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Inhalation Incidents and Respiratory Health: Results From the European Community Respiratory Health Survey

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Abstract

Background—Inhalation incidents are an important cause of acute respiratory symptoms, but little is known about how these incidents affect chronic respiratory health.

Methods—We assessed reported inhalation incidents among 3,763 European Community Respiratory Health Survey (ECRHS) participants with and without cough, phlegm, asthma, wheezing or bronchial hyperresponsiveness. We then examined whether inhalation incidents during the 9-year ECRHS follow-up period were associated with a new onset of any of these respiratory outcomes among 2,809 participants who were free of all five outcomes at the time of the baseline ECRHS survey.

Results—Inhalation incidents were reported by 5% of participants, with higher percentages reported among individuals with asthma-related outcomes at the time of the baseline survey. Among participants without symptoms at baseline, our analyses generated non-statistically significant elevated estimates of the risk of cough, phlegm, asthma and wheezing and a non-statistically significant inverse estimate of the risk of bronchial hyperresponsiveness among participants who reported an inhalation incident compared to those without such an event reported.

Discussion—Our findings provide limited evidence of an association between inhalation incidents and asthma-related symptoms. These data could be affected by differences in the reporting of inhalation incidents according to symptom status at the time of the baseline survey; they should thus be interpreted with caution.

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Keywords

accident; asthma; epidemiology; inhalation; respiratory health

INTRODUCTION

Inhalation incidents are an important cause of respiratory symptoms and pulmonary injury in occupational and other indoor and outdoor environments. Work-related asthma and other respiratory health effects that occur after acute, occupational inhalation exposures to chlorine, isocyanates, formaldehyde, glutaraldehyde, and other sensitizing and/or irritant agents are well documented [Ross and McDonald, 1996; Sallie and McDonald, 1996; Olin et al., 1999; Henneberger et al., 2003; Henneberger et al., 2005; McDonald et al., 2005; Andersson et al., 2006]. Criteria for diagnosing asthma-like illness following acute inhalation exposures to respiratory irritants were initially proposed in a case series report describing respiratory impairment among patients with no pre-existing respiratory illness and who experienced acute high-level, uncontrolled irritant exposures [Brooks et al., 1985]. To highlight the hyperreactive airway symptoms shared by each of the victims of inhalation incidents, Brooks et al. applied the term “reactive airways dysfunction syndrome” (RADS) to the resulting illness. Longitudinal monitoring of respiratory symptoms and lung function among individuals who experience such exposures indicates that, in addition to the acute bronchial hyperreactivity (BHR) identified, the exposures often initiate notable intermediate and long-term respiratory symptom sequelae [Ross and McDonald, 1996; Agabiti et al., 2001; Demeter et al., 2001; Prezant et al., 2002; Banauch et al., 2003; Bonetto et al., 2006].

To date, the most informative data available about respiratory symptoms following inhalation incidents at work are available through the Surveillance of Work-related and Occupational Respiratory Disease (SWORD) project [Ross and McDonald, 1996; Sallie and McDonald, 1996; McDonald et al., 2005]. In this occupational health surveillance system, participating chest physicians and occupational medicine physicians in the UK reported newly diagnosed cases of work-related respiratory disease. From January 1990 to June 1993, the participating physicians reported over 700 cases, including those that arose from six multi-case work-related accidents and hundreds of single-case incidents. Overall, the inhalation incidents were largely attributed to leaks or spills, equipment failure, and lack of adequate respiratory or ventilation equipment [Sallie and McDonald, 1996]. These surveillance data suggest that workers in selected industries (e.g., mining, petrochemical manufacturing, manufacturing of metallic products) and those using chemical and organic agents on the job may be at the highest risk of illness caused by inhalation incidents in the workplace [Sallie and McDonald, 1996; McDonald et al., 2005].

In non-occupational settings, inadequate ventilation and the location of the exposure may lead to particularly high risks of respiratory health effects in individuals with increased respiratory susceptibility. Indeed, observation of children and adults exposed to sudden releases of chlorine gas into indoor swimming pool facilities indicates that such exposures frequently trigger or exacerbate respiratory health symptoms that persist for up to several months after exposure [Agabiti et al., 2001; Bonetto et al., 2006].

