clerks (Administration), Service, care, and shops sales workers (Service), Agricultural horticultural, forestry, and fishery work (Agriculture), Building and manufacturing work (Building), Mechanical manufacturing and transport work (Manufacturing), Elementary occupations (Elementary), and Other and unspecified with students, professional military personnel and non-classifiable individuals (Other). Longest held job title was also used to classify socioeconomic status groups according to the Swedish Socioeconomic classification (SEI) [26]: Manual workers in industry (Manual work industry), Manual workers in service (Manual work service), Non-manual employees, lower level (Non-manual employees L) and intermediate level (Non-manual employees I), Professionals and executives (Professionals and executives), Self-employed non-professionals (Self-employed non-prof), and Other and unspecified (Other) with students and non-classifiable individuals. All three classification systems are issued by Statistics Sweden and based on ISCO. Exposure to vapour, gas, dust or fumes (VGDF) was based on the question: Have you, in your work, been heavily exposed to vapours, gas, dust, and/or fumes? Of the 9,992 subjects, 2.3% did not answer this question.

**Productive cough:** Do you usually have phlegm when coughing, or do you have phlegm in your chest which is difficult to bring up, and have you had this during most days for at least three months? **Recurrent wheeze:** Do you usually have wheeze, whistling, or a
Prevalence (% of family history of asthma, smoking habits, respiratory symptoms, and asthma in the population, by age group and sex.

**Results**

**Basic characteristics**

Subjects in ages 40–59 years reported the highest prevalence of smoking. Productive cough was most prevalent in the oldest age groups, while current asthma, allergic rhino-conjunctivitis and rhinitis were most prevalent in the younger age groups. The prevalence of current asthma, allergic rhino-conjunctivitis, and rhinitis were higher among women than men (Table 1). The largest SEI groups were **manual workers service** and **industry**, the former dominated by women and the latter by men. The largest occupational NYK-groups were **administration** and **manufacturing**. The largest SSYK-groups were service and occupations requiring advanced education. Of the total population, 30.9% reported exposure to VGDF with the highest prevalence among older subjects and men (Table 2).

**Prevalence of respiratory symptoms in relation to socioeconomic group and occupational groups**

According to SEI, current asthma and all respiratory symptoms were most prevalent among **manual workers service** and **industry**. The largest NYK groups were **professionals and executives**, and **managers**, respectively, were used as reference groups. For NYK, the largest group, **administration**, was used as reference group. The logistic regression models were adjusted for sex, age, family history of asthma, and smoking habits. Separate models were additionally adjusted for VGDF-exposure. Furthermore, for the variables productive cough, recurrent wheeze, and current asthma, the logistic regression analyses were performed stratified by quartiles of the number of years of working in the main occupation. The logistic regression analyses were also performed after excluding subjects with onset of asthma before the age of 18 years and are presented in online table 2. The logistic regression analyses of the confounding factors are presented in online table 3. Statistical significance was defined as a two-sided $p < 0.05$. All analyses were carried out using IBM SPSS Statistics version 23 (IBM Corp, New York, NY, USA).

### Table 1. Prevalence (%) of family history of asthma, smoking habits, respiratory symptoms, and asthma in the population, by age group and sex.

