Occupational Asthma in a National Disability Survey

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The contribution of workplace exposures to the prevalence of asthma in adults has been minimized in the epidemiology of this illness. Analysis of the 1978 Social Security Disability Survey provides a population-based assessment as a novel approach utilizing self-attributed, occupationally related asthma as a measure of disease. Of 6,063 respondents, 468 (7.7 percent) identified asthma as a personal medical condition; 72 (1.2 percent [15.4 percent of all those with asthma]) attributed it to workplace exposures. These subjects were older and included more men and cigarette smokers than groups of both asthmatic and nonasthmatic subjects. The relative risk for occupationally attributed asthma was elevated among industrial and agricultural workers as compared with white collar and service occupations. Analysis of disability benefit status did not indicate that this introduced major reporting bias in this survey. This study suggests that occupational factors may have a greater role in adult asthma than previously thought.

Occupational asthma is linked to a variety of trades. Individual associations with materials as diverse as plants, animals, metals, and synthetic organic chemicals have been established through cohort or case studies. This agent-by-agent approach has not been supplemented by a systematic assessment of the prevalence of occupational asthma in the workplace because of both an absence of valid surveillance measures of occupational disease and a lack of population-based studies of asthma. A recent thorough review cites estimates for the proportion of asthma due to occupation as ranging from 2 to 7 percent.4 However, such projections are forced to depend on precisely these limited agent-specific approaches. Two United States population-based community surveys of respiratory symptoms and pulmonary function have examined the association between dusty or high exposure environments and complaints consistent with obstructive lung disease, although occupation-specific data were not studied.5,7

This study utilizes the 1978 Social Security Administration Survey of Disability and Work (SDA) to assess occupational asthma. The purpose in analyzing these survey data is to assess occupational asthma in the community, as opposed to studying samples drawn from clinical series or limited occupational cohorts.

Specifically, this study identifies individuals attributing their asthma to workplace exposures. Study goals were to ascertain the prevalence of such occupationally attributed asthma and the degree to which those with presumptive occupationally related asthma differ from others who have asthma and from those who do not. Differences of interest include demographic attributes, duration and severity of disease, and occupational risk factors. By addressing these questions utilizing a population-based approach, this investigation hopes to provide a perspective not typically applied to the problem of occupationally related asthma.

**METHODS**

Survey Design

The SDA was completed in 1978 by the Social Security Administration. Questionnaires were administered in household interviews to a national sample of noninstitutionalized adults aged 18 to 64 years. Respondents were derived from two sampling frames. One frame comprised 6,900 subjects selected from 1976 Health Interview Survey (HIS) respondents, representing the community at large but drawing disproportionately among those with activity limitations. The second frame comprised 4,500 subjects chosen from applicants for Social Security disability (SSDI) benefits, a group representing the chronically ill population base. This latter SSDI sampling frame includes approximately 10 percent who were denied such benefits.8

Survey respondents provided demographic data and information on any medical conditions that they might have, beginning with physician-diagnosed illnesses. Specific pulmonary conditions elicited included asthma, chronic bronchitis, and emphysema, although additional diagnoses could be supplied by the respondent. Up to 20 conditions could be listed.

Case Definition of Occupationally Related Asthma

For each health condition the patient was asked, "Was this condition caused by bad working conditions, such as noise, heat, or smoke?" Since this question was asked for each identified condition, it is nonspecific but clearly refers to the general physical nature of the workplace. It is an affirmative response to this question that defines occupationally related asthma for the epidemiologic purposes of this study. Although questionnaire respondents were allowed the equivocal answer of "maybe," this was not considered positive for this case definition.

**Exposure and Employment Histories**

Survey respondents provided occupational histories as follows:
employer at the time of the interview; one year prior to the interview if different than the current employer (for example, "Was the main job you had last year for the same employer as your main job last week?"); if not employed during that year, employer if within five years preceding the interview; or, work history dating to the time of disabling health condition, if present. In this study, employment is collapsed into a single set of variables corresponding to those present in the record for the time period most closely predating the interview. The SDA designates industry and occupation according to three-digit census codes.

This approach assumes that dislocations in employment did not typically reflect a career change and that therefore the last occupation and industry available formed a representative work history. It was possible to test the validity of this assumption by identifying those for whom the employer had not changed since at least before the onset of their asthma: those with duration of symptoms less than duration of last employment. This could then be applied to test whether occupation by this conservative requirement demonstrated a different relationship to workplace-attributed asthma than the less restrictively defined classification.

This study limits analysis to the 6,063 respondents in the survey with histories of any active work force participation. Of these, 2,022 remained from the HIS and 4,041 from SSDI sampling frames. Analyses requiring specific job histories were further restricted to 5,005 respondents for whom such data were available.