Overall, however, little is known about inhalation incident exposures among members of the general population. In an analysis of occupational exposures among participants in the occupational health portion of the European Community Respiratory Health Survey II (ECRHS II), Kogevinas et al. [2007] reported a threefold higher incidence of asthma with BHR among respondents who reported experiencing inhalation incidents during the ECRHS follow-up period, compared to those who did not report such an incident. Using the same data source, we

conducted further analyses to assess the risk of additional respiratory health outcomes among ECRHS II participants who reported inhalation incidents. We also discuss observed differences in the reporting of inhalation incidents by respondents with and without respiratory symptoms at the time of the baseline ECRHS survey and the potential impact of these observed differences.

METHODS

European Community Respiratory Health Survey

The ECRHS is a population-based cohort study of respiratory health among adults living near 28 study centers in 13 countries. The study design and methods have been described previously [Burney et al., 1994; The European Community Respiratory Health Survey Steering Committee, 2002]. Summarized briefly, the ECRHS is a longitudinal study with a fixed cohort; initial survey of the population began in 1991 (ECRHS I), and in 1998–1999, investigators began follow-up of a center-stratified random sample of ECRHS I participants (ECRHS II). Each ECRHS II participant completed an interviewer-administered questionnaire, including a survey about respiratory symptoms and asthma therapies. Institutional Review Boards in each participating study center approved the protocol and instruments and all participants provided written informed consent.

Inhalation Incidents

To identify participants who experienced inhalation incidents, the main ECRHS II questionnaire included the question ‘Since the last survey have you been involved in an accident at home, work, or elsewhere that exposed you to high levels of vapours, gas, dust or fumes? (no/yes).’

Respiratory Symptoms, Bronchial Hyperresponsiveness and Atopy

We identified participants with asthma-related symptoms at the times of the baseline and follow-up surveys using responses to questions about the following symptoms: wheeze in the absence of a cold, chronic cough, chronic phlegm, waking due to shortness of breath, use of asthma medication and asthma attack. Responses about waking due to shortness of breath, use of asthma medication and asthma attacks have been used previously as a definition of current asthma [Mirabelli et al., 2007], and therefore, to maintain consistency with previous analyses, we group these three outcomes together as “current asthma” rather than considering them separately. In addition, we identified participants with BHR based on responses to methacholine challenge tests administered with the ECRHS I and ECRHS II surveys. As in previous analyses of ECRHS data, a positive response to the methacholine challenge was defined as a 20% decrease in FEV₁ for any dose of methacholine equal to or below 1 mg [The European Community Respiratory Health Survey Steering Committee, 2002]. In these analyses, respondents were categorized as atopic if they had a specific serum IgE level >0.35 kU/L to at least one of four common environmental allergens (dust mite, cat, Timothy grass, *Cladosporium herbarum*), as measured at the time of the baseline ECRHS survey.

Work-Related Characteristics

At the time of ECRHS I, each participant reported his/her employment status as employed (manager, supervisor/foreman or other employee), self-employed, or not-employed. Respondents who reported being employed or self-employed answered follow-up questions about whether they had ever experienced work-related exposures to vapors, dust, gas, or fumes (yes/no). At the time of ECRHS II, each respondent provided job titles as well as starting and ending dates for each job held during the follow-up period. In this analysis, we used the occupational category corresponding to the job held for the longest period during the follow-

up. Jobs were coded into occupational categories according to the International Standard Classification of Occupations (ISCO-88) [ILO, 1990], and occupations were then grouped using asthma-relevant occupational categories identified for previous analysis of ECRHS data [Kogevinas et al., 2007].