<table>
<thead>
<tr>
<th>Age groups</th>
<th>All (n = 9,992)</th>
<th>30–39 y (n = 2,050)</th>
<th>40–49 y (n = 2,455)</th>
<th>50–59 y (n = 2,868)</th>
<th>60–69 y (n = 2,619)</th>
<th>$p \chi^2$</th>
<th>Women (n = 5,030)</th>
<th>Men (n = 4,962)</th>
<th>$p \chi^{***}$</th>
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</thead>
<tbody>
<tr>
<td>Family history of asthma</td>
<td>22.0</td>
<td>24.5</td>
<td>24.7</td>
<td>22.2</td>
<td>17.4</td>
<td>&lt;0.001</td>
<td>25.0</td>
<td>19.0</td>
<td>&lt;0.001</td>
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<tr>
<td>Non-smoker</td>
<td>54.7</td>
<td>73.7</td>
<td>57.9</td>
<td>45.6</td>
<td>46.6</td>
<td></td>
<td>52.9</td>
<td>56.5</td>
<td></td>
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<tr>
<td>Ex-smoker</td>
<td>25.7</td>
<td>13.6</td>
<td>20.4</td>
<td>30.3</td>
<td>35.0</td>
<td>&lt;0.001</td>
<td>24.4</td>
<td>26.9</td>
<td>&lt;0.001</td>
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<td>Current smoker</td>
<td>19.2</td>
<td>12.4</td>
<td>21.0</td>
<td>23.7</td>
<td>17.8</td>
<td></td>
<td>22.3</td>
<td>16.0</td>
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<td></td>
<td></td>
<td></td>
<td>6.0</td>
<td>9.2</td>
<td>0.697</td>
<td></td>
</tr>
<tr>
<td>Productive cough</td>
<td>9.1</td>
<td>6.0</td>
<td>7.9</td>
<td>9.7</td>
<td>12.0</td>
<td>&lt;0.001</td>
<td>9.0</td>
<td>9.2</td>
<td>0.697</td>
</tr>
<tr>
<td>Recurrent wheeze</td>
<td>12.1</td>
<td>11.3</td>
<td>12.5</td>
<td>12.6</td>
<td>11.8</td>
<td>0.485</td>
<td>12.1</td>
<td>12.1</td>
<td>0.970</td>
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<td>Allergic rhino-conjunctivitis</td>
<td>23.9</td>
<td>31.4</td>
<td>28.3</td>
<td>22.3</td>
<td>15.5</td>
<td>&lt;0.001</td>
<td>25.6</td>
<td>22.1</td>
<td>&lt;0.001</td>
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<td>Rhinitis</td>
<td>21.6</td>
<td>23.8</td>
<td>22.5</td>
<td>21.3</td>
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<td>0.002</td>
<td>22.8</td>
<td>20.4</td>
<td>0.003</td>
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<td>Current asthma</td>
<td>9.2</td>
<td>9.8</td>
<td>10.3</td>
<td>8.5</td>
<td>8.4</td>
<td>0.048</td>
<td>10.1</td>
<td>8.3</td>
<td>0.002</td>
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<tr>
<td>Allergic asthma</td>
<td>5.4</td>
<td>6.9</td>
<td>6.9</td>
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<td>6.0</td>
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<td>Non-allergic asthma</td>
<td>3.8</td>
<td>2.9</td>
<td>3.3</td>
<td>3.5</td>
<td>5.3</td>
<td>&lt;0.001</td>
<td>4.1</td>
<td>3.4</td>
<td>0.080</td>
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</table>

*-comparing age-groups. **-comparing sex. ***-comparing all SSYK/NYK/SEI groups respectively. ****-comparing VGDF to No VGDF.
workers industry and service. Within the NYK-occupational groups, productive cough and recurrent wheeze were most prevalent among mining, manufacturing, and service while current asthma was most prevalent among healthcare and service. Regarding the SSYK-occupational groups, productive cough was most prevalent among administration, agriculture, manufacturing, and elementary, while recurrent wheeze was most prevalent among service, building, manufacturing, and elementary. All respiratory symptoms and asthma were significantly more prevalent among subjects reporting exposure to VGDF compared to non-exposed (Table 3).

**Socioeconomic group as a risk factor for respiratory symptoms and asthma**

In logistic regression models adjusted for sex, age, family history of asthma, and smoking habits, manual workers industry, and service were significantly associated with productive cough and recurrent wheeze. Non-manual employees had increased risk of productive cough (Table 4). When adjusted also for VGDF-exposure, manual workers service and non-manual employees remained significantly associated with productive cough (Table 4). When stratifying for years in occupation, the risk for productive cough was increased in the 1st and 2nd quartiles among manual workers, while the risk for recurrent wheeze and current asthma was increased in the 3rd quartile among manual workers and non-manual employees (online table 1).

**Occupational group as a risk factor for respiratory symptoms and asthma**

Adjusted analyses were also performed for the occupational groups. Regarding the NYK-occupational groups, healthcare and service were both significantly associated with non-allergic asthma while manufacturing was associated with recurrent wheeze (Table 4). When stratifying for years in occupation, transportation in the 3rd quartile had increased risk...
of current asthma, and the 3rd and 4th quartiles of manufacturing had increased risk of recurrent wheeze (online table 1).

For the SSYK-occupational groups, all groups but occupations requiring advanced or higher education were associated with productive cough. Building, manufacturing, and elementary were also associated with recurrent wheeze. The association between administration, service, and elementary and productive cough remained statistically significant when also adjusting for occupational exposure to VGDF.

### Occupational exposure to VGDF as risk factor for respiratory symptoms and asthma

Occupational exposure to VGDF was associated with increased risks of all outcomes. Analyses executed among only non-smokers yielded similar results (Table 4). When stratifying for years in occupation, the risks remained significantly increased in all quartiles (online table 1).