Statistical Analyses and Risk Calculations

Analysis of means or proportions for demographic variables among occupational asthmatic subjects and all other asthmatic and nonasthmatic subjects required three-way pair-wise comparisons between groups. Differences in these values were tested with the use of the Kramer modification of the Tukey multiple comparison adjustment. Comparisons, such as those for length and severity of illness restricted to occupationally attributed vs all other asthma, were tested using the Student t test or the continuity-adjusted chi square.

Risk factors for occupationally related asthma were assessed by calculating the prevalence of workplace-attributed asthma among certain industrial or occupational classifications relative to all other employment. Confidence intervals about these relative risks were based on the ratio of a Poisson variable to its expectation.*

The relative risk for occupationally related asthma associated with a broadly defined occupational category of industrial-agricultural employment (census occupational codes 400-900) also was calculated. The choice of this broad exposure category is consistent with study goals utilizing a nonexclusive risk measure not dependent on a narrowly defined list of specific hazards. At the same time, this exposure designation recognizes that most workplace causes of asthma would be expected in industrial as opposed to service or managerial trades. Since age and sex are both possible confounders of industrial or agricultural employment and illness prevalence, adjustment for these factors was carried out. Sex and age adjustment was accomplished with the use of a multiple logistic regression with a specified model. This analysis was further refined by stratification according to smoking status.

Confidence intervals about these adjusted relative risks were calculated directly with the use of regression statistics. In both this case and that of the Poisson-generated statistic, 95 percent confidence intervals (CI) excluding 1.0 indicate relative risks differing significantly from unity (p<0.05).

In order to assess the contribution of industrial-agricultural employment to the prevalence of occupational asthma, the attributable risk in addition to the relative risk of illness also was analyzed. The difference in prevalence between those with and without the occupational risk factor, which is the calculated attributable risk, divided by the overall prevalence, yields the population attributable risk.

Because of the design of the SDA survey, identification by sampling frame was possible. Therefore, the HIS sampling frame also was analyzed in a separate stratification. This analysis was designed to exclude the effect of prior application for disability benefits on the attribution of occupational cause, as it was primarily the SSDI frame that contained such applicants. All computations were made with the use of a standard statistical package (SAS:1982, 1983), with the exception of the relative risks as cited.

RESULTS

Of 6,063 respondents, 468 (7.7 percent) stated that they had asthma. All but 12 listed this as a physician's diagnosis. Seventy-two respondents attributed asthma to "bad working conditions." These occupationally related asthma cases represented 15.4 percent of all asthma and 1.2 percent of all respondents. Table 1 presents demographic data for those with occupationally related asthma, those with all other types of asthma, and nonasthmatic subjects. Occupational cases were older and had a greater proportion of men, smokers, and former smokers. On average, they also had attended fewer years of school, had lower incomes, and were more frequently union members in their last place of employment as compared with other respondents.

As shown in Table 2, a significantly greater proportion of those attributing their asthma to occupational causes stated that this condition limited their ability to work. Table 2 also illustrates that the mean duration of asthma was similar between groups. Among those for whom detailed work histories were available, almost half of the respondents with workplace-related asthma were with their last employer at the onset of their symptoms. Twenty-one of the occupationally attributed cases had at some time applied for workers'
compensation for any reason, although only two were receiving such benefits at the time of interview.

Table 3 delineates the relative risks of occupational asthma for a variety of employment. Not listed in Table 3 are certain trades of expected elevated risk for which there were no observed cases of occupationally attributed asthma in this survey, including animal handlers, painters, solderers, and grain millers. The risk of workplace-attributed asthma among agricultural and industrial occupations relative to all other employment was elevated and remained so even controlling, through stratification, for cigarette smoking and, by adjustment, for age and sex. Paradoxically, this relative risk was lower for smokers than for subjects who had never smoked.

In order to test whether a more restrictive occupational history would change the estimated effect of industrial-agricultural employment, the relative risk was recalculated limiting workplace-attributed cases to those that had not changed employers since the onset of symptoms (n = 29). In this analysis, the relative risk of occupationally related asthma associated with industrial-agricultural employment was 2.55 (95 percent CI 1.04 to 6.17), which is similar to previous estimates.

For industrial-agricultural employment, the population-attributable risk was 37.3 percent. This is based on the difference rather than the ratio of rates of illness among exposed vs nonexposed subjects and reflects the amount of observed disease accountable to the risk factor in question.