Statistical Analysis

Our analyses are restricted to the random sample of ECRHS II participants for whom complete data are available for the variables included in our final analysis ($n = 3,763$). We excluded participants due to missing information about one or more of the following: inhalation incidents ($n = 950$), BHR ($n = 4,372$), and survey-based respiratory symptoms ($n = 519$). We also excluded 412 additional participants with missing information about the covariates included in our final models. The resulting population included ECRHS II participants from 23 study centers located in 10 countries. Using this population, we first evaluated associations between asthma-related symptoms, including BHR, reported at the time of the baseline ECRHS survey and inhalation incidents reported at time of the follow-up ECRHS survey. We conducted these analyses using Poisson regression with robust error variances. Measures of association are reported as risk ratios (RRs) with 95% confidence intervals (95% CIs), indicating the risk of an inhalation incident during the ECRHS follow-up period among respondents with each of the respiratory outcomes at the time of the baseline ECRHS survey, as compared to the risk among respondents without such outcomes reported at the time of the baseline survey.

In a second series of analyses, we restricted our population to the 2,809 participants without any of the asthma-related symptoms or BHR at the time of the baseline survey, in order to assess associations between inhalation incidents during the approximately 9-year ECRHS follow-up period and new-onset symptoms reported at the time of the ECRHS II follow-up survey. As with the previous analyses, we conducted these analyses using Poisson regression with robust error variances, and measures of association are reported as RRs with 95% CIs. This was done in order to compare the risk of developing new-onset symptoms among previously symptom-free respondents who reported inhalation incidents to the risk of new-onset symptoms among previously symptom-free respondents without an inhalation incident reported. In both sets of analyses, all models were adjusted for age, sex, country, atopic status at ECRHS I and smoking status at ECRHS II (current smoker, ex-smoker, never a smoker). In addition, we conducted sensitivity analyses to assess the impact of excluding from our final study population 2,618 (60%) of the 4,372 individuals without BHR measurements in the baseline and follow-up surveys. Because these 2,618 participants had complete data about the inhalation incident exposure, respiratory symptoms and covariates included in our final models, their exclusion was entirely due to the missing BHR status and they would have been included if we had not assessed BHR as a respiratory outcome. These analyses allowed us to include participants in Belgium and Estonia, the two countries in which BHR testing was not included in the ECRHS II protocol. All analyses were performed using SAS version 9.1 (SAS Institute, Inc., Cary, NC).

RESULTS

Overall, inhalation incidents were reported by over 5% (220/3,763) of our final study population (Table I). Only slight differences in the percentages of respondents reporting inhalation incidents were observed by age, sex, atopic status and smoking status.

The percentages of respondents with inhalation incidents were consistently larger in the population with asthma-related symptoms at the time of the baseline survey, compared to the population without each of the corresponding symptoms and the population with none of the five symptoms (Table II). Overall, the smallest difference was observed when individuals were classified based on their BHR status using responses to the methacholine challenge test, and

the lowest percentage was observed among individuals without BHR and without any of the questionnaire-based asthma symptoms (5%). RR point estimates for the risk of reported inhalation incidents increased monotonically as the total number of asthma-related respiratory outcomes (i.e., BHR, chronic cough, chronic phlegm, current asthma, current wheeze) identified at the time of the baseline ECRHS survey increased.

Among the 2,809 participants who were free of all of the five respiratory outcomes at the time of the baseline survey, analyses of the associations between inhalation incidents and new-onset of each outcome generated non-statistically significant elevated estimates of risk of the questionnaire-based symptoms and a non-statistically significant inverse estimate of risk of BHR (RR: 0.43, 95% CI: 0.16, 1.14) among participants who reported inhalation incidents, compared to those without such an incident reported (Table III).

To further investigate whether the inhalation incidents reported in the ECRHS II may have been work-related events, we examined the percentage of respondents reporting inhalation accidents by type of employment and occupational category (Table IV). Higher percentages were reported among employed managers and supervisors than among respondents in the remaining employment categories; across occupational categories, inhalation incidents were reported less frequently among respondents in professional, non-manual occupations (e.g., legislators, managers, administrators, clerks: 5%), than among those in professional, manual occupations, or among homemakers. Among the 1,600 respondents who reported occupational exposure to vapors, gas, dust or fumes in the baseline survey, and who thus may be considered at high risk of experiencing a subsequent work-related inhalation incident, the percentage of individuals reporting inhalation incidents was similar to or higher than that reported by the total study population overall, and in each of the professional non-manual and manual occupational categories except nursing.