#### Prevalence of occupational exposure to VGDF in the different socioeconomic and occupational groups

Within the SEI groups, manual workers in industry reported significantly higher prevalence of occupational exposure to VGDF compared to the rest of the population (Figure 1(A)). In the NYK-occupational groups this was true for agriculture, mining, and manufacturing (Figure 1(B)), and for the SSYK-occupational groups: agriculture, building, and manufacturing (Figure 1(C)).

#### Sensitivity analysis

When excluding individuals with asthma onset before the age of 18 years, the results did not change significantly (online table 2).
Table 4. Risk for respiratory symptoms and asthma by socioeconomic group (SEI), occupational groups (NYK and SSYK), and self-reported occupational exposure to VGDF analysed by multivariable logistic regression and expressed as odds ratios (OR) and 95% confidence intervals (95% CI). All analyses were adjusted for sex, age, family history of asthma and smoking habits. Significant results in bold, borderline significant results in bold italic.

<table>
<thead>
<tr>
<th></th>
<th>Productive cough</th>
<th>Recurrent wheeze</th>
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<th>Rhinitis</th>
<th>Current asthma</th>
<th>Allergic asthma</th>
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<td>OR</td>
<td>95% CI</td>
<td>OR</td>
<td>95% CI</td>
<td>OR</td>
<td>95% CI</td>
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<td>2.34</td>
<td>0.81</td>
<td>0.65</td>
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<td>2.11</td>
<td>0.87</td>
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<td>2.36</td>
<td>2.06</td>
<td>2.71</td>
<td>1.32</td>
<td>1.18</td>
</tr>
<tr>
<td>Occupational exposure (among non-smokers*)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No VGDF</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VGDF</td>
<td>2.21</td>
<td>1.76 2.78</td>
<td>2.46</td>
<td>2.00</td>
<td>3.03</td>
<td>1.30</td>
<td>1.13</td>
</tr>
</tbody>
</table>

*Significantly increased when also adjusted for VGDF.

*The analyses were performed among non-smokers only.
Discussion

In this population-based study, we found that two of the systems of classifying job titles, SEI and SSYK, gave in most aspects similar results and could identify subjects with increased risk for respiratory symptoms also after adjusting for exposure to VGDF, while the third, NYK, did not give any conclusive results. We found associations between productive cough and manual workers as well as non-manual employees. Within these socioeconomic groups, there are jobs such as builders, transportation workers, service workers, nurses, teachers, and administration clerks which also were found in the SSYK-groups associated with respiratory symptoms. Not surprisingly, the reported prevalence of exposure to VGDF was highest among subjects belonging to these occupational and socioeconomic risk groups. However, the association between respiratory symptoms and these socioeconomic and occupational groups remained after adjustment for exposure to VGDF, indicating that other factors than VGDF may contribute to the observed associations.

A Swedish study from the mid-eighties and early nineties reported associations between wheeze and cough, and...
which can create bias as exposure to specific job agents in certain occupations can cause symptoms after a shorter period of time, and we do not have data on job changes. However, our results indicate that symptoms such as cough may develop after a shorter period of exposure while a longer period of exposure is needed for symptoms such as wheeze. Further, we have in a previous study found indications that different types of exposure associate with different types of respiratory symptoms [35].
The job titles and occupational exposure to VGDF were self-reported, and recall bias cannot be ruled out; those with respiratory symptoms/asthma may have been more prone to report previous occupational exposure. Occupational exposure can be estimated using a single-item question of exposure or by using a JEM based on job titles [14,36]. Some argue that a JEM leads to more accurate measures of occupational exposure, while others have reported that the difference between self-reporting and JEM are less than expected and that a question of VGDF-exposure is applicable in epidemiological research [14–16]. However, it should be noted that self-reporting usually yields higher risks and more strongly statistically significant results than a JEM [14]. The strength with our study was the large population-based cohort with a high participation rate resulting in a representative study population. Furthermore, the questionnaire and questions [7–10,14,16,24,26,28,35] have been used in several studies.

In summary, in this cross-sectional study, two of the three different classification systems, SSYK and SEI gave similar results and identified groups with increased risk for respiratory symptoms and asthma, while NYK did not give conclusive results. Occupational exposure to VGDF was consistently and significantly associated with all respiratory symptoms and asthma. The increased risk for respiratory conditions associated with certain socioeconomic and occupational groups were independent of exposure to VGDF indicating that also other job-related factors than VGDF contribute to respiratory illness.

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Disclosure statement

No potential conflict of interest was reported by the authors.

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CS contributed in the study design, carried out the statistical analyses, and drafted the manuscript. ER contributed in the study design, collection of data, and critical revision of the manuscript. AL, MA, LH, ME, and HB contributed with critical revision of the manuscript. LH also contributed with collection of data and HB with data management.
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