In order to assess possible bias toward occupational attribution of disease in the SSDI sampling frame, HIS data were analyzed separately. This removed from analysis cases that had previously applied for disability and thus may have been more inclined to misattribute their disease to occupational causes in the belief that this would promote award of benefits. Of 2,022 HIS respondents, 159 (7.9 percent) identified asthma as a health condition; 19 of these cases were occupationally attributed (11.9 percent of all asthma; 0.94 percent of all HIS respondents). This compares to a prevalence of occupationally attributed asthma of 1.31 percent among the disability sample, or 17.1 percent of all asthma in that group. Although the disability prevalence was higher, this difference did not achieve statistical significance. Moreover, the risk of occupational asthma associated with industrial-agricultural employment remained elevated among HIS respondents when analyzed separately: sex- and age-adjusted relative risk is 1.85. Concomitant with smaller sample size, the 95 percent CI was larger: 0.89 to 3.40.

**Discussion**

These data indicate that the problem of occupationally related asthma may be larger indeed than previously estimated. These results, which suggest reconsideration of the minor role generally allotted workplace exposures in the etiology of asthma overall, must be interpreted with the caution warranted by the study design.

In the ideal world (if the workplace was not then risk-free), one could study all employees, identifying prospectively, by strict medical criteria, all those with asthma, correlating this with industrial hygiene data-quantifying exposures. The proxy used here to evalu-

### Table 2—Duration and Severity of Illness

<table>
<thead>
<tr>
<th>Duration and Severity</th>
<th>Subjects With Occupational Asthma</th>
<th>Subjects With All Other Types of Asthma</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean duration of asthma, yr (± SD)</td>
<td>17.0 (± 12.8)</td>
<td>18.8 (± 15.3)</td>
</tr>
<tr>
<td>Asthma limiting ability to work, n (%)</td>
<td>26/72 (36%)</td>
<td>95/396 (24%)</td>
</tr>
<tr>
<td>Asthma onset with last employer, n (%)</td>
<td>29/59 (49%)</td>
<td>77/315 (24%)</td>
</tr>
</tbody>
</table>

*p<0.05, as compared with subjects with all other types of asthma.

### Table 3—Relative Risks of Occupational and All Asthma by Employment

<table>
<thead>
<tr>
<th>Employment</th>
<th>Relative Risk for Occupational Asthma Only</th>
<th>(95% CI)*</th>
<th>Relative Risk for all Asthma</th>
<th>(95% CI)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm machinery manufacture</td>
<td>11.0</td>
<td>(1.33-39.6)</td>
<td>4.22</td>
<td>(1.15-9.85)</td>
</tr>
<tr>
<td>Coal Mining</td>
<td>7.37</td>
<td>(1.52-21.6)</td>
<td>1.87</td>
<td>(0.60-4.36)</td>
</tr>
<tr>
<td>Agricultural</td>
<td>3.74</td>
<td>(1.37-8.15)</td>
<td>1.38</td>
<td>(0.77-2.27)</td>
</tr>
<tr>
<td>Textile</td>
<td>3.03</td>
<td>(0.62-8.86)</td>
<td>2.19</td>
<td>(1.19-3.67)</td>
</tr>
<tr>
<td>Bakery</td>
<td>2.85</td>
<td>(0.07-16.4)</td>
<td>2.32</td>
<td>(0.75-5.42)</td>
</tr>
<tr>
<td>Lumber, wood</td>
<td>1.76</td>
<td>(0.21-6.35)</td>
<td>1.90</td>
<td>(0.99-3.07)</td>
</tr>
<tr>
<td>All industrial or agricultural occupations†</td>
<td>1.93</td>
<td>(1.06-3.50)</td>
<td>1.05</td>
<td>(0.85-1.30)</td>
</tr>
<tr>
<td>Never Smoked Cigarettes†</td>
<td>5.81</td>
<td>(1.18-27.3)</td>
<td>1.02</td>
<td>(0.68-1.52)</td>
</tr>
<tr>
<td>Cigarette Smokers†</td>
<td>1.50</td>
<td>(0.79-2.82)</td>
<td>1.06</td>
<td>(0.83-1.36)</td>
</tr>
</tbody>
</table>

*95 percent confidence intervals about the point estimate of the relative risk. Confidence intervals excluding 1.0 indicate relative risks with associated p values <0.05.
†Age- and sex-adjusted. Cigarette smoker defined as greater than 100 cigarettes, lifetime consumption.
ate the prevalence of occupationally related asthma is far from that ideal. Data are retrospective, sample-based, dependent on self-attributed etiology, defined by nonmedical-record-verified physician diagnosis, and correlated with job title rather than directly with exposure. Furthermore, the sample is weighted with those at risk of disability and therefore potentially prone to be influenced in disease attribution. When interpreting the findings of this study, these potential sources of bias must be considered.