By excluding from our analysis 2,618 participants for whom we did not have valid information about BHR status at the times of the baseline and follow-up surveys but for whom we had complete data for the remaining covariates included in our models, we were able to assess associations between BHR at baseline and self-reported inhalation incidents as well as the risk of developing BHR among those who experienced an inhalation incident. Among these excluded participants, 5% (n = 141) reported inhalation incidents. Inclusion of these individuals increased the percentage of individuals reporting inhalation incidents by 0.3% and increased the precision of the RRs estimated, but this inclusion did not result in marked changes in the associations presented in Table II (chronic cough: RR: 1.59, 95% CI: 1.16, 2.13; chronic phlegm: RR: 1.46, 95% CI: 1.04, 2.04; current asthma: RR: 1.43, 95% CI: 1.04, 1.98; current wheeze: RR: 1.73, 95% CI: 1.33, 2.24). The corresponding inclusion of data from 2,108 of these participants to the analysis of new-onset symptoms (i.e., Table III), resulted in similarly modest changes in the RR estimates (chronic cough: RR: 1.27, 95% CI: 0.78, 2.08; chronic phlegm: RR: 1.64, 95% CI: 0.94, 2.87; current asthma: RR: 1.83, 95% CI: 1.22, 2.76; current wheeze: RR: 1.31, 95% CI: 0.86, 1.99).

DISCUSSION

These findings provide limited evidence of an elevated risk of new-onset respiratory symptoms among ECRHS II respondents who reported experiencing an inhalation incident, compared to those without such a report. By presenting RRs for each of four asthma-related symptoms and for new-onset BHR among previously symptom-free and BHR-free ECRHS II participants, these results support and extend previously published analyses of new-onset asthma symptoms and work-related exposures, including inhalation incidents, among ECRHS II respondents [Kogevinas et al., 2007]. However, interpretation of our findings as further evidence of elevated risk of new-onset symptoms is clearly limited by the non-significant associations generated,

and such an interpretation is not supported by the RRs generated for the risk of developing BHR.

Overall, the observation of elevated risks of new-onset asthma symptoms identified using the ECRHS II questionnaire was not accompanied by elevation in the risk of BHR. This finding raises the possibility that, if participants who reported experiencing an inhalation incident are more likely to self-identify themselves as having respiratory symptoms in the ECRHS II survey than those who did not experience such an incident, then the reporting of inhalation incidents may be affected by an important differential reporting bias. Further evidence of bias in the reporting of inhalation incidents is indicated by the differences observed between the percentages of respondents reporting inhalation incidents in the ECRHS II survey among those with and without symptoms reported in the ECRHS I survey. If having respiratory symptoms at the time of the baseline survey increases the risk of experiencing an inhalation incident in subsequent years, then the observed differences may reflect the actual experience of this population. Indeed, individuals in occupations or performing non-work-related activities with strong potential for inhalation exposures that initiate or trigger asthma may also be more likely to experience an inhalation incident. Our data do not include sufficient detail about environmental or occupational inhalation exposures at the time of the baseline survey to adequately assess this hypothesis. However, over 60% of the individuals who reported inhalation incidents also reported occupational exposures to vapors, gas, dusts or fumes, strongly suggesting that the majority of inhalation incidents reported here may be work-related. Equally likely, however, is the possibility that respondents with symptoms or occupational exposures at the time of the baseline ECRHS survey were more likely to identify and report an exposure as an inhalation incident due to a heightened awareness of respiratory health.

The RR point estimates for the survey-based asthma symptoms presented here should be interpreted with caution and should be balanced with the inverse estimates generated for BHR. Using data from the ECRHS I and II questionnaires, we were unable to assess the timing and severity of the inhalation incidents. This limitation also led us to restrict our original hypothesis to assessing changes in incidence of respiratory symptoms and BHR rather than in pulmonary function, as the changes in measurements of lung function may be more likely to be driven by other factors (e.g., an advancement in age of approximately 9 years) than by the occurrence of an inhalation incident during that period. Furthermore, there was considerable variation between countries in the percentages of respondents reporting inhalation incidents, raising the possibility that not only do jobs, household tasks, hobbies and other activities vary within and between countries, but that the interpretation of an inhalation incident may vary by culture and/or by language. Evidence of this can be seen in the broad range of verbatim descriptions of the inhalation incidents reported by Kogevinas et al. [2007]. Our analyses include ECRHS respondents from the 22 European ECRHS II centers and one participating center in the United States. In our total study population, 74 of the 220 respondents who reported inhalation accidents provided verbatim descriptions of the incidents. In the U.S. population, nearly 30% (n = 32) of respondents reported experiencing an inhalation incident, and, notably, each of the 32 respondents who indicated that they experienced an inhalation incident during the ECRHS follow-up period provided a description of the incident. Textual explanations of the events ranged from descriptions that identify work-related activities (e.g., glutaraldehyde used to clean rubber surgical instruments, toluene in a molecular biology laboratory, a methyl ethyl ketone spill at work) to those with more ambiguous work-relatedness (e.g., sewage vapors due to mechanical malfunction of sewage [treatment facility]). The variety of descriptions provided by this population clearly justifies the inclusion of more detailed survey questions, including those that explicitly solicit information about the event and would provide sufficient detail to further describe the inhalation exposures.

Each of the estimates generated in these analyses were based on a final population that excluded ECRHS participants with missing data for any of the following variables: age, atopic status, country, sex, and smoking status. While this definition of our final study population allowed us to more precisely interpret the risk estimates generated for each of the covariates included in the model, it noticeably reduced the size of the final population and potentially introduced additional bias into our final estimates. In our final study population, inhalation incidents were reported among 5% of atopic respondents and 6% of non-atopic respondents, compared to 8% of the 370 respondents excluded solely due to missing atopic status data. Including these respondents in our analyses of the associations between symptoms reported in the baseline ECRHS I survey and inhalation incidents (i.e., Table II) resulted in attenuated RR estimates and only slight changes in the precision of each estimate. For example, estimates of RR for chronic cough were attenuated from 1.78 (95% CI: 1.22, 2.61) to 1.57 (95% CI: 1.08, 2.28) and those generated for current wheeze were attenuated from 1.64 (95% CI: 1.15, 2.33) to 1.54 (95% CI: 1.12, 2.12). Similar analyses that included the 260 participants who were originally excluded from the study population that was symptom-free at the time of the baseline survey (i.e., Table III) resulted in less consistent changes (e.g., chronic cough: RR =1.45, 95% CI: 0.78, 2.68 vs. RR =1.32, 95% CI: 0.74, 2.36; current wheeze: RR =1.33, 95% CI: 0.74, 2.38 vs. RR =1.34, 95% CI: 0.78, 2.28).

Despite these limitations, the findings of our analyses conducted in the population without any of the five respiratory outcomes at the time of the ECRHS I survey raise the possibility that inhalation incidents are associated with self-identified asthma symptoms in the general population. In particular, the elevated RR point estimates generated for the associations of inhalation incidents with chronic cough and current asthma are consistent with previously published reports of the onset and persistence of upper airway irritation (i.e., reactive upper airways disease syndrome (RUDS)), indicated by nasal, pharyngeal, and laryngeal tract symptoms following inhalational exposures, as described in the literature [Demeter et al., 2001; Matrat et al., 2004]. Additional information about the inhalation exposure events and the subsequent symptoms would be necessary to classify these ECRHS participants as having RADS or RUDS. The inclusion of the occupational category of each of the respondents provides valuable preliminary information about occupations that may be associated with higher risk of such inhalation exposures. Although specific information about the work-relatedness of the exposure would enable us to more clearly assess the frequency of inhalation incidents among workers in various types of jobs, the available data suggest that such incidents are more common among workers in manual occupations, such as cleaning, construction, and metalworking, than among those in non-manual and administrative fields or among students, retirees, and unemployed persons. Finally, the small number of participants who reported inhalation incidents during the ECRHS follow-up period and with any of the respiratory outcomes examined prohibits extensive analysis of interaction by atopic status. In these data, atopic status clearly emerges as a confounder of the associations between inhalation incidents and new-onset symptoms, but whether the associations vary by atopic status remains unclear. For example, assessing the risk of new-onset BHR separately among respondents with and without atopy does not provide evidence that the association varies by atopic status (atopic population: RR =0.52, 95% CI: 0.14, 1.88 vs. non-atopic population: RR =0.36, 95% CI: 0.09, 1.48; data not shown). Assessing the risk of new-onset of current wheeze (the only other respiratory outcome for which both strata-specific models converged) resulted in similarly ambiguous differences (atopic population: RR =1.84, 95% CI: 0.73, 4.66 vs. non-atopic population: RR =1.05, 95% CI: 0.48, 2.30; data not shown). Additional information about the exposures, including specific questions about the timing, location, duration, and work-relatedness of the incident, would provide further information with which to describe inhalation incidents, assess the extent to which specific exposure scenarios trigger or exacerbate respiratory symptoms, and examine whether the effects of inhalation incidents may be more prominent among individuals with or without atopy.

Our data also provide sufficient evidence to suggest that survey-based assessment of symptoms following inhalation incidents should be interpreted with caution. More specific information about the exposures, including whether any ventilation or personal protection equipment was in use and the type of agents involved, would provide further information with which to assess the respiratory health risks of sudden and unexpected inhalation exposures in the multitude of settings in which they occur.

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TABLE I
 Characteristics of the Total Study Population and Respondents Who Reported Experiencing an Inhalation Incident During the ECRHS Follow-Up Period

	Total population (n =3,763)	No. (%) with inhalation incidents (n = 220, 5.8%)
Age at ECRHS I (years)		
Mean (SD)	34.2 (7.1)	33.7 (7.3)
Median	34.5	33.2
Minimum–maximum	20.1–48.1	20.7–47.5
Atopic status at ECRHS I		
No	2,662	162 (6.1%)
Yes	1,101	58 (5.3%)
Country		
France	636	74 (11.6%)
Germany	370	10 (2.7%)
Iceland	317	4 (1.3%)
Italy	246	9 (3.7%)
Norway	260	2 (0.8%)
Spain	715	56 (7.8%)
Sweden	666	21 (3.2%)
Switzerland	194	3 (1.5%)
United Kingdom	251	9 (3.6%)
United States	108	32 (29.6%)
Sex		
Female	1,737	88 (5.1%)
Male	2,026	132 (6.5%)
Smoking status at ECRHS II		
Current smoker	1,271	80 (6.3%)
Ex-smoker	1,142	69 (6.0%)
Lifetime non-smoker	1,643	87 (5.3%)

TABLE II
Respiratory Outcomes at ECRHS I and Self-Reported Inhalation Incident
During The ECRHS Follow-Up Period Among 3,763 ECRHS II Participants

Respiratory outcomes at ECRHS I	Total population	Respondents with inhalation incidents	RR (95% CI) ^a
	No.	No. (%)	
Bronchial hyperresponsiveness			
No	3,380	191 (5.7%)	1.00
Yes	383	29 (7.6%)	1.18 (0.81,1.73)
Chronic cough			
No	3,510	191 (5.4%)	1.00
Yes	253	29 (11.5%)	1.78 (1.22, 2.61)
Chronic phlegm			
No	3,553	202 (5.7%)	1.00
Yes	210	18 (8.6%)	1.25 (0.79,1.99)
Current asthma			
No	3,527	202 (5.7%)	1.00
Yes	236	18 (7.6%)	1.25 (0.78, 2.00)
Current wheeze			
No	3,384	186 (5.5%)	1.00
Yes	379	34 (9.0%)	1.64 (1.15, 2.33)
No. of respiratory outcomes listed above at ECRHS I			
0	2,809	139 (4.9%)	1.00
1	612	48 (7.8%)	1.46 (1.04, 2.04)
2+	342	33 (9.6%)	1.77 (1.20, 2.61)

^a Adjusted for age, atopy, country, sex, and smoking status.

TABLE III

New-Onset Asthma-Related Symptoms Among 2,809 ECRHS II Participants Who Were Free of BHR, Chronic Cough, Chronic Phlegm, Current Asthma and Current Wheeze at the Time of the Baseline ECRHS I Survey

Symptom reported at ECRHS II	No inhalation incident	Inhalation incident	RR (95% CI) ^{a,b}
	No. (%)	No. (%)	
Bronchial hyperresponsiveness	164 (6.1%)	4 (2.9%)	0.43 (0.16, 1.14)
Chronic cough	96 (3.6%)	11 (7.9%)	1.45 (0.78, 2.68)
Chronic phlegm	84 (3.1%)	6 (4.3%)	1.21 (0.51, 2.89)
Current asthma	100 (3.7%)	10 (7.2%)	1.77 (0.95, 3.33)
Current wheeze	143 (5.4%)	11 (7.9%)	1.33 (0.74, 2.38)

^aNo inhalation incident =referent category.

^bAdjusted for age, atopy, country, sex, and smoking status.

TABLE IV

Employment Status and Occupational Category of the Longest Held Job Among All Participants and Among Those Who Reported Ever Being Occupational Exposed to Vapors, Gas, Dust or Fumes

Employment characteristics	Total study population		Population ever exposed to vapors, gas, dust or fumes	
	No.	No. (%) with inhalation incidents	No.	No. (%) with inhalation incidents ^a
Total	3,763	220 (5.8%)	1,600	134 (8.4%)
Employment status at ECRHS I				
Employed, as a manager	254	19 (7.5%)	94	10 (10.6%)
Employed, as a supervisor/foreman	521	37 (7.1%)	203	21 (10.3%)
Employed, other employee	2,191	120 (5.5%)	997	83 (8.3%)
Self-employed	438	24 (5.5%)	192	14 (7.3%)
Not employed ^b	359	20 (5.6%)	114	6 (5.3%)
Occupational category during ECRHS follow-up ^c				
Professional, non-manual occupations				
Legislators, managers, administrators, clerks	2,406	112 (4.7%)	804	54 (6.7%)
Professional, manual occupations				
Cleaning and building care	120	11 (9.2%)	57	7 (12.3%)
Construction, mining and mineral plant operators	98	10 (10.2%)	89	9 (10.1%)
Medical and pharmacy, excluding nursing	151	10 (6.6%)	51	5 (9.8%)
Metal work, including metal making and treating	151	11 (7.3%)	128	11 (8.6%)
Nursing	121	10 (8.3%)	30	1 (3.3%)
Transport and storage, including driving	118	9 (7.6%)	81	8 (9.9%)
Other manual occupations ^d	427	36 (8.4%)	309	31 (10.0%)
Homemakers	84	4 (4.8%)	18	2 (11.1%)
Other/unclassified/missing occupational category ^e	112	8 (7.1%)	46	7 (15.2%)

^a36/3763 respondents, including 1 who reported an inhalation incident, had missing responses to the ECRHS I survey question about exposure to vapors, gas, dust or fumes.

^bIncluding respondents in the following employment categories: full-time students, homemakers, unemployed/looking for work, unemployed/not looking for work, retired.

^cParticipants who held more than one job of equal and longest duration for which the jobs were classified in distinct occupational categories are included in two occupational categories. As a consequence, the sums of the participants in the occupational categories are greater than the total study population and the population ever exposed to vapors, gas, dust or fumes.

^dIncluding agricultural and forestry, chemical and physical science technical work, chemical processing, electrical processing, food processing and related trades, glass and ceramics work, hairdressers and related occupations, painting and spray painting, paper, plastics and rubber work, printing, textile and related trades, welding, woodworking and other manual work.

^eIncluding students, unemployed and retired persons.