Sample-Based Data

Collection of a national sample such as done by the SDA is beyond the scope of any individual researcher. The ability to exploit such valuable information is a major advantage of secondary data analysis.

The 7.7 percent sample-based rate of asthma in this survey is consistent with other population-based data. The 1979-1981 National Health Survey estimate for the prevalence of asthma among those 45 to 64 years of age was 3.2 percent.\textsuperscript{10} The reported prevalence of wheeze in the Six Cities Study ranges from 6.1 percent for women to 8.6 percent for men.\textsuperscript{11} In Tucson, AZ, the overall prevalence of asthma is 9.6 percent.\textsuperscript{12}

The SDA survey data have proved useful in previous evaluations of occupational disease; 1972 and 1974 SDA data were applied to a comprehensive assessment of such illness.\textsuperscript{13} Although asthma was not analyzed separately, of those at least partially disabled from any respiratory disease, 18.6 percent attributed their condition to occupational exposures. A more recent study of causes of disability in the 1978 SDA found that occupational and health factors and not income replacement were predictors of disability, although occupational illness was not considered directly.\textsuperscript{14}

Self-Attributed Disease

Patients' self-attributions of disease cause evoke skepticism. One study of medical record confirmation of chronic disease conditions elicited by patient interview found that only 49 percent of asthma cases could be so verified.\textsuperscript{15} However, that survey did not differentiate between respondent-reported physician- and self-diagnosed illness. Accuracy of diagnosis specific to occupational asthma is further complicated by the frequent difficulty in identifying a link between workplace exposure and disease even if it were present.

Moreover, the diagnoses of asthma, emphysema, and chronic bronchitis often are overlapping.\textsuperscript{16} This complicates any nosology of occupational asthma, as does continuing debate over the meaning of the diagnostic entity "industrial bronchitis."\textsuperscript{17} It is probable that the association between occupational asthma and coal mining in this study reflects obstructive lung disease in the face of coal workers' pneumoconiosis. Similarly, the increased relative risk of occupational asthma among textile workers might more appropriately be considered a risk of byssinosis than of asthma \textit{per se}. It is interesting to speculate that some cases of extrinsic alveolitis among agricultural workers in this study may have been misdiagnosed as asthma. A population survey of agricultural workers in Italy has found a prevalence of farmer's lung equal to half that of asthma, as well as a significant increase in chronic bronchitis as compared with control subjects.\textsuperscript{19}

For these reasons, occupationally attributed asthma cannot achieve, as an epidemiologic category, the accuracy of a rigorous clinical diagnosis, nor is it meant to do so. It does provide a measure of disease that can then be tested against known or proposed attributes in order to assess its external validity. In this respect, the consistency of risk factors and demographic variables with known parameters supports the validity of the case definition of occupationally related asthma as it is used in this study.

Exposure Risk Measures

The risk of workplace-attributed asthma among survey respondents employed in industrial or agricultural trades was twice that of others. This employment factor alone accounted for over a third of the occupationally attributed asthma noted. These are precisely the employments, in general, for which elevated risk of job-related asthma would be expected. Specific occupations also demonstrated elevated risks consistent with known mechanisms.

Analysis limited to cases with definite job histories at the time of illness onset yielded results similar to that using all employment data. This again supports the validity of occupation identified in this survey as a measure of exposure.

Risk association does not indicate causality: occupation may lead to asthma, or asthma may influence employment choice. Indeed, the relative risk for asthma overall was not elevated among industrial-agricultural workers. Restated, there is reduced risk for nonoccupational asthma among these workers. This could be explained by the selection of those with preexisting asthma out of such employment. That would be consistent with the long recognized "healthy worker effect"\textsuperscript{18} and supported by observations specifically among those at risk for occupational asthma.\textsuperscript{21}

Influences of Disability Status

Occupational attribution of asthma did differ among those who had or had not applied for disability benefits: reporting such an association was about a third less in the nondisability group. Reporting bias is one explanation for this observed difference. An equally plausible explanation is that disabling asthma is more likely to be occupational in etiology than nondisabling asthma. Finally, the probability of seeing such a
difference by chance alone was approximately one in four.

**Conclusion**

In summary then, potential effects of selection through sampling error; of assessment in illness and exposure; and of misattribution of cause do not appear to have been major sources of bias in this analysis. Rejecting these as likely explanations for the findings reported here, one must return to the conclusion that the high prevalence of occupationally attributed asthma detected in this study is a valid observation, implying that revision is necessary in our assessment of this public health problem.